China Green Agricultural and Rural Revitalization Program for Results (Hubei and Hunan) - (P178907)

Technical Assessment

March 31, 2023

ABBREVIATIONS AND ACRONYMS

BOD	biochemical oxygen demand
CH_3	ammonia
CH_4	methane
CO_2	carbon dioxide
COD	chemical oxygen demand
CNY	Chinese yuan
CPF	Country Partnership Framework
CSA	climate-smart agriculture
DARA	Department of Agriculture and Rural Affairs
DEE	Department of Ecology and Environment
DHE	dragon head enterprises
DLI	disbursement-linked indicator
DLR	disbursement-linked result
DOF	Department of Finance
DRC	Development and Reform Commission
EFA	expenditure framework assessment
FAO	Food and Agriculture Organization of the United Nations
FIRR	financial internal rate of return
FY	fiscal year
FYP	five-year plan
GAP	green agricultural practices
GARR	Green Agricultural and Rural Revitalization
GDP	gross domestic product
GHG	greenhouse gas
GI	geographical indication
GPG	global public goods
HLG	higher-level governments
IBRD	International Bank for Reconstruction and Development
IPM	integrated pest management
IPRCC	International Poverty Reduction Center of China
IT	information technology
IVDP	integrated village development plan
LGOPAD	Leading Group Office of Poverty Alleviation and Development
MARA	Ministry of Agriculture and Rural Affairs

M&E	monitoring and evaluation
MEE	Ministry of Ecology and Environment
MIS	management information system
MOF	Ministry of Finance
MOHURD	Ministry of Housing Urban and Rural Development
MRV	measurement, reporting, and verification
$mtCO_2e$	metric tons of carbon dioxide equivalent
NDRC	National Development and Reform Commission
N_2O	nitrous oxide
NH_3	ammonia
NH_3-N	ammoniacal nitrogen
NPS	nonpoint source
NRRA	National Rural Revitalization Administration
O&M	operation and maintenance
PAP	program action plan
PIP	program implementation plan
PDO	program development objective
PforR	Program for Results
PIU	Program Implementation Unit
PMO	Program Management Office
RA	results area
RRB	Rural Revitalization Bureau
RRP	Rural Revitalization Program
RRS	Rural Revitalization Strategy
RRTF	Rural Revitalization Transition Fund
SOC	soil organic carbon
SWMS	solid waste management systems
SWTS	solid waste transfer stations
TN	total nitrogen
TP	total phosphorus
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VA	verification agency
VDAP	Village Development Action Plan
WTS	wastewater treatment system
WUA	water user association
WWTF	wastewater treatment facilities

CONTENTS

I. INTRODUCTION

1. **This Technical Assessment has been carried out as part of the preparation of the China Green Agricultural and Rural Revitalization Program (Hubei and Hunan) – (GARR, or "the Program").** GARR is based on Program for Results (PforR) financing. The purpose of this technical assessment is to present the World Bank's evaluation—undertaken with data and support from the national, provincial, and county governments—of program arrangements across four aspects: (1) strategic relevance and technical soundness, (2) expenditure framework, (3) results framework and monitoring and evaluation capacity, and (4) economic justification.

2. **The PforR is anchored on the National Rural Revitalization Strategy (RRS), which is implemented in phases of five-year RRS plans.** The national RRS plan provides the overarching rural development vision and broadly defined actions. The national RRS plan phase 1 (2018–22) focuses on consolidating and sustaining the poverty eradication gains; and has four pillars: (1) green agricultural development, (2) agricultural modernization, (3) rural infrastructure and public services, and (4) rural governance. The PforR will support a subset of activities based on the priorities and targets articulated in the National Implementation Plan for Carbon Reduction and Sequestration in Agriculture and Rural Areas and the Hubei and Hunan provincial Rural Revitalization Programs (RRPs). These activities contribute to improving the national inventory report and monitoring, reporting, and verification (MRV) methodology of carbon emission in agriculture and rural areas and enhancing the adoption of environmentally-sustainable agricultural and rural infrastructure development practices in selected areas of Hubei and Hunan.

II. PROGRAM DESCRIPTION

A. The Government Rural Revitalization Program

3. **Since 2017, the Chinese government has adopted an ambitious national RRP, implemented in phases of five-year RRS plans.** The national RRS plan provides the overarching rural development vision and broadly defined actions. The RRS plans are framed around the *three rurals*: agriculture, rural areas, and farmers. The main objectives of the RRS plans are to sustainably increase rural income, increase access to rural infrastructure and public services, and improve the living environment in rural areas. Thus far, the national RRS Plan Phase 1 (2018–22) focuses on consolidating and sustaining the poverty eradication gains; and has four pillars: (1) green agricultural development, (2) agricultural modernization, (3) rural infrastructure and public services, and (4) rural governance. The national RRS Plan Phase 1 overlaps with the transition period (2021–25),[1] coinciding with the 14th five-year plan (FYP) (2021–25). The Rural Revitalization Promotion Law[2] provides a legal framework for implementing the phased RRS plans.

4. **The green agricultural development pillar of RRS Plan Phase 1 has seven subprograms, further elaborated in the 14th FYP for the National Green Development of Agriculture Plan.**[3] These include: (1) strengthening the protection and utilization of agricultural resources (e.g., protecting and improving the quality of farmland, improving the efficiency of agricultural irrigation water use, and protecting agricultural biological resources); (2) preventing and controlling agricultural nonpoint source (NPS) pollution (e.g., promoting the

1 Transition from the Poverty Reduction Program (PRP) to the Rural Revitalization Program (RRP) with the first phase of the Rural Revitalization Strategy (RRS) plan (2018–2022) focusing on consolidating and sustaining extreme poverty alleviation gains, tackling pollution, and greening the economy.

2 Adopted by the National People's Congress on April 29, 2021.

3 A joint notice of Ministry of Agriculture and Rural Affairs (MARA), National Development and Reform Commission (NDRC), Ministry of Science and Technology (MOST), Ministry of Natural Resources (MNR), Ministry of Ecology and the Environment (MEE), and Nong Gui Fa (NGF) [2021] No. 8) issued in August 2021.

reduction in fertilizer use and increasing the efficiency of fertilizer and pesticide use, promoting the recycling of livestock and poultry manure and crop straw, and strengthening white [agricultural plastics] pollution control); (3) strengthening agricultural ecological protection and restoration (e.g., protecting and restoring farmland ecology, and protecting and restoring agricultural ecosystems); (4) building green and low-carbon agricultural industry chains (e.g., promoting green agricultural value chains, industrial agglomeration, and circular economy); and promoting green, organic, and geographical indication (GI) agricultural products; (5) improving the innovation system for green agricultural technology development (e.g., promoting innovations in green agricultural science and technologies, accelerating the adoption of good agriculture practices (GAPs), and building green talents and skills); (6) improving the governance systems and mechanisms for enhancing green development of agriculture (e.g., improving the legal framework for green agricultural technology development and innovations, creating incentives and strengthening mechanisms for regulating agricultural inputs, and continuing with market reforms); and (7) planning and implementing green agricultural development (e.g., strengthening organizational leadership and carrying out performance evaluations).

5. **The rural infrastructure and public services pillar of RRS Plan Phase 1 has six subprograms**. These include: (1) building an ecologically livable beautiful village (e.g., coordinating the management of landscapes and ecosystems, promoting rural ecological civilization, and building a clean living environment); (2) improving the rural habitat environment (e.g., constructing rural solid waste [garbage] and wastewater [sewerage] treatment systems; improving rural domestic waste collection and disposal systems; promoting classification and resource reuse [recycling] of waste, and promoting the “toilet revolution”); (3) improving the appearance of the village (e.g., professionally planning the layout of villages; rehabilitating village buildings to preserve original cultural [traditional] architecture; constructing rural and household roads; renovating public space and courtyard environment; promoting rural greening; and enhancing village landscapes); (4) improving the rural water infrastructure network (e.g., building a network of rural water conservancy infrastructure to improve water saving, water supply, flood control, and disaster mitigation; improving rural drinking water quality and safety); and constructing, rehabilitating, and modernizing irrigation systems and drainage and pumping stations; (5) strengthening rural transport infrastructure (e.g., constructing roads connecting rural areas to urban centers; upgrading rural transport logistic facilities; deepening reforms in long-term mechanisms for rural roads operations and maintenance (O&M); improving public transportation routes; and providing public transportation); and (6) building a modern energy system in rural areas (e.g., developing renewable energy—solar, biomass, water, and wind; improving rural energy infrastructure networks; accelerating the upgrading of new rural power grids; and promoting the expansion of gas supply facilities to rural areas).

B. Theory of Change

6. **The key assumptions for the GARR PforR to satisfactorily achieve its expected outcomes and program development objectives (PDO) are:** (1) central-level governance frameworks, such as an information technology-based (IT) platform for mapping and monitoring and evaluation (M&E) of rural infrastructure and public services, and methodology for MRV of greenhouse gas (GHG) emissions are developed on schedule to facilitate adoption by provinces and use by program counties; (2) effective cross-sectoral coordination and inter-jurisdictional cooperation at the central, provincial, and county government levels exist throughout the program implementation period; (3) efficient provincial green-budgeting and expenditure tracking systems are established on schedule and resources are mobilized to finance results areas’ (RAs) activities to achieve the expected results (disbursement-linked indicators [DLIs]); (4) requisite GAP and climate-smart agriculture (CSA) practices and technical assistance are readily available to help provinces and counties implement activities to achieve the expected results; and (5) effective M&E systems are in place and competent third-party verification agencies (VA) are hired to verify the results.

7. **The Bank’s GARR PforR support focuses on four interlinked RAs (Figure 1).** They support activities aimed to (1) strengthen the RRP governance systems, (2) reduce GHG emissions (mainly methane [CH_4] and nitrous oxide [N_2O]) and pollutant loads from agriculture and rural wastewater and solid waste, and (3) conserve and improve the efficiency of natural resources use (especially land and water). The four RAs are chosen to address the main challenges facing agriculture and rural infrastructure development under the RRP, including (1)

filling the remaining gaps in institutional capacity for governance (RA1), (2) reducing agricultural GHG emissions and NPS pollution (RA2), (3) reducing wastewater and solid waste pollution (RA3), and (4) restoring degraded natural capital—especially land and water (RA4). RA1 is a key platform for monitoring progress and supporting the implementation of RA2, RA3, and RA4, while RA4 complements the implementation and achievement of results under RA2. The rationale and activities under each RA and the expected outcomes are described in detail in the section on PforR Program Scope.

8. **RA1 - Strengthening institutional capacity for governance.** This RA aims at improving the implementation performance (efficiency and impact) of the results-based green agriculture and climate-resilient rural infrastructure development (wastewater and solid waste management systems [SWMS]) activities. It will support the National Rural Revitalization Administration (NRRA) (central component) and the Hubei and Hunan provinces to close the institutional capacity gap by developing governance frameworks for efficient and effective implementation of GAPs and delivery of climate-resilient rural infrastructure and public services under the phased RRS plans. At the national level, it will include the following: (1) developing a national IT-based platform for mapping and M&E of the delivery of rural infrastructure and public services; and (2) developing the MRV methodologies for measuring the GHG emissions reduction from three primary agriculture sources: livestock and poultry manure, chemical fertilizer, and rice. At the provincial level, it will include: (1) developing and/or adopting regulations, standards, and guidelines for GAP and the delivery of climate-resilient rural infrastructure and public services; (2) mainstreaming the national IT-based system for mapping and M&E of the delivery of rural infrastructure and public services which is developed by the NRRA; and (3) establishing frameworks for nurturing green skills and talents. The governance frameworks, including the national IT-based platform for mapping and M&E of rural infrastructure, MRV methodologies for GHG emissions reduction, and mechanisms for green tagging of program budgets and expenditure tracking, will contribute to climate co-benefits by helping program counties incorporate GAP and CSA in agricultural plans and climate-resilience in rural infrastructure development designs.

9. **RA2 - Greening selected agricultural value chains.** This RA aims to reduce the agricultural environmental footprint by adopting CSA and GAP to reduce GHG emissions, especially CH_4 and N_2O from rice and livestock production systems, and NPS pollution. Activities under this RA will include: (1) reducing the use of chemical fertilizers and toxic pesticides and treating and recycling livestock and poultry wastes; (2) adopting CSA practices (e.g., increasing the efficiency of irrigation water use and improving nutrient and water management for rice); (3) training farmer cooperatives, farmer associations, water user associations (WUAs), input suppliers, agro-enterprises, and rural extension staff on green technologies; and (4) implementing the MRVs to measure the GHG emissions reduction from manure, chemical fertilizer, and rice. Additional support will be provided for investments that address the gaps in agricultural production and value-addition infrastructure. These include efficient irrigation systems, cold storage, cold-chain logistics, and other public services, such as agricultural extension and advisory services, animal health and veterinary services, business development services, and marketing services. Matching grants will be provided to smallholder farmers and FCs, and output-based or performance-based subsidies to enterprises as incentives for adopting GAP; and as compensation for generating global public goods (GPGs) from the reduction in GHG emissions.

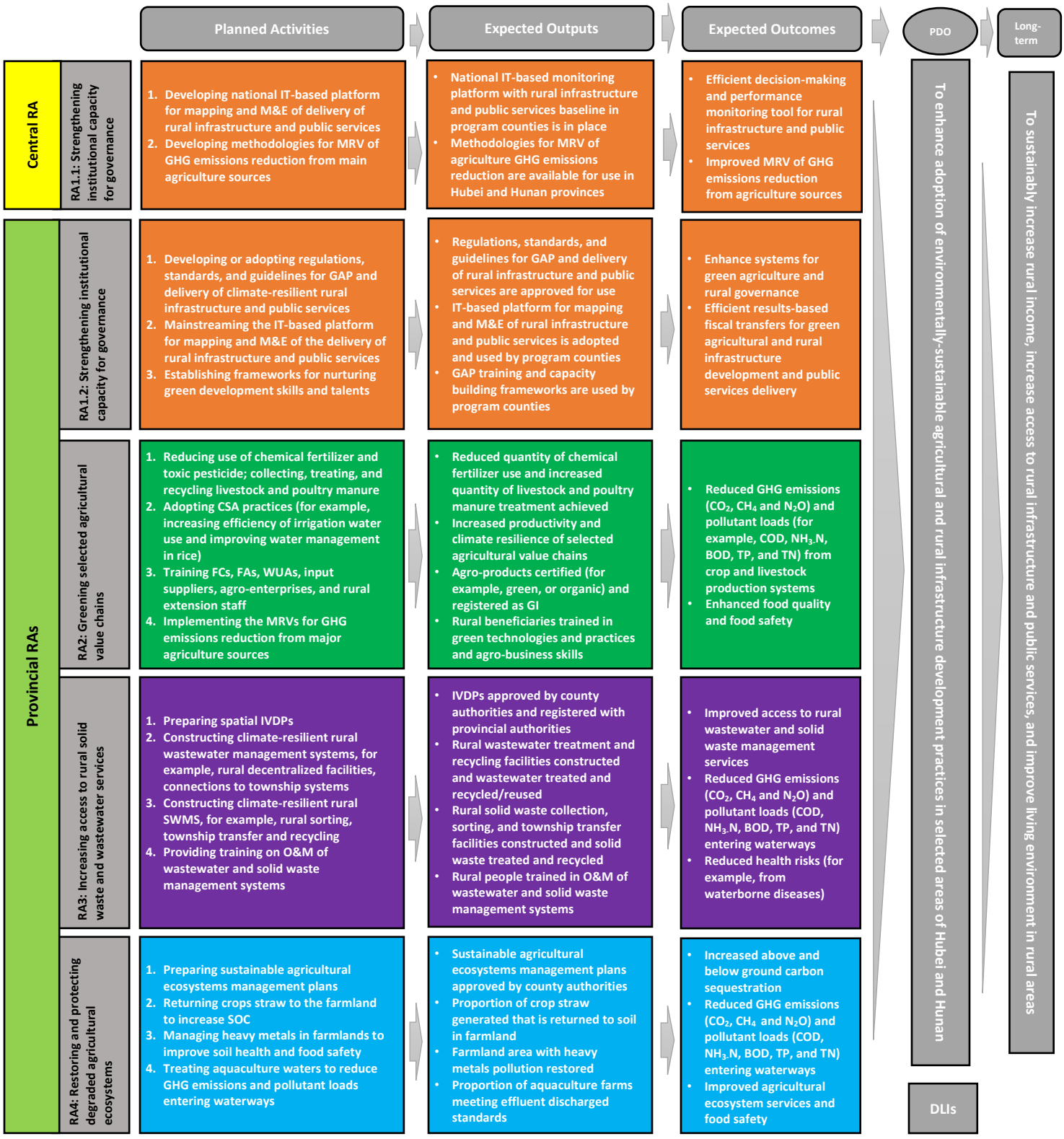
10. **RA3 - Increasing access to rural solid waste and wastewater services.** This RA aims to reduce GHG emissions (especially CH_4 and N_2O from wastewater and solid waste leachates) and pollutant loads (chemical oxygen demand [COD], biochemical oxygen demand [BOD], total phosphorus [TP], total nitrogen [TN]), and improve the rural living environment. It will also help the two provinces to close the urban-rural infrastructure and public service delivery gap. Activities to be supported under RA3 include: (1) preparing spatial integrated village development plans (IVDPs), which are mandatory and binding instruments to guide all future private and public rural investments; (2) constructing rural wastewater management systems (e.g., rural decentralized facilities, connections to township systems) to reduce GHG emissions and pollutant loads entering waterways; (3) constructing rural SWMS (e.g., rural sorting, township transfer, and recycling); and (4) providing training on O&M of wastewater and SWMS. While the wastewater management facilities and SWMS will contribute to GHG emissions reduction, the spatial IVDPs will help program counties incorporate climate-resilience planning in their designs and operations and reduce health risks during disasters, such as floods or wildfires.

11. **RA4 - Restoring and protecting degraded agricultural ecosystems.** This RA aims to improve soil health and food safety, sequester carbon, and reduce GHG emissions. It will support the integrated management of natural capital (especially land and water) and increase their use efficiency. The main activities will include (1) preparing sustainable agricultural ecosystem management plans, (2) returning crop straw to the farmland to increase soil organic carbon (SOC), (3) managing heavy metals[4] to improve soil health and food safety, and (4) treating aquaculture wastewater to reduce GHG emissions and pollutant loads entering waterways. The goal is to increase agricultural productivity, build resilience, and reduce GHG emissions through carbon sequestration above- and belowground. Matching grants and eco-compensation mechanisms to participating farmers and farmer cooperatives will provide incentives for adopting these measures. In addition to complementing the activities under RA2, the integrated management of natural resources (land and water) under RA4 will contribute to increasing climate-resilience in the sector.

12. **The expected outcomes of implementing activities vary based on each RA.** For RA1, these are efficient decision-making and performance monitoring systems for climate-resilient rural infrastructure and public services, improved MRV of GHG emissions reduction from primary agriculture sources, enhanced green agriculture and rural governance systems, and efficient results-based fiscal transfers for green agricultural and rural revitalization. For RA2, these are reduced GHG emissions (e.g., carbon dioxide [CO_2], CH_4, and N_2O) and pollutant loads (e.g., COD, BOD, TP, TN) from crop and livestock and poultry production systems; and enhanced food quality and food safety. For RA3, these are improved access to rural wastewater and solid waste management services; reduced GHG emissions (CH_4 and NH_3-N) and pollutant loads (COD, BOD, TP, TN) entering waterways; and reduced health risks (e.g., waterborne diseases). For RA4, these are increased above- and belowground carbon sequestration; reduced GHG emissions (CH_4 and N_2O, mainly from reduced burning of crop residues and integrated fish-rice systems), and pollutant loads (COD, BOD, TP, TN from intensive aquaculture and integrated fish-rice production systems entering waterways); and improved agricultural ecosystem services and food safety.

4 As heavy metals are non-biodegradable, they persist in the environment, have potential to enter the food chain through crop plants, and eventually may accumulate in the human body through biomagnification. Owing to their toxic nature, heavy metal contamination has posed a serious threat to human health and the ecosystem.

Figure 1. The GARR PforR Results Chain



C. PforR Program Scope

13. **Hubei and Hunan will be responsible for delivering results under RA1.2, RA2, RA3, and RA4.** The GARR PforR will support 10 demonstration counties (out of 103 counties) in Hubei Province: Honghu, Chongyang, Xishui, Yangxin, and Yunxi Shishou, Suixian, Xiantao, Danjiangkou, and Xianfeng. Similarly, the GARR PforR will support 13 demonstration counties (out of 122 counties) in Hunan Province: Hengyang, Li Xian, Taojiang, Cili, Suining, Yueyang, Huaheng, Liling, Jiangyong, Yongding, Linxiang, Hengnan, and Yongshun. These demonstration counties were selected based on agreed criteria, which include: (1) geographic distribution (i.e., demonstration counties from different municipalities/cities); (2) large users of chemical fertilizer and pesticide (to maximize impacts of GHG emissions reduction [e.g., reducing CH_4, N_2O, and CO_2 emissions] and NPS pollution reduction [e.g., TN and TP pollutant loads]); (3) large producers of livestock and poultry, to maximize the impacts of better management of manure and other waste (dead animals and by-products) (e.g., reducing COD, BOD, and NH_3-N); (4) lack of/inadequate solid waste management system (e.g., for collecting, sorting, and treating; and converting to organic fertilizer or biogas/energy generation); and (5) lack of/inadequate wastewater management system (e.g., for collecting, treating, and recycling water for irrigation and/or construction of wetlands). The linkages between the RAs of GARR PforR and the government's RRS Plan Phase 1 are summarized in Table 1.

14. **The GARR PforR and the Yangtze River Protection and Ecological Restoration PforR (Hubei) (P178338) include Honghu as a program county.** RA2 - Greening of selected agricultural value chains under the GARR PforR and RA3 - Reducing water pollution and transmission of plastic waste under the Yangtze River PforR (Hubei) are supporting improvements in (1) the treatment and utilization of livestock and poultry manure; and (2) the collection, transfer, and treatment of domestic wastewater and solid waste in Honghu. The two program activities will complement each other by substantially contributing to reducing GHG emissions and NPS pollution and adopting a rural circular economy, such as using treated manure as organic fertilizer and biogas for energy generation. To foster synergies and avoid overlap and duplication of efforts, the GARR PforR will support only the centralized manure treatment facilities constructed to cater to small- and medium-sized farms in Honghu. At the same time, the Yangtze River PforR (Hubei) will focus on large-scale livestock and poultry farms in the county. Similarly, GARR PforR will support the construction or rehabilitation of natural villages' wastewater treatment facilities (WWTF) and SWMS. At the same time, the Yangtze River PforR (Hubei) will focus on integrating administrative villages' domestic waste systems with the treatment facilities of towns or urban areas.

Table 1 GARR Program Boundary

Description	Government Rural Revitalization Program/Rural Revitalization Strategy (RRS) Plan Phase 1 (under the 14th FYP 2021–25)	Program Supported by the World Bank's GARR PforR
Objectives[5]	To sustainably increase rural income, increase access to rural infrastructure and public services, and improve the living environment in rural areas	To strengthen institutional capacity for implementing the Rural Revitalization Program and enhancing the adoption of environmentally-sustainable agricultural practices and rural infrastructure development in selected areas of Hubei and Hunan
Duration	Rural Revitalization Program (RRP) (2018–35) Rural Revitalization Strategic (RRS) Plan Phase 1 (2018–22) or 14th FYP (2021–25)	FY2024–29
Geographic coverage	Mainland China: 22 provinces, 4 municipalities, and 5 autonomous regions	Central: National Rural Revitalization Administration (NRRA) Provinces: Hubei (10 counties) and Hunan (13 counties)
Subprograms (SPs)/Results areas (RAs)	A. Green Agricultural Development Pillar 1 • Strengthening the protection and utilization of agricultural resources • Strengthening the prevention and control of agricultural NPS pollution • Strengthening agricultural ecological protection and restoration • Building green and low-carbon agricultural industry chains • Improving the innovation system for green agricultural technology development • Improving the governance systems and mechanisms for enhancing the green development of agriculture • Planning and implementing green agricultural development B. Rural Infrastructure and Public Services Pillar 3 • Building an ecologically livable beautiful village • Improving rural habitat environment6 • Improving the appearance of the village • Improving rural water infrastructure network • Strengthening rural transportation infrastructure • Building a modern energy system in rural areas	Green Agricultural and Rural Revitalization PforR • RA1: Strengthening institutional capacity for governance (RRS plan SP #6) • RA2: Greening agricultural value chains (RRS plan SPs #1, #2, #4, and #5) • RA3: Increasing access to rural solid waste and wastewater services (RRS plan SPs #9, #10, and #11) • RA4: Restoring and protecting agricultural ecological ecosystems (SP#3)
Overall financing	National RRP: Total financing of USD 960 billion (22 provinces, 4 municipalities, and 5 autonomous regions, 2022–25)	• IBRD loan of US$345.46 million • Government financing of US$4,100 million for Hubei and Hunan (23 program counties) • Total program financing is US$4,445.46 million

D. Program Financing

5 Aim to revitalize rural areas on all fronts: industries, human resources, culture, ecosystems, and institutions

6 Further elaborated in the 14th FYP on Municipal Solid Waste Separation and Treatment Facilities Development (2021–25).

15. **The total GARR PforR financing is estimated at USD 4,445.46 million, of which USD 4,100 million (CNY 29.3 billion) will be financed by the Chinese government. USD 345.46 million will be financed by the International Bank for Reconstruction and Development (IBRD) Loan.** Of the USD 4,100 million Chinese government financing, it is estimated that USD 2,464 million will come from Hubei; USD 1,605 million from Hunan; and 31 million from NRRA (see Table 2).

Table 2 Program Financing Plan (FY2024–29) (Million USD)

Source	National Rural Revitalization Administration (NRRA)		Hubei Province		Hunan Province		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Government budget	31.00	85.02	2,464.00	93.5	1,605.00	90.40	4,100.00	92.22
International Bank for Reconstruction and Development (IBRD) loans	5.46	14.98	170.00	6.5	170.00	9.60	345.46	7.78
Total	**36.46**	**100.0**	**2,634.00**	**100.0**	**1,775.00**	**100.00**	**4,445.46**	**100.00**

16. **The public financing of GARR PforR from the central and provincial government budgets and the IBRD loan proceeds will leverage significant private financing under RA2 and RA4.** While RA1 and RA3 will be wholly financed through public expenditures, RA2 and RA4 financing will primarily come from the resources of farmers, cooperatives, and agro-enterprises. The public financing under RA2 and RA4 will be limited to output-based subsidies and matching grants to agro-enterprises and farmers adopting GAP and CSA technologies.

III. PROGRAM RESULTS FRAMEWORK AND MONITORING & EVALUATION

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

17. **The PDO is to enhance the adoption of environmentally-sustainable agricultural and rural infrastructure development practices in selected areas of Hubei and Hunan.** The institutional capacity for governance will be strengthened at the central (at NRRA) and provincial levels. To incentivize counties to promote environmentally-sustainable practices, the higher-level governments' (central and provincial) fiscal transfers will be made against achieving specific verifiable environmental results. These will be monitored and evaluated through green tagging of program budgets and expenditures tracking and the IT platform for mapping and M&E of rural infrastructure and public services. Farmers and agro-enterprises will be incentivized to adopt GAP and CSA practices through targeted green matching grants and output-based green subsidies, respectively.

18. The **GARR PforR's PDO-level indicators** are: (1) reduction in pollutant loads from agricultural (crops, livestock, and aquaculture) production systems and rural domestic WWTFs (COD, NH_3-N)[7] achieved in the program counties (RA2, RA3, and RA4) (metric tons/year); (2) GHG emissions reduction achieved in the program counties (RA2, RA3, and RA4) (metric tons/year CO_2-equivalent [$mtCO_2e$); and (3) beneficiaries reached with

7 These two key pollutants have been selected because they are priorities set since the 12th FYP, under which specific reduction targets and detailed monitoring and verification arrangements have been spelled out.

assets or public services (disaggregated by gender) in the program counties (RA1, RA2, RA3, and RA4) (number).

19. **The GARR PforR's contribution to GHG emission reductions will be indirectly calculated during program implementation.** This will be done at the midterm and the end of the program (compared with the 2021 baseline values) by using M&E data on quantities of nutrient load reduction and pollutant load reduction achieved under PDO/outcome indicators to calculate the metric tons of CO_2 equivalent reduced by the mitigation measures. This approach would give third-party VA sufficient time to verify the results using the agreed protocols and apply MRV methodologies developed under the GARR PforR. Additional GHG reductions will be derived from adaptation measures, such as a reduction in food loss and waste; adoption of CSA practices (e.g., technologies that increase water use efficiency, such as drip irrigation and fertigation); returning crop straw/residues to soil; using green manure; and practicing crop rotation.

20. **The Ex-Ante Carbon-balance Tool (EX-ACT) estimated net emissions reduction by RA (Table 3).** Preliminary assessment shows that the GARR PforR will reduce approximately 397,520 $mtCO_2e$)/year, 1,987,600 $MtCO_2e$) over its five-year implementation period. The assessment does not include the mitigation climate co-benefits generated from carbon storage or improved institutional policies, regulations, and plans. In addition, the estimated GHG emission reduction presented herein is restricted to activities under the 23 program counties. Thus, these estimates could be considered conservative, especially given the considerable potential for scaling up the GARR PforR activities beyond the program counties.

Table 3 Estimated Ex Ante Net Emissions Reductions by RA and DLI ($mtCO_2e$)/year)

Result Area	DLI	Project Intervention	Greenhouse Gas (GHG) Reduction/ Year
RA2 - Greening of selected agricultural value chains	DLI2.1	Fertilizer reduction	66,276
	DLI2.2	Livestock manure treatment	197,626
RA3 - Increasing access to rural solid waste and wastewater services	DLI3.2	Wastewater treatment	66,461
RA4 - Restoring and protecting degraded agricultural ecosystems	DLI 4.2	Crop straw utilization	67,157
Total			397,520

F. Disbursement-linked Indicators and Verification Protocols

21. The GARR PforR's DLIs quantify the parameters and values that need to be achieved to trigger disbursements (table 3). Each province is responsible for measuring the achievement of DLIs within a consistent framework allowing for aggregation and reporting at the program level: DLIs that were chosen (a) represent improvements in key aspects of the government program and the key priorities in each RA, (b) are within the control of the Government, (c) are achievable in the Program period, and (d) are verifiable. The GARR PforR prioritizes the use of existing indicators and reporting mechanisms within the government system and the GARR PforR (Guangxi and Guizhou) to help aggregation and ensure sustainability.

