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Report No: PAD5362

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
PROGRAM APPRAISAL DOCUMENT

ON A

PROPOSED LOAN

IN THE AMOUNT OF EUR 234.7 MILLION
(US\$255 MILLION EQUIVALENT)

TO THE

THE PEOPLE'S REPUBLIC OF CHINA

FOR A

METHANE-REDUCING AND WATER-SAVING PADDY RICE PROGRAM FOR RESULTS (HUNAN)

(P178796)

May 10, 2023

Water Global Practice
East Asia and Pacific Region

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CURRENCY EQUIVALENTS

(Exchange Rate Effective March 31, 2023)

Currency Unit = Chinese Yuan (CNY)

CNY 1 = US\$0.15

CNY 1 = EUR 0.13

US\$1 = CNY6.87

US\$1 = EUR 0.92

EUR 1 = US\$1.09

EUR 1 = CNY 7.49

FISCAL YEAR

July 1 – June 30

ABBREVIATIONS AND ACRONYMS

ACR	American Carbon Registry
AM	Accountability Mechanism
AWD	Alternate Wetting and Drying
CAR	Climate Action Reserve
CARB	California Air Resources Board
CBA	Cost-Benefit Analysis
CCDR	Country Climate and Development Report
CCER	China Certified Emission Reduction
CDM	Clean Development Mechanism
COP26	The 26th United Nations Climate Change Conference of the Parties
CPCG	County Program Coordination Group
CPF	Country Partnership Framework
CPMO	County Program Management Office
DARA	Department of Agriculture and Rural Affairs
DLI	Disbursement-Linked Indicator
DLR	Disbursement-Linked Result
DNDC	Denitrification Denitrification-Decomposition
DRC	Development and Reform Commission
EFA	Expenditure Framework Assessment
ERR	Economic Rate of Return
E&S	Environmental and Social
EIA	Environmental Impact Assessment
ESSA	Environmental and Social Systems Assessment
FM	Financial Management
FSA	Fiduciary Systems Assessment



FYP	Five-Year Plan
GARR (Hubei and Hunan)	China Green Agricultural and Rural Revitalization Program for Results (Hubei and Hunan)
GCRF	Global Crisis Response Framework
GDP	Gross Domestic Product
GPBR	General Public Budget Revenue
GPG	Global Public Good
GPL	Government Procurement Law
GHG	Greenhouse Gas
GRS	Grievance Redress Service
GWP	Global Warming Potential
HLG	Higher-Level Government
HSFCP	High-Standard Farmland Construction Plan
ICR	Implementation Completion and Results Report
IFMIS	Integrated Financial Management Information System
IPCC	Intergovernmental Panel on Climate Change
IPF	Investment Project Financing
JCM	Joint Crediting Mechanism
M&E	Monitoring and Evaluation
MEE	Ministry of Ecology and Environment
MIS	Management Information System
MOF	Ministry of Finance
MRV	Measurement, Reporting, and Verification
NDC	Nationally Determined Contribution
O&M	Operation and Maintenance
PAO	Provincial Audit Office
PAP	Program Action Plan
PCPB	Public Complaints and Proposals Bureau
DARA	Provincial Department of Agriculture and Rural Affairs
PDEE	Provincial Department of Ecology and Environment
PDO	Program Development Objective
PDOF	Provincial Department of Finance
PDRC	Provincial Department of Development and Reform Commission
PDWR	Provincial Department of Water Resources
PFM	Public Financial Management
PforR	Program for Results
PIP	Program Implementation Plan
PMO	Program Management Office
PPCG	Provincial Program Coordination Group
PPMO	Provincial Program Management Office
TBL	Tendering and Bidding Law
TOR	Terms of Reference



VCU	Verified Carbon Unit
WUA	Water User Association
1M5R	One Must Do, Five Reductions

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**DATASHEET****BASIC INFORMATION**

Country(ies)	Project Name	
China	Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)	
Project ID	Financing Instrument	Does this operation have an IPF component?
P178796	Program-for-Results Financing	No

Financing & Implementation Modalities

<input type="checkbox"/> Multiphase Programmatic Approach (MPA)	<input type="checkbox"/> Fragile State(s)
<input type="checkbox"/> Contingent Emergency Response Component (CERC)	<input type="checkbox"/> Fragile within a non-fragile Country
<input type="checkbox"/> Small State(s)	<input type="checkbox"/> Conflict
<input type="checkbox"/> Alternate Procurement Arrangements (APA)	<input type="checkbox"/> Responding to Natural or Man-made Disaster
<input type="checkbox"/> Hands-on Enhanced Implementation Support (HEIS)	
Expected Project Approval Date	Expected Closing Date
30-May-2023	31-Dec-2028

Bank/IFC Collaboration

No

Proposed Program Development Objective(s)

To reduce methane emissions and support climate resilient rice production in China's Hunan Province.

Organizations

Borrower :	The People's Republic of China
Implementing Agency :	Hunan Provincial Department of Agriculture and Rural Affairs
Contact:	Yanqing Ma



Title: Deputy Director General

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COST & FINANCING

SUMMARY

Government program Cost	1,243.00
Total Operation Cost	1,243.00
Total Program Cost	1,243.00
Total Financing	1,243.00
Financing Gap	0.00

Financing (USD Millions)

Counterpart Funding	988.00
Borrower/Recipient	988.00
International Bank for Reconstruction and Development (IBRD)	255.00

Expected Disbursements (USD Millions)

Fiscal Year	2023	2024	2025	2026	2027	2028	2029
Absolute	0.00	16.59	33.57	52.25	59.02	53.43	40.15
Cumulative	0.00	16.59	50.15	102.41	161.42	214.85	255.00

INSTITUTIONAL DATA

Practice Area (Lead)

Water

Contributing Practice Areas

Agriculture and Food



Climate Change and Disaster Screening

This operation has been screened for short and long-term climate change and disaster risks

SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category	Rating
1. Political and Governance	● Low
2. Macroeconomic	● Low
3. Sector Strategies and Policies	● Moderate
4. Technical Design of Project or Program	● Substantial
5. Institutional Capacity for Implementation and Sustainability	● Substantial
6. Fiduciary	● Substantial
7. Environment and Social	● Moderate
8. Stakeholders	● Moderate
9. Other	
10. Overall	● Substantial

COMPLIANCE

Policy

Does the program depart from the CPF in content or in other significant respects?

☐ Yes ☒ No

Does the program require any waivers of Bank policies?

☐ Yes ☒ No

Legal Operational Policies

	Triggered
Projects on International Waterways OP/BP 7.50	No
Projects in Disputed Areas OP/BP 7.60	No

Legal Covenants



Sections and Description

Program Institutions

Program Agreement (PA), Schedule, Section I.B.1: The Program Implementing Entity shall maintain, and cause to be maintained, the following entities, with composition, powers, functions, staffing, facilities and other resources acceptable to the Bank: (a) at provincial level: (i) a Provincial Program Coordination Group; (ii) a Provincial Program Management Office; and (iii) an expert panel, responsible for providing in-depth expert advice on the Program preparation and implementation at provincial and county levels; and (b) at county level: (i) a county program coordination group in each of the Demonstration Counties; and (ii) a county program management office in each of the Demonstration Counties.

Sections and Description

Program Action Plan

PA, Schedule, Section I.B.2: The Program Implementing Entity shall (a) undertake the actions set forth in the Program Action Plan; (b) not amend, revise or waive, nor allow to be amended, revised or waived, the provisions of the Program Action Plan, or any provision thereof, without the prior written agreement of the Bank; and (c) maintain policies and procedures adequate to enable it to monitor and evaluate, in accordance with guidelines acceptable to the Bank, the implementation of the Program Action Plan.

Sections and Description

Program Implementation Plan

PA, Schedule, Section I.B.3: The Program Implementing Entity shall apply, throughout the period of implementation of the Program, the Program Implementation Plan in a timely and efficient manner acceptable to the Bank. The Program Implementing Entity shall not amend, suspend, or waive said Program Implementation Plan or any provision or schedule thereof, without the prior written agreement of the Bank.

Sections and Description

Mid-term review

PA, Schedule, Section III.2: The Program Implementing Entity shall prepare, under terms of reference acceptable to the Bank, and furnish to the Borrower and the Bank no later than June 30, 2026, a consolidated mid-term review report for the Program summarizing the results of the monitoring and evaluation activities carried out from the inception of the Program, and setting out the measures recommended to ensure the efficient completion of the Program and to further the objectives thereof.

Sections and Description

Verification Agency

PA, Schedule, Section III.4: The Program Implementing Entity shall, not later than three (3) months after the Effective Date, hire, and thereafter maintain, throughout the period of Program implementation, verification agent(s) having experience and qualifications in the relevant technical fields, acceptable to the Bank, and under terms of reference, including a time-table and adequate budget for its activities, acceptable to the Bank, to monitor and verify the achievement of the DLRs.



Conditions

Type	Financing source	Description
Effectiveness	IBRD/IDA	Loan Agreement, Article V, Section 5.01: The Program Implementing Entity has adopted the Program Implementation Plan in form and substance acceptable to the Bank.



I. STRATEGIC CONTEXT

A. Country Context

1. **China is the largest rice producer and consumer in the world, with very high methane emissions and intensive water use.** China contributes to around 30 percent of global rice production,¹ with a total of 30 million hectare (ha)² of harvested area.³ Rice is the staple food for over 60 percent of the population in China.⁴ Once a net exporter of rice, China has been a net rice importer since 2011 and has emerged as the largest rice importer and a major exporter in the world. China exported 2.4 million tons of rice and imported 2.8 million tons of rice annually from 2019 to 2021. Raising yields on existing rice lands is critical for food security in China and globally.⁵ China is also the world's largest methane emitter,⁶ and rice production contributes significantly to the methane emissions in the country. Rice accounts for 40 percent of China's agricultural methane emissions and 16 percent of the country's total methane emissions.⁷ Domestic rice production relies heavily on irrigation. Over 90 percent of rice areas in China are irrigated, much higher than the global average. Fertilizer and pesticide use in rice production in China is excessive and inefficient, contributing to significant environmental and carbon footprints.⁸

2. **Rice is essential for global food security, yet it is the largest methane emitter and most water intensive among all crops.** Rice is one of the most important staple foods for more than half of the world's population,⁹ accounting for 21 percent of global caloric intake and 15 percent of protein.¹⁰ The aggregate world demand for rice grew faster than that of both wheat and coarse grains.¹¹ The world's demand for rice will continue to rise to feed the growing population and support global food security.¹² While rice

¹ Data extracted from FAOSTAT, based on the data of 2020. Global rice production was approximately 760 million tons in 2020, of which China accounted for 28 percent with around 214 million tons of rice produced. 214 million tons of rice production are equivalent to 142 million tons of rice milled.

² Data extracted from FAOSTAT, based on the data of 2020.

³ Rice is a short season crop that can be planted two to three times per year in the same plot. Hence, harvested area is used here to distinguish from the rice land areas.

⁴ Peisong, Hu, and Seng Zhonghua. 2021. *The History and Future of Rice Production*. Ministry of Agriculture and Rural Affairs. (link)

⁵ Deng, N., P. Grassini, H. Yang, J. Huang, K. Cassman, S. Peng. 2019. "Closing Yield Gaps for Rice Self-Sufficiency in China." *Nature Communication* 10, 1725. (link)

⁶ Kirschke, S., Bousquet, P., Ciais, P. 2013. "Three Decades of Global Methane Sources and Sinks." *Nature Geoscience* 6: 813–823. (link)

⁷ The People's Republic of China. *Second Biennial Update Report on Climate Change*. (link)

⁸ To ensure the country's food security, China developed intensive crop production systems and consistently applied new, more productive infrastructure, production technologies, and rice varieties. At the same time, China relied on excessive and inefficient use of fertilizers, pesticides, and irrigation water inputs. These technologies were rigorously applied by farmers, leading to high rice yields almost every year. As a result, China's average yield is around 6.5 tons per ha, which is among the highest in Asia (International Rice Research Institute, IRRI). According to the IRRI, 49 super rice varieties have been released in China since 1999, with yield increases to as much as 12 tons per ha. China is also the largest adopter of hybrid rice.

⁹ IRRI (International Rice Research Institute). 2019. *Feeding the World while Caring for the Planet*. (link)

¹⁰ Sekhar, C. S. C. 2018. *Climate Change and Rice Economy in Asia: Implication for Trade Policy*. Rome, FAO. 62 pp. Licence: CC BY-NC-SA 3.0 IGO.

¹¹ This reflects essentially the fact that rice is used predominantly for food in the most populous region, while a good part of coarse grains, and increasingly of wheat, are used for animal feed. FAO. *World Agriculture: Towards 2015/2030*. An FAO perspective. (link)

¹² It was predicted that the world demand for rice (milled) would increase from 472 million tons in 2015 to 533 million tons in 2030. FAO. *World Agriculture: Towards 2015/2030*. An FAO perspective. (link)



accounts for around one-fifth of global caloric intake, it contributes to 48 percent of total crop greenhouse gas (GHG) emissions¹³ and around 2.5 percent of global anthropogenic emissions. In particular, rice is one of the principal anthropogenic sources of methane (CH₄), following the methane emissions from fossil fuels, livestock, and wastes.¹⁴ It was estimated that the methane emissions from rice globally were 31 teragrams of methane per year (Tg CH₄/year) in 2008–2017, accounting for about 9 percent of global anthropogenic methane emissions.¹⁵ Rice is also a ‘thirsty crop’, accounting for the largest irrigated area globally. Over 60 percent of the global rice growing areas are irrigated¹⁶ and use around 30 percent of global freshwater withdrawals. Although majority of rice areas are in humid and sub-humid regions,¹⁷ there are looming water shortages in most major rice growing regions, with water scarcity already affecting about one-third of the rice growing areas globally.

3. 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.¹⁸ Methane is a much more powerful GHG than carbon dioxide (CO₂), however, it is also short-lived.¹⁹ In the first 20 years after its release, methane is around 80 times more powerful than CO₂ in global warming potential (GWP).²⁰ But it also breaks down much more quickly than CO₂. 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 26th United Nations Climate Change Conference of the Parties (COP26) Global Methane Pledge highlighted that rapidly reducing methane emissions is regarded as the single most effective strategy for keeping the goal of limiting warming to an additional 1.5 degree centigrade within reach; this strategy will also yield co-benefits of improving public health and agricultural productivity.²¹ In November 2021, China and the United States signed the US-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s,²² which underscores actions required to enhance methane measurement and mitigation, as well as incentives and programs to reduce methane from the agriculture sector. COP27 reiterated the importance of reducing methane emissions, including reducing methane from rice cultivation. At COP27, China announced it had drafted a methane reduction plan, including reducing methane emissions from the agricultural sector.

¹³ Carlson, K., J. Gerber, N. Mueller, et al. 2017. “Greenhouse Gas Emissions Intensity of Global Croplands.” *Nature Climate Change* 7: 63–68. (link)

¹⁴ The principal sources of anthropogenic methane emissions are from agriculture and waste management, fossil fuels, and biomass burning and biofuels. Fossil fuels contributed around 115 Tg CH₄/year from 2008–2017, including the methane emissions from coal, oil and gas, transport, and industry. In the agriculture and waste sectors, livestock production has the largest emissions source (109 Tg CH₄/year in 2008–2017), dominated by about 90 percent of enteric fermentation. Landfills and wastes contribute to 64 Tg CH₄/year in 2008–2017. *Intergovernmental Panel on Climate Change (IPCC). 2021. Sixth Assessment Report. Chapter 5.* (link).

¹⁵ IPCC. 2021. *Sixth Assessment Report. Chapter 5.* (link)

¹⁶ Portmann, F. T., S. Siebert, and P. Döll. 2010. “MIRCA2000 - Global Monthly Irrigated and Rainfed Crop Area around the Year 2000: a New High-Resolution Data Set for Agricultural and Hydrological Modeling.” *Global Biogeochemical Cycles* Vol. 24, GB1011. (link)

¹⁷ Siebert, S., M. Kummu, M. Porkka, P. Döll, N. Ramankutty, and B. R. Scanlon. 2015. “A Global Data Set of the Extent of Irrigated Land from 1900 to 2005.” *Hydrology and Earth System Science* 19: 1521–1545. (link)

¹⁸ Global Methane Pledge (link).

¹⁹ IPCC. 2021. *Sixth Assessment Report. Chapter 5.* (link).

²⁰ “Control Methane to Slow Global Warming - Fast.” *Nature* 596: 461 (2021) (link).

²¹ Global Methane Pledge (link).

²² U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s (link).



4. **Rice production in China is also vulnerable to climate change.** The major rice producing regions in China are increasingly affected by floods and droughts. The Yangtze River Basin, the region with the largest rice areas in China, experienced record-breaking floods in 2020 and severe droughts in 2022.²³ Projections for the Yangtze River Basin indicate a hotter future, with more variable rainfall and more frequent floods and droughts.²⁴ Climate change has negative impacts on rice, such as shortening the growth period, decreasing yields, increasing pests and diseases, causing uneven quality, and increasing production costs. The growth period and yields of double-cropping rice will decrease with climate change impacts in the middle reaches of the Yangtze River. The increase in temperature also accelerates the decomposition nutrients, such as chemical fertilizer and soil organic matters, which lead to rapid release of available nitrogen, reduction of fertilizer utilization efficiency, and decline in soil fertility. Climate warming in winter can also accelerate rice pests. Enhancing climate resilience of rice production in China is considered a key priority to enhance food security.

5. **The Government of China has embarked on a path of green agriculture development that focuses on promoting sustainable and resilient production and lowering GHG emissions.** 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.²⁵ Following the country's decision on carbon peaking before 2030 and carbon neutrality before 2060, the Government formally launched the China Green Agriculture Development Strategy²⁶ 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 Sector²⁷ in May 2022, which includes the following 10 focus areas: rice paddy methane emission reduction, fertilizer reduction and use efficiency improvement, livestock GHG reduction, aquaculture GHG emission reduction, agricultural machinery energy saving, farmland carbon sequestration, integrated straw management, renewable energy development and utilization, research and development enhancement, and improvement of monitoring and verification. Among all these focus areas, the Government considered rice paddy methane emission reduction a top priority. These policies have paved the way to low-methane rice production in China. However, such high-level guidance has yet to be fully translated into specific measures and actions to promote and scale up low-methane and water-saving rice production.

B. Sectoral (or Multi-Sectoral) and Institutional Context

6. **Water-saving technologies provide a win-win solution to significantly reduce methane emissions and water use in rice production.** Methane is emitted from rice fields due to organic matter decomposition under anaerobic soil conditions when soil is submerged under water. The water blocks oxygen from penetrating the soil, creating the anaerobic conditions favorable for methane-producing bacteria. The longer the rice field is flooded, the more methane-producing bacteria will grow, and the

²³ Siyi, Huo. 2022. "News-The Entire Yangtze River Basin Suffered the Worst Drought in 61 Years." (link)

²⁴ CWR. 2016. *Yangtze Water Risks, Hotspots, and Growth*. China Water Risk, Hong Kong SAR, China (link).

²⁵ *Statistical Bulletin of the People's Republic of China on National Economic and Social Development in 2021*. (link)

²⁶ Ministry of Agriculture and Rural Affairs, National Development and Reform Commission, Ministry of Science and Technology, Ministry of Natural Resources, Ministry of Ecology and Environment, State Forestry and Grassland Administration, 2021. *China Green Agriculture Development Strategy (14th Five-Year Plan)* (link).

²⁷ Ministry of Agriculture and Rural Affairs, National Development and Reform Commission. 2022. *Implementation Plan for Emission Reduction and Carbon Sequestration in the Agricultural Sector* (link).



more methane will be generated. Therefore, one of the most promising approaches for reducing rice methane emission is to reduce or interrupt the periods of flooding.²⁸ Water-saving technologies, such as alternate wetting and drying (AWD), can reduce methane emissions up to 50 percent and water use by 30 percent without reducing rice yields.²⁹ With AWD, the rice field gets alternately flooded and drained, which reduces submergence, leading to a significant reduction of methane emissions and water use. Other practices, such as intermittent irrigation, mid-season drainage, and dry direct seeding, can also reduce the period of flooding and reduce methane emissions. Water-saving technologies also reduce surface runoff and percolation, which can further lower non-point source pollution to surface water and groundwater.

7. Co-management of water, straw, and fertilizer provides an integrated package solution to effectively reduce rice methane emissions, making best use of the synergies and interactions among various affecting factors. The package solution considers the offsets between methane and nitrous oxide (N₂O) emissions under AWD.³⁰ AWD can significantly reduce methane emissions; it however may increase nitrous oxide emissions, as the recurring shift between aerobic and anaerobic conditions favors bacterial conversion of nitrogen compounds to nitrous oxide. Increase in nitrogen fertilizer utilization efficiency can reduce fertilizer use and the related nitrous oxide emissions. Better fertilizer application approach, such as deep fertilizer application, can also slow down the emissions of nitrous oxide. Thus, co-management of water and fertilizer application can reduce methane emissions while ensuring that the nitrous oxide emissions remain low.³¹ These benefits extend to the reduction of non-point source pollution from rice cultivation. The package solution also considers the impacts of straw returning on methane emissions. Returning straws to soil can improve soil fertility and increase soil carbon sequestration. However, the decomposition of fresh crop straws under anaerobic soil conditions can also increase methane emissions. Combining AWD with proper straw returning enables the aerobic decomposition of straw residues, which will significantly lower methane emissions.³² Thus, the co-management of water and straw is critical. In addition, off-farm straw utilization, optimal rice varietal selection, and improved machinery management

²⁸ World Resources Institute. Searchinger, T., and T. Adhya., et al. 2014. *Wetting and Drying: Reducing Greenhouse Gas Emissions and Saving Water from Rice Production*. (link)

²⁹ Richards, M., B. O. Sander. 2014. "Alternate Wetting and Drying in Irrigated Rice." Climate-Smart Agriculture Practice Brief. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). (link).

Jiang, Y., D. Carrijo, S. Huang, J. Chen, N. Balaine, W. Zhang, K. van Groenigen, B. Linquist. 2019. Water Management to Mitigate the Global Warming Potential of Rice Systems: A Global Meta-analysis. *Field Crops Research* (link).

³⁰ It was estimated that, under AWD, 15–20 percent of the benefit gained by decreasing methane emission is offset by the increase in nitrous oxide emissions. However, the net GWP is still significantly lower under AWD than in continuously flooded fields due to the substantial reduction of methane emissions under AWD. Richards, M., B. O. Sander. 2014. "Alternate Wetting and Drying in Irrigated Rice." Climate-Smart Agriculture Practice Brief. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). (link); Yu Jiang, Daniela Carrijo, Shan Huang, et al. 2019. "Water Management to Mitigate the Global Warming Potential of Rice Systems: A Global Meta-Analysis." *Field Crops Research* 234: 47–54. ISSN 0378-4290 (link)

³¹ Balaine, N., D. R. Carrijo, M. A. Adviento-Borbe, and B. Linquist. 2019. "Greenhouse Gases from Irrigated Rice Systems under Varying Severity of Alternate-Wetting and Drying Irrigation." *Soil Science Society of America Journal*, 83: 1533–1541. (link)

³² Hang, X., et al. 2014. "Differences in Rice Yield and CH₄ and N₂O Emissions among Mechanical Planting Methods with Straw Incorporation in Jianghuai Area, China." *Soil and Tillage Research* 144: 205–210.

Linquist, B. A., M. M. Anders, M. A. A. Adviento-Borbe, R. L. Chaney, L. L. Nalley, E. F.F. da Rosa, C. van Kessel. 2015. "Reducing Greenhouse Gas Emissions, Water Use, and Grain Arsenic Levels in Rice Systems." *Global Change Biology* 21: 407–417. (link)



can further contribute to the reduction of rice GHG emissions.³³ Post-harvest systems, including processing, waste disposal, and transportation, account for a small portion of rice GHG emissions through the rice value chains in China.³⁴ Thus, the proposed Program-for-Results (PforR) mainly focuses on the reduction of rice methane emissions during rice production.

8. The Government faces challenges in creating the enabling environment for promoting low-methane rice.

- (a) **Guiding documents, regulations, and technical standards.** The Government lists the reduction of rice methane emissions as a high priority. However, it has yet to be translated into widespread adoption of actions. Specific guiding documents, regulations, and technical standards to promote and guide the implementation of climate mitigation measures for rice production are not yet developed.
- (b) **Data constraints.** The Government faces information challenges to better measure, report, and verify rice methane emissions. The Global Methane Pledge recognizes that the improvements to the transparency, accuracy, completeness, comparability, and consistency of methane emissions data assessed and validated can promote more ambitious and credible actions.³⁵ China also highlighted at COP27 that a lack of reliable baseline data on methane emissions hampered the implementation of its methane reduction plan. Thus, developing a measurement, reporting, and verification (MRV) system is crucial to track GHG emission reduction from rice fields and support carbon trading.
- (c) **Coordination between agriculture and water sectors.** The agriculture and water sectors lack adequate coordination, while they both manage irrigation- and drainage-related infrastructure development and operation and maintenance (O&M) in China. The agriculture sector is responsible for development and O&M of on-farm irrigation and drainage systems and small water storage systems. The water sector is responsible for development and O&M of the high-level irrigation systems such as headworks and primary and secondary canals. Strong coordination between the agriculture and water sectors is needed to ensure good performance and sustainability of irrigation and drainage services.

³³ In the major rice production regions of south China, methane emissions account for around 65–75 percent of the total rice GHG emissions. Fertilizer application accounts for 5–10 percent of total emissions, straw burning contributes to 5–20 percent of emissions, and agricultural machinery is responsible for 5–10 percent of emissions. Thus, besides the water-saving technologies for methane emission reduction, other agricultural solutions are also critical to further reduce rice GHG emission. Zhang, D., J. Shen, F. Zhang, et al. 2017. “Carbon Footprint of Grain Production in China.” *Scientific Reports* 7: 4126. (link) The results were based on the life cycle analysis of carbon emissions per unit yield (kgce/kg).

³⁴ Zhen, Huayang, Xu Feng, Muhammad Ahmed Waqas, et al. 2023. “Solutions to Neutralize Greenhouse Gas Emissions of the Rice Value Chain - A Case Study in China.” *Sustainable Production and Consumption* 35: 444–452. ISSN 2352-5509 (link).

³⁵ Global Methane Pledge. (link)



9. **Farmers also face challenges in adopting the package of climate mitigation solutions, especially water-saving technologies.** Although China has been promoting water-saving technologies for rice production for several decades (see box 2),³⁶ farmers are still facing challenges to adopt these practices.

- (a) **System constraints.** Adopting water-saving technologies, such as AWD, requires well-performing and properly maintained infrastructure, as it requires the system to irrigate and drain the right amount of water at the right time. Reliable irrigation and drainage services are also crucial as farmers will not be willing to drain their fields unless they know irrigation water will be delivered on time. Well-leveled farmlands are also needed to avoid irregular drying and wetting. O&M of the infrastructure system with a reliable financing mechanism are key for the sustainability of irrigation and drainage services.
- (b) **Limited incentives.** Farmers lack incentives to reduce methane emissions and save water. Irrigation service is free in some regions of China or is charged based on farmland area rather than the volume of water used. Farmers may incur extra labor costs to implement multiple wetting and drying. Drying the rice fields could increase weed growth, which may lead to additional costs for weed control. Although adopting water-saving technologies can generate positive externalities for reducing methane emissions, water use, and pollution; these externalities are usually not valued and materialized to create incentives for farmers.
- (c) **Lack of capacity.** Farmers lack capacity to adopt low-methane and water-saving practices. Without proper training and adequate extension support services, farmers will continue the traditional flood irrigation and fertilizer use practices that they are familiar with. Strong collective actions among farmers are also required, as one farmer cannot properly drain a field if the neighbors are flooding theirs.

10. **The Government's High-Standard Farmland Construction Plan (HSFCP, 2021–2030) lays a solid foundation for low-methane and water-saving rice production.** Over the past five years, the Government has increasingly emphasized food security and highlighted the urgent need for developing national high-standard farmlands. The national HSFCP was issued in September 2021³⁷ and was followed by the development of provincial HSFCP for each province. The national HSFCP sets ambitious goals to develop 72 million ha (1.075 billion mu) of high-standard farmlands³⁸ by 2025 and 80 million ha (1.2 billion mu) by 2030, leveraging international cooperation and the use of international loans to support these goals. The HSFCP places food security as the top priority and 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, ensuring well-performing irrigation and drainage facilities is a key task of the HSFCP for reliable irrigation and drainage under changing climate. This is well aligned with the system

³⁶ Dong, B., Z. Mao, Y. Cui, Y. Luo, and Y. Li. 2020. "Controlled Irrigation for Paddy Rice in China." *Irrigation and Drainage* 69 (S2): 61–74. (link)

³⁷ National High-Standard Farmland Construction Plan (HSFCP, 2021–2030) (link).

³⁸ The national standards on "high standard farmland" are articulated in GB/T30600—2022 (link). "High standard farmlands" are the upgraded farmlands which are suitable for modern agricultural production and can ensure stable and high productivity even under floods and droughts. These farmlands should be flat and well-leveled, have water-saving facilities to support high-efficiency water use, have improved electrical facilities and enhanced soil fertility, be suitable for machinery operation, be eco-friendly, and have strong resilience to disasters. The GB/T30600—2022 also articulated specific technical standards and the Ministry of Agriculture and Rural Affairs issued the detailed methodology on the completion and acceptance of the high-standard farmland construction in 2021 (link). They are the key documents to measure and evaluate the high-standard farmland development.



requirements of adopting water-saving technologies such as AWD. The HSFCP also emphasizes the improvement of soil fertility for yield enhancement through returning straw to soil, organic fertilizer application, and green manure use, which are also important parts of the rice production climate mitigation strategies. Incorporating and enhancing climate mitigation actions in the HSFCP can leverage this ambitious Government program to further reduce GHG emissions, particularly methane emissions from rice production.

11. **These recent policy reforms in China create opportunities to generate incentives for low-methane and water-saving rice production.** The country is now widely promoting eco-compensation mechanisms to reward positive (or to reduce negative) environmental externalities.³⁹ Market-based eco-compensation mechanisms, such as the carbon market, water rights trading, and pollution emission trading, are also being piloted and can be leveraged to promote low-methane rice transformation. In addition, in 2016, China launched the Comprehensive Agricultural Water Pricing Reform program.⁴⁰ This Program was incorporated in the national HSFCP to enhance the sustainability of irrigation systems O&M. It lays the foundation for incentivizing water savings through tariff reform, including establishing an irrigation water rights system, establishing a 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).

12. **Hunan Province, the province with the largest rice-producing area in China, has great potential to lead the way in low-methane and water-saving rice production.** Hunan has 4.2 million ha of rice harvested areas,⁴¹ which is nearly the same as the 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- or double-cropping rice. Most of the rice areas in Hunan rely on surface water for irrigation. Hunan produces 13 percent of China's total rice production in a water-intensive manner. Hunan started promoting rice water-saving technologies in the 1990s, yet many farmers are still practicing continuous flood irrigation, especially on the farmlands where drainage facilities are lacking or deteriorated. Therefore, Hunan has become a global hotspot for rice methane emissions according to the space observation data from the Sentinel-5P satellite.⁴² Hunan Province committed itself in the provincial HSFCP (2021–2030) to establish high-standard farmlands in 85 percent of its farmlands by 2030, which are mainly for rice production. Embedding and scaling up low-methane and water-saving rice practices through this ambitious provincial program are expected to significantly reduce rice methane emissions and save water.

13. **Hunan Province is highly committed to climate adaptation and mitigation in the agricultural sector.** Rice production in Hunan is highly vulnerable to climate change given the province's significant

³⁹ World Bank. 2022. *Ecological Compensation in China: Trends and Opportunities for Incentive-Based Policies towards a Greener China* (link).

⁴⁰ State Council. 2016. *Opinions on Promoting Agricultural Water Tariff Comprehensive Reform* (link).

⁴¹ China Statistical Yearbook 2018. (link)

⁴² World Bank researchers developed a new database and open data service for tracking methane emissions (link). It uses information from the European Space Agency's Sentinel-5P satellite platform, which provides reliable information on global methane emissions. The methane emission data from rice fields were analyzed. Dasgupta, Susmita, V. Somil Lall, and David Wheeler. 2022. *Tracking Methane Emissions by Satellite: A New World Bank Database and Case Study for Irrigated Rice Production*. Washington, DC: World Bank Group. (link)



exposure to floods and droughts.⁴³ In 2020, around 7 million residents and over 95 percent of the counties in Hunan suffered from the largest flood since 1998.⁴⁴ In 2022, Hunan was heavily hit by its most severe drought since 1961. One-third of the meteorological stations in Hunan did not observe any effective rainfall for over 50 days and over 900 km of rivers were completely dry.⁴⁵ Enhancing climate resilience is a priority in the Hunan HSFCP, reflecting the significant impact of frequent floods and droughts on rice production. Furthermore, following China's carbon peaking commitment, Hunan Province issued the implementation plan for Hunan carbon peaking,⁴⁶ which included promoting agricultural climate mitigation measures, enhancing agricultural GHG accounting and monitoring, and exploring carbon trading. In 2022, Hunan also issued an implementation plan for emission reduction and carbon sequestration in its agricultural and rural sectors.⁴⁷ Rice methane emission represented the largest agricultural GHG emission in Hunan, accounting for 51 percent of total agricultural GHG emissions.⁴⁸ Thus, rice methane emission reduction was considered the top priority in the Government's agricultural climate mitigation plan.

C. Relationship to the CPS/CPF and Rationale for Use of Instrument

14. **The proposed Program will contribute significantly to global public goods (GPGs) and is well aligned with the World Bank Group's Country Partnership Framework for China (CPF, FY2020–2025, Report No. 11785-CN), which was discussed by the World Bank Board of Executive Directors on December 5, 2019.⁴⁹ The PforR will contribute to GPGs through reducing methane emissions, promoting knowledge sharing, and supporting food security (box 1). The proposed Program is directly linked to Engagement Area 2 of the CPF, Promoting Greener Growth, which includes support to government in (a) reducing air, soil, water, and marine plastics pollution; (b) demonstrating sustainable agricultural practices and improving food system quality and safety; and (c) strengthening sustainable natural resource management. The Program will enhance resilience and reduce methane emissions from rice production, which is also well aligned with the climate adaptation and mitigation goals of the Paris Agreement.**

⁴³ Yin, X., M. Huang, and Y. Zou. 2018. "Changes in Rice Yield Stability in Southern China from 1949 to 2015." *Agricultural & Environmental Letters* 3: 170038. (link)

Wang, Z., P. Shi, Z. Zhang, et al. 2018. "Separating out the Influence of Climatic Trend, Fluctuations, and Extreme Events on Crop Yield: A Case Study in Hunan Province, China." *Climate Dynamics* 51: 4469–4487. (link)

⁴⁴ News--6.86 million people and 117 counties and municipalities in Hunan are affected by the floods this year. (link)

⁴⁵ News--97 of Hunan's 122 counties and municipalities are experiencing extreme drought. (link)

⁴⁶ People's Government of Hunan Province, Implementation Plan for Carbon Peaking in Hunan Province. (link)

⁴⁷ Implementation Plan for Agricultural and Rural Sector Carbon Emission Reduction and Sequestration in Hunan Province. (link)

⁴⁸ 2020 Hunan provincial GHG emission inventory. Data from Hunan Provincial Department of Ecology and Environment.

⁴⁹ World Bank Group. 2021. *China - Country Partnership Framework for the Period FY2020–2025* (Report No. 117875-CN). Washington, DC: World Bank Group. (link)



Box 1. Contribution to GPGs

The Program contributes to three primary GPGs: reducing methane emissions, promoting global knowledge for development, and enhancing food security.

Climate change mitigation. The Program is expected to significantly reduce GHG emissions, especially methane emissions from rice production. The Program will promote water-saving techniques widely that can substantially reduce methane emissions and save water. A package of climate mitigation solutions of water-straw-fertilizer co-management will be applied to reduce overall rice GHG emissions; these solutions include optimized AWD, better co-management of water, straw returning and fertilizer regimes, improved fertilizer management, enhanced soil fertility and soil carbon sequestration, and optimal rice varietal selection. The Program is also expected to generate substantial climate co-benefits by implementing adaptation measures such as improving irrigation and drainage systems to provide irrigation during droughts and to reduce waterlogging during floods.

Global knowledge for development. The low-methane and water-saving practices applied in this Program will not only support Hunan Province in reducing rice methane emissions but also provide important lessons and examples for rice production in China and globally. The proposed PforR will support the Hunan provincial HSFCP under the overall national HSFCP. Since every province in China has a similar program under the HSFCP, the lessons from Hunan can be scaled up and applied in China through those provincial programs. Hunan is a humid region that still relies heavily on continuous flood irrigation, similar to the practice in many Asian countries. Therefore, these lessons are also relevant for other rice producing countries. This Program will also support the establishment of demonstration farms and knowledge exchange for training, showcasing good practices and disseminating information. The Program will develop and issue a provincial strategy and implementation plan to consolidate the experiences and lessons learned on low-methane rice production and lay out the plan for knowledge dissemination and scaling-up. The innovations and advancement in the MRV system expected to be established by June 2025, agricultural water pricing reform, and trading mechanisms will provide lessons to other countries to strengthen their information and institutional systems.

Food security. The Program will contribute to food security in China, which has significant implications for global food security. The climate adaptation measures will help farmers maintain or achieve higher yields during floods and droughts. The climate mitigation measures will consider the interactions among water, fertilizer, and straw management to co-manage these factors to reduce methane emissions and increase yields. The Program's lessons learned will be relevant for other rice producing countries to improve food security and contribute to the goals in the Nationally Determined Contribution (NDC). The actions supported by the Program that contribute to these GPG outcomes are described further in section II.

In addition, adopting water-saving techniques can significantly reduce water use, which can increase downstream water availability and enhance ecological flows for ecosystems. The climate mitigation measures of water-straw-fertilizer co-management in this Program will reduce non-point source pollution from rice production as well, which will help improve downstream water quality and sustain ecosystem services and biodiversity.

15. The Program will contribute to China's ambitious goal of carbon peaking and neutrality pledges.

It will contribute to China's NDC,⁵⁰ which underscores the importance of reducing emissions and improving efficiency in the agricultural sector and strengthening market-based mechanisms including carbon trading. The Program is also well aligned with China's implementation plan for emission reduction and carbon sequestration in the agricultural sector,⁵¹ which considers the reduction of rice methane emissions as the first key task. The Program is consistent with the climate mitigation actions

⁵⁰ China—NDC (Updated Submission) (link).

⁵¹ Ministry of Agriculture and Rural Affairs, National Development and Reform Commission. 2022. *Implementation Plan for Emission Reduction and Carbon Sequestration in Agricultural Sector* (link).



recommended in this implementation plan, including optimizing water management in rice fields, improving fertilizer management, and promoting resilient rice varieties.

16. **The proposed PforR is in line with the recommendations of the China Country Climate and Development Report (CCDR).**⁵² This Program is fully aligned with Policy Package 3 of the CCDR - Enhance climate resilience and low-carbon development in rural landscapes and urban areas. From the climate adaptation perspective, the CCDR emphasized that climate change will affect the country's agricultural production potential, and the changes in crop yields and the availability of arable lands will affect agricultural outputs. The PforR will support the development and protection of high-standard farmlands, improve rice yields, and implement climate adaptation measures to enhance the climate resilience of rice production. From the climate mitigation perspective, the CCDR highlighted the importance of reducing food system related GHG emissions. This Program focuses on the methane emission reduction from the rice sector, the largest GHG emitter among all crops. The comprehensive climate mitigation measures consisting of the water-straw-fertilizer co-management are expected to significantly reduce the GHG emissions, especially methane emissions from rice production. In addition, the CCDR highlighted that China's emission trading scheme provides an opportunity to leverage new sources of financing. Consistent with the CCDR recommendations, the Program will explore the trading schemes of carbon trading and water rights trading to generate incentives and financing to support water-saving and low-methane rice development.

17. **The Program is also consistent with the Global Crisis Response Framework (GCRF).** The Program responds to three key pillars of the GCRF—Pillar 1: Responding to Food Insecurity; Pillar 3: Strengthening Resilience; and Pillar 4 Strengthening Policies, Institutions and Investments for Rebuilding Better. Under Pillar 1, the Program design is consistent with the World Bank's Planned Actions for Global Food Crisis Response.⁵³ It will support producers through promoting more efficient use of water and fertilizer and better infrastructure services and soil improvement. It will also invest in sustainable food and nutrient security by strengthening the food system to make it more resilient to rising climate risks. Under Pillar 3, the Program aligns well with the World Bank Group's Green, Inclusive, and Resilient Development Framework and the Climate Change Action Plan (2021–2025). The Program will focus on climate mitigation and adaptation measures to reduce methane emissions from rice production while enhancing rice yields under climate change risks. Under Pillar 4, the Program will support institutional strengthening and capacity building required for promoting low-methane and water-saving rice production, which will improve the long-term development outcomes of food security and climate mitigation.