Table 4 Disbursement-linked Indicators and Allocations

DLI	Allocated Amount (US$)	% of Total	Rationale for Selection
RA1: Strengthening institutional capacity for governance			
DLI1.1: Development and use of a comprehensive national IT-based monitoring platform for mapping and M&E of the delivery of rural infrastructure, public services and spatial Integrated Village Development Plans of rural villages	5,461,000	1.6%	The purpose of this DLI is to enable the NRRA to expand the functions of the existing National Poverty Reduction Monitoring Platform developed by the State Council LGOPAD, the predecessor of the NRRA, which was developed about 10 years ago to facilitate accurate targeting of government support to the poor villages and extreme poverty households. Currently, the upgraded IT-based platform is used to monitor vulnerable rural households and facilitate timely access to support policies to avoid their falling back into extreme poverty. Since the government program is transitioning from eliminating extreme rural poverty to rural revitalization, the NRRA will expand the coverage of the platform from poverty-stricken villages to all villages in China and the functions from basic infrastructure and social services to all rural infrastructure and public services, including SWMS and WWTF. Thus, the IT-based monitoring platform will function as a decision support tool to manage the RRP implementation, regularly evaluate its performance, and ensure that newly developed rural infrastructure is climate resilient (for example, can withstand climate-induced floods and wildfires).
DLI1.2: Adoption of regulations, standards, and guidelines on green agricultural development and the number of agro-products produced in the Program Counties that are certified and/or registered as green, organic, or GI pursuant to said regulations, standards, and guidelines (provincial level)	13,615,160	3.9%	This DLI aims to enable Hubei and Hunan provincial governments to adopt MARA's national regulations, standards, and guidelines for green agricultural development and customize or tailor them to fit and meet provincial/local conditions and requirements. County governments will use the approved provincial regulations, standards, and guidelines to certify agro-products as green and organic and register as GI. The standards and guidelines are critical for ensuring that agro-products meet the targets for GHG emissions and nutrient and pollutant loads reduction before being certified as green and organic or registered as GI agro-products. The regulations, standards, and guidelines will also promote GAP (that is, a set of standards for the safe and sustainable production of crops and livestock, verified through voluntary audit. GAP aims to help farm owners maximize yields and optimize business operations, while also minimizing production costs and environmental impact, and adoption of CSA technologies (for example, increased irrigation efficiency, improved water management in paddy rice, and improved animal feeds).
RA2: Greening selected agricultural value chains			
DLI2.1: Tons of chemical fertilizer use reduced due to the adoption of green technologies and sustainable practices in selected crop production systems in the Program Counties (provincial level)	60,984,840	17.7%	This DLI aims to enable Hubei and Hunan to achieve a net reduction in quantity and intensity of chemical fertilizer use in selected value chains (for example, rice, fruits, and vegetables). The goal is to achieve provincial targets for reducing agricultural NPS water pollution and increasing the fertilizer utilization rates set in the RRSPs under the 14th FYP. The reductions can be achieved partly by increasing the efficiency of chemical fertilizer use (for example, by improving the rate, timing, placement, or precision of application) and partly by using substitutes, including organic, green, and formula (based on soil testing) fertilizers and fertigation technologies. These improved practices have been proven to substantially reduce GHG emissions (CH_4, N_2O, and CO_2) and nutrient loads (NH_3-N, TP, and TN).
DLI2.2: Percentage increase of treated and recycled livestock and poultry manure	71,700,000	20.8%	This DLI aims to enable Hubei and Hunan to increase the quantities of livestock and poultry manure collected, safely treated, and recycled into organic fertilizer, biogas/energy generation, and irrigation water. The aim is to achieve provincial comprehensive livestock and poultry

DLI	Allocated Amount (US$)	% of Total	Rationale for Selection
from large- and small-scale farms meeting effluent standards in the Program Counties (provincial level)			manure utilization rates and pollutant reduction targets set in the provincial RRSPs under the 14th FYP. Livestock and poultry manure management activities contribute to substantially reducing GHG emission (for example, by removing COD, BOD, and NH_3-N and efficiently using recovered gases [CH_4] and treated effluents from livestock and poultry production systems as organic fertilizer in crop production—circular economy) and nutrient loads (TP and TN) entering waterways and increasing health risks.
RA3: Increasing access to rural solid waste and wastewater services			
DLI3.1: Number of spatial IVDPs approved by the Program Counties (provincial level)	34,000,000	9.8%	This DLI aims to enable the Hubei and Hunan governments to properly plan climate-resilient rural infrastructure development under their phased RRSPs. While the priority under the Poverty Reduction Program had been on investing in rural roads and water supply, the RRP priority is to increase investment in rural wastewater and solid waste management systems which have been lagging. Preparation of spatial IVDPs is mandatory and they will include plans for settlement, farmland, forestry and protected land, recreation, social services, and rural infrastructure. They are binding and will guide all future rural investment to improve the village living environment. Thus, spatial IVDPs are viewed as future investment decision support tools. Spatial planning would help avoid protected land use changes; and guide investment in WWTFs and SWMS to help reduce GHG emissions and pollutant loads (for example, COD, TP, and NH_3-N) entering waterways.
DLI3.2: Number of demonstration villages with newly constructed or rehabilitated climate-resilient WWTFs and established solid waste collection, sorting, and transfer systems meeting effluent standards in the Program Counties (provincial level)	105,200,000	30.5%	This DLI aims to enable Hubei and Hunan to provide climate-resilient rural WWTFs and SWMS to prevent pollutants (for example, COD, TP, and NH_3-N) from entering waterways and improve living conditions in the demonstration villages. Solid waste will be sorted at source into organics, recyclables/reuse, hazardous, and residuals. Treating and recycling solid waste and wastewater would contribute to a substantial reduction in GHG emissions. This will also contribute to the achievement of a rural circular economy, including through the efficient use of treated wastewater (for example, reuse for irrigation to build resilience to drought), use of compost material (for example, as a substitute for chemical fertilizer), and use of nature-based solutions (for example, retention ponds or constructed wetlands to filter pollutants). Climate-resilient infrastructure will contribute to climate change adaptation.
RA 4: Restoring and protecting degraded agricultural ecosystems			
DLI4.1: Percentage increase in comprehensive crop straw (rice, wheat, rapeseed, and corn) utilization in the Program Counties (provincial level)	24,500,000	7.1%	This DLI aims to enable Hubei and Hunan to increase the use of large quantities of crop straw generated as a resource rather than waste. In general, crop straw has three uses: as an animal feed, as a source of biomass energy, or as SOC—when returned to the soil in the farmlands. This DLI will primarily focus on increasing the quantities of crop straw returned to the soil in farmland to increase carbon sequestration below ground and reduce GHG emissions (for example, CO_2) by avoiding burning. This activity will also contribute substantially to climate change adaptation.
DLI4.2: Number of hectares of treated aquaculture ponds meeting effluent discharge standards in the Program Counties	15,000,000	4.3%	This DLI aims to enable Hubei to reduce GHG emissions (CO_2, CH_4 and N_2O) and pollutant loads (COD, NH_3-N, BOD, TP, and TN) from large-scale aquaculture farms by improving treatment standards of pollutants using climate-resilient infrastructure. The aquaculture pollution results from the industry's use of inputs and its poor management of pond tail water. Inputs into aquaculture ponds include

DLI	Allocated Amount (US$)	% of Total	Rationale for Selection
(Hubei)			feed, drugs, and a variety of chemicals. Most inland aquaculture ponds regularly release large volumes of tail water, which pollutes downstream water bodies affecting other aquaculture operations and farmlands. Aquaculture pond water will be treated using existing ecological models as well as rotation between aquaculture and crop (especially rice and lotus roots) farming.
DLI4.3: Number of hectares of treated farmlands with a safe utilization rate in the Program Counties (Hunan)	15,000,000	4.3%	This DLI aims to enable Hunan to better manage the heavy metal pollution problem, affecting the food systems and causing human health risks. The primary goals are demonstrating integrated risk-based heavy metal pollution control measures and sustainable natural resources management approaches, promoting GAP (especially agronomic measures) and CSA technologies and improving the agricultural ecosystem environment. Safe utilization rate means both soil quality and food safety must meet minimum provincial standards. This DLI will contribute to GHG emissions reduction due to sustainable agriculture practices. It will also contribute to the reduction of pollutant loads entering waterways and human health risks emanating from contaminated agro-products.
Total IBRD loan	**345,461,000**	**100.0%**	

IV. VERIFICATION OF DLIS

22. **The achievement of the above DLIs will be verified by a VA based on agreed protocols.** The provincial governments will prepare consolidated reports on the achievement of results using M&E data and information collected and reported by the county government agencies with help from the third-party M&E firms hired under the GARR PforR. All M&E data and information collected by these agencies and M&E firms will be uploaded to the management information system (MIS). The third-party VA will use the MIS data and conduct field visits to verify the reported results. The detailed verification protocols for each DLI are presented in the technical assessment report and are summarized below.

23. **DLI1.1 includes two sub-DLIs.** DLI1.1.1 requires the NRRA as an implementing agency of the central component to develop an IT-based platform for mapping and M&E of rural infrastructure and public services for the provincial and county governments to adopt and use as a decision-making tool to guide investment and O&M activities. DLI1.1.2 requires that program counties install and use the IT-based platform developed under DLI1.1.1 to record, analyze, and report on the performance of rural infrastructure (including solid waste and wastewater management facilities), public services, and the spatial IVDPs of rural villages. The data collected, analyzed, and reported through the IT-based platform will include basic rural household (poor and non-poor) information on access to rural infrastructure and public services, such as wastewater and solid waste in all villages in the program counties and village socioeconomic parameters.

24. **Verification Protocol for DLI1.1.1:** A third-party VA will verify whether: (1) the NRRA has developed and installed the IT-based platform for mapping and M&E of rural infrastructure and public services and spatial IVDPs of rural villages through on-site review of the system and the official/regular performance evaluation documents, or reports generated; (2) the IT-based platform meets data security and confidentiality standards; (3) the NRRA has established mechanisms for the protection of personal data; and (4) the NRRA has issued guidelines for installing and using the IT-based platform at the county level. Upon achieving the results, a single disbursement of 77 percent of the budget allocated for DLI1.1 will be made.

25. **Verification Protocol for DLI1.1.2:** The third-party VA will verify whether: (1) the IT-based platform has been adopted and installed in the program counties; (2) the data and information are being collected and entered in the platform; (3) the platform can regularly generate the required official reports, including on the performance of the solid waste, and wastewater facilities, public services, and IVDPs to inform investment and O&M decision-making; (4) the platform meets data security and confidentiality standards; and (5) the provincial and county Rural Revitalization Bureau (RRB) have established mechanisms for protecting personal data. The NRRA targets all 23 program counties to achieve these results by FY2026. The remaining 23 percent of the budget allocated to DLI1.1 is scalable. Based on the agreed unit price, disbursements will be made progressively against the number of new program counties achieving these results each year.

26. **DLI1.2 also has two sub-DLIs:** (1) DLI1.2.1: Provinces will adopt regulations, standards, and guidelines on green agricultural development issued by the Ministry of Agriculture and Rural Affairs (MARA), which set the minimum requirements for certifying or registering agro-products as green, organic, or GI. Depending on target markets, provinces may approve regulations, standards, and guidelines that are more stringent or higher than MARA's. The adopted/customized regulations, standards, and guidelines will be approved by the relevant authorities at the provincial level. The provincial Departments of Agriculture and Rural Affairs (DARAs) will issue the official notice to the 23 program counties to use them. (2) DLI1.2.2: Number of agro-products produced in the program counties certified as green or organic or registered as GI using the approved provincial regulations, standards, and guidelines. This sub-DLI aims to provide evidence that farmers in the program counties are adopting GAP and can meet environmental and food safety standards. Certified and registered agro-products fetch premium prices in the niche domestic, regional, and international markets, incentivizing the two provinces to adopt the national certification and registration systems. Hubei and Hunan aim to certify or register 157 and 200 agro-products in the program counties, respectively.

27. **Verification Protocol for DLI1.2.1:** The third-party VA will verify the documents approved by the relevant provincial authorities (i.e., regulations, standards, and guidelines), and a single disbursement of 20 percent of the allocated budget for DLI1.2 is made upon achieving the results.

28. **Verification Protocol for DLI1.2.2:** The third-party VA will verify the green and organic agro-product certificates issued by the provincial DARAs and the GI agro-product registration documents issued by MARA. Disbursements of the remaining 80 percent of the budget allocated to DLI1.2 are scalable. Based on the agreed unit price, disbursements will be made against the number of agro-products certified or registered in each calendar year.

29. **DLI2.1 measures the reduction in net chemical fertilizer use in the program counties.** The cumulative chemical fertilizer use reduction achieved by reducing application intensity (e.g., quantity per unit area) or increasing use efficiency will be monitored using MARA's national platform. The cumulative chemical fertilizer use reduction achieved due to the increased use of substitute technologies will be estimated using conversion coefficients approved by MARA. This is because the utilization rates are calculated by combining experimental data on fertilizer absorption by different crops over multiple seasons and data from substitute technologies, or GAP. The experiments use MARA's methodology to monitor fertilizer application rates and crop yields and account for crop nutrient use. Therefore, the program counties will collect data on the quantity and area (hectares) of chemical fertilizer use substituted by GAP and prepare annual reports. The net reduction in chemical fertilizer use will be calculated by provincial DARAs from a decrease in application intensity and an increase in substitute technologies, or GAP using the conversion coefficients approved by MARA. Hubei and Hunan are targeting to reduce the chemical fertilizer use in the program counties by 38,361 and 78,176 metric tons, respectively.

30. **Verification Protocol: The third-party VA will verify the cumulative quantity of organic and formula fertilizers and area under the green manure and fertigation practices in selected cropping systems monitored by county DARAs and reported to the World Bank by provincial DARAs annually.** The third-party VA will verify whether the provincial DARAs have used appropriate conversion coefficients to calculate reduced net tons of chemical fertilizers. The third-party VA will randomly sample and review the county DARAs' analyses

and results, which are reported to the provincial DARAs to check whether they are consistent with the reduction in chemical fertilizer use due to the adoption of GAP. Chemical fertilizer reduction targets and budgets are spread over 2025–28 period. Disbursements are scalable and are made against the target net metric tons of chemical fertilizer reduction achieved in the program counties each calendar year based on the agreed unit price.

31. **DLI2.2 measures the incremental adoption of good livestock and poultry manure management practices due to the program interventions.** These include expanding on-site manure treatment capacity at large farms and constructing centralized treatment facilities to cater to small- and medium farms.[8] The cumulative data on the quantity of manure collected, treated, and recycled will be obtained from large farms with on-site treatment facilities and centralized treatment facilities for small and medium livestock and poultry farms. MARA has established a national platform for monitoring the quantities of livestock and poultry manure produced, collected, treated, and utilized (e.g., as organic fertilizer, conversion to biogas/energy, and crop irrigation) by large farms. Data from this platform enables MARA and provincial DARAs to scientifically calculate the comprehensive utilization rate of livestock and poultry manure. Supplementary data will be collected from the on-site ledgers of large farms and centralized facilities serving the small- and medium livestock and poultry farms and through annual M&E socioeconomic surveys. The County Department of Ecology and Environment (DEE) will monitor the effluents discharged from the manure treatment facilities to ensure they meet environmental standards. Hubei and Hunan aim to increase the manure treatment capacity in the program counties by 6 and 11 percent, respectively.

32. **Verification Protocol: Cumulative quantities of livestock and poultry manure collected, treated, and recycled that are reported by the provincial DARAs will be verified by the third-party VA based on a random sampling of large farms and centralized facilities serving small and medium farms and by reviewing other supporting documents, such as inspection reports from county DARAs and annual M&E socioeconomic survey reports.** Livestock and poultry manure treatment and recycling targets and budgets are spread over FY2024–28. The third-party VA will verify the results and estimate the annual manure treatment rates. Disbursement will be made against the percentage increase of livestock and poultry manure treated that meets provincial effluent discharge standards achieved in the program counties per year based on the agreed unit price.

33. **DLI3.1 measures the number of professionally-developed spatial IVDPs, which include settlement, farmland, forestry/protected land, recreation, social services, and infrastructure areas in rural villages.** As village masterplans, the spatial IVDPs would guide future rural village development to improve living conditions. The county RRB will collect data on the number of spatial IVDPs prepared by professional spatial planning firms. The spatial IVDPs will be approved by the county authorities for implementation at the county level to ensure they meet the required technical, environmental, and social standards specified in the program implementation plan (PIP). The target is to develop 200 and 213 spatial IVDPs in the program counties in Hubei and Hunan, respectively.

34. **Verification Protocol: The third-party VA will verify the achievements reported by provincial RRBs by reviewing the minutes of meetings approving the spatial IVDPs and the final documents provided by the county RRBs on a random sampling basis.** Based on the agreed unit price, disbursements will be made against the number of spatial IVDPs approved by the relevant county authorities and registered by the provincial authorities each year.

35. **DLI3.2 measures the number of demonstration villages with solid waste and wastewater management facilities meeting effluent discharge standards.** The aim is to track the improvement in the waste management systems to prevent pollutants (e.g., COD, TP, and NH_3-N) from entering waterways and increasing health risks. The main objective is to meet the provincial effluent discharge standards. Data on the number of newly-constructed or rehabilitated and operational WWTFs and SWMS will be collected by the relevant

8 Small-and medium-scale animal farms are defined as less than 500 head of pigs, less than 2,000 egg chickens (layers), less than 10,000 meat chicken (broilers), and/or less than 30 head of cattle.

departments at the county level during the handover of the facilities/systems. The provincial RRBs will consolidate data from the program counties into a provincial report. Hubei and Hunan aim to construct 49 and 59 centralized WWTFs or SWMS in the program counties, respectively.

36. **Verification Protocol: The third-party VA will verify whether the WWTFs and SWMS are fully operational by randomly sampling batches of facilities and systems completed and accepted each year.** Using data from county DEEs and its own sample-based analyses, the third-party VA will also verify whether the waste management facilities and systems meet provincial effluent discharge standards. Disbursement will be made against the number of demonstration villages with waste management facilities and systems that meet the provincial effluent discharge standards each year based on the unit price.

37. **DLI4.1 measures the residual crop straw returned (plowed in) to the soil in farmlands.** The program will focus on returning residual crop straw into the soil to increase SOC (through carbon sequestration); improve soil health (for higher water retention, cation exchange, and nutrient absorption capacity); and reduce GHG emissions (by avoiding burning or decomposition). The program counties' DARAs will collect data on the quantities of residual crop straw (left in the field) that are returned to the soil in farmlands. The provincial DARAs will prepare consolidated reports based on the data collected in the program counties and MARA's platform for crop straw utilization. Hubei and Hunan aim to increase their comprehensive crop straw utilization rate in the program counties by 3 percent and 6 percent, respectively.

38. **Verification Protocol: The third-party VA verifies the quantities of residual crop straw reported by the provincial DARAs by randomly sampling program counties and carrying out on-site or spot checks.** To estimate their uptake, the third-party VA verifies the quantities of straw used by large animal farms and biomass-to-energy generation firms. Disbursement will be made based on the estimated tons of residual crop straw returned to the soil in farmlands using MARA's guidelines.

39. **DLI4.2 measures the reduction in pollutant loads from large-scale aquaculture farms in Hubei Province. Inland aquaculture is a booming industry in Hubei Province.** The intensive use of inputs and poor management of aquaculture pond wastewater is increasingly causing environmental pollution. This is primarily because many aquaculture operations regularly release large volumes of untreated pond wastewater into waterways. In the 10 program counties, aquaculture pond wastewater will be treated using the existing ecological models, and rotation between aquaculture and crop (mainly rice and lotus roots) farming will be done. County DARA and the Ministry of Ecology and Environment (MEE) will monitor the tailwater from the aquaculture ponds to ensure they meet provincial effluent discharge standards. Hubei targets implementing ecological aquaculture wastewater treatment models in 10,938 hectares in the 10 program counties.

40. **Verification Protocol: The third-party VA will review the provincial DARA and MEE aquaculture wastewater treatment monitoring reports to establish the number and area of ponds with treated tailwater meeting effluent discharge standards.** The third-party VA will also randomly collect and analyze samples from large-scale aquaculture farms that have installed pond water treatment facilities to check whether tailwater meet provincial effluent discharge standards. The third-party VA will then compare the data from automatic loggers installed by large-scale farms with its results. Based on the agreed unit price, the disbursement will be made based on the percentage of the total number of hectares of aquaculture ponds meeting effluent discharge standards each year.

41. **DLI4.3 measures the area of agricultural farmland degraded by heavy metals treated and brought back to safe crop production in Hunan Province.** Technical measures for risk-based heavy metal pollution management will be implemented, including (1) source control measures, such as increasing the flooding irrigation regime to reduce uptake of cadmium, removing rice straw from contaminated fields, and growing

hyperaccumulator[9] plants in the winter season; (2) agronomic management measures to help reduce active heavy metals in crops, such as cultivating rice varieties that do not accumulate heavy metals, increasing soil pH by applying lime, and applying organic fertilizers and soil immobilization agents; (3) switching crops by growing non-metal accumulating species, such as oil crops or fodder crops; and (4) phytoremediation,[10] especially for high-risk farmlands, where growing highly accumulating plant species, such as Sedum (*Pteris vittata*), water onion, and grain amaranth can help to reduce heavy metals from the farmland. Hunan targets to treat a total of 8,029 hectares of heavy metal polluted farmlands in the program counties.

42. **Verification Protocol: The third-party VA will review the provincial DARAs' heavy metals pollution control reports and randomly collect and analyze soil and crop samples from treated farmlands in the 13 program counties.** The third-party VA will calculate the percentage of soil and crop samples that meet soil quality and food safety standards. Disbursement will be made based on the proportion (or percentage) of treated farmland area (hectares) with soil and crop samples meeting the minimum provincial soil quality and food safety standards (i.e., safe utilization of treated farmland).

V. EXPENDITURE FRAMEWORK ASSESSMENT

43. **The Expenditure Framework Assessment (EFA) was carried out based on financial data and information provided by Hubei and Hunan provincial and county/city governments, a review of public financial management regulations, and interviews with government officials during field visits.** The EFA covered the following aspects: (1) fiscal sustainability and resource predictability; (2) budget allocation and execution; and (3) incentives for efficient service delivery and value for money.

44. **The EFA was based on financial data and information from the Hubei and Hunan provincial and county/city governments, a review of public financial management regulations, and interviews with government officials during field visits.** The EFA covered the following aspects: fiscal sustainability and resource predictability, budget allocation and execution, and incentives for efficient service delivery and value for money. The GARR PforR will be implemented from FY2024–29. It covers the NRRA, Hubei (10 counties out of 102 counties), and Hunan (13 counties out of 122 counties) (see Annex 1). The total GARR PforR financing is estimated at USD 4,445.46 million, of which an equivalent of USD 4,100 million (CNY 29.3 billion) will be financed by the Chinese government and USD 345.46 million by the IBRD Loan (see Table 5). Of the USD 4,100 million, it is estimated that Chinese government financing of USD 2,464 million will come from Hubei, USD 1,605 million from Hunan, and USD 31 million from NRRA.

Table 5 Program Financing (FY2024–29)

Source	National Rural Revitalization Administration (NRRA)	Hubei Province	Hunan Province	Total

9 A hyperaccumulator is a plant capable of growing in soil or water with very high concentrations of metals, absorbing these metals through their roots, and concentrating extremely high levels of metals in their tissues. https://en.wikipedia.org/wiki/Hyperaccumulator

10 Phytoremediation is a plant-based approach, which involves the use of plants to extract and remove elemental pollutants or lower their bioavailability in soil. Using phytoremediation is economically feasible (phytoremediation is an autotrophic system powered by solar energy, therefore, simple to manage, and the cost of installation and maintenance is low); environment- and eco-friendly (it can reduce exposure of the pollutants to the environment and ecosystem); applicable (it can be applied over a large-scale field and can easily be disposed); it prevents erosion and metal leaching through stabilizing heavy metals, reducing the risk of spreading of contaminants; and able to improve soil fertility by releasing various organic matter to the soil.

	Amount (Million USD)	% of Total	Amount (Million USD)	% of Total	Amount (Million USD)	% of Total	Amount (Million USD)	% of Total
Government Budget	31.00	85.02	2,464.00	93.5	1,605.00	90.40	4,100.00	92.22
International Bank for Reconstruction and Development (IBRD) Loans	5.46	14.98	170.00	6.5	170.00	9.60	345.46	7.78
Total	**36.46**	**100.0**	**2,634.00**	**100.0**	**1,775.00**	**100.00**	**4,445.46**	**100.00**

Note: The exchange rate is USD 1 = CNY 7.14

A. Expenditure Scope

45. **The GARR PforR expenditures by RAs and provinces are presented in Table 6**. Of the total GARR PforR government financing of USD 4,100 million equivalent, RA1 accounts for only 0.8 percent, RA2 for 36.6 percent, RA3 for 53.0 percent, and RA4 for 9.6 percent. RA2, RA3, and RA4 involve massive public investment. RA1 puts more emphasis on institutional strengthening and innovation, including the improvement of program governance frameworks and/or systems, for which public expenditure is relatively small.

46. **The RA1 activities are implemented centrally by NRRA and locally by the two provinces.** The RA1 activities implemented by NRRA involve mainly the development and maintenance of the IT system, for which the public expenditure is recorded on budget reports of NRRA under the special fund allocated to the IT center of NRRA. After reviewing the budget report of the IT center, we identified two items under budget line 2130599 (2130599 data analysis and application; and 2130599 IT system operation and maintenance) in which the expenditure for the central component-IT platform of the PforR is recorded. The RA1 activities implemented by the two provinces involve mainly institutional strengthening and innovation and adoption of the IT platform, for which the public expenditure is estimated to be negligible.

Table 6 Governments' Program Financing by Result Areas (FY2024–29)

Result Area	2018–21 Actual (Million USD)			FY2024–29 Estimated (Million USD)				
	NRRA	Hubei	Hunan	NRRA	Hubei	Hunan	Subtotal	Share (%)
RA1	25.0	0.0	0.0	31.3	0.0	0.0	31.3	0.8
RA2	0.0	733.4	466.4	0.0	916.7	583.0	1,499.7	36.6
RA3	0.0	1,125.0	614.6	0.0	1,406.3	768.3	2,174.6	53.0
RA4	0.0	112.7	202.7	0.0	140.9	253.3	394.2	9.6
Subtotal	**25.0**	**1,971.2**	**1,283.7**	**31.3**	**2,463.9**	**1,604.6**	**4,099.8**	

Note: We use the simple average number of the program financing from 2018–21 to forecast the program financing from FY2024–29. The data source for actual expenditures from 2018–21 is shown in Table 4.

47. **The RA2, RA3, and RA4 activities are implemented by the two provinces.** The provincial governments in China adopt uniform budget classification codes and report public expenditures based on formats provided or established by the central Ministry of Finance (MOF). Hubei and Hunan use an integrated financial management system to allocate budgets and track public expenditures. DARA is primarily responsible for implementing the "Agricultural and Rural Modernization" government program and records the related expenditures under the budget line *agriculture and rural affairs* (code 21301). Besides, the DARA also takes the main responsibility for "Rural Environmental Protection". It records the related expenditures under the budget line "Rural Environmental Protection" (code 2110402). The Department of Housing and Urban-Rural Construction Affairs takes the main responsibility for implementing the government program of "Providing Rural Solid Waste and Wastewater Services" and records the related expenditures under the budget line *urban and rural community environment* (code 21205) and *other urban and rural community spending* (code 21299). The government RRP is mainly implemented by the Rural Revitalization Administration Bureau (RRAB). The related expenditures are recorded under the poverty alleviation budget line (code 21305). After achieving the goal of lifting all poor households out of extreme poverty, China is transitioning into implementing the RRP. However, the rural revitalization expenditures continue to be recorded under the "Poverty Alleviation" budget line.

48. **The GARR PforR will support a subset of activities under the government's RRP and Green Agricultural Development Plan program in NRRA and the selected counties in Hubei and Hunan.** The RA1 activities are implemented centrally by NRRA and locally by the two provinces. The RA1 activities implemented by NRRA involve mainly the development and maintenance of the IT platform, for which the public expenditures are recorded in the budget report of NRRA under the special fund allocated to its IT center. The RA1 activities implemented by the two provinces involve mainly institutional strengthening and innovation and adoption of the IT platform, for which the public expenditure is estimated to be negligible. The two provinces implement the RA2, RA3, and RA4 activities, including greening selected agricultural value chains, increasing access to rural solid waste and wastewater services, and restoring and protecting degraded agricultural ecosystems. The provincial governments in China adopt uniform budget classification codes and report public expenditures based on formats provided or established by the central MOF. Hubei and Hunan use an integrated budget management system (IBMS) to allocate budgets and track public expenditures. DARA is responsible for implementing the government's Agricultural and Rural Modernization Program. It records the related expenditures under the budget line *agriculture and rural affairs* (code 21301). Based on the budget data for 2018–21, the overall public expenditure for the GARR PforR-related activities is estimated to be about 45.5 percent of the government program, 54.0 percent for Hubei, and 36.7 percent for Hunan (see Table 7).

Table 7 Program Expenditure Boundary in 2018–21 (Million USD)

Code	Budget Line	Government Program				PforR Program		
		NRRA	10 counties of Hubei	13 counties of Hunan	Result Area	NRRA	10 counties of Hubei	13 counties of Hunan
2130599	Data analysis and application	5.2*			RA1	5.2		
2130599	Information operation and maintenance for poverty alleviation and development	19.8			RA1	19.8		
21104	Natural ecology protection		299.7	133.6				
2110401	Ecological protection		23.8	33.9				
2110402	Rural environmental protection		245.2	80.9	RA3		245.2	80.9
2110404	Conservation of biological and species resources		0.3	2.2				
2110499	Other natural and ecological protection expenditures		30.4	16.6				
21205	Urban and rural community environment		234.9	171.6				
2120501	Urban and rural community environment		234.9	171.6	RA3		234.9	171.6
21299	Other urban and rural community spending		95.6	124.8				
2129901	Other urban and rural community spending		95.6	124.8	RA3		95.6	124.8
21301	Agriculture and rural affairs		1427.6	1903.6				
2130101	Administrative operation		69.0	246.6				
2130102	General administrative services		9.2	22.2				
2130103	Agency service		2.4	0.2				
2130104	Business operation		79.9	72.5				
2130105	Farm reclamation operation		25.9	0.4				
2130106	Technology transformation and promotion services		146.5	30.6	RA2		146.5	30.6
2130108	Pest control		48.7	52.2	RA2		48.7	52.2
2130109	Agricultural product quality and safety		3.7	14.5				
2130110	Law enforcement supervision		4.3	7.3				
2130111	Statistical monitoring and information services		0.1	0.7				

Code	Budget Line	Government Program				PforR Program		
		NRRA	10 coun-ties of Hubei	13 coun-ties of Hunan	Result Area	NRRA	10 coun-ties of Hubei	13 coun-ties of Hunan
2130112	Industry business management		5.3	2.7				
2130114	Foreign exchange and cooperation		0.0	0.5				
2130119	Disaster prevention and relief		14.8	5.2	RA2		14.8	5.2
2130120	Stable farmers' income subsidy		0.0	1.6				
2130121	Agricultural structural adjustment subsidies		1.0	13.0	RA4		1.0	13.0
2130122	Agricultural production development		442.8	309.6	RA2		442.8	309.6
2130124	Rural cooperative economy		27.0	28.7				
2130125	Agricultural processing and promotion		9.5	22.7				
2130126	Rural social undertaking		60.2	77.4				
2130135	Protection, restoration, and utilization of agricultural resources		80.5	68.8	RA2		80.5	68.8
2130142	Rural road construction		69.5	43.2				
2130148	Refined oil price reform subsidy to fishery		15.9	4.7				
2130152	Subsidy for college graduates to work at the grassroots level		3.3	0.9				
2130153	Farmland construction		111.7	189.7	RA4		111.7	189.7
2130199	Other agricultural and rural expenditures		196.1	687.6				
21305	Poverty Alleviation / Rural Revitalization		1,595.7	1,159.4				
2130501	Administrative operation		10.6	24.4				
2130502	General administrative services		4.2	9.7				
2130503	Agency service		0.0	0.1				
2130504	Rural infrastructure construction		549.2	237.4	RA3		549.2	237.4
2130505	Production development		183.2	162.7				
2130506	Social development		57.8	28.1				

Code	Budget Line	Government Program				PforR Program		
		NRRA	10 coun-ties of Hubei	13 coun-ties of Hunan	Result Area	NRRA	10 coun-ties of Hubei	13 coun-ties of Hunan
2130507	Poverty alleviation loan awards and interest subsidies		35.1	9.2				
2130508	"Three West" subsidy for agricultural construction		0.0	0.0				
2130550	Poverty alleviation institutions		1.4	0.4				
2130599	Other poverty alleviation expenditures		754.3	687.4				
Total Amount			**25.0**	**3,653.5**	**3,493.0**	**25.0**	**1,971.2**	**1,283.7**
As percent of gov't program			100	54.0	36.7	0	0	7

B. Program Financing

49. **Program financing seems to be adequate and reliable.** Expenditures of NRRA are fully financed by the central government's general budget. County governments will implement activities under RA2, RA3, and RA4. The corresponding expenditures will be recorded under the county government's budget, heavily relying on the central and provincial governments' transfers.

50. **There are three mechanisms used by the higher-level governments (HLGs) to transfer funds to county governments,** namely, (1) transfer for central-local shared functions on agriculture, forestry, and water affairs; (2) transfer for poor areas; and (3) special transfers for agricultural, forestry, and water affairs of which the third item is an earmarked transfer, while the other two are general transfers. The earmarked transfer incentivizes counties to implement the GARR PforR activities. In contrast, general transfers help fill the financing gaps as needed. Table 8 shows that the total amount of the three transfers (USD 6,914 million) from HLGs to program counties is higher than the total expenditures (Hubei USD 2,124 + Hunan USD 1,664 = Total USD 3,788 million equivalent) from their own sources. Given that the bulk of GARR PforR expenditures would come from HLG transfers, it can be concluded that the program financing is adequate and largely predictable.

Table 8 Program Funding Sources for RA2, RA3, and RA4 during 2018–21 (Million USD)

	10 Counties of Hubei					13 Counties of Hunan					Total
	2018	2019	2020	2021	Total	2018	2019	2020	2021	Total	
General Transfers											
Transfer for central-local common functions on agriculture, forestry, and water affairs	3.6	416.4	450.6	491.8	1362.4	12.5	520.7	549.2	621.0	1703.4	3065.8
Transfer for poor areas	95.9	135.4	152.8	147.7	531.8	152.7	182.4	202.0	206.9	744.0	1275.9
Earmarked Transfers											
Special transfer for agricultural, forestry, and water affairs	552.5	206.2	206.6	296.4	1261.8	780.5	418.3	312.0	239.6	1750.4	3012.1
Total	**652.1**	**758.0**	**810.0**	**936.0**	**3,156.0**	**945.7**	**1,121.4**	**1,063.2**	**1,067.5**	**4,197.8**	**7,353.8**
Share of Earmarked Transfers	84.7	27.2	25.5	31.7	40.0	82.5	37.3	29.3	22.4	41.7	41.0

C. Expenditure Performance

51. **The quality of program expenditure management will be critical to achieving the GARR PforR objectives.** While the county governments are responsible for implementing the program activities and delivering the results, the HLGs are responsible for providing incentives to the program counties through (1) earmarked transfers that mandate program counties to use the funds for implementing activities that are critical to the achievement of expected results; (2) expenditure performance evaluation and rewards; and (3) technical guidance and close supervision.

RA1 activities

52. **The expenditure framework for RA1 is assessed to be adequate. The central MOF conducts a needs assessment for budget proposals all ministries submit.** Proposals aligned with the government policy priority receive an adequate budget allocation. For the cost of the IT platform, MOF allocates about CYN 50 million budget for the yearly operation and maintenance. NRRA sets performance targets for its major programs, including IT system development and maintenance, and recruits a third-party agent to conduct an ex-post performance evaluation. Based on NRRA's self-assessment and the evaluation by a third-party agent in the last two years, the IT system development and maintenance program was well implemented with a budget execution rate close to 100 percent and delivered the expected performance targets.

RA2 and RA4 activities

53. The **expenditure framework for RA2 and RA4 is assessed to be adequate.** The earmarked transfers, performance evaluation, and reward systems have incentivized program counties to deliver green agriculture development and agricultural ecosystem restoration and protection objectives. In both Hubei and Hunan, the budgets for financing RA2 and RA4 activities are managed by the DARA. Several central and provincial earmarked transfers are aligned with green agriculture development objectives (see Annex 2 and Annex 3). In both Hubei and Hunan, the earmarked transfers for agriculture and rural affairs are through special purpose funds and projects, including the Agricultural Production Development Fund (APDF), Farmland Construction Fund (FCF), Agricultural Resources and Ecological Protection Fund (AREPF), Agricultural Production Development

Project (APDP), and the Agricultural Sustainable Development Project (ASDP). Most funds are transfers from the central and provincial governments, with the central government's share being about 80 percent (see Table 9).

Table 9 Earmarked Funding Sources Supporting RA2 and RA4 in Hubei and Hunan (2018–21) (Million USD)

	10 counties of Hubei					13 counties of Hunan					Total
Funding Program	**Province**	**%**	**Central**	**%**	**Total**	**Province**	**%**	**Central**	**%**	**Total**	**Total**
Agricultural Production Development Fund (APDF)	33.0	8.9	338.1	91.1	371.1	84.8	18.1	383.5	81.9	468.3	839.4
Farmland Construction Fund (FCF)	96.5	36.3	169.2	63.7	265.7	130.1	44.8	160.1	55.2	290.3	555.9
Agricultural Resources and Ecological Protection Fund (AREPF)	0.0	0.0	8.5	100.0	8.5	0.0	0.0	25.4	100.0	25.4	34.0
Agricultural Production Development Project (APDP)	0.0	0.0	37.9	100.0	37.9	0.0	0.0	35.0	100.0	35.0	72.9
Agricultural Sustainable Development Project (ASDP)	0.0	0.0	12.5	100.0	12.5	0.0	0.0	4.6	100.0	4.6	17.1
Total	**129.4**	**18.6**	**566.2**	**81.4**	**695.7**	**214.9**	**26.1**	**608.7**	**73.9**	**823.6**	**1,519.3**

54. **MOF and DARA in Hubei and Hunan have issued a series of documents on managing earmarked funds.** Accordingly, the transferred funds shall only be used for the specified activities. The allocation of the funds is factor-based or project-based and shall all be subject to performance evaluation. The performance evaluation results are an important factor for the fund allocation. Therefore, there are strong incentives for the program counties to achieve the desired objectives of greening agricultural development and to ensure value for money. Taking an example of the biggest earmarked transfer program, the APDF, its performance is evaluated by, among others, a number of green agriculture indicators, such as fertilizer use/intensity reduction, rural ecological environment improvement, and comprehensive utilization rate of straw.

RA3 activities

55. **The EFA found that there are also some earmarked funds from the central and provincial governments for financing RA3 activities and increasing access to rural solid waste and wastewater services. Still, the amounts are significantly smaller than those of RA2 and RA4 (see Table 10).** Accordingly, governments are mainly responsible for financing rural solid waste and wastewater services. Fiscal transfers from the central and provincial governments account for only a small share of the counties' total budget funding.

Table 10 Earmarked Funding Sources Supporting RA3 Activities in Hubei and Hunan (2018–21)

Funding Program	10 Counties of Hubei					13 Counties of Hunan					Total
	Province	%	Central	%	Total	Province	%	Central	%	Total	
Township domestic sewage treatment	36.5	100.0	0.0	0.0	36.5	36.1	100.0	0.0	0.0	36.1	72.6
Rural toilet revolution	7.7	28.0	19.9	72.0	27.6	17.7	64.2	9.8	35.8	27.5	55.1
Harmless treatment of urban and rural domestic waste/garbage classification	43.7	100.0	0.0	0.0	43.7	0.2	100.0	0.0	0.0	0.2	43.8
Rural living environment improvement project	0.0	0.0	14.2	100.0	14.2	0.0	0.0	26.4	100.0	26.4	40.6
Total	**87.9**	**72.1**	**34.0**	**27.9**	**121.9**	**54.0**	**59.8**	**36.3**	**40.2**	**90.2**	**212.1**

56. **The Rural Revitalization Transition Fund (RRTF), the successor of the Poverty Reduction Fund managed by the RRAB, is another vital source of financing for the RA3 activities.** The RRTF is formed by integrating various rural development-related earmarked funds from various HLGs. However, the county governments can decide how to use the fiscal resources. Activities that are eligible for financing include, among others, industrial development, rural living environment improvement, and the construction of small-scale rural infrastructure. During 2021, the first year of the transition from the poverty reduction program to the RRP, the priority of RRTF was to consolidate the achievements of poverty eradication. As a result, more than half of the RRTF was spent on industrial development to sustain farmers' income. In contrast, only about 2.5 percent (74.06/2,922.48*100) was spent on rural toilet rehabilitation and sewage and garbage management services under the subprogram "Improvement of living conditions" (see Table 11). As such, the current government funding of RA3 activities is significantly limited. Repurposing poverty-related budgets to finance the improvement of rural solid waste and wastewater services is urgently needed.

Table 11 Usage of RRTF Funds in Project Counties of Hubei and Hunan (2018–21), Million CNY

Program (Subprogram)	Hubei		Hunan		
	Amount	Share	Amount	Share	Total
Industrial development	480.05	24.91	331.64	33.33	811.68
Ecological poverty alleviation, leisure agriculture and rural tourism, planting, breeding, and processing services	480.05	24.91	331.64	33.33	811.68
Village infrastructure	315.43	16.37	329.68	33.13	645.10
Rural road construction, power supply, and small-scale water conservancy facilities	315.43	16.37	329.68	33.13	645.10
Poverty alleviation	820.44	42.57	102.91	10.34	923.35
Health, education, finance, employment, and comprehensive poverty alleviation	820.44	42.57	102.91	10.34	923.35
Improvement of living conditions	214.75	11.14	112.11	11.27	326.86
Safe drinking water supply and roads leading to houses	176.34	9.15	76.46	7.68	252.80
Reconstruction of kitchen, toilet, enclosure, etc.	38.41	1.99	35.65	3.58	74.06
Other	96.68	5.02	118.80	11.94	215.48
Public welfare jobs supply, reconstruction of endangered buildings, project management fees	96.68	5.02	118.80	11.94	215.48
Total	**1,927.33**	**100.00**	**995.14**	**100.00**	**2,922.48**

Note: However, RRTF potentially can become the primary source of funds to support RA3 activities.

57. **In May 2022, the Office of the Central Committee of the Communist Party and the Office of the State Council of China jointly issued the "Implementation Plan for Rural Construction Actions," pointing out that rural construction is an important task in implementing the RRS.** In the next five years (2023–27), China will focus on implementing the five-year actions to improve the rural living environment, which covers the revolution of rural toilets; treatment of domestic sewage and black and odorous water bodies; and collection, transfer, and treatment systems of rural domestic garbage. Given that it is the county governments' responsibility to implement these actions, with the support of the GARR PforR, the project counties would be incentivized to allocate more RRTF funds to finance the RA3 activities and achieve the DLI3.2.

D. Financial Sustainability

58. **The recent General Public Budget Revenue (GPBR) in Hubei and Hunan provinces has been relatively unstable (see Table 12), partly due to the negative impacts of the COVID-19 pandemic.** However, the total expenditure of the GARR PforR accounts for only about 1.3 percent (=2.8/222.5×100)[11] of the GPBR in Hubei and 1.1 percent (=2.3/216.3×100) of the GPBR in Hunan. Overall, financial sustainability is not deemed a significant concern for the program.

Table 12 Financial Situation in terms of General Public Budget in Hubei and Hunan

Description	Hubei				Hunan			
	2018	2019	2020	2021	2018	2019	2020	2021
General public budget revenue (GPBR), USD Billion	47	48	36	47	41	43	43	46
Transfer from central government (TFCG), USD Billion	62	68	89	77	50	53	60	58
Gross domestic product (GDP), USD billion	600	649	614	714	519	570	593	658
Debt balance (DB), USD billion	95	115	144	170	124	145	169	194
Debt repayment amount 2021 (DRA)	51	59	68	-	17	21	13	20
Debt-to-GPBR ratio (=DB/GPBR+TFCG), %	88	99	115	137	137	152	164	186
Debt-to-GDP ratio (=DB/GDP), %	16	18	23	24	24	26	28	30
Debt repayment ratio (=DRA/GPBR+TFCG), %	43	46	50	-	18	22	13	19

According to Table 6, the projected program financing from FY2024–29 is USD 2.46 billion in Hubei and USD 1.60 billion in Hunan.

E. Recommendations

59. **The expenditure framework presents a strong basis for the governments of Hubei and Hunan to finance green agriculture development and the delivery of rural infrastructure and public services.** Budgets appear largely adequate relative to the GARR PforR's expected results, and aggregated fiscal sustainability issues were not identified as a core concern associated with public expenditures. The project counties' transfers from the central and provincial governments are stable and predictable. However, the following points need to be addressed during the GARR PforR implementation:

- **The central and provincial governments have adopted various measures to incentivize county governments to deliver green agricultural development results.** However, the public expenditures on activities that support the greening of the agriculture sector are not monitored and reported. This makes it impossible to assess the county governments' efforts. The Bank recommends that the central and provincial governments consider: (1) developing a green agriculture expenditure taxonomy and monitoring the expenditures accordingly and (2) allocating the agriculture-related transfers among

11 According to the figures of the general public budget revenue (GPBR) from 2018–21, it can be predicted that the GPBR of Hubei from 2023–27 is USD 222.5 billion ((47+48+36+47)/4×5=222.5), the GPBR of Hunan from 2023–27 is USD 216.3 billion ((41+43+43+46)/4×5=216.3).

counties based on the achievement of green agricultural development results to enhance incentives and performance.

- **Under rural infrastructure and public services, although the funding is available to program counties, the governments need to reallocate funds from the RRTF to finance solid waste and wastewater management services.** To ensure expenditure efficiency and value for money, the county governments should develop integrated village plans to inform the annual sub-project selection and budget allocation. The integrated village plans should consider: (1) the connection of the villages to the county's infrastructure network system; (2) the costs of the infrastructure assets over their life cycle, including capital expenditures and the O&M budgets; and (3) the O&M financing constraint faced by the rural villages and their sponsoring county governments. The institutional capacity of program counties also needs to be enhanced to appropriately manage and implement the GARR PforR activities.

VI. STRATEGIC RELEVANCE AND TECHNICAL SOUNDNESS

A. Strategic Relevance

60. **After 40 years of unprecedented economic growth, China eradicated absolute poverty in 2020, 10 years ahead of the United Nations' Sustainable Development Goal target of 2030.** Currently, the share of people living below the extreme international poverty line of USD 1.90 per day is below 1 percent. Despite this remarkable achievement, about 250 million Chinese remain below the USD 5.50 per day poverty line recommended for upper-middle-income countries (MICs), of which two-thirds reside in rural areas. Approximately 40 percent of China's population (or 570 million people) still lives in rural areas. Many are vulnerable to falling back into poverty in the case of an economic shock or natural disasters, such as floods and droughts, some due to climate change.

61. **China's past rapid agricultural growth has come at increasing environmental costs.** It is estimated that the cost of environmental pollution and resource (mainly land and water) degradation in China amounts to about 9 percent of its gross domestic product (GDP), 10 times higher than corresponding levels in Korea and Japan.[12,13] The 2022 Environmental Performance Index (EPI)[14] report ranked China 160th out of 180 countries for environmental performance across 24 indicators in 10 categories: air quality, water and sanitation, heavy metals, biodiversity and habitat, forests, fisheries, climate, energy, water resources, and agriculture. The EPI shows that China lags behind many other upper MICs with comparable per capita income, such as Brazil, Mexico, Russia, and Turkey.

62. **China's transition from its current resource-intensive economy to a green economy started with a greener growth strategy in its 13th FYP (2015–20), emphasizing quality over quantity of growth and the need for green development.** This greener growth strategy is being pursued through productivity and innovation-driven development; rebalancing toward consumption and services; improving equitable access to basic public services; and adopting stringent environmental regulations. Through actions in various sectors, China has started to slow GHG emissions growth, reduce air and water pollution, improve the economy's resource efficiency, and enhance land management. But more needs to be done, including in the agriculture and rural

12 World Bank Group. 2010. *Cost of Pollution in China: Economic Estimates of Physical Damages (English).* Washington, D.C: World Bank Group. http://documents.worldbank.org/curated/en/782171468027560055/Cost-of-pollution-in-China-economic-estimates-of-physical-damages

13 World Bank and Development Research Center of the State Council, People's Republic of China. 2013. *China 2030: Building a Modern, Harmonious, and Creative Society*. Washington, D.C.: World Bank. https://openknowledge.worldbank.org/handle/10986/12925

14 The 2018 Environmental Performance Index (EPI) ranks 180 countries on 24 performance indicators across 10 issue categories covering environmental health and ecosystem vitality. These metrics provide a gauge at a national scale of how close countries are to established environmental policy goals.

development sector, which is highly vulnerable to climate change and dependent on natural resources, especially land and water.

63. **To promote green growth and sustainably address the above agricultural and rural development challenges, China adopted the National RRP(2018–35) in 2017.** The No. 1 Central Documents in 2018, 2019, 2020, 2021, and 2022 focused on rural revitalization framed around the three rurals: *agriculture, rural areas, and farmers*. The RRP is being implemented through a series of five-year rural RRS plans, which serve as the basis of the GARR PforR (Hubei and Hunan). The RRP objectives and milestones have been further elaborated in annual policy documents[15] and the *14th Five-Year Plan (2021–25) for the National Green Development of Agriculture* [16] and the *14th FYP on Municipal Solid Waste Separation and Treatment Facilities Development Plan (2021–25).*[17] The Rural Revitalization Promotion Law of April 29, 2021, provides the legal framework for implementing the RRP through phased five-year RRS plans aimed at promoting the overall upgrading of agriculture, the professional development of farmers, the modernization of agriculture and rural areas, and the revitalization of the countryside.

64. **Despite the greater prominence given to green economic development in the RRP, in practice, the government's rural revitalization and greening objectives are not fully aligned.** Central and provincial government transfers targeting rural revitalization do not consider green, low-carbon, and sustainable agriculture and rural development as their primary objectives. Instead, the bulk of agricultural support policy measures (e.g., input subsidies, guaranteed purchase schemes, subsidized credit, etc.) are still tied to farmland area, production volumes, and yields without considering their environmental costs and benefits. Critical funding gaps remain for some rural infrastructure and public services, especially rural wastewater and solid waste management, and the sustainable management of the natural capital, such as agricultural landscapes and ecosystems. While in the European Union (EU), 40 percent of agricultural support policies are now related to green agricultural development, in China, this proportion is estimated to be only 5 percent.[18]

65. **To achieve the specific targets for green, low-carbon, and sustainable agriculture and rural development objectives, there is an urgent need to develop new governance frameworks necessary for mobilizing fiscal resources (and expenditure tracking) that can be transferred to counties.** The GARR PforR (Hubei and Hunan) provides incentives for strengthening the central and provincial levels' institutional delivery mechanisms, with a sharper focus on the delivery of results related to green, low-carbon, and sustainable development of agriculture; management of agricultural ecosystems; and delivery of climate-resilient rural infrastructure and public services, while keeping the focus on poor and vulnerable households in Hubei and Hunan provinces. The GARR PforR promotes the greening of agricultural production and rural revitalization and provides additional incentives by leveraging World Bank financing to enhance the delivery efficiency and impact of RRS implementation.

66. **The GARR PforR (Hubei and Hunan) complements the Green Agricultural and Rural Revitalization Program PforR for the Guangxi Zhuang Autonomous Region ("Guangxi") and Guizhou Province (GARR PforR, Guangxi and Guizhou) approved by the Bank in March 2022 to support the implementation of the national RRP.** Building on the GARR PforR (Guangxi and Guizhou), the GARR PforR (Hubei and Hunan) adds a central component supporting the NRRA under MARA to enhance the overall central governance framework toward greener agriculture and rural development. The NRRA is an agency within MARA responsible for China's efforts to sustain and consolidate poverty alleviation gains and promote green agriculture and rural infrastructure development in rural areas. Established on February 25, 2021, it supersedes the former State Council Leading Group Office of Poverty Alleviation and Development (LGOPAD), which was mandated to coordinate the

15 The No. 1 Document issued by the Central Committee of the Communist Party of China and the State Council in 2018, 2019, 2020, 2021, and 2022 focused on green agricultural development, market reforms, and modernization of the rural economy.

16 A joint notice of MARA, NDRC, MOST, MNR, MEE, and NFGA (Nong Gui Fa [2021] No. 8) issued in August 2021.

17 Issued jointly by the Ministry of Housing, Urban, and Rural Development (MOHURD) and the NDRC.

18 World Bank. 2022. *Toward a Greener China: A Review of Recent Agricultural Support Policies and Public Expenditures*. Washington, D.C.: World Bank

eradication of extreme rural poverty. The NRRA's mandates include coordinating the transition from China's Poverty Reduction Program into the RRP (2018–35). The NRRA will coordinate the implementation of the two GARR PforRs, facilitating national and global knowledge exchange and the sharing and scale-up of good practices developed under the two GARR PforRs. In addition, it expands the geographic coverage to Hubei and Hunan provinces in the mid-reaches of the Yangtze River, which share subtropical monsoon climatic conditions to apply green agricultural and rural revitalization approaches under different agro-ecological and socioeconomic conditions, compared to the mountainous Guangxi and Guizhou settings.

67. **Hubei and Hunan provinces were competitively selected based on technical proposals submitted to the National Development Reform Commission (NDRC) and criteria agreed upon with the Bank.** The two provinces are among the largest agricultural producers (including rice, livestock, and poultry), generating large quantities of GHG emissions, such as CH_4 and N_2O, using large quantities of agricultural inputs and natural resources (land and water), and facing severe soil and water pollution challenges. Together, they contribute significantly to China's agricultural environmental footprint through (1) excessive and improper use of chemical fertilizers, (2) poor management of livestock and poultry manure, (3) poor management of aquaculture farms or ponds wastewater, and (4) degradation of agricultural ecosystems. Hubei and Hunan also have relatively large rural populations—about 37 percent in Hubei and 40 percent in Hunan, most of whom are engaged in agriculture, albeit with inadequate access to climate-resilient rural infrastructure and public services. Currently, only 25 percent of rural wastewater is properly treated and recycled in Hubei and Hunan provinces. But under the 14th FYP, the two provinces' target is to increase the overall treatment and recycling rate to 35 percent, and in demonstration villages under the program, to 85 percent.

Green Agricultural Development

68. **China's agriculture sector is one of the largest in the world**. In 2021, the country's agricultural GDP amounted to USD 1.37 trillion (constant 2010 USD), equivalent to 7.3 percent of the national GDP (USD 17.7 trillion). Over the past 40 years, China's inflation-adjusted average annual growth rate of agricultural output value and agricultural GDP was 5.3 percent and 4.5 percent, respectively, driven mainly by the growth in total factor productivity, the introduction of new technologies, and large producer subsidies, primarily for rice, wheat, and maize production. China has now surpassed the EU and the United States (US) in terms of total agricultural support,[19] which has also led to the excessive use of chemical fertilizers, resulting in significant GHG emissions, pollution, and environmental degradation. The Chinese government is implementing major policy and regulatory adjustments to reduce the agriculture sector's environmental footprint and market distortions. Accompanying these policy and regulatory shifts are broad changes in the purpose and targeting of subsidies—now decoupled from commodity production and aiming to incentivize the adoption of low-carbon, green, and sustainable agricultural practices—as well as significantly increased expenditures on the agricultural ecosystem and landscape restoration and protection programs.

69. **China is the largest emitter of GHGs as a country. Its agriculture sector accounts for 27 percent of global emissions and 13 percent of total agriculture emissions.**[20] While agricultural GHG emissions are overshadowed by those of other sectors,[21] China's agricultural sector emits about as much as the entire economy of Canada. China's agricultural sector (i.e., agriculture, land use, land-use change, and forestry [LULUCF]) accounted for 6 percent of China's GHGs, or about 667 million $mtCO_2e$, in 2019.[22,23] Of note, this footprint

19 The MOF and MARA consolidated three subsidies—the direct subsidy for grain growers, purchasing improved crop varieties, and the general subsidies for agricultural inputs—into an agricultural support and protection subsidy.

20 The main agricultural and land use change greenhouse gas (GHG) emissions are CO_2, CH_4, and N_2O.

21 China's agriculture GHG emissions are ranked fourth after electricity and heating, industry, and transportation.

22 FAO (Food and Agriculture Organization of the United Nations). 2021. "FAOSTAT Statistical Database." https://www.fao.org/faostat/en/.

23 Climate Watch. 2020. "Historical GHG Emissions." https://www.climatewatchdata.org/ghg-emissions?breakBy=sector&chartType=percentage&end_year=2018&gases=ch4&regions=CHN&sectors=total-excluding-lucf&source=CAIT&start_year=1990.

excludes indirect emissions, like those relating to fertilizer and pesticide production and on-farm energy-related emissions. It is also based on what China produces domestically, not what it consumes. The sector's footprint would be larger if it included the impacts of feed, meat, and dairy imports on the emissions of exporting countries, especially those experiencing tropical deforestation and landscape degradation like Brazil.

70. **Overall, livestock, synthetic chemical fertilizer use, and rice farming are the largest sources of agricultural GHG emissions in China in that order.** On-farm energy use comes next if its emissions are counted in the sector total. Breaking down agriculture sector emissions by type, CH_4 accounts for the highest share at 46 percent, followed by N_2O at 39 percent and CO_2 at 15 percent. Methane is 81 times more potent, and N_2O is 273 more potent than CO_2 in trapping heat in the atmosphere. After increasing for several decades, China's farm-related GHGs declined between 2016 and 2019, consistent with the decline in chemical fertilizer use. According to the Food and Agriculture Organization of the United Nations (FAO, 2021) statistics, China's GHG emissions from agricultural land peaked at 842 mtCO2e in 2016. Between then and 2019, they declined by 6 percent annually, returning approximately to their 2007 levels. However, climate models estimate that, without serious national mitigation efforts, agricultural GHG emissions in China will rise to 1,350 mtCO2e per year by 2050, driven mainly by increased livestock production in response to the growing demand for animal-based protein (due to increasing incomes, especially beef, pork, and poultry. Going forward, mitigating China's agricultural GHG emissions requires deploying a food-system approach (i.e., reducing GHG emissions along the value chains), and adopting CSA practices, which increase productivity, build resilience to climate change, and reduce GHG emissions.

71. **China's reductions of potent CH_4 and N_2O are considered critical for mitigating near-term warming, while structural changes to reduce fossil fuel dependence are undertaken.**[24] At the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 27 in November 2022, the Chinese government announced its plan to curb methane emissions from energy, agriculture, and waste.[25] Methane accounts for about half of the net rise in global average temperature since the pre-industrial era. Thus, rapidly reducing methane emissions from energy, agriculture, and waste is the single most effective strategy to limit global warming to 1.5˚C while yielding co-benefits, including improving public health and agricultural productivity. The commitment includes agriculture, where subsectors, such as rice and livestock production systems, are major contributors to methane emissions (e.g., manure management at 9 percent and enteric fermentation at 27 percent). The COP 27 participating countries also committed to moving toward using the highest tier of the Intergovernmental Panel on Climate Change good practice inventory methodologies (e.g., MRV).[27] But many participating countries (67 percent), including China, reported that MRV methodologies to track mitigation measures are either not planned or established. This presents an opportunity for the GARR PforR to support China in developing its MRV methodologies.

72. **Agriculture is China's main NPS of water pollution.** As of 2020, the government deemed that over 86 percent of China's monitored groundwater sources were unfit for human contact.[26] In comparison, China's surface waters are in far better condition and generally improving. In 2020, six of seven monitored river basins met national targets, and the worst quality waters have almost been eliminated. And yet, nearly 17 percent of surface water was still considered unsafe for human contact. Agriculture remains the leading source of nutrient pollution. In 2017, the national pollution census showed that a decade after the first survey, agriculture remained responsible for more nitrogen and phosphorus pollution than other sources, like industry. The sector accounted for nearly half (47 percent) of national nitrogen pollution and over two-thirds (67 percent) of phosphorus

24 In that respect, one noteworthy trend is that if agricultural emissions have long been dominated by CH4 (and continue to be), N2O emissions have risen faster, and fallen more slowly in recent years.

25 Stanway, David. 2022. "China announces plan to curb rising methane emissions but challenges await." Reuters, November 10. https://www.reuters.com/business/cop/china-announces-plan-curb-rising-methane-emissions-challenges-await-2022-11-09/

26 MEE (Ministry of Ecology and Environment). 2021. *Report on the State of the Ecology and Environment in China 2020*. Beijing: MEE.

pollution.[27] Agricultural sources of excess nutrients are primarily farmed animals' feces (including those generated by aquaculture operations), chemical fertilizer, and to a lesser extent, aquaculture feed and detritus.

73. **China's agriculture is also highly vulnerable to climate change.** The country faces significant climate change-related disaster risks and is ranked 87th out of 193 countries by the 2023 Inform Risk Index.[28] This ranking is driven strongly by the exposure component of risk. China has very high exposure to flooding (ranked jointly 13th), including riverine, flash, and coastal, and very high exposure to tropical cyclones and their associated hazards (ranked 6th). Projected precipitation trends show a likely reduction in rainfall across the central regions, such as in Hubei and Hunan provinces, but an increase in intensity for extreme rainfall events. The majority of China's provinces are at high flood risk. In China, flooding is the most significant driver of average annual losses to disaster. The United Nations International Strategy for Disaster Reduction Secretariat (UNISDR) estimates flood impacts at around USD 19 billion annually. Storm surge impacts also represent a major risk, costing an estimated USD 5 billion per year.[29] The nature of this risk varies by region. Still, China's central provinces, such as Hubei and Hunan, experience the highest risk in terms of vulnerable populations and agricultural vulnerability.[30]

74. **The increasing severity and frequency of extreme weather events (especially floods and droughts), rising sea levels, destruction of ecosystems, and loss of biodiversity will significantly weaken China's agricultural productive capacity.** While all of China will experience warming trends, temperature increases in China are expected to be most severe in its central (including Hubei and Hunan) and northern regions. An increase in the frequency and intensity of heat waves has already been documented in recent decades. This trend is expected to continue and lead to more frequent droughts. Two primary types of drought may affect China, meteorological (usually associated with a precipitation deficit) and hydrological (usually associated with a deficit in surface and subsurface water flow, potentially originating in the region's wider river basins). As a result, climate change will influence food production via direct and indirect effects on crop growth processes. Direct effects include alterations to carbon dioxide availability, precipitation, and temperatures. Indirect effects include impacts on water resource availability and seasonality, soil organic matter transformation, soil erosion, changes in pest and disease profiles, the arrival of invasive species, and a decline in arable areas due to the submergence of coastal lands and desertification. Across China, seasonal droughts driven by climate change could lead to substantial crop yield losses of nearly 8 percent by 2030 for its three primary crops (rice, wheat, and corn). Corn yields are likely to suffer the greatest losses, with a projected drop of nearly 20 percent of total production, followed by wheat with a 4 percent decline and rice with a 1.5 percent decline.[31]

75. **In China, farmers' and cooperatives' adoption of green technologies and practices is hampered by perverse incentives, commercial risks, and insufficient technical and advisory services.** Chinese farmers face these key challenges: (1) input-oriented subsidies encourage the overuse of more harmful chemical agricultural inputs, especially fertilizer and pesticide, in crop production; (2) CSA technologies and practices, including the use of formula fertilizer, fertigation, organic and green manure, and livestock and poultry manure treatment and recycling facilities require upfront costly investments, hence risk-averse and credit-constrained farmers are reluctant to adopt them; (3) farmers need extensive technical training and capacity building to fully

27 Gao, Shangbin. 2021. *Green Agricultural Development in China*. Unpublished background report prepared for the World Bank.