18. **The PforR instrument is the most appropriate instrument to promote and scale up low-methane and water-saving rice production in China.** The Government has an ambitious and solid program with strong commitment from the provincial and local governments and agencies. The PforR instrument will leverage ongoing activities and resources under the existing Hunan HSFCP, providing coverage beyond that possible under Investment Project Financing (IPF). It will use and strengthen the government systems to improve the efficiency and effectiveness of expenditures and focus on results in scaling up low-methane and water-saving practices. This Program will address the institutional gaps by improving regulations and technical standards, strengthening MRV, and enhancing coordination between agriculture and water sectors. The Program will also emphasize capacity building to help farmers master low-methane rice

⁵² World Bank. 2022. *China - Country Climate and Development Report*. Washington, DC: World Bank Group. (link)

⁵³ World Bank Announces Planned Actions for Global Food Crisis Response (link).



practices. The PforR instrument will provide the incentives for farmers to adopt climate mitigation measures. This Program is the first World Bank-supported PforR that explicitly addresses the challenges of low-methane and water-saving rice production. It is underpinned by a complementary Advisory Services and Analytics (ASA) product on greening the rice value chain in China.⁵⁴

19. **The Program design draws upon the domestic and international experiences and will generate replicable and scalable lessons for China and other rice growing countries.** The effectiveness of water-saving and low-methane rice production has been demonstrated in several World Bank-supported projects in China, Indonesia, and Vietnam. China also has been promoting water-saving technologies for rice production for several decades.⁵⁵ Drawing upon the domestic and international experiences (box 2), this Program will incorporate modern climate mitigation measures of water-straw-fertilizer co-management into the Government program and strengthen both climate mitigation and adaptation aspects of the Hunan HSFCP to significantly reduce methane emissions while enhancing climate resilience for rice production. Hunan Province, with the largest rice production areas in China, is well positioned to provide replicable operational models for other provinces with similar HSFCPs and other rice producing countries with similar challenges.

Box 2. Water-Saving Practices in Rice Production in China and World Bank Support to Low-Methane Rice Production

Water-Saving Practices in Rice Production in China. The unprecedented economic and social development in China after the 1978 opening-up and reforms led to increasing water use competition among the agricultural sector and other sectors. Agriculture is the largest water use sector in China, and rice is the most water-intensive crop. Thus, in the 1980s, China initiated large-scale research and experiments on rice water-saving techniques to enhance rice water use efficiency, reduce water use, and enhance yields. Many universities, colleges, and research institutes were encouraged to carry out research and experiments at irrigation experiment stations and irrigation schemes in the major rice producing provinces. With the encouraging research and experimental data, over 10 rice water-saving techniques were promoted during the 1990s and the 2000s. Among these techniques, the shallow-wet-dry irrigation technique (also called ‘shallow water depth with wetting and drying’), is the most widely used technique. This technique consists of two drying periods—one at the late stage of tillering and one at the yellow ripening stage. Given the decade-long promotion of rice water-saving practices, rice farmers in China usually have a good understanding of the importance of drying, especially the drying at the late stage of tillering, which can help rice increase early tillering (additional shoots) and suppress unproductive late tillering (new small stems consuming the plant’s energy while producing few or no rice gains), develop sturdy stems and roots that are resistant to lodging, enhance resistance to rice diseases, and ultimately enhance yields. Therefore, many rice farmers in China practice mid-season drainage at the late stage of tillering if irrigation and drainage conditions allow. The current water-saving techniques, however, have been in place since the 1990s and 2000s. It is important to update these techniques considering the changes in agronomic practices, machinery, rice varieties, soil conditions, and climate.

World Bank support for low-methane rice production. Several World Bank-financed projects promoted rice water-saving techniques and other climate mitigation measures to reduce rice GHG emissions. It is expected that the farmers under this Program will similarly benefit from the increased yields and the reduced operating cost reductions when applying the PforR-supported solution package.

⁵⁴ Greening China's Rice Value Chain - (P179193).

⁵⁵ Dong, B, Z. Mao, Y. Cui, Y. Luo, and Y. Li. 2020. "Controlled Irrigation for Paddy Rice in China." *Irrigation and Drainage* 69 (S2): 61–4. (link)

Zhi, Mao. 2000. *Water Efficient Irrigation and Environmentally Sustainable Irrigated Rice Production in China*.



- China.** Under the Integrated Modern Agriculture Development Project (P125496) in China, irrigation and drainage infrastructure was improved and WUAs were established and strengthened to support better O&M of the irrigation infrastructure. Climate-smart agriculture practices were enhanced, such as the improved fertilizer and crop residue management, the improved soil fertility management, and integrated pest management. In the Hunan project area, this project increased soil organic matter from 2.4 to 12.5 percent, increased rice water productivity by 15 percent, enhanced rice yields by 9 percent, reduced nitrogen chemical fertilizer use by 23 percent, and reduced pesticide application by 21 percent. Under the Global Environment Fund (GEF)-funded Climate Smart Staple Crop Production Project (P144531) in China, climate-smart agriculture practices were demonstrated, including efficient irrigation practices for rice production, integrated straw management, and the application of new fertilizers and methane inhibitors. The farmers in Anhui Province benefited from an increase in rice yields of 22 percent and reduced GHG emissions by about 2.9 tCO₂ equivalent per ha, while cutting fertilizer and water use by 30 percent and 38 percent, respectively. More timely and better tailored fertilizer application helped increase rice yields by 53 kg per mu (795 kg per ha) and reduced fertilizer application by CNY 115 per mu (US\$254 per ha). Better pesticide management and integrated pest management reduced the cost of application (one spray three prevention) by CNY 90 per mu (US\$198 per ha). Water-saving irrigation technology increased the rice yield by 40 kg per mu (600 kg per ha) and resulted in water use reduction of 115 m³ per mu (1,725 m³ per ha or 38 percent). Straw returning to the field resulted in CNY 15 per mu (US\$33 per ha) savings compared to the cost of comprehensive use and collection.
- India.** The Uttar Pradesh Program for Agricultural Transformation and Increased Incomes (UP PRAGATI) is an ambitious initiative implemented by the Government of Uttar Pradesh with the active support of the 2030 Water Resources Group of the World Bank, Bill and Melinda Gates Foundation, private sector partners, and a civil society organization. The Program aims to transform traditional rice cultivation through increased adoption of direct seeded rice and other sustainable low-carbon practices over 40,000 ha land. In the first year of Program implementation, the direct seeded rice pilots covered over 800 ha paddy resulting in water-saving of 8,000 m³ and carbon emissions reduction of 2,000 tCO₂ equivalent in addition to saving on fuel and labor.
- Indonesia.** Under the Indonesia Strategic Irrigation Modernization and Urgent Rehabilitation Project (P157585), the project piloted the application of AWD, intermittent irrigation, use of low-emission stress-tolerant rice varieties, and improved fertilizer and pesticide management (including the use of organic fertilizers and bio-pesticides). The early results of the pilots showed reductions in methane emissions by an average of 39 percent.
- Vietnam.** The Vietnam Sustainable Agriculture Transformation Project (P145055) promoted sustainable rice production techniques, including ‘three reductions, three gains’ (the reduction of seed rate, fertilizer use, and pesticide use, and the gains in yield, quality of farm products, and net farmer profit) and ‘One Must Do, Five Reductions’ (1M5R, the use of good quality/certified seeds, and the reduction of seed rate, pesticide use, fertilizer inputs, water use, and post-harvest losses). In the rice areas in the Mekong Delta adopting the 1M5R approach, the project reduced irrigation water use through AWD by 30 percent, reduced fertilizer use by 35 percent and pesticide use by 48 percent, increased rice yields by 5 to 10 percent, resulting in increased farmer profits by about 30 percent, while reducing GHG emissions (CH₄, NO₂, and CO₂) by about 27 percent (10 million ton CO₂ equivalent per ha per year).

II. PROGRAM DESCRIPTION

A. Government Program

20. **The Government program is outlined in the ‘Hunan High-Standard Farmland Construction Plan’ (Hunan HSFCP) 2021–2030.** Following the national HSFCP guidance, in June 2022, Hunan issued its



provincial HSFCP. The HSFCP focuses on the farmlands for major grain production to support food security, of which around 85 percent of Hunan's farmlands are for rice production. Hence, the high-standard farmlands under the Hunan HSFCP are mainly for rice production. The Hunan HSFCP aims to increase 3.1 million ha high-standard farmland by 2025 and an additional 3.91 million ha by 2030. The Hunan HSFCP involves eight key actions: 'Farmland'—leveling farmlands; 'Soil'—enhancing soil quality and fertility by straw returning, organic fertilizer and green manure application, protecting and improving farming layer, enhancing soil organic matters, lowering shallow groundwater table, and maintaining suitable soil pH; 'Water'—improving irrigation and drainage systems by desilting small water storages, and rehabilitating the existing irrigation and drainage facilities; 'Road'—improving the existing farm roads to meet the needs of agricultural machinery and transport; 'Forest'—improving windbreak to prevent soil erosion and building ecological ditches to reduce pollution; 'Electricity'—improving power supply facilities for agricultural production; 'Technology'—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; and 'Management'—improving O&M and monitoring.

21. The Government program of Hunan HSFCP provides opportunities to address the institutional challenge of strengthening the enabling environment for low-methane and water-saving rice production:

- (a) **Guiding documents, strategy, and technical standards.** The national government encourages the provinces to issue related provincial/local guiding documents and standards. Hunan has yet to issue the dedicated guiding documents, strategy, or standards related to water-saving and low-methane rice production. Current water, straw and fertilizer management practices promoted in Hunan do not consider the synergies and interactions among the factors affecting GHG emissions (see section II. C and annex 3). The current water quota for rice irrigation in Hunan only considers the water quota of traditional flood irrigation, which should be updated to promote water-saving technologies. A dedicated provincial strategy is needed to incentivize and scale up water-saving and low-methane rice production. Although water rights trading had been piloted in the Hunan Province, a document guiding implementation on water rights trading is needed to guide and regulate the water market and to reward the positive externalities of water savings.
- (b) **Data constraints.** The Hunan HSFCP requires the establishment of an information system and monitoring networks to track high-standard farmland construction, which can be expanded to include the in-situ measurements of rice GHG emissions. A national MRV methodology for rice will be developed under the China Green Agricultural and Rural Revitalization Program for Results (Hubei and Hunan) – (P178907, hereafter, GARR [Hubei and Hunan]). The national MRV methodology can be adopted and applied in Hunan to track rice GHG emissions and guide rice carbon trading.
- (c) **Coordination between the agriculture and water sectors.** The HSFCP highlights the importance of the coordination between the agriculture and water sectors. The main irrigation system is managed by the water sector, including the headworks and primary and secondary canals, which are very important for reliable and flexible irrigation services for AWD application. Good coordination between the agriculture and water sectors can ensure that the development and O&M of high-standard farmlands are well aligned with those of



the main irrigation systems for the effective functioning of the entire irrigation and drainage system. The agriculture and water sectors in Hunan have established an initial coordination mechanism for planning purposes. However, such a coordination mechanism has yet to be formalized and the coordination between the two sectors should be extended beyond infrastructure development to include management information sharing and O&M for related service delivery.

22. The Government program of Hunan HSFCP also provides opportunities to address the challenges that farmers face in adopting water-saving and low-methane rice practices:

- (a) **System constraints.** The Hunan HSFCP focuses on resilience enhancement investments. The investments in rehabilitation and upgrading of the on-farm irrigation and drainage systems and related activities account for 70 to 80 percent of the total investment costs. These investments will help remove the system constraints for flexible irrigation and drainage services with reliable water sources, which will lay the foundation for adopting water-saving technologies to reduce rice methane emissions. The Hunan HSFCP also promotes soil fertility improvement practices and the application of modern agricultural machinery, which will improve rice yields and can further reduce GHGs and enhance soil carbon sequestration. Experience from previous projects showed that the HSFCP investments can increase rice yields by 10 to 15 percent. However, as stated in the Hunan HSFCP, the province faces big challenges related to O&M of the irrigation and drainage infrastructure built. Without sustainable O&M, the irrigation and drainage infrastructure will deteriorate quickly, as evidenced by the large area of high-standard farmland where the infrastructure constructed in the 2010s needs to be rehabilitated due to deferred maintenance before they reach the design life. Hunan HSFCP considers agricultural water pricing reform a key mechanism for improving the O&M cost recovery. The capacity of farmer cooperative organizations (including WUAs) also needs to be strengthened to better fulfill their O&M responsibilities.
- (b) **Financial incentives.** Supporting the implementation of the HSFCP and promoting climate change mitigation measures will reduce losses from climate extremes, save production costs and increase yields, and provide additional revenues through possible carbon and water rights trading (see section IV and annex 3). Farmers also have a good understanding of the importance of AWD on improving rice production (see box 2 and Farmer consultation in section IV. A). Besides these essential benefits, agricultural water pricing reform can be leveraged to create incentives to save water and further promote the adoption of water-saving technologies. Mechanisms for water pricing reform and water-saving rewards in Hunan are under development, and the collection rate of the agricultural water tariff is still low. Market-based mechanisms, such as water rights trading and carbon trading, can be explored to generate additional incentives. Water rights trading has been piloted in several irrigation districts in Hunan since 2015 and can continue rewarding the positive externalities of saving water. The trading mechanisms require further improvement. Although some carbon trading pilots on rice methane emission reduction have been carried out in China,⁵⁶ Hunan has not conducted carbon trading in the agricultural sector.

⁵⁶ In July 2022, one case of carbon trading on rice methane emission reduction in China was completed in the Fujian Province. It traded the methane emission reduction from rice paddies due to the adoption of AWD. ([link](#))



- (c) **Capacity building and empowerment.** The Hunan HSFCP provides support for training farmers and promotes good practices. However, capacity building is not thoroughly provided. As a result, after the construction of high-standard farmlands, many farmers continue using traditional, inefficient water and fertilizer practices, and thus do not maximize potential yield increases. In addition, water-saving technologies, the key climate mitigation measures, were not included in the Hunan HSFCP. Farmer consultation and stakeholder engagement also revealed that farmers lack technical guidance on integrated water-straw-fertilizer practices. Hunan has a wide training and extension service network (see annex 3). There are important opportunities to embed climate mitigation measures in the Hunan HSFCP and leverage the training system to maximize climate mitigation results. Targeted training and capacity building should be provided to women to address the issue of women's underrepresentation in decision-making roles and their limited access to extension services (see annex 3).

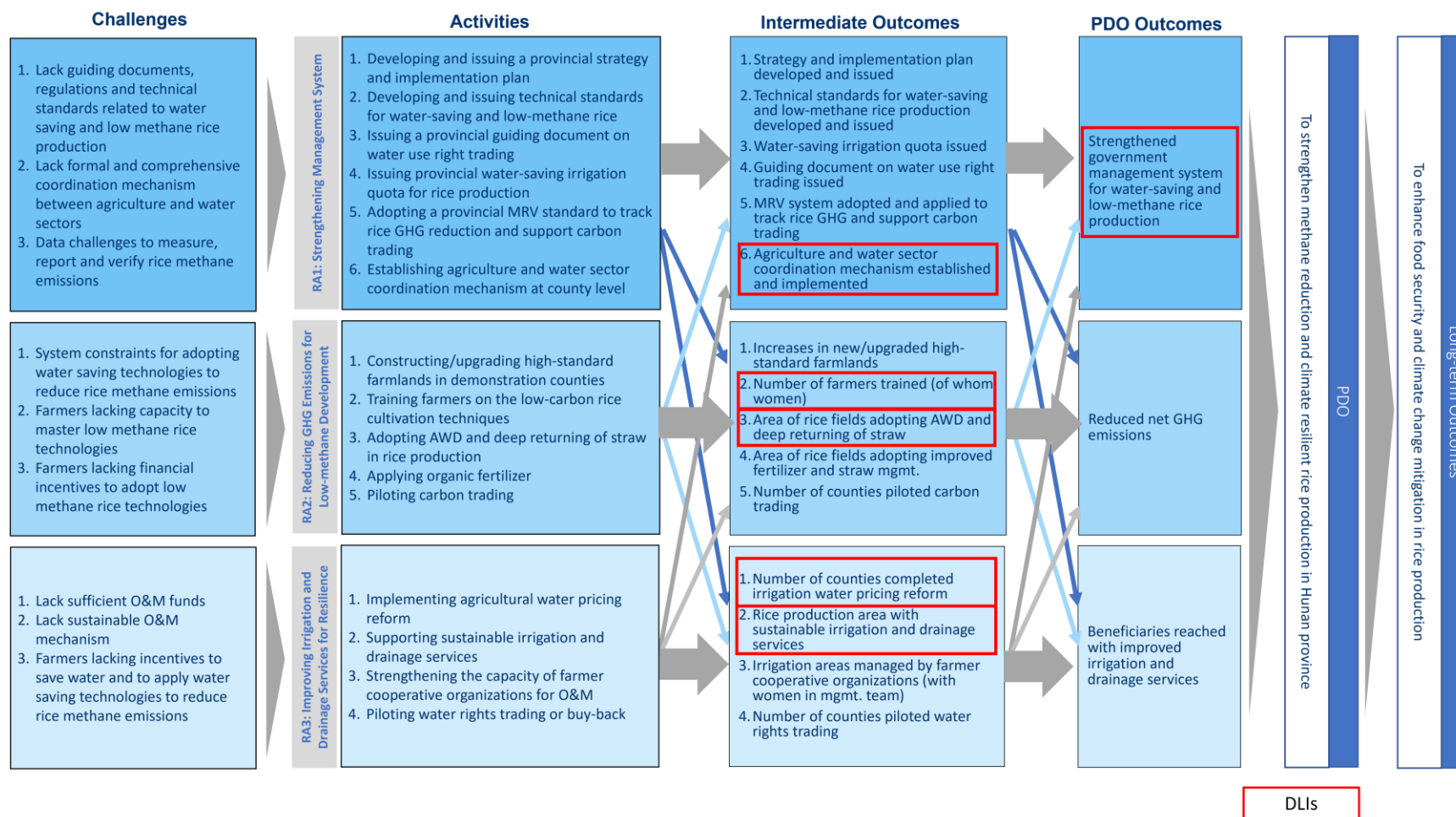
B. Theory of Change

23. **The Program contributes to low-methane and climate resilient rice production.** The core challenges to this goal include the irrigation system constraints to promote climate mitigation and resilience in rice cultivation; inadequate incentives for farmers to adopt the package of climate mitigation solutions systematically to achieve multiple win objectives; the institutional constraints to guide and coordinate climate mitigation actions; the information constraints to measure, report, and verify GHG emission reductions; and the capacity constraints to adopt and scale up climate mitigation measures. The Program will support interventions that address these challenges at both the provincial and county levels through (a) supporting the development and upgrading of high-standard farmlands at the county level to remove the major system constraints; (b) supporting comprehensive agricultural water pricing reform and carbon trading and water rights trading pilots at the county level to create incentives; (c) developing guiding documents, strategy, technical standards, and agriculture and water sector coordination mechanisms to strengthen the management system; (d) adopting and applying an MRV system to fill the information gaps; and (e) carrying out comprehensive training and strengthening the extension services to enhance farmers' capacity. A detailed description of the Program structure, activities, and outcome indicators is presented in section II.C.

24. **Key assumptions required for the Program's success are that** (a) the provincial and county governments remain committed to the policy and management reforms under the Program; (b) the institutional arrangements and strong Program leadership and management capacity at the provincial and county levels are maintained throughout the Program; and (c) provincial MRV methodology will be developed on time under the GARR (Hubei and Hunan) Program as planned to ensure sufficient time for the adoption and application of the MRV system under this Program.



Figure 1. Theory of Change



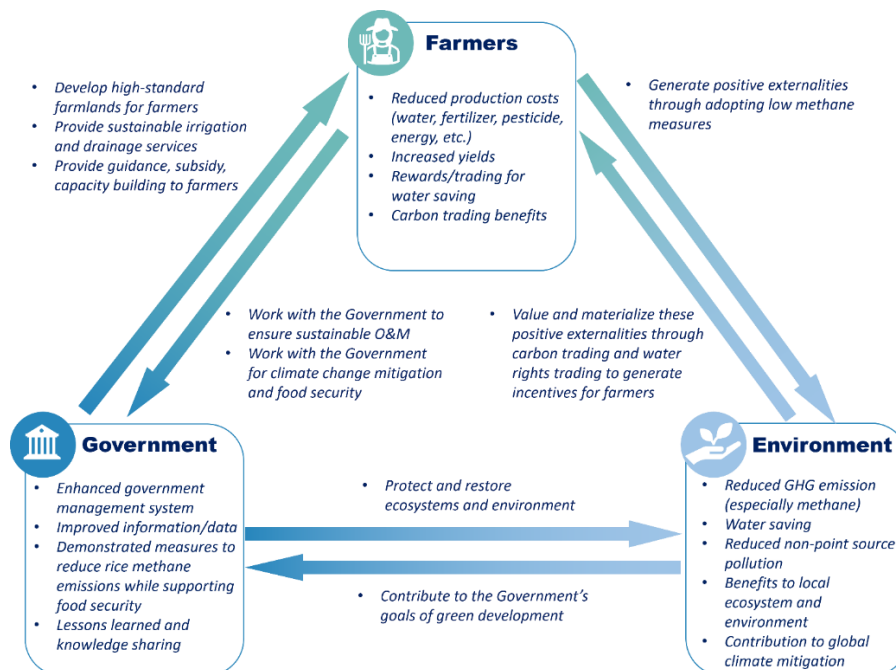


25. **The Government, farmers, and the environment will benefit from this Program to achieve triple-win outcomes of climate change mitigation, climate resilience enhancement and food security** (see figure 2).

- **Government.** The Program will demonstrate the effective climate mitigation measures of reducing rice methane emissions, support the Government to strengthen its management system to scale up emission reduction, bridge the data gaps in tracking rice methane emissions, and test incentive mechanisms. The Program will support the Government to develop high-standard farmlands and provide sustainable irrigation and drainage services for farmers, and to enhance the farmers' capacity. This Program will provide the Government with replicable lessons to reduce rice methane emissions while improving food security. The Program is expected to generate knowledge on low-methane rice production that will benefit other provinces in China and other rice-producing nations.
- **Farmers.** Farmers will benefit from the reduction in production costs, specifically water, fertilizer, pesticide and pumping energy, as well as increasing their incomes through increased yield and enhanced climate resilience in rice production and financial rewards/trading of water savings. Carbon trading can bring in additional benefits. Farmers will benefit from the high-standard farmlands and improved irrigation and drainage services and from empowerment through participatory management critical for the sustainable O&M, contributing to the Government's goal of climate mitigation and food security. The cost-benefit analysis (CBA) (table 3.9 in annex 3) shows that rice farmers could gain incremental net income at around CNY 1,935 per ha (or US\$280 per ha) without carbon trading benefits, and CNY 2,608 per ha (or US\$380 per ha) with carbon trading benefits.
- **The environment.** The Program will generate positive externalities of methane emission reduction, water saving, and non-point source pollution reduction, which will benefit local ecosystems and environment, as well as contribute to global climate change mitigation. This Program will pilot the market mechanisms of carbon and water rights trading to value and materialize these positive externalities, which will in turn generate incentives for farmers to adopt low-methane and water-saving measures.



Figure 2. Program Benefits for the Government, Farmers, and the Environment



C. PforR Program Scope

26. **The PforR is anchored in the Government program of Hunan HSFCP to achieve triple win outcomes of reduced methane emissions, enhanced climate resilience in rice production, and food security.** The proposed PforR will be implemented at both the provincial and demonstration county levels. The PforR will leverage the opportunities in the Hunan HSFCP to address the system constraints for adopting climate mitigation measures and enhancing resilience by building more reliable and flexible irrigation and drainage systems, enhancing soil quality and fertility, improving fertilizer and pesticide management, and improving associated high-standard farmland facilities. The Program will incorporate the integrated climate mitigation and adaptation measures into the Hunan HSFCP and scale up these measures with comprehensive training programs for farmers. Provincial strategy, guiding documents, and standards will be developed and issued to strengthen the Government management system for low-methane and water-saving rice production, and guide the implementation at the county level. A coordination mechanism between the agriculture and water sector will be established at the county level to ensure synergy in investment planning, implementation, and O&M. The Program will apply the MRV system to track rice GHG emissions, including methane. Agricultural water pricing reform will be implemented to create incentives for saving water and sustainable O&M. Carbon and water rights trading mechanisms will be piloted to generate financial incentives for farmers to adopt water-saving and low-methane rice production technologies.

27. **The solution package for low-methane and climate-resilient rice production under this PforR is water-straw-fertilizer co-management.** Based on scientific research, field studies over several decades,



farmer consultations and stakeholder engagement, and remote sensing analysis (see annex 3), the water-straw-fertilizer co-management approach is proposed for rice production in Hunan Province:

- (a) **Water management.** This Program promotes optimized AWD with wetting and drying at three rice growing stages—the early stage of rice growing, the late stage of tillering, and the yellow ripening to harvesting stage. Many farmers in Hunan practice drying at the yellow ripening stage to enhance rice resistance to lodging and facilitate harvesting. Some farmers in Hunan also practice drying at the late stage of tillering. The farmers of the demonstration counties consulted expressed their willingness to adopt drying at the late stage of tillering, demonstrating a good understanding that drying can increase rice yield and enhance rice resistance to lodging and disease. A limited number of farmers have practiced drying at the early stage of rice growing before or after transplanting. This is partly because the water-saving practices promoted in the 1990s did not include drying at the early stage of rice growing. However, as straw returning to soil has been widely adopted in Hunan in recent years, the decomposition of fresh straw residues under flooded anerobic conditions at the early rice growing stage significantly increased methane emissions.⁵⁷ Therefore, this Program will also promote drying at the early stage of rice growing to allow straw aerobic decomposition to reduce methane emissions in rice fields⁵⁸ while benefiting the development of rice roots and enhancing the resistance to lodging and disease. Dry direct seeding, which usually requires a longer rice growing season, will not be promoted in this Program. Hunan encourages double-cropping rice production to enhance food security. Dry direct seeding is thus not suitable for Hunan given the limited rice growing time and tight rotation schedule.
- (b) **Straw management.** Besides the co-management of straw returning and drying period, the Program will promote deep returning of straw residues. Returning crop straw and applying green manure to farmlands can raise and stabilize crop yields, improve soil health and fertility, and significantly increase soil carbon sequestration.⁵⁹ However, farmers usually return straw residues at a shallow soil depth (less than 10 cm). The straw decomposition at a shallow soil depth under flooded conditions will increase methane emissions and generate reductive substances (such as hydrogen sulfide) that are toxic for rice roots. The deep returning of straw residues can help further reduce methane emissions, promote rice root development, reduce borer pests, and enhance soil fertility and soil carbon sequestration.
- (c) **Fertilizer management.** The application of decomposed organic materials, such as compost, biogas slurry and biogas residues, and commercial organic fertilizers significantly increases soil organic matters without accelerating methane emissions from the rice paddies.⁶⁰ The

⁵⁷ Jiang, Y., H. Qian, S. Huang, X. Zhang, L. Wang, L. Zhang, M. Shen, X. Xiao, F. Chen, H. Zhang, C. Lu, C. Li, J. Zhang, A. Deng, K. J. van Groenigen, W. Zhang. 2019. "Acclimation of Methane Emissions from Rice Paddy Fields in Response to Straw Incorporation." *Science Advances* 2019: 5. (link)

⁵⁸ Hang, X., et al. 2014. "Differences in Rice Yield and CH₄ and N₂O Emissions among Mechanical Planting Methods with Straw Incorporation in Jianghuai Area, China." *Soil and Tillage Research* 144: 205–210.

Linquist, B. A., M. M. Anders, M. A. A. Adviento-Borbe, R. L. Chaney, L. L. Nalley, E. F.F. da Rosa, C. van Kessel. 2015. "Reducing Greenhouse Gas Emissions, Water Use, and Grain Arsenic Levels in Rice Systems." *Global Change Biology* 21: 407–417. (link)

⁵⁹ Lal, R., 2004. "Soil Carbon Sequestration Impacts on Global Climate Change and Food Security." *Science* 304 (11): 1623–1627. (link)

⁶⁰ Feng, J., et al., 2013. "Impacts of Cropping Practices on Yield-Scaled Greenhouse Gas Emissions from Rice Fields in China: A Meta-Analysis." *Agriculture, Ecosystems and Environment* 164: 220–228. (link).



Program will promote the use of organic fertilizer to enhance soil fertility and carbon sequestration and reduce the application of chemical fertilizer and the associated nitrous oxide emissions. The Program will also support various soil fertility improvement activities under the Hunan HSFCP, such as deep fertilizer application, straw returning, organic fertilizer, and green manure utilization. In addition, the timing of drying and the methods of fertilizer application will be further optimized to maintain low levels of nitrous oxide emissions during the implementation of AWD.⁶¹

28. **Six counties were selected to demonstrate water-saving and low-methane rice production.** The demonstration counties were selected following a set of criteria, including that (a) the counties should have solid HSFCPs and a large area of surface water irrigated rice farmlands; (b) the selected investments should have significant economic, social, and environmental benefits; (c) the counties should have strong commitment and willingness to adopt new technologies and explore pilots and institutional reform; (d) the counties should have a dedicated Program management team with the support of technical experts; (e) the county governments have enough borrowing capacity and willingness to apply for the International Bank for Reconstruction and Development (IBRD) loan; and (f) the counties do not have similar ongoing projects supported by other international loans. The six demonstration counties are Lukou, Jiahe, Qiyang, Louxing, Dingcheng, and Hanshou, which are in two of the most typical rice production regions of Hunan Province, specifically the following:

- (a) **Dongting Lake Plain Region.** The demonstration counties of Dingchen and Hanshou are in this region. The region is next to the Dongting Lake, the second largest freshwater lake in China. The region has relatively abundant water resources and is affected by frequent flooding. Surface water irrigation systems mainly rely on pumping in this region. The groundwater table is high, causing water logging and soil gleying issues. The priorities for this region in the Hunan HSFCP are enhancing resilience to flood events and improving drainage.
- (b) **Hilly Region.** The demonstration counties of Lukou, Jiahe, Qiyang, and Louxing are in this region. The region has the largest farmland areas in Hunan. It has a complex topography with undulating low hills. The distribution of water resources is uneven, with high risks of both floods and droughts. The priorities for this region in the Hunan HSFCP are enhancing climate resilience to floods and droughts.

29. **The PforR will strengthen government management systems for water-saving and low-methane rice production (Results Area [RA]1).** The Program will address the institutional constraints to guiding and coordinating climate mitigation actions. The Program will develop and issue a number of guiding documents and technical standards, including (a) the provincial strategy and implementation plan to guide the implementation and knowledge dissemination of water-saving and low-methane rice production over the medium and long term; (b) the provincial guiding document on water rights trading to guide the implementation of water rights trading to reward water saving from rice production; (c) the integrated

⁶¹ Jiang, Y., D. Carrijo, S. Huang, J. Chen, N. Balaine, W. Zhang, K. van Groenigen, B. Linquist., 2019. Water Management to Mitigate the Global Warming Potential of Rice Systems: A Global Meta-Analysis. Field Crops Research (link). Jiang et al. 2019 found that, on average, AWD increases the emissions of nitrous oxide by 105 percent. However, the overall nitrous oxide emission is low and contributes to around 12 percent of the GWP. The increased GWP from higher nitrous oxide emissions is much lower than the decreased GWP through the reduction of methane emissions.



provincial technical standards, which will provide detailed guidance on the water-straw-fertilizer co-management measures based on different local contexts; and (d) the updated irrigation water quota for rice production, which will incorporate the quotas for water-saving techniques based on typical local conditions. The Program will establish and strengthen the coordination mechanisms between the agriculture and water sectors and promote data sharing at the county level to further bridge the institutional gaps. The Program will also address the information gaps. A parallel PforR approved by the Board in FY2023, the GARR (Hubei and Hunan), plans to develop the MRV methodology for rice paddies by early 2025. Building upon the MRV methodology developed under the GARR (Hubei and Hunan), this Program will adopt and apply the MRV to measure, report, and verify rice GHG emissions in selected counties, as well as support carbon trading pilots in several counties. A monitoring network will be established with both remote sensing and in-situ measurements. The Program will explore digital MRV (see box 3) to apply innovative remote sensing technology to measure methane emissions at a large scale as well as other factors impacting rice GHG emissions, such as rice production areas, rotation practices, and rice water practices. In-situ ground monitoring will be established to directly measure rice GHG emissions, as well as the impacting factors of climate, soil types, fertilizer and straw management practices, and other agronomic practices. The MRV system will generate lessons on good practices for monitoring the implementation of rice climate mitigation actions and for assessing the impact on GHG emissions, especially methane reduction effects.

30. The PforR will support climate mitigation actions to reduce GHG emissions for low-methane development (RA2). The Program will address the system constraints for adopting climate mitigation measures by supporting selected key activities in the Hunan HSFCP, including rehabilitation and upgrading of existing irrigation and drainage systems, desilting of small water storages,⁶² and improvement of soil quality and fertility, as well as associated facilities such as improvement of existing farm access roads. These interventions will enable flexible irrigation and drainage services with reliable water supply, and improved farm roads will facilitate production machinery operation, which will create the foundation for adopting climate mitigation measures and enhancing rice yields. A package solution of water-straw-fertilizer co-management will be promoted and scaled up through comprehensive training programs. Carbon trading is considered one of the incentive mechanisms for farmers to adopt climate mitigation measures. China has a voluntary carbon market, the China Certified Emission Reduction (CCER),⁶³ for rice carbon trading. However, the CCER has been suspended since 2017.⁶⁴ Recent developments are moving towards the relaunch of the CCER. The China Beijing Green Exchange (CBGEX),⁶⁵ a professional market platform that integrates various environmental trading services, was launched in Beijing on February 6,

⁶² The PforR will only support desilting of existing small water storages, such as rainwater harvesting systems and ponds. Dam construction and rehabilitation led by the water sector are excluded from the PforR. Similarly, the construction and rehabilitation of headworks and primary and secondary canals are implemented under the national program, the Large and Medium Irrigation District Upgrading and Water Saving Improvement Program, which is also led by the water sector, excluded from the PforR. The coordination between the agriculture and water sectors can help ensure that development of high-standard farmlands will align well with the development of large water storage, and main irrigation systems to provide reliable irrigation and drainage services.

⁶³ CCER Platform (link). The CCER scheme focuses on voluntary GHG emission reduction transactions, such as the GHG emission reductions from renewable energy, forestry carbon sink, methane reduction and utilization. The CCER used to apply CDM methodology (link) to quantitatively verify and register the credits of rice methane reduction through better water management.

⁶⁴ CCER was suspended in March 2017 by the National Development and Reform Commission, due to the low trading volume and requirements for its standardized operation. However, credits issued when the Program was operational can still be traded. China Daily--Nation set to relaunch carbon cut program (link).

⁶⁵ Green exchange launched in Beijing's sub-center. (link).



2023, bringing China one step closer to the relaunch of the CCER.⁶⁶ On March 30, 2023, the Ministry of Ecology and Environment (MEE) officially announced its plan to open the national voluntary carbon market and called for proposals to develop and refine the methodologies for voluntary GHG emission reduction projects, including the methane reduction projects in agricultural sector.⁶⁷ Some provinces are piloting small-scale carbon trading on rice methane emissions reduction, such as Fujian Province. The Program will pilot the carbon trading mechanism and apply an MRV system to track rice GHG emission reduction, and pilot carbon trading in selected counties.

31. **The PforR will support the interventions required to provide sustainable irrigation and drainage services for climate-resilient rice production (RA3).** Building upon the improved irrigation and drainage infrastructure, the Program will address the constraints for sustainable O&M. The Program will support the implementation of a Comprehensive Agricultural Water Pricing Reform, which was launched nationally in 2016⁶⁸ and has been incorporated into the HSFCP as a key mechanism to improve O&M sustainability. The Program will audit the O&M costs for each irrigation district, establish a water pricing mechanism based on the cost auditing, develop a water-saving rewards mechanism, establish a precise subsidy mechanism, improve water flow measurement facilities, and develop a water use management mechanism. The O&M cost of irrigation water supply will be reasonably covered by the collected water tariff and budget support/subsidy. A precise subsidy mechanism will be established to ensure that sufficient budget support/subsidy will be allocated for O&M. Agricultural water pricing reform is also an incentive mechanism to motivate farmers to adopt AWD technologies and save water. As generating incentives for water saving should avoid creating extra burdens to farmers, water pricing reform is complemented with water-saving reward strategies; farmers will be charged higher tariffs if they exceed their water quota, while they will be rewarded if they use less water than the quota. The Program will strengthen the capacity of farmer cooperative organizations (including WUAs) and promote women's participation and leadership to enhance the participatory management of irrigation and drainage services. With the improved infrastructure, reformed agricultural water pricing mechanisms, enhanced farmer organization capacity, increased tariff collection, and precise financial subsidy for O&M cost recovery, the demonstration counties are expected to provide sustainable irrigation and drainage services for climate-resilient rice production. In addition, water rights trading is considered an incentive mechanism for farmers to adopt AWD technologies. Hunan has piloted water rights trading and government buy-backs in several counties (see annex 3). The Program will explore water rights trading mechanisms, improve trading rules, develop monitoring networks, and pilot water rights trading in three selected counties.

32. **Targeted training and extension services will be provided to support farmers to adopt the package of climate mitigation solutions.** Farmers need extensive training and capacity building to adopt and fully master the climate adaptation and mitigation measures. Farmer consultation revealed that farmers have seldom received training and guidance on water-saving techniques nor the integrated approach of co-managing water, straw, and fertilizer (see section IV. A). The targeted training programs will address three aspects:

⁶⁶ Beijing municipal authorities are planning to build a national trading center for China Certified Emission Reduction or CCER, as part of the city's efforts to further cut carbon emissions and achieve renewable energy goals. (link).

Beijing to Construct Chinese Certified Emission Reduction Trading Center. (link).

⁶⁷ MEE. *Public Solicitation of Methodologies for Greenhouse Gas Voluntary Emission Reduction Projects*. (link)

⁶⁸ State Council. 2016. *Opinions on Promoting Agricultural Water Tariff Comprehensive Reform*. (link)



- (a) **Training beneficiaries.** Training will be provided to smallholder farmers, as well as professional farmers, farmer cooperatives, farmer associations, family farms, and agro-enterprises. Targeted training and capacity building will be provided to women to address the issue of women's underrepresentation in decision-making and their limited access to extension (see Gender assessment in annex 3). Local women's federations will be engaged to carry out targeted training for women.
- (b) **Training platform.** Various training platforms will be established such as the demonstration farmlands, on-farm learning schools, and new agricultural business entity demonstration platforms. Demonstration farmlands should be less than 1 ha and have water-straw-fertilizer co-management measures in place. Comprehensive training formats will be used such as teaching courses and workshops, on-farm training and practices, and online learning and live streaming. On-farm training and practice is mandatory for each participant.
- (c) **Training mechanism.** Tailored training mechanisms will be established to ensure sustainable and long-term training. Both 'Top-Down and Bottom-Up' approaches will be adopted. 'Top-down' approaches will be used, including issuing technical standards to guide the application of climate mitigation measures, developing annual training work plans, coordinating with the high-competency farmer training program and other farmer training programs in Hunan, and ensuring specific budgets allocated for trainings. 'Bottom-up' approaches will be applied, including carrying out annual surveys to understand farmers' training needs (including the specific training needs of female farmers), developing and tailoring the training curriculum and materials according to local conditions, preparing annual training implementation plans, and conducting monitoring and evaluation (M&E) to track training outcomes. In addition, as adopting climate mitigation measures requires the application of agricultural machinery, extension service systems will be strengthened. Government-administrated agricultural machinery centers are responsible for the subsidies for purchasing machinery, and agricultural machinery service stations will provide affordable agricultural machinery services to farmers to support their climate mitigation measures.

Table 1. Overview of the Government Program and PforR: Results Areas and Key Activities

Description		Government Program Hunan HSFCP, 2021-2030	Program Supported by the PforR Anchored in Hunan HSFCP
Objective		To ensure food security and enhance agricultural productivity and resilience	To reduce methane emissions and support climate resilient rice production in China's Hunan Province
Duration		2021–2030	2024–2028
Geographic coverage		Hunan Province	Hunan Province and six demonstration counties within Hunan
Ras / Activities		The Government program covers eight key tasks as follows: <ul style="list-style-type: none"> • Farmland: Land leveling • Soil: Enhancing soil quality and fertility • Water: Improving irrigation and drainage systems and small water 	The PforR will support selected activities of Hunan HSFCP under the following three RAs: <ul style="list-style-type: none"> • RA1: Strengthening government management systems for sustainable development impacts • RA2: Reducing GHG emissions for low-methane development



	<ul style="list-style-type: none"> storage systems • Road: Improving farm roads • Forest: Improving windbreak and building ecological ditches • Electricity: Improving on-farm power supply facilities for agricultural production • Technology: Promoting good technologies and management practices, and enhancing training and capacity building • Management: Improving O&M and monitoring. 	<ul style="list-style-type: none"> • RA3: Improving irrigation and drainage services for climate resilient rice production
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33. **The Program's RAs support a nested hierarchy of activities at the provincial and county levels, as follows:**

- (a) **RA1: Strengthening government management system for sustainable development impacts.** This results area will support the issuance of selected approaches, guiding documents, and technical standards; enhance capacity for rice GHG MRV; and establish coordination mechanisms between the Agriculture and Rural Affairs and Water Resources related agencies at the county level. Activities under RA1 include the following:
- Developing and issuing of the provincial strategy and implementation plan⁶⁹ on water-saving and low-methane rice production
 - Developing and issuing the provincial technical standards⁷⁰ for water-saving and low-methane rice production
 - Revising and issuing a provincial water-saving irrigation quota⁷¹ for rice production
 - Developing and issuing a provincial guiding document⁷² on water use rights trading
 - Adopting a provincial MRV methodology 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 and maintaining agriculture and water sector coordination mechanisms at the county level.