28 European Commission. 2023. INFORM Index for Risk Management. China Country Profile.

URL: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

29 UNISDR. 2014. Basic Country Statistics and Indicators: China. Geneva, Switzerland: UNISDR. https://www.preventionweb.net/countries/chn/data/

30 Huang, D., R. Zhang, Z. Huo, F.E. Mao, and W. Zheng. 2012. "An Assessment of Multidimensional Flood Vulnerability at the Provincial Scale in China based on the DEA method. *Natural Hazards*, 64(2), 1575–1586. https://link.springer.com/ article/10.1007%2Fs11069-012-0323-1

31 Tebaldi, C., and D. Lobell. 2018. "Differences, or Lack Thereof, in Wheat and Maize Yields Under Three Low-Warming Scenarios." *Environmental Research Letters* 13: 065001. https://iopscience.iop.org/article/10.1088/1748-9326/aaba48

master the details of GAP,[32] but the local institutional capacity to deliver them is limited; and (4) farmers find it difficult to recoup the costs of producing green agricultural products unless these are certified as green or organic, or registered as GI, and are sold in niche markets, where consumers are willing to pay premium prices.

Rural Revitalization

76. **After achieving its goal of eliminating extreme poverty in 2020, China is transitioning from its Poverty Reduction Program into the RRP.** Under the Poverty Reduction Program, China achieved its goal of universal coverage of paved rural roads, drinking water supply, and rural housing—dubbed the *three guarantees*. The RRP focuses on increasing access to other rural infrastructure and public services, especially solid waste and wastewater services, to improve the rural living environment. Following the guidelines issued by the State Council in 2019, improving these types of rural infrastructure at the village level is being promoted by developing spatial IVDPs representing rural service delivery compacts. Once approved by the relevant authorities, they are binding. In May 2022, the State Council released a Village Development Action Plan (VDAP), which sets out the main principles for developing rural infrastructure under the RRP. The VDAP requires spatial IVDPs, viewed as "village masterplans" and developed based on the approved "county masterplan" to guide all future investment decisions and O&M of rural infrastructure, including those to be supported by the GARR PforR. The VDAP also calls for performance evaluation of provincial and county RRP implementation.

77. **As the central agency mandated to coordinate the implementation of the RRP, the NRRA needs accurate data and information to monitor and evaluate the performance of RRP implementation at the subnational level and to inform policy decision-making.** The NRRA will provide technical guidance and financial incentives to subnational governments to promote the adoption of GAP, deliver low-carbon and climate-resilient rural infrastructure and public services, facilitate peer learning among provinces, and scale up good practices. The existing national IT platform, developed by the State Council's LGOPAD in 2014, for managing the poverty reduction program is deemed insufficient to support the RRP implementation regarding the sectoral scope and geographic coverage. Thus, under the GARR PforR, the national IT platform will be expanded to include all types of rural infrastructure and public services in its database and IVDPs. Currently, most central government fiscal transfers to finance the RRP activities at the subnational level are based on inputs. This presents an opportunity for the NRRA to incentivize county governments to improve performance through program-based and results-oriented transfers. Therefore, green tagging of program budgets and expenditures system will be established under the GARR PforR to ensure that central government transfers are made against verifiable green agriculture and climate-resilient rural infrastructure development results.

78. **China's rural solid waste collection, transfer, and treatment are much below the levels in urban areas.** In 2019, waste generation was estimated at 0.76 kilograms per capita per day (kg/capita/day) in rural areas. While urban waste collection and treatment is almost universal, in 2017, it was estimated that only 47 percent of rural waste was disposed of according to the existing national standards.[33] In 2018, MARA reported that rural solid waste was not adequately managed in at least a quarter of China's administrative villages. Open dumping was routine, and littering was ubiquitous. China is currently piloting the separation of rural solid waste at source into four categories: organics, recyclables, hazardous, and residuals. In rural areas, kitchen (organic) waste is mainly used by households as animal feed. Recyclables are partially collected outside the public service (e.g., by the informal and private sectors) due to low profit margins and long transportation distances. But residual and hazardous waste often remain uncollected, littered into the environment, placed at informal dumpsites, or burned. Separating rural solid waste at the source facilitates the collection and recycling of agricultural plastic (e.g., plastic mulch film residues, pesticide containers, and chemical fertilizer packages). The GARR PforR

32 Good agricultural practices (GAP) are a set of standards for the safe and sustainable production of crops and livestock, which is verified through voluntary audit. It aims to help farm owners maximize yields and optimize business operations, while also minimizing production costs and environmental impact.

33 China Association of Urban Environmental Sanitation. 2017, October. *The China Municipal Waste Development Report*. Beijing: China Association of Urban Environmental Sanitation.

complements a series of Bank-funded operations aimed at abating solid waste and plastic pollution in rural areas, as described in Box 1.

79. **Despite China's rural solid waste policy framework being tightened, fragmented institutional authority and responsibilities for rural solid waste services impact its implementation.** The Ministry of Housing, Urban, and Rural Development (MOHURD) is responsible for planning, construction, and O&M of solid waste management facilities; service delivery; and data and information management. The Market and Supply Cooperative, a nationwide network, handles resource recycling in rural areas. At the same time, MARA organizes agricultural waste treatment, including agricultural mulch, plastic film, and plastic packaging materials. Environmental monitoring of and compliance with solid waste management and resource recycling facilities are the responsibility of the MEE. Since several institutions have different mandates, an effective institutional coordination framework is needed to better manage rural solid waste in China, especially in rural areas. Addressing the low institutional capacity for local infrastructure planning and life cycle operation and maintenance are imperatives to closing China's urban-rural infrastructure and public services gap.

80. **Inadequate rural wastewater collection, treatment, and recycling infrastructure and services are also major concerns in China.** In 2018, China had 2.45 million villages with a total population of 580 million.[34] Simple pit latrines and flush toilets connected to septic tanks are still commonly used in rural areas. But many villagers continue to face poor sanitation and hygiene conditions because of inadequate, outdated, and/or faulty sanitary facilities. The sewage generated in these villages daily is approximately 17.6 million cubic meters (m^3). Still, the daily treatment capacity is only about 494,700 m^3, so only 2.8 percent of wastewater is treated. The untreated wastewater discharged into the environment contributes to GHG emissions (CH4 and N2O) and cause various health risks because of the higher COD, TN, TP, and NH_3-N[35] in the drinking water sources.

34 Ministry of Housing and Urban-Rural Development of the People's Republic of China. 2018. *Chinese Urban-Rural Construction Statistical Yearbook* 2018. Beijing: China Planning Press (in Chinese).

35 Ammoniacal-nitrogen (NH_3-N) is a measure for the amount of ammonia, a toxic pollutant often found in landfill leachate and in waste products, such as sewage, liquid manure and other liquid organic waste products.

Box 1. Evolution and Complementarity of International Bank for Reconstruction and Development (IBRD) Operations for Pollution Abatement in Rural Areas

Point source pollution control in China has improved through significant investment in collecting and treating domestic wastewater. But most of these improvements have occurred in urban areas where the wastewater treatment rate increased from 15 percent in 1991 to more than 95 percent in 2020. In contrast, in rural areas, challenges remain in point source and agricultural NPS pollution, giving rise to persistent pollutants driving non-compliance with water quality standards— primarily soil organic matter, nitrogen, and phosphorus. Plastic pollution, which is at the origin of the global marine plastics problem, follows similar patterns, with the plastic collection and recycling improving in cities but lagging far behind in small towns and rural areas.

Recently approved IBRD operations focus on helping the Chinese government and provincial and county authorities enhance solid and plastic waste management and wastewater treatment policies and institutions and invest in physical pollution abatement in the rural space.

The Hubei Smart and Sustainable Agriculture Project (P168061), approved in FY2020, promotes integrated environmentally- sustainable and climate-smart agriculture (CSA) and agri-food quality and safety in targeted value chains and landscapes in the Hubei Province. This includes preventing and mitigating pollution from heavy metals and agricultural plastics.

The Plastic Waste Reduction Project (Chongqing and Ningbo municipalities) (P174267), approved in FY2021, improves plastic waste management nationally and subnationally and reduces plastics pollution from municipal solid waste. This project will be followed by the China Plastic Waste Reduction Project (Shaanxi) (P176989) in FY2023, which will continue improving the policy framework while investing in plastic abatement in rural areas.

The Food Safety Improvement Project (Guangdong and Shandong) (P162178), approved in F2021, supports food safety management at national and targeted subnational levels and reduces food safety risks in selected value chains due to contamination of soil and water through a range of contaminants, including agricultural NPS pollutants and plastics.

The Yangtze River Protection and Ecological Restoration Program (Hunan and Jiangxi) (P171644), approved in FY2022, improves institutional coordination, enhances ecological protection, and reduces water pollution loads in select regions of the Yangtze River Basin, including from uncollected or mishandled rural waste and agricultural plastics. This program is followed by the Yangtze River Protection and Ecological Restoration Program for Results (Hubei) (P178338), to be approved in FY2023.

The Yellow River Basin Ecological Protection and Pollution Control Program (Henan and Shaanxi) (P172806), approved in FY2022, supports activities that improve institutional coordination, enhance ecological protection, and reduce water pollution loads in select regions of the Yellow River Basin. This includes reducing marine plastics pollution through improved collection and treatment of solid waste and improved agricultural practices. The Yellow River Basin Ecological Protection and Environmental Pollution Control Program (Gansu and Shandong) (P178401), to be approved in FY2024, promotes improved watershed management and water use efficiency to enhance ecosystem services and restore biodiversity.

The Green Agricultural and Rural Revitalization Program (Guangxi and Guizhou) (P177590), also approved in FY2022, supports the greening of selected value chains and the reduction of agricultural point and NPS pollutants, especially from overuse of chemical fertilizers and pesticides, untreated livestock and poultry manure, untreated domestic wastewater, and mismanaged solid waste, including agricultural plastics. This entails reducing agricultural plastics pollution through the improved collection, sorting, and transfer of rural solid waste and improved agricultural practices.

81. **Most rural infrastructure are prone to climate change-related disasters, especially floods and storm surges.** Technical standards would need to be strengthened for critical rural infrastructure, particularly in areas expected to be most severely affected by rising temperatures, changing precipitation patterns, or flooding. Thus, the GARR PforR will support planning and developing climate-resilient rural infrastructure (solid waste systems and wastewater facilities)[36] in vulnerable areas.

82. **The GARR PforR will endeavor to address the underlying institutional constraints for implementing green agriculture and rural revitalization in Hubei and Hunan.** This would be achieved by strengthening national and subnational (provincial and county level) institutional capacity for governance, including developing systems for resource mobilization; program budgeting and expenditure tracking; and MRV of GHG emissions (especially methane) from primary agriculture sources: manure, chemical fertilizer, and rice.

GARR PforR Provinces

83. **The GARR PforR will support adopting green agricultural and rural infrastructure development practices in the Hubei and Hunan provinces, located in the central region of China.** The two provinces have adequate fiscal space (sustainable debt ratio) to borrow from the World Bank. The two provincial governments believe that adopting GAP and CSA—to achieve the triple wins of increasing productivity, building resilience, and reducing GHG emission; restoring and protecting degraded agricultural ecosystems; and increasing access to low-carbon, energy-efficient, and climate-resilient rural infrastructure and public services are imperatives to achieving the *harmonious coexistence of man and nature*.

Hubei Province

84. **Hubei is among the top 10 economies and is a major agricultural province in China.** According to China's National Bureau of Statistics (NBS), Hubei's GDP in 2021 was CNY 5,001.29 billion (USD 781.45 billion), ranking seventh in the country, with a per capita income of CNY 86,600 (USD 13,531.25 billion), ranking ninth in the country. The total output value of agriculture, forestry, animal husbandry, and fishery in 2021 was CNY 668.19 billion (USD 104.40 billion, or about 13.35 percent of the total GDP of the province). The per capita farmer income was CNY 18,259 (USD 2,853), ranking 14th in the country. In 2020, Hubei had about 5.24 million ha of arable land, or approximately 7.30 mu/farmer (0.49 ha/farmer). The total area under irrigation was 2.97 million ha. Hubei is an important grain-producing province, including summer grain: rice, corn, sorghum, millet, and soybean. Hubei also produces several industrial crops, such as tea, fruit, cotton, oilseeds, hemp, sugar, tobacco, and medicinal plants. Hubei ranks first in rapeseed production in China. In addition, Hubei is a large livestock producer of pigs, cattle, sheep, and poultry (broilers and layers). In 2020, there were about 24,989 large-scale livestock farms in the province; the province produced about 26.31 million pigs, 1.01 million cattle, 5.33 million sheep, and 593 million poultry slaughtered for meat. Given its abundant water resources, Hubei is also one of China's largest producers of aquaculture products, comprising mainly freshwater fish, shrimp, crab, and shellfish, some integrated into the rice-fish-production systems.

85. **Being a major agricultural producer, Hubei is one of the largest users of agricultural inputs, with significant implications on its environmental footprint.** In 2020, 2.67 million tons of chemical fertilizer were used in the province, with an average application intensity of about 26.8 kg/mu (402 kg/ha) and 4.9 kg/mu (73.5 kg/ha) higher than the national average. Commercial pesticide use was about 52,000 tons. However, chemical fertilizers and pesticides' actual plant utilization rate remains low. The unused parts enter the environment through runoff, denitrification, adsorption, and erosion, polluting the soil, water, and air. Long-term excessive and improper application of chemical fertilizers have resulted in acidification, compaction, and a decrease in soil fertility, which, in turn, increased agricultural production costs and lowered the yield and quality of crops. The livestock and

36 "Climate-resilience infrastructure" refers to how well infrastructure withstands, and how quickly it recovers from, natural hazards made worse by climate change. As climate change causes disasters like floods, hurricanes, heatwaves, and wildfires to become more severe or frequent, much of rural infrastructure will need to be redesigned and rebuilt for climate resilience.

poultry industry uses large pasture areas and consumes large quantities of fodder and animal feed. In 2021, the livestock and poultry sector produced over 100 million tons of manure. At less than 80 percent, livestock and poultry manure's comprehensive utilization rate remains low. In 2021, Hubei's combined COD, NH_3-N, TN, and TP were about 729,419 tons; 16,103 tons; 98,763 tons; and 15,231 tons, respectively. In addition, Hubei generates large quantities of crop straw residues (often burned in the fields) and aquaculture wastewater, which are not adequately managed, causing air and water pollution.

86. **Although the absolute value of rural productive infrastructure investment has increased rapidly in recent years in Hubei, the relative proportion still lags behind more developed provinces, such as Jiangsu, Shandong, and Guangdong.** Only 16.2 percent of Hubei's farmers use modern agricultural equipment, such as sprinklers and drip irrigation. Only 41.7 percent of wholesale markets of agricultural products have cold storage. In addition, the quality and use efficiency of existing productive infrastructure is relatively low, while the operation and maintenance costs are high. Thus, increasing investment in rural productive infrastructure and improving its quality and use efficiency is necessary. Due to inadequate processing, marketing, and logistics infrastructure, the value addition of agricultural products is relatively low. Most agri-business entities are engaged in raw material production and/or the primary processing of products. The overall processing rate of agricultural products in Hubei is about 68 percent, of which the final processing rate (or finished agro-products) is less than 20 percent. In contrast, in the more developed provinces (e.g., Jiangsu, Guangdong, and Shandong), these rates are about 60– 90 percent.

87. **In recent years, the supply of essential public services in rural areas in Hubei has continued to increase. However, the solid waste and wastewater infrastructure are still below par.** Since 2018, Hubei has taken the lead in promulgating local standards for rural toilet improvement in China and has built and renovated about 3.76 million household toilets and 29,000 public toilets in rural areas, achieving a penetration rate of 90.15 percent of rural sanitary toilets. By the end of 2020, 150 rural waste treatment facilities have been built in Hubei Province, with a daily processing capacity of 45,600 tons, which meet the "five-point" governance standards. In addition, 897 township domestic sewage treatment plants have been built, with 10,723 kilometers (km) of main and secondary pipelines, increasing the province's sewage treatment capacity from 1.14 million tons/day to 1.7 million tons/day. However, 9.85 percent of the rural areas in Hubei still do not have sanitary toilets, and the overall rural sewage treatment rate is less than 34 percent. These basic rural public services must be improved to close the urban-rural gap and achieve the common prosperity goal.

Hunan Province

88. **Hunan is also among the top 10 economies and one of China's major agricultural production areas.** Based on China's NBS data, Hunan's total GDP in 2021 was CNY 4,606.31 billion (USD 719.74 billion), ranking ninth in the country, with a per capita income of CNY 69,300 (USD 10,828), ranking 14th in the country. In 2021, the total output value of agriculture, forestry, animal husbandry, and fisheries was CNY 751.20 billion (USD 117.38 billion, or about 16.31 percent of the province's GDP). The per capita disposable income of the farmers was about CNY 18,295 (USD 2,859), ranking 13th in the country. The province is an important producer of grains, tea, and citrus and a major producer of pigs. Its total grains (mainly rice, wheat, and corn) output is around 60 billion catties (100 million metric tons). In 2021, Hunan ranked first in the size of area planted with rice planted area in the country and second by output. The tea area reached 2.66 million mu (177,300 ha), ranking eighth in the country, and the citrus area of 5.7 million mu (380,000 hectares), ranking third in the country. The effective irrigation area was 32.93 million ha. Hunan is also a major producer of livestock and poultry. In 2021, there were 42.02 million live pigs (ranking second in the country), 4.35 million cattle, 7.75 million sheep, and 374.56 million poultry. There were about 17,657 farms with more than 500 pigs; 1,437 farms with more than 10,000 broilers; and 2,097 farms with more than 2,000 layers.

89. **Hunan's intensive agricultural production systems also use large quantities of agricultural inputs, resulting in a significant environmental footprint.** In 2021, the province's total chemical fertilizer use amounted to 2.24 million tons (ranking 11th in the country), with an average application intensity of 16.37 kg/mu

(245.55 kg/ha) and a low plant utilization rate. In addition, the province used 101,450 tons of pesticides, ranking third in the country. Hunan also used 75,998 tons of agricultural plastics, including greenhouse, mulch film, and agrochemical packaging materials. Less than a third of this amount was recovered. In the same year, the livestock and poultry manure generated amounted to about 25.18 million tons, of which only 83 percent were treated and recycled. Hunan's combined COD, NH_3-N, TN, and TP were about 653,600 tons; 20,400 tons; 99,200 tons; and 14,400 tons, respectively. Hunan also generates large quantities of crop straw residues (with significant amounts burned in the field) and aquaculture wastewater, which are poorly managed, causing air and water pollution.

90. **The greening of agricultural value chains is facing significant challenges.** Hunan's agricultural production is predominantly carried out by small farmers. Their scale of operation is relatively small, and product quality and safety assurance are difficult partly due to a lack of province-wide production standards, regulations, and guidelines; and partly due to a lack of monitoring and enforcement mechanisms. Awareness of and skills in green and modern agricultural management practices are also low. In addition, inadequate productive infrastructure, such as irrigation and drainage, processing, marketing, and logistics, is hampering the value-addition efforts for agro-products. Furthermore, the quality and use efficiency of existing productive infrastructure need to be improved, and sustainable financing of O&M costs is also badly needed. Agricultural landscapes and ecosystems are highly degraded in Hunan Province. Agricultural production areas in Hunan have been affected by heavy metal contamination (about 13 percent of arable land), mainly caused by industrial discharges of flu gas, wastewater and waste residue, and metal mine tailings. Agricultural soil quality is further affected by the overuse of agrochemicals and poor farming practices.

91. **Despite the increase in public investments in agricultural and rural infrastructure in Hunan, a large deficit still needs to be addressed.** Hunan's inadequate and aging agricultural infrastructure, such as irrigation and drainage, markets and warehouses, and cold storage and chains, constrain the transformation into green, low-carbon, and sustainable agricultural development. In addition, many facilities that help to improve rural living conditions, such as solid and wastewater management systems, are inadequate. The distribution of rural infrastructure and public services is also uneven. Hunan has tried to improve the living environment and public services in rural areas and build beautiful and livable villages. For example, Hunan has increased the number of solid waste and sewage treatment facilities in rural areas, promoted the classification of rural domestic waste, increased capacity for rural domestic waste and sewage treatment, promoted improvements in rural toilets, and improved the rural living environment. However, access to rural wastewater management services is only between 20 percent and 25 percent.

92. **Hubei and Hunan are among the large agricultural producers, large users of chemical inputs, and major polluters in China.** With only 3.9 percent of China's total farmland, Hubei produces 8.4 percent of rice, 10.3 percent of oil crops, 18 percent of freshwater aquatic products, and 5.4 percent of pork. Similarly, with only 3.1 percent of China's total farmland Hunan produces 12.6 percent of rice, 16.4 percent of rapeseed, 6.6 percent of freshwater aquatic products, and 8.2 percent of pork of the country's total outputs, ranking first in the area under rice and rapeseed production, and second in pork production nationally. In 2021, Hubei and Hunan provinces used 2.67 million and 2.24 million tons (ranking 11th in the country) of chemical fertilizer, with application intensity of 26.8 kg per mu (4.9 kg higher than the national average) and 16.37 kg per mu, respectively. Hubei and Hunan also used 52,000 tons and 101,450 tons (ranking third in the country) of pesticides. In the same year, the combined COD, NH_3-N, TN, and TP, were about 1.43 million metric tons, 36,673 tons, 196,650 tons, and 30,170 tons, respectively (Table 13).

Table 13 Agricultural pollution in 2021 (metric tons)

Province	Agricultural Subsectors	Chemical Oxygen Demand (COD)	Ammoniacal Nitrogen (NH3-N)	Total Nitrogen (TN)	Total Phosphorus (TP)
Hubei	Crops	-	5,589.30	54,019.05	6,209.61
	Livestock	719,427.59	9,700.88	41,358.45	9,680.65
	Aquaculture	93,643.50	1,455.00	4,441.50	313.50
	Total	813,071.09	16,745.18	99,819.00	16,203.76
Hunan	Crops	-	11,716.00	56,055.00	5,151.00
	Livestock	584,210.00	6,862.00	36,096.00	8,366.00
	Aquaculture	28,890.00	1,350.00	4,680.00	450.00
	Total	613,100.00	19,928.00	96,831.00	13,967.00
Total		1,426,171.09	36,673.18	196,650.00	30,170.76

93. **The two provinces also generate large quantities of GHG emissions from crops, especially paddy rice, livestock, and aquaculture production systems.** The GARR PforR presents an excellent opportunity for helping Hubei and Hunan to reduce these GHG emissions and pollutant loads.

94. **The GARR PforR aims to finance green agricultural and rural infrastructure and public services that generate substantial climate co-benefits through mitigation and adaptation measures.** It will generate climate co-benefits from mitigation measures in several ways. First, reducing GHG emissions (e.g., CO2, CH4, and N2O measured in mtCO_2e) from crop production systems through reducing chemical fertilizer use. Second, by reducing GHG emissions (e.g., removal of COD, CH_4, and NH_3-N) from the livestock and poultry production systems through the collection, treatment, and recycling of manure. Third, by reducing GHG emissions (e.g., COD, BOD, or COD5 and NH_3-N) through the collection, transfer, and treatment of solid waste and the treatment and recycling of domestic and aquaculture wastewater. Fourth, by enhancing carbon sequestration (SOC) through returning crop straw residues into the farmland soil and applying organic fertilizer as a substitute for chemical fertilizer.

95. **The GARR PforR will also generate climate co-benefits from adaptation measures. These** include (1) adopting CSA practices (e.g., increasing efficiency of irrigation water use, fertigation, and water management in paddy rice); (2) reducing food loss and waste (e.g., through village-level cold storage facilities and cold chains, improved postharvest handling technologies, and primary processing); (3) increased energy use efficiency (e.g., in primary production through new, efficient farm machinery, use of renewable energy [solar and wind power for irrigation], and in value addition, such as the conversion of biogas to energy); and (4) integrated pest management (IPM) technologies (e.g., use of pest lamps and insect glue boards, biological pesticides, and low-residue and high-efficiency pesticides). The climate co-benefits will be measured in mtCO2e of GHG emissions reduced by PforR-supported activities.

96. **While it is relatively easy to measure the GARR PforR's contribution to the generation of climate co-benefits, its impacts on biodiversity protection and restoration will be technically difficult to measure.** This is because it involves setting up sampling points in the treated and control fields and monitoring the typology and number of species throughout the GARR PforR. In addition, biodiversity improvement on farmland is usually realized toward the end of or beyond the program's implementation period. For example, experience from the Guangdong Agricultural Pollution Control Projects shows significant improvement in biodiversity (e.g., pollinators in fruit orchards and fish and amphibian species in paddy rice fields) in farmland ecosystems due to the reduction of agricultural pollutants (especially chemical fertilizers and high residue pesticides) and the promotion of IPM technologies (e.g., use of pest lamps and insect glue boards, biological pesticides, and low-residue high-efficiency

pesticides). In addition, the GARR PforR will support the restoration and protection of degraded and/or polluted agricultural ecosystems (e.g., management of acidic soils, heavy metals, and aquaculture wastewater) to enhance soil health and improve biodiversity. Using experience from the Guangdong Agricultural Pollution Project, a third-party technical agency will monitor the GARR PforR's impacts on biodiversity protection and restoration. The results will be included in the annual environmental and social monitoring reports.

97. **The reduction of pollutant loads entering waterways will also generate local environmental benefits.** These will mainly arise from the reduction of the point source and NPS water pollution (e.g., NH_3-N, COD, TN, and TP) through the reduction and efficient use of chemical fertilizer (e.g., improving application rate and improving timing and precision of application) and increased use of formula and organic fertilizer; and treatment and recycling of livestock and poultry manure, tailwater of aquaculture (or fishponds' effluent discharges) and fish-rice systems, as well as rural wastewater. One of the critical local environmental benefits would be improving water quality, with the associated improvement of health outcomes, such as reducing waterborne diseases in rural areas.

Rural Solid Waste Management

98. **Rural solid waste collection and treatment falls way behind levels in urban areas.** In 2019, waste generation was estimated at 0.76 kg/capita/day in rural areas. However, up to half of the rural solid waste may not be disposed of safely, thus becoming a major environmental pollution source.[37] While urban waste collection is almost universal, in 2017, it was estimated that only 47 percent of rural waste was disposed of according to the existing national standards.[38] In 2018, MARA reported that rural solid waste was not adequately managed in at least a quarter of administrative villages in China, where open dumping was normal and littering was ubiquitous. China is currently piloting the separation of rural solid waste into four (i.e., organics, recyclables, hazardous, residual) categories at the source. In rural areas, kitchen (organic) waste is mainly used by households as animal feed. Recyclables are partially collected outside the public service (e.g., by the informal and private sectors due to low profit margins and long transport distances). But residual and hazardous waste often remain uncollected and either littered in the environment, placed at informal dumpsites, or burned by the population. Separating rural solid waste at source would also facilitate collecting and recycling agricultural plastic (e.g., plastic mulch film residues, pesticide containers, and chemical fertilizer packages).

99. **China has put in place several policies and plans for improving rural solid waste management.** In 2015, the *Opinions on Comprehensive Implementation of Rural Solid Waste Management* issued by MOHURD and 10 other ministries required localities to establish rural waste management systems that follow the management modality of "waste collection by villages, transfer by towns, and treatment by counties." In 2018, the State Council issued the *Three-Year Action Plan for Rural Living Environment Improvement (2018–20)*, promoting the establishment of a comprehensive and diverse rural waste management system centered around waste minimization and recycling. The plan also targets 90 percent coverage of solid waste collection facilities in administrative villages nationwide by the end of 2020.[39] However, many provinces report that this target is yet to be achieved and that unauthorized dumping of waste continues at scale. Waste collection facilities (e.g., collection containers and pads) often remain idle due to the unavailable waste flow chain. The latter includes transfer stations, storage facilities, treatment facilities, and financing and institutional capacities that ensure the waste is managed holistically from generation to final placement. Recognizing these challenges, the *14th FYP on Municipal Solid Waste Separation and Treatment Facilities Development Plan* NDRC/MOHURD, 2021–25) envisages rural waste management to gradually integrate with the urban system. In June 2020, MOHURD launched a nationwide program to pilot urban-rural integrated waste management and rural waste separation in

37 World Bank. 2019. *Urban and Rural Municipal Solid Waste in China and the Circular Economy*. Washington, D.C.: World Bank.

38 China Association of Urban Environmental Sanitation. 2017. The China Municipal Waste Development Report (October 2017). Beijing: China Association of Urban Environmental Sanitation.

39 Coverage of waste collection infrastructure, (e.g., collection bins and pads), should not be confused with service coverage of the population, assessed to remain far below.

141 demonstration counties. In April 2021, MOHURD issued the *Standards for Rural Municipal Solid Waste Collection, Transfer, and Treatment*, setting up standards and technical specifications for the construction and operation of rural segregated waste collection, transfer, and treatment systems while considering diverse local conditions.

100. **Although the rural solid waste policy framework has been tightened in the past five years, enforcement remains a key challenge.** This is partly due to the fragmented institutional authority and responsibilities for rural solid waste services. MOHURD is responsible for planning, construction, and O&M of solid waste management facilities, service delivery, and data and information management. The Market and Supply Cooperative (COOP), a nationwide network, handles resource recycling in rural areas. MARA organizes the treatment of agricultural wastes, including agricultural mulch film and plastic packaging. Environmental monitoring and compliance with solid waste management and resource recycling facilities is the responsibility of the MEE. Given that several institutions have different mandates, an effective institutional coordination framework is needed to better manage rural solid waste.

101. **The Green Agricultural and Rural Revitalization (Hubei and Hunan) PforR will focus on rural solid waste collection and sorting in villages and transfer to township waste handling facilities.** The PforR will not support county-level solid waste treatment because incineration and landfills are high environmental risk activities. The PforR complements a series of Bank-funded operations to abate solid waste and plastic pollution in rural areas, as described in Box 1 above.

Rural Wastewater Management

102. **Rural wastewater collection, treatment, and recycling have increasingly become a major concern in China.** In 2018, there were 2.45 million villages in China with a total population of 580 million.[40] Simple pit latrines and flush toilets connected to septic tanks are commonly used in rural areas. But still, many villagers face poor sanitation and hygiene conditions because of inadequate, outdated, and/or faulty sanitary facilities. The sewage generated in these villages each day is approximately 17.6 million m^3, but the daily treatment capacity is only around 494,700 m^3, which means that only 2.8 percent of wastewater is treated.[41] The untreated wastewater discharged into the environment generates all kinds of health risks and NPS water pollution—due to higher content of COD, TN, TP, and ammonia nitrogen (NH_3-N).