⁶⁹ A provincial strategy and implementation plan is an official document that articulates the strategies and plans to promote and scale up within Hunan, the water-saving and low-methane rice production in short- and long- term.

⁷⁰ The technical standard will be issued by the Provincial Department of Agriculture Rural Affairs, together with the other related government departments. The technical standard will provide technical guidance on specific technologies of low-methane and water-saving rice production in Hunan Province.

⁷¹ The water quota will be issued by the Provincial Department of Water Resources (PDWR), together with the other related government departments. The latest provincial water quota was issued in 2020, with rice irrigation quota only for traditional flood irrigation. The provincial water quota is requested to be updated every five years. The next updating will be by 2025.

⁷² The guiding document, or guiding opinion is an official document issued by the PDWR, together with the other related government departments, to guide the water rights trading at county of irrigation district levels within Hunan Province.



- (b) **RA2: Reducing GHG emissions for low-methane development.** This results area will focus on the climate mitigation actions to reduce rice GHG emissions, in particular the methane emissions. It will support the development and upgrading of high-standard farmlands to remove the system constraints for adopting climate mitigation measures, scale up mitigation measures through targeted training and capacity building, and pilot carbon trading. Activities under RA2 include the following:
- Developing/upgrading high-standard farmlands, including rehabilitation and upgrading of existing irrigation and drainage systems, improvement of existing small water storages (mainly desilting), improvement of soil quality and fertility, and upgrading of existing on-farm roads
 - Scaling up the integrated package of climate mitigation solutions, consisting of water-straw-fertilizer co-management (including AWD, deep returning of straw to soil, and organic fertilizer application) and selected complimentary measures (including deep fertilizer application, formula fertilizer use, integrated pest management, climate-smart rice varieties, and aerobic cultivation practices)
 - Providing targeted training and capacity building to support farmers adopting the integrated package of climate mitigation solutions, including actions to enhance the capacity of female farmers
 - Piloting carbon trading in the selected counties.
- (c) **RA3: Improving irrigation and drainage services for climate resilient rice production.** The upgrading and rehabilitation of irrigation, drainage, and water storage systems under RA2 will improve the physical facilities, while the activities under RA3 will improve the O&M of irrigation and drainage systems to ensure sustainable, reliable, and flexible irrigation and drainage services for resilient rice production. The activities under RA3 include the following:
- Supporting comprehensive agricultural water pricing reform
 - Supporting sustainable irrigation and drainage services, through improved infrastructure, appropriate O&M arrangements, and sustainable O&M funding mechanism
 - Enhancing the capacity of farmer cooperative organizations and WUAs for O&M, including promoting women's participation and leadership in O&M
 - Piloting water rights trading or buy-back in the selected counties.

34. **Program financing.** Based on the expenditure framework assessment (EFA), total program financing over FY2024–2029 is expected to be US\$1,243 million equivalent, of which an expected US\$988 million (79 percent) will be financed by the Government and US\$255 million (21 percent) by the IBRD loan. The proposed PforR will exclude high-risk activities with potentially adverse impacts on the environment 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.

**Table 2. Program Financing**

Source	Amount (US\$, millions)	% of Total
Government	988	79
IBRD	255	21
Total Program Financing	1,243	100

D. Program Development Objective(s) (PDO) and PDO Level Results Indicators

35. **The PDO is “To reduce methane emissions and support climate resilient rice production in China’s Hunan Province.”** The PDO-level results indicators are the following:

- **PDO#1: Strengthening government management system for water-saving and low-methane rice production.** The development and issuance of several key documents at the provincial level that will enable and mainstream the production of water-saving and low-methane 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 tCO₂ 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.
- **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.

E. Disbursement Linked Indicators and Verification Protocols

36. **The Program’s disbursement-linked indicators (DLIs) quantify the parameters and values that need to be achieved to trigger disbursements.** Hunan Province and the demonstration counties are responsible for measuring achievement of the DLIs within a consistent framework allowing for aggregation and reporting at the Program level. The DLIs that were chosen (a) represent improvements in key aspects of the Government program and the key priorities in each results area, (b) are within the control of the Government, (c) are achievable in the Program period, and (d) are verifiable. They prioritize the use of existing indicators and reporting mechanisms within the Government system where possible to ensure sustainability.

37. **Verification will be carried out by a third-party verification agency based on data collected by the provincial and county agencies.** At the county level, Program results inspections will be conducted by the County Program Management Office (CPMO) on behalf of the county government; at the province level, sample inspections will be conducted by the Provincial PMO (PPMO) on behalf of the provincial government. County-level inspections will cover county-level Program activities. An independent verification agency will be contracted by the PPMO within three months after loan effectiveness. The World Bank will review and approve the terms of reference (TORs) for the verification agency. The



Program verification procedures and implementation arrangements are to be detailed in the Program Implementation Plan (PIP).

Table 3. Overview and Rationale for DLIs

DLI	Rationale for Selection
Results Area 1: Strengthening management system for sustainable development impacts	
DLI 1: Strengthening government management system for water-saving and low-methane rice production	<ul style="list-style-type: none"> This DLI aims to address the institutional constraints and strengthen the government system for water-saving and low-methane rice production. The achievement of DLI 1 will consist of the issuance of four key provincial-level documents, which together form the critical document package for enabling, mainstreaming, and incentivizing adoption of the new technologies and practices for water-saving and low-methane rice production. This DLI will contribute to climate change mitigation and adaptation by supporting low-methane and resilient rice production. It will also improve the related management strategy and technical standards This DLI will contribute to the GCRF Pillar 4: Strengthening Policies, Institutions and Investments for Rebuilding Better.
DLI 2: Demonstration counties establishing and maintaining an agriculture and water sector coordination mechanism for high-standard farmland construction and O&M	<ul style="list-style-type: none"> This DLI aims to incentivize effective coordination between the agriculture and water sectors in investment planning, implementation, and O&M of irrigation and drainage systems. The data-sharing mechanism between the agriculture and water sectors will also be established. This DLI will support the development of sustainable irrigation and drainage services, which play key roles in enhancing the climate resilience of rice production under floods and droughts. It also lays the foundation to adopt water-saving technologies to reduce methane emissions, which contributes to climate mitigation. This DLI will contribute to the GCRF Pillar 3: Strengthening Resilience.
Results Area 2: Reducing GHG emissions for low-methane development	
DLI 3: Farmers trained on the low-methane rice cultivation technologies (of whom women)	<ul style="list-style-type: none"> This DLI aims to track the number of farmers (of whom women) trained on low-methane rice cultivation technologies. Systematic training and capacity building are crucial to support farmers to adopt these technologies and to achieve multiple-win results. This DLI will enhance the farmers' capacity to adopt and master the climate mitigation measures in rice production, contributing to climate mitigation. This DLI will contribute to the GCRF Pillar 3: Strengthening Resilience.
DLI 4: Rice areas where both AWD technology and deep returning of rice straw are used (ha)	<ul style="list-style-type: none"> This DLI aims to promote synergized adoption of AWD and deep returning of straws soil practices. It measures the adoption of integrated AWD practice and deep returning of rice straw in the demonstration counties. Methane is the major GHG emitted from rice paddies, and AWD can help substantially reduce methane emissions. Deep returning of rice straw can be coupled with AWD to further reduce methane emissions. The co-management of water and straw can ensure that methane emissions remain low under the condition of straw returning to the soil. This DLI will promote the adoption of key climate mitigation measures in rice production, contributing to climate change mitigation. This DLI will contribute to the GCRF Pillar 3: Strengthening Resilience.
Results Area 3: Improving irrigation and drainage services for resilient rice production	
DLI 5: Demonstration Counties completing a comprehensive	<ul style="list-style-type: none"> This DLI aims to motivate water users to save irrigation water and pay for the irrigation services based on the amount of water used, a crucial reform for irrigation O&M cost recovery. Comprehensive agricultural water pricing reform will contribute to improve the sustainability of the irrigation and drainage services, which can enhance the



DLI	Rationale for Selection
agricultural water pricing reform (Number)	<p>resilience of rice production and create conducive conditions for practicing AWD technologies to reduce methane emissions.</p> <ul style="list-style-type: none"> This DLI will support the sustainable irrigation and drainage services, contributing to climate adaptation. It will enable and promote AWD with reduced water use quota and with incentive for irrigation costs reduction and water-saving reward, contributing to climate mitigation and water-saving. This DLI will contribute to the GCRF Pillar 4: Strengthening Policies, Institutions and Investments for Rebuilding Better in the GCRF and Pillar 3: Strengthening Resilience.
DLI 6: Rice production area with sustainable irrigation and drainage services (ha)	<ul style="list-style-type: none"> This DLI aims to support improving the sustainability of irrigation and drainage services for rice producers. Sustainable irrigation and drainage services will be achieved with improved infrastructure, appropriate O&M arrangements including empowerment of farmer water user associations, and sustainable O&M funding mechanism. This DLI will ensure sustainable irrigation and drainage services to support the application of AWD, contributing to climate mitigation. The sustainable services will also enhance climate resilience to floods and droughts, contributing to climate change adaptation. This DLI will contribute to both the GCRF: Pillar 1 Responding to Food Insecurity, and Pillar 3 Strengthening Resilience.

38. **DLI 1: Strengthening government management system for water-saving and low-methane rice production (Text).** DLI 1 incentivizes the province to develop and issue critical strategy, technical standards, and guiding documents to strengthen the enabling environment for mainstreaming the production of water-saving and low-methane rice. The regulatory package of documents at the provincial level will consist of the four key documents: (a) a water-saving and low-methane rice production strategy and implementation plan; (b) technical standards for water-saving and low-methane rice production; (c) a provincial water-saving irrigation quota for rice production; and (d) a guiding document on water use rights trading. The preparation, due approval, and issuance of the critical documents will be carried out by the provincial authorities, supported by the PPMO, and in close collaboration with the relevant authorities of the participating counties.

- Verification.** The verification will be done at the provincial level. The DLI will be verified by a third-party verification agency, to ensure that the documents have been prepared, duly approved and issued in the required manner, and the documents are of acceptable technical quality that (a) the strategy and implementation plan should develop the short- and long-term plans of promoting and scaling up water-saving and low-methane technologies, consolidate the experiences and lessons learned on low-methane rice production, and lay out the plan for knowledge dissemination and scaling-up; (b) the technical standards should include the water-saving and low-methane technologies for typical agro-climatic zone conditions, covering the main technologies of low-methane rice varietal selection, water-saving, fertilizer management, and straw management; (c) the provincial irrigation quota should include the water-saving irrigation quota for single- and double-cropping rice under the conditions of different irrigation zones and irrigation design standard; and (d) the guiding documents on water rights trading should include the management of irrigation water rights, principles of water rights trading/buy-back, development of trading platform, and monitoring and data management. The verification will be carried out on the final issuance of these documents.



39. **DLI 2: Demonstration counties establishing and maintaining an agriculture and water sector coordination mechanism for high-standard farmland construction and O&M (Text).** DLI 2 is measured by the number of demonstration counties officially establishing the coordination mechanisms and maintaining of such mechanism throughout the Program period. These county-level mechanisms will cover coordination on related investment planning, project design, implementation, and O&M to ensure synergy between main and on-farm irrigation and drainage systems and services. The agriculture and water sectors are required to share data on the HSFCP and the related water sector projects.

- **Verification.** Verification will be carried out by the third-party verification agency based on (a) the establishment of an official coordination mechanism at the county level, including the official coordination mechanism with agreed operational procedures, verified based on the official announcement by the county governments; the assignment of dedicated staff with clear responsibilities, verified based on official documents from the county governments or a joint official document between agriculture and water sectors; and the agreed data-sharing mechanism under which the database information of large and medium irrigation district upgrading and management and the database information of high-standard farmland construction are shared and verified based on the official data sharing agreement between the agriculture and water sectors and (b) the maintenance of the coordination mechanism, including the annual coordination between the implementation of the HSFCP projects and Large and Medium Irrigation District Upgrading and Water Saving Improvement Program projects, verified based on annual project plans, project implementation reports, annual project summary reports and completion reports; the regular meetings and coordination, verified based on event records, meeting minutes, and official documents jointly issued by the agriculture and water sectors; and the implementation of data sharing, verified based on a joint official document signed by the agriculture and water sectors indicating data sharing is applied in annual project planning, design, implementation, and O&M.

40. **DLI 3: Farmers trained on the low-methane rice cultivation technologies (of whom women).** This DLI supports the targeted training of rice farmers in adopting low-methane package solutions in the demonstration counties. The low-methane package solutions include the water-straw-fertilizer co-management measures, including water-saving practices, deep returning of straw, and organic fertilizer application, as well as other complementary climate mitigation measures, such as fertilizer deep application, fertilizer use reduction and efficiency improvement, integrated pest management, climate-smart rice varieties, and aerobic cultivation techniques. The training curriculum and training plan are subject to review by the World Bank.

- **Verification.** Data on farmer training will be collected by the PPMO and CPMOs. The CPMOs shall establish training ledgers. Surveys and interviews will be carried out by the CPMOs to monitor and evaluate the training outcomes. Verification will be carried out by the third-party verification agency based on the following:
 - (a) The review of the training ledgers, training summary reports, training curriculum and materials, and training plans, based on the training beneficiaries, training platforms, training formats, and training materials articulated in the Program Action Plan (PAP) and PIP.



- (b) Sequential sampling inspections to randomly sample no less than 10 trained farmers in each township; 3 percent of professional farmers, farmer cooperatives, farmer associations, family farms, and agro-enterprises; and 1 percent of smallholder farmers. Within these samples, at least 80 percent of sampled farmers should have received the full training and at least 30 percent of the trained farmers sampled should be female. The verification will also track and report on the cumulative number of male and female farmers trained on an annual basis to ensure that the request for disbursements under this DLI for male farmers trained does not exceed 70 percent of the total target.
- (c) Field visits to verify the demonstration farmlands and training programs are implemented as planned.

41. **DLI 4: Rice areas where both AWD technology and deep returning of rice straw to soil are used (ha).** This DLI measures the areas of high-standard rice farmland in the demonstration counties adopting AWD technology and deep returning of rice straw, as detailed in the technical standard prepared under DLI 1. Optimized AWD is promoted under this Program, including AWD at three rice growing stages: (a) the early stage of rice growing: around 7 days of cumulative drying before and after transplanting, (b) the late stage of tillering: around 10 days of cumulative drying, and (c) the yellow ripening to harvesting stage: around 15 days of drying before harvesting. The deep returning of rice straw requires a burying depth of over 15 cm.

- **Verification.** Data on the rice field area adopting AWD technology and deep returning of rice straw will be collected by PPMOs and CPMOs. The CPMOs will establish the ledgers for each village to record the rice areas adopting AWD and deep returning of rice straw for double-cropping rice, ratooning rice, one-cropping early rice, one-cropping middle rice, and one-cropping late rice. The CPMOs will carry out the preliminary verification on the project implementation reports, machinery application contracts, completion reports, and ledgers, and submit these materials to the PPMO for further verification and auditing. Verification will be carried out by the third-party verification agency based on (a) the verification of ledgers and other complementary materials, including the project implementation reports, machinery application contracts, and completion reports; (b) random sampling of three villages in each Program county, including random sampling of 5 percent of straw returning machinery contracts to verify deep returning of straw and random sampling of 1 percent to 3 percent of rice farmers to verify the adoption of both AWD and deep straw returning technologies (1 percent of sampling when the number of rice farmers are more than 500 households and 3 percent of sampling when the number of rice farmers are less than 500 households); (c) field soil sampling to verify the depth of straw returning; and (d) remote sensing to verify the application of AWD in 10 percent of the areas for the drying at the early stage of rice growing. All the reports, records and ledgers need to be countersigned by the respective village supervisory committees.

42. **DLI 5: Demonstration counties completing a comprehensive agricultural water pricing reform (Number).** This DLI will measure the number of demonstration counties which have completed a comprehensive agricultural water pricing reform, including (a) completing the O&M cost estimation of irrigation and drainage systems, carrying out O&M cost auditing and irrigation water pricing auditing, and establishing a rational agricultural water tariff regime (including a progressive tariff scheme); (b)



establishing an irrigation water quota management mechanism and a cap on total agricultural water withdrawal, developing a water-saving reward mechanism, and establishing precise budget support/subsidy mechanism; (c) installing water flow measurement facilities; and (d) the promulgation of the reformed water tariff. The DLI will create the conducive conditions and generate incentive for farmers to adopt AWD, contributing to climate mitigation and water-saving.

- **Verification.** Data will be collected by the provincial and county PMOs. Verification will be carried out by the third-party verification agency based on the related government's official documents, including (a) official approval of the implementation plan by the higher-level municipal or provincial government; (b) official approval documents by the county governments for O&M cost auditing, an agricultural water tariff regime, a water-saving reward mechanism, and a precise budget support/subsidy mechanism; (c) official completion reports on the installation of flow measurement facilities; (d) verification of annual progress reports and ledgers; (e) official approval documents and implementation reports by county governments on the cap on total agricultural water amount, water quota management, and progressive tariff scheme; and (f) official completion acceptance document on the comprehensive agricultural water pricing reform, approved and verified by the higher-level municipal or provincial government.

43. **DLI 6: Rice production area with sustainable irrigation and drainage services (ha).** This DLI will motivate the counties to improve the long-term sustainability of irrigation and drainage services which are essential for climate-resilient and low-methane rice production. The sustainable irrigation and drainage services consist of (a) well-functioning irrigation and drainage infrastructure; (b) appropriate O&M arrangements with a well-conceived O&M plan, dedicated O&M entities (such as WUAs, farmer cooperation organizations, and village collectives), and clear O&M responsibility; and (c) a sustainable O&M funding mechanism established to ensure O&M cost recovery. The sustainable irrigation and drainage system and services are necessary for farmers to adopt AWD because of their increased confidence in irrigation water supply reliability for the wetting period. In other words, the DLI6 enables DLI4 as AWD would not be possible without DLI6. The AWD technology will be applied on rice production area with sustainable irrigation and drainage services.

- **Verification.** Data will be collected by provincial and county PMOs. Verification will be carried out by the third-party verification agency based on (a) the rice cultivation areas that have modernized irrigation and drainage infrastructure systems which meet the reliability design criteria for high-standard farmland construction, verified by official annual completion reports, final acceptance certificates, and the completion data reported and incorporated into the existing 'One Map' information database on high-standard farmland construction and management; (b) the newly constructed/rehabilitated irrigation and drainage infrastructure has dedicated entities responsible for the O&M, verified by official and/or signed contract documents showing the dedicated WUAs, farmer cooperation organizations, and village collectives as the main O&M entities; and (c) the O&M cost should be reasonably covered with a combined source of collected irrigation water tariff, precise financial budget support, and other sources, verified by the actual financial reports recording water tariff collection, budget support, and other sources which cover at least 80 percent of the O&M costs. The verification of (b) and (c) will be based on random sampling, which will



cover one-third of the large and medium irrigation districts, as well as 2 percent of the O&M entities.

III. PROGRAM IMPLEMENTATION

A. Institutional and Implementation Arrangements

44. **The proposed PforR Program will be implemented by Hunan Province.** At the provincial level, a Provincial Program Coordination Group (PPCG), headed by the Vice Governor in charge of agriculture and comprising senior officials from the Provincial Department of Agriculture and Rural Affairs (PDARA), Provincial Development and Reform Commission (PDRC), Provincial Department of Finance (PDOF), Provincial Department of Natural Resources, PDWR, and Provincial Department of Ecology and Environment (PDEE) as members, has been set up to provide high-level coordination and policy guidance. PDARA is the lead implementation agency for the Program while other departments contribute to the implementation of some soft activities. A PPMO hosted and led by DARA has been established to assist the PPCG and be responsible for day-to-day coordination of Program implementation at the provincial level. A technical assistance team has been contracted to support the operation of the PPMO. An expert panel will also be established at the provincial level to provide in-depth expert advice for Program preparation and implementation.

45. **The county governments will be responsible for implementing the Program activities in the demonstration counties.** At the county level, a County Program Coordination Group (CPCG) headed by a responsible county leader and comprising senior officials from related sector departments will be established and a CPMO with a technical support team will be set up in each of the six demonstration counties. The agricultural and rural affairs bureau will be the lead implementing agency at the county level while other related sector agencies are expected to implement their respective activities.

B. Results Monitoring and Evaluation

46. **The two levels of PMOs (PPMO and CPMO) will be responsible for M&E of implementation progress, the results of the Program activities, and the PAP actions.** An M&E plan will be prepared, specifying the unit of measurement, baseline value, targets, and data sources for each indicator, along with the methodology and responsibility for data collection and reporting. The detailed M&E plan and a tailored expenditure and financial reporting system will be prepared and included in the PIP. Existing government systems based on the relevant technical guidelines applied by authorities will be used for results measurement. The PPMO will consolidate reports on the Program based on the reports from the CPMOs and submit reports to the World Bank for review. Technical assistance will be provided by the PPMO and its technical experts to the Program counties to assist with monitoring and reporting during the implementation of the Program. The PPMOs will prepare and submit semiannual progress reports, M&E reports, a midterm review report, and a Program Implementation Completion and Results Report (ICR) by the close of the Program. The PforR Program disbursement-linked results (DLRs) will be monitored and verified by the third-party verification agency.



C. Disbursement Arrangements

47. **The World Bank will advance up to 25 percent of the total IBRD loan amount to Hunan Province by loan effectiveness.** After the DLIs against which the advances will be disbursed are achieved, the amounts of the advances will be deducted from the total amount to be disbursed against such DLIs. The World Bank will record any amounts of advance as disbursed for an achieved DLRs ('recovered') after it has notified the borrower of its acceptance of the evidence of achievement of the results for which the advance was provided. The PPMO will be responsible for consolidating reports from participating agencies at the provincial and county levels and submitting them to the PDOF. The IBRD loan disbursements will be made periodically upon receiving and accepting the third-party verification agency's reports on the DLRs for the respective DLIs. The PPMO will submit a verification letter with the results to the World Bank and, upon acceptance of the verification results by the World Bank, the PDOF will prepare disbursement applications and submit them to the World Bank. The applied disbursed amount will depend on the verified results. Some annual allocations are scalable and non-fixed, meaning that the World Bank will disburse for over-performance up to the DLIs' total allocation. Over-performance will enable the PDOF to bring forward disbursements from Year 4 and 5 to Years 2 and 3. The PDOF can apply for disbursements as soon as the province meets targets, provides the necessary evidence to the World Bank, and the World Bank accepts that evidence in a formal notice to the borrower with the disbursement amounts. The PDOF can also request to be reimbursed for any results achieved beyond the indicative annual target up to and not exceeding the total PforR target and amount allocated for those DLIs that are scalable and confirmed by the World Bank.

D. Capacity Building

48. **Capacity building and technical assistance are necessary at both the provincial and county levels.** At the provincial level, capacity building for development of the related strategic plans, technical standards, guiding documents, and the MRV system are needed. Related experts (through the expert panel) and consultants will provide advice and support. An experienced technical support team will be engaged to assist with implementation management including implementation of the PAP actions (fiduciary, environmental and social [E&S], and technical) under the Program and internal M&E and reporting, and a third-party/independent verification agency for the verification of the Program's achievement of the DLRs. At the county level, technical support and expert advice are needed for the carbon trading and water rights trading activities as well as for the implementation of climate mitigation measures. At the community level, technical assistance may be required in engaging the WUAs and farmer organizations and promoting women's participation and leadership in O&M. This would be in addition to the envisaged comprehensive training on low-methane and water-saving technologies and agronomic practices. These capacity-building and technical assistance interventions (including support from the World Bank team) will serve as climate mitigation measures to reduce the risks associated with the technical design of the Program and institutional capacity for implementation and sustainability.

IV. ASSESSMENT SUMMARY

A. Technical (including program economic evaluation)

Strategic Relevance



49. **The proposed PforR Program will support Hunan Province's efforts to achieve the triple-win outcomes of climate change mitigation, enhanced climate resilience, and increased productivity in the rice sector and will also generate valuable lessons for China and beyond.** Rapid reduction of methane emissions is regarded as the single most effective strategy to keep the Paris Agreement goal of limiting global warming to 1.5°C. Reducing rice methane emission is the key path to reduce methane while also bringing the co-benefit of improving agricultural productivity. Reducing rice methane emissions is also considered as the first task for emission reduction in the agricultural sector in China and Hunan Province. However, these priorities have not been translated into specific climate mitigation actions and measures. This Program will address these priorities and provide replicable lessons to reduce rice methane emissions while supporting food security. The Program is anchored in an ambitious and solid Government program, the Hunan HSFCP. The Program will leverage the opportunities of the Hunan HSFCP to create conducive conditions for adopting climate mitigation measures, bridging the gaps to improving the enabling environment, scaling up mitigation measures to reduce rice GHG emissions, and improving irrigation and drainage services to enhance resilience. This Program will address both climate mitigation and adaptation aspects of rice production and will contribute to the long-term outcomes of climate change mitigation and food security. The Program is expected to generate knowledge on low-methane rice production that will benefit other rice-producing nations.

Technical Soundness

50. **The technical assessment has established a sound PforR boundary.** The Program is embedded within the Hunan HSFCP (2021–2030). The Program boundary will include physical and non-physical activities in the six demonstration counties, as well as non-physical or soft activities under RA1 at both the provincial and county levels. The Program boundary that was agreed upon after the E&S risk screening (excluding the high-risk activities) is shown in table 3.10 in annex 3. The timeline for the PforR is from 2024 to 2028, with 2021 as the baseline year. This is well aligned with the timeline of the Hunan HSFCP, which goes from 2021 to 2030 and has clear, annual targets established for each county.

51. **The technical assessment identified institutional opportunities to strengthen the government management systems for promoting rice climate mitigation measures—the focus of RA1.** RA1 will strengthen the management system for low-methane and climate-resilient rice production. The assessment of the Government management system in Hunan Province revealed that there are general policies, regulations, and strategic plans for agriculture green development, water resources management, and agricultural water conservation (table 3.6 in annex 3). However, there is a lack of specific guiding documents, strategy, and implementation plans for water-saving and low-methane production. The related technical standards also need to be updated. The agriculture and water sectors have some coordination mechanisms, but these mechanisms need to be improved and formalized. The assessment also identified the need to promote and institutionalize data sharing between the two sectors. In the effort to fill information gaps, the Program gives priority to develop a MRV standard and implement it in the selected counties. As the GARR (Hubei and Hunan) Program plans to develop the national MRV methodology for rice paddies and apply it in Hunan Province, this Program will focus on the implementation of this MRV in the selected counties to support carbon trading pilots.

Box 3. MRV for Rice Sector

Rice cultivation has significant methane abatement potential in China and globally. There is a significant opportunity to implement the mitigation actions through innovative financial schemes tied to robust MRV



systems (see references in paragraph 12–13 in annex 3).

Main standards for rice GHG emission quantification. Six main standards quantify GHG emissions from the rice sub-sector: UNFCCC’s Clean Development Mechanism (CDM), California Air Resources Board (CARB) Compliance Offset Protocol, Gold Standard, Verra, Climate Action Reserve (CAR), and Japan’s Joint Crediting Mechanism (JCM) that recently approved the J-Credit Methodology for Paddy Rice Cultivation. Gold Standard and Verra both follow CDM’s *‘Methane Emission Reduction by Adjusted Water Management Practice in Rice’* (AMS-III.AU) methodology though Verra has recently paused the use of CDM methodology for review. Gold Standard has announced that it is working on publishing a revised version of the CDM AMS-III.AU methodology. The American Carbon Registry (ACR)’s *Emission Reductions in Rice Management Systems* is currently inactive. CDM’s AMS-III.AU methodology includes rice farms that (a) change the water regime during the cultivation period from continuous to intermittent flooded conditions and/or a shortened period of flooded conditions, (b) follow AWD and aerobic rice cultivation methods, and (c) change their rice cultivation practice from transplanted to direct seeded rice. The methodology relies on reference field approach to quantify GHG emissions. Alternatively, emission reductions can also be calculated using the IPCC tier 1 approach or default values. The CARB *Compliance Offset Protocol Rice Cultivation Project* also includes rice farms that follow AWD practices, but in addition includes practices such as dry seeding and early drainage. The methodology uses a denitrification-decomposition (DNDC) biogeochemical process model for soil dynamics and emission factors for secondary emissions. CAR’s US Rice Cultivation Version 1.1 methodology includes rice farms that practice dry seeding with delayed flooding and post-harvest rice straw removal and baling. This methodology also uses the DNDC biogeochemical process model for soil dynamics followed by emission factors for cultivation equipment and crop residue management and baling emission factors for crop residue baling. Japan’s J-Credit Methodology for Paddy Cultivation extends the ‘mid-drying’ session for seven days or more during the rice cultivation period to assess the exact reduction of methane emissions. This Program will promote optimum AWD with the co-management of rice straw and fertilizer as a package solution. The GARR (Hubei and Hunan) will develop the MRV methodology corresponding to the package solution, and this Program will adopt and apply the MRV to quantify GHG emissions from rice production.

Rice credits. Gold Standard has generated an estimated 952,990 credits across the three projects in Pakistan, India, and Thailand (but not yet issued) and Verra (before the pause) had issued verified carbon units (VCUs) totaling 4.56 million or 0.43 percent of all VCUs across 37 projects in China. On the other hand, the first pilot under CAR’s methodology which was implemented across 2,000 acres of land by seven growers in Arkansas, Mississippi, and California generated an estimated 600 credits. These credits were bought by Microsoft at an undisclosed price.

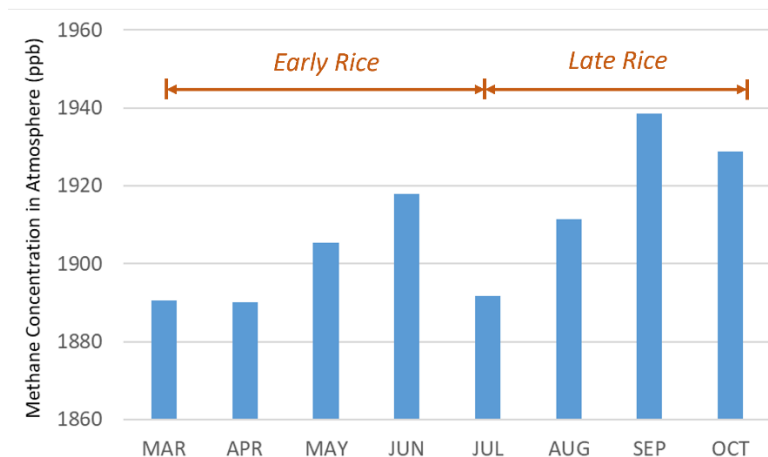
Opportunities for digital MRV. Under the Paris Agreement, MRV systems are fundamental. Countries are required to measure and report their GHG emissions as well as their NDCs and both require a robust MRV system. While time-consuming and costly, MRV systems of agricultural emissions have matured over time with the continuous innovation in satellite imagery, artificial intelligence, and machine learning. This cost curve continues to trend downward. In a conventional MRV system, project data are often recorded manually and stored as a hard copy or in an Excel worksheet. This is both difficult to analyze for reporting purposes and costly to verify. Digital MRV systems use emerging digital technologies such as smart meters, remote sensors, and even satellite data to digitally report, record, and analyze project information. This increases the reporting accuracy, reduces the time required for data collection, and lowers the cost of third-party verification of the project’s performance. Digital MRV systems are a key component in future climate markets to ensure robustness and the smooth functioning of those markets. There is a significant opportunity here to leverage technology to develop end-to-end platforms that connect MRV with carbon payments. This Program has explored use of the Sentinel-5P satellite data to understand the historical methane emissions from the Program areas (see paragraph 52 and annex 3).

52. **The assessment led to the design of an integrated approach to leverage the Government program of Hunan HSFCP to scale up rice climate mitigation measures—the focus of RA2.** RA2 supports the Government’s endeavor to promote low-methane rice production and thus reduce methane emission.



The Program is anchored in the Hunan HSFCP. Over the past decade, Hunan has seen increasing investments in high-standard farmlands, which lays a sound foundation for adopting mitigation practices. Research, farmer consultations, field studies, and revealed the importance of water-straw-fertilizer co-management to reduce rice GHG emissions (see annex 3). The assessment collected the satellite Sentinel-5P methane emission data from the rice fields in Hunan and analyzed the monthly averaged results from Year 2019 to 2022 for the major rice production municipalities of the Program counties (table 3.8 in annex 3). The four-year averaged data during rice growing season for Changde Municipality (including Hanshou county and Dingcheng district) are shown in figure 3 as an example, which indicated that methane concentrations from the late rice were higher than these from early rice, due to the anerobic straw decomposition and the flooded condition at early growing stage. The remote sensing data also highlighted the importance of water-straw-fertilizer co-management. However, the counties are falling short in the systematic adoption of those technologies as an integrated solution package. Stakeholder consultation and field studies indicated a solid training and extension service system in Hunan, which will be further leveraged and strengthened to promote and scale up this integrated climate mitigation solution package through comprehensive training and capacity building. Female farmers will be targeted to enhance women's participation and decision making in low-methane rice production. In addition, trading the reduced carbon emissions from the Program can generate financial revenue to incentivize farmers to adopt low-methane and water-saving cultivation practices. Although the voluntary GHG emission reduction trading platform of CCER has not accepted new applications since 2017, the Government and other entities are still exploring opportunities for rice carbon trading.

Figure 3. Methane Concentration in Changde Municipality based on Remote Sensing Data from the Sentinel-5P Satellite (4-year Monthly Average, 2019–2022)



53. **RA3 aims to improve the sustainability of irrigation and drainage services for climate resilient rice production.** Previous high-standard farmland development in the 2010s in Hunan was heavily focused on infrastructure investment and placed less emphasis on O&M. The Hunan HSFCP includes the upgrading and rehabilitation of a large area of high-standard farmlands as the irrigation and drainage infrastructure deteriorated quickly due to the lack of proper O&M. Sustainable irrigation and drainage services consist of improved irrigation and drainage infrastructure, sustainable O&M funding mechanism, and enhanced O&M capacity. The assessment showed that current irrigation O&M cost recovery is at a relatively low level in Hunan, with a provincial average of less than 50 percent, owing to low irrigation water tariffs and low to modest tariff collection rates. The Program will support the reform of the agricultural water tariff



to ensure sustainable funding for O&M. Several institutional mechanisms will be established, including a water tariff mechanism, a water-saving reward mechanism, a precise budget support/subsidy mechanism, and a water use management mechanism (see annex 3). The EFA revealed that a noticeable amount of earmarked funds have been assigned to support agricultural water pricing reform. The Program will also empower farmer organizations in irrigation and drainage management. Hunan has been a leader in promoting participatory irrigation management—farmers are encouraged to join WUAs or farmer cooperative organizations to manage on-farm irrigation systems below tertiary canals. The Program will support the Government efforts to enhance the capacity and engagement of WUAs and farmer organizations in O&M in all demonstration counties, as well as promoting women’s leadership in the farmer organizations. In addition, Hunan has started piloting water rights trading and government buy-back for water saved in several counties (see annex 3). The Program is expected to support extending these pilots into additional counties, which can provide additional incentives for adopting water-saving techniques.

54. Farmer consultation and engagement. Farmer consultation and stakeholder engagement was carried out in the demonstration counties to understand farmers’ agronomic practices and behaviors and to gauge their willingness and incentives to adopt the low-methane and water-saving technologies. Majority of farmers have already practiced, to some extent, water-saving techniques similar to basic AWD in the demonstration counties, especially drying during the yellow ripening stage to facilitate harvesting. Even without subsidies and external incentives, the farmers expressed their willingness to embrace AWD technologies during the late stage of tillering because they have a wide understanding that wetting and drying during the late stage of tillering can help increase yields and enhance resistance to lodging and rice disease. But they also expressed the difficulties in practicing frequent wetting and drying in some farmlands due to the lack of reliable irrigation and drainage systems and services. Some farmers in the two demonstration counties in the Dongting Lake Plain Region (that is, Dingchen and Hanshou) pump surface water for irrigation. Thus, the farmers in these counties have additional incentives to adopt AWD technologies to save on water and energy costs. A limited number of farmers practice wetting and drying regimes during the early rice growing stage. Most farmers are not aware of the benefits of draining their fields at the early rice growing stage. Farmers expressed less concern on the potential increase of weed growing under AWD, as they usually apply herbicides that are effective to control weeds. The field study and farmer consultations revealed a wide application of rice straw returning and green manure returning in Hunan. However, majority of farmers return rice straw and green manure within a shallow depth of soil (<10 cm) using shallow rotary tillage. The farmers usually received training and technical guidance on fertilizer application and straw management, but they have seldom received training and guidance on proper AWD technologies. These farmers are practicing AWD technologies according to their own experiences, which can be further improved and optimized. Some farmers are reluctant to adopt these new techniques because they are not sure about the potential impacts on yields. Farmer consultations helped identify the opportunities and gaps to adopt climate mitigation measures that have informed the Program design, especially the designs of water-straw-fertilizer co-management approach and the targeted training.

55. Gender. The implementation of the Program provides the opportunity to empower women in decision-making roles for low-methane and water-saving rice production. Although women are crucial contributors to the agricultural production, it is still men who are the key opinion leaders in managing local public affairs and community governance. Major gender gaps were identified in women’s representation in farmer cooperative organizations and WUAs evidenced by the data from six



demonstration counties in Hunan, despite more women taking on crucial roles and tasks in rice production. The percentage of farmer cooperative organizations with women in management teams generally range from 5 to 30 percent. The limited participation of women in farmer cooperative organizations/WUAs represents a missed opportunity to have women as advocates for climate adaptation and mitigation measures in rice production, as trained women, evidenced by a study conducted in Hubei Province, are more likely to adopt low-methane technologies than men.⁷³ The gender assessment also found that women had less opportunities than men to receive extension and technical trainings, which further hindered their participation in governance and advancement into leadership roles. Gender actions proposed include (a) the development of guidelines of farmers' cooperative organizations/WUAs, such as setting membership gender quota; (b) strengthening of gender awareness of local people via gender equality trainings which provides them with the relevant knowledge, skills, and values that allow them to contribute to the effective implementation of the gender-mainstreaming strategy in agriculture; and (c) public outreach/communications programs featuring women role models in local natural resource management and governance; and (d) targeted technical trainings for female farmers. The detailed gender result chain is included in annex 3.

56. **Citizen engagement.** This PforR has been promoting citizen engagement through wide stakeholder consultation during the environmental and social systems assessment (ESSA) and technical assessment as well as the Program design and optimization. The mechanism for citizen engagement will be expanded during Program implementation to include (a) stakeholder engagement and consultation on the selection, design and implementation of the investment activities under the Program, (b) participatory management approaches to O&M of the Program facilities through farmer cooperative organizations and WUAs, (c) regularly seeking feedback from the farming communities and related stakeholders on the effectiveness and improvement of the farmer training program, (c) public consultation on the comprehensive agricultural water pricing reform, (d) wide stakeholder consultation and participation in the development of the provincial strategy and implementation plan for scaling up low-methane and water-saving rice production, and (e) the contact information of the provincial and county PMOs made public for receiving feedback and complaints in all Program counties as part of the grievance redress mechanism. In addition, workshops and knowledge exchange events will be organized to share the experiences and lessons learned from the Program with other provinces and rice growing countries.

Expenditure Framework Assessment

57. **The expenditure framework in the six demonstration counties in Hunan Province presents an adequate basis for the Program.** RA2 and RA3 involve massive public investment, while RA1 focuses on institutional strengthening and innovation with relatively small public expenditure. Thus, the EFA mainly focuses on the budgets and expenditures related to the activities under RA2 and RA3, which are supported under the budget lines of both the agriculture and water sectors. Based on the budget data from 2019 to 2022, the EFA has shown that the six demonstration counties spent a total of US\$790.5 million equivalent for the Program-related activities. It is forecasted that the Program financing from the Government will reach US\$988 million from FY2024 to 2029.

⁷³ Liu, Yong, Jorge Ruiz-Menjivar, Lu Zhang, Junbiao Zhang, and Marilyn E. Swisher. 2019. "Technical Training and Rice Farmers' Adoption of Low-Carbon Management Practices: The Case of Soil Testing and Formulated Fertilization Technologies in Hubei, China." *Journal of Cleaner Production* 226: 454–462.



58. **The overall Program funding is expected to be adequate, predictable, and sustainable.** The counties rely heavily on the transfers from the higher-level governments (HLGs) or the central and provincial governments for financing the Program activities. Three mechanisms are used by the HLGs to transfer funds to county governments to support the Program-related activities: 'Transfer for central-local shared functions on agriculture, forestry and water affairs,' 'Incentive funds of major grain (oil) producing counties,' and 'Earmarked transfers for agricultural, forestry and water affairs.' The 'Earmarked transfer for agricultural, forestry and water affairs' is an earmarked transfer and the other two are general transfers. The earmarked transfers provide strong incentives for counties to implement the Program-related activities, while general transfers help fill financing gaps. From 2019 to 2022, the three transfers allocated by the HLGs to the Program counties amounted to US\$1,320.7 million equivalent. The bulk of the Program expenditures would be financed by HLG transfers, which are adequate and largely predictable. Noticeable amounts of earmarked funds have been arranged to support incentive reforms such as the agricultural water pricing reform. Specifically, from 2019 to 2022, US\$2.3 million equivalent from the Central and Provincial Water Conservancy Development Fund was allocated to these six demonstration counties to support the agricultural water tariff reform. In addition, a series of documents on earmarked fund management have been issued by the MOF, DARA and PDWR in Hunan, stipulating that the transferred funds shall only be used for the specified activities. The fund allocations are factor based or project based and subject to performance evaluations. The performance evaluation results are an important factor for fund allocation. Therefore, there are strong incentives for the Program counties to achieve the desired objectives of promoting low-methane and water-saving rice production and to ensure value for financing. The recent General Public Budget Revenue (GPBR) in Hunan Province has been relatively stable, despite the negative impacts of the COVID-19 pandemic. The total expenditure of this Program only accounts for about 0.5 percent of the GPBR in Hunan. Thus, the Program funding appears sustainable.

Economic Assessment

59. **The economic assessment adopts a CBA approach based on the quantifiable benefits from rice production at the local level and global benefits of GHG reduction.** The assessment compares a scenario of no-government program to a scenario of a Government program including World Bank support.⁷⁴ The incremental economic costs include investment costs for infrastructure improvement, technical package adoption, operational costs for agricultural production, and training and capacity-building costs. The major benefits included in the analysis are incremental crop production and price premiums from quality improvement; savings from reduced agricultural input costs (fertilizer, agrochemicals, diesel, and irrigation water); and benefits from GHG emission reductions. Other substantial positive externalities, including improved soil quality and biodiversity, are not included in the analysis as they are not easily quantifiable.

60. **The following assumptions have been applied in the analysis:** (a) increased production and reduced inputs are based on the evaluation findings of the government agencies and complemented by experts' and extension workers' opinions; (b) investment costs are in line with the standard unit cost norms as mandated by the provincial government; (c) carbon shadow prices are set following the World

⁷⁴ This approach is used because under a PforR, Government and World Bank funds are combined to achieve results, with no distinction at the activity level between World Bank-financed and Government-financed achievements.



Bank Guidance Note on Shadow Price of Carbon in Economic Analysis (November 2017);⁷⁵ (d) Program life of 20 years; (e) the discount rate adopted by the analysis is 6 percent, chosen according to guidelines from the NDRC, which is in line with the World Bank's guidance for discount rates;⁷⁶ and (f) taxes, duties, and subsidies are not included as they represent transfer payments instead of real costs or benefits to society as a whole.

61. Cash flows of benefits and costs for the economic model are projected over 20 years to estimate their economic rate of return (ERR). The ERR with GHG reductions is estimated at 24 percent (at a low-carbon shadow price), 34 percent (at a high-carbon shadow price), and 14 percent at ERR without GHG reductions. These are all well above the discount rate of 6 percent, indicating that the Program is economically viable and robust.

62. Net GHG Emission Reduction. The GHG emission reduction will be achieved mainly through three activities: (a) AWD practices in the six counties; (b) HSFC practices, especially soil carbon sequestration; and (c) organic fertilizer application, which will replace a certain percentage of chemical fertilizer, thus reducing GHG emission. The EX-Ante Carbon-balance Tool (EX-ACT) was used to estimate net emissions reduction by results area (See table 5). Preliminary assessment shows that the Program will reduce some 479,391 MtCO₂-e per year or about 2,396,957 MtCO₂-e over its five-year implementation period. The GHG analysis is based on the rice cultivation areas with modernized irrigation and drainage infrastructure systems, and that the emission reduction from the infrastructure inputs has been taken into account. The assessment does not include the climate mitigation co-benefits generated from irrigation energy-saving or improved institutional interventions and plans. In addition, the estimated GHGs emission reduction presented herein are restricted to activities under the six Program counties. Thus, these estimates could be considered as conservative, especially given that there is huge potential for scaling up the Program activities beyond the Program counties. The GHG emission reduction estimation will be done at the midterm and the end of the Program (compared with the 2021 baseline values) in the six demonstration counties and will be measured by metric tons of CO₂ equivalent. This approach would give the third-party independent verification agency sufficient time to verify the results using the agreed protocols and MRV methodologies.

Table 5. Estimated Ex Ante Net Emissions Reductions by Results Area and DLI (Metric ton CO₂e/year)

Results Areas	DLIs	Program Interventions	GHG Reduction/year
RA2 – Reducing GHG emissions for low-methane development	DLI4	Increased rice areas adopting AWD technology and deep returning of straw	366,363
		Increase in new/upgraded high-standards farmland area in demonstration counties-especially soil carbon sequestration	111,068
		Organic fertilizer (replacing chemical fertilizer)	1,960
Total			479,391

⁷⁵ According to the World Bank's Guidance Note on Shadow Price of Carbon in Economic Analysis issued on November 12, 2017, the projects' economic analyses should use a low and high estimate of the carbon price starting at US\$40 and US\$80 in 2020 and increasing to US\$50 and US\$100 by 2030. The low and high values on carbon prices are extrapolated from 2030 to 2050 using the same growth rate of 2.25 percent per year that is implicit from 2020 to 2030, leading to values of US\$78 and US\$156 by 2050.

⁷⁶ World Bank. 2015. *Technical Note on Discounting Costs and Benefits in Economic Analysis of World Bank Projects*. The discount rate is recommended to be 6 percent for investments with long-term unquantified E&S benefits.



B. Fiduciary

63. **Adequacy of the Program's fiduciary systems.** Pursuant to the World Bank's Policy and its associated Directive on PforR Financing of November 10, 2017, and June 20, 2019, respectively, as well as the World Bank's PforR Fiduciary Systems Assessment Guidance Note issued on June 30, 2017, the World Bank's Fiduciary Team carried out a Fiduciary Systems Assessment (FSA). According to the FSA and given the agreed actions to strengthen the fiduciary systems, as reflected in the PAP, and other proposed mitigation measures that will be implemented—the Program's fiduciary systems, including the financial management (FM), procurement, and governance systems, are considered to adequately meet the requirements laid out in the World Bank's PforR Policy and Directive. They provide reasonable assurance that the Program's financing proceeds will be used for the intended purposes, with due attention to the principles of economy, efficiency, effectiveness, transparency, and accountability.

64. **FM risks.** Major risks identified include the following: (a) budget quota was distributed to counties/district in batches and some Program funds were delivered in the second half year or even the year end which prevents the county/district government from including the entire program funds in its annual budget; (b) 'Program' is not a budget classification element in China and the required Program financial reporting cannot be generated from the Government's treasury system; (c) the high-standard farmland construction fund which is the main financing source of program funds is not integrated in the management information system (MIS) developed by the DARA and the MIS developed by DARA does not have a function for financial reporting; (d) Program funds are not always delivered to the beneficiaries timely; (e) the internal audit function is relatively weak and most government entities do not established internal audit unit and equipped with sufficient staff; and (f) Government auditors did not audit the Program funds and prepare the Program audit report.

65. **Mitigation measures.** The proposed mitigation measures include the following:

- (a) Provincial entities should revisit their budget quota distribution and take actions to ensure the budget quota could be distributed to county/city in advance. County/district government should include all program funds in its approved annual budget.
- (b) A green tagging mechanism which can trace program expenditures from the Government's existing integrated financial management system (IFMIS) has been recommended and it is expected to be piloted, especially in those demonstration counties, during project implementation. This also creates fundamental basis for generating Program financial reporting from the Government's treasury system.
- (c) All budget funds managed by DARA should be included in the MIS so that the funds could be properly monitored, and the financial reporting function should be added in the MIS.
- (d) PDARA should work with the PDOF closely to supervise the delivery of program funds to ensure the funds reach the beneficiaries on time. The external auditors will verify the timely delivery of program funds in the annual audit.
- (e) The capacity of internal auditors should be strengthened, and the supervision of Program funds by the province should be enhanced.



- (f) The World Bank will work with the Provincial Audit Offices (PAOs) to develop the TORs for the Program auditing to ensure Program funds can be audited in line with the World Bank's policy.

66. **Procurement overview.** The Government of China has a robust legal framework for procurement, which includes the Tendering and Bidding Law (TBL) of 1999; the Government Procurement Law (GPL) of 2003; and regulations and orders issued at the national, provincial, and county levels. Although the laws could be modernized and aligned to modern principles such as 'value for money' and 'fit for purpose', both offer a fair playing field for bidders and promote transparency and competitiveness. The Government has recently encouraged the use of electronic bidding. All open bidding competitive processes are conducted by public resources trading centers, which provide facilities and modern platforms for processing procurement activities electronically.

67. **Procurement risks and mitigation measures.** Five major procurement risks have been identified as follows:

- (a) TBL Clause 41 defines two evaluation methods: comprehensive scoring method and lowest evaluated responsive bid method. In line with this TBL clause and the provincial TBL implementation notice issued by the provincial DRC, the PDARA-issued MBDs provide three evaluation methods: comprehensive evaluation method I, comprehensive evaluation method II, and lowest evaluated responsive method. The comprehensive evaluation method (30–80 percent weighting for technical qualification and 70–20 percent for price) is commonly adopted while the lowest evaluated responsive method is used sometimes. There appear potential risks of inappropriate flexibility in setting and evaluating technical criteria, which might have an impact on the economy, fairness, and transparency. The mitigation measure is proposed: 'the comprehensive evaluation method' shall be used subject to the weighting percentage of financial proposal to be greater than 70 percent for most of farmland construction works, while 'the lowest evaluated responsive bid' will be encouraged as an alternative option of bid evaluation principle.
- (b) Contracts may be awarded to firms or individuals which are debarred or under temporary suspension by the World Bank or other multilateral development banks. The following mitigation measures are proposed:
 - (i) Upon Program loan effectiveness, the Hunan Program Provincial Leading Group/provincial authority/PDRC shall issue a high-level official letter or official instruction to require Program implementation agencies to ensure that no contract will be awarded to ineligible firms or individuals. The Program implementation agencies (that is, procuring entities) should include the World Bank's website link to the debarment list (which is dynamic) as one of the minimum qualification requirements in the bidding documents. When the bid evaluation starts or before contract award is issued, the implementation agencies and/or the bid evaluation committees shall check the latest lists of the debarred and temporarily suspended firms and individuals to ensure contract being awarded to eligible firms or individuals or as an alternative to the measure in above, since the full-process electronic bidding (e-procurement) has functioned in the provincial e-procurement system and the systems in the six counties, the World Bank recommends that one additional function may be developed in the



existing e-procurement systems to link to the sanction list of the World Bank's website and the procuring entities are required to check the website and the list, and shall confirm in the e-procurement system that the recommended bidder is not included in the list, before the bid evaluation results are allowed to be published through the e-procurement systems.

- (ii) The TOR for annual external audit shall include the task of randomly selecting contracts and assessing whether they have been awarded to an ineligible firm or individual.
- (c) The World Bank may not be informed of fraud allegations and corruption issues during the Program's implementation. Besides specific trainings that shall be provided to all staff who will handle procurement under the Program on the subject, a PIP shall be prepared by the PPMO and CPMOs, and they are required to inform the World Bank of any credible and material allegations of fraud and any corruption issues as part of the Program progress reports, as mandated in the Loan Agreement. Non-reporting shall be regarded as a gross deviation from provisions of the Anti-Corruption Guidelines for PforRs.
- (d) Payment schedules in the signed contracts of several counties lag far behind the construction progress and lack milestones or timeline of each payment. The payment schedule in the contract should follow the requirements of Standard Bidding Document issued by government authorities and ensure (i) payment is made in proportion to the construction progress and (ii) explicitly state milestones or timeline of each payment.
- (e) Contracts may not be completed within the contractual completion time, and the contract completion audit may not be completed on time. Procedures or a guidance note should be produced by the PPMO and/or CPMOs that define the undertaking of contract administration responsibilities in line with the agencies' Regulatory Framework.

68. **Fiduciary supervision.** Procurement and FM are subject to annual audit by government audit offices. Procurement following the procedures of the TBL is subject to regular supervision and oversight by Development and Reform Commissions (DRCs) at various levels and relevant sector authorities. The Finance Department or bureaus at various levels exercise regular supervision and oversight for procurement following the procedures of the GPL.

69. **Fraud and corruption risks.** The Government has institutions in place to combat fraud and corruption. These institutions are designed to prevent, report, detect, investigate, prosecute, and sanction fraud and corruption. These institutions include the discipline inspection commissions within all implementation agencies, supervision bureaus, anticorruption bureaus under People's Procuratorates, and audit offices, all at the central, provincial, prefectural, and county levels. These agencies have comprehensive mandates to combat fraud and corruption. Any bidder or any party can report fraud and corruption issues to any of these government agencies. The World Bank's right to conduct an inquiry into such allegations or other indications, independently or in collaboration with the borrower regarding activities and expenditures supported by the Program, as well as its right to access to the required persons, information, and documents will be observed in accordance with the standard arrangements for this purpose between the Government and the World Bank. The Program's Legal Agreement will also oblige the client to fully comply with obligations under the World Bank's Anti-Corruption Guidelines for PforR operations.



C. Environmental and Social

70. **An Environmental and Social Systems Assessment (ESSA) was prepared to evaluate the soundness of applicable E&S 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. Due to COVID-19, the ESSA was mainly drafted based on desktop review, and robust engagement with various stakeholders at province, county, and local levels, and cross-reference to the ESSA for recent World Bank-financed PforR with Hunan and other provinces. During the pre-appraisal mission, site visits and supplementary interviews was carried out to supplement and strengthen the ESSA. Annex 5 summarizes the ESSA's main conclusions.

71. **The Program will focus on supporting small-scale physical activities and non-physical activities.** The Program is to support methane-reduction and climate-resilient rice production with physical activities in six demonstration counties of Hunan Province and non-physical activities and actions, some of which would have province-wide implications. The main types of physical works supported by the PforR will mainly involve upgrades, rehabilitation of existing infrastructure (within the existing footprint of designated protected farmland) to improve efficiency (for example, upgrading and improving small-scale existing irrigation and drainage system, on-farm access roads, and rehabilitating and desilting existing small water storage ponds). The Program primarily focuses on smaller existing irrigation canals, mostly 4th and 5th level, and to some extent the 3rd level. In China, the farmland irrigation system is typically classified based on the level of the canals, which follow on from the main irrigation system, including the water sources, main canals (1st level), branch canals (2nd level), to on-farm system including the lateral canals (3rd level), farm ditch (4th level), and field ditch (5th level). The high-standard farmlands activities under this program focus on the on-farm irrigation canals with relatively small sizes, mainly the farm ditch, field ditch, and partially lateral canals. These canals have such typical cross-sections as 80x80 cm (width x height), or 100x100 cm for lateral canals, 40x45 cm for farm ditches, and smaller sizes for field ditches. Only these three types of canals are included in the Program scope. On-farm access roads include tractor ploughed roads (typical roads with width 2.5–3.5 m) and production roads (typical roads with width 2.0–2.5 m). The works will focus on the upgrading of the existing access roads by hardening the road surface with sand-gravel rather than developing a completely new road. Rehabilitation of small water storage ponds includes the desilting and upgrading measures to the existing ponds instead of building new ponds. These designated areas contain contiguous farmland with supporting facilities. The PforR does not support development of high-standard farmlands beyond the designated farmland area.

72. The application and extension of agricultural technologies (for example, nutrient management and test-based fertilization to reduce chemical fertilizer use, AWD irrigation, and integrated pest management service provided by specialized organizations to reduce pesticides use and efficiency improvement). E&S impacts of the technologies are considered moderate at most, as the impacts are generally positive. These technologies will be applied on existing farmlands to reduce chemical pesticides and chemical fertilizer use and related pollution, improve soil quality, reduce methane emissions, and enhance the ecological environment. The main types of non-physical activities supported by PforR relate to development/revision of related guiding documents, strategy and standards, improvement of irrigation and drainage services, engagement of farmer users and private sector, as well as to agricultural water



pricing reform, water rights and carbon trading, and institutional strengthening and support services, such as strengthening farmer water user groups/cooperatives, smart irrigated agriculture management and targeted training and capacity building, and so on.

73. **The Program would generate broad and significant E&S benefits.** The PforR Program aims to promote a transition to green, resilient, and inclusive rice production in Hunan Province. It will generally significantly improve the regional environment and the well-being of community residents through reducing GHG emissions, promoting food security, improving water and resources efficiency, reducing chemical fertilizer and pesticides use and efficiency improvement, reducing agricultural non-point pollution, and improving agricultural eco-environment, among others. Some inevitable, transient, and small-scale adverse E&S risks and impacts will essentially be managed by the existing E&S systems at the national, provincial, and local levels.

74. **The overall E&S risks/impacts associated with these PforR activities are rated moderate.** This risk rating is supported by the following rationale:

- (a) The physical civil works under the Program will mainly involve upgrades, and rehabilitation of existing infrastructure (within the existing footprint of designated protected farmland) to improve efficiency, including upgrading small irrigation and drainage canals, resurfacing roads, and desilting water storage ponds.
- (b) All investments will be implemented on existing farmlands, which are considered as having relatively low sensitivity. The results of the works are to increase effective cultivation area and improve the farming conditions and will not cause land acquisition or adverse income impact because the implementation is between crop seasons. The civil work construction involves small-scale employment of labor with low or moderate potential adverse impacts on health and safety of workers and communities. Any changes in contractual rights and management rights of farmers, not required by the program, are completely on voluntary basis.
- (c) The client, Hunan DARA, has sufficient experience with World Bank projects (for example, the World Bank-funded Hunan Integrated Agricultural Land Pollution Management Project, for which the PPMO is also located at PDARA, who assigned staff responsible for E&S management and engaged the external E&S monitoring teams) and has a strong team and commitment, indicating adequate capacity for program implementation. Furthermore, the Program coordinating groups at provincial and county levels are established to guide the PMOs in managing the E&S risks.
- (d) The institutional capacity and complexity risks, as well as political and reputational risks, are assessed to be low or moderate for all Program activities from E&S perspective. Consistent with the World Bank Guidance on PforR ESSA, a Program-specific E&S exclusion list was established (see annex 5) 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. The small-scale civil works investments will be implemented on existing farmlands, which the team considers having relatively low sensitivity, and scattered in hundreds of villages, with small scale activities in each village. The physical works consist of rehabilitation and minor upgrading of existing small-scale linear rural infrastructure and will



be undertaken using a staged approach to minimize associated impacts. The E&S impacts at each site are very minimal, localized, and temporary and can be readily addressed with mitigation measures using the existing system.

75. 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 issues, as physical civil works under the Program will mainly involve upgrading and rehabilitation of existing infrastructure (within the existing footprint of designated protected farmland) to improve their performance and efficiency, including upgrading small irrigation and drainage canals, resurfacing roads, and desilting water storage ponds, and so on. The local endemic pathogen threats have been very low: Hanshou County and Dingcheng District have not found any positive cases of human infection nor positive snail and positive livestock (cattle and sheep) cases in local areas over the past eight consecutive years since 2014, reaching the lowest epidemic level in history. 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 World Bank OP/BP 7.50 (Projects on International Waterways) nor OP/BP 7.60 (Projects in Disputed Areas) applies to the Program.

76. **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 execute the existing legal framework generally well and guarantee the achievement of sound performance tracks on the ground. The track records show that the management capacity and performance are 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.

77. **Four E&S actions are recommended for inclusion in the PAP for risk mitigation.** The ESSA report recommends that the Program should enhance Hunan's E&S management systems at all levels. Effective prevention and mitigation measures should be formulated for the E&S risks in the process of high-standard farmland construction and agricultural water price reform. The following actions have been proposed in the PAP:

- (a) The existing mechanism of interdepartmental joint prevention and control of schistosomiasis shall be integrated into the Program activities to safeguard health and safety of construction workers and farming operators related to water in the endemic area of Hanshou County and Dingcheng District, in line with the Government efforts to minimize the risk of infection.



- (b) Inclusion of specific and standardized subsections on E&S management in the design documents for the Program activities.
- (c) For the documentation of the non-physical activities with possible downstream adverse impacts (for example, agricultural water pricing reform program). The TORs shall set out requirements to identify and assess downstream E&S risks and impacts, explore means to engage with farmers and other stakeholders during the study, and formulate appropriate mitigation measures and assistance to vulnerable groups in the outputs.
- (d) For water right trading activity, survey on farmers' affordability and willingness to pay for water use shall be conducted while formulating the plan. Before and during the implementation of the plan, extensive publicity and public engagement by means of public hearings and mobilizing of farmers and WUAs shall be carried out.

78. **Consultation and stakeholder engagement.** Robust engagement was carried out with relevant stakeholders during the ESSA process, including with the government departments at the provincial, county/city, and township levels, local communities, and relevant groups by means of meetings, and online and face-to-face interviews during pre-appraisal mission with a total of over 300 interviewees, of which more than 30 percent were female participants. The draft ESSA report was shared with Hunan PPMOs and CPMOs, relevant provincial government departments, and relevant agencies of all demonstration counties/districts on February 6, 2023. Consultation meetings on the draft ESSA report was carried out with all the key stakeholders at county and provincial levels from February 16 to 21, 2023. During the preparation of the ESSA report, the stakeholders consulted voiced their support for the proposed Program. The feedback from the participants have been reflected in the revised ESSA report. The revised ESSA report was disclosed on the World Bank's website and the client's websites before the Program appraisal.

79. **The country system has in place grievance redress mechanism (GRMs).** The existing program grievance mechanism has included community and enterprise GRMs. The community GRM consists of four levels: first, grievances are reported directly to the relevant PIUs to seek a solution; second, grievances are reported to the village or community committee for address; third, grievances are reported to the township government or sub-district office for coordination and address; and fourth, grievances are reported to the county Public Complaints and Proposals Bureaus (PCPBs) or the county head's hotline/mailbox, and so on, which includes a mechanism of collection, initiation within seven days, and solving within two months. In addition, residents can resolve more serious disputes through civil actions at court. that is, communities and individuals who believe they are adversely affected due to World Bank-supported Program operations, as defined by the applicable policy and procedures, may also submit complaints to the existing program grievance mechanism or the World Bank's grievance redress service (GRS). The GRS ensures that complaints received are promptly reviewed to address pertinent concerns.

80. Communities and individuals who believe that they are adversely affected by the PforR operation, as defined by the applicable policy and procedures, may submit complaints to the Bank's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed to address pertinent concerns. Project affected communities and individuals may submit their complaint to the Bank's independent Accountability Mechanism (AM). The AM houses the Inspection Panel, which determines whether harm occurred, or could occur, because of Bank non-compliance with its policies and procedures, and the Dispute Resolution Service, which provides communities and borrowers with the



opportunity to address complaints through dispute resolution. Complaints may be submitted at any time after concerns have been brought directly to the Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the Bank's Grievance Redress Service (GRS), please visit <http://www.worldbank.org/GRS>. For information on how to submit complaints to the Bank's Accountability Mechanism, please visit <https://accountability.worldbank.org>.

V. RISK

81. **The overall risk is rated Substantial.** The risk assessment is informed by the results of the technical, fiduciary, and environmental and social systems assessments.

82. **The technical design risk is rated Substantial.** The Program will require close engagement with a large number of rice farmers and farming communities in adopting climate mitigation measures. This Program also involves some innovative interventions, including MRV application, agricultural water pricing reform, and carbon and water rights trading. The comprehensive technical design and involvement of many farmer communities pose a substantial technical design risk. Farmer consultation and stakeholder engagement identified the opportunities and internal incentives for farmers to adopt the climate mitigation measures, which have been used to inform the Program design. The demonstration counties showed strong interests to explore carbon trading and water rights trading. The detailed implementation plans for the carbon trading and water rights trading pilots are subject to review by the World Bank. Beside the requirements in the Hunan HSFCP, China launched a Comprehensive Agricultural Water Pricing Reform Program in 2016 with strong commitments from central to local governments and clear guidance from the central government on the reform's implementation (annex 3), which can help mitigate the risks of reform under this Program. As another PforR Program, GARR (Hubei and Hunan), aims to develop the MRV methodology for paddy rice GHG emissions covering Hunan Province, this Program will adopt and apply the MRV developed to measure, report, and verify rice GHG emissions and support the carbon trading pilots in selected counties. In Hunan, DARA hosts the PPMOs of both GARR (Hubei and Hunan) and this Program, which will coordinate the development of an MRV methodology and its applications under two Programs. However, the uncertainty with the timely completion of MRV development under GARR (Hubei and Hunan) poses a significant risk for this Program. The mitigation measure is to include MRV development as a PAP action for this Program, so that if there are significant delays in MRV development under GARR (Hubei and Hunan), Hunan Province commits itself to developing the MRV under this Program.

83. **The institutional capacity for implementation and sustainability risk is rated Substantial.** Despite the experiences of the provincial implementing agency (DARA) with IPF operations, the agency has limited experience with results-based financing in the agriculture and water sectors. The responsibility for Program implementation remains largely with county governments with limited institutional capacity. Training for provincial and local government officials on the rationale and implementation of the PforR mechanism has been carried out during Program preparation and will continue during Program implementation. The expert panel at the provincial level and technical support teams at the county level will be established to provide technical support. The high-level PPCGs and CPCGs will provide the required cross-sectoral coordination.

84. **The fiduciary risk is rated Substantial.** Fiduciary systems, including the FM and procurement, are considered adequate to meet the World Bank's requirements. Risks include the delays in the delivery of



some program funds. The Government program has no budget classification element, and the required Program financial reporting cannot be generated from the Government treasury system. The funds for high-standard farmland construction have not been integrated into the MIS system developed by DARA. Government auditors have not yet audited the program's funds and there were delays in the payment of some program funds. Main procurement risks are associated with the selection of the bid evaluation method, the complaint reporting mechanism, and contract management process. The mitigation measures include (a) the lead provincial implementation agency, DARA, works closely with the PDOF to supervise the timely delivery of Program funds, (b) the provincial entities take necessary actions to ensure the budget quota distributed to the counties in advance, while the county governments are requested to include all Program funds in the approved annual budget, (c) all budget funds managed by DARA be included in the MIS to properly monitor the funds, (d) a green tagging mechanism will be used to track program expenditures from the Government's existing integrated FM system, (e) comprehensive evaluation method is recommended for consulting services contracts, and (f) an annual external audit process shall be adopted to ensure ineligible firms or individuals do not receive contracts and contract payments are made timely under the Program.

85. **The overall E&S risk is rated Moderate.** With the application of the exclusion list (see annex 5) and given that all investments will be implemented on existing footprint of designated farmlands with relatively low sensitivity, the focus of physical activities is on upgrading and rehabilitation of existing small-scale infrastructure to improve efficiency. 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 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. The client, Hunan DARA, has sufficient experience with World Bank projects, and Program coordinating groups at provincial and county levels are established to strengthen the PMOs for managing the E&S risks. The institutional capacity and complexity risks, as well as political and reputational risks, are assessed to be low or moderate for all Program activities from an E&S perspective. Neither the World Bank OP/BP 7.50 (Projects on International Waterways) nor OP/BP 7.60 (Projects in Disputed Areas) applies to the Program.

86. **The stakeholder risk is rated Moderate.** The Program involves several sector departments at the provincial and county levels, including agriculture, water, ecology, and environment, and there is a risk associated with cross-sectoral coordination in Program planning and implementation. To mitigate the risk, the provincial government issued instructions requiring the agriculture and water sector agencies to coordinate and collaborate closely in planning and implementing the HSFCP and irrigation/water management interventions. A cross-sectoral Program coordination group as well as a PMO with members from related departments will be established at the provincial and county levels to ensure effective coordination. The Program will also engage a large number of farmers, which poses a significant risk. This will be mitigated by providing farmers with a combination of financial incentives, capacity building, and empowerment as indicated in the sections above.



ANNEX 1. RESULTS FRAMEWORK MATRIX

Results Framework

COUNTRY: China

Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)

Program Development Objective(s)

To reduce methane emissions and support climate resilient rice production in China's Hunan Province.

Program Development Objective Indicators by Objectives/Outcomes

Indicator Name	DLI	Baseline	Intermediate Targets				End Target
			1	2	3	4	
Strengthened government management system for sustainable development impacts							
Strengthening government management system for water-saving and low-methane rice production (Text)	DLI 1	The related strategy, standards and guiding documents need to be developed or revised	Issuance of a provincial guiding document on water use right trading implementation	Development/issuance of integrated provincial technical standards for water-saving and low-methane rice production;	Development/issuance of a provincial water-saving and low-methane rice production strategy and implementation plan;	Revision/issuance of provincial water-saving irrigation quota for rice production;	Four key standards and guiding documents developed and issued for water-saving and low-methane rice production
Reduced GHG emissions in demonstration counties							
Net GHG emission reduction in demonstration counties (Ton CO2 equivalent) (Metric ton)		0.00	479,391.00	958,782.00	1,438,173.00	1,917,564.00	2,396,957.00
Improved irrigation and drainage services for resilient rice production							



Indicator Name	DLI	Baseline	Intermediate Targets				End Target
			1	2	3	4	
Beneficiaries reached with improved irrigation and drainage services in demonstration counties (of whom women) (Number)		0.00	185,100.00	288,800.00	402,800.00	515,900.00	647,500.00
Female farmers reached with improved irrigation and drainage services in demonstration counties (Number)		0.00	90,840.00	141,400.00	196,100.00	252,100.00	316,600.00



Intermediate Results Indicator by Results Areas

Indicator Name	DLI	Baseline	Intermediate Targets				End Target
			1	2	3	4	
Results Area 1: Strengthening management system for sustainable development impacts							
Development/issuance of a provincial water-saving and low-methane rice production strategy and implementation plan (Text)		No provincial strategy and implementation plan	Complete the TORs	Develop the strategy and implementation plan	Issue the strategy and implementation plan	--	The strategy and implementation plan issued
Development/issuance of (provincial) technical standards for water-saving and low-methane rice production (Text)		No integrated technical standard	Complete the TORs; Prepare the integrated standards	Approve and issue the integrated standards	--	--	The integrated standards approved and issued
Development/issuance of provincial water-saving irrigation quota for rice production (Text)		No irrigation quota for water-saving rice production	Complete the TORs	Data collection and experiment on water quota under different irrigation zones	Revise the existing irrigation quota	Approve and issue the water-saving irrigation quota for rice production	The water-saving irrigation quota for rice production approved and issued
Issuance of a provincial guiding document on water use right trading (Text)		Draft guiding document under preparation	Approve and issue guiding document	--	--	--	Guiding document approved and issued
Demonstration counties establishing and maintaining an agriculture and water sector coordination mechanism for high-standard farmland construction and O&M (Text)	DLI 2	No formal coordination mechanism	No formal coordination mechanism	Establishment of coordination mechanisms in six demonstration counties	Annual implementation of coordination mechanisms in six demonstration counties	Annual implementation of coordination mechanisms in six demonstration counties	Annual implementation of coordination mechanisms in six demonstration counties
Results Area 2: Reducing GHG emissions for low-methane development							
Increase in new/upgraded high-standards farmland area		0.00	15,940.00	24,320.00	33,110.00	42,277.00	51,183.00



Indicator Name	DLI	Baseline	Intermediate Targets				End Target
			1	2	3	4	
in demonstration counties (Hectare(Ha))							
Farmers trained on the low-methane rice cropping package solution/technologies (of whom women) (Number)	DLI 3	0.00	14,687.00	14,692.00	13,238.00	13,238.00	13,238.00
Rice areas where both AWD technology and deep returning of rice straw are used (Hectare(Ha))	DLI 4	0.00	24,382.00	47,763.00	71,138.00	95,853.00	117,198.00
Increase in rice field area applying organic fertilizer (Tons/year)		12,030.00	21,430.00	30,830.00	40,230.00	49,630.00	59,030.00
Counties which pilot carbon trading (Number)		0.00	0.00	0.00	3.00	3.00	3.00
Results Area 3: Improving irrigation and drainage services for resilient rice production							
Demonstration counties completing a comprehensive agricultural water pricing reform (Number)	DLI 5	0.00	0.00	3.00	6.00	6.00	6.00
Rice production area with sustainable irrigation and drainage services (Hectare(Ha))	DLI 6	42,891.00	73,888.00	84,458.00	97,315.00	110,638.00	125,899.00
Percentage of irrigated areas managed by farmer cooperative organizations (%) (Text)		Qiyang 20%, Jiahe 20%, Lukou 20%, Louxing 20%, Hanshou 65%, Dingcheng 0%;	Qiyang 27%, Jiahe 34%, Lukou 27%, Louxing 27%, Hanshou 70%, Dingcheng 0%;	Qiyang 30%, Jiahe 41%, Lukou 34%, Louxing 34%, Hanshou 75%, Dingcheng 10%;	Qiyang 35%, Jiahe 48%, Lukou 41%, Louxing 41%, Hanshou 80%, Dingcheng 20%;	Qiyang 43%, Jiahe 53%, Lukou 48%, Louxing 48%, Hanshou 85%, Dingcheng 35%;	Qiyang 51%, Jiahe 60%, Lukou 55%, Louxing 55%, Hanshou 90%, Dingcheng 50%;
of which with women on management team, % (Text)		Qiyang 20%, Jiahe 5%, Lukou 30%, Louxing 30%;	Qiyang 30%, Jiahe 10%, Lukou 32%, Louxing	Qiyang 35%, Jiahe 15%, Lukou 34%, Louxing	Qiyang 40%, Jiahe 15%, Lukou 36%, Louxing	Qiyang 45%, Jiahe 20%, Lukou 38%, Louxing 46%;	Qiyang 50%, Jiahe 20%, Lukou 40%, Louxing 50%;



Indicator Name	DLI	Baseline	Intermediate Targets				End Target
			1	2	3	4	
		Hanshou 5%, Dingcheng 0%	34%, Hanshou 15%, Dingcheng 0%	38%, Hanshou 20%, Dingcheng 40%	42%, Hanshou 25%, Dingcheng 45%	Hanshou 30%, Dingcheng 50%	Hanshou 30%, Dingcheng 60%
Counties that pilot water rights trading or buy-back (Number)		0.00	0.00	1.00	3.00	3.00	3.00

**Monitoring & Evaluation Plan: PDO Indicators**

Indicator Name	Definition/Description	Frequency	Datasource	Methodology for Data Collection	Responsibility for Data Collection
Strengthening government management system for water-saving and low-methane rice production	Indicated by the issuance of the documents at the provincial level, consisting of four key documents to promote and mainstream water-saving and low methane rice production and incentivize adoption by the rice of farmers the new production technologies and practices in the province.	Semi-annual	Report from verification agency		PPMO
Net GHG emission reduction in demonstration counties (Ton CO2 equivalent)	Indicated by the net GHG emission reductions in six demonstration counties, measured by tons of CO2 equivalent. The net GHG emission reductions are mainly the methane emission reduction through water management, nitrous oxide emission reduction through fertilizer management, and carbon sequestration through straw management and soil fertility improvement.	Annual	Annual report on provincial Program progress	During the first and second year of implementation, the net GHG reduction will be estimated based on the MRV methodology and data monitored. From the third year of implementation until Program closure, the net GHG reduction will be estimated and verified based on the database of emission factors.	PPMO and CPMOs



Beneficiaries reached with improved irrigation and drainage services in demonstration counties (of whom women)	Measured by the total number of beneficiaries with access to improved and reliable irrigation and drainage services as defined in the HSFCP designs in six demonstration counties. Beneficiaries are the farmers with access to the improved services.	Semi-annual	Semi-annual report on provincial Program progress	The verification of improved irrigation and drainage services is based on the project design and inspection report of a specific project. The beneficiaries are the farmers who are directly benefited from the project.	PPMO and CPMOs
Female farmers reached with improved irrigation and drainage services in demonstration counties					



Monitoring & Evaluation Plan: Intermediate Results Indicators

Indicator Name	Definition/Description	Frequency	Datasource	Methodology for Data Collection	Responsibility for Data Collection
Development/issuance of a provincial water-saving and low-methane rice production strategy and implementation plan	A provincial water-saving and low-methane rice production strategy and implementation plan developed and issued	Semi-annual	Semi-annual report on provincial Program progress	Official document on the issuance	PPMO
Development/issuance of (provincial) technical standards for water-saving and low-methane rice production	Technical standards for water-saving and low-methane rice production developed and issued, including the standards on low-methane rice varietal selection, water-saving cultivation, fertilizer management, and straw management.	Semi-annual	Semi-annual progress report	Official document on the standard issuance	PDARA and PPMO
Development/issuance of provincial water-saving irrigation quota for rice production	The irrigation water quota should be updated based on the application of water-saving techniques and the requirements of the most strict water resources management	Semi-annual	Semi-annual Program progress report	Official document	PDWR and PPMO
Issuance of a provincial guiding document on water use right trading	Provincial guiding document on water use right trading and government buy-back developed and issued	Semi-annual	Official document	Official document on water saving irrigation quota for rice production	PDWR and PPMO



Demonstration counties establishing and maintaining an agriculture and water sector coordination mechanism for high-standard farmland construction and O&M	Measured by the official establishment of the coordination mechanisms at the county level and the mechanism implementation throughout the Program period. These mechanisms will cover coordination on related investment planning, project design, implementation, and O&M to ensure synergy between main and on-farm irrigation and drainage systems and services. The agriculture and water sectors are required to share data on the High-Standard Farmland Construction Plan and the related water sector projects.	Semi-annual	Report from verification agency	Data collection is based on official documents. Verification will be carried out by the third-party verification agency based on: (i) the establishment of an official coordination mechanism at county level, including the official coordination mechanism with agreed operational procedures, verified based on the official announcement by the county governments; the assignment of dedicated staff with clear responsibilities, verified based on official documents from the county governments or a joint official document between agriculture and water sectors; and the agreed data sharing mechanism under which the database information of large and medium irrigation district upgrading and	PPMO and CPMOs
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				management and the database information of high-standard farmland construction are shared, verified based on the official data sharing agreement between the agriculture and water sectors; and (ii) the implementation of the coordination mechanism, including the annual coordination between the implementation of the HSFCP projects and Large and Medium Irrigation District Upgrading and Water Saving Improvement Program projects, verified based on annual project plans, project implementation reports, annual project summary reports and completion reports; the regular meetings and coordination, verified based on event records, meeting minutes, and official documents	
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				jointed issued by the agriculture and water sectors; and the implementation of data sharing, verified based on a joint official document signed by the agriculture and water sectors indicating data sharing is applied in annual project planning, design, implementation, and O&M.	
Increase in new/upgraded high-standards farmland area in demonstration counties	Newly constructed or updated high-standard farmland area; Annual target is the cumulative value.	Semi-annual	Semi-annual Program progress report	Semi-annual Program progress report	PPMO and CPMOs
Farmers trained on the low-methane rice cropping package solution/technologies (of whom women)	Number of farmers who are trained on the low-methane rice cropping package solution/technologies per year. The low methane package solutions include the water-straw-fertilizer co-management measures, including water-saving practices, dep straw returning, and organic fertilizer application, as well as other	Semi-annual	Report from verification agency	Data on farmer training will be collected by the PPMO and county Program Management Offices (CPMOs). The CPMOs shall establish training ledgers. Surveys and interviews will be carried out by the CPMOs to monitor and evaluate the training outcomes. Verification will be carried out by the third-party verification	PPMO and CPMOs