103. **China has several policies and programs for improving rural wastewater treatment systems (WTS).** The '*Plan for Preventing Water Pollution,*' published by the State Council in 2015, requires the rural WTS to use standard design for construction and management. These unified standards have led to over-designed rural wastewater infrastructure with little prospect for recouping investment and meeting O&M costs. Rural WTS design standards must be customized to fit local conditions. The 13th FYP (2016–20) set a target for a rural wastewater treatment rate of over 60 percent[42] by the end of 2020. However, despite increased subsidies and vigorous promotions from the central government, only about 25 percent of villages in China have WTS.[43] Many of these WTS are not fully functional because of unsuitable technology, insufficient financial resources for O&M, ineffective governance structure, weak institutional capacity for enforcing effluent discharge standards, and limited public participation. Due to the scattered villages and rugged terrain in some parts of the country, the logistics of transferring large volumes of wastewater remain challenging.

40 Ministry of Housing and Urban–Rural Development of the People's Republic of China. 2018. *Chinese Urban–Rural Construction Statistical Yearbook (2018)*. Beijing: China Planning Press.

41 Ministry of Housing and Urban–Rural Development of the People's Republic of China. 2018. *Chinese Urban–Rural Construction Statistical Yearbook (2018)*. Beijing: China Planning Press.

42 In 2018, Zhejiang and Jiangsu provinces, and Shanghai and Beijing municipalities had more than 70 percent of the villages with wastewater treatment systems (WTS).

43 National Bureau of Statistics of China. 2018. *2018 China Statistical Yearbook (2018)*. China Statistic Press, Beijing

104. **The PforR II is aligned with the World Bank's Country Partnership Framework (CPF, FY2020–25) for China (Report No. 11785-CN)**,[44] which was discussed by the World Bank Board of Directors on December 5, 2019. The CPF focuses on closing the remaining institutional gaps and supporting interventions that generate significant GPGs. The PforR II supports the implementation of the October 2021 updated National Determined Contribution (NDC)[45] and is consistent with a range of recent climate policy commitments made by China, including the Glasgow Leaders' Declaration on Forests and Land Use and a joint declaration signed by China and the US in the margin of the UNFCCC COP26 providing, among other things, for incentives and programs to reduce methane from the agricultural sector.

105. **The main GPGs supported by this operation are the following (Box 2)**: (1) GHG emission reductions; (2) agricultural plastics recovery, treatment, and recycling; and (3) biodiversity conservation and protection. The GARR PforR is directly linked to Engagement Area 2 (EA2) of the CPF—Promoting Greener Growth. Under EA2, the Bank aims to support the government's efforts to (1) reduce air, soil, water, and marine plastics pollution; (2) demonstrate sustainable agricultural practices and improve agro-food products quality and safety; and (3) strengthen institutional capacity for sustainable natural resource (especially the efficient use of scarce arable land and water) management. The PforR is also aligned with the World Bank Group's Green, Inclusive, and Resilient Development framework and the World Bank Group Climate Change Action Plan (2021–25).[46]

Box 2. Contribution of the PforR to Global Public Goods

The Green Agricultural and Rural Revitalization for Results (GARR PforR) contributes to the following global public goods (GPGs): (1) reducing greenhouse gas (GHG) emissions, (2) increasing carbon sequestration in agricultural ecosystems, and (3) improving biodiversity protection and restoration.

Reducing GHG emissions. GARR PforR is expected to generate substantial climate co-benefits by implementing mitigation and adaptation measures. The climate co-benefits from mitigation measures are expected to be generated in several ways. First, by reducing GHG emissions (e.g., carbon dioxide [CO2], methane [CH4], and nitrous oxide [N2O] measured in CO2 equivalent) from crop production systems through the reduction of chemical fertilizer use and increasing the use of organic fertilizer, such as green manure, treated sludge, and compost material, as substitutes for chemical fertilizer. Second, by reducing GHG emissions (e.g., removal of COD, CH4, and ammoniacal nitrogen [NH3-N]) from livestock and poultry production systems through the collection, treatment, and recycling of manure. Third, reducing GHG emissions (e.g., N2O and CH4) from the rice-fish/shrimp co-culture crop production systems. Fourth, by sequestering carbon through the restoration and protection of agricultural ecosystems (e.g., agroforestry and grasslands restoration). Similarly, the climate co-benefits from adaptation measures are expected to be generated through the adoption of climate-smart agricultural (CSA) practices, including (1) increasing efficiency of irrigation water use, such as through fertigation; (2) improving water management in paddy rice to reduce CH4 emissions; (3) adopting IPM technologies and practices to reduce N2O; and (4) reducing food loss and waste from more efficient agricultural value chains (e.g., improved postharvest management, such as cold storage and primary processing).

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

45 China updated its nationally-determined contribution (NDC) targets to include: (1) carbon dioxide emissions will strive to peak by 2030, and strive to achieve carbon neutrality by 2060; (2) by 2030, China's carbon dioxide emissions per unit of GDP will drop by more than 65 percent compared with 2005; (3) the proportion of non-fossil energy in primary energy consumption will reach about 25 percent (4) the forest volume will increase by 6 billion cubic meters compared with 2005; and the total installed capacity of solar power generation will reach more than 1.2 billion kilowatts.

46 Alignment with GRID (https://openknowledge.worldbank.org/bitstream/handle/10986/36322/Green-Resilient-and-Inclusive-Development.pdf?sequence=5) and the Climate Change Action Plan 2021–25 (https://openknowledge.worldbank.org/handle/10986/35799 License: CC BY 3.0 IGO) is seen in the PforR's focus on environmental sustainability objectives, while increasing resilience to climate change threats, mitigating emissions, and promoting inclusivity in economic opportunities.

Increasing carbon sequestration in agricultural ecosystems. Adopting agroforestry practices, improving the management of forests and grasslands, and returning crop straw residues to the farmland supported under the GARR PforR will significantly increase carbon sequestration above- and belowground and reduce GHG emissions by not burning the crop straw residues in the fields. It will also increase soil organic carbon (SOC); improve soil health (e.g., higher water retention, cation exchange, and nutrient absorption capacity); and promote a rural circular economy, such as better utilization of crop residues, which would, in turn, help reduce emissions intensity.

Improving biodiversity protection and restoration. Hubei and Hunan are part of the Yangtze River Basin, a globally-significant biodiversity hotspot, as its waterways, floodplains, and wetland systems provide habitat to various endangered species. The GARR PforR will indirectly contribute to the protection and restoration of the biodiversity through the reduction of point and nonpoint source (NPS) pollution (especially from high toxicity and high residue pesticides, and treatment and recycling of livestock and poultry manure, as well as domestic wastewater); promotion of IPM technologies and practices (e.g., use of pest lamps and insect glue boards, biological pesticides, and low-residue, high-efficiency pesticides); and the ecological management and recycling of tailwater from intensive aquaculture systems and rice-fish production systems.

The activities under the GARR PforR also contribute to improving food safety and reducing health risks related to China's large food exports through improved market infrastructure and livestock rearing and handling practices that help to reduce the risk of zoonotic diseases. Widely sharing global knowledge, such as methodologies for measuring GHG emissions reduction from chemical fertilizer, livestock and poultry manure, and paddy rice production systems, can also help. These impacts are not central to the theory of change of the GARR PforR and, thus, will be monitored separately.

106. **The GARR PforR aims to finance green agricultural and rural development activities that generate substantial climate co-benefits through mitigation and adaptation measures.** The PforR will generate climate co-benefits from mitigation measures in several ways. First, reducing GHG emissions (e.g., CO2, CH4, and N2O mtCO2e) from crop production systems through reducing chemical fertilizer use. Second, by reducing GHG emissions (e.g., removal of COD, CH4, and NH3-N) from the livestock and poultry production systems through the collection, treatment, and recycling of manure. Third, by reducing GHG emissions (e.g., COD, BOD, or COD5 and NH3N) through circular economy practices, including the efficient use of treated wastewater, such as reuse for irrigation to build resilience to drought, use of treated sludge and compost material as a replacement of chemical fertilizer, and use of nature-based solutions, such as retention ponds or constructed wetlands to filter pollutants from the rural solid waste and wastewater. Fourth, by supporting the collection, transfer, and recycling of agricultural plastics (e.g., mulch film residues, pesticide, and chemical fertilizer packages) and using biodegradable mulch film. Fifth, by enhancing soil carbon sequestration through returning crop straw to farmland and organic fertilizer application for soil fertility improvement of polluted farmland. The GARR PforR will also generate climate co-benefits from adaptation measures. These include: (1) adoption of climate-smart agriculture practices (e.g., recycling of crop straws/residues, increasing efficiency of irrigation water use, fertigation,47 and water management in paddy rice); (2) reducing food loss and waste (e.g., through village-level cold storage facilities and cold chains, improved postharvest handling technologies, and processing); (3) increased energy use efficiency (e.g., in primary production through new efficient farm machinery, use of renewable energy (solar and wind power for irrigation), and in value addition, such as the conversion of biogas to energy); and (4) restoring and protecting agro-ecosystems (polluted farmland conservation and tailwater ecological management and recycling utilization of aquaculture systems). The climate co-benefits will be measured in CO2 equivalent of GHG emissions reduced from PforR-supported activities.

47 Fertigation is the injection of fertilizers, used for soil amendments, water amendments and other water-soluble products into an irrigation system. Fertigation is related to chemigation, the injection of chemicals into an irrigation system.

107. **While it is relatively easy to measure the PforR's contribution to the generation of climate co-benefits, its impacts on biodiversity protection and restoration will be difficult to measure.** However, experience from the Guangdong Agricultural Pollution Control Project shows significant improvement in biodiversity (e.g., pollinators in fruit orchards and fish and amphibian species in paddy rice fields) in farmland ecosystem due to the reduction of agricultural pollutants (especially chemical fertilizers and high residue pesticides) and the promotion of IPM technologies (e.g., use of pest lamps and insect glue boards, biological pesticides and low-residue high-efficiency pesticides). Meanwhile, the PforR will support polluted farmland and water ecosystem restoration and protection (e.g., crop straw application, lime application, tailwater ecological treatment, and recycling utilization). The degraded and polluted farmland (acidified and heavy metal pollution) restoration can enhance soil health for biodiversity improvement, and tailwater ecological treatment of aquaculture systems can improve water biodiversity in wetlands, lakes, and rivers.

108. **The reduction of pollutant loads entering waterways will generate local environmental benefits.** These will mainly arise from the reduction of point source and NPS water pollution (e.g., COD, TN, and TP) through the reduction and efficient use of chemical fertilizer (e.g., improving application rate, improving timing and precision of application) and increased use of formula and organic fertilizer; and treatment and recycling of livestock and poultry manure, tailwater of aquaculture and fish-rice systems, as well as rural wastewater. One of the key local environmental benefits would be improving water quality, with associated improved health outcomes, such as reducing waterborne diseases in rural areas.

109. **The PforR draws lessons and experience from Bank-financed agricultural and rural development projects in China and the Transforming Rural China study.** These include ongoing or recently closed projects in sustainable agriculture (Hubei Sustainable and Smart Agriculture Project [P168061] and Climate-Smart Staple Crop Production Project [P144531]); agricultural pollution control (Hunan Integrated Management of Agricultural Land Project [P153115] and Guangdong Agricultural Pollution Control Project [P127775, TF018176]); value chains development (Jiangxi Farm Produce Distribution System Project [P147009]; agriculture finance (Henan Green Agriculture Finance Project [P169758]) and food quality and safety (China Food Safety Improvement Project [P162178]). These projects are piloting new, sustainable agricultural practices through a combination of technical assistance, public investment, green finance, and matching grants to farms and cooperatives. The PforR II also builds on the long history of Bank involvement in poverty alleviation/reduction (Guangxi Poverty Alleviation Project [P153892], Shaanxi Poor Rural Areas Community Development Project [P153541], Poverty Alleviation in Poor Areas Project [P133326] International Poverty Reduction Center in China (IPRCC), Sichuan, Gansu, and Guizhou provinces, Guizhou Rural Development Project (P133261) and the Guangxi Poverty Reduction PforR [P163138]) which have helped to target central and provincial budget transfers to achieve more significant impact in poverty reduction, including by pooling funds from various budget lines at the local level and introducing the PforR instrument. The design of the PforR is also informed by the recently completed studies undertaken as part of the Bank's Programmatic Advisory Services and Analytics (PASA) on *Transforming Rural China – Greening Agricultural Modernization*. The studies undertaken under the PASA include: (1) Toward a Greener China – A Review of Recent Agricultural Support Policies and Public Expenditure; (2) Rural Transformation and Policies in China; (3) An Overview of Degradation and Restoration of Ecosystems and Landscapes in China; (4) Agricultural Water Use Efficiency Experience in China; (5) Analysis of Farmland Policy for Greening Agricultural Modernization; (6) Challenge of Agricultural Pollution in China; and (7) Promoting a New Agricultural Research and Development Strategy for Greener Development in China.

110. **The proposed GARR PforR presents an opportunity for the Bank to leverage this experience to bring poverty reduction and sustainable agricultural practices together in one design while helping the government improve the effectiveness and results orientation of its RRS.** The value added of the Bank lies in introducing greater results focus on the substantial public investments made in rural areas and in helping to improve the coherence of activities across multiple agencies involved in implementing the rural revitalization strategy (RSS). The PforR instrument is thereby capitalizing on the evolving national and provincial policy

frameworks (e.g., eco-compensation)[48] for results-based fiscal transfers to improve a range of environmental outcomes. In leveraging budget resources under the RSS, the PforR instrument provides geographical coverage beyond that possible under the standard Investment Project Financing instrument. A key contribution of the operation is strengthening institutional capacity and developing governance frameworks (e.g., MRV methodology for carbon emission reduction and sequestration in agricultural and rural areas for a more accurate report of carbon peak and net zero of agriculture sectors; regulations, standards, and guidelines for green development; and program budgeting, expenditure tracking, and M&E and verification of results) for implementing the RRS plan, which can be rolled out throughout the country or to other provinces (i.e., beyond the geographic boundaries of PforR's participating counties). The PforR instrument can also help the government repurpose its agricultural subsidies toward achieving green and sustainable agricultural development. Hubei and Hunan have requested Bank support based on the positive track record of past projects to help them increase the impact of their substantial RRS-related commitments.

111. **The proposed GARR PforR complements other Bank-supported operations in managing solid waste and water resources prepared under the current CPF.** The China Plastic Waste Reduction Project (P174267), approved in June 202, builds on the tightened national framework for solid waste management to support plastic waste avoidance, separation, and recycling in two pilot cities, Chongqing and Ningbo. This work is now being extended to rural areas under a follow-up operation (P176989), planned for board presentation in FY2023. The GARR PforR complements this work by focusing on the avoidance and improved collection of plastic waste at the farm and village levels. Issues of NPS pollution of waterways are also addressed in the Yangtze River Protection and Ecological Restoration project (P178338), approved by the board in December 2021, and the Yellow River Resilience Program (P172806). These operations focus on the inter-jurisdictional coordination issues involved in pollution abatement at the river basin level. The GARR PforR moves further upstream to work directly with farmers on adopting greener agricultural production practices. The parallel and focused engagement on related issues working at the farm, village, county, province, and river basin levels provides significant opportunities for knowledge exchange and learning that will facilitate the scaling up of successful experiences to the national level.

112. **Hubei and Hunan regional/provincial leaders are committed to addressing the environmental challenges related to the overuse of chemical fertilizer and toxic pesticides; improper management of livestock and poultry manure, unreasonable utilization of crop straw, farmland pollution (e.g., heavy metal pollution and soil acidification); and inadequate recovery and recycling of agricultural plastics in the agricultural sector.** The two provinces' leadership have also expressed their commitment to addressing the challenges related to underdeveloped rural solid waste and wastewater services. These commitments are presented in Hubei's and Hunan's "proposals on comprehensively promoting rural revitalization and accelerating agricultural and rural modernization." This presents an opportunity for the Bank to support the two provincial governments' efforts to promote green agricultural and rural development activities through results-based financing.

113. **Hubei and Hunan are among the large agricultural producers, users of chemical inputs, and polluters in China.** With only 3.9 percent of China's total farmland, Hubei produces 8.4 percent of rice, 10.3 percent of oil crops, 18 percent of freshwater aquatic products, and 5.4 percent of pork of the nation's total output. Similarly, with only 3.1 percent of China's total farmland, Hunan produces 12.6 percent of rice, 16.4 percent of rapeseed, 6.6 percent of freshwater aquatic products, and 8.2 percent of pork of the country's total outputs, respectively; ranking first in the area under rice and rapeseed production, and second in pork production in the

48 Eco-compensation is a system of payments for ecosystem services (PES). It aims at incentivizing local governments, private and state-owned enterprises, and farmers to adopt better environmental management practices to protect ecosystems. The Sloping Land Conversion Programme (SLCP), or the "Green for Grain" scheme in China is one of the largest PES in the developing world, with a total investment of more than USD 69 billion. Its initial goal was to reduce soil erosion, deforestation, and flood risk by restoring forest and grasslands. The scheme operates through cash transfers to farmers, in return for reforesting marginal agricultural land. Payments are made only after verification that the trees planted have at least 85 percent survival rate. Additional subsidies are available for specific species of trees.

nation. In 2021, Hubei and Hunan provinces used 2.67 million and 2.24 million tons (ranking 11th in the country) of chemical fertilizer, with application intensity of 26.8 kg per mu (4.9 kg higher than the national average) and 16.37 kg per mu, respectively. Hubei and Hunan also used 52,000 tons and 101,450 tons (ranking third in the country) of pesticides. In the same year, the reported combined COD, NH_3-N, TN, and TP were about 1.43 million metric tons; 36,673 tons; 196,650 tons; and 30,170 tons, respectively. The two provinces also generate large quantities of GHG emissions from the crop, especially rice paddy, livestock, and aquaculture production systems. The GARR PforR presents an excellent opportunity for helping Hubei and Hunan to reduce these GHG emissions and pollutant loads.

114. **Hubei is China's largest province for freshwater aquaculture, with great potential for nutrient load and GHG reduction through tailwater management.** Hubei and Hunan are typical water network regions in China, especially Hubei Province. Freshwater aquaculture in agricultural areas has developed rapidly, and the output of freshwater products has ranked first in China for 25 consecutive years. The province's per capita consumption of aquatic products has increased by 21.4 percent from 2015 to 2020, and still shows a rapidly increasing trend. Compared with 2001, the total output of freshwater aquaculture in Hubei Province in 2020 has increased by 1.4 times, accounting for more than 15.0 percent of the total output of freshwater aquaculture in the country. In 2020, the area of pond aquaculture in agricultural areas of the province will be 7.89 million mu, accounting for more than 20 percent of the total area of pond aquaculture in the country. It will expand from more than 100,000 mu in the initial stage in 2005 to 7.91 million mu in 2021, accounting for more than 20 percent of the rice field area in the province, of which the rice-shrimp model accounts for more than 20 percent of the comprehensive planting and breeding of rice fields in the province. The discharge of water pollutants from freshwater aquaculture is more serious. Taking Hubei Province as an example, the contribution of freshwater aquaculture to the agricultural source COD and NH_3-N emissions of the province is 17.1 percent and 12.0 percent, respectively, far higher than the national level. In addition, the 10 project counties selected by the province have particularly serious water pollutant emissions from aquaculture. Their contribution to the total emissions of COD and NH_3-N from their agricultural sources has reached 29.1 percent and 20.4 percent, respectively, with tremendous pressure and potential for pollution reduction.

B. Technical Soundness

RA1 - Strengthening Institutional Capacity for Governance

115. **RA1 aims to put in place governance and training, and capacity-building frameworks needed to enhance the effectiveness of the government's RRS plans.** At the central level, the NRRA will implement activities under RA1.1. These include (1) developing a national IT-based platform for mapping and M&E of rural infrastructure and public services delivery and (2) developing methodologies for MRV of GHG emissions reduction from the primary agriculture sources. Developing a national IT-based platform would entail expanding the functions of the existing National Poverty Reduction Monitoring Platform, developed by the LGOPAD, the predecessor of the NRRA. The IT-based platform was developed about 10 years ago to accurately target government support for poor villages and extreme poverty households. Currently, the upgraded platform tracks vulnerable rural households with a high risk of falling back into extreme poverty.

116. **The State Council issued a VDAP in May 2022, which sets out the main principles and implementation measures for developing rural infrastructure and highlights key types of infrastructure to be covered under the RRP.** The GARR PforR focuses on activities covered under the VDAP, including developing the spatial IVDPs and constructing WWTFs and solid waste collection and transfer systems. The VDAP calls for making IVDPs binding, establishing a pipeline project management system, and improving the mechanisms for the O&M of rural infrastructure assets. The VDAP also emphasizes enhancing the performance evaluation of the implementation of RRP activities. Therefore, it will be necessary for the IT-based platform to be aligned with the evolving strategy, policy objectives, and implementation measures of rural revitalization; cost-effectiveness in the data collection, analyses, and reporting processes; cognizant of the institutional capacity-building needs of the county governments. It is also an opportunity for integrating and streamlining the

governments' business processes, such as THE IBMS, by the Departments of Finance (DOFs), the investment project management system by Development and Reform Commissions (DRCs), and the digital mapping and integrated planning system by Ecology and Environment Bureaus and natural resource bureaus (NRBs).

117. **Since the government program is transitioning from eliminating extreme rural poverty to rural revitalization, the NRRA plans to further upgrade the IT-based platform.** The geographic coverage will be expanded from poverty-stricken villages to all villages in China, and the functions will be expanded from basic infrastructure and social services to all rural infrastructure and public services. Specifically, the NRRA will do the following: (1) expand the village data to cover non-poverty villages and non-poverty households; (2) add data and information on the spatial IVDPs; (3) add modules on rural infrastructure (especially solid waste and wastewater services) and living environment based on the needs identified in the IVDP approved by county/city authorities (with data inputs done at village or county levels); (4) pilot the IT-based platform under the GARR PforR in administrative and traditional villages of the 25 participating counties/cities and some villages in the eastern and western provinces under the government program; (5) ensure smooth data and information exchange between the IT-based platform and other central government agencies (MARA, MOHURD, MEE, MWR, MNR etc.); (6) ensure adequate household and sensitive data security and confidentiality; and (7) ensure that the system is generating regular automated reports and it is used for decision-making on rural infrastructure investment and O&M activities.

118. **At the central level, the NRRA will also coordinate the development of MRV methodologies for GHG emissions reduction from three main agriculture sources**: livestock and poultry manure, chemical fertilizer, and paddy rice. These MRV methodologies are critical for the success of the GARR PforR because these will be used to measure the PDO-level indicator on GHG emissions reduction at the midterm and end of the program and will be used to measure GHG emissions reduction to facilitate agricultural carbon trading in the two program provinces. The NRRA will be responsible for hiring a reputable research and/or academic institution to develop and pilot the MRV methodologies in the 23 program counties. The NRRA will set up a panel of experts to provide technical guidance and quality control of the MRVs development process. The Bank team will provide much-needed technical assistance by bringing in international experts. Once developed, Hubei and Hunan provinces will ensure the MRV methodologies are used in the 23 program counties. MARA and the two program provinces (Hubei and Hunan) can roll out or upscale the MRV methodologies nationwide or province-wide, respectively.

119. **The IT-based platform for mapping and M&E of rural infrastructure and public services is a decision-support tool for future investment and O&M of the facilities.** Its successful development by the NRRA and adoption for implementation by program provinces and counties/cities will become disbursement-linked indicators (DLI). Similarly, the MRV methodologies for agricultural GHG emissions reduction will help to accurately measure and report the sector's contribution to achieving China's carbon peaking goals by 2030 and net zero by 2060. The successful development of MRV methodologies at most two years after the GARR PforR effectiveness and adoption by program provinces and counties/cities will become a program action plan (PAP). The NRRA will be solely responsible for hiring a third-party VA to verify the achievement of results under DLI1.1.1 and DLI1.1.2 and the PAP under RA1.1 (i.e., the MRV methodologies) reported by the 23 program counties.

120. **At the provincial level, the relevant departments will be responsible for implementing four main activities (RA1.2):** developing a national IT-based platform for mapping and M&E of rural infrastructure and public services delivery and developing MRV methodologies of GHG emissions reduction from the main agriculture sources. At the provincial level, these will include: (1) developing regulations, standards, and guidelines for GAPs and delivery of rural infrastructure and public services; (2) implementing the IT-based platform for mapping and M&E of rural infrastructure and public services delivery; and (3) establishing frameworks for nurturing green development skills and talents.

121. **The program budgeting and expenditure tracking frameworks are tools for the transparent allocation of fiscal resources based on delivering verifiable results; and for enhancing the accountability**

of public expenditures. The provincial regulations, standards, and guidelines will strengthen the legal framework for green agricultural technologies and innovations and the mechanisms for regulating agricultural inputs and livestock and poultry waste management. Similarly, developing green skills and talents is key to accelerating the adoption of GAPs to reduce environmental footprint. The development, adoption, and use of outputs under activities (1) and (2) will become DLIs under RA2.

122. **RA1 will strengthen institutional capacity at all levels and enhance the efficiency, effectiveness, and impact of public expenditures by linking the disbursement of funds to the achievement of specific results.** Through the PforR instrument, the fiscal transfers from the central and provincial governments to counties and rural areas will directly be linked to monitorable and verifiable results, including the amount or proportion of (1) reduced use of chemical fertilizer; (2) increased treatment and recycling of livestock and poultry manure; (3) increased safety utilization rate of polluted farmland; (4) reduced toxic pesticide application; and (5) increased collection, treatment, and recycling of solid waste and wastewater in rural areas. The PforR instrument is capitalizing on the evolving national and provincial policy frameworks (e.g., eco-compensation) for results-based fiscal transfers related to point and NPS water pollution control, GHG reduction, increased water use efficiency, improved soil health and food safety, and improved landscape and ecosystem management, among others.

123. **Similarly, capacity building for administrating rural infrastructure and public services is integral to strengthening governance for rural revitalization.** The central and provincial governments have significantly increased investment in rural infrastructure and public services. However, the capacity for investment planning, implementation, and O&M of rural infrastructure and public services, especially concerning wastewater and solid waste systems, is relatively weak. This includes inadequate qualified and experienced staff, poor incentive mechanisms, insufficient budget allocations, and a lack of performance evaluation systems. The GARR PforR will help the provincial and county/city governments strengthen their capacity through training local technical and administration officials, especially in areas that enhance the solid waste and wastewater services' delivery and management systems, to improve the livable environment and reduce pollution in rural areas.

Results Area 2 - Promoting green agricultural value chains development

124. **The main objectives of RA2 are to increase rural incomes (farm and off-farm) and promote environment-friendly agricultural production practices.** The RA2 will promote GAP and CSA practices in selected value chains (e.g., rice, rapeseed, vegetable, and fruit). The aim is to further increase productivity and food quality, build resilience to climate change and reduce pollution loads and GHG emissions. Activities under RA2 include (1) Reducing the use of chemical fertilizer and toxic pesticides and treating and recycling livestock and poultry wastes, especially manure and urine; (2) Adopting CSA practices—that aim at increasing productivity, building resilience, and reducing GHG emissions (CO_2, CH_4, and N_2O) from crop, livestock, and aquaculture production systems; (3) Training members of the FCs, FAs, WUAs, input suppliers, agro-enterprises, and village extension staff; and (4) Implementing the MRV methodologies for the GHG emissions reduction from major agriculture sector sources—to be developed by a national institution under RA1.1.

Chemical Fertilizer Use

125. **In China, the total use of agricultural chemical fertilizers has shown a negative growth trend for five consecutive years since 2015, with an average annual decrease of about 2.6 percent.** Chemical fertilizer application intensity dropped from 369.9 kg/ha in 2015 to 313.5 kg/ha in 2020. The utilization rate for major crops reached 40.2 percent, an increase of 7.2 percentage points over 2013. By 2025, the utilization rate of chemical fertilizers for major crops is projected to reach 43 percent.

126. **In Hubei and Hunan, however, the chemical fertilizer intensity is significantly above the national average.** In 2020, the pure amount of agricultural chemical fertilizers used in Hubei and Hunan were 2.673 million tons and 2.237 million tons, respectively. In 2020, the chemical fertilizer application intensity of major crops in

Hubei was about 319 kg/ha for rice and 270 kg/ha for rapeseed; more than 302 kg/ha for wheat, 391 kg/ha for fruit, and 547 kg/ha for vegetables. The chemical fertilizer application intensity of major crops in Hunan was about 282 kg/ha for rice and 224 kg/ha for rapeseed; more than 645 kg/ha for fruit and 742 kg/ha for vegetables. Hubei and Hunan also used 52,000 tons and 101,450 tons (ranking third in the country) of pesticides.

127. **These high rates of chemical fertilizer application cause significant NPS pollution in waterways and contribute to GHG emissions and climate change.** In addition, the high fertilizer application intensity is a major concern to food safety. The reported combined COD, NH_3-N, TN, and TP from the agriculture sector were about 1.43 million metric tons, 36,671 tons, 196,650 tons, and 30,171 tons, respectively, from agricultural sectors. The two provinces also generate large quantities of GHG emissions from the crop, livestock, and aquaculture production systems. The GARR PforR presents a great opportunity for helping Hubei and Hunan to reduce these GHG emissions and pollutant loads.

128. **China has put in place national and provincial policies, regulations, standards, and guidelines for chemical fertilizer reduction and efficiency enhancement.** A “zero growth” in chemical fertilizer use was adopted under the 13th FYP. The goal was to promote the green development of agriculture. The central government also issued a series of policy documents to promote reducing chemical fertilizer use and increasing efficiency or utilization rate. In 2015, MARA issued the National Agricultural Sustainable Development Plan (2015–30). In 2017, the State Council issued the Opinions on Innovative Systems and Mechanisms to Promote Green Agricultural Development. In 2018, MARA issued Technical Guidelines for Agricultural Green Development (2018–30). In 2020, six ministries and commissions jointly issued the Action Plan for the Tough Battle of Agricultural and Rural Pollution Control (2021–25). In 2020, a notice of work on Doing a Good Job in the Replacement of Chemical Fertilizer with Organic Fertilizer Pilot Program in Fruit, Vegetable, and Tea was launched. In 2021, MARA and five other national agencies jointly issued the 14th FYP for the National Agricultural Green Development.

129. **At the subnational level, Hubei and Hunan have also issued a series of regional/provincial policies, regulations, and development plans.** These include the Action Plan for Chemical Fertilizer Reduction and Use Efficiency Improvement in Hubei (2021), the 14th FYP for Promoting Agricultural and Rural Modernization in Hubei, the Agriculture Sustainable Development Plan (2016–30) in Hubei, the Action Plan of Pesticide Reduction in Hunan (2020), key works of green agriculture and rural development in Hunan (2020), and the 14th FYP for Promoting Agricultural and Rural Modernization in Hunan. Table 14 indicates the intensity of chemical fertilizer application on major crops in Hubei and Hunan compared to the national average in 2020.