	<p>complementary mitigation measures, such as deep application of nitrogen fertilizer, test-based formula fertilizer application, climate-smart rice varieties, and aerobic cultivation techniques. The training curriculum and training plan are subject to review by the World Bank. The cumulative numbers of women farmers to be trained for Years 1-5 are: 4,407; 8,816; 12,821; 16,826; and 20,831, respectively.</p>			<p>agency based on: (i) the review of the training ledgers, training summary reports, training curriculum and materials, and training plans, based on the training beneficiaries, training platforms, training formats, training materials articulated in the Program Action Plan (PAP) and PIP; (ii) sequential sampling inspections to randomly sample no less than ten trained farmers in each township, three percent of professional farmers, farmer cooperatives, farmer associations, family farms, and agro-enterprises, and one percent of smallholder farmers. Within these samples, at least 80 percent of sampled farmers should have received the full training and at least 30 percent of the trained farmers sampled should be</p>	
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				female; and (iii) field visits to verify the demonstration farmlands and training programs are implemented as planned.	
Rice areas where both AWD technology and deep returning of rice straw are used	It measures the areas of high-standard rice farmland adopting AWD technology and deep returning of rice straw, as guided in the government technical standards. Optimized AWD is promoted under this Program, including AWD at three rice growing stages: (i) The early stage of rice growing: around 7 days of cumulative drying before and after transplanting; (ii) The late stage of tillering: around 10 days of cumulative drying; and (iii) The yellow ripening to harvesting stage: around 15 days of drying before harvesting. The deep returning of rice straw should return straw residues into the soils with	Semi-annual	Report from verification agency	Data on the rice field area adopting AWD technology and deep returning of rice straw will be collected by provincial and county PMOs. The CPMOs will establish the ledgers for each village to record the rice areas adopting AWD and deep returning of rice straw for double-cropping rice, ratooning rice, one-cropping early rice, one-cropping middle rice, and one-cropping late rice. The CPMOs will carry out the preliminary verification on the project implementation reports, machinery application contracts, completion reports, and ledgers, and submit these materials	PPMO and CPMOs



	over 15 cm depth.			to the PPMO for further verification and auditing. Verification will be carried out by the third-party verification agency based on: (i) the verification of ledgers and other complementary materials, including the project implementation reports, machinery application contracts and completion reports or machinery use records; (ii) random sampling of three villages in each Program county, including random sampling of five percent of straw returning machinery contracts or machinery use records to verify deep returning of straw and random sampling of one percent to three percent of rice farmers to verify the adoption of both AWD and deep straw returning technologies (one	
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				percent of sampling when the number of rice farmers are more than 500 households, and three percent of sampling when the number of rice farmers are less than 500 households); (iii) field soil sampling to verify the depth of straw returning; and (iv) remote sensing to verify the application of AWD in 10 percent of the areas for the drying at the early stage of rice growing. All the reports, records and ledgers need to be countersigned by the respective village supervisory committees.	
Increase in rice field area applying organic fertilizer	It measures the application of organic fertilizer in rice production; Annual target is the cumulative value.	Semi-annual	Semi-annual Program progress report	Semi-annual Program progress report	PPMO and CPMOs
Counties which pilot carbon trading	Number of the demonstration counties pilot carbon trading (cumulative)	Semi-annual	Semi-annual Program progress report	Official document on carbon trading	PPMO and CPMOs



Demonstration counties completing a comprehensive agricultural water pricing reform	<p>It measures the results of comprehensive agricultural water tariff reform in all demonstration counties, including (a) completing the O&M cost estimation of irrigation and drainage systems, carrying out O&M cost auditing and irrigation water pricing auditing, and establishing rational agricultural water tariff regime (including progressive tariff scheme); (b) establishing irrigation water quota management mechanism and the cap on total agricultural water withdrawal, developing water-saving reward mechanism, and establishing precise budget support/subsidy mechanism; (c) installing water flow measurement facilities; and (d) the promulgation of reformed water tariff.</p> <p>The indicator targets are cumulative.</p>	Semi-annual	Report from verification agency	<p>Data will be collected by the provincial and county PMOs.</p> <p>Verification will be carried out by the third-party verification agency based on the related government's official documents, including (i) official approval of the implementation plan by the higher-level municipal or provincial government; (ii) official approval documents by the county governments for O&M cost auditing, an agricultural water tariff regime, a water-saving reward mechanism, and a precise budget support/subsidy mechanism; (iii) official completion reports on the installation of flow measurement facilities; (iv) verification of annual progress reports and ledgers; (v) official approval documents and implementation reports</p>	PPMO and CPMOs
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				by county governments on the cap on total agricultural water amount, water quota management, and progressive tariff scheme; and (vi) official completion acceptance document on the comprehensive agricultural water pricing reform, approved and verified by the higher-level municipal or provincial government.	
Rice production area with sustainable irrigation and drainage services	It will motivate the counties to improve the long-term sustainability of irrigation and drainage services which are essential for climate-resilient and low-methane rice production. The sustainable irrigation and drainage services consist of (a) modernized irrigation and drainage infrastructure; (b) appropriate O&M arrangements with a well-conceived O&M plan and clear O&M responsibility;	Semi-annual	Report from verification agency	Data will be collected by provincial and county PMOs. Verification will be carried out by the third-party verification agency based on: (i) the rice cultivation areas that have modernized irrigation and drainage infrastructure systems which meet the reliability design criteria for high-standard farmland construction, verified by official annual completion reports, final acceptance	PPMO and CPMOs



	and (c) a sustainable O&M funding mechanism established to ensure O&M cost recovery.			certificates, and the completion data reported and incorporated into the existing 'One Map' information database on high-standard farmland construction and management; (ii) the newly constructed/rehabilitated irrigation and drainage infrastructure has dedicated entities responsible for the O&M, verified by official and/or signed contract documents showing the dedicated WUAs, farmer cooperation organizations, and village collectives as the main O&M entities; and (iii) the O&M cost should be reasonably covered with a combined source of collected irrigation water tariff, precise financial budget support and other sources, verified by the actual financial reports	
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				recording water tariff collection, budget support and other sources which cover at least 80 percent of the O&M costs. The verification of (ii) and (iii) will be based on random sampling, which will cover one third of the large and medium irrigation districts, as well as two percent of the O&M entities.	
Percentage of irrigated areas managed by farmer cooperative organizations (%)	Percentage of irrigated areas managed by farmer cooperative organizations (%)	Semi-annual	Semi-annual Program progress report	Semi-annual Program progress report	PPMO and CPMO
of which with women on management team, %					
Counties that pilot water rights trading or buy-back	Number of the Program demonstration counties that pilot water rights trading or buy-back (cumulative)	Semi-annual	Semi-annual Program progress report	Semi-annual Program progress report	PPMO and CPMOs



ANNEX 2. DISBURSEMENT LINKED INDICATORS, DISBURSEMENT ARRANGEMENTS AND VERIFICATION PROTOCOLS

Disbursement Linked Indicators Matrix				
DLI 1	Strengthening government management system for water-saving and low-methane rice production			
Type of DLI	Scalability	Unit of Measure	Total Allocated Amount (USD)	As % of Total Financing Amount
Outcome	Yes	Text	30,000,000.00	11.76
Period	Value		Allocated Amount (USD)	Formula
Baseline	The related guiding documents, strategy and technical standards need to be developed or revised, and issued.			
2024	Issuance of a provincial guiding document on water rights trading implementation		7,500,000.00	US\$7,500,000 for each issued document
2025	Issuance of integrated provincial technical standards for water-saving and low-methane rice production		7,500,000.00	US\$7,500,000 for each issued document
2026	Issuance of a provincial water-saving and low-methane rice production strategy and implementation plan		7,500,000.00	US\$7,500,000 for each issued document
2027	Issuance of provincial water-saving irrigation quota for rice production		7,500,000.00	US\$7,500,000 for each issued document
2028	All documents developed and issued.		0.00	All documents issued



DLI 2	Demonstration counties establishing and maintaining an agriculture and water sector coordination mechanism for high-standard farmland construction and O&M			
Type of DLI	Scalability	Unit of Measure	Total Allocated Amount (USD)	As % of Total Financing Amount
Intermediate Outcome	Yes	Text	25,000,000.00	9.80
Period	Value		Allocated Amount (USD)	Formula
Baseline	No county has official coordination mechanisms			
2024	No county has official coordination mechanisms		0.00	0.00
2025	Six demonstration counties have established the coordination mechanisms		10,000,000.00	US\$ 1,666,667 per county establishing a coordination mechanism
2026	Six demonstration counties have maintained the coordination mechanisms		5,000,000.00	US\$ 833,333 per county maintaining the coordination mechanism
2027	Six demonstration counties have maintained the coordination mechanisms		5,000,000.00	US\$ 833,333 per county maintaining the coordination mechanism
2028	Six demonstration counties have maintained the coordination mechanism		5,000,000.00	US\$ 833,333 per county maintaining the coordination mechanism
DLI 3	Farmers trained on the low-methane rice cropping package solution/technologies (of whom women) (Number)			
Type of DLI	Scalability	Unit of Measure	Total Allocated Amount (USD)	As % of Total Financing Amount
Intermediate Outcome	Yes	Number	50,000,000.00	19.61
Period	Value		Allocated Amount (USD)	Formula



Baseline	0.00		
2024	14,687.00	10,628,427.00	US\$ 723.67 for each additional farmer trained
2025	14,692.00	10,632,047.00	US\$ 723.67 for each additional farmer trained
2026	13,238.00	9,579,842.00	US\$ 723.67 for each additional farmer trained
2027	13,238.00	9,579,842.00	US\$ 723.67 for each additional farmer trained
2028	13,238.00	9,579,842.00	US\$ 723.67 for each additional farmer trained
DLI 4	Rice areas where both AWD technology and deep returning of rice straw to soil are used		
Type of DLI	Scalability	Unit of Measure	Total Allocated Amount (USD)
Intermediate Outcome	Yes	Hectare(Ha)	62,500,000.00
Period	Value	Allocated Amount (USD)	Formula
Baseline	0.00		
2024	24,382.00	13,002,568.00	US\$ 533.3 per each ha. of rice area adopting both AWD and deep straw returning technologies. The annual target is cumulative number.
2025	47,763.00	12,468,750.00	US\$ 533.3 per each ha. of rice area adopting both AWD and deep straw



			returning technologies. The annual target is cumulative number.	
2026	71,138.00	12,465,550.00	US\$ 533.3 per each ha. of rice area adopting both AWD and deep straw returning technologies. The annual target is cumulative number.	
2027	95,853.00	13,180,152.00	US\$ 533.3 per each ha. of rice area adopting both AWD and deep straw returning technologies. The annual target is cumulative number.	
2028	117,198.00	11,382,980.00	US\$ 533.3 per each ha. of rice area adopting both AWD and deep straw returning technologies. The annual target is cumulative number.	
DLI 5	Demonstration counties completing a comprehensive agricultural water pricing reform			
Type of DLI	Scalability	Unit of Measure	Total Allocated Amount (USD)	As % of Total Financing Amount
Intermediate Outcome	Yes	Number	37,500,000.00	14.71
Period	Value		Allocated Amount (USD)	Formula
Baseline	0.00			
2024	0.00		0.00	0.00
2025	3.00		18,750,000.00	US\$6,250,000 per each county completed the reform.
2026	3.00		18,750,000.00	US\$6,250,000 per each county



			completed the reform.	
2027	0.00	0.00	Target achieved	
2028	6.00	0.00	Target achieved	
DLI 6	Rice production area with sustainable irrigation and drainage services			
Type of DLI	Scalability	Unit of Measure	Total Allocated Amount (USD)	As % of Total Financing Amount
Intermediate Outcome	Yes	Hectare(Ha)	50,000,000.00	19.61
Period	Value		Allocated Amount (USD)	Formula
Baseline	42,891.00			
2024	73,888.00		18,671,092.00	US\$ 602.35 per ha. of rice area with sustainable I &D services over the baseline. The annual target is cumulative number.
2025	84,458.00		6,366,856.00	US\$ 602.35 per ha. of rice area with sustainable I &D services over the baseline. The annual target is cumulative number.
2026	97,315.00		7,744,436.00	US\$ 602.35 per ha. of rice area with sustainable I &D services over the baseline. The annual target is cumulative number.
2027	110,638.00		8,025,130.00	US\$ 602.35 per ha. of rice area with sustainable I &D services over the baseline. The annual target is



			cumulative number.
2028	125,899.00	9,192,486.00	US\$ 602.35 per ha. of rice area with sustainable I &D services over the baseline. The annual target is cumulative number.



Verification Protocol Table: Disbursement Linked Indicators

DLI 1	Strengthening government management system for water-saving and low-methane rice production
Description	DLI 1 incentivizes the province to develop and issue critical strategy, technical standards, and guiding documents to strengthen the enabling environment for mainstreaming the production of water saving and low methane rice. The regulatory package of documents at the provincial level will consist of the four key documents: (i) a water-saving and low-methane rice production strategy and implementation plan; (ii) technical standards for water-saving and low-methane rice production; (iii) a provincial water-saving irrigation quota for rice production; and (iv) a guiding document on water use rights trading. The preparation, due approval and issuance of the critical documents will be carried out by the provincial authorities, supported by the PPMO, and in close collaboration with the relevant authorities of the participating counties.
Data source/ Agency	Verification report from an independent agency
Verification Entity	Verification agency
Procedure	The verification will be done at the provincial level. The DLI will be verified by a third-party verification agency, to ensure that the documents have been prepared, duly approved and issued in the required manner; and the documents are of acceptable technical quality that (i) the strategy and implementation plan should develop the short- and long-term plans of promoting and scaling up water saving and low methane technologies, consolidate the experiences and lessons learned on low methane rice production, and lay out the plan for knowledge dissemination and scaling-up; (ii) the technical standards should include the water-saving and low-methane technologies for typical agro-climatic zone conditions, covering the main technologies of low-methane rice varietal selection, water-saving, fertilizer management, and straw management; (iii) the provincial irrigation quota should include the water-saving irrigation quota for single- and double-cropping rice under the conditions of different irrigation zones and irrigation design standard; and (iv) the guiding documents on water rights trading should include the management of irrigation water rights, principles of water rights trading/buy-back, development of trading platform, and monitoring and data management. The verification will be carried out on the final issuance of these documents.
DLI 2	Demonstration counties establishing and maintaining an agriculture and water sector coordination mechanism for high-standard farmland construction and O&M
Description	DLI 2 is measured by number of demonstration counties officially establishing the coordination mechanisms and maintaining of such mechanism throughout the Program period. These county-level mechanisms will cover coordination on



	related investment planning, project design, implementation, and O&M to ensure synergy between main and on-farm irrigation and drainage systems and services. The agriculture and water sectors are required to share data on the High-Standard Farmland Construction Plan and the related water sector projects.
Data source/ Agency	Verification report from an independent agency
Verification Entity	Verification agency
Procedure	Verification will be carried out by the third-party verification agency based on: (i) the establishment of an official coordination mechanism at county level, including the official coordination mechanism with agreed operational procedures, verified based on the official announcement by the county governments; the assignment of dedicated staff with clear responsibilities, verified based on official documents from the county governments or a joint official document between agriculture and water sectors; and the agreed data sharing mechanism under which the database information of large and medium irrigation district upgrading and management and the database information of high-standard farmland construction are shared, verified based on the official data sharing agreement between the agriculture and water sectors; and (ii) the maintenance of the coordination mechanism, including the annual coordination between the implementation of the HSFCP projects and Large and Medium Irrigation District Upgrading and Water Saving Improvement Program projects, verified based on annual project plans, project implementation reports, annual project summary reports and completion reports; the regular meetings and coordination, verified based on event records, meeting minutes, and official documents jointly issued by the agriculture and water sectors; and the implementation of data sharing, verified based on a joint official document signed by the agriculture and water sectors indicating data sharing is applied in annual project planning, design, implementation, and O&M.
DLI 3	Farmers trained on the low-methane rice cropping package solution/technologies (of whom women) (Number)
Description	This DLI supports the targeted training of rice farmers in adopting low-methane package solutions in the demonstration counties. The low-methane package solutions include the water-straw-fertilizer co-management measures, including water-saving practices, straw deep returning, and organic fertilizer application, as well as other complementary climate mitigation measures, such as fertilizer deep application, fertilizer use reduction and efficiency improvement, integrated pest management, climate-smart rice varieties, and aerobic cultivation techniques. The training curriculum and training plan are subject to review by the World Bank.
Data source/ Agency	Verification report from an independent agency



Verification Entity	Verification agency
Procedure	Data on farmer training will be collected by the PPMO and county Program Management Offices (CPMOs). The CPMOs shall establish training ledgers. Surveys and interviews will be carried out by the CPMOs to monitor and evaluate the training outcomes. Verification will be carried out by the third-party verification agency based on: (i) the review of the training ledgers, training summary reports, training curriculum and materials, and training plans, based on the training beneficiaries, training platforms, training formats, training materials articulated in the Program Action Plan (PAP) and PIP; (ii) sequential sampling inspections to randomly sample no less than ten trained farmers in each township, three percent of professional farmers, farmer cooperatives, farmer associations, family farms, and agro-enterprises, and one percent of smallholder farmers. Within these samples, at least 80 percent of sampled farmers should have received the full training and at least 30 percent of the trained farmers sampled should be female. The verification will also track and report on the cumulative number of male and female farmers trained on an annual basis to ensure that the request for disbursements under this DLI for male farmers trained does not exceed 70% of the total target; and (iii) field visits to verify the demonstration farmlands and training programs are implemented as planned.
DLI 4	Rice areas where both AWD technology and deep returning of rice straw to soil are used
Description	This DLI measures the areas of high-standard rice farmland in the demonstration counties adopting AWD technology and deep returning of rice straw, as detailed in the technical standard prepared under DLI 1. Optimized AWD is promoted under this Program, including AWD at three rice growing stages: (i) the early stage of rice growing: around 7 days of cumulative drying before and after transplanting; (ii) the late stage of tillering: around 10 days of cumulative drying; and (iii) the yellow ripening to harvesting stage: around 15 days of drying before harvesting. The deep returning of rice straw requires a burying depth of over 15 cm.
Data source/ Agency	Verification report from an independent agency
Verification Entity	Verification agency
Procedure	Data on the rice field area adopting AWD technology and deep returning of rice straw will be collected by provincial and county PMOs. The CPMOs will establish the ledgers for each village to record the rice areas adopting AWD and deep returning of rice straw for double-cropping rice, ratooning rice, one-cropping early rice, one-cropping middle rice, and one-cropping late rice. The CPMOs will carry out the preliminary verification on the project implementation reports, machinery application contracts and completion reports or machinery use records, and ledgers, and submit these materials to the PPMO for further verification and auditing. Verification will be carried out by the third-party verification agency based on: (i)



	the verification of ledgers and other complementary materials, including the project implementation reports, machinery application contracts & completion reports and machinery use records; (ii) random sampling of three villages in each Program county, including random sampling of five percent of straw returning machinery contracts (and machinery use records where applicable) to verify deep returning of straw and random sampling of one percent to three percent of rice farmers to verify the adoption of both AWD and deep straw returning technologies (one percent of sampling when the number of rice farmers are more than 500 households, and three percent of sampling when the number of rice farmers are less than 500 households); (iii) field soil sampling to verify the depth of straw returning; and (iv) remote sensing to verify the application of AWD in 10 percent of the areas for the drying at the early stage of rice growing. All the reports, records and ledgers need to be countersigned by the respective village supervisory committees.
DLI 5	Demonstration counties completing a comprehensive agricultural water pricing reform
Description	This DLI will measure the number of demonstration counties which have completed a comprehensive agricultural water pricing reform, including (i) completing the O&M cost estimation of irrigation and drainage systems, carrying out O&M cost auditing and irrigation water pricing auditing, and establishing a rational agricultural water tariff regime (including a progressive tariff scheme); (ii) establishing an irrigation water quota management mechanism and a cap on total agricultural water withdrawal, developing a water-saving reward mechanism, and establishing precise budget support/subsidy mechanism; (iii) installing water flow measurement facilities; and (iv) the promulgation of the reformed water tariff.
Data source/ Agency	Verification report from an independent agency
Verification Entity	Verification agency
Procedure	Data will be collected by the provincial and county PMOs. Verification will be carried out by the third-party verification agency based on the related government's official documents, including (i) official approval of the implementation plan by the higher-level municipal or provincial government; (ii) official approval documents by the county governments for O&M cost auditing, an agricultural water tariff regime, a water-saving reward mechanism, and a precise budget support/subsidy mechanism; (iii) official completion reports on the installation of flow measurement facilities; (iv) verification of annual progress reports and ledgers; (v) official approval documents and implementation reports by county governments on the cap on total agricultural water amount, water quota management, and progressive tariff scheme; and (vi) official completion acceptance document on the comprehensive agricultural water pricing reform, approved and verified by the higher-level municipal or provincial government.



DLI 6	Rice production area with sustainable irrigation and drainage services
Description	This DLI will motivate the counties to improve the long-term sustainability of irrigation and drainage services which are essential for climate-resilient and low-methane rice production. The sustainable irrigation and drainage services consist of (i) well-functioning irrigation and drainage infrastructure; (ii) appropriate O&M arrangements with a well-conceived O&M plan, dedicated O&M entities (such as WUAs, farmer cooperation organizations, and village collectives), and clear O&M responsibility; and (iii) a sustainable O&M funding mechanism established to ensure O&M cost recovery.
Data source/ Agency	Verification report from an independent agency
Verification Entity	Verification agency
Procedure	Data will be collected by provincial and county PMOs. Verification will be carried out by the third-party verification agency based on: (i) the rice cultivation areas that have modernized irrigation and drainage infrastructure systems which meet the reliability design criteria for high-standard farmland construction, verified by official annual completion reports, final acceptance certificates, and the completion data reported and incorporated into the existing 'One Map' information database on high-standard farmland construction and management; (ii) the newly constructed/rehabilitated irrigation and drainage infrastructure has dedicated entities responsible for the O&M, verified by official and/or signed contract documents showing the dedicated WUAs, farmer cooperation organizations, and village collectives as the main O&M entities; and (iii) the O&M cost should be reasonably covered with a combined source of collected irrigation water tariff, precise financial budget support and other sources, verified by the actual financial reports recording water tariff collection, budget support and other sources which cover at least 80 percent of the O&M costs. The verification of (ii) and (iii) will be based on random sampling, which will cover one third of the large and medium irrigation districts, as well as two percent of the O&M entities.



ANNEX 3. (SUMMARY) TECHNICAL ASSESSMENT

COUNTRY: China

Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)

1. **The Program is designed to address the priorities in Hunan Province to achieve climate mitigation and resilience in the rice sector and generate lessons for China and other countries.** Rapid reduction of methane emissions is regarded as the single most effective strategy to keep the Paris Agreement goal of limiting global warming to 1.5°C. Reducing rice methane emissions is the key path to reducing methane and the reduction process will yield co-benefits of improving agricultural productivity. Reducing methane emissions from rice is also considered the first task for emission reduction in the agricultural sector in China and Hunan Province. However, these priorities have not been translated into specific climate mitigation actions and measures. This Program will address these priorities and provide replicable lessons to reduce rice methane emissions while supporting food security. The Program is anchored in the ambitious and solid Hunan HSFCP. The Program will leverage the opportunities of the Hunan HSFCP to create conducive conditions for adopting climate mitigation measures, while bridging the gaps to improve the enabling environment, scale up mitigation measures to reduce GHG emissions from rice, and improve irrigation and drainage services to enhance resilience. This Program will address both climate mitigation and adaptation aspects of rice production and will contribute to the long-term outcomes of climate change mitigation and food security. The Program is expected to generate lessons that will benefit other rice-producing nations.

2. **The PforR Program will leverage the HSFCP to scale up climate mitigation measures and enhance resilience.** The proposed PforR will be implemented at both the provincial and demonstration county levels. The PforR Program will leverage the opportunities in the Hunan HSFCP to remove the system constraints for adopting climate mitigation measures and enhancing resilience by building more reliable and flexible irrigation and drainage systems, enhancing soil quality and fertility, and improving associated high-standard farmland facilities. The Program will incorporate climate mitigation concepts and measures into the Hunan HSFCP and scale up these measures with comprehensive training programs. Provincial strategy, guiding documents, and standards will be developed and issued to guide the implementation of climate mitigation measures at the county level. A coordination mechanism between the agriculture and water sectors will also be established at the county level. The Program will use 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 O&M sustainability. Carbon and water rights trading mechanisms will be piloted to generate further incentives and contribute to creation of a virtuous cycle of low-methane and water-saving rice production.

Program Expenditure Frameworks

3. **Total Program financing over the period from FY2024 to FY2029 is expected to be US\$1,243 million.** This estimation is based on the initial EFA. The expenditure framework in the six demonstration counties in Hunan Province presents an adequate basis for the PforR Program. RA2 and RA3 involve intensive public investment, while RA1 focuses on institutional strengthening and innovation with relatively small public expenditure. Thus, the EFA mainly focuses on the budgets and expenditures related to the activities under RA2 and RA3 that are supported under the budget lines of both the agriculture and



water sectors. Based on the budget data from 2019–2021, the EFA shows that the six demonstration counties spent a total of US\$790.5 million equivalent for Program-related activities. It is forecasted that the Program financing from the Government will reach US\$988 million from FY2024 to 2029.

Table 3.1. Program Financing by Result Areas (FY2024–2029)

Result Areas	2019–2022 Actual (US\$, million)	FY2024–2029 Estimated (US\$, million)	
	Hunan	Hunan	Share (%)
RA1	1.6	2.0	0.2
RA2	469.4	586.7	59.4
RA3	319.5	399.3	40.4
Total	790.5	988.1	100.0

4. **Program expenditure boundary.** Hunan has an IFMIS to allocate budgets and track public expenditures. According to the budget classification, there are some major budget lines recording the budget expenditures for the Government program: ‘Agriculture and Rural Affairs’ (code 21301) managed by the DARA, including ‘Agricultural Production Development’ (code 2130122), and ‘Farmland construction’ (code 2130153); and ‘Water Conservancy Affairs’ (code 21303) managed by the PDWR, including ‘Water Resource Conservation Management and Protection’ (code 2130311) and ‘Farmland water conservancy’ (code 2130316).

Table 3.2. Program Expenditure Boundary in 2019–2021 (US\$, million)

Code	Budget Line	Government program	PforR Program	
		Six Counties of Hunan	Results Area	Six Counties of Hunan
21301	Agriculture and Rural Affairs	926.4		
2130101	Administrative Operation			
2130102	General Administrative Services			
2130103	Agency Service			
2130104	Business Operation			
2130105	Farm Reclamation Operation			
2130106	Technology Transformation and Promotion Services		RA2	13.0
2130108	Pest Control		RA2	14.9
2130109	Agricultural Product Quality and Safety		RA2	1.9
2130110	Law Enforcement Supervision			
2130111	Statistical Monitoring and Information Services		RA1	0.0
2130112	Industry Business Management		RA1	0.0
2130114	Foreign Exchange and Cooperation			
2130119	Disaster Prevention and Relief			
2130120	Stable Farmers Income Subsidy			
2130121	Agricultural Structural Adjustment Subsidies		RA2	14.8
2130122	Agricultural Production Development		RA2	276.0
2130124	Rural Cooperative Economy		RA3	8.9



Code	Budget Line	Government program	PforR Program	
		Six Counties of Hunan	Results Area	Six Counties of Hunan
2130125	Agricultural Processing and Promotion			
2130126	Rural Social Undertaking			
2130135	Protection, Restoration and Utilization Of Agricultural Resources		RA2	34.0
2130142	Rural Road Construction			
2130148	Refined Oil Pricing Reform Subsidy to Fishery			
2130152	Subsidy For College Graduates to Work at The Grassroots Level			
2130153	Farmland Construction		RA2	114.9
2130199	Other Agricultural and Rural Expenditures			
21303	Water Conservancy	542.6		
2130301	Administrative Operation			
2130302	General Administrative Services			
2130303	Agency Service			
2130304	Business Management of Water Conservancy Industry		RA1	1.5
2130305	Water Conservancy Project Construction		RA3	207.5
2130306	Operation and Maintenance of Hydraulic Engineering		RA3	46.3
2130307	Yangtze River And Yellow River Basin Management			
2130308	Preliminary Work of Water Conservancy			
2130309	Water Conservancy Law Enforcement Supervision			
2130310	Soil And Water Conservation			
2130311	Water Resources Conservation Management and Protection		RA3	1.3
2130312	Water Quality Monitoring			
2130313	Hydrologic Survey			
2130314	Flood Control			
2130315	Drought Resistance			
2130316	Farmland Water Conservancy		RA3	55.4
2130317	Water Conservancy Technology Popularization			
2130318	International River Governance and Management			
2130319	Comprehensive Improvement of River, Lake and Reservoir Water Systems			
2130321	Support the Late Migration of Large and Medium-Sized Reservoirs			
2130322	Water Conservancy Safety Supervision			
2130333	Information Management			
2130334	Land Expropriation and Immigration for Water Conservancy Construction			
2130335	Drinking Water for Rural People and Animals			



Code	Budget Line	Government program	PforR Program	
		Six Counties of Hunan	Results Area	Six Counties of Hunan
2130336	Construction of the South-To-North Water Diversion Project			
2130337	Management of South-To-North Water Diversion Project			
2130399	Other Water Expenditure			
Total Amount		1,469.1		790.5
As percent of Government Program (%)				53.8

5. **Program funding source.** The county-level governments and the counties rely heavily on the transfers from the HLGs or the central and provincial governments for financing of the Program activities. Three mechanisms are used by the HLGs to transfer funds to the county governments to support the Paddy Rice PforR activities: ‘Transfer for central-local shared functions on agriculture, forestry and water affairs’, ‘Incentive funds of main grain (oil) producing counties,’ and ‘Earmarked transfers for agricultural, forestry and water affairs,’ of which the ‘Earmarked transfer for agricultural, forestry and water affairs’ is a earmarked transfer, while the other two are general transfers. The earmarked transfers provide strong incentives for counties to implement the Program activities, while general transfers help fill in the financing gaps as needed. From 2019 to 2022, the three transfers allocated by HLGs to the program counties amounted to US\$1,320.7 million equivalent. Given that the bulk of the Paddy Rice PforR expenditures would be financed by HLG transfers, it can be concluded that the Program financing from the Government is adequate and largely predictable.

Table 3.3. Program Funding Sources during 2019–2022 (US\$, millions)

Transfers	Six Project Counties of Hunan				
	2019	2020	2021	2022	Total
General Transfers					
Incentive Funds for Main Grain (Oil) Producing Counties	23.5	30.9	30.5	37.4	122.2
Transfers for Central-Local Common Functions on Agriculture, Forestry and Water Affairs	194.8	100.3	73.0	88.1	456.1
Earmarked Transfers					
Earmarked Transfers for Agricultural, Forestry and Water Affairs	140.3	192.2	202.2	207.8	742.4
Total	358.6	323.3	305.7	333.2	1,320.7
Share of Earmarked Transfers (%)	39.1	59.4	66.2	62.4	56.2

6. **Expenditure performance and financial sustainability.** The assessment found that the earmarked transfers related to the Program activities under RA2 and RA3 are adequate, and that the expenditure performance evaluation system is in place. A series of documents on earmarked fund management have been issued by the MOF and PDARA and PDWR in Hunan that stipulate that the transferred funds will only be used for the specified activities. The fund allocations are factor based or project based and are subject to performance evaluation. The performance evaluation results are taken as an important factor for fund allocation. Therefore, there are strong incentives for the Program counties to achieve the desired objectives of promoting water-saving and low-methane rice production and to ensure value for financing. The recent GPBR in Hunan Province has been relatively stable, despite the negative impacts of the COVID-



19 pandemic. The total expenditure of this Program only accounts for about 0.5 percent of the GPBR in Hunan. Thus, the Program funding appears sustainable.

7. Noticeable amounts of earmarked funds have been arranged in recent years to support the agricultural water pricing reform, which involves several activities closely related to the objectives of the Paddy Rice Program. These activities include providing water-savings awards and water price subsidies as well as constructing and maintaining water metering facilities in irrigation areas. Specifically, from 2019 to 2022, a US\$2.3 million equivalent from the Central and Provincial Water Conservancy Development Fund was allocated to six demonstration project counties to support comprehensive agricultural water pricing reforms; in 2021, a US\$0.2 million equivalent from the provincial budget funds was allocated to the pilot county of Hanshou where the agricultural water tariff reforms were taking place, to support the construction and maintenance of water metering facilities. In general, both the central government and Hunan provincial government have been enhancing financial support for water-saving paddy production. In 2019, the Hunan PDRC, PDOF, PDWC, and PDARA jointly issued the Management Method of the Fund for Awards and Subsidies of the Agricultural Water Price Comprehensive Reform in Hunan, which stipulates that the DWC will organize and implement the performance evaluation for the Fund and the PDOF will review the performance evaluation results and allocate the Fund accordingly.

Table 3.4. Earmarked Funds Supporting RA2 and RA3 Activities in Hunan (2019–2022), US\$, millions

Earmarked Transfer Program	Six Program Counties of Hunan				
	Province	%	Central	%	Total
Finance Department	187.7	27.2	502.2	72.8	689.9
Agricultural Production Development Fund	17.5	5.2	317.2	94.8	334.7
Farmland Construction Subsidy	58.7	31.6	126.9	68.4	185.6
Water Conservancy Development Fund	94.8	64.7	51.6	35.3	146.4
High Standard Farmland Management and Protection Fund	16.8	100.0	0.0	0.0	16.8
Agricultural Resources and Ecological Environment Protection Fund	0.0	0.0	6.4	100.0	6.4
Development and Reform Commission	0.2	0.1	151.5	99.9	151.7
Funds for Agricultural Production Development Project	0.0	0.0	89.0	100.0	89.0
Funds for Ecological Protection and Restoration Projects in Key Areas	0.0	0.0	19.9	100.0	19.9
Funds for Large-scale Irrigation Area Construction and Modernization Projects	0.0	0.0	19.0	100.0	19.0
Funds for Water Security Projects	0.0	0.0	15.3	100.0	15.3
Funds for Agricultural Sustainable Development Projects	0.0	0.0	8.2	100.0	8.2
Funds for Comprehensive Agricultural Water Pricing Reform in Selected Counties	0.2	100.0	0.0	0.0	0.2
Total	187.9	22.3	653.7	77.7	841.6

Table 3.5. Financial Situation in Terms of General Public Budget in Hunan

Description	Hunan		
	2019	2020	2021
GPBR, US\$, billions	43	43	46
Transfer From Central Government (TFCG), US\$, billions	53	60	58



Description	Hunan		
	2019	2020	2021
GDP, US\$, billions	570	593	658
Debt Balance (DB), US\$, billions	145	169	194
Debt Repayment Amount (DRA), US\$, billions	21	13	20
Debt-to-GPBR Ratio (= DB / GPBR + TCG), %	152	164	186
Debt-to-GDP Ratio (= DB / GDP), %	26	28	30
Debt Repayment Ratio (= DRA / GPBR + TCG), %	22	13	19

Technical Soundness

Program Boundary

8. **The technical assessment has established a sound PforR boundary.** The Program is embedded within the Government's program of Hunan HSFCP (2021–2030). The Program boundary will include physical and non-physical activities in the six demonstration counties (distributed in five municipalities) under RA2 and RA3, as well as non-physical or soft activities under RA1 which are mostly at the provincial level. The agreed Program boundary after E&S risk screening (excluding the high-risk activities) is shown in table 3.10. The timeline for the PforR is from FY 2024 to 2029, with 2021 being the baseline year. This is well aligned with the timeline of the Hunan HSFCP, which goes from 2021 to 2030 and has clear targets established.

RA 1: Strengthening management system for sustainable development impacts

9. **RA 1 will strengthen government management system for promoting rice climate mitigation measures.** RA1 will focus on strengthening the government management system for low-methane and climate-resilient rice production. The management system includes strategic plans, technical standards, and other guiding documents as well as management organizations. A preliminary assessment of the government management system in Hunan Province shows that there are general policies, regulations, and strategic plans for green agriculture development, most stringent water resources management, and agricultural water conservation. However, there are no specific strategy and implementation plans and guiding documents for water-saving and low-methane production in Hunan. The related technical standards also need to be updated. The agriculture and water sectors have some coordination mechanisms, but these mechanisms need to be improved and formalized. To fill the critical information gaps, the Program also gives priority to the development and implementation of a provincial MRV methodology for the selected counties. As the GARR (Hubei and Hunan) Program plans to develop the MRV methodology for rice paddies in Hunan Province, this Program will focus on the implementation of the MRV in selected counties to support carbon trading.

10. **The assessment shows that Hunan has a relatively good institutional system at the provincial and county levels for water-saving and low-methane rice production.** The assessment in table 3.6 shows that both national- and provincial-level governments have launched general policies to support green and low-carbon development. However, specific strategy and guiding documents are yet to be developed in Hunan to guide water-saving and low-methane rice production. Therefore, the Program will support the development and issuance of a provincial strategic plan for promoting and scaling up climate mitigation measure, and a provincial guiding document on water use rights trading. The assessment also indicated



that the existing technical standards are not adequate to support water-saving and low-methane rice production. Thus, the Program will support the development and issuance of these technical standards on the co-management of water-straw-fertilizer, which can guide the counties to implement the recommended mitigation measures. Both the agriculture sector and water sector at the county level expressed the needs and willingness to coordinate and collaborate in the areas of high-standard farmland development and O&M and agricultural water conservation. However, there is not yet an operational coordination mechanism, and related information sharing between the two sectors requires improvements. The Program will support the establishment of an official coordination mechanism between the agriculture and water sectors at the county level.

Table 3.6. Summary Assessment on Policy, Standards, and Agriculture and Water Coordination Mechanisms

Status	Findings and Gaps	Recommendations
Policy		
National level <ol style="list-style-type: none"> 1. The State Council's Guiding Opinions on Accelerating the Establishment and Improvement of a Green and Low-carbon Circular Development Economic System (GF [2021] No. 4) 2. Opinions of the Central Committee and the State Council on Innovating System and Mechanism to Promote Agricultural Green Development (September 2017) 3. Regulation on Farmland and Water Conservancy (Order No. 669 of the State Council of the People's Republic of China) 4. Yangtze River Protection Law of the People's Republic of China (December 26, 2020) 5. No. 1 central documents over the years Provincial Level <ol style="list-style-type: none"> 1. Hunan's Implementation Plan for Carbon Peaking (XZF [2022] No. 19) 2. Administrative Measures of Hunan Province on Water Conservation (Order No. 293 of the People's Government of Hunan Province) 3. Implementation Plan for Promoting the Comprehensive Reform of Agricultural Water Price in Hunan Province in an Orderly Manner (2022) 4. The General Office of the People's Government of Hunan Province: Measures for the Assessing the Performance of the Most Strict Water 	National level <p>National policies are issued on such areas as agricultural water conservation, low-carbon and ecological circular agriculture, manure resource utilization, crop straw utilization, treatment of agricultural plastic film pollution, planning and construction of farmland water conservancy projects, and management and clearer protection responsibilities.</p> Provincial Level <p>Hunan has in place general policies for green agriculture development and yet lacks operational strategy and specific guiding documents for promoting low-methane and water-saving rice production.</p>	Provincial level: <p>A strategy for promoting and mainstreaming water-saving and low-methane rice production in Hunan should be developed and issued.</p> <p>An MRV methodology in line with the internationally recognized practices should be developed to support the GHG emission reduction measurement and verifications, and the planned carbon trading pilots.</p> <p>The guiding document on water rights trading in Hunan Province should be issued.</p> County Level <p>The related management measures at the county level should be put in place to reflect local conditions. For example, whether the counties can issue and implement detailed rules for water rights trading in accordance with the provincial guidelines on water rights trading.</p>



Status	Findings and Gaps	Recommendations
Resources Management System in Hunan (XZBF [2013] No. 62)		
Technical Standards and Guidelines		
There are no technical guidelines or standards for water conservation and carbon reduction in paddy fields at both the national level and the Hunan Provincial level (Jiangsu and Heilongjiang have issued technical standards for rice water-saving irrigation).	There is no standard for water saving and carbon reduction for paddy fields at the national level, in the water resources sector, and locally in Hunan. These gaps need to be filled.	Provincial Level: <ol style="list-style-type: none"> 1. Technical standards for water-saving and low-methane rice production in Hunan Province should be prepared and issued by the DARA. Alternatively, Hunan could authorize national academic societies (for example, the Chinese Academy of Agricultural Sciences) to prepare the recommended technical standards, which could also be proposed for adoption at the national level. 2. The Department of Water Resources should formulate and issue Technical Standards for Rice Water-saving Irrigation in Hunan Province 3. The MRV for carbon sequestration and emission reduction in rice production should be developed and issued.
Capacity Building for Extension Service Providers		
<ol style="list-style-type: none"> 1. Law of the People's Republic of China on Agricultural Engineering Extension (2012) 2. Measures of Hunan Province for Implementing the Law of Agricultural Technology Engineering Extension (2012) 3. At present, the extension network is built with the national agricultural technology extension center, and extension stations in provinces, cities, counties, and towns, to promote and extend good practices and technologies. 	The Government and public institutions are responsible for the extension; the market mechanism and private technology extension service institutions or organizations shall also be developed and engaged.	County Level: <p>Hunan proposes to establish county (grass-root) agricultural machinery service centers, which is a market-driven mechanism to strengthen services and institutional capabilities and promote technologies for rice water conservation and carbon reduction. In this way, the service mechanism driven by both the Government and the market will be utilized.</p>
Agriculture and Water Coordination Mechanism		
1. The Department of Water Resources and the Department of Agriculture and Rural Affairs together issued Guiding	Both water resources and agriculture sectors are willing to collaborate in areas such as high-	County Level <p>In the Program counties, a coordination mechanism (such</p>



Status	Findings and Gaps	Recommendations
Opinions on Strengthening the Cooperation between the Reconstruction of Large and Medium-sized Irrigation Areas and the Construction of High-standard Farmland (2022) 2. The Department of Water Resources issued the Opinions on Strengthening the Construction and Management of Large and Medium-sized Irrigation Districts (2022)	standard farmland development and agricultural water conservation, but a concrete and operational cooperation and coordination mechanism has not yet been built.	as a joint meeting system) should be established between the agriculture and water sectors for high-standard farmland construction and O&M.

Table 3.7. Technical and Procedural Criteria for DLI 1

1. Low-methane and water-saving production strategy and implementation plan
<p>Technical:</p> <ul style="list-style-type: none"> • Includes short- and long-term plans of promoting and scaling up water-saving and low-methane technologies • Consolidates the experiences and lessons learned on low-methane rice production and lays out the plan for knowledge dissemination and scaling-up • Supports enabling, mainstreaming, and incentivizing of water-saving and low-methane rice in Hunan Province • Provides strategic vision and long-term goals to be achieved • Indicates instruments to achieve the goals and budget availability • Has specific annual targets, implementation pathways, and budget allocation and indicates responsible institutions (these should also be reflected in the implementation plan) • Reflects the M&E mechanism, budget, and institutional responsibility • Provides evidence of consultations and contributions with, at a minimum, the PforR demonstration counties • Should be based on conditions and specifications of Hunan or those adopted for use in Hunan • Supports voluntary uptake by farmers and provides relevant support <p>Procedural:</p> <ul style="list-style-type: none"> • Has been duly approved by the competent authorities • Issued for public access through websites and in printed form, with at least one website and one printed form disseminated



2. Technical standards for low-methane and water-saving rice production
<p>Technical:</p> <ul style="list-style-type: none"> • Prepares the standards for the water-saving and low-methane technologies of typical agro-climatic zone conditions, covering the main technologies of low-methane rice varietal selection, water saving, fertilizer management, and straw management • Supports enabling, mainstreaming, and incentivizing of water-saving and low-methane rice in Hunan Province • Describes the technical parameters of water-saving and low-methane rice production, as well as the technologies and practices to comply with the technical parameters • Includes the procedures related to the enforcement of such standards, institutional arrangements, and responsibilities • Establishes parameters and procedures for M&E of the compliance with the technical standards <p>Procedural:</p> <ul style="list-style-type: none"> • Has been duly approved by the competent authorities • Issued for public access through a relevant website and awareness measures taken to announce the availability of the technical standards on the relevant website
3. Water-saving irrigation quota for rice production
<p>Technical:</p> <ul style="list-style-type: none"> • Develops irrigation water quota for single- and double-cropping rice under the conditions of different irrigation zones and irrigation design guarantee • Supports enabling, mainstreaming, and incentivizing of water-saving and low-methane rice in Hunan Province • Describes the technical parameters of the water-saving irrigation quota for rice production, as well as the technologies and practices to comply with the technical parameters • Includes the procedures related to the enforcement of such standards, institutional arrangements, and responsibilities • Establishes parameters and procedures for M&E of the compliance with the technical standards <p>Procedural:</p> <ul style="list-style-type: none"> • Has been duly approved by the competent authorities • Issued for public access through a relevant website and awareness measures taken to announce the availability of the technical standards on the relevant website
4. Guiding document on water rights trading
<p>Technical:</p> <ul style="list-style-type: none"> • Includes trading methods, principles, procedures, and management system • Supports promotion of water-saving and low-methane rice in Hunan Province • Defines the financial instrument (water use rights) and its key terms and conditions • Establishes eligibility criteria for buyers and sellers • Includes description of trading mechanism and relevant procedures • Includes guidance on resolutions of issues and disputes • Raises awareness on mechanism and supports farmer training <p>Procedural:</p> <ul style="list-style-type: none"> • Has been duly approved by the competent authorities • Issued for public access through a relevant website and awareness measures taken to announce its availability on the relevant website.

11. An MRV system is crucial to measure and verify GHG emission reductions from rice paddies and support the carbon trading pilot. The Government is facing an information challenge to better measure, report, and verify GHG emissions. The Global Methane Pledge recognized that the improvements to the transparency, accuracy, completeness, comparability, and consistency of methane emissions data



assessed and validated can promote more ambitious and credible actions. China also highlighted at COP27 that a lack of reliable baseline data on methane emissions hampered the implementation of its methane reduction plan. An MRV system is crucial to track GHG emission reduction and support carbon trading. Built upon the MRV methodology that will be developed under the GARR (Hubei and Hunan), this Program will measure, report, and verify rice GHG emissions in selected counties; this will also support the carbon trading pilots in these counties. A monitoring network will be established with both remote sensing and in-situ measurements. Remote sensing technology will be explored to measure methane emissions at a large scale, as well as other factors affecting rice GHG emissions, such as rice production areas, rotation practices, and rice water practices. In-situ ground monitoring will be established to directly measure rice GHG emissions, as well as the impacting factors of climate, soil types, fertilizer and straw management practices, and other agronomic practices.

12. **Six main standards quantify emissions from the rice sub-sector:** UNFCCC's CDM,⁷⁷ CARB Compliance Offset Protocol, Gold Standard, Verra, CAR, and Japan's JCM that recently approved the J-Credit Methodology for Paddy Rice Cultivation.⁷⁸ Gold Standard⁷⁹ and Verra both follow CDM's *Methane Emission Reduction by Adjusted Water Management Practice in Rice* (AMS-III.AU) methodology though Verra has recently paused the use of CDM methodology for review.⁸⁰ Also, to note here is that the ACR's *Emission Reductions in Rice Management Systems* is currently inactive⁸¹ and Gold Standard has announced that it is working on publishing a revised version of the CDM AMS-III.AU methodology, which was published for consultation last year.⁸²

- (a) CDM's AMS-III.AU methodology includes rice farms that (i) change the water regime during the cultivation period from continuous to intermittent flooded conditions and/or a shortened period of flooded conditions, (ii) follow AWD method and aerobic rice cultivation methods, and (iii) that change their rice cultivation practice from transplanted to direct seeded rice. The methodology relies on reference field approach to quantify GHG emissions. Alternatively, emission reductions can also be calculated using IPCC tier 1 approach or default values.
- (b) The CARB *Compliance Offset Protocol Rice Cultivation Projects*⁸³ also includes rice farms that follow AWD practices, but in addition includes practices such as dry seeding and early drainage. The methodology uses DNDC biogeochemical process model for soil dynamics and emission factors for secondary emissions. CAR's *US Rice Cultivation Version 1.1*⁸⁴ methodology includes rice farms that practice dry seeding with delayed flooding and post-

⁷⁷ United Nations Framework Convention on Climate Change. CDM Methodology AMS-III.AU Small-scale Methodology: Methane Emission Reduction by Adjusted Water Management Practice in Rice Cultivation. Version 04.0.

⁷⁸ Carbon Pulse. 2023. "Japan Adds J-credit Methodology for Paddy Rice Cultivati." *Carbon Pulse*, March 1, 2023. Retrieved March 10, 2023 (link).

⁷⁹ Gold Standard. Requirements to Apply CDM Methodology for Gold Standard Certification. CDM Methodology - AMS.III.AU. *Methane Emission Reduction by Adjusted Water Management Practice in Rice Cultivation*.

⁸⁰ Verra. 2023. "Verra Pauses and Will Review the Use of UNFCCC CDM Rice Cultivation Methodology." *Verra*, February 15, 2023. Retrieved March 6, 2023 (link).

⁸¹ American Carbon Registry. (n.d.). "Inactive: Rice Management Systems." Retrieved March 10, 2023 (link).

⁸² Carbon Pulse. 2023. "UNDP, Switzerland Defend Rice Farming Methodology Amid Verra Decision to Halt Use." February 7, 2023.

⁸³ California Air Resources Board. (2015 June). *Compliance Offset Protocol Rice Cultivation Projects*. Retrieved March 7, 2023 (link).

⁸⁴ U.S. Rice Cultivation Protocol. *Climate Action Reserve*, December 21, 2022. Retrieved March 10, 2023 (link).



harvest rice straw removal and baling. This methodology also uses the DNDC biogeochemical process model for soil dynamics followed by emission factors for cultivation equipment and crop residue management and baling emission factors for crop residue baling. And finally, Japan's J-Credit Methodology for Paddy Cultivation extends the 'mid-drying' session for seven days or more during the rice cultivation period to assess the exact reduction of methane emissions.

- (c) Gold Standard has generated an estimated 952,990 credits across the three projects⁸⁵ in Pakistan, India, and Thailand (but not yet issued) and Verra (before the pause) had issued VCUs totaling 4.56 million or 0.43 percent of all VCUs across 37 projects in China. On the other hand, the first pilot under CAR's methodology which was implemented across 2000 acres of land by seven growers in Arkansas, Mississippi, and California generated an estimated 600 credits. These credits were bought by Microsoft at an undisclosed price.⁸⁶

13. **The continuous innovations bring opportunities for digital MRV.** Under the Paris Agreement, MRV systems are fundamental. Countries are required to measure and report their GHG emissions as well as their NDCs and determining either will require a robust MRV system. While time-consuming and costly, MRV systems of agricultural emission has matured over time owing to the continuous innovation in satellite imagery, artificial intelligence, and machine learning. This cost-curve continues to trend downward. In a conventional MRV system, project data are often recorded manually and stored as a hard copy or in an Excel worksheet. This is both difficult to analyze for reporting purposes and costly to verify. Digital MRV systems use emerging digital technologies such as smart meters, remote sensors, and even satellite data to digitally report, record, and analyze project information. This increases the reporting accuracy, reduces the time required for data collection, and lowers the cost of third-party verification of the project's performance. Digital MRV systems are a key component in future climate markets to ensure robustness and the smooth functioning of those markets.⁸⁷ There is a significant opportunity here to leverage technology to develop end-to-end platforms that connects MRV with carbon payments. This Program will also explore some digital MRV technologies to use remote sensing measure methane emissions and other factors affecting rice GHG emissions.

RA2: Reducing GHG emissions for low-methane development

14. **RA2 will leverage the Hunan HSFCP to scale up rice climate mitigation measures.** RA2 supports the Government's endeavor in promoting low-methane rice production and reducing methane emission from rice paddies. The Program is anchored in the Hunan HSFCP. Over the past decade, Hunan has seen increasing investments in high-standard farmlands, which lays a sound foundation for adopting mitigation practices. Rice methane emissions are expected to be effectively reduced through the adoption of water-saving techniques, such as AWD. Fertilizer and straw management will further reduce rice GHG emissions. However, the counties are falling short of adopting an integrated solution package that promotes co-management of water, fertilizer, and straw residue. For that reason, the Program will give priority to promoting and scaling up an integrated climate mitigation solution package through comprehensive training and capacity building. Trading of carbon emission reductions achieved under the Program will

⁸⁵ Gold Standard Impact Registry. (link).

⁸⁶ Gustin, G. (2020, December 7). "U.S. Rice Farmers turn Sustainability into Carbon Credits, with Microsoft as First Buyer." *Inside Climate News*. Retrieved March 6, 2023 (link).

⁸⁷ World Bank. 2022. *Digital Monitoring, Reporting, and Verification Systems and Their Application in Future Carbon Markets*. World Bank, Washington, DC. (link).



also be piloted in selected counties to generate financial revenue for motivating farmers to adopt low-methane and water-saving cultivation. Although the CCER system,⁸⁸ the voluntary GHG emission reduction trading platform, has not accepted new applications since 2017, the Government and other entities still explore opportunities for rice carbon trading.⁸⁹

15. **The Program will support specific activities in the Hunan HSFCP, which will lay solid and conducive conditions for adopting climate mitigation measures.** The Program will remove the system constraints for adopting climate mitigation measures by supporting the selected key activities in the Hunan HSFCP, including rehabilitation and upgrading of the existing irrigation and drainage systems, improvement of small water storage ponds (desilting), improvement of soil quality and fertility, and improvement of associated facilities such as that of existing on-farm access roads. These interventions will enable flexible irrigation and drainage services with reliable water supply and support facilities for agricultural machinery operation, which are essential for farmers' adopting climate mitigation measures. The detailed comparison of the PforR Program activities and the Hunan HSFCP is shown in table 3.10.

16. **AWD technology is among the most effective ways to reduce methane emissions from rice production.** Methane in rice paddies is mainly produced by microbial decomposition of organic matter in flooded and anaerobic environments. When rice paddy fields are drained or alternately dried, there is more oxygen in the soil, which is not conducive to the production of methane. Most of the formed methane will be converted into carbon dioxide by microorganisms, which has a significant reduction in GWP. Many scientific and field monitoring studies have proved that water control and shortening the number of days of flooding in the rice growing season can reduce methane emissions by 30 to 70 percent.⁹⁰ A global meta-analysis revealed that mild drying did not reduce the rice yields. Safe-AWD with mild drying provides benefits of allowing drying periods to reduce methane emissions without sacrificing yields.⁹¹ China has been promoting water-saving techniques, including AWD, for over four decades. Among these techniques, the shallow-wet-dry irrigation technique (also called as shallow water depth with wetting and drying) is the most widely used technique. The shallow-wet-dry irrigation technique consists of two drying periods—one at the late stage of tillering and one at yellow ripening stage. The intermittent irrigation technique, one kind of AWD technique, is also frequently used in south, north, and northeast China. The semi-dry technique (also called controlled irrigation) is used in some relatively water scarce regions and only keeps a water layer at the stages of turning green and early tillering and keeps the field dry during other growing stages. With the long-term promotion of rice water-saving practices, rice farmers in China usually have a good understanding of the importance of drying, especially drying at the late stage of tillering, which can help rice increase more profuse early tillering and suppress unproductive late tillering to enhance yields, develop sturdy stems and well-developed roots to be resistant to lodging, and enhance resistance to rice diseases. Therefore, many rice farmers in China practice mid-season drainage at the late stage of tillering if irrigation and drainage conditions allow. Farmer consultation and stakeholder engagement under this Program showed that most farmers in Hunan

⁸⁸ The CCER scheme focuses on voluntary GHG emission reduction transactions, such as GHG emission reductions from renewable energy, forestry carbon sink, and methane reduction and utilization. CCER used to apply CDM methodology (link) to quantitatively verify and register the credits of rice methane reduction through better water management.

⁸⁹ In July 2022, one case of carbon trading on rice methane emission reduction was completed in the Fujian Province. It traded the methane emission reduction from rice paddies due to the adoption of AWD. (link)

⁹⁰ Jiang, Y., et al. 2019. "Water Management to Mitigate the Global Warming Potential of Rice Systems: A Global Meta-Analysis." *Field Crops Research* (link).

⁹¹ *ibid.*



practice drying at the yellow ripening to harvesting stage, while only some farmers practice drying at the late stage of tillering if conditions allow.

17. **Straw returning to rice fields can improve soil fertility, increase soil carbon sequestration, and reduce chemical fertilizer use.** Fresh plants such as crop stalks and green manure contain a lot of mineral nutrients, and they are also the main food source for soil organisms. Soil is a living body, and soil health and productivity need to be maintained and improved by organisms such as soil animals and microorganisms. Therefore, returning crop straw and green manure to farmlands not only benefits high and stable crop yields but also strengthens soil health and fertility. In addition, these organic substances can also significantly increase the content of the soil's organic carbon and promote soil carbon sequestration to mitigate climate change.⁹² The effect of increasing the sink of straw returning to the field can last for 20 to 30 years, and the effect of increasing the sink of organic fertilizer application can last for 40 to 50 years.⁹³ Moreover, the input of these organic materials can significantly reduce the application of chemical fertilizers, for example, green manure planting can reduce the amount of fertilizer applied for conventional crops by 30 to 40 percent, and the effect of fertilizer saving and emission reduction is remarkable. In the IPCC guidelines and International Organization for Standardization (ISO) emission reduction standards, these measures are recommended as important measures to improve farmland climate resilience, reduce emissions, and enhance carbon sequestrations. Stakeholder consultation under this Program showed that the comprehensive utilization rate of major crop straws in Hunan aims to reach over 88 percent, of which nearly 60 percent will be used as fertilizers, such as straw returning to the field, which promotes carbon sequestration in paddy soil.

18. **Straw returning can significantly increase methane emissions; thus, co-management of water and straw at the early rice growing stage is crucial.** Although straw returning has significant benefits in soil fertility improvement and carbon sequestration, returning organic materials, such as fresh crop stalks, can also significantly increase methane emissions from paddy fields. Under modern high-yield rice planting practices, especially under straw returning, methane emissions from paddy fields mainly occur in the early growth stage, accounting for more than 80 percent of the total emissions during the whole growth period.⁹⁴ But if farmers change the traditional continuous flooding irrigation and use AWD with the returning of fresh organic straws to allow seven to ten days of aerobic decomposition before transplanting, it will not significantly increase methane emissions and can even have significantly lower emissions than the continuous flooding irrigation without straw returning.^{95, 96} Therefore, field water control at the rice seedling or transplanting stage is a critical period for methane emission reduction in rice fields. At present, in rice production, most of the water management methods in field production are to retain the water layer at the early stage of rice growth, which is not conducive to the significant reduction of methane emission.

⁹² Lal, R. 2004. "Soil Carbon Sequestration Impacts on Global Climate Change and Food Security." *Science* 304 (11): 1623–1627. (link)

⁹³ Rui, W., and W. Zhang. 2010. "Effect Size and Duration of Recommended Management Practices on Carbon Sequestration in Paddy Field in Yangtze Delta Plain of China: A Meta-Analysis." *Ecosystems and Environment* 135: 199–20. (link)

⁹⁴ Jiang, Y., D. Carrijo, S. Huang, J. Chen, N. Balaine, W. Zhang, K. van Groenigen, B. Linquist. 2019. "Acclimation of Methane Emissions from Rice Paddy Fields in Response to Straw Incorporation." *Science Advances* 2019: 5. (link)

⁹⁵ Hang, X., et al. 2014. "Differences in Rice Yield and CH₄ and N₂O Emissions among Mechanical Planting Methods with Straw Incorporation in Jianghuai Area, China." *Soil and Tillage Research* 144: 205–210.

⁹⁶ Linquist, B. A., M. M. Anders, M. A. A. Adviento-Borbe, R. L. Chaney, L. L. Nalley, E. F.F. da Rosa, C. van Kessel. 2015. "Reducing Greenhouse Gas Emissions, Water Use, and Grain Arsenic Levels in Rice Systems." *Global Change Biology* 21: 407–417. (link)



19. **Deep returning of rice straw to soil will further reduce methane emissions and benefit rice growth.** Research, field visits, and farmer consultations showed that, under the traditional straw shallow rotary tillage, a large amount of straw is retained on the surface or within a shallow depth (<10 cm) of soil, which hampers the growth of rice roots and leads to the risks of yield reduction. The decomposition of straw residue within a shallow soil layer under flooded conditions will significantly increase methane emissions and generate reductive substances harmful to rice roots and the environment. Therefore, it is recommended to change from the traditional paddy cultivation with shallow rotary tillage and flooding to new cultivation with deep plough tillage or deep rotary tillage with around seven to ten days of drying before transplanting. The new measure will benefit rice growth and further reduce methane emissions. The returning of decomposed straw residues can also reduce methane emissions. However, in Hunan Province, with tight rotation of double-cropping rice or rice-oilseed double-cropping areas, there is not enough time for the pretreatment of straw and green manure. Therefore, when organic materials such as straw and green manure are returned to the field, it is recommended to implement integrated practices: (a) deep rotary tillage or deep plough tillage with straw application, (b) water control for seven to ten days during the early stage of rice growth, and (c) selection of decomposed organic materials and returning them to the field.

20. **The co-management of water-straw-fertilizer is critical to reduce rice GHG emissions.** The application of decomposed organic materials such as compost, biogas slurry, and biogas residues, and commercial organic fertilizers significantly increased the content of soil organic matter without accelerating methane emissions from rice paddy.⁹⁷ It is important to optimize water and straw co-management for rice methane emission reduction. The use of organic fertilizer and straw returning can also reduce the application of chemical fertilizer. The Hunan HSFCP promotes various soil fertility improvement activities, such as fertilizer deep application, straw returning, organic fertilizer, and green manure utilization, to further reduce the application of chemical fertilizer. In addition, drying rice paddy can significantly reduce methane emissions, but it may increase the emissions of nitrous oxide. Although the overall nitrous oxide emission is low,⁹⁸ the timing of drying and the methods of fertilizer application can be further optimized to reduce methane emissions, maintain low nitrous oxide emissions, and improve fertilizer use efficiency. Thus, the co-management of water, straw, and fertilizer can significantly reduce the overall GHG emissions from rice paddies, including the reduction of methane and nitrous oxide emissions and the increasing of soil carbon sequestration.

21. **The rapid development of remote sensing techniques provides opportunities to directly measure methane emissions from rice paddies.** The data from the European Space Agency's Sentinel-5P satellite platform provide reliable information on global methane emissions at high levels of spatial resolution.⁹⁹ A new World Bank database¹⁰⁰ of monthly atmospheric methane concentrations was recently launched, with high-resolution spatial grid calculated from data provided by the European Space

⁹⁷ Feng, J., et al. 2013. "Impacts of Cropping Practices on Yield-Scaled Greenhouse Gas Emissions from Rice Fields in China: A Meta-Analysis." *Agriculture, Ecosystems and Environment* 164: 220–228. (link).

⁹⁸ Jiang Y., et al., 2019. "Water Management to Mitigate the Global Warming Potential of Rice Systems: A Global Meta-Analysis." *Field Crops Research* (link). Jiang et al. (2019) found that, on average, AWD increases the emissions of nitrous oxide by 105 percent. However, the overall nitrous oxide emission is low and contributes to around 12 percent of the GWP. The increased GWP by the increasing of nitrous oxide emissions is much lower than the decreased GWP by the reduction of methane emissions.

⁹⁹ Blankespoor, Brian, Susmita Dasgupta, Nagaraja Rao Harshadeep, Somik Lall, and David Wheeler. 2022. "Eyes in the Sky: Tracking Methane through Satellites to Facilitate Emissions Reduction for Climate Mitigation." World Bank Blog. (link)

¹⁰⁰ <https://datacatalog.worldbank.org/search/dataset/0062871>.



Agency's Sentinel-5P satellite platform. It also illustrates the potential utility of the database with a global study of methane emissions from irrigated rice production.¹⁰¹ A comparative analysis suggests that the Sentinel-5P methane data can supplement the Emissions Database for Global Atmospheric Research data with more fine-grained spatial information, which may be used to measure, verify, and reward methane reduction from rice paddies. This Program collected the Sentinel-5P methane emission data from the rice paddies in Hunan Province and analyzed the monthly average results from 2019 to 2022 for the major rice production municipalities in Hunan by municipality (table 3.8).

Table 3.8. Atmospheric Methane Concentration for Rice Production Areas in Hunan (unit: ppb)

ADMIN	YEAR	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Changde	2019	1,871	1,868	1,898	1,889	1,882	1,933	1,919	1,902
Changde	2020	1,885	1,882	1,905			1,895	1,939	1,936
Changde	2021	1,905	1,906	1,897	1,922	1,907	1,906	1,923	1,934
Changde	2022	1,901	1,904	1,921	1,943	1,886		1,973	1,943
Changsha	2019	1,863	1,868	1,892	1,890	1,887	1,916	1,918	1,894
Changsha	2020	1,870	1,881	1,893		1,883	1,890	1,949	1,941
Changsha	2021	1,894	1,907	1,891	1,909	1,899	1,910	1,920	1,930
Changsha	2022	1,899	1,905	1,923	1,927	1,867		1,973	1,940
Chenzhou	2019	1,859	1,859	1,861	1,867			1,921	1,904
Chenzhou	2020	1,871	1,881	1,893		1,880	1,923		1,930
Chenzhou	2021	1,872	1,909	1,892	1,912	1,896	1,910	1,917	1,916
Chenzhou	2022	1,888	1,905	1,925		1,860		1,969	1,943
Hengyang	2019	1,859	1,859	1,863	1,867	1,863		1,920	1,903
Hengyang	2020	1,871	1,881	1,893		1,880	1,922		1,929
Hengyang	2021	1,873	1,910	1,894	1,912	1,896	1,909	1,918	1,916
Hengyang	2022	1,888	1,905	1,924	1,885	1,860		1,969	1,943
Xiangtan	2019	1,857	1,857	1,891	1,859	1,863		1,908	1,895
Xiangtan	2020	1,871	1,882	1,885		1,883	1,904		1,912
Xiangtan	2021	1,895	1,921	1,912	1,911	1,893	1,894	1,925	1,912
Xiangtan	2022	1,887	1,909	1,916	1,885	1,857		1,967	1,934
Yiyang	2019	1,868	1,868	1,896	1,891	1,885	1,926	1,919	1,899
Yiyang	2020	1,879	1,882	1,900			1,892	1,943	1,940
Yiyang	2021	1,900	1,906	1,893	1,916	1,904	1,909	1,922	1,934
Yiyang	2022	1,901	1,904	1,922	1,939	1,879		1,973	1,942
Yongzhou	2019	1,862	1,880	1,861	1,867		1,918	1,911	1,901
Yongzhou	2020	1,871	1,890	1,893		1,880	1,910	1,962	1,938
Yongzhou	2021	1,877	1,923	1,892	1,906	1,891	1,939	1,918	1,907
Yongzhou	2022	1,895	1,912	1,919		1,870		1,968	1,943
Yueyang	2019	1,864	1,865	1,888	1,889	1,882	1,932	1,917	1,897
Yueyang	2020	1,881	1,880	1,893			1,894	1,939	1,926

¹⁰¹ Dasgupta, Susmita, Somik. V. Lall, and David Wheeler. 2022. *Tracking Methane Emissions by Satellite: A New World Bank Database and Case Study for Irrigated Rice Production*. Washington, DC: World Bank Group. (link).



ADMIN	YEAR	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Yueyang	2021	1,897	1,902	1,896	1,917	1,913	1,906	1,918	1,926
Yueyang	2022	1,897	1,900	1,913	1,933	1,887		1,966	1,938
Zhuzhou	2019	1,857	1,857	1,891	1,859	1,863		1,908	1,895
Zhuzhou	2020	1,871	1,882	1,885		1,883	1,904		1,912
Zhuzhou	2021	1,895	1,921	1,912	1,911	1,893	1,894	1,925	1,912
Zhuzhou	2022	1,887	1,909	1,916	1,885	1,857		1,967	1,934

Source: World Bank Disruptive KIDS (Knowledge, Information & Data Services) analysis based on Sentinel-5P methane emission data.

Note: Data only for rice growing season (March to October). Some monthly satellite data are missing.

22. **Remote sensing-based methane emission data also revealed the importance of water-saving practices and the needs of water-straw-fertilizer co-management.** The four-year averaged data during rice growing season for Changde City (including Hanshou county and Dingcheng district) are shown in figure 3 as an example. Double-cropping rice is the common practice in Changde City, with early rice growing from March to July and late rice growing from July to October. Water practice significantly affected rice methane emissions. Methane concentration was low in July, as farmlands were drained for harvesting early rice. Methane emissions from late rice were higher than those from early rice due to the water practice, straw returning, and temperature. The straw residues from early rice were usually fully returned to the field in July during harvesting due to the very tight rotation schedule between early and late rice. Farmers got used to flooding their fields after straw returning in July to accelerate straw decomposition. The decomposition of these fresh straws under anaerobic soil conditions during high or moderate temperature in August and September can significantly increase methane emissions. Thus, the timing of flooding and the techniques of straw returning and decomposition should be optimized to further reduce methane emissions and increase soil carbon sequestration. In addition, drying rice paddies can significantly reduce methane emission, but it may increase nitrous oxide emission. Thus, the timing of drying and the methods of fertilizer application should also be optimized to reduce methane emission, maintain low nitrous oxide emission, and improve fertilizer use efficiency. Therefore, the Program will promote water-saving techniques to reduce methane emissions but also highlight the importance of water-straw-fertilizer co-management.

23. **Farmer consultation and stakeholder engagement was carried out in the demonstration counties to understand farmers' agronomic practices and behaviors and to gauge their willingness to adopt low-methane and water-saving technologies.** Majority of the farmers have already practiced some type of water-saving techniques in the demonstration counties, especially drying during the yellow ripening period to facilitate harvesting. Even without subsidies, the farmers still expressed their willingness to embrace water-saving techniques during the late stage of tillering because they understand that wetting and drying regimes during the late stage of tillering can help increase yields and enhance resistance to lodging and rice disease. But they also expressed the difficulties in practicing frequent wetting and drying in some farmlands due to the lack of flexible irrigation and drainage systems and reliable water sources. Two demonstration counties in the Dongting Lake Plain Region (that is, Dingchen and Hanshou) mainly rely on pumping for surface water irrigation. Thus, the farmers in these counties also have their own incentives to adopt water-saving techniques to save water and energy. A limited number of farmers practice wetting and drying regimes during the early rice growing stage. Most farmers are not aware of the benefits of draining their fields during this stage. Farmers did not express huge concerns on the potential increase of weed growing under AWD, as they usually apply herbicides that are



effective for weed control. The field study and farmer consultations revealed a wide application of rice straw returning and green manure returning in Hunan. However, most farmers return rice straw and green manure within a shallow depth of soil (<10 cm) with shallow rotary tillage. Most farmers had received training and technical guidance on fertilizer application and straw management, but they have seldom received training and guidance on water-saving techniques. The farmers are practicing water-saving techniques according to their own experiences, which can be further improved and optimized. Some farmers are reluctant to adopt new techniques because they are not sure about the potential impacts on yields. Farmer consultation helped identify the opportunities and gaps to adopt climate mitigation measures and guide the Program design.

24. Hunan Province has an established training and extension service system, which can be leveraged to promote low-methane rice production. Based on communication with provincial and county governments and stakeholders, it was found that Hunan Province and the Program counties have a solid foundation in terms of agricultural technology training and services. The agricultural technology extension and demonstration service organizations at the provincial, municipal, and county levels are relatively sound. However, the technical service capabilities at the township and village levels are relatively weak. Hunan Province and the Program counties have relatively rich training experience in rice production technology, relatively strong service capabilities, and relatively comprehensive training content, which can be leveraged to enhance the farmer's capacity for adopting climate mitigation measures. However, the trainers and local experts lack an understanding of rice GHG emissions and related mitigation measures. Female farmers are not fully engaged in the training.

RA3: Improving irrigation and drainage services for resilient rice production

25. RA3 aims to improve the sustainability of irrigation and drainage services for climate-resilient production. Previous high-standard farmland development in the 2010s in Hunan heavily focused on infrastructure investment and had less emphasis on O&M. The Hunan HSFCP includes a large area of high-standard farmlands to be upgraded and rehabilitated, as the irrigation and drainage infrastructure, which had inadequate O&M, deteriorated quickly. Sustainable irrigation and drainage services consist of improved irrigation and drainage infrastructure, sustainable O&M funding, and enhanced O&M capacity. The assessment showed that current irrigation O&M cost recovery is at a relatively low level in Hunan, with a provincial average of around 50 percent, owing to low irrigation water tariffs and low-to-modest tariff collection rates. The Program will support the reform of agricultural water tariffs to ensure sustainable O&M funding. Several institutional mechanisms will be established, including a water pricing mechanism, a water-saving reward mechanism, a precise budget support/subsidy mechanism, and a water use management mechanism. The Program will also empower farmer organizations in irrigation and drainage management. Hunan has been a leader in promoting participatory irrigation management—farmers are encouraged to join WUAs or farmer cooperative organizations to manage on-farm irrigation systems below tertiary canals. The Program will support the Government efforts to enhance the capacity and engagement of WUAs and farmer organizations in O&M in all the demonstration counties, including enhancing the role of women in these farmer organizations and WUAs. In addition, Hunan has started piloting water rights trading and Government buy-backs for water saved in several counties. The Program is expected to support extending these pilots into additional counties, which can provide additional incentives for adopting water-saving techniques.



26. **The Government has been pursuing comprehensive agricultural water pricing reforms since 2016.**¹⁰² It is expected that agricultural water tariff reform can reasonably cover the O&M cost of water supply for irrigation. The key tasks of comprehensive agricultural water tariff reform include (a) consolidating the foundation of agricultural water tariff reform, including improving water metering facilities, establishing agricultural water rights systems, improving agricultural water supply efficiency and benefits, promoting demand-driven irrigation water management, and enhancing the capacities of farmers and WUAs; (b) establishing and improving pricing regimes for agricultural water use, including exploring different water pricing systems by quotas, cropping types, seasonal variability, and water sources; and (c) establishing a targeted subsidy and water-saving incentive mechanism, including establishing a targeted subsidy mechanism for agricultural water use, developing a water-saving incentive mechanism, and promoting public-private partnership in irrigation system development and management.

27. **In 2019, a Notice on Accelerating the Comprehensive Agricultural Water Pricing Reform was issued.**¹⁰³ The notice summarized the emerging challenges and made clear requirements for establishing four mechanisms: (a) a pricing mechanism for agricultural water use, (b) a mechanism for targeted subsidies and water-saving incentives, (c) a mechanism for project construction and maintenance, and (d) a mechanism for water use management. It also required that the provinces should allocate the task of comprehensive reform to cities and counties and promote the reform through a goal-oriented approach. The annual reform progress list was established, including the scope of reform implementation, the reform schedule and plan, and the implementation agencies. The specific reform measures of different regions are determined according to local conditions. The reform progress list is submitted to the NDRC, MOF, MWR, and MARA twice a year. The annual reform progress and the reform implementation plan for the next year is submitted by the end of each year.

28. **Although the Government had established a clear pathway for agricultural water pricing reform, implementation in Hunan Province still lags.** Due to the relatively abundant water resources in Hunan, the deep-rooted traditional concepts of farmers and the low awareness of water saving and environmental protection, the implementation progress of the reform still lags. Therefore, in 2021, Hunan Province issued the Options on Promoting Comprehensive Agricultural Water Reform¹⁰⁴ to accelerate implementation. A total of 14 counties, including the PforR Program County of Hanshou, have been selected as demonstration counties for agricultural water pricing reform in Hunan Province. All counties selected in the PforR Program have prepared implementation plans with annual reform targets allocated to townships or specific projects, permitting the PforR Program to further support the implementation of the agricultural water tariff reform. Field studies and stakeholder consultations in the demonstration counties showed that many irrigation districts have not collected agricultural water tariffs yet. In some districts with tariff collection, the collected tariff can only cover around 20 percent of the O&M costs. Even with the budget support from local governments, only 20 percent to 80 percent of the O&M costs can be covered. The gaps in funding for O&M have significantly affected the sustainability of the systems.

29. **There is strong governmental support for farmer organizations to engage in the management of irrigation and drainage systems.** In 2005, the MWR, NDRC, and the Ministry of Civil Affairs jointly issued the Opinions on Strengthening the Development of WUAs for Farmers, emphasizing the importance of

¹⁰² State Council. 2016. *Opinions on Promoting Agricultural Water Tariff Comprehensive Reform* (link).

¹⁰³ National Development and Reform Commission, Ministry of Finance, Ministry of Water Resources, Ministry of Agriculture and Rural Affairs. *Notice on Accelerating the Comprehensive Agricultural Water Pricing Reform*. 2019. (link)

¹⁰⁴ Hunan Province, *Options on Promoting Comprehensive Agricultural Water Reform*, 2021. (link)



WUAs for O&M. According to the Regulations on Agricultural Water Conservancy promulgated by the State Council in 2016, irrigation and agricultural water conservancy projects should be managed by irrigation management organizations, as well as WUAs, farmer cooperative organizations, and farmers. According to the Comprehensive Agricultural Water Tariff Reform, WUAs, farmer cooperative organizations, and farmers who adopt water-saving measures and/or adjust cropping patterns to save water will be rewarded. In 2014, Hunan Province issued Guiding Opinions on Strengthening the Development of Farmers' WUAs, which clarifies the basic principles of developing WUAs and their responsibilities. It also requires the governments at all levels to effectively support the development and capacity building of WUAs and allocate funds to support O&M costs. These policies and regulations will help support the capacity-building activities under this Program. Field studies and stakeholder consultations in the demonstration counties found that the development of WUAs and farmer cooperation organizations is well advanced in Hanshou County, the pilot county for WUA management in Hunan. Over 65 percent of the irrigated areas are managed by the WUAs in Hanshou. However, in Dingcheng, irrigation and drainage facilities are mainly managed by village governments, rather than farmers or farmers' organizations. In other demonstration counties, the percent of irrigated areas managed by farmer cooperative organizations ranges from 15 to 30 percent. Most WUAs and farmer organizations do not collect agricultural water tariffs. The farmers, who usually cover only a small amount of O&M costs, rely heavily on budget support from the counties. It lacks clear O&M responsibilities and sustainable funding mechanisms for O&M.

30. **China has developed the related policies to support the transfer of water rights and the buyback of water use rights and has successfully piloted water rights trading in different regions.** The Comprehensive Pricing Reform of Agricultural Water requests the establishment of an agricultural water rights system. In 2022, the MWR, NDRC, and MOF issued the Guiding Opinions on Promoting the Reform of Water Rights,¹⁰⁵ which require accelerating the allocation of initial water rights, promoting market-oriented trading, improving the trading platform, and strengthening the supervision of water rights trading. It is expected that, by 2025, the allocation of initial water rights will be established, regional water rights and water intake rights of water users will be clarified, the trading mechanism for water rights will be further improved, market-based trading of water rights will become more active, trading supervision will be comprehensively strengthened, and a unified national water rights trading market will be initially established. The trading of water use rights should be promoted, and the trading of irrigation water rights should be conducted within irrigation areas or among water users or water organizations. If irrigation water users are willing to transfer their saved water use rights, the local governments at or above the county level, its authorized water administrative department, or the irrigation area management organizations may repurchase the saved water use rights and redistribute or trade it on the premise of meeting reasonable agricultural water demand within the region.

31. **Hunan Province has piloted water rights trading and buyback.** In 2022, the PDWR and PDRC of Hunan Province jointly issued a notice to control the total water amount and water use intensity in the 14th Five-Year Plan (FYP) period, which determined the total amount of water use control targets for each city in 2025. In 2022, the PDWR issued the Forecasting and Distribution Plan of Total Agricultural Water Use for the 14th FYP period, which clarified the total agricultural water consumption of each city under the condition of annual average precipitation in 2025. The cap on total water uses and total agricultural water consumption lays the ground for water rights trading. From 2015 to 2017, a pilot reform of water rights was carried out in Jiangbei Town, Changsha County, and water rights in different sectors were

¹⁰⁵ MWR, MOF, and NDRC. *Guiding Opinions on Promoting the Reform of Water Rights*. (link)



confirmed and registered. From 2019 to 2021, the annual saved water rights buyback of Tongrenqiao Irrigation District in Changsha County was completed through the National Water rights trading platform for three consecutive years. The experience from these pilots can be used to guide the water rights trading activities in the demonstration counties under this PforR Program.

Gender Gap Analysis

32. Despite the feminization of agricultural labor in rural China, women are less represented in farmer cooperative organizations, which play a key role in local natural resource management. Data (figure 3.2) from the demonstration counties show that women account for only 12.55 to 20 percent of the decision-making roles in the farmer cooperative organizations. As shown by figure 3.2, the percentage of women on management teams of farmer cooperative organizations ranges from 5 to 30 percent. Data from the China Health and Nutrition Study show that the average share of farm work performed by women increased from 53 percent in 1997 to 59 percent in 2009.¹⁰⁶ The White Paper of ‘Gender Equality and Women's Development in China’ in 2015 pointed out that women account for about 70 percent of the agricultural labor force.¹⁰⁷ In the past decades, a significant number of people have migrated from rural to urban areas in search for better paying jobs, and the majority of them were men. Women, especially those between the ages of 36 and 45, remained in the rural areas, spending more hours than men on the farm.¹⁰⁸ Although women are crucial contributors to the agricultural production, it is still men who are the key opinion leaders in managing local public affairs and community governance. Factors such as the patriarchal line of power that bring about gender bias, gendered division of labor within and outside of the household, various informal customs/norms, and the interaction between institutions including the state, village, and household¹⁰⁹ which produced gender disparities in ownership of land/properties all lead to the lower representation of women in governance of local natural resources and common goods.

33. Farmers’ cooperative organizations are effective vehicles for building a sense of shared purpose and enabling cooperative actions in sustainable natural resources management and development.¹¹⁰ Women’s participation in such organizations is crucial for a green transition of agricultural practices, as trained women, evidenced by a study conducted in Hubei Province, are more likely to adopt low-methane technologies than men.¹¹¹ Research also indicated the different typologies of tasks borne by women and men involved in climate smart practices in rice cultivation; hence, both men and women should be included in communications and training.¹¹² The gender differences in perceptions/knowledge of climate

¹⁰⁶ de Brauw, Alan. 2014. “Women and Agricultural Labor in China.” In the *Oxford Companion to Economics in China*: 502–506.