Table 14 Chemical fertilizer application intensity of major crops in 2020 (kg/ha)

	Rice	Wheat	Corn	Rapeseed	Fruit	Vegetable	Field crops
China	347.4	425.0	374.6	246.5	829.0	643.7	348.3
Hubei	319.1	301.7	365.9	269.9	391.8	546.6	314.1
Hunan	281.5	--	--	223.8	644.6	741.7	252.7
Mean					**581.2**		**283.4**

Source: Compilation of national agricultural product cost-benefit information

130. **China has developed technical approaches and practices for fertilizer use reduction and efficiency enhancement.** Four technical approaches are commonly used to achieve these goals. The first is to promote precise fertilization. Based on the different agroecological soil conditions, crop yield potential, and comprehensive

nutrient management requirements, the fertilization rates (kg/area) for each region/agroecological zone and crop type are established to reduce the overuse of chemical fertilizers. The second is to adjust the composition of fertilizer use. The ratio of nitrogen (N), phosphorus (P), and potassium (K) are optimized to promote the interaction of macro-elements and medium and trace elements. The optimization and upgrading of fertilizer products are complemented by high-efficiency chemical fertilizers. The third is to improve the fertilization method. This includes undertaking soil testing and developing formula fertilizers, mechanical deep placing of chemical fertilizer, integrating irrigation water and soluble chemical fertilizer (fertigation), using slow-release and high-efficiency fertilizers, and foliar fertilizer application. The fourth is to replace chemical fertilizers with organic fertilizers. This includes utilizing organic nutrient resources and replacing some chemical fertilizers with organic fertilizers. The soil fertility and structure are improved by returning crop straws and residues to fields, planting green manure, and using biogas and organic fertilizer from treated livestock and poultry manure.

131. **The national and regional/provincial levels' chemical fertilizer use reduction and efficiency enhancement estimates are mainly based on field experiments.** By soil testing and applying formula fertilizer in experimental fields, the fertilizer utilization rate of main crops can be estimated by monitoring fertilization rates and crop yields and accounting for crop nutrient utilization. In addition, the amounts of chemical fertilizer reduction due to substituting green technologies, including formula fertilizer, organic fertilizer, fertigation, and green manure, are estimated using established coefficients for the program provinces (see Table 14).

Table 14 Reduction in chemical fertilizer by substitute technologies

Technical Approach	Hubei Province (pure tons)	Hunan Province (pure tons)
Formula fertilizer (ha)	0.063	0.05
Organic fertilizer (tons)	0.025	0.025
Fertigation (ha)	0.19	0.28
Green manure (ha)	0.09	0.08

132. **Under this program, in 23 counties in both Hubei and Hunan, the cumulative reduction in chemical fertilizer by substitute technologies is shown in the following tables.**

Table 15 Cumulative reduction in chemical fertilizer by substitute technologies in program counties (in pure tons)

	2024	2025	2026	2027	2028	Total
Hubei	2,455.43	4,984.23	7,589.36	10,286.91	13,045.17	38,361.10
Hunan	5,651.44	11,009.75	15,970.88	20,593.56	24,950.03	78,175.64

Table 16 Implementation of substitute fertilizing technologies in program counties

	2024	2025	2026	2027	2028	Total
Annual increase in organic fertilizer application (tons)						
Hubei	57,200	58,400	59,400	61,400	62,500	298,900

Hunan	143,394	133,594	123,594	117,694	112,794	631,070
Annual increase in formula fertilizer application area (ha)						
Hubei	5,986.67	6,080	6,173.33	62,73.33	63,86.67	30,900
Hunan	17,580	17,346	15,982.33	15,770.33	14,013	80,691.67
Annual increase in fertigation area (ha)						
Hubei	626.67	704	785.33	833.33	860	3,809.33
Hunan	1,337.67	1,307	1,320.67	1,200	1,084	6,249.33
Annual increase in green manure planting area (ha)						
Hubei	5,880	6,133.33	6,466.67	6,766.67	7,000	32,246.67
Hunan	10,163	9,815	8,779.67	6,947.67	6,655.67	42,361

Livestock and Poultry Manure Management

133. **By the end of 2021, the national stock of live pigs, cattle, sheep, and poultry was 449.22 million, 98.17 million, 319.69 million, and 6.79 billion, respectively.** Through MARA's implementation of measures to increase the utilization of livestock and poultry manure resources, the national comprehensive utilization rate of manure was more than 76 percent. The supporting rate of facilities and equipment of large-scale livestock farms reached 97 percent.

134. **During the 13th FYP, the General Office of the State Council issued the *Opinions on Accelerating the Resource Utilization of Livestock and Poultry Breeding Wastes*.** MARA issued the Specifications for the Construction of Facilities for the Resource Utilization of Manure in Large-scale Livestock and Poultry Farms; the Livestock and Poultry Waste Resource Utilization; and the Poultry Manure Land Carrying Capacity Calculation Technical Guidelines. In addition, MARA, jointly with the MEE, issued the Assessment Method for the Resource Utilization of Livestock and Poultry Breeding Wastes.

135. **In 2021, MARA issued the 14th FYP for the Combined Construction of National Livestock and Poultry Manure Utilization, Planting, and Breeding.** The plan focuses on returning and utilizing the livestock and poultry manure in the field, improving facilities and equipment, and strengthening the extension services. The plan aims to integrate crop production and animal breeding RRS implementation. By 2025, the plan targets to support more than 250 pilot counties to construct livestock and poultry manure treatment facilities, establish demonstration bases for returning manure to fields (including five in Hubei and four in Hunan), and promote the use of composted manure and liquid manure in accordance with local conditions. The plan also intends to support the construction of manure storage facilities and promote the biogas fertilizer return to the field and other technical models; and the construction of manure and sewage transportation pipeline networks. MARA strives to reach more than 80 percent nationwide comprehensive utilization rate of livestock and poultry manure by 2025.

136. **Technologies for livestock and poultry manure resource utilization are in place.** They are based on the *Typical Model of Resource Utilization of Livestock and Poultry Manure* issued by the Department of Animal Husbandry of the Ministry of Agriculture on March 22, 2017. It mainly includes the following models: (1) full collection and return of manure, (2) specialized energy utilization of manure, (3) solid manure composting, (4) Ectopic fermentation bed, (5) fecal bedding reuse, and (6) sewage standard discharge models. Hubei prefers solid manure composting models, sewage standard discharge models, and full collection and return of manure to the farmland as the main technologies for the resource utilization of livestock and poultry manure. Hunan opts mainly for the sewage standard discharge models, solid manure composting, specialized energy utilization, and full collection and return of manure to the field (water and fertilizer integration model) models.

137. **Hubei has clear baseline and target values for treating and recycling livestock and poultry manure.** In 2021, the total livestock and poultry manure generation in the nine program counties (one of the program counties, Xiantao, will not implement this action) was 10.30 million tons, of which 9.44 million tons were treated and reused, with a comprehensive utilization rate of manure reaching 89 percent. The rate for large-scale farms is 94 percent. Of the total amount of manure generated, about 6.99 million tons came from large-scale livestock and poultry farms, of which about 6.54 million tons were treated and reused, with a comprehensive utilization rate reaching 94 percent. By 2027, Hubei is targeting to generate 14.1 million tons of livestock and poultry manure, treat and recycle 13.5 million tons, and achieve a comprehensive utilization rate of manure of more than 96 percent. Of this total amount, the quantity of manure to be generated by large-scale farms is projected to reach 8.91 million tons, the treated and reused amount to be 8.61 million tons, and the comprehensive utilization rate to reach 97 percent. Similarly, the amount of manure generated from small farms (households) is projected to reach 5.16 million tons, the treated and reused quantity of manure to be 4.87 million tons, and the comprehensive utilization rate of manure to reach approximately 94 percent.

138. **Under the program, Hubei plans to construct 38 centralized livestock and poultry manure treatment and recycling facilities to cater to small farms' needs.** Upgrading treatment plants at large-scale farms through output-based subsidies, together with the newly- constructed centralized facilities will increase Hubei's manure treatment capacity by 4.0 million tons, and increase the comprehensive utilization rate of manure by 7 percent. The manure treatment capacity by large-scale farms will be increased by 2.1 million tons, while the centralized facilities' capacity will be increased by 2.1 million tons. Hubei has set annual targets for the increase in manure treatment and recycling. Consistently, Hubei proposes to allocate program budgets in accordance with the increase in the amount of manure treated and recycled in each year of the program's life. The budget proportions for the 2023–27 period are 46 percent, 12 percent, 11 percent, 14 percent, and 16 percent, respectively.

139. **Similarly, Hunan has clear baseline and target values for treating and recycling livestock and poultry manure.** In 2020, the total amount of manure generated in the 14 program counties was 15.84 million tons, of which 13.14 million tons were treated and reused, achieving a comprehensive utilization rate of manure of 83 percent. The rate for large-scale farms is 56 percent. Of the total amount, the quantity of manure from the large-scale farms was 8.87 million tons, the treated and recycled quantity was 7.98 million tons, and the comprehensive utilization rate of manure was 90 percent. The quantity of livestock and poultry manure from the small farms (households) was 6.97 million tons, the treated and reused amount was 5.30 million tons, and the comprehensive utilization rate was 76 percent. By 2027, Hunan projects the total output of livestock poultry manure in the 14 project counties to reach 15.83 million tons, the treated and reused manure to be 13.93 million tons, and the comprehensive utilization rate of manure to reach 88 percent. Of the total amount, the output of manure from large-scale farms will be about 8.86 million tons, the treated and reused manure will be 8.42 million tons, and the comprehensive utilization rate will reach 95 percent. Hunan will take great efforts to further increase the utilization of manure resources by constructing more organic fertilizer processing plants. More contributions will come from the small farms (households), which account for more than 40 percent of total livestock and poultry manure in the program counties (Table 17).

Table 17 Livestock manure production and utilization in the program counties

Program Areas	Farm Type	Manure Production and Utilization in 2021 (tons)		Recycle Utilization Rate (%)	
		Production	Utilization	2021	Target
Hubei	Large-scale	6,174,525.73	5,198,415.031	84.19	90.00
	Small-scale	4,088,820.17	3,012,571.519	73.68	85.00
	Subtotal	10,263,345.90	8,210,986.55	80.00	85.00

Hunan	Large-scale	9,019,129.12	8,053,975.56	89.30	94.34
	Small-scale	7,918,471.63	5,853,577.36	73.92	83.81
	Subtotal	16,937,600.75	13,907,552.92	82.11	89.42
Total		**27,200,946.65**	**22,118,539.47**	**81.06**	**87.21**

140. **The PforR is technically sound because it is geared toward helping Hubei and Hunan provinces to address their agricultural and rural development challenges.** The Bank's PforR support focuses on three Results Areas (RAs): (1) RA1 - Strengthening institutional capacity for governance—to improve institutional coordination and management frameworks for the results-based green agriculture and rural infrastructure development (wastewater and SWMS); (2) RA2 - Greening agricultural value chains—to sustainably increase rural incomes by adopting environmentally-friendly production practices; and (3) RA3 - Increasing access to rural solid waste and wastewater services—to improve the rural living environment and reduce pollutants; (4)RA4 – Restoring and protecting degraded agricultural ecosystem to enhance the agricultural products' quality and safety, and to improve soil health and biodiversity. The activities under each RA are described in detail in Section C – PforR Program Scope. The expected outcomes of implementing activities under these RAs include: (1) RA1- efficient decision-making and performance monitoring tool for rural infrastructure and public services; improved MRV of GHG emissions reduction from main agriculture; enhance systems for green agriculture and rural governance; efficient results-based fiscal transfers for green agricultural and rural revitalization; (2) RA2 - reduced GHG emissions (e.g., CH_4, N_2O, and CO_2) and pollutant loads (e.g., NH_3-N, COD, BOD, TP, and TN) from crop and livestock production systems; enhanced food quality and food safety; enhanced rural households' incomes (farm and non-farm); (3) RA3 – improved access to rural wastewater and solid waste management services; reduced GHG emissions (CH_4 and N_2O) and pollutant loads (NH_3-N, COD, BOD, TP, TN) entering waterways; (4) RA4 - increased belowground carbon sequestration; reduced GHG emissions (CH_4 and N_2O) and pollutant loads (NH_3-N, COD, BOD, TP, and TN) entering waterways; improved agricultural ecosystem services and food safety.

141. **The four RAs and associated DLIs will significantly contribute to GPGs.** These include (1) a significant reduction in GHG emission (e.g., CH_4, N_2O, and CO_2) due to reduced use of chemical fertilizer and increased fertilizer use efficiency in selected agricultural value chains; (2) reduction in point and NPS water pollution (NH_3-N, COD, TN, and TP) due to reduction in fertilizer use, treatment, recycling of livestock and poultry manure, and tailwater ecological treatment of aquaculture and fish-rice systems; (3) reduced agricultural plastics pollution due to collection, sorting, and recycling of rural solid waste; and (4) increased biodiversity in farmland due to reduced pollution from chemical fertilizer and pesticide and restoring and protecting polluted farmland. As far as possible, these co-benefits will be monitored, evaluated, and quantified. Their total estimated CO_2 equivalent values will be included in the economic and financial analysis of the PforR. Table 5, Table 6, and Table 7 summarize the PforR's mitigation and adaptation measures that are likely to generate substantial GHG emissions reduction or climate co-benefits.

142. **To complement pollutant reduction efforts, the PforR will support innovations.** Specifically, fertilizer use reduction will be complemented by (1) improving soil nutrient management through the deep placement of formular fertilizers; (2) using formula and slow-release fertilizers; (3) investing in fertigation facilities for vegetables and fruit orchards; (4) mechanizing fertilization; (5) using organic fertilizer from treated livestock and poultry manure and green manure to replace chemical fertilizer; (6) rotating crops with green manure plants; and (7) applying livestock-crop integrated systems. Similarly, livestock waste management will be improved through more efficient aerobic composting, bedding preparation, and matrix transformation for solid feces, full-amount field incorporation upon storage or upon combined storage processing, and anaerobic treatment for liquid manure; and improved manure transport vehicles and facility.

Results Area 3 - Increasing access to rural solid waste and wastewater services

143. **RA3 aims to reduce GHG emissions, point, and NPS pollution and improve rural living conditions.** RA3 will also promote the rural circular economy (e.g., efficient use of treated wastewater for reuse in irrigation and compost material as a substitute for chemical fertilizer) and use nature-based solutions to reduce pollution, including constructing retention ponds and wetlands to filter pollutants. RA3 activities include supporting activities aimed at developing spatial IVDPs; constructing and/or rehabilitating rural wastewater management systems (e.g., rural decentralized facilities and connections to township systems); constructing rural SWMS (e.g., household sorting, township transfer, and recycling); and providing training on O&M of wastewater and SWMS. These activities will be implemented by the relevant provincial and county/city government departments.

Developing Spatial Integrated Village Development Plans (IVDPs)

144. **Spatial IVDP is a multi-dimensional planning tool for the rural areas of natural or administrative villages.** This detailed plan forms a statutory basis for carrying out territorial space development and protection activities, implementing control over the use of territorial space, issuing planning permits for rural construction projects, and carrying out various construction projects at the village level. The spatial IVDPs will specifically: (1) define the red lines (boundaries) for ecological protection, arable land, and permanent prime farmland; (2) optimize land use by consolidated planning and spatial layout; (3) promote cultural heritage with distinguished local features; and (4) encourage phased development based on the local context. Hubei and Hunan provinces have already developed provincial guidelines and specifications for preparing spatial IVDPs, which will be prepared by qualified and competent professional planning agencies in full consultation with and participation of villagers. The respective county NRBs and Agriculture and Rural Affairs Bureaus will jointly oversee the preparation of the spatial IVDPs. The respective county DRCs, DOFs, and other relevant agencies will approve the spatial IVDPs. The spatial IVDPs will guide future village-level investments and public services delivery financed by the government and the private sector. The development of spatial IVDPs is a DLI under RA3.

145. **Two program provinces have already developed provincial guidelines and specifications for preparing IVDPs.** The IVDPs will be prepared by qualified professional agencies for spatial planning with full consultation and participation from villagers based on the provincial guidelines. County Natural Resource Bureau and County Agriculture and Rural Affairs will jointly approve the IVDPs. They should be appropriately disclosed to the public. The IVDPs should be followed with a detailed implementation plan in the next five years, including government and private sector financing. The guidelines will be updated with the experiences and lessons learned from their implementation in the demonstrated villages and the change of upper-level master planning.

146. **The program will finance 413 villages (including 213 villages in Hunan and 200 villages in Hubei) to develop and approve their IVDPs for program counties as pilots, although more IVDPs are encouraged to be developed under the national rural revitalization plan.** The indicators will be verified upon an IVDP's approval and disclosing status upon the county government's report and project MIS.

Constructing and/or Rehabilitating Rural WWTFs

147. **In China, with the rural "toilet revolution" gaining momentum in the last decade, the generation of rural wastewater increased from 16.7 billion tons in 2013 to 23 billion tons in 2018.** The average national ratio of household sanitary toilets reached 81 percent in 2017. In contrast, the average rural wastewater treatment ratio was only 11 percent in 2015, while the average urban wastewater treatment ratio was over 95 percent in 2019. Both central-level and provincial-level governments underscore the importance of investing in rural WWTFs. Under the 14th FYP, Hubei and Hunan provincial governments have targeted increasing rural wastewater treatment from 25 percent to 35 percent. Both provinces are committed to developing and/or updating their rural wastewater policy to support, guide, and leverage the central government's funds to develop WWTFs. In addition, technical guidelines for managing WWTFs will be developed and/or updated by the two provinces and adopted by the program counties.

148. **The GARR PforR will support selected traditional and administrative demonstration villages with approved spatial IVPDs in each program county to build and/or rehabilitate rural WWTFs for proper wastewater treatment to avoid direct discharge into the environment resulting in water, soil, and air pollution and increase health risks.** To embrace nature-based solutions, Hubei and Hunan will use wetlands and ecological ponds to remove physical, chemical, and biological pollutants and meet provincial effluent discharge standards. To ensure the stability of the constructed wetland ecosystem and increase the life and processing capacity of the wetland treatment system, Hunan and Hubei will ensure that the sewage is adequately treated before it is discharged into the constructed wetlands or ecological ponds. The pre-treatment of wastewater will help to prevent odor or blockage of sewage during storage and transportation, prevent untreated sewage from polluting soil and groundwater, reduce sewage treatment load, and ensure the quality of effluent from constructed wetlands.

149. **Hubei and Hunan rural wastewater treatment processes will include** (1) wetland processes, (2) combined process of anaerobic ponds and wetlands, (3) combined process of hydrolysis acidification ponds and wetlands, (4) hydrolysis acidification/contact oxidation/constructed wetland treatment process; (5) combined process of artificial wetlands and ecological ponds, (6) combined process of an ecological pond with artificial wetland, and (7) treatment process of combined ecological ponds. Under the GARR PforR, centralized WWTFs will be built for those villages with larger populations. But for small villages with smaller populations, ecological treatment technologies without (or low) power, such as 3-cell septic tanks, anaerobic tanks, or/and small-scale wetlands (where the effluent can be used for fertigation), will be used.

150. **Hubei and Hunan will ensure that effluents discharged from WWTFs meet provincial environmental standards** based on the process adopted and the condition of the receiving environment (e.g., water bodies, farmland, wetlands, ecological ponds). Rural domestic wastewater is categorized into black water and gray water. Black water refers to high-concentration domestic wastewater used for flushing feces in toilets. Gray water refers to low-concentration domestic wastewater like the kitchen, laundry, and bathing water. Black water can be used for irrigation in agricultural production systems after composting in three-grid septic tanks, purification biogas tanks, and other treatments to meet crop production standards. Gray water can be used for farmland irrigation or reuse after technical treatment, such as in artificial wetlands, stabilization ponds, and land treatment, or it can be directly discharged. Two program provinces have already developed their rural wastewater treatment standards[49] and technical guidance according to the local context.[50]

151. **The program will finance 108 villages (49 in Hubei and 59 in Hunan Provinces) to build, rehabilitate, and improve their domestic wastewater collection and proper treatment to avoid direct discharge to the environment resulting in water, soil pollution, and health issues.** The selected villages for financing will be picked up from those villages with IVDPs approved and in implementation.

152. **For the pilot villages, the wastewater treatment ratio should be more than 80 percent as a result of the successful achievement of DLI3.2 for the wastewater part.** For those villages with full coverage of wastewater collection networks and centralized treatment facilities, the ratio should be more than 85 percent to meet the disbursement threshold.

Rural Solid Waste Management

153. **The GARR PforR will also support a selected demonstration of traditional and administrative villages with approved spatial IVPDs in each program county to build and/or rehabilitate rural solid waste**

49 DB43/1665-2019 Effluent Discharge Standard of Hunan Rural Domestic Wastewater Treatment Facilities; DB42/1537 Effluent Discharge Standard of Hubei Rural Domestic Wastewater Treatment Facilities

50 Hunan Rural Domestic Wastewater Management Guidance, issued by Hunan Ecology and Environment Department on August 31, 2020; Working Guidance of Hubei Province Domestic Wastewater Treatment of Towns and Villages, issued by the Hubei Provincial Government on March 22, 2017

management stations for proper solid waste collection, sorting, and transfer to avoid open dumping into the environment. Hubei and Hunan are committed to closing all existing solid waste dumpsites by the end of the 14th FYP. In addition, Hubei and Hunan have stopped issuing permits for new dumpsites. Solid waste collection is ongoing in all natural and administrative villages. However, sorting domestic waste at source, particularly into organics, recyclables, hazardous, and residuals, is rarely done. This is partly because the rural communities are not properly trained in solid waste sorting or separation techniques.

154. **Hubei and Hunan have developed provincial technical specifications for rural solid waste systems (RSWS).** These include (1) principles for the selection of solid waste collection sites; (2) facilities and equipment (e.g., sorting bins, carts) required at each site to serve 500–600 residents, such as fencing, parking space, solid waste containers, and leachate collection ditches; (3) building code for the solid waste transfer stations (SWTS); and (4) standards for safety, sanitation, and hygiene, including regular cleaning and disinfection. The two provinces plan to construct and/or rehabilitate at least one domestic solid waste collection station for each demonstration village. Its size would depend on the estimated quantity of waste generated and the frequency of collection and transfer to township facilities. The spatial IVDPs will determine the site for the RSWS. The RSWS will be appropriately designed using cost-effective technology and materials based on local conditions. The size of the RSWS will be determined by the estimated quantity of domestic waste generated in the village. The service radius of a small RSWS that collects garbage with manpower will not exceed 0.5 kilometers (km); a small RSWS that uses small motor vehicles to collect garbage will not exceed 2.0 km. For garbage transportation distances exceeding 20 km, medium- and large-sized RSWS will be set up.

155. **The two provinces plan to construct and/or rehabilitate township SWTS, designed according to local specifications and conditions.** The layout of the buildings and structures shall comply with provincial fire protection, hygienic regulations, and safety requirements. Depending on the geographic and economic conditions, the township SWTS will use different methods and equipment to load the garbage onto the transport vehicles. The solid waste transfer volume will determine the equipment at the township SWTS. To maximize the efficiency of the township SWTS and solid waste transfer vehicles, garbage storage tanks will be set up in distant locations. To meet hygiene and safety standards, the township SWTS will have auxiliary rooms for workers to change clothes or store tools and materials.

156. **The construction of WWTFs and RSWSs in the selected demonstration villages will become a second DLI under RA3.** The DLI will only be met when a full range of solid waste collection, sorting, and transfer services are provided for all natural villages within an administrative village. The county/city governments will be responsible for O&M arrangements, including designating operations staff and providing a sufficient budget.

157. **The program will finance 108 villages (49 in Hubei and 59 in Hunan Provinces) to set up/ rehabilitate their comprehensive solid waste management system. This will include the following:**

- Closure and clearance of all existing informal dumpsites of domestic and agricultural solid waste;
- Full coverage of solid waste collection services in all natural villages of the pilot administrative village;
- Collection of waste plastic films at a 90 percent ratio and full separation from other domestic solid waste.
- Source separation of plastic, hazardous, and kitchen waste to minimize transfer and final disposal.
- Include informal solid waste pickers in the solid waste management system for proper training, sorting, and separation of solid waste.

158. **The technical specifications for those facilities financed under the program are summarized as follows:**

Solid Waste collection facilities

- The principle of location selection of solid waste collection facilities should minimize the negative impacts on the surrounding living environment. The distance between the outer wall of the collection point and the

adjacent buildings should be greater than 5 meters. The selected location can facilitate the operation and temporary parking of sanitation vehicles, and the nearby municipal facilities should be opposite each other. It should be convenient for daily cleaning and leachate collection.

- According to the standard, the solid waste collection facility may serve 500 to 600 residents with closed SW container plus a number of solid waste bins.
- The collection facility (building) should be equipped with a roof cover.
- The construction form of the solid waste collection facility may be specified by the county. The materials, such as the access door and roof cover of the discharge port of the solid waste collection facility, should be made of stainless steel and other anti-corrosion materials.
- Leachate interception and drainage ditch shall be set up for the collection facility. The leachate shall be collected and treated with rural wastewater or discharged into the municipal wastewater pipe network system.
- Water faucets should be set up in the domestic garbage collection points, and sanitation and cleaning measures should be standardized, cleaned at least twice a week, and regularly sprayed with disinfection and mosquito-killing drugs.
- The area of the sinking-type collection facility should not be less than 6 square meters, with its inner wall lined with materials that are easy to clean. Tap water and drainage facilities should be provided.

Construction of Village-level Solid Waste Transfer Stations (SWTS)

159. **At least one centralized transfer station for domestic waste needs to be built in each natural village. The construction area should be calculated and determined according to the actual amount of domestic waste generated and the frequency of collection and transportation in each village.** The transfer station shall be designed appropriately based on local conditions with good technology and cost-effectiveness, meeting relevant health and safety executive (HSE) standards.

- Site selection and scale meet the requirements of the overall planning of the village.
- The size of the transfer station shall be determined according to the amount of waste transferred. The amount of waste transshipment shall be determined according to the actual data of the average daily output in the high-yield months of waste in the service area. The service radius of a small transfer station that collects garbage with manpower collection vehicles should not exceed 0.5 km; the service radius of a small transfer station that uses small motor vehicles to collect garbage should not exceed 2.0 km; when the garbage transportation distance exceeds 20 km, large- and medium-sized transfer stations should be set up.
- In terms of building construction and environment, the general layout of the transfer station should be economical and reasonable according to the local conditions. The operation area should be arranged in the downwind direction of the dominant wind direction. The layout of buildings and structures in the transfer station shall comply with fire protection, hygienic regulations, and various safety requirements. The architectural design and external decoration of buildings and structures shall be coordinated with the surrounding residential buildings, public buildings, and the environment.
- Regarding equipment and facilities, the transfer station should use different methods and equipment to load the garbage onto the transport vehicles according to different regions and conditions. The number of equipment at the transfer station shall be determined according to the transfer volume. To adjust the relationship between the working efficiency of the transfer station and the frequency of vehicle calls, garbage storage tanks should be set up as needed. The depth of the container pit should ensure that the upper edge is flush with the indoor floor or not higher than 5 cm above the indoor floor. The distance between the outer wall of the container and the pit wall should be kept at 15–20 cm, and a positioning device should be installed. The container should match the capacity and box of the garbage truck. The transfer station shall have auxiliary rooms for workers on duty to change clothes or store tools and materials. The transfer station should have an emergency power supply, and the corresponding machine

room should be considered. Telephone or other communication facilities should be set up in the transfer station.

160. **Only when the full range of solid waste collection and transfer services are provided for all natural villages within an administrative village will the criteria for the relevant DLI be met.** For pilot villages, the wastewater and solid waste management services shall be well set up and accessible to the villagers above the threshold documented in the verification threshold. The O&M arrangement should be in place with evidence of designated operation staff and sufficient financing.

O&M Plan and Capacity Building

161. **The overall training plan for the O&M of the township SWTS, rural WWTF, and RSWS for the duration of the program will be developed** and will form part of the PIP. This will become a PAP under GARR PforR. In addition, annual training plans and budgets will be prepared each year. The trainees will include the facilities management staff, and formal and/or informal operations staff (villagers), with at least 50 percent being female.

Results Area 4 (RA4) - Restoring Degraded Agricultural Ecosystems

162. **RA4 supports integrated management of the natural resources to complement activities under RA2.** The main activities under RA4 include: (1) preparing sustainable agricultural ecosystems management plans, (2) managing heavy metals to improve soil health and food safety, (3) returning crops straw to the farmland to increase SOC, and (4) treating aquaculture wastewater to reduce GHG emissions and pollutant loads entering waterways.

Preparing Sustainable Agricultural Ecosystems Management Plans

163. **The sustainable agricultural ecosystem management plans would be prepared through participatory approaches.** The aim is to map degraded farmlands, identify the sources and severity of degradation in the participating counties/cities, and develop appropriate integrated risk-based land restoration measures. The plans will include interventions to increase the rate of returning crop straw to farmland (Hubei and Hunan), treating aquaculture wastewater (Hubei), and managing heavy metal pollution (Hunan). Both Hubei and Hunan are familiar with participatory planning methodologies and approaches. However, heavy metal pollution management is technically complex. And one key lesson learned from the national programs for heavy metal pollution prevention and control is that the application of lime, water management, and low metal accumulating variety substitution requires careful planning, and strict and effective implementation and supervision, which implies that professional services will be needed for demonstration planning, implementation, and supervision to allow the accurate evaluation of demonstration results.

Returning Crop Straw to the Farmland

164. **Hubei and Hunan provinces produce large quantities of crop straw, especially from rice, wheat, corn, and rapeseed.** The comprehensive use of crop straw (to avoid burning) includes animal feed, biomass energy generation, and return to soil in farmlands. But GARR PforR will focus on returning crop straw to the soil to increase SOC (carbon sequestration) and improve soil health (e.g., water retention, cation exchange, and nutrient absorption capacity).

165. **Although open burning is gradually being prevented, burning agricultural residues after harvest remains a major seasonal polluting event in some parts of China, including in Hubei and Hunan.** Agricultural burning has been controlled to a large extent since the early 2000s after it was banned. However, China still burns more straw than any other country. According to FAO statistics, mainland China accounted for 17 percent of global open burning of agricultural residues (mainly maize, rice, wheat, and sugar cane) in 2019,

burning 23 percent more biomass than all of Africa and 40 percent more than India. The open burning of straw creates a complex mix of air pollutants, including ones that can seriously endanger human health. These include fine particulates, such as $PM_{2.5}$, dioxins, polycyclic aromatic hydrocarbons, carbon monoxide, arsenic, mercury, lead, hydrochloric acid, and volatile organic compounds. Studies carried out in China between 2000 and 2014 indicate that biomass burning activity, in general (not exclusive to field burning), can account for up to about 19 percent, 25 percent, and 37 percent of fine particle emissions depending on the season—in autumn, winter, and summer, respectively. The implication is that biomass burning is a major driver of particulate pollution alongside traffic and coal combustion—at least seasonally. Straw burning is indeed a major contributor to secondary pollutants associated with air quality impairment and climate pollution. The major sources of climate pollution from straw burning are organic aerosols—black and brown carbon—and, indirectly, tropospheric ozone.

166. **Straw burning has been difficult to bring to a complete stop in part because many farmers continue to view it as beneficial.** Some farmers believe straw burning can quickly improve soil fertility, kill pests, eliminate weeds and grass seeds, and block the inter-year or inter-season spread of pests and weeds. And while these agronomic benefits are debatable, the economic benefits are clear: straw burning is a time and cost-saver for farmers. Available alternatives are generally more costly. For example, incorporating straw residues into agricultural fields takes more time and effort because farmers must buy or rent costly machinery. Inadequately processed straw or straw incorporated at a shallow depth can cause soil to clot and interfere with subsequent planting activities. Thus, under the GARR PforR, subsidies will be provided as incentives to offset the cost of field incorporation and increase carbon sequestration belowground. The quantity of crop straw (rice, rapeseed, wheat, and corn/maize) returned to the soil in farmland and the increased rate (or percentage) of comprehensive straw utilization is a DLI under RA4.