¹⁰⁷ Information Office of the State Council of the People's Republic of China. 2015. *Gender Equality and Women's Development in China*. (link)

¹⁰⁸ International Food Policy Research Institute. 2012. “The Feminization of Agriculture with Chinese Characteristics.” Discussion Paper. (link)

¹⁰⁹ Sargeson, Sally. 2008. “Women’s Property, Women’s Agency in China’s ‘New Enclosure Movement’: Evidence from Zhejiang.” *Development and Change* 39 (4): 641–665.

¹¹⁰ Lu, Caizhen. 2008. “Why Is it so Difficult to Tackle Gender in Water User Associations? A Case Study from Gansu, China.” European Association of Development Research and Training Institutes.

¹¹¹ Liu, Yong, Jorge Ruiz-Menjivar, Lu Zhang, Junbiao Zhang, and Marilyn E. Swisher. 2019. “Technical Training and Rice Farmers’ Adoption of Low-Carbon Management Practices: The Case of Soil Testing and Formulated Fertilization Technologies in Hubei, China.” *Journal of Cleaner Production* 226: 454–462.

¹¹² Brodsky, Alyssa. “The Intersection of Gender, Climate Change and Rice Cultivation.” Blog on Center for Gender Health and Equity Website. (link)



change and water saving also make it important to include both genders' thoughts and perspectives in governance.

Figure 3.1. Proportion of Women in Farmer Cooperative Organizations

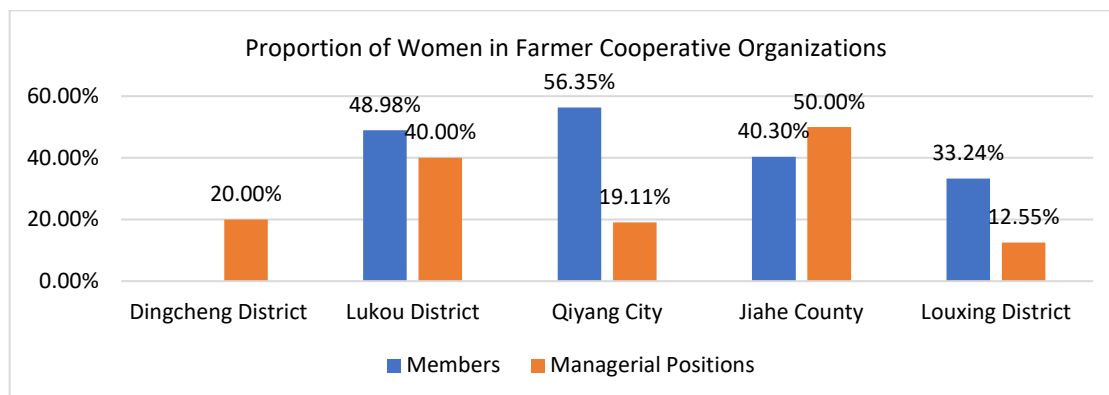
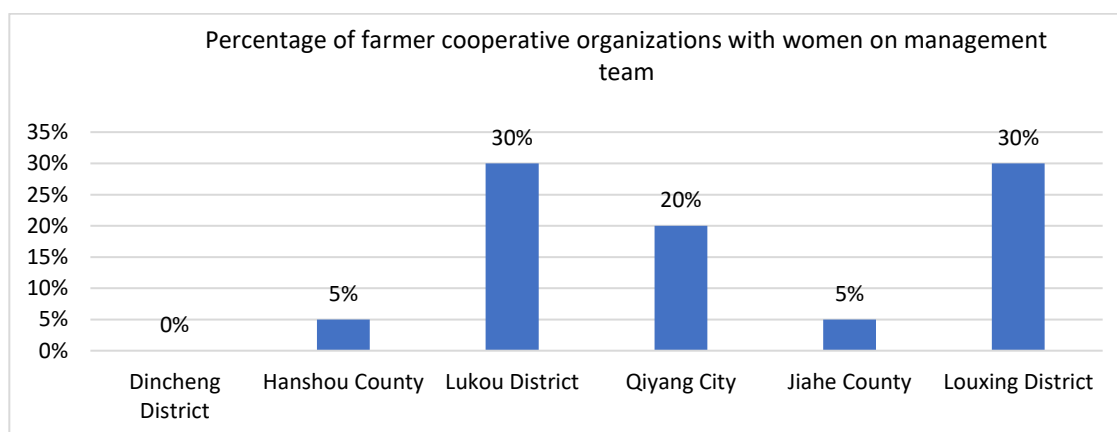


Figure 3.2. Percentage of Farmer Cooperative Organizations with Women on Management Team



34. **Fewer women engage in WUAs,¹¹³ and the women's representation in management teams of WUAs is even lower.** Data from demonstration counties show that women account for around 44.53 percent of WUA members and 18 percent play a managerial role on WUA management teams. In addition, women's presence in irrigation management units is generally lower than men's. Women in general account for less than 30 percent of technical/general positions, and the proportion of women in managerial positions can be low as 6.25 percent. The male-dominated culture, the relatively low educational level and social skills of rural women, and women's high domestic and productive workloads may all limit women's participation in WUA activities.¹¹⁴ Women's role in local water governance is further affected by the long existing gender bias that men have better leadership capacity than women. The underrepresentation of women in WUAs showcases a missed opportunity for women's empowerment in the adoption of new and improved water-saving technologies. The result of a study on the gendered responses to drought in Yunnan showed that despite the increasingly active role of women in managing water during the drought, they are excluded from community-level decision-making on water. Given the

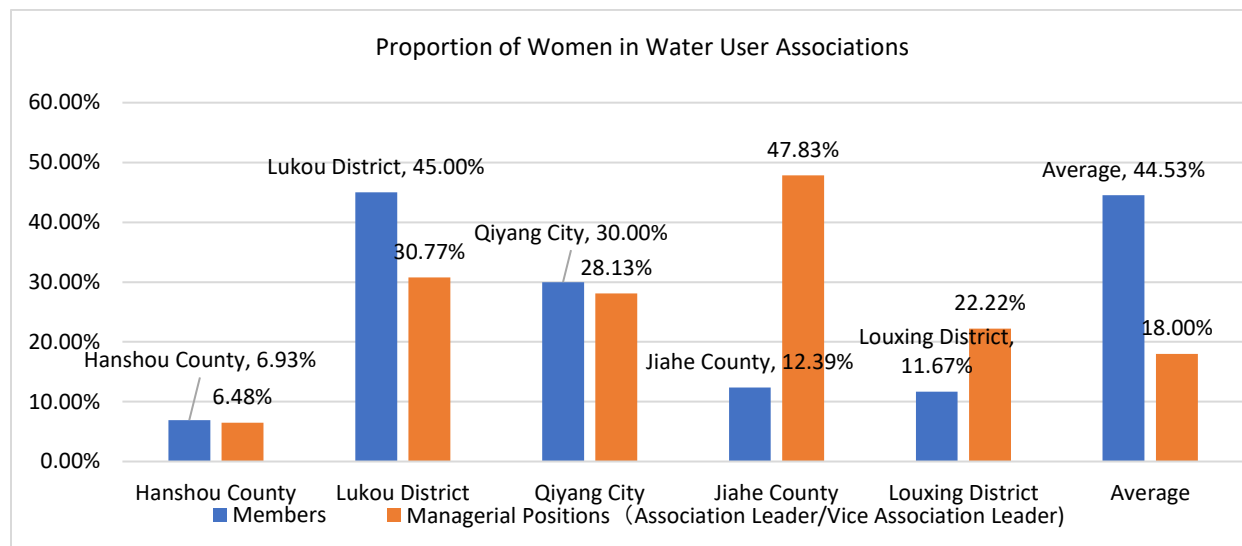
¹¹³ Lukou District does not have WUA, the function is fulfilled by the village collective economic organization(村集体经济组织).

¹¹⁴ Lu 2008.



importance of gender differences in perceptions of and responses to drought, efforts to support local resource management and climate adaptation will be undermined in the absence of women's perspective.¹¹⁵ In addition, the female rice farmers earn structurally less than male farmers in the six counties. Women's monthly earnings can be 68.05 to 84.35 percent of their male counterparts.

Figure 3.3. Proportion of Women in WUAs



35. **Although women can be key agents of change in sustainable paddy rice farming, they lack training opportunities.** Data from the five counties show that climate-smart trainings covered only a very small portion of the population, and the proportion of women included was much lower than that of men. This manifests a large gender imbalance considering the increasingly important role of women in agriculture in China. Some counties have not yet conducted trainings on low-methane rice cropping package solution/technologies.

36. **Gender actions.** To increase women's participation in local farmer's cooperative organizations and WUAs as decision-makers, the Program will support the following gender actions:

- It will empower women participation and leadership in farmers' cooperative organizations and WUAs. For example, farmer cooperative organization/WUA membership should not be limited to registered landowners only (which are predominantly men), and the membership/advancement into management roles should not be linked with member's economic status.
- It will help local authorities strengthen local people's gender awareness in irrigation management activities. This will include the development of gender equality trainings targeting both the management teams and members of farmer cooperative organizations/WUAs, staff from the irrigation management units, and relevant government bureaus; cooperation with local women's federation in developing workshops/social

¹¹⁵ Su, Yufang, Suman Bisht, Andreas Wilkes, Neera Schstha Prahan, Yahui Zou, Song Liu, and Kevin Hyde. 2017. "Gendered Responses to Drought in Yunnan Province China." *Mountain Research and Development* 37 (1): 24–34. <https://doi.org/10.1659/MRD-JOURNAL-D-15-00041.1>



activities for female farmers; working with local TV/radio programs and actively using social media to feature women in the management of local natural resources and the spread of climate-smart agro-technologies.

- Targeted extension and training activities will be organized to enhance women's capacities on rice production, irrigation methods, water-saving techniques, and the adoption of climate-smart technologies, and also importantly, their leadership skills, preparing women with capacities and skills to lead and advocate for new technologies in rice production practices. Pre-training surveys on both men's and women's training needs are necessary to ensure quality delivery of these training sessions.

Economic Assessment

The Rationale for Public Sector Financing

37. **The Program is expected to contribute to China's low-carbon agricultural development, generate substantial GPGs and strengthen provincial- and county-level institutional capacity for governance.** The Program will generate substantial GPGs and climate co-benefits through (a) reducing GHG emissions from rice fields, (b) improving natural resource (water and land) management and climate resilience, and (c) reducing pollution from reduced use of fertilizer and pesticide for rice cultivation. As such, the Program will contribute to the achievement of China's carbon peaking and carbon neutrality pledges. The lessons learned and knowledge generated from the Program will be relevant for addressing similar development challenges in other rice growing Asian countries and beyond. In that sense, the Program also supports the Cross-Cutting Theme: Cooperating on Global Knowledge and Development of the CPF. The Program will also contribute to other GPGs by supporting food security and enhancing biodiversity through the reduction of agricultural pollutants and water use. Furthermore, the Program will contribute to GPGs through knowledge management (sharing methodologies and approaches developed under the program). Finally, the Program will contribute to institutional development and improve the efficiency and effectiveness of public service delivery. This will be achieved through the development of frameworks or governance systems and capacity building at the provincial and county levels.

Assessment Methodology

38. **The benefits of the Program include both global and local benefits** generated through (a) strengthening agricultural resources protection and use efficiency and improving production infrastructure to increase production capacity, (b) improving irrigation and drainage systems and water management for resilient production, (c) reducing agricultural NPS pollution and uplifting the production environment, (d) enhancing ecological protection for sustainable production, (e) promoting green and low-methane technologies and practices for mitigating climate change impacts, and (f) improving institutions and their capacity for O&M and providing sustainable services.

39. **Quantifiable benefits included in the analysis cover three aspects:** (a) at the local level, benefits will accrue from improved paddy quality, yield increases, and input cost reduction in water, fertilizer, and pesticide for rice cultivation and (b) at the global level, substantial public good will be generated through reducing GHG emissions (CH₄ and N₂O) from rice fields. The Program costs include all the incremental costs related to high-standard farmland construction according to the provincial government guidance as well as capacity-building and extension training costs.



40. **The economic assessment uses a CBA based on the quantifiable benefits from rice production at the local level and the global benefit of GHG reduction.** The Program includes three RAs: RA1: Strengthening government management system for sustainable development impacts; RA2: Reducing GHG emissions for low-methane development; and RA3: Improving irrigation and drainage services for resilient rice production. RA1 activities will be implemented largely at the provincial level, while RA2 and RA3 activities will be implemented at the demonstration county level. The assessment implicitly combines activities under Results Areas 1, 2, and 3 to value outcomes as a combined effort to achieve Program outcomes. RA1 is regarded as facilitating outcomes achieved under RA2 and RA3. The CBA shows in table 3.9 that farmers can save significant production costs in water, fertilizer, and pesticide while at the same time increasing their income through yield increase and rewards/payment for water saved. The carbon trading can bring in additional benefits. The analysis shows that rice farmers could gain incremental net income at around CNY 1,935 per ha (US\$280 per ha), and CNY 2,608 per ha (US\$380 per ha) with carbon trading benefits.

41. **The assessment compares a scenario of no Government program to a scenario of a Government program including World Bank support.** This approach is used because under a PforR, Government and World Bank funds are combined to achieve results, with no distinction at the activity level between Government-financed and World Bank-financed achievements. This approach can determine whether the overall program—of which World Bank financing partially-supports—has a net social benefit.

42. **Net GHG emission reduction is measured by the quantity of CO₂ equivalent reduced from the rice fields in the demonstration counties.** The GHG (CH₄ and N₂O) emission reduction is expected to come mainly from improved water and nutrient management, including increases in soil carbon through returning crop straw to the rice field, and so on. The quantity has been estimated using the available tools until an MRV system is developed under the Program. Net GHG emission reduction in demonstration counties under the with-Program scenario is estimated, using the FAO Ex-ACT Calculation Tool for GHG emissions from paddy rice, to be about 2.4 million tons of CO₂ equivalent. DLI 1 will create the enabling environment to adopt climate mitigation measures to reduce rice GHG emissions. DLIs 3 and 4 will promote the adoption of key climate mitigation measures (AWD and deep returning of straw) with capacity building and training. DLIs 5 and 6 will provide sustainable irrigation and drainage services to create the conducive conditions for AWD, contributing to the reduction of rice GHG emissions.

43. **Economic model (for 1 hectare of paddy rice production) in the demonstration areas has been formulated.** The incremental economic costs include investment costs for infrastructure improvement, technical package adoption, operational costs for agricultural production, and training and capacity-building costs. The major benefits included in the analysis are incremental crop production and price premiums from quality improvement; savings from reduced agricultural input costs (fertilizer, agrochemicals, diesel, and irrigation water); and benefits from GHG emission reductions. Other substantial positive externalities (for example, improved soil quality and biodiversity are not included in the analysis as they are not easily quantifiable). The following assumptions have been applied for the analysis: (a) increased production and reduced inputs are based on the evaluation findings of the government agencies and complemented by judgement from experts and extension workers; (b) investment costs are in line with the standard unit cost norms as mandated by the provincial government; (c) carbon shadow prices are set following the World Bank *Guidance Note on Shadow Price of Carbon in*



Economic Analysis (November 2017);¹¹⁶ (d) Program life of 20 years; (e) the discount rate adopted by the analysis is 6 percent, chosen according to guidelines from the NDRC, which is in line with the World Bank's guidance for discount rates;¹¹⁷ and (f) taxes, duties, and subsidies are not included as they represent transfer payments instead of real costs or benefits to society as a whole.

Table 3.9. Cost-Benefit Analysis for Farmers' Incentives

Cost Benefit Analysis for Farmers' Incentives to Participate in the Program (CNY/ha)		
AWD (costs)	<i>Specific Activities</i>	<i>Incremental Costs</i>
	Electricity for drainage	450
	Labor cost	90
AWD total incremental cost (a)		540
AWD (benefits)	<i>Specific Activities</i>	<i>Incremental Benefits</i>
	Reduced electricity cost for irrigation	187.5
	Reduced cost for water charge for irrigation	225
	Government subsidies for reduced water use	37.5
	Reduced water use for water rights trading	225
AWD total incremental benefits (b)		675
AWD net benefits (b-a)		135
Fertilizer reduction cost savings		450
Pesticide use savings		180
Yield increase		1,170
Total incremental income (without carbon trading)		1,935
Carbon trading (12 tons/ha @ CNY 56/ton)		672
Total incremental income (with water and carbon trading)		2,608

Note: The rice fields with better drainage condition can have gravity driven drainage, which may not need electricity or energy for drainage.

Results of the Economic Analysis

44. **Cash flows of benefits and costs for the model are projected over 20 years to estimate their ERR.** The ERR with GHG reductions is estimated at 24 percent (at a low-carbon shadow price), 34 percent (at a high carbon shadow price), and 14 percent at ERR without GHG reductions. These are all well above the discount rate of 6 percent, indicating that the Program is economically viable.

45. **No sensitivity test is warranted because** (a) lower bounds of production increases and inputs reduction are used in the analysis throughout the Program's life; (b) unit cost or investment in high standard farmland construction is virtually fixed by the provincial government; and (c) significant

¹¹⁶ According to the World Bank's *Guidance Note on Shadow Price of Carbon in Economic Analysis* issued on November 12, 2017, the projects' economic analysis should use a low and high estimate of the carbon price starting at US\$40 and US\$80 in 2020 and increasing to US\$50 and US\$100 by 2030. The low and high values on carbon prices are extrapolated from 2030 to 2050 using the same growth rate of 2.25 percent per year that is implicit from 2020 to 2030, leading to values of US\$78 and US\$156 by 2050.

¹¹⁷ World Bank. 2015. *Technical Note on Discounting Costs and Benefits in Economic Analysis of World Bank Projects*. The discount rate is recommended to be 6 percent for investments with long-term unquantified E&S benefits.



unquantifiable positive externalities (soil quality and biodiversity improvement) are not included in the analysis.

46. **The Program will provide financial incentives for farmers' participation.** In adopting the AWD, deep application of nitrogen fertilizer and retention of paddy straw in soil, incremental costs will be incurred given the need for more labor and energy input for drainage and deep ploughing; however, additional benefits will accrue from the (a) reduction in chemical fertilizer use, (b) reduction in irrigation water use resulting in less energy use and water charges, (c) cash rewards from ongoing government subsidy programs for water savings against the set quotas, and (d) the water rights trading to be implemented under the Program. Furthermore, all the stakeholders confirmed that adoption of these technical interventions will not reduce the crop yields and expected that the carbon trading, if materialized, will bring additional income to farmers. On balance, the farmers will gain additional net income at around CNY 135 per ha (without carbon trading benefits) for adopting these technological packages, indicating that the Program will be financially attractive for farmers. The main constraints identified by farmers and extension workers for the current low adoption are the unreliable water supply and drainage facilities and the lack of training and capacity building, all of which will be addressed by the Program's activities.



Table 3.10 Government program and PforR Program (Activity) Boundary

Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
(1) Strengthening agricultural resources protection and use efficiency and improving production infrastructure to increase production capacity	Land Leveling and Consolidation	Large-scale land pooling and consolidation for relative concentration of arable land.	None	None	High potential E&S risk
		Levelling land, including stripping topsoil, deep excavation to loosen the soil, backfilling the topsoil to balance the earthwork, compaction field base to improve farmland soil fertility with ridge diked for easy irrigation and drainage. For example: In the 6 demonstration counties, about 40,000 mu paddy field will be levelled during the 14th FYP period.	Same as the left column	RA2 (1): Investing in high standard farmland construction in demonstration counties Improving climate resilience	
	Soil Improvement	Any activities on polluted soil in cultivated land	None	None	High potential E&S risk
		Improving poor soil structure and increasing soil organic matters by means of thickening tillage, test-based scientific fertilization, planting green fertilizer, retuning crops' straw to the field, and improving tillage method and so on. For example, in the 6 demonstration counties, farmland soil will be improved according to their respective soil conditions during the 14th FYP period. Jiahe County: 14,370 mu of farmland will be fertilized with soil improved in 134 villages of 15 towns/townships during the 14th FYP period. Louxing District: farmland soil improvement will be carried out during the 14th FYP period. Hanshou County: 25,060 mu of farmland soil will be improved in 17 administration villages during the 14th FYP period.	Same as the left column	RA2 (1): Investing in high standard farmland construction in demonstration counties, Improving climate resilience Promoting farmland carbon sequestration	
	On-farm Access Road	Optimal planning in harmony with water system, irrigation and drainage system and the field ridges and improving on-farm access road, including tractor-ploughed roads, crops production	Same as the left column		



Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
		roads, and ancillary facilities for farm machineries to access to the field. For example: In the 6 demonstration counties: 320 km of crop production roads and 360 km of tractor-ploughing roads will be rehabilitated or upgraded during the 14th FYP period.			
	Farm Power Supply Facility	Providing power support for pumping stations, machinery wells and information engineering, including the required strong and weak current transmission lines, transformer and distribution devices, and other facilities	None	None	Not a PforR priority
(2) Improving irrigation and drainage systems and water management	On-farm Irrigation and Drainage Facility	Developing on-farm irrigation and drainage system required for the high standard farmland (paddy field) and providing high-efficient water-saving facilities, small-scale village-to-township level irrigation facilities (for example, water storage ponds and ungated weirs for irrigation), drainage pumping stations; Lining the canals/ditches and installing water pipelines, and so on; implementing AWD irrigation measures; establishing demonstration bases for intelligent water-saving system by applying crop models that analyze water demand for rice production, estimate irrigation water volume to instruct the automatic sluice gates for paddy irrigation. For example: In the 6 demonstration counties, 16 demonstration bases covering total area of 3,200 ha of intelligent water-saving system will be established (two bases for each county and 200 ha for each base) during the 14th FYP period.	Same as the left column	RA2 (1). Investing in high standard farmland construction in demonstration counties, RA3. Promoting adoption of AWD technology. Improving climate resilience. RA3. Improving irrigation and drainage services for resilient rice production	
(3) Reducing agricultural NPS pollution and improving production environment	Farm Return Flow Pollution Control	Constructing bio-ditches to reduce the non-point pollution from farming runoff. For example: In the 6 demonstration counties, in combining with irrigation and drainage canal systems, bio-ditches will be constructed to intercept and reduce the impact of nitrogen and phosphorus pollution from farming runoff on environment during the 14th FYP period.	Same as the left column	RA2 (1) Investing in high standard farmland construction in demonstration counties	
	Chemical Fertilizer Use Reduction	Implementing test-based fertilization and expanding the use of formula fertilizer and organic fertilizers (incorporated with the activity type of technological extension services). For example:	Same as the left column	RA2 (4) Support efficient fertilizer application and	



Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
	and Efficiency Improvement	In the 6 demonstration counties, test-based fertilization technology will be applied of over 10,000 ha during the 14th FYP period.		appropriate returning of crop straw to field; Reduce GHG emissions	
	Pesticide Use Reduction and Efficiency Improvement	Reducing the use of chemical pesticides and carrying out comprehensive green prevention and control of diseases and pests through physical and biological measures. Providing precise and specialized pests control services timely (incorporated with the activity type of technological extension services).	None	None	Not a PforR priority
	Crop Straw Return to Field and Utilization	Strengthening multipurpose utilization of crops straws (used as livestock fodders, culture base for mushroom cultivation, building materials, bio-mass fuels, and so on)	None	None	Not a PforR priority
		Promoting fertilizer utilization technologies, such as straw returning to field (incorporated with the activity type of technological extension services). For example: In the 6 demonstration counties, advanced straw returning to field technologies will be applied over 10,000 ha of farmland during the 14th FYP.	Same as the left column	RA2 (4) Support efficient fertilizer application and appropriate returning of crop straw to field Promoting farmland carbon sequestration	
(4) Enhancing ecological protection and restoration for sustainable production	Farmland Protection and Ecological-Environment Protection Facility	Constructing on-farm windbreak (such as shelter forest/grasses on terrace ridges, stream/riverbanks and slopes, roadsides, canal/ditch sides); In the areas prone to soil erosion, reasonable construction of bank slope protection, taking actions for gully erosion control, field barrier protection, and so on, and repairing damaged farmland. For example: In the 6 demonstration counties, shelter forest will be established to cover total area of 5,440 mu and an area of 4,000 mu will be covered by ecological grass planting during the 14th FYP period.	Same as the left column	RA2 (1) Investing in high standard farmland construction in demonstration counties Promoting farmland carbon sequestration	
(5) Promoting green and low-methane technologies	Technological Extension Services	Advancing the application of digital agriculture, smart irrigation of paddy field and green prevention and control technologies. For example: In the 6 demonstration counties, it is planned to advance the application of green prevention and control	Same as the left column	RA2 (1) Investing in high standard farmland construction in demonstration counties	



Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
and practices for mitigating climate impacts		technology on the 3,200 hectares of the intelligent water-saving systems: for example, smart spore traps, smart pest forecast lights, and smart gyplure (sex attractant) monitors will be used to monitor, forecast, and control occurrence of rice disease and pests to minimize the use of chemical pesticides while ensuring the increase of rice yield during the Program implementation; Gyplure will be widely applied and solar-powered insect killing lamps will be purchased to serve for more than 5,000 ha of paddy field, and so on.		RA2 (2) Organizing farmer training on solution package for low-methane and water-saving rice production. RA2 (3) Promoting adoption of AWD technology RA2 (4) Support efficient fertilizer application and appropriate returning of crop straw to rice field	
		Modern farmers' training: during the Program implementation, farmers from cooperations, family farms, large planters of the 6 demonstration counties and the peripheral areas will be provided with trainings on practical agricultural techniques and new technologies. Training courses will include, but not be limited to, climate-smart agricultural techniques for rice production such as (a) selection of rice varieties with high yield and low emission, (b) formula fertilization, (c) use of aerobic tillage and aerated cultivation, (d) use of water-saving irrigation technology, (e) implementation of green prevention and control of diseases and pests, and (f) high-quality straw returning to the field; other practical technologies related to agricultural machinery operation, drone operation, information technology. Management trainings: during the Program implementation, trainings will be provided to staff engaged in managing the Program implementation, including the Program management and operation, establishment and management of intelligent agricultural system, and management of agricultural carbon reduction and carbon trading.	Same as the left column	Reducing GHG emission and Promoting farmland carbon sequestration	
		Popularizing the application of scientific fertilization technology, AWD irrigation technology, and water-controlled irrigation technology. For example: In the 6 demonstration counties, abovementioned technologies will be widely popularized during the 14th FYP.	Same as the left column	RA2 (3) Promoting adoption of AWD irrigation technology RA2 (4) Supporting efficient fertilizer application and	



Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
				appropriate returning of crop straw to rice field. Promoting farmland carbon sequestration	
		Promoting low-emission varieties and advanced straw returning to field technologies (improved varieties and methods), and so on. For example: In the 6 demonstration counties, advanced straw returning to field technology will be widely promoted during the 14th FYP.	Same as the left column	RA2 (4) Supporting efficient fertilizer application and appropriate returning of crop straw to rice field Promoting farmland carbon sequestration	
		Equipping with new agricultural machinery equipment and facilities, deepening the integration of agricultural machinery and agricultural technology. For example: In the 6 demonstration counties during the Program implementation, it is planned to (a) install on-farm water level indicators, Tada intelligent control valves on branch canals and lateral ditches; (b) install agricultural environment meteorological detectors, intelligent insect warning lights, intelligent automatic monitoring, and so on; and (c) establish agricultural machinery service centers (one center for each county).	Same as the left column	RA2 (3) Promoting AWD technology and integrated water and nutrient management Reduce carbon emission RA2 (1) Investing in high standard farmland construction in demonstration counties	
	Smart Monitoring and Evaluation	Establishing the paddy investment results M&E system and conducting monitoring, evaluation, and reporting for carbon sequestration and GHG emission reduction from rice production. For example: At Hunan Provincial level, a monitoring, reporting, and verification (MRV) standard will be established during the Program implementation. In the 6 demonstration counties, monitoring and evaluation of carbon sequestration and emission reduction in rice production will be carried out during the Program implementation, and so on.	Same as the left column	RA1 (4) Improving enabling environment for sustainable development impacts	



Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
(6) Improving institutions and capacity for O&M and sustainable services.	Smart Management	Strengthening information management and sharing. Results of high-standard farmland construction will be integrated into the “one map” of land and resources remote sensing, the regulatory platform of the Ministry of Land and Resource, and subject to on-line monitoring & supervision and unified evaluation and assessment. For example: At Hunan Provincial level, an M&E system and information platform for high-standard farmland construction investment will be established during the Program implementation.	Same as the left column	RA1 Strengthening government management system for sustainable development impacts	
		Advancing comprehensive agricultural water pricing reform. During the Program implementation, it is planned to be in line with the relevant national policies on promoting comprehensive agricultural water pricing reform and targeting water organization to formulate water price policies based on the actual situation of Hunan Province. A water supply metering system will be established, and a precise subsidy and water-saving incentive mechanism will be improved. Based on water price affordability analysis, plan for adjusting water price scientifically will be formulated and agricultural water price mechanism will be advanced to promote water-saving and sustainable development of agriculture. For example: At Hunan Provincial level and in the 6 demonstration counties, a comprehensive agricultural water pricing reform will be carried out. The pilot county of water rights trading/buyback will be determined after the Program County self-declaration and PPMO’s study and confirmation. Hanshou County, it is planned during the 14th FYP period to carry out agricultural water pricing reform in Yanma irrigation district, covering 5 towns/townships and 3 sub-districts, and in Xihu irrigation district, covering 4 towns/townships, for establishing a reasonable water pricing mechanism, a precise subsidy and a reward incentive mechanism for water-saving in agriculture, establishing agricultural water right and small water-	Same as the left column	RA1 Strengthening government management system for sustainable development impact RA3: Improving irrigation and drainage services for resilient rice production	



Government program: Hunan High-standards Farmland Construction Plan (2021-2030)			PforR Program Boundary		Reason for Exclusion
Theme	Activity Type	Typical Activities at Provincial and (6) County Levels (2023–2028)	Included or Not	Related PforR Results Area and Activity	
		saving project property right system reform, as well as management and protection mechanism, and so on.			
		Improving O&M and management system and the standard system. For example: At Hunan Provincial level and in the 6 demonstration counties, it is planned to (a) improve the management system for water-saving and low-methane rice production, including establishing new/revising policies, regulations, and standards; (b) develop/issue a provincial technical standards for water-saving and low-methane rice production; (c) establish a provincial MRV standard for carbon sequestration and GHG emission reduction from rice production; (d) develop/issue a water-saving and low-methane rice production replication plan; (e) strengthen farmer water users' participation in managing irrigation area; (f) achieve sustainable irrigation and drainage services; and (g) pilot carbon trading and water rights trading or buy-back during the Program implementation. Hanshou County: it is planned during the 14th FYP period to carry out standardized management on the construction of irrigation areas, including management of high-standard farmland construction, safety, water rights and other agricultural economic development, and so on.	Same as the left column	RA1 Strengthening government management system for sustainable development impact RA3: Improving irrigation and drainage services for resilient rice production	
		Promoting agricultural carbon emission reduction and sequestration and planning to carry out pilot carbon trading during the implementation of the Program	Same as the left column	RA1 Strengthening gov. management system for sustainable development impact RA2 Reducing GHG emissions for low-methane development	



ANNEX 4. (SUMMARY) FIDUCIARY SYSTEMS ASSESSMENT

COUNTRY: China

Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)

1. **Program scope.** The scope of the FSA is based on the defined boundary and Program Expenditure Framework. The Government program for the proposed PforR is the HSFCP of Hunan Province. The scope of program includes six counties/districts and several activities implemented by related provincial entities. Implementation of the Program will follow the existing national, provincial, and sectoral legal framework and practices for fulfilling public financial management (PFM), public procurement, and governance responsibilities. The FSA provides a comprehensive review and analysis of the current systems, identifies risks, and recommends mitigation measures for implementation to enhance the performance of the current systems in meeting the Program objectives. This annex summarizes the main conclusions of the FSA.
2. **Assessment of fiduciary systems.** The fiduciary team has assessed the fiduciary systems of all key Program implementing agencies in Hunan Province, including the Provincial Finance Department, DRC, DARA, Department of Water Resources, PAO, and related line bureaus in the demonstration counties/districts. The assessment covers the review of the PFM cycle, Program systems and capacity improvements, and the Program implementation support.
3. **The assessment concludes that the Program's fiduciary systems are adequate** for meeting World Bank's PforR Policy and Directive requirements. The systems can reasonably ensure that the Program's financing proceeds will be used for the intended purposes, with due attention to the principles of economy, efficiency, effectiveness, transparency, and accountability.
4. **PFM system.** The funds to be invested in the proposed Program would stem from various funding sources, including transfer funds from the central and provincial governments, as well as funds from the respective county government's budget. The higher-level transfers from the central and provincial government, which are more stable and reliable, are the dominant financial sources of the program budget. Since the county sector entities prepare their budget in line with the pre-noticed quota, there were no big gaps in program counties between the requested and approved program budget in the last three years. The upper-level government transfers are normally distributed to counties in batches. Most central government transfers for the current year are distributed at the end of previous year, the others and most provincial government transfers are delivered to counties in different months of the year and some even in the last quarter of the year. The lack of predictability of the budget quota hampers the capacity of local governments to forecast cash or credibly allocate budgets to budgetary units. It is noted that county governments neither prepare medium-term budgets nor do they link budgets to the prevailing development strategies or provide any explanation about the fiscal implications of policy changes. The budget preparation process at the county level appears to be carried out in an orderly manner. The completion of county government annual budgets varies as different counties adopt different approaches in integrating upper-level transfers in their annual budget although the distribution is in batches. Some counties/districts included all transfers in their annual budget and estimated the upper transfers based on previous years' budget and made adjustment when the budget quota was received. But no payment could be made until the budget quota was received. Some counties/districts only included the transfers



which the budget quota was received when preparing the annual budget and reflected those funds with the budget quota received late in the final accounts. Since some budget quotas were distributed to counties/districts quite late, program implementation was negatively affected in some places.

5. Since the Program is not an element of budget classification in China, the required Program reporting cannot be generated from the government IFMIS. Related provincial line departments did not require counties to report program expenditures regularly. Several budget items which can capture program expenditures were selected and the data were analyzed to review the budget execution status. Budget completion rate is relatively satisfactory in counties that identify program expenditure in this manner, which demonstrates that the budgetary entities take budget execution seriously. Once the budget is approved, the completion is not a questionable issue. However, there are still some circumstances that the completion rate is low and budget execution status is not quite stable. Governments at all levels have integrated all financial funds into the treasury single account (TSA) system. All revenues are directly collected into the treasury account or the special financial account, and all expenditures are paid to the contractors/suppliers/beneficiaries through the TSA. County governments effectively supervise funds and ensure efficient utilization of funds by strictly following the basic requirements of special funds, centralized payment by the national treasury, public bidding, and Government Procurement. The county finance bureaus allocate funds based on relevant materials such as the acceptance and settlement statement prepared by the project supervisory entity, project unit, county auditing bureau, and county finance bureau. Related regulations have been established in some counties to standardize the appropriation principle, appropriation conditions, appropriation process, and account review procedures to ensure the fund appropriation system is implemented within a time limit, and the funds are allocated to the user unit on time, which has improved the use of funds and ensured the safety of fund operations. Payments can be made to the budgetary units within the approved budget. The centralized payment center at each county finance bureau is responsible for initiating all payments, following the request of the budgetary units. Disbursement of IBRD loan will follow the traditional procedures. After the Loan Agreement is signed by the World Bank and MOF, the MOF will sign an on-lending agreement with Hunan Province. Therefore, a separate account will be opened and managed by Hunan Provincial Finance Department. The IBRD loan will be disbursed to the account based on the request from the Provincial Finance Department for advance and achievement of DLIs.

6. In Hunan Province, the counties/districts receiving Program funds were not required to report Program expenditures regularly to the upper-level government. As a result, Program expenditures were not properly monitored and managed at the provincial level. In addition, some transferred funds are distributed in the form of general budget rather than earmarked budget; absence of regular monitoring may dilute the efficient budget management. Therefore, a budget tagging (green tagging) system is recommended by the World Bank to ensure Program expenditures can be traced and monitored properly. The detailed arrangement of the green tagging needs to be further discussed with related government entities. It was agreed that the provinces will explore piloting 'Green Tagging Program' for Program-related expenditures in the Government treasury system. This would allow Program financial reports to be generated directly from the treasury system during project implementation, especially in the demonstration counties/districts. Detailed arrangements will be prescribed in the PIP to be developed by the PPMO. The Provincial Finance Department will decide when and how to implement this piloting by considering the readiness of Government reform on the IFMIS.

7. Based on the discussion with the budget division of the Provincial Finance Department, it is noted that selecting some budget line items which can capture program expenditures and summing up the



account balances is the normal practice for them to report program expenditures when needed. Therefore, a similar measure is adopted to design a tailored Program financial reporting template which will be discussed and agreed on by the World Bank and all government entities involved.

8. An MIS has been developed by DARA to monitor and manage all budgetary funds under the administrative management of DARA but the high-standard farmland construction fund which is the main financing source of program funds is not included in the MIS. Some modules are designed in the MIS, including annual plan distribution, funds management, and performance management, and so on. It is noted the users are required to enter the vouchers in the MIS (which is the important database for accounting and financial reporting), the financial reporting function has not been developed. The high-quality farmland construction fund is using the platform developed by MARA, and county/district agriculture bureaus to prepare and submit monthly program reports through the platform, but the data are mostly on physical progress and the financial data are quite limited. Therefore, DARA is recommended to integrate the high-quality farmland construction fund in the MIS so that all budgetary funds within DARA could be monitored and managed in the same efficient manner. Meanwhile, the financial reporting module should be developed to efficiently use the data stored in the system.

9. **There is adequate control over, and stewardship of program funds, with well-defined delegation of authority.** Following the national policy and regulations issued by the MOF and NDRC, the provincial governments have issued a series of regulations regarding fund management, implementation measures, result verification procedures, and so on. For example, the following government decrees have been issued by both central and provincial government for some ear-marked funds, which are the main financing sources of program activities, to regulate the usage of these earmarked funds to ensure the budget could be used for intended purposes. A set of performance indicators are attached to these earmarked funds which cover very broad aspects that include economic, social, ecological, and other aspects. Each year a performance assessment is jointly organized by the Provincial Finance Department and the responsible sectoral department. The allocation of the next year's budget is linked with the performance of the current year. The IFMIS has been established in Hunan Province; county finance bureaus are required to report their budget execution monthly by using the data generated from IFMIS so that budget execution can be monitored closely. Most Program counties/districts prepared detailed practicable guidance on these higher-level regulations/decrees. Based on the interviews on provincial entities and counties interviewed and the data collected, it is noted that internal audit function has not been widely established in Hunan Province. At the provincial level, internal audit function (rather than the independent internal audit unit) has been set up in the Provincial Water Resources Department but not in DARA. The supervision and performance evaluation bureau (the unit responsible for the internal control and internal audit) within the Provincial Finance Department carries out its inspection on the usage of program funds. At the county level, besides the supervision and performance evaluation unit being established within each county finance bureau, the internal audit function has been set up in a few sectoral bureaus in program counties/districts, their assigned responsibilities are quite limited due to budget constraints and quality of internal auditors. Internal audit is not a mandatory requirement in China and the internal audit function is relatively weak compared to external audit, especially in public sector where most government entities still rely on the external auditors or their self-inspections. The recommended mitigating measures include (a) strengthening of the capacity of external auditors; and (b) enhanced supervision of program funds by the province that will be trained.



10. Although Government auditors may audit program funds when they carry out budget execution audit, accountability audit, and other types of audits, no specific program audit was conducted by the PAO and audit offices of interviewed counties/districts on the usage of Program funds in the past years. However, the audits were conducted on some Program funds, like high-quality farmland construction funds and water irrigation fund, in the past three years by different external auditors. The audit of the proposed Program will be conducted by Hunan PAO. Besides conducting the audit on budget execution and other provincial-level entities, the PAO has been the auditor of World Bank-financed projects for about three decades. They are the auditors the World Bank accepted in China. The first year's audit report issued by the PAO is subject to the quality review by the China National Audit Office. Audit TOR will be agreed with the PAO.

11. **Public procurement system.** The TBL and GPL are the primary public procurement laws governing public procurement in China. The TBL focuses on construction related works, goods, and consulting services; while the GPL focuses on fiscal budget funds-financed purchasing activities carried out by government departments, institutions, and organizations. The demarcation line is not very clear between the two until the issuance of monetary threshold for tendering and bidding activities by the NDRC and guidance documents by the MOF, NDRC, and respective line ministries. Each province and line ministry issue procurement-related guidance and orders to regulate procurement in its respective administrative jurisdiction or sector. Though they are fragmented, there is no conflict with the two laws. Anticorruption requirements and measures are available in laws and regulations to prevent, report, detect, investigate, prosecute, and sanction fraud and corruption conducts.

12. The assessment analyzed data, interviewed, and discussed in person with procuring entities and public trading centers (mandated by the Government for providing service and supervision to procuring activities through open and selective bidding) on procurement legal framework implementation in practice. It identifies no deviations from the legal requirements.

13. The key stakeholders of procurement under the Program are line government agencies, procuring entity, procurement agent, design institute, supervisor, transaction center, and the selected supplier/contractor/consultant. The line government agencies plan and get approval for the activities to be carried out under the Program; the procurement agent assists the procuring entity (government agency itself or its delegated agencies) to prepare procurement documents and facilitates the procurement process; the design institute provides technical contribution to the procurement process; the supervisor monitors contract implementation; the trading center provides service to procurement process and supervises the process simultaneously; and the selected supplier/contractor/consultant implements the contract as agreed with the employer/purchaser/client.

14. A complaint mechanism is provided in both the TBL and GPL. A complainant has the right to file a complaint with the procuring entity or supervising authority of the procuring entity. The GPL further allows administrative reconsideration or administrative proceedings to the People's court in case the complainant is unsatisfied with the resolution or any delay handling of the case by the supervising authority of the procuring entity.

15. **Key conclusions and recommendations.** A comprehensive PFM framework has been established including government regulations, decrees, standards, and procedures, and so on, which regulate the Program activities to ensure Program funds are used for the intended purposes. However, the enforcement varies at different places and the World Bank's involvement could strengthen the



institutional capacity of related government entities. Given the Program is not an element for budget classification in China, which brings challenges in most PFM areas. During the fiduciary assessment, the major FM risks have been identified and mitigation measures provided:

- (a) Budget quota was distributed to counties/cities in batches and some Program funds were delivered in the second half year or even the year end which prevents the county/district government from including the entire program funds in its annual budget. Provincial entities should revisit their budget quota distribution and take actions to ensure the budget quota could be distributed to county/district in advance. County/district government should include all program funds in its approved annual budget.
- (b) 'Program' is not a budget classification element in China and the required Program financial reporting cannot be generated from the government treasury system. A green tagging mechanism which can trace Program expenditures from the government's existing IFMIS has been recommended and it is expected to be piloted, especially in those demonstration counties/districts, during program implementation. This also creates fundamental basis for generating program financial reporting from government treasury system.
- (c) The high-standard farmland construction fund which is the main source of Program funds is not integrated in the MIS developed by the DARA; Therefore, it is recommended all budget funds managed by DARA should be included in the developed MIS so that the funds could be properly monitored. In addition, the financial reporting module should be added in the developed MIS.
- (d) Program funds are not always delivered to the beneficiaries on time, based on DARA's annual supervision observations. It is recommended that DARA should work with the Provincial Finance Department closely to supervise the delivery of Program funds to ensure the funds reach the beneficiaries in time. The external auditors will supervise the timely payments of Program funds during the annual program audit.
- (e) The internal audit function is relatively weak, and most government entities do not have an established internal audit unit equipped with sufficient staff. The capacity of internal auditors should be strengthened, and the supervision of Program funds by the province should be enhanced.
- (f) Government auditors did not audit the Program funds and prepare the Program audit report. The World Bank will work with the PAO to develop the TOR for Program auditing to ensure Program funds could be audited in line with the World Bank's policy.

16. The Program has a robust legal framework for procurement, which includes the TBL of 1999; the GPL of 2003; and regulations and orders issued at the national, provincial, and county levels. Although the laws could be modernized and aligned to modern principles such as 'value for money' and 'fit for purpose,' both offer a fair playing field for bidders and promote transparency and competitiveness. Four major procurement risks have been identified and mitigation measures provided:

- (a) TBL Clause 41 defines two evaluation methods: comprehensive scoring method and lowest evaluated responsive bid method. In line with this TBL clause and the provincial TBL implementation notice issued by the provincial DRC, the DARA issued Model Bidding Documents that provide three evaluation methods: comprehensive evaluation method I,



comprehensive evaluation method II, and lowest evaluated responsive method. The comprehensive evaluation method (30–80 percent weighting for technical and qualification and 70–20 percent for price) is commonly adopted while the lowest evaluated responsive method is used sometimes. There appear to be potential risks of inappropriate flexibility in setting and evaluating technical criteria, which might have an impact on the economy, fairness, and transparency of the process. The proposed mitigation measure is the use of the comprehensive evaluation method with the weighting percentage of financial proposals to be greater than 70 percent for most of farmland construction works, while the lowest evaluated responsive bid will be encouraged as an alternative option for bid evaluations.

- (b) Contracts may be awarded to firms or individuals which are debarred or under temporary suspension by the World Bank or other multilateral development banks. The following mitigation measures are proposed:
 - (i) Upon Program loan effectiveness, the PDRC shall issue a high-level official letter or official instruction to require Program implementation agencies to ensure that no contract will be awarded to ineligible firms or individuals. The Program implementation agencies (that is, procuring entities) should include the World Bank's website link to the debarment list (which is dynamic) as one of the minimum qualification requirements in the bidding documents. When the bid evaluation starts or before contract award is issued, the implementation agencies and/or the bid evaluation committees shall check the latest lists of the debarred and temporarily suspended firms and individuals to ensure the contracts are being awarded to eligible firms or individuals or as an alternative to the measure above, since the full-process electronic bidding (e-procurement) has functioned in the provincial e-procurement system, and the systems in the six cities/counties, the World Bank recommends that an additional function be developed in the existing e-procurement systems to link to the sanction list of the World Bank's website. The procuring entities would then be required to check the website and the list and shall confirm in the e-procurement system that the recommended bidder is not included in the list before the bid evaluation results are allowed to be published through the e-procurement systems.
 - (ii) The TOR for annual external audits shall include the task of randomly selecting contracts and assessing whether they have been awarded to an ineligible firm or individual.
- (c) The World Bank may not be informed of fraud allegations and corruption issues during the Program's implementation. The PIP will require the client to inform the World Bank of any credible and material allegations of fraud and any corruption issues as part of the Program progress reports, as mandated in the Loan Agreement.
- (d) The payment schedule in the contract should follow requirements of the Standard Bidding Document issued by government authorities and ensure (i) payment is made in proportion to the construction progress and (ii) explicitly state milestones or the timeline for each payment.
- (e) Contracts may not be completed within the contractual completion time, and the contract completion audit may not be completed on time. Procedures or a guidance note should be produced by the PPMO and/or CPMOs that define the undertaking of contract administration responsibilities in line with the agencies' Regulatory Frameworks.



Table 4.1. Program Fiduciary Systems Risks and Mitigation Measures

Risk	Mitigation Action
<p>The DARA issued Model Bidding Documents provide three evaluation methods: comprehensive evaluation method I, comprehensive evaluation method II, and lowest evaluated responsive method. The comprehensive evaluation method (30–80% weighting for technical and qualification and 70–20% for price) is commonly adopted while the lowest evaluated responsive method is used sometimes. There appear potential risks of inappropriate flexibility in setting and evaluating technical criteria, which might have an impact on economy, fairness, and transparency.</p>	<p>PAP: ‘The comprehensive evaluation method’ shall be used subject to the weighting percentage of financial proposal to be greater than 70% for most of farmland construction works, while ‘the lowest evaluated responsive bid’ will be encouraged as an alternative option of bid evaluation principle.</p>
<p>The contracts may be awarded to firms or individuals which are debarred or under temporary suspension by the World Bank or other multilateral development banks.</p>	<p>PAP: (a) Upon Program loan effectiveness, the Program Provincial Leading Group or the Provincial Authority/PDRC shall issue a high-level official letter or official instruction to require Program implementation agencies to ensure that no contract will be awarded to ineligible firms or individuals. The Program implementation agencies (that is, procuring entities) are to include the World Bank’s website link to the debarment list (which is dynamic) as one of the minimum qualification requirements in the bidding documents. When the bid evaluation starts or before contract award is issued, the implementation agencies and/or the bid evaluation committees shall check the latest lists of the debarred and temporarily suspended firms and individuals to ensure the contract is awarded to eligible firms or individuals or as an alternative to the above, since the full-process electronic bidding (e-procurement) has functioned in the provincial e-procurement system and the systems in the six cities/counties, the World Bank recommends that one additional function may be developed in the existing e-procurement systems to link to the sanction list of the World Bank’s website, and the procuring entities will be required to check the sanctions list in the website and confirm in the e-procurement system that the recommended bidder is not included in the list, before the bid evaluation results are allowed to be published through the e-procurement systems.</p> <p>(b) The TOR for annual external audit shall include the task of randomly selecting awarded contracts to check whether they have been awarded to ineligible firms or individuals.</p>
<p>The World Bank may not be informed of credible and material allegations of fraud and corruption during the Program’s implementation.</p>	<p>PAP: Besides specific trainings to be provided to all staff who will handle procurement under the program on the subject, the Program manual will require the PPMO to regularly inform the World Bank of any credible and</p>



Risk	Mitigation Action
	material allegations of fraud and corruption in the Program progress report, as required in the Loan Agreement. Non-reporting shall be regarded as a gross deviation from provisions of the Anti-Corruption Guidelines for PforRs.
Payment schedules in the signed contracts of several counties lag far behind the construction progress and lack of milestones or timeline of each payment.	PIP: The payment schedule in the contract should follow the requirements of Standard Bidding Document issued by government authorities and ensure (a) payment is made in proportion to the construction progress and (b) explicitly state milestones or timelines of each payment.
Based on the analyses of the contract administration, most contracts were completed within the contractual period. However, some contracts could not be completed within the contractual completion time; the longest delay was over one year. Some contract completion audits could not be conducted on time.	PIP: Procedures or a guidance note should be produced by the PPMO and/or CPMOs that define the undertaking of contract administration responsibilities in line with the agencies' Regulatory Framework.
Budget quota was distributed to counties/cities in batches and some program funds were delivered in the second half year or even the year end which prevents the county government from including the entire program funds in its annual budget.	PIP: Provincial entities should revisit their budget quota distribution and take actions to ensure the budget quota could be distributed to counties/districts in advance. County/district governments should include all program funds in their approved annual budget.
'Program' is not a budget classification element in China and the required Program financial reporting cannot be generated from the Government treasury system.	PIP: A green tagging mechanism which can trace Program expenditures from the Government's existing integrated FM system has been recommended, and it is expected to be piloted during project implementation, especially in those demonstration counties. The Provincial Finance Department will decide when and how to implement this piloting by considering the readiness of government reform on the IFMIS.
The high-standard farmland construction fund which is the main financing source of program funds has not been integrated in the MIS developed by DARA. The financial reporting function has not been developed in the MIS.	PAP: DARA should integrate the high-standard farmland construction fund in the MIS so that all budgetary funds under the administrative management of DARA could be managed at the same efficiency. The financial reporting module should be added in the developed MIS.
Program funds are not always delivered to the beneficiaries on time.	PIP: DARA should work with PFD closely to supervise the delivery of program funds to ensure the funds could reach the beneficiaries on time. The external auditors will supervise the timely payments of Program funds during the annual Program audit.
The internal audit function is relatively weak, and most government entities do not establish an internal audit unit and recruit sufficient staff.	PIP: The capacity of internal auditors should be strengthened, and the supervision of Program funds by the province should be enhanced.
Government auditors did not audit the Program funds and prepare the Program audit report.	PIP: The World Bank will work with the PAO to develop the TOR for program auditing to ensure Program funds shall be audited in line with the World Bank's policy.

17. Considering the abovementioned FM and procurement risks and the proposed mitigation measures, the overall fiduciary risk of the Program is rated as 'Substantial'.



18. **Program implementation support.** During Program implementation, the proposed fiduciary implementation support includes the following:

- Work with the team to review Program implementation progress, including the achievement of Program results and implementation of PAP.
- Work with the team to assess timeliness and adequacy of Program fund appropriation as approved in the budget.
- Continuously assess and monitor the performance of the FM and procurement systems under the Program and provide suggestions for enhanced efficiency and effectiveness.
- Monitor application of the PforR Anticorruption Guidelines.
- Monitor the performance of the fiduciary systems and the audit report, including the implementation of the PAP
- Monitor the PforR financial statement reporting process and assist the client as necessary.
- Monitor the contracts implementation, including cost, time, and quality control.
- Help the client resolve implementation issues and carry out institutional capacity building.
- Assist CNAO and the audit offices at provincial and county levels in strengthening audit arrangements.
- Hold regular trainings for provincial and county audit offices, particularly with respect to procurement post audit to build capacity.
- Monitor changes in fiduciary risks of the Program and, as relevant, compliance with the fiduciary provisions of legal covenants.



ANNEX 5. SUMMARY ENVIRONMENTAL AND SOCIAL SYSTEMS ASSESSMENT

COUNTRY: China

Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)

1. The proposed Program is to support low-methane and climate-resilient rice production with physical actions in six demonstration counties of Hunan and non-physical actions across provinces. The ESSA was carried out to evaluate the soundness of the systems and recommend actions to address the identified gaps to enhance E&S management performance. Overall, the aim of the ESSA is to bring E&S benefits, and its moderate E&S impact and risk will be managed by the existing E&S systems at the national, provincial, and local levels with the recommendations and actions proposed in the ESSA. The ESSA is drafted and was consulted during February 17–21, 2023. The following paragraphs summarize the main findings and conclusions of the draft ESSA report.

2. **ESSA methodology.** The ESSA was carried out using the following methodology: (a) in reference with and using relevant findings of the recent ESSAs in China, especially in Hunan Province, such as the Yangtze River Protection and Ecological Restoration Project (Hunan and Jiangxi) and the Green Agriculture and Rural Revitalization Project (Hubei and Hunan); (b) thorough screening and assessment of the potential E&S risks/impacts from the activities to be supported by the Program; (c) desk review of the E&S laws, regulations, and procedures related to managing the E&S risks/impacts associated with the Program activities at the national, provincial, and local levels; (d) field visits to sites of typical Program activities in selected counties, with extensive consultation meetings, virtually and physically, with key stakeholders, including government officials at provincial, county/districts, township, and village levels, as well as representatives of local communities and civil organizations (such as farmers' rice production cooperatives, farmers' water users' groups); The observations and discussions provided a good understanding of the potential E&S risks/impacts associated with the Program and the procedures and institutions to deal with such risks/impacts.

3. **E&S exclusion list.** An E&S screening was carried out on the proposed Program activities to exclude those have potentially high E&S risks. The excluded activities include the following: (a) exploitation of groundwater for paddy field irrigation that would involve the physical conveyance or allocation of water with the potential to result in significant changes to water quality, water availability, and local aquatic ecosystem; (b) significant conversion or degradation of critical natural habitats, for example, activities not compliant with the national Ecological Redline system requirements for building small-scale water ponds and stream damming; (c) activities that would be conducted in areas with significant legacy pollution; (d) other activities with potentially significant E&S impacts, particularly those requiring a full Environmental Impact Assessment (EIA) report following China's existing EIA system; (e) land pooling or consolidation activities that would lead to relocation or acquisition/redistribution of land use rights for a large number of people (for instance, Government-initiated programs to merge farmland blocks to achieve the relatively high concentration of cultivated land blocks); (f) activities that would involve acquisition of basic farmland; (g) activities that would use or acquire farmland for non-agricultural facilities; and (h) activities that have significant adverse effects on ethnic minorities.

4. **Program activities.** The Program is to support the Government HSFCP on existing farmland located within designated basic farmland protection areas. These designated areas contain contiguous farmland with supporting facilities. The PforR does not support development of high-standard farmlands



beyond the designated farmland area. With the E&S exclusion list, the Program will focus on supporting selected non-physical or technical assistance activities and small-scale physical activities. The main types of physical activities supported by the PforR involve upgrades and rehabilitation of existing small-scale infrastructure to improve soil fertility and water efficiency and productivity, including (a) upgrading and improving existing small-scale irrigation and drainage system, mostly 4th and 5th level, and to some extent 3rd level,¹¹⁸ focusing on the ‘last one km’ of the Government irrigation program, which implies smaller investments on existing farms; (b) on-farm access roads, including tractor ploughed roads (typical roads of 2.5–3.5 m width) and production roads (typical roads of 2.0–2.5 m width), wherein the works will focus on the upgrading of the existing access roads by hardening the road surface with sand-gravel rather than developing completely new roads; and (c) small water storage ponds: desilting and upgrading of the existing ponds instead of building the new ponds. The small-scale physical civil works investment will be implemented on existing farmlands, which are considered to have relatively low sensitivity.

5. The application and extension of agricultural technologies (for example, fertility management and fertilization measures, test-based fertilization to reduce chemical fertilizer used, AWD irrigation, and green and integrated pest management service provided by specialized organization to reduce pesticides use and efficiency improvement). E&S impacts of the technologies are considered moderate at most, as the impacts are generally positive. These technologies will be applied on existing farmlands to reduce chemical pesticides and chemical fertilizer use and related pollution, improve soil quality, reduce methane emissions, and enhance the ecological environment. The main types of non-physical activities supported by PforR include approaches, guiding documents, and pilots related to improvement of irrigation services, involvement of farmer users and private sector, as well as to agricultural water pricing, water rights and carbon trading, institutional strengthening and support services, and targeted training and capacity building, and so on.

6. **E&S Impacts Assessment and risk rating.** The overall E&S risks/impacts associated with these PforR activities are deemed to be moderate. The rationale behind the moderate risk rating is the following:

- (a) The physical civil works under the Program will mainly involve upgrades and rehabilitation of existing small-scale infrastructure (within the existing footprint of designated protected farmland) to improve efficiency, including upgrading small irrigation and drainage canals, resurfacing roads, and desilting water storage ponds.
- (b) All investments will be implemented on already existing farmlands, which are considered to have relatively low sensitivity. The results of the works are to increase effective cultivation area and promote farming condition and will not cause land acquisition or adverse income impacts because the implementation is between crop seasons. The civil work construction is to use small-scale employment of labor and cause low or moderate potential adverse impacts on health and safety of workers and communities. Any changes in contractual rights

¹¹⁸ In China, the farmland irrigation system is typically classified based on the level of the canals, which follow on from the main system, including the water source, main canals (1st level) and branch canals (2nd level), to on-farm system, including lateral canals (3rd level), farm ditch (4th level), and field ditch (5th level). The construction of high-standard farmlands under this Program focuses on the on-farm irrigation canals with relatively small sizes, mainly the farm ditches, field ditched, and some lateral canals. These canals have typical cross-sections of 80x80 cm (width x height) and 100x100 cm for lateral canals, 40x45 cm for farm ditches, and smaller sizes for field ditches. Only these three types of canals are included in the Program scope. The main canals and branch canals are considered ‘backbone irrigation facilities,’ and the responsibility for their construction, operation, and maintenance lies with the water sector agencies, which is outside the scope of the PforR Program.



and management rights of farmers, not required by the program, are completely on a voluntary basis.

- (c) The client, Hunan DARA, has sufficient experience with World Bank projects (for example, the World Bank-funded Hunan Integrated Agricultural Land Pollution Management Project, for which the PPMO is also located at DARA, which assigned staff responsible for E&S management and entrusted the external E&S monitoring teams) and has a strong team and commitment, indicating adequate capacity for program implementation. Furthermore, the Program coordinating groups at the provincial and county levels are established to provide guidance to the PMOs for managing the E&S risks.
- (d) The institutional capacity and complexity risks, as well as political and reputational risks, are assessed to be low or moderate for all program activities from E&S perspective.

7. The small-scale physical works investment will be implemented on existing farmlands, which the team considers as having relatively low sensitivity, and which are scattered in hundreds of villages, with small-scale activities in each village. The physical works consist of rehabilitation and upgrading of existing small-scale linear rural infrastructure and will be undertaken using a staged approach to minimize associated impacts, the E&S impacts at each site are minimal, localized, and temporary and can be readily addressed with mitigation measures using the existing system. Given that the budget allocated by upper-level governments for the upgrading of high-standard farmland infrastructure is CNY 1,600 per mu (1 mu equals 667 square meters or one-fifteenth of a hectare). The average agricultural land size of an administrative village in Hunan is about 500 mu (400–600 mu), the biggest administrative village is about 1,000–2,000 mu agricultural lands. For the biggest village, the investment for the PforR activities will be around CNY 1.6 million, which will be shared for rehabilitation of existing irrigation and drainage, on-farm access roads (hardening or pavement of surface of existing roads), and water storage ponds (desilting and strengthening, not constructing new water pond). The funds will be used to cover the costs of the materials (sands, stone, gravel, and cement) and local labors (usually the elder people, at a daily cost of about CNY 200 per person per day), and the profits of the contractors. The low investment intensity determines the scale of program activities and related E&S risks. Neither World Bank Operation Policy (OP)/Bank Procedure (BP) 7.50 (Projects on International Waterways) nor OP/BP 7.60 (Projects in Disputed Areas) apply to the Program.

8. **E&S management systems assessment.** A comprehensive review of the legal and regulatory framework for E&S management relevant to the Program activities was carried out, including the legal framework, management procedures, and institutional arrangements, performance, and capacity. Overall, China has established a comprehensive legal framework for the management of E&S issues at both the national and provincial levels, which consists of laws, regulations, guidelines, and standards that are largely consistent with the World Bank's Program for Results Policy and Directive. The legal framework provides a reasonable basis for addressing the E&S issues related to the Program activities.

Environmental Management Systems

9. China's environmental management system related to the PforR activities in terms of legal framework, management mechanism, and institutional arrangement are well established, and the implementation performance are demonstrated substantially satisfactory. The environmental management system assessment focused on eco-environment conservation management system, EIA management system, water and soil conservation management system, agricultural NPS management



system, and health and safety management system. In general, these environmental management systems are consistent with the World Bank's PforR ESSA Guidance, the core principles, and the Environmental Health and Safety Guidelines (including the general guidelines and guidelines for annual crop production) and are qualified to manage the environmental issues associated with the PforR activities, particularly on the construction of high-standard farmland and low-methane and water-saving rice production management.

10. The applicable laws and regulation empowered governmental authorities, mainly the ecology and environmental bureaus, water and resources bureaus, natural resources bureaus, forestry and grassland bureaus, and agricultural and rural affairs bureaus at provincial, municipal and county levels, with clear responsibilities and qualified staff for managing corresponding environmental risks and impacts, which are reviewed to be consistent with principles and elements set out in the World Bank's PforR ESSA guidance.

11. China and Hunan Province have established mechanisms of EIA, water and soil conservation, ecological protection redlines, a series of mechanisms for managing agricultural eco-environmental management and abating NPS pollution. Various measures are taken to manage environmental risks.

- (a) The investment in HSFCP will be implemented on already existing farmlands, which are considered to have relatively low sensitivity. Even though early screening is practiced when selecting areas for rehabilitating/upgrading high-standard farmlands to avoid, minimize, or mitigate adverse impacts on natural habitats resulting from the Program, EIA registration for endorsement of ecological and environmental bureaus procedure for high-standard farmland construction works is done.
- (b) Such works of land levelling and consolidation, soil improvement, on-farm irrigation, and drainage system including bio-ditches, on-farm access roads, on-farm wind break, and so on are included in the construction of high-standard farmland for conserving water, soil resources and use efficiency, reducing agricultural NPS pollution and uplifting the production environment, and enhancing ecological protection.
- (c) Agricultural technologies such as test-based fertilization, planting of green manure, deep returning of rice straw to soil, integrated pest management service provided by professional organization for unified prevention and control crop pests, crop rotation, and so on are applied and extended in Hunan and the six counties to reduce the use of chemical fertilizers and pesticide which are beneficial to the reduction of NPS pollution and safeguard the health and safety of farmers and rural communities.

12. While many counties in Hunan Province have been free of schistosomiasis for many years. Hanshou and Dingcheng counties struggled the longest and currently hold a status of transmission interruption (blocking) criteria.¹¹⁹ Over the past eight consecutive years since 2014, the two counties find no positive cases of human infection and no positive snail and livestock (cattle and sheep) cases in local areas, reaching the lowest epidemic level in history. At present, Hunan Province is moving toward the goal

¹¹⁹ The criteria for schistosomiasis control is classified as follows in the schistosomiasis endemic area: uncontrolled epidemic (The population incidence is greater than 5 percent); controlled epidemic (The population incidence is lower than 5 percent); transmission control: population and livestock (mainly buffalos and goats) incident is lower than 1 percent; blocking of transmission: there were no positive cases of human infection, infected snails, cattle, and goats in local areas for five consecutive years; and phase of elimination (consolidation for another five consecutive years after reaching the blocking criteria).



of the Hunan Province Schistosomiasis Elimination Program (2016–2025), that is, by 2025, all schistosomiasis-endemic counties in the province will meet the schistosomiasis elimination criteria.

Social Management Systems

13. The social assessment concluded that China has formulated a series of laws and policies at the national and provincial levels and has established appropriate management agencies and mechanisms to govern social risks in relation to the Program activities. The social system assessment focused on the social impacts and risk assessment and management system, cultural heritage protection, occupational health and community safety, land acquisition and resettlement, public participation, ethnic minorities, and vulnerable groups. The social systems are deemed comprehensive and consistent with the World Bank's Program for Results Policy and Directive.

14. Hunan has established management agencies with clear responsibilities and qualified staff for managing corresponding social risks and impacts at the provincial, municipal, and county levels. Under the social systems assessment, the World Bank team reviewed the organizational setup of the relevant agencies against the principles and elements set out in the World Bank guidance. For example, China has established a functioning mechanism of Social Stability Risk Assessment (SSRA), which is used by project implementation agencies and managed through the committees of provincial and county political and legislative affairs. The labor authorities have established a tripartite mechanism on labor relations with trade unions and enterprises to solve relevant labor issues. The cultural departments are responsible for managing adverse impacts on physical cultural heritage. The natural resource bureaus enforce land acquisition, compensation, and resettlement with support from and coordination with township governments and village committees. The ethnic and religious affairs bureaus develop the related development plans as required by the jurisdictional governments, protecting the lawful rights and interests of minority residents. Other line bureaus, such as social security bureaus and women's federations, are also involved in livelihood restoration for project-affected persons. China has also established various competent authorities to manage and support vulnerable groups. For example, poverty reduction offices or county-level revitalization bureaus are mainly responsible for poverty reduction, the disabled person federation for assistance to disabled people, civil affairs bureaus for support to left-behind older people and children, and women's federations for assistance to women.

15. **Gaps identified.** Following the engagement with various stakeholders from each level, it was concluded that the E&S management systems are functioning well. However, following international good practice, the E&S management systems assessment also identified some areas require special attention in E&S risks management with respect to the specific characteristics of the activities supported by the program: Hanshou and Dingcheng counties still have snail areas mainly outside of the dykes of Dongting Lake (around 280 million square meters), posing a risk of infection after heavy flooding. The Program supports the ongoing Government program to keep the risk low through preventive actions, with an aim of elimination.

16. The assessment team found that the environmental management measures included in the preliminary design documents of the high-standard farmland construction project varies considerably in content and depth among the demonstration counties. There might be some adverse environmental impacts, for example, pollution during construction, soil erosion, and workers' health and safety. These adverse impacts are low to moderate, short term, and site specific and shall not be partially ignored. This needs to be properly addressed in the standardized preliminary design through identifying, prioritizing



the design, and proposing known and demonstrated technologies and good management practice as mitigation measures that are costed and included in the bidding documents and contracts.

17. The assessment team also found that there may be some social risks in the upgrading of high-standard farmland. For example, although the Program will not support the transfer of land use rights, farmers may request to renew the terms to increase rent for existing land transfer agreements given that the Program will improve production conditions, which may result in disputes between the transferor and the transferee and affect the Program implementation. In this regard, special attention needs to be paid to the project preparation and implementation stages. However, the assessment team found that the preparation procedures before project implementation are relatively simplified. After the project is assigned by the provincial government and approved by the prefecture-level municipality, it directly enters the preliminary design process. The local practice does not require a stand-alone SSRA. The preliminary design report also does not include relevant substance to specifically address social risk assessment.

18. Some of the non-physical activities may have downstream social implications. For instance, the agricultural water pricing reform process in the Program area has been initiated and will be completed by 2025 according to the plan; however, some of the farmers who are paying very low irrigation water tariff or using water for free may not be fully ready for it. Under the current 'two-part' tariff system, the actual water tariff borne by farmers is extremely low (for example, CNY 0.06 per cubic meter in Dingcheng District), and in some areas, farmers are using irrigation water for free. Farmers still lack understanding and experience of measures such as water use quota and progressive water charges for overuses. Although the actual charge imposed on farmers is very low (about CNY 10 per mu per year) as a result of the financial subsidy, there is a psychological acceptance process for farmers who have long been accustomed to free water, calling for proactive actions to identify and assess the risks during relevant studies to inform related decision-making.

19. **Key conclusions and recommendations.** The Program aims to promote a transition to green, resilient, and inclusive rice production in Hunan Province. Although the content of these activities will inevitably have some transient, smaller-scale, and site-specific adverse impacts on the environment and community, they are predictable and mitigatable through the implementation of known measures. The PforR Program will significantly improve the regional environment and the well-being of community residents and contribute to the reduction of GHG emission. The E&S screening in the assessment has excluded the activities that may have high E&S risks, and with the effective implementation of the existing E&S management system, the Program will not cause significant negative E&S impacts. The E&S risk level of the program is deemed to be moderate.

20. The ESSA report recommends that the Program should enhance Hunan's E&S management systems at all levels. Effective prevention and mitigation measures should be formulated for the social risks in high-standard farmland construction and agricultural water price reform. The following actions have been proposed in the PAP:

- (a) The existing mechanism of interdepartmental joint prevention and control of schistosomiasis shall be mainstreamed into the Program activities to safeguard health and safety of construction workers and farming operators related to water in the endemic area of Hanshou County and Dingcheng District, in line with the Government efforts to minimize the risk of infection.



- (b) Include specific and standardized subsections on E&S management in the design documents for the Program activities.
- (c) Documentation of the non-physical activities with possible downstream adverse impacts (for example, agricultural water pricing reform program). The TORs shall set out requirements to identify and assess downstream E&S risks and impacts and explore means to engage with farmers and other stakeholders during the study and formulate appropriate mitigation measures and assistance to vulnerable groups in the outputs.
- (d) For water rights trading activity, survey on farmers' affordability and willingness to pay for water use shall be conducted in the process of formulating the plan. Before and during the implementation of the plan, extensive publicity and public engagement by means of public hearings, mobilizing farmers, and WUAs shall be carried out.

21. **Consultation and stakeholder engagement.** Robust engagement was carried out with relevant stakeholders during the ESSA process, including with the government departments at the national, provincial, county/city, and township levels, local communities, and relevant groups by means of meetings, and online interviews with a total of over 300 interviewees, of which more than 30 percent were female participants. The draft ESSA report was shared with Hunan PPMOs and CPMOs, relevant provincial government departments, and all demonstration counties/districts on February 6, 2023. Consultation meetings on the draft ESSA report was carried out with the key stakeholders at the county level during the pre-appraisal mission, and a province wide ESSA consultation workshop was held on February 21, 2023. During the preparation of the ESSA report and in the consultation workshop, the stakeholders consulted voiced their support for the proposed Program. The feedback from the participants was reflected in the revised ESSA report. The revised ESSA report will be disclosed on the World Bank's website and the client's websites before the Program appraisal.

22. **Grievance redress.** The existing program grievance mechanism has included community and enterprise GRMs. The community GRM consists of four levels: first, grievances are reported directly to the relevant PIUs to seek a solution; second, grievances are reported to the village or community committee for address; third, grievances are reported to the township government or sub-district office for coordination and address; and fourth, grievances are reported to the county PCPBs or the county head's hotline/mailbox, and so on, which includes a mechanism of collection, initiation within seven days, and solving within two months. In addition, residents can resolve more serious disputes through civil actions at court.

23. **World Bank GRS.** Communities and individuals who believe that they are adversely affected because of a Bank supported PforR operation, as defined by the applicable policies and procedures, may submit complaints to the Bank's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed to address pertinent concerns. Project affected communities and individuals may submit their complaint to the Bank's independent Accountability Mechanism (AM). The AM houses the Inspection Panel, which determines whether harm occurred, or could occur, because of Bank non-compliance with its policies and procedures, and the Dispute Resolution Service, which provides communities and borrowers with the opportunity to address complaints through dispute resolution. Complaints may be submitted at any time after concerns have been brought directly to the Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the Bank's Grievance Redress Service (GRS), please visit



<http://www.worldbank.org/GRS>. For information on how to submit complaints to the Bank's Accountability Mechanism, please visit <https://accountability.worldbank.org>.



ANNEX 6. PROGRAM ACTION PLAN

Action Description	Source	DLI#	Responsibility	Timing		Completion Measurement
Develop a detailed trainer's manual for training farmers on low-methane rice production	Technical	DLI 3	DARA and PPMO	Other	By loan effectiveness	A copy of the training manual submitted to the World Bank as part of the PIP
Develop and issue a provincial MRV standard for carbon sequestration and GHG emission reduction from rice production	Technical		PPMO and PDEE	Other	By June 30, 2026	An MRV standard issued by the responsible provincial authority. It will be developed in coordination with the related activities under the GARR (Hubei and Hunan) Program
Prepare detailed implementation plans for carbon trading pilots	Technical		CPMOs concerned and PPMO	Due Date	30-Jun-2024	A copy of the detailed implementation plans for carbon trading pilots submitted to the World Bank
Prepare detailed implementation plans for water right trading/buy-back pilots	Technical		CPMOs concerned and PPMO	Due Date	30-Jun-2024	A copy of the detailed implementation plans for water right trading/buy-back pilots submitted to the World Bank
Issue an official letter/instruction to implementation agencies to ensure no contract will be awarded to debarred or temporarily suspended firms or individuals	Fiduciary Systems		PDRC and PPMO	Other	By loan effectiveness	A copy of the high-level official letter or instruction submitted to the World Bank
Include in the TOR for annual external audit the task of randomly selecting awarded contracts to check whether they have been awarded to firms or individuals debarred or temporarily suspended by the World Bank, and ensure Program	Fiduciary Systems		PPMO	Other	By loan effectiveness	A copy of the TOR for the annual external audit submitted to the World Bank as part of the PIP.



funds shall be audit						
Use the comprehensive evaluation method for consulting services, subject to the weighting of financial proposal equal to or greater than 70% of the total weighting, while “the lowest evaluated responsive bid” is encouraged as an alternative option	Fiduciary Systems		PPMO and CPMOs	Other	Throughout Program implementation stage	Semiannual progress reports submitted to the World Bank, including records on the evaluation methods.
For water rights trading, conduct survey on farmers’ affordability and willingness to pay for water use before and during the plan implementation, extensive publicity and public engagement by means of public hearings, mobilizing farmers, and WUAs	Environmental and Social Systems		PPMO and CPMOs of pilot counties	Other	Throughout the water right trading pilot period	Documentation available for World Bank inspection: Records on farmers’ affordability and willingness to pay; Evidence material of public engagement on water right trading; Record of WUA public hearings; Above actions reflected in semiannual progress
Integrate the information on HSFCP funds into the MIS so that all budgetary funds administered by DARA could be managed efficiently	Fiduciary Systems		DARA and PPMO	Other	Throughout Program implementation stage	Semi-annual progress reports submitted to the World Bank, including evidence showing that information on the HSFCP funds is integrated in the MIS
Regularly inform the World Bank of any credible and material allegations of fraud and corruption in the Program progress reports.	Fiduciary Systems		PPMO and CPMOs	Other	Throughout Program implementation stage	Semi-annual progress reports containing information on credible and material allegations of fraud and corruption, if any, submitted to the World Bank.
Integrate the existing mechanism of prevention and control of schistosomiasis	Environmental and Social Systems		PPMO, Hanshou County, Dingcheng District	Recurrent	Continuous	Reports of hygienic assessment on schistosomiasis transmission risk prepared; Assessment Reports on snail spread risk prepared; Records of actions



into the Program activities to safeguard health and safety of construction workers & farming operators related to water in the endemic area of Hanshou and Dingcheng.						timely taken; The implementation of the above actions are reflected in semiannual progress reports
Include a specific subsection on environmental and social management in the preliminary design documents for the Program activities	Environmental and Social Systems		PPMO and CPMOs	Other	Throughout Program implementation stage	The design documents for the Program activities available for World Bank inspections, include: screening and assessment of E&S risks and mitigation measures in bidding documents; and public consultation documented by township and village committees.
For the documentations of non-physical activities with possible downstream adverse impacts (e.g., agricultural water pricing reform, etc.), set out in the relevant TORs requirements on screening and assessment of downstream E&S risks and impacts	Environmental and Social Systems		PPMO and CPMOs	Other	Prior to carrying out relevant non-physical activity throughout Program implementation stage	A copy of the TA ToRs submitted to the World Bank, including requirements on screening and assessment of downstream E&S risks; records of farmers and stakeholders engagement; and appropriate mitigation measures and assistance to vulnerable groups.



ANNEX 7. IMPLEMENTATION SUPPORT PLAN

COUNTRY: China

Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)

1. The implementation of the Program will require continuous support and attention from the World Bank team. The PforR instrument is new to some government teams involved in the Program, and support will be provided to ensure all teams are acquainted with its requirements. This annex also outlines the key activities proposed to address risks identified by the risk assessment and provides an indication of the technical assistance and resources needed to improve the quality of Program implementation. Emphasis is placed on (a) supporting early-stage implementation and building institutional capacity, (b) reviewing implementation progress (including PAP implementation) and achievement of Program results and DLIs, (c) providing support to resolve emerging implementation issues, (d) monitoring the adequacy of systems performance and monitoring compliance with Legal Agreements, and (e) supporting the Government in monitoring changes in risks.

2. The strategy and approach for implementation support includes an emphasis on the technical, fiduciary, and E&S support needed during implementation. During Program preparation, the World Bank team provided technical expertise—and will continue to do so during implementation—as well as guidance to the agencies on fiduciary and E&S aspects to ensure completion of the actions agreed in the PAP. Implementation support from the procurement and FM team will focus on reviewing and monitoring compliance with the Government's own systems and the actions defined in the PAP, while the implementation support will also provide technical assistance to address shortcomings identified during the assessment.

Table 7.1. Main Focus of Implementation Support

Time	Focus	Skills Needed	Resources Estimate (Staff Weeks)
First 12 months	<ul style="list-style-type: none"> Implementation of Program management systems Setting up cross-administrative-level coordination mechanism Staff capacity building, on-the-job training on E&S and fiduciary Procurement process and training E&S training, support to implementation of policy requirements Technical support to activities and implementation FM and disbursement training and capacity building 	<ul style="list-style-type: none"> Core team, particularly technical, FM, procurement, and E&S experts Integrated water and nutrient management expert 	72
12–48 months	<ul style="list-style-type: none"> Technical support to implementation Providing policy advice, especially related to institutional reforms and carbon trading and water rights trading pilots Review of environmental, social, and financial performance of central components 	<ul style="list-style-type: none"> Core team, particularly technical, FM, procurement, and E&S experts Integrated water and nutrient management expert 	120



Time	Focus	Skills Needed	Resources Estimate (Staff Weeks)
	<ul style="list-style-type: none"> Continued improvements in project management systems including fiduciary and E&S Program midterm review 	<ul style="list-style-type: none"> Carbon trading and carbon finance experts Water rights trading expert 	
Other	<ul style="list-style-type: none"> Completion of activities Capacity building and facilitation of knowledge exchange and events Support for technical and financial analysis of program investments End-term evaluation and client ICR. 	<ul style="list-style-type: none"> Core team, particularly technical, FM, procurement, and E&S experts Integrated water and nutrient management 	56

3. The Program implementation also requires expertise and technical assistance with PforR instruments during implementation. This support will be ensured through leadership and close contributions from team members in the China Country Office, in Beijing, with additional support and leadership from international technical specialists. This combination will leverage the World Bank's global knowledge and local expertise to enable timely and effective responses to the needs of the borrowers. Formal implementation support missions and field visits covering all aspects of implementation will be conducted periodically during implementation. The characteristics of the Program necessitate that these implementation support missions will be longer than the standard single province or agency engagement. Tables 7.1 and 7.2 outline the estimated inputs from different specialists and resources required at different stages of Program implementation.

Table 7.2. Task Team Skills Mix Requirements for Implementation Support

Skills Needed	Number of Staff Weeks	Number of Trips	Comments
Task team leader/program management	10 annually	Three in the first year, two thereafter	Internationally based staff
Task team leader(s)/program management	14 annually	Three in the first year, two thereafter	Country office-based staff
Procurement specialist	3–6 annually	Two per year	Country office-based staff
FM specialist	3–4 annually	Two per year	Country office-based staff
Operations specialist	4–6 annually	Two per year	Country office-based staff
Environmental specialist	3–4 annually	Two per year	Country office-based staff
Social specialist	3–4 annually	Two per year	Country office-based staff
M&E specialist	4–6 annually	Two per year	Country office-based staff
Water expert (irrigation and drainage services, agricultural water tariff reform, and water rights trading)	2–4 annually	Two per year	Consultant (national)
Agricultural expert (low-methane rice production technology)	2–4 annually	Two per year	Consultant (national)
Agricultural expert (farmer training and extension service)	2–4 annually	Two per year	Consultant (national)
Agricultural sustainable development expert (agricultural GHG emission monitoring and carbon trading)	2–4 annually	Two per year	Consultant (national)



ANNEX 8. MAPS

COUNTRY: China

Methane-Reducing and Water-Saving Paddy Rice Program for Results (Hunan)