Treating Aquaculture Wastewater in Hubei

167. **Aquaculture significantly contributes to surface water pollution downstream of areas where the industry is highly developed in Hubei Province.** Aquaculture pollution results from the industry's use of inputs and its management of wastewater. Inputs into aquaculture include feed, drugs, and a variety of chemicals. Most inland aquaculture operations regularly release large volumes of wastewater. While these contribute to the endogenous pollution of aquaculture water, their discharge also pollutes downstream bodies of water, potentially affecting other aquaculture operations and farmlands.

168. **Overall, China's aquaculture industry has scaled and moved in directions that have tested or exceeded environmental carrying capacity.** Between 1978 and 2019, aquaculture production in China increased 40-fold, growing about 3.5 times larger than capture fisheries' output. By 2019, the industry produced nearly 51 million tons of seafood, over 60 percent of the world's total. While this scale-up has expanded the industry's environmental footprint, the latter has also been widened by the development (including in Hubei, of large-scale, high-density production systems that rely more on inputs). As a result, China's expansive and crowded fish farms have seriously overloaded water bodies by releasing large amounts of residual feed, fertilizer, feces, dead fish, metabolites, drugs, and other chemical wastes. Aquaculture operations have contributed to widespread water quality degradation and eutrophication by overwhelming many water bodies' capacity to self-purify, including some rivers and streams in Hubei. China's water conservation efforts have not kept pace with the development of its aquaculture industry.

169. **Freshwater aquaculture, especially eel and shrimp production, is a critical value chain in Hubei.** The integrated fish (eel and shrimp)–rice production system is also expanding rapidly. Both production systems have great concerns over GHG emissions from the fishponds and rice fields; and pollution loads from the tailwater entering waterways. In addition, no specific institution is responsible for monitoring and enforcing effluent standards for aquaculture tailwater.

170. **Today, China's inland aquaculture waters, especially in the southern and central regions (including Hubei), are seriously polluted, endangering the quality and safety of products and diminishing**

the productivity of aquaculture operations. The aquaculture subsector accounts for 6.2 percent, 10.3 percent, 7.0 percent, and 7.6 percent of COD, NH3-N, TN, and TP, respectively, of the agricultural pollution sources. On the other hand, properly treating aquaculture wastewater can help improve water biodiversity in wetlands, lakes, and rivers.

171. **Under the Hubei program, the planned treated aquaculture areas that meet effluent discharge standards are 10,938 ha from the baseline of 5,564 ha in 2021.** This results in an 8 percentage increase in the proportion of aquaculture farms that meet effluent discharge standards in program counties in Hubei (Table 18).

Table 18 Proportion of aquaculture farms that meet effluent discharge standards in Hubei

Program County	Aquaculture Baseline of Program Counties in 2021			Target Treated Areas (ha) in 2028	Proportion of aquaculture farms meeting effluent discharged standards (%)	
	Pond Area (ha)	Tailwater discharge (tons)	Area Meeting Effluent Discharge Standards (ha)	Area Meeting Effluent Discharge Standards (ha)	2021 Baseline	2028 Target Value
Hubei	127,879	323,797,616	5,564	10,938	4.35	12.86

Managing Heavy Metals[51] in Hunan

172. **Hunan, the largest rice producer in China, produces about 10 percent of the nation's rice, significantly contributing to food security in China.** It is estimated that heavy metals affect about 13 percent of the farmlands in Hunan, which is well-known as a home to nonferrous metal, nonferrous metallurgy, chemical, and mining industries that account for more than 80 percent of the province's industry. Heavy metal contamination is mainly caused by industrial discharges of flu gas, wastewater and waste residue, and metal mine tailings. Agricultural soil quality is further affected by the overuse of agrochemicals and poor farming practices. In addition, severe air pollution (e.g., sulfur dioxide emission from fossil fuel combustion at power plants and other industrial facilities) increases the frequency of acid rain in Hunan, causing soil acidity, which in turn increases the availability of heavy metals to be absorbed by plants.

173. **Hunan's provincial DARA has been monitoring heavy metals in soil in the mining and industrial areas, irrigation areas, and suburbs, especially in the Xiang River basin.** It is estimated that 58 percent of sample points exceed the soil's maximum threshold of safe heavy metals. In Hunan, this contamination imposes enormous economic and financial costs (i.e., discounted prices to farmers and millers, accumulated public sector stocks disposed of at a loss, reduced trade and tourism) and increased health risks. In response, the central and provincial governments have invested large amounts in helping manage heavy metal pollution in agricultural lands. The Ecology and Environmental Department (EED) has inspected and monitored all industries discharging heavy metals. Some enterprises have been ordered to close or improve their waste treatment to meet the emission and discharge standards, and some contaminated sites have been treated.

174. **To date, progress has been made in reducing cadmium concentrations in crops in demonstration areas.** However, this is very challenging because of existing institutional and technical constraints. While industrial pollution (the main source of agricultural land pollution) control is under the responsibility of the EED, agricultural land and crop pollution management is under the administration of DARA. The lack of a credible coordination framework between these agencies has made restoring and protecting agricultural land contaminated by heavy metals difficult. Agricultural agencies are paying close attention to safe agricultural production but are unable to address heavy metal pollution sources, especially polluted irrigation water from rivers and lakes and industrial emissions, because of their functional limitations. Under the GARR PforR, a collaboration mechanism between DEE and DARA will be established.

175. **Technical measures for risk-based heavy metal pollution management will continue to be implemented.** The first type is source control measures (e.g., increased flood irrigation regime to reduce uptake of cadmium—but this may increase CH_4 emissions in paddy rice fields), rice straw removal from fields, and growing heavy metal high-accumulating plants in the winter season). Another type is agronomic management measures to reduce active heavy metals in crops (e.g., cultivating rice varieties that do not accumulate heavy

51 Heavy metals are naturally-occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb).

metals, optimizing water management in the paddy rice fields, increasing soil pH by applying lime or other soil amendments, and applying organic fertilizers and soil immobilization agents). Adjusting the crop planting structure or switching to non-metal accumulating food crops, oil crops, or fodder crops can also be done. The last type is phytoremediation, especially for high-risk farmlands, where agronomic and switching crops measures are not suitable (e.g., growing hyper-accumulative plant species, such as Sedum (*Pteris vittata*), water onion, and grain amaranth). The area of farmland with treated heavy metals and the percentage of crop sampling points meeting food safety standards in program counties is a DLI under RA4.

176. **The GARR PforR activities will substantially contribute to GHG emissions reduction.** This would lead to the generation of both GPGs and local public goods. The eligible activities are summarized in Table 19.

Table 19 Eligible GHG Emission Reductions Activities under the GARR PforR

Category	Eligible Activity	Screening Criteria
RA1 - Strengthening institutional capacity for governance		
1. Policy support and technical assistance for climate change mitigation	• National, subnational, or territorial cross-sectoral policy actions that aim to lead to climate change mitigation actions or technical support for such actions	• Policy actions or technical support shall be for activities that will lead to an increase in carbon sinks or a substantial reduction in net GHG emissions or if the sector concerned is already low in CO_2e emissions, at a minimum does not increase the current level of emissions. Activities under the GARR PforR will include policy actions supporting the National Green Agriculture Development Plan (2021–2025), National Sustainable Agricultural Development Plan (2015–2030) targeting zero growth of fertilizers, and other plans for scaling up zero or low-emission technologies and measures.
2. Monitoring	• Systems or transparency tools for monitoring GHG emissions	• Systems or transparency tools shall be expected to lead to an improvement in gathering data and information on GHG emissions. Systems or transparency tools for monitoring GHG emissions can be implemented at the national, subnational, sector, or entity level. Under the GARR PforR, the methodologies for MRV of GHG emissions form the three agriculture sources will be supported.
3. Policy support and technical assistance for low-carbon development	• Policy actions, programs, or technical assistance for establishing fiscal incentives for scaling up investments in or deployment of low-carbon technologies and measures	• Under the GARR PforR, activities will include providing matching grants to small farmers and cooperatives as well as performance-based or output-based subsidies to agro-enterprises as incentives for adopting greener production technologies, which lead to the reduction of GHG emissions reduction. Fiscal incentives will be provided through transfers from the national and provincial governments to counties.
4. Policy support and technical assistance for carbon pricing	• Policy actions, programs, or technical assistance that target carbon prices or other payments that have the equivalent effects	• Under the GARR PforR, activities will include promoting eco-compensation and carbon trading mechanisms in the agriculture sector.
RA2 - Greening selected agricultural value chains		
5. Agriculture: GHG emission reductions	• Reduction of non-CO_2 GHG emissions from agricultural practices or technologies	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions or carbon intensity (for example, tCO_2e/unit of outcome). • Potentially eligible activities under the GARR PforR include more efficient nitrogen fertilizer use (by improving the rate, type, timing, placement, or precision of application, formula, and

Category	Eligible Activity	Screening Criteria
		organic fertilizer use), manure management including anaerobic digestion, drainage management, improved crop breeds, and biotechnology that reduce emissions, and water management in rice.
6. Agriculture: carbon sequestration	• Agricultural activities that contribute to increasing the carbon stock in the soil or avoiding loss of soil carbon through erosion control measures	• This includes activities that shall demonstrate a substantial increase in the aboveground or belowground carbon stock. • Potentially eligible activities under the GARR PforR include degraded land rehabilitation, erosion control measures, reduced tillage intensity and cover crops, crop rotation, higher inputs of organic matter to soil, processing and application of manure/digestate preferably with biogas capture for energy, perennial cropping systems, cultivation of deep rooting species, and circular/integrated activities that enhance carbon stock, fire management, and peatland restoration and conservation.
7. Agriculture: energy efficiency	• Reduction in energy consumption in operations	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions, carbon intensity, or energy intensity against a selected benchmark. • Potentially eligible activities under the GARR PforR include increasing energy efficiency of crop production and increasing use of energy-efficient equipment for crop planting, agricultural processing, and storage. • Examples of operations are traction, irrigation, pumping, harvesting, crop cooling, storage, and transportation.
8. Livestock: GHG emission reductions	• Activities that reduce CH_4 or other GHG emissions from livestock	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions or carbon intensity (for example, tCO_2e/unit of outcome). • Potentially eligible activities under the GARR PforR include manure management with biodigesters, wastewater management, improved feeding practices, feed production with reduced GHG emissions, investments in reducing feed losses along the value chain, sourcing of low-emission feeds or forage to increase feed conversion efficiency and reduce CH_4 emissions, and efficiency improvement measures to reduce the herd size.
9. Livestock: carbon sequestration	• Livestock production activities that improve carbon sequestration through rangeland management	• The eligible activities shall demonstrate a substantial increase in the aboveground or belowground carbon stock. • Potentially eligible activities under the GARR PforR include improved integrated crop-livestock production systems to increase application of treated animal manure on farmlands, improved animal manure treatment to produce biogas as source of energy, improved pasture management to increase soil carbon stocks and reduce erosion, improved grazing management, circular or integrated activities that enhance carbon stock, and the promotion of silvo-pastoralism and nitrification-inhibiting practices in pastures.
10. Food and diet:	• Activities that reduce food	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions or

Category	Eligible Activity	Screening Criteria
resource use efficiency	losses or waste or promote lower-carbon diets	carbon intensity (tCO_2e/unit of outcome). • Potentially eligible activities under the GARR PforR include food waste utilization (circular economy systems), policy interventions resulting in reduced food waste, and investments in avoided food losses along the value chain (for example, better managed cold chain infrastructure to reduce crop or food spoilage).
RA3 - Increasing access to rural solid waste and wastewater services		
Solid waste management services		
11. Waste collection and transport	• Separate collection and transport of source-segregated waste fractions	• The activity shall support recovery of eligible materials aimed at preparing them for reuse or recycling, including recovery and valorization of biowaste. • Potentially eligible activities under the GARR PforR include the deployment or operation of (a) waste collection equipment, for example, bins and containers (including underground systems); (b) waste collection and transport vehicles; (c) technological equipment and applications of information and communications technologies, for example, for collection route optimization, pay-as-you-throw schemes, product tracking, and take-back systems; and (d) construction or operation of infrastructure for separate waste collection, for example, civic amenity centers, vehicle depots, vehicle washing, and maintenance and repair facilities.
12. Waste storage and transfer	• Temporary storage, bulking, or transfer of separately collected, source-segregated waste fractions	• The activity shall support recovery of eligible materials aimed at preparing them for reuse or recycling, including recovery and valorization of biowaste. • Potentially eligible activities under the PforR include construction or operation of temporary storage, bulking, or transfer facilities and ancillary equipment and vehicles.
13. Material recovery from solid waste	• Material recovery from separately collected or presorted waste involving processes other than mechanical processes	• The activity shall be aimed at recovering secondary materials from waste in preparation for reuse or recycling. • Examples of typical feedstock used in this activity are plastic and rubber waste, spent oils, lubricants, solvents, and other chemicals produced by households and businesses.
14. Recovery and valorization of biowaste	• Anaerobic digestion of separately collected biowaste	• Biowaste means biodegradable garden and livestock waste; food and kitchen waste from households and wholesale and retail markets; and comparable waste from food processing plants. • Potentially eligible activities under the GARR PforR include (a) Greenfield projects - construction or operation of new plants and small-scale units for anaerobic digestion of biowaste, for biogas treatment or utilization, or for the treatment of digestates for use as fertilizers or soil conditioners and (b) Brownfield projects - modification, replacement, or upgrading of existing facilities resulting in improved CH_4 yields from the anaerobic digestion process (for example, by enabling co-digestion of biowaste with other biodegradable feedstock such as agricultural

Category	Eligible Activity	Screening Criteria
		residues and manure); reduced CH_4 leakages (for example, sealed digestate storage tanks); enhanced biogas utilization (for example, through biogas conversion to biomethane and its compression for use as a fuel or injection in a natural gas grid); or enhanced digestate utilization (for example, through additional composting and storage).
15. Recovery and valorization of biowaste	• Composting of separately collected biowaste	• The biowaste shall be segregated at source and collected separately. • The compost produced shall be used as a natural fertilizer or soil conditioner or, where it can be demonstrated that there is no market for such use, it shall be used for other purposes (for example, as backfilling or cover material), but shall not be incinerated. • Potentially eligible activities under the GARR PforR include (a) Greenfield projects: (i) construction or operation of new composting plants, including equipment for the conditioning of composts for use as fertilizers or soil conditioners and (ii) deployment of household and community-based composting schemes and (b) Brownfield projects - modification, replacement, or upgrading of existing facilities resulting in a reduction of CH_4 emissions from composting plants (for example, equipment for active aeration of windrows) or improvements in compost quality (for example, equipment for compost conditioning and valorization).
Wastewater management services		
16. Energy and resource efficiency and GHG emission reduction in wastewater management	• Greenfield and brownfield projects that promote improved O&M, to reduce wastewater leakages, promote energy savings, or meet or exceed wastewater treatment targets	• This includes activities that shall demonstrate a substantial increase in energy efficiency or a substantial reduction in net GHG emissions. • Potentially eligible activities under the GARR PforR include (a) training programs that emphasize wastewater leak detection and prevention, improved maintenance, or energy efficiency improvements and (b) programs ensuring that the levels of removal of BOD or five-day biochemical oxygen demand (BOD5), COD, or nitrogen[52] reach or exceed their targets.
17. GHG emission reduction in wastewater management	• Greenfield projects that reduce CH_4 or N_2O emissions through wastewater, fecal sludge, or septage collection and treatment	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions. The treatment system shall remove BOD. If there is no treatment of the collected wastewater, fecal sludge, or septage—that is, no BOD is removed—as part of the project, the activity shall not be eligible. • Potentially eligible activities under the GARR PforR include (a) the treatment systems that remove BOD. If there is no treatment of the collected wastewater, fecal sludge, or septage—that is, no BOD is removed—as part of the PforR, the activity shall not be eligible; (b) anaerobic treatment activities that generate an appreciable amount of CH_4 and use it in energy generation

[52] For wastewater, fecal sludge or septage systems that are ex ante expected to result in net GHG emissions reductions through collection and treatment, reaching or exceeding their targeted levels of BOD, BOD5, COD, or nitrogen removal are necessary for ensuring net emission reductions of CH_4 or N_2O.

Category	Eligible Activity	Screening Criteria
		or production processes, or, if use of CH_4 is not economically viable, flare CH_4 to release CO_2; and (c) appropriate mitigation measures are put in place to minimize and control CH_4 leakage.
18. Emission reduction in wastewater collection	• Greenfield or brownfield projects that improve latrines or collection of wastewater, fecal sludge or septage	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions once treatment of the collected material is considered. • Potentially eligible activities under the GARR PforR include the following: (a) gravity-based collection systems in greenfield projects are eligible if they result in near zero energy-related GHG emissions due to a lack of energy use; (b) building or improvement in latrines with reduced anaerobic conditions compared to the baseline scenario; and (c) investments in wastewater, fecal sludge, or septage collection that lead to a substantial reduction in net GHG emissions through collection and treatment.
19. Efficient use of wastewater	• Wastewater reuse	• This includes activities that shall demonstrate a substantial reduction in net GHG emissions between the wastewater reuse activity and the expected activity to be replaced or prevented. • Potentially eligible activities under the GARR PforR include (a) gray water and black water reuse at the building or local level, (b) treated wastewater reuse for irrigation, (c) treated sludge as a fertilizer replacement, and (d) nature-based solutions using retention ponds or constructed wetlands as part of integrated flood risk management.
RA4 - Restoring and protecting degraded agricultural ecosystems		
20. Carbon sequestration	• Polluted farmland restoration and safe utilization of food products • Crop straw returning to farmland soil	• The activities shall support carbon sequestration above ground and below ground in the program areas. • Potentially eligible activities under the GARR PforR include the implementation of (a) crop straw returning to the field and manure or organic fertilizer application to increase SOC content in the belowground and (b) polluted farmland return to forestry to increase aboveground carbon sequestration.
21. GHG emission reduction in aquaculture system	• Tail-water ecological treatment and recycling or reuse in farmlands	• The activity shall support GHG emission reduction such as CH_4, N_2O, and CO_2 in intensive fish pond and rice-fish production systems. • Potentially eligible activities under the GARR PforR include (a) reducing of fish feed input through improving fish culture technologies, (b) tail-water ecological treatment to reduce CH_4 and N_2O emissions, and (c) water-saving technologies and tail-water recycling for power saving.
22. CH_4 emission reduction	• Polluted rice field conservation and safety utilization • MRV application for rice straw returning into farmland soil	• The activities shall support CH_4 emission reduction in polluted rice fields. • Potentially eligible activities under the GARR PforR include (a) lime application to control heavy metal pollution, (b) polluted rice fields converted into dryland or upland production system, and (c) crop straw removal from the high-risk paddy fields.

VII. PROGRAM IMPLEMENTATION

Institutional and Implementation Arrangements

At the Central Level

177. **The NRRA will be the lead implementing agency of the central component of GARR PforR**. The NRRA will coordinate the implementation of activities under RA1.1, which include: (1) developing a national IT-based platform for mapping, M&E, and reporting of rural infrastructure and public services; and (2) developing the methodology for MRV of GHG emissions reduction from manure, chemical fertilizer, and rice. A Central Program Coordination Office will be established by the NRRA at the IPRCC to be responsible for coordinating day-to-day GARR PforR activities at the national level, including (1) delivery of the RA1.1 results; (2) coordinating the preparation of annual program implementation progress reports, semiannual M&E reports, and implementation completion report; (3) knowledge management and sharing of green agricultural and rural revitalization approaches and methodologies nationally and globally; and (4) dissemination of lessons learned from the implementation of GARR (Guangxi and Guizhou) and this GARR PforR (Hubei and Hunan). A steering group at the national level will be established, comprising representatives from the NDRC, MOF, NRRA, MARA, and two GARR PforR provinces. The leading group will be responsible for overall strategic direction, oversight, and facilitation of national policy dialogue.

At the Provincial Level

178. **The provincial RRB and DARA will coordinate the implementation of GARR PforR.** The county-level RRB and DARA will implement GARR PforR activities to deliver the results (achieve the DLIs). In both Hubei and Hunan, a provincial-level program steering committee to be chaired by the vice-governor and with members (at the Deputy Director General level) from the DRC, DOF, RRB, DARA, and other relevant departments will be established to oversee both program preparation and implementation activities.

179. **Hubei Province.** The provincial RRB will be the lead implementing agency and host the provincial Program Management Office (PMO), which is responsible for the overall day-to-day coordination of GARR PforR implementation. Under RA1.2, the RRB will be responsible for mainstreaming the IT-based platform for mapping and M&E of the delivery of rural infrastructure and public services. Similarly, under RA3, RRB will be responsible for coordinating the implementation of the following activities: (1) preparing the spatial IVDPs; (2) constructing rural wastewater management systems (e.g., rural decentralized facilities, connections to township systems); (3) constructing rural SWMS (e.g., rural sorting, township transfer, and recycling); and (4) providing training on O&M of wastewater and SWMS. The RRB will work with other departments responsible for rural infrastructure development, including DARA, the Department of Water Resources (DWR); the Department of Housing, Urban, and Rural Development (DHURD); DEE; the Department of Natural Resources (DNR); and Comprehensive Enforcement Bureaus (CEB), among others.

180. **A provincial-level program implementation unit (PIU) will be established under DARA,** which will be responsible for coordinating the implementation of the following activities under RA1.2: (1) developing regulations, standards, and guidelines for GAP and delivery of rural infrastructure and public services; and (2) establishing frameworks for nurturing green development skills and talents. In addition, under RA2, DARA will coordinate the implementation of the following activities: (1) reducing chemical fertilizer and toxic pesticide use from selected crop production systems (e.g., rice, fruits, and vegetables) and increasing livestock and poultry manure collection, treatment, and recycling; (2) adopting CSA practices—increasing productivity, building resilience, and reducing GHG emissions; (3) enhancing green

skills and talents through training of farmer cooperatives, farmer associations, WUAs, input suppliers, agro-enterprises, and rural extension staff; and (4) implementing the MRVs for GHG emissions. Finally, under RA4, DARA will coordinate the following activities: (1) preparing sustainable agricultural ecosystem management plans; (2) returning crop straw to the soil in farmlands to increase SOC; and (3) treating aquaculture ponds' wastewater to reduce GHG emissions and pollutant loads entering waterways.

181. **The DARA PIU will coordinate activities of relevant divisions/stations** responsible for crops (chemical fertilizer and pesticide reductions, straw management); livestock (manure and other waste management), agricultural ecological ecosystems, and training and capacity building. An expert panel will provide technical assistance to the provincial PMO or PIU—RRB and DARA. The provincial-level institutional arrangements will be replicated at the GARR PforR program counties.

182. ***Hunan Province*. The provincial DARA will be the lead implementing agency and host the provincial PMO,** responsible for the overall day-to-day coordination of the GARR PforR implementation. DARA will coordinate the implementation of the following activities under RA1.2: (1) developing regulations, standards, and guidelines for GAP and delivery of rural infrastructure and public services; and (2) establishing frameworks for nurturing green development skills and talents. In addition, under RA2, DARA will coordinate the implementation of the following activities: (1) reducing chemical fertilizer and toxic pesticide use from selected crop production systems (e.g., rice, fruits, and vegetables) and increasing livestock and poultry manure collection, treatment, and recycling; (2) adopting CSA practices—increasing productivity, building resilience, and reducing GHG emissions; (3) enhancing green skills and talents through training of farmer cooperatives, farmer associations, WUAs, input suppliers, agro-enterprises, and rural extension staff; and (4) implementing the MRVs for GHG emissions reduction. Finally, under RA4, DARA will coordinate the following activities: (1) preparing sustainable agricultural ecosystem management plans; (2) returning crop straw to the soil in farmlands to increase SOC; and (3) managing heavy metals pollution to improve soil health and food safety.

183. **A provincial-level PIU will be established under RRB and will coordinate the implementation of the following activities.** Under RA1.2, the RRB will be responsible for mainstreaming the IT-based platform for mapping and M&E of the delivery of rural infrastructure and public services. In addition, under RA3, RRB will be responsible for coordinating the implementation of the following activities: (1) preparing the spatial IVDPs; (2) constructing rural wastewater management systems (e.g., rural decentralized facilities, connections to township systems); (3) constructing rural SWMS (e.g., rural sorting, township transfer, and recycling); and (4) providing training on O&M of wastewater and SWMS. The RRB will work with other departments responsible for rural infrastructure development, including DARA, DWR, HURD, DEE, DNR, and CEB, among others. An expert panel will be established to provide technical assistance to the provincial PMO/PIU—both RRB and DARA. The provincial-level institutional arrangements will be replicated at the GARR PforR program counties.

VIII. ECONOMIC AND FINANCIAL ASSESSMENT

Economic Rationale

184. **The GARR PforR will strengthen institutional capacity for governance, generate public goods (both global and domestic) due to pollution reductions, and provide rural infrastructure and public services.** The GARR PforR will directly contribute to GPGs through (1) reducing GHG emissions by supporting measures to reduce chemical fertilizer use and increase efficiency; collection, treatment, and recycling of livestock and poultry manure; and adoption of CSA technologies and practices; (2) supporting investments in treatment and recycling of rural wastewater and solid waste; and (3) supporting investments aimed at increasing soil carbon, such as returning crop straw into farmlands. Eligible GHG emissions reduction activities under the GARR PforR are summarized in Table 19. The GARR PforR will

also indirectly contribute to protecting and restoring biodiversity in the farmland ecosystem by reducing agricultural pollutants (especially chemical fertilizers and pesticides) and promoting IPM technologies. Further, it will improve the efficiency and effectiveness of public goods delivery by strengthening institutional frameworks or governance systems (e.g., an IT platform for rural infrastructure mapping and M&E, program-based budgeting of green agricultural development and expenditure tracking) and capacity building at the national, provincial, and county levels. This will help the central and provincial governments to adopt results-based fiscal transfers to finance activities aimed at achieving green agricultural and sustainable rural development objectives at the county level, which are set in their 14th FYP and phase 1 RRS plans.

Value Added of Bank Support

185. **The Bank's involvement will help expose the borrowers to the international experience and good practices in green agricultural development, climate-resilient rural public infrastructure, and agricultural ecosystem management.** In addition, Bank involvement can incorporate into the government's RRS the lessons learned and experience gained from other Bank-financed agricultural and rural development projects in China and related knowledge products. The recently completed studies undertaken as part of the Bank's PASA are particularly relevant for informing the GARR PforR design and its implementation (see Section 1C - Relationship to the CPS/CPF and Rationale for the Use of the Instrument).

186. **The Bank's involvement will help leverage its vast international experience and good practices in green agricultural development, rural wastewater and solid waste management, NPS water pollution control, and degraded agricultural ecosystem restoration and protection.** The Bank has also supported the implementation of several projects related to ecosystem restoration and water pollution control in China and conducted analytical work, including through the Country Water Resources Partnership Strategy, the Water Governance Strategy, and studies on eco-compensation mechanisms. Lessons learned and good practices generated from these projects and analytics can be readily used to enhance the effectiveness and impact of the GARR PforR during its implementation.

Assessment Methodology

187. **The economic assessment compares a scenario of "no government program" to a scenario of "a government program," including the Bank's support.** This approach is used because, under a GARR PforR, the governments' and Bank's funds are combined to achieve results, with virtually no distinction at the activity level between government-financed and Bank-financed achievements. This approach can determine whether the overall program, which the Bank is partly financing, is socially beneficial after considering economic benefits and costs. Given the wide range of the program's interventions, the economic assessment is carried out by RAs using different methodologies.

RA1: Strengthening Institutional Capacity for Governance

188. **RA1 will strengthen institutional capacity to develop and improve governance frameworks at both central and provincial levels** (e.g., national IT-based platform for mapping and M&E of infrastructure and public services; and provincial-level regulations, standards, and guidelines for green development for implementing the RRS plan. The effectiveness and impact of public expenditures will be enhanced by linking the disbursement of funds to the achievement of specific results. RA1 will also improve the transparency and accountability of governance systems. Although it does not directly generate social benefits, RA1 will create an enabling environment for implementing the GARR PforR and enhance the impact of activities under RA2, RA3, and RA4. In addition, RA1 will help upscale green agricultural development, rural infrastructure, and public services province-wide, far exceeding the program's scope. As such, no separate analysis is needed for activities under RA1.

RA2: Greening Selected Agricultural Value Chains

189. **RA2 supports farmers, cooperatives, and enterprises by matching grants or output-based subsidies.** The support for green value chain development generates both private (increased productivity/income) and public (reduced GHG emissions and nutrient/pollutant loads entering waterways) benefits. Adopting new CSA technologies and practices promoted by the program partly depends on the profitability of farm operations/value chains.

190. **Economic analysis.** Cost-benefit analysis has been conducted to assess the economic viability of RA2 by aggregating activities in crop production (value chains) and manure treatment interventions based on the physical targets contained in DLI2.1 and DLI2.2 and based on crop production and manure treatment models in the financial analysis. The incremental economic costs include investment costs for 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, including fertilizer, agrochemicals, diesel, and irrigation water; income from biogas, electricity, and organic fertilizer generated from manure treatment; and benefits from GHG emission reductions. Other substantial positive externalities (e.g., reduced water pollution and improved soil biodiversity) are not included in the analysis as they are not easily quantifiable. The following assumptions have been applied for the analysis: (1) carbon shadow prices are set following the World Bank *Guidance Note on Shadow Price of Carbon in Economic Analysis* (November 2017);[53] (2) program life of 20 years; (3) 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 rate;[54] and (4) taxes, duties, and subsidies are not included as they represent transfer payments instead of real costs or benefits to society as a whole.

191. **Results of the economic analysis.** Cash flows of benefits and costs for RA2 are projected over 20 years to estimate their economic rate of return (ERR). The ERR with GHG reductions is estimated at 15 percent (at a low-carbon shadow price), 18 percent (at a high-carbon shadow price), and 11 percent at ERR without GHG reductions. These are all above the discount rate of 6 percent, indicating that RA2 is economically viable.

192. **Financial analysis.** The project's financial benefits were analyzed based on the program's incremental benefits and costs from the perspective of farmers/cooperatives. Assumptions for the financial analysis are the same as for the economic analysis, except that subsidies for farmers/manure treatment facilities are treated as income. The GHG reduction benefits are excluded as they cannot be internalized by farmers/owners of manure treatment facilities. Major crop production models for fertilizer reduction were selected for the financial analysis (Table 20).

Table 20 Results of Financial Analysis for Major Crop Value Chains

Technical Packages to be Adopted	Main Crop	FIRR With Subsidies (%)	FIRR Without Subsidies (%)

53 According to the World Bank's *Guidance Note on Shadow Price of Carbon in Economic Analysis* issued on November 12, 2017, projects' economic analysis should use a low and high estimate of the carbon price starting at USD 40 and USD 80 in 2020 and increasing to USD 50 and USD 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 USD 78 and USD 156 by 2050.

54 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.

Formula fertilizer and/or organic fertilizer and/or green manure and/or deep-side placement	Rice	15	11
Fertigation and/or formula fertilizer and/or organic fertilizer	Vegetables	19	16
Fertigation and/or formula fertilizer and/or organic fertilizer	Fruits	18	15

193. **The crop financial analysis shows that green agricultural technologies and practices are financially viable in the long- run, even without government subsidies.** However, the subsidies are justified during the initial years for the following reasons: (1) promoting the adoption of new technologies and practices; (2) compensating farmers for their contribution to the generation of public goods (e.g., GHG emission and nutrient and pollutant reductions); and (3) providing upfront financial incentives to hedge against the risks associated with switching to new technologies and practices. In China, experience has shown that once new technical packages are proven financially viable, farmers will continue using them even without subsidies.

194. **For manure treatment, the construction of a centralized livestock and poultry manure treatment and recycling facility has been adopted for analysis.** The facility will adopt the odorous fermentation bed technology with an annual treatment capacity of at least 6,600 metric tons of manure (for roughly 9,000 standing pigs annually). Based on the estimated capital investment, operational cost, and revenues, the facility will have a financial internal rate of return (FIRR) of 5 percent without subsidies and 12 percent with subsidies

195. **The financial analysis of the manure treatment facility shows that it is not financially viable without subsidies**.[55] Because the centralized facilities will provide manure treatment services to small-scale livestock and poultry farms and generate substantial public goods by reducing the quantity of pollutant loads entering waterways, there is strong justification for the program to provide subsidies for their construction. The analysis also shows that, with subsidies, the facilities could run profitably. No sensitivity test is warranted because conservative values of outputs and income are used in the analysis throughout the program's life. The financial analysis does not include significant unquantifiable positive externalities (e.g., water, soil quality, and biodiversity improvement).

RA3: Increasing Access to Rural Solid Waste and Wastewater Services

196. **RA3 involves the preparation of spatial IVDPs, which are the planning and future decision tools for the rural infrastructure and public service investments at the village level.** The spatial IVDPs will contribute to the efficient allocation of resources as one of the economic benefits. However, the main activities are related to constructing village-level wastewater and solid waste treatment and recycling facilities. Their economic benefits include improved health outcomes (e.g., reduced incidences of waterborne diseases) and reduced pollutants entering waterways (i.e., improving water quality), which are not easily quantifiable. Given the geographically- scattered small natural villages, the construction and/or rehabilitation of decentralized rural wastewater and solid waste management facilities are seen as the most cost-effective way of delivering public services. This is obviously true because, in the long- run, the cost of transferring rural waste to centralized township treatment plants is higher than the construction and/or rehabilitation of decentralized rural facilities.

55 This is supported by the analysis in the government implementation completion report for the Guangdong Agricultural Pollution Control Project, in which, out of 21 pig farms, only three high-rise facilities were financially viable without subsidies.

RA4: Restoring and Protecting Degraded Agricultural Ecosystems

197. **RA4 focuses on the integrated management of natural resources (e.g., land and water) to complement the efforts of greening selected agricultural value chains under RA2.** While there is abundant evidence from the literature that returning crop straw residues into the soil in farmlands, controlling heavy metal pollution, and treating aquaculture wastewater contribute to the increase in carbon sequestration and food safety and lead to the reduction in environmental footprint, especially from reduction in GHG emissions and pollutant loads entering waterways, it is very difficult to quantify the costs and benefits. However, the qualitative analysis concludes that the benefits of implementing these activities far outweigh the costs. The main unquantified benefits include increased soil carbon, reduced GHG emissions, improved food safety, and reduced human health risks.

198. **The GARR PforR is consistent with the Bank's corporate priorities, including maximizing finance for development, citizen engagement, climate co-benefits, and gender consideration.**

199. **Maximizing Finance for Development.** The GARR PforR will support creating an enabling environment for attracting private investment in greening agricultural value chains. China has an established system of mobilizing private capital to support agricultural development. Under its agricultural industrialization (*Chanye Fupin*) policy, Hubei and Hunan provincial governments will provide incentives to agro-enterprises (often called dragon head enterprises [DHEs]) with productive partnership/contractual arrangements with farmer cooperatives to invest in the production, value addition, and marketing of branded (and green or organic certified, or GI-registered) agro-products. The DHEs become responsible for the quality and safety of agro-products, which means they are liable for enforcing standards. Incentives provided include performance-based subsidies, land allocation for agricultural production and processing facilities, construction of industrial parks, and tax rebates/holidays. Similar performance-based subsidies are provided to medium- and large-sized livestock and poultry farms investing in livestock waste management (e.g., collection, treatment, and conversion into organic fertilizer or energy/biogas). Such farms must receive waste from small livestock and poultry farms to help smallholder producers manage manure. The GARR PforR will encourage the Hubei and Hunan provincial governments to expand the scope of such support to private enterprises.

200. **Citizen engagement.** The proposed GARR PforR has promoted citizen engagement through more comprehensive stakeholder consultation during the environmental and social systems assessment (ESSA), with local communities benefiting farmers, villagers, and private enterprise owners. The mechanism for citizen engagement will be expanded during project implementation to include that the (1) contact details of persons from provincial and county PMOs receiving feedback and complaints will be made public during the ESSA disclosure process in all program counties as part of the grievance redress mechanism, and (b) participatory approaches will be used under DLI4.1. Records of people participating in planning and implementing the spatial IVDPs will be kept at the village level. Citizen engagement will be used as a tool for transparency and accountability, including full disclosure of plans, budgets, expenditures, and results. In addition, a comprehensive GARR PforR communication strategy will be developed and implemented to inform the wider public and rural communities of the achievement of results and share lessons learned and approaches and methodologies for upscaling nationwide.

201. **Climate co-benefits.** The GARR PforR will generate climate change mitigation and adaptation benefits in the two provinces in line with China's NDC. The climate co-benefits from mitigation measures are expected to be generated in several ways. First, by reducing GHG emissions (e.g., CH_4, N_2O, and CO_2, measured in $mtCO_2e$) from crop production systems through the reduction of chemical fertilizer use and increasing the use of organic fertilizer, such as green manure, treated sludge, and compost material, as substitutes for chemical fertilizer (RA2 – DLI2.1). Second, reducing GHG emissions from livestock and poultry production systems through collecting, treating, and recycling manure (RA2 – DLI2.2). Third, reducing GHG emissions from treating rural domestic wastewater and solid waste leachate (RA3 –

DLI3.2). Fourth, by reducing GHG emissions from aquaculture wastewater (RA4 – DLI4.2). Fifth, by sequestering carbon through the restoration and protection of agricultural ecosystems (e.g., returning crop straw to the soil to avoid open burning). Similarly, the climate co-benefits from adaptation measures are expected to be generated through the adoption of (1) climate-smart agricultural practices (e.g., returning crop straw/residues to the farmland to increase soil carbon (RA4 – (DLI4.1); increasing efficiency of irrigation water use, such as through fertigation and improved water management in paddy rice to reduce CH_4 emissions); (2) nature-based solutions, such as retention ponds or constructed wetlands to manage floods; and (3) circular economy practices, including the efficient use of treated wastewater, such as water reuse for irrigation to build resilience to droughts. These adaptation measures will complement activities under RA2 (Greening of selected value chains) and contribute to climate resilience. Additional mitigation and adaptation climate co-benefits will be derived from creating an enabling environment to mainstream climate change within the governance frameworks of provinces, including (1) the development of IT-based mapping and M&E of rural infrastructure and public services (RA1 – DLI1.1); and (2) development of spatial IVDPs (RA3 – DLI3.1), which incorporate climate-resilience infrastructure planning and development considerations. The climate co-benefits will be measured in metric tons equivalent ($mtCO_2e$) of GHG emissions reduced from the GARR PforR-supported activities.

Gender Results Chain

Gap Analysis

202. **Overall, Chinese women are more engaged in farming activities than men. Still, due to skill and information gaps, they mainly engage in upstream activities of agricultural value chains.** According to the White Paper *Gender Equality and Women's Development in China*, in 2015, women accounted for about 70 percent of the agricultural labor force. However, the GARR PforR gender analysis found that, on average, women only account for 37.1 percent of agriculture extension personnel, 39.3 percent of agri-entrepreneurs, and 41.7 percent of agro-processing jobs program counties (see FigureA3.1). In the last four decades, a significant number of rural people migrated to urban areas in search of better-paying jobs, most of whom were men. Women, especially those between 36 and 50 years old, remained in the rural communities, spending more hours on the farm.[56] Notwithstanding the higher participation of women, men continue to make major production decisions and play the role of experts and managers in the agricultural sector. This is mainly because of their better access to agricultural technologies, knowledge, and information.

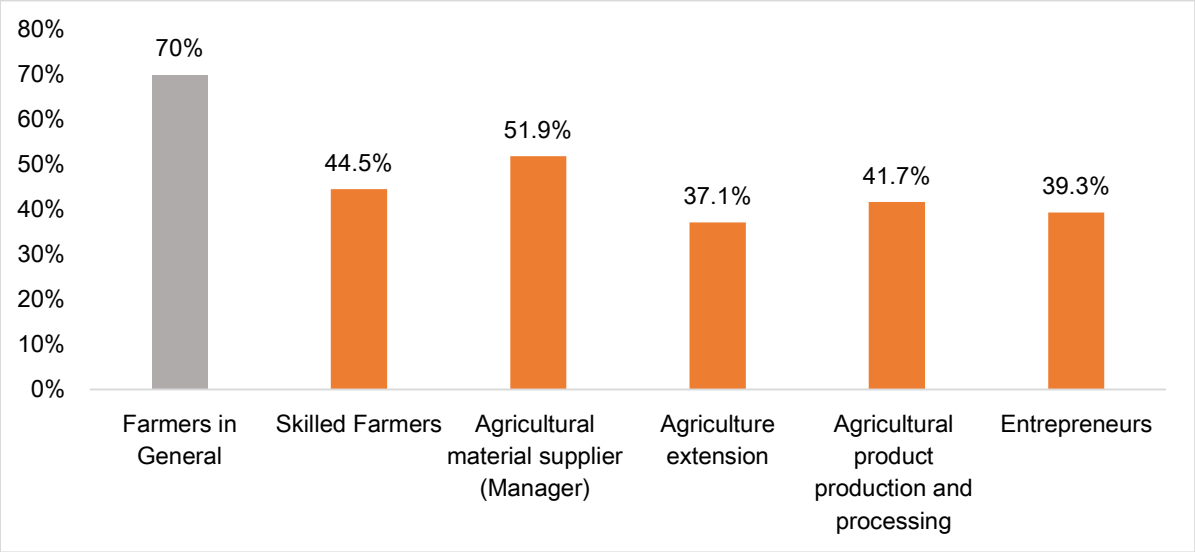
203. **Factors such as limited access to educational resources, market information, extension and advisory services, and occupational segregation and bias that encompass gender discrimination in the family and labor market affect women's uptake of green agricultural technologies and their contribution to the development of green and sustainable agricultural value chains.** Due to lower education levels and low exposure to extension and advisory services, women lag behind when they compete in emerging economic opportunities in the rapidly transforming agricultural sector.

204. **Women earn significantly less than men due to limited participation in downstream agricultural value chain activities.** This exacerbates their disadvantaged socioeconomic status in the process of agricultural transformation. The gender analysis found that the gender annual income gap in rural areas is much wider than in urban areas. For example, rural women earn 11.2 percent to 38.9 percent less than their male counterparts in the program counties. In comparison, the gap in urban areas ranges from 5.8 percent to 33 percent. This is because women are less likely to acquire technical and

56 International Food Policy Research Institute. 2012. *The Feminization of Agriculture with Chinese Characteristics*. Discussion Paper. http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/126960/filename/127171.pdf

managerial positions in agricultural value chains. Positions such as agri-technicians and advisors at the agricultural technical service stations; and agri-business leads and decision-makers at the rural cooperatives usually require diplomas or technical certificates and qualifications. In addition, they depend on the ability to access the job market and engage with local elites in a male-dominated rural community. As a reverse flow of labor (from cities to the countryside) emerged after the outbreak of the COVID-19 pandemic, the majority of female returnees reengaged in farming activities. Because of their limited technical skills, knowledge, and low social capital, they tend to converge upstream of the agricultural value chains.

Figure 2 Share of Women in Agricultural Value Chains



205. **The gender analysis also found that women's share of technical and managerial positions in rural SWMS and WWTFs was smaller relative to men.** Data from Hunan shows that although there is no considerable gender gap in the total number of staff working in general positions in rural WWTFs, the gap was significant for technical and managerial positions (see Figure 3). And this is also true for SWMS (see Figure 4). The largest gap exists in technical roles in rural SWMS, where only 27.5 percent of employees are female, despite having more women than men working in general positions. Once again, this clearly indicates that a gender-based knowledge, skills, and technical gap hinder women from accessing and retaining technical and managerial jobs and may exacerbate the rural women-men income disparity.

Figure 3 Proportion of Women Working in Water Treatment Facilities (Hunan)

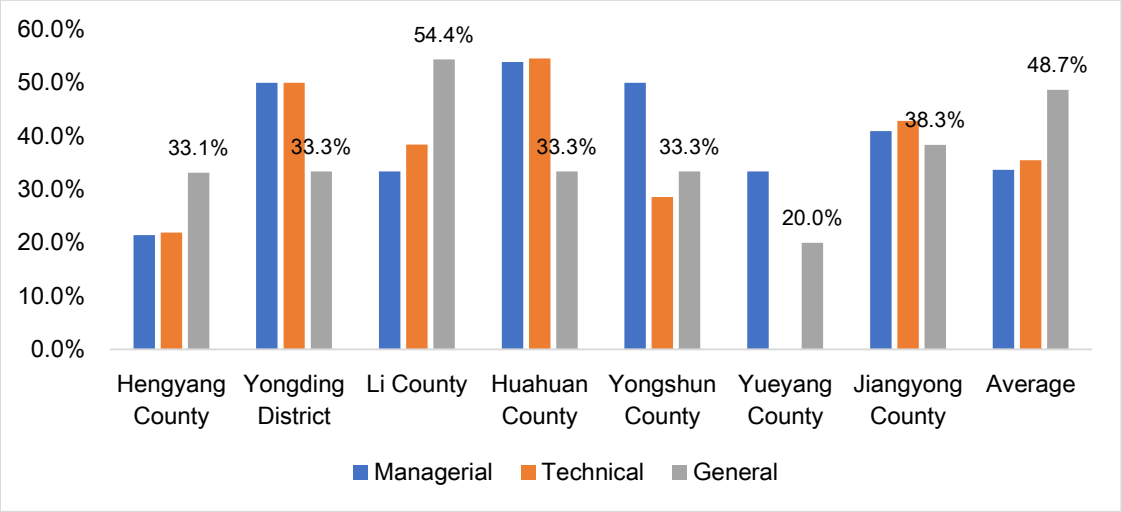
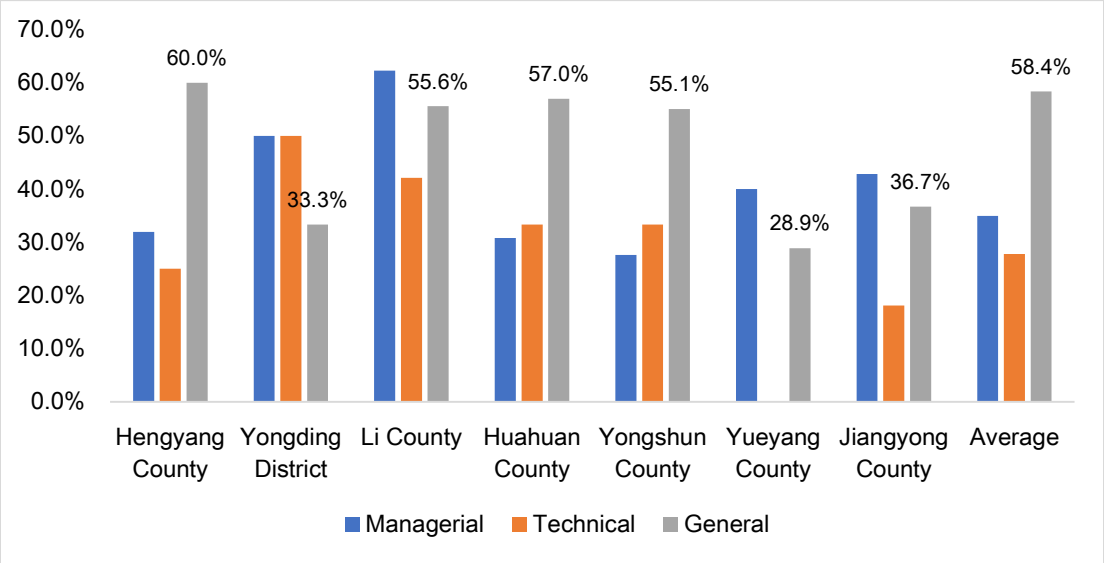


Figure 4 Proportion of Women Working in Solid Waste Management System (Hunan)



Gender Actions

206. **To address the gender gap, targeted training and capacity-building activities will be provided to women in the program counties.** This will help them better prepare for the emerging employment opportunities downstream of agricultural value chains, including processing, cold storage, logistics, and marketing. To facilitate the achievement of results under RA2 and RA4, the GARR PforR will nurture women's green skills and talents through training and capacity-building activities, including exchange visits and internships. The knowledge and skills acquired will help women apply green technologies and practices to reduce chemical fertilizer use; improve management of livestock and poultry manure; use digital tools and services (e.g., online learning, live streaming, and other e-commerce methods for marketing certified green and organic, or registered GI agricultural products); and use mobile-based payment and billing services.

207. **Given the low literacy level among rural women engaged in agriculture, the GARR PforR will train a growing number of female agri-entrepreneurs as model farmers.** In addition, "modern farmers" who return from cities with knowledge and skills learned from their previous positions will be targeted to help them better understand the agricultural production economics, commercial mechanisms, market trends, financial tools, and technological innovations and advances, such as the rapidly expanding digitalization of agricultural economy in China. These training activities will help them adapt to the local communities through mutual learning platforms in a hybrid format. Local radio broadcasting services and TV programs would feature these female agri-entrepreneurs as role models in green agricultural development to gradually shift the social norms and gender bias that limit women's participation in downstream agricultural value chain activities. This would also help encourage more women, especially young graduates, to take up more challenging roles in technical and managerial jobs along the agricultural value chains.

208. **Similarly, the GARR PforR will promote equal employment opportunities in rural SWMS and WWTFs.** This will help to achieve gender balance in technical and managerial positions during recruitment and improve retention and advancement of female staff/workers. The GARR PforR will also create new job opportunities for women, supporting the construction and rehabilitation of climate-resilient WWTFs and solid waste collection, sorting, and transfer systems. These jobs are envisioned beyond the program's closing date because they are needed to sustain greener and more resilient rural wastewater and solid waste management services. The GARR PforR will encourage Hubei and Hunan to improve their human resource (HR) systems by adopting gender-balanced international practices to provide equal job opportunities for both men and women. Gender awareness training will be conducted for the HR and management teams of the waste management facilities to provide up-to-date perspectives on good international practices of gender equity in job markets. Further, these employers would be encouraged to better link up with the local talent pool, including by selecting trainees from technical schools and colleges, while ensuring that female and male students have an equal chance of being recruited based on their capacity and level of skills.

Gender Indicator

209. **Newly created and upgraded jobs held by women in the transformation of agricultural value chains and in rural waste management and environmental rehabilitation (percentage) are the gender indicators.**

IX. RESULTS MONITORING AND EVALUATION

210. **M&E capacity will need to be strengthened during the GARR PforR implementation.** Each province will prepare an M&E plan, specifying the units of measurement, baseline values, targets, data sources for each indicator, methodology, and responsibility for collection and reporting. The provinces will recruit third-party M&E agencies to collect, analyze, and report survey-based data. Administrative data will be collected by the relevant county government departments implementing the GARR PforR activities. The M&E data will be stored in the MIS for the GARR PforR. The M&E of livestock and poultry manure pollution reduction, wastewater treatment, and recycling will be based on the established monitoring and verification system under the MEE. Similarly, the M&E of chemical fertilizer reduction will follow protocols established by MARA. This will provide a solid basis for the official recognition and credibility of PfoR's disbursement-linked results (DLRs). The M&E system will be linked to the IT-based platforms for rural infrastructure management and the IT-based program for budgeting and expenditure reporting. This will enable the provinces to evaluate the results and performance of the GARR PforR activities and analyze the cost-effectiveness of various activities implemented to generate the results. The provincial PMOs will prepare and submit to the Bank consolidated semiannual progress reports (including findings of third-party M&E reports), a midterm review report, and an implementation completion report. The provincial

PMOs will periodically submit to the Bank the VA's verification reports on the achievement of DLRs to enable IBRD loan disbursements against the DLIs.

211. **The provincial PMOs will be responsible for consolidating reports from provincial agencies participating in the GARR PforR and submitting them to the provincial DOF (PDOFs), copying the county PMOs.** IBRD loan disbursements will be made periodically upon receiving and accepting the third-party verification reports on the DLRs for the respective DLIs. The amount in the submitted withdrawal applications will depend on the verified results. Some annual allocations are scalable and non-fixed, meaning the Bank can disburse for over-performance up to the DLIs' total allocation. Over-performance will enable the PDOFs to bring forward disbursements from Year 4 and Year 5 to Year 3 and Year 4, respectively. The PDOFs can apply for disbursements as soon as the provinces achieve the results and provide the necessary evidence verified by the VA to the Bank. The Bank then accepts the evidence in a formal notice to the MOF specifying the eligible disbursement amounts. Annex 2 shows the Results Framework of the program.

X. CAPACITY BUILDING

212. **As indicated above, the technical capacity of the region/provinces in green agriculture and rural infrastructure is generally adequate.** The central and provincial governments are paying high attention to the training and capacity building of farmers and extension workers and developing rural talents. During the 13th FYP period, MARA launched a five-year program to develop a new type of occupational farmer equipped with a wide variety of skills—from soil management and crop production to marketing and business planning. In addition, the Department of Human Resources and Social Security also organizes short-term training for farmers and returning migrant workers. Under the PforR, technical assistance and outreach programs through training and demonstration will be provided based on needs assessment for the various categories (farmer, input suppliers, enterprises, and extension workers); development of training modules; outsourcing the delivery of the training activities; and evaluating the adoption rates.

213. **Given that the responsibility of delivering most of the DLIs is with the counties, capacity building for planning, budgeting, implementation, and M&E and reporting will be needed.** Overall, capacity gaps remain on how to design and implement specific activities to achieve the expected results, conduct effective M&E of the results, and strengthen the linkages (better manage the results chain) between inputs, outputs, and outcomes to achieve the PDO of the PforR. The technical assessment will also be needed to strengthen the capacity for program-based budgeting and expenditure reporting (including compliance with fiduciary requirements); management of the rural infrastructure (wastewater and solid waste management); and handling of the environmental and social safeguards issues (e.g., assessment of impacts of rural investments and putting in place acceptable mitigation measures) at the county level. The value added of the Bank financing is to bring in international experience in these aspects, especially with program-based budgeting and expenditure tracking and results-based fiscal transfers to the counties and rural areas. The PforR also incorporates training and capacity building (nurturing green skills and talents) of the beneficiaries, including members of the farmer cooperatives, farmer associations, WUAs, input suppliers, extension workers, and agro-enterprises. The results framework (RF) includes intermediate indicators to measure the performance of training and capacity-building activities.

214. **Specifically, green agricultural skills should be strengthened to support green agricultural development and rural revitalization.** The National 14th FYP Green Agricultural Development Plan highlighted building green talent and skills to promote innovations and adopting GAP. The National Rural Revitalization Strategic Plan pointed out that developing rural talent is one of the key pillars for rural revitalization. Following the two plans, MARA has recently introduced various training programs for

farmers, extension workers, youth, women, and entrepreneurs. Among them, the high-competency farmer training program is a flagship one funded by the central government and implemented at the subnational level. It covers all provinces, including Hubei and Hunan. The two provinces run the high-competency farmer training program based mainly on the funds available from the central level and face challenges in the areas of adequacy, relevance, quality, and effectiveness. The training resources could only meet two-thirds of the training needs in Hubei and less than half of the training needs in Hunan, leading to fewer beneficiaries who received training. The two provinces conducted a training needs assessment to inform their annual training plans. Still, those plans are often formulated following the business-as-usual approach, which does not systematically capture the requirements of green talent and skills. The format and mode of training activities are not well designed by considering the profile of rural farmers who are older and less educated, and a large portion being female. The training materials cover some modules on green agricultural technology and best practices but are not developed by following the green agricultural value chain to facilitate well-organized and systematic learning. The training program for rural extension staff is not well coordinated with the high-competency farmer training program. The M&E largely focuses on the process instead of the adoption of green agricultural technologies and practices.

215. **The GARR II program can help strengthen existing government programs to address the above challenges and meet the increasing demand for green talent and skills.** It will support a series of training and capacity-building activities for farmers, cooperatives, inputs suppliers, agri-businesses, and rural extension workers, which will be organized and managed in a systematic and coordinated manner along the green agricultural value chain to increase its adequacy, relevance, quality, and effectiveness. Similarly, capacity building for administrating rural infrastructure and public services is integral to strengthening governance for rural revitalization. The national and provincial governments have increased investment in rural infrastructure and public services. However, the capacities for operating and managing rural infrastructure and public services are quite weak, especially for effectively managing wastewater and solid waste systems. This includes issues related to inadequate staff, incentive mechanisms, public inputs, and performance management. The program will help the government strengthen capacity building through training local administrative workers and officials, especially enhancing the wastewater and solid waste service delivery and management systems, to improve the livable environment and reduce rural pollution. It is expected that the number of beneficiaries in the program counties who will be trained in green agricultural technologies and practices (e.g., farmers, input suppliers, enterprises, extension staff) will reach 39,521 people, among which women participants amount to 13,953. It is also expected that 70 percent of the trained people will adopt the green agricultural technologies and practices in the program counties.

XI. PROGRAM ACTION PLAN

216. **The program action plan (PAP) presents activities or measures that need to be carried out to facilitate the achievement of the DLIs during program implementation.**

Table 21. Program Action Plan

Action Description	Source	Responsibility	Timing		Completion Measurement
Develop the measurement, reporting, and verification (MRV) methodologies for calculating greenhouse gas (GHG) emissions reduction due to improved management of	Other	National Rural Revitalization Administration (NRRA) / International Poverty	Due date	June 30, 2025	The three MRVs are prepared by experts hired by the NRRA for use in the two program provinces.

Action Description	Source	Responsibility	Timing		Completion Measurement
livestock and poultry manure, chemical fertilizer, and rice		Reduction Center of China (IPRCC)			
Issue an official notification that no contract will be awarded to a firm or an individual appearing on the World Bank's debarred list or under temporary suspension list.	Fiduciary systems	NRRA/Hubei (RRA)/Hunan Department of Agriculture and Rural Affairs (DARA)	Other	No later than loan effectiveness	NRRA and provincial official notifications to affiliations/counties are issued, and copies are shared with the World Bank. The notice is also included in the program implementation plan (PIP).
Regularly inform the World Bank of any credible and material allegations of fraud and/or corruption regarding the GARR PforR's activities as part of the overall program's reporting requirements.	Fiduciary Systems	IPRCC/ Provincial Program Management Office (PMO)	Recurrent	Semiannuall y	Reflected in the PforR's quarterly/annual progress reports
Finalize the program financial reporting template, including budget codes and lines based on program- related sources of funds and budgeted expenditures.	Fiduciary systems	IPRCC, Provincial Department of Finance (PDOF) and provincial PMO	Other	By effectiveness	A formal response through email by IPRCC and provincial PMO with looping in the PDOF. The final templates are shared with the Bank for review and records and with the PIP.
Finalize the program external audit terms of reference (TOR) drafted by the Bank, which elaborates the program background, audit objective, scope, applicable audit standards, description of financial statements, and requirements on the audit report.	Fiduciary Systems	CNAO, PAO, and provincial PMO	Other	By effectiveness	The auditor's formal response for concurrence through email with the provincial PMO being informed. Final TOR shared with the Bank for review and records. Ensure that the final TOR is included in the PIP.
Implement mitigation measures to ensure that the odor treatment equipment for new or upgraded livestock and poultry manure treatment facilities and domestic solid waste transfer stations (SWTS) are well	Environm ental and social systems	County PMOs and provincial PPMOs	Recurrent	Yearly	Third-party Verification Agents confirm that new or upgraded facilities are free of odor.

Action Description	Source	Responsibility	Timing		Completion Measurement
designed, constructed, and operated.					
Prepare and implement occupational health and safety training for agro-enterprise employees; livestock and poultry manure; wastewater treatment facilities (WWTFs); SWTS; and crop straw storage and processing.	Environmental and social systems	Provincial PMOs and county PMOs	Recurrent	Yearly	The training and capacity-building plans are prepared by provincial PMOs and cleared by the World Bank. People trained in various enterprises and facilities are recorded.
Prepare and implement two detailed training and capacity-building plans: a green agricultural skills training plan and a capacity-building plan for the operations and maintenance (O&M) of the rural solid waste and wastewater facilities.	Other	Provincial PMOs and county PMOs	Recurrent	Yearly	The two training and capacity-building plans are prepared and shared with the World Bank. Records of the people trained in various skills development categories are kept in the MIS.

Annex 1 Allocation of the International Bank for Reconstruction and Development (IBRD) loan to Disbursement-linked Indicators (DLIs)

Disbursement- linked Indicators Matrix						
DLI1.1: Development and use of a comprehensive national IT-based platform for mapping and M&E of the delivery of rural infrastructure, public services, and spatial IVDPs of rural villages (central-level)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	Number (23)		5,461,000		1.6%
Period		Hubei (10)	Hunan (13)	Hubei 546,100	Hunan 709,930	
2024	No	1		4,204,970		USD 4,204,970 (77%) for the National Rural Revitalization Administration (NRRA) to develop an IT-based platform for mapping and M&E of rural infrastructure and public services for the provincial and county governments to use as a decision-making tool to guide investment and operations and maintenance (O&M) activities
2025	Yes	3	3	163,830	163,830	USD 54,610 (1%) per county connecting to central IT-based platform (Hunan 13 counties in total; Hubei 10 counties in total)
2026	Yes	7	10	382,270	546,100	
2027	Yes	0				
2028	Yes	0				
DLI1.2: Adoption of green regulations, standards, and guidelines, and the number of agro-products produced in the program counties that are certified or registered as green, organic, or geographical indication (GI) pursuant to said regulations, standards, and guidelines (provincial level)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	Number (357)		13,615,160		3.9%
Period		Hubei	Hunan	Hubei	Hunan	
		157	200	6,803,800	6,811,360	

Disbursement- linked Indicators Matrix						
2024	Yes	0	0	1,363,750	1,371,360	For Hubei and Hunan provincial governments to adopt the green agricultural development regulations, standards, and guidelines (20% of the DLI allocation in total)
2025	Yes	30	55	1,386,000	1,496,000	USD 27,200 and USD 25,539.91 per agro-product certified and/or registered in the Hubei and Hunan PforR counties, respectively, as either green, organic, or GI (80% of the DLI allocation in total).
2026	Yes	42	54	1,386,000	1,468,800	
2027	Yes	51	49	1,386,000	1,332,800	
2028	Yes	34	42	1,282,050	1,142,400	
DLI2.1: Tons of chemical fertilizer use reduced due to the adoption of green technologies and sustainable practices in selected crop production systems in the program counties (provincial level)						
Type of DLI	**Scalability**	**Unit of Measure (Tons)**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	Number		60,984,840		17.7%
Period		Hubei	Hunan	Hubei 30,496,200	Hunan 30,488,640	
2024	Yes	2,455	5,651	1,951,725	2,203,890	The total cumulative quantity of chemical fertilizer reduction by the end of the program is 38,361 tons in Hunbei and 78,176 tons in Hunan. USD 795 per ton for Hubei and USD 390 per ton for Hunan in terms of chemical fertilizer reduction.
2025	Yes	4,984	11,010	3,962,280	4,293,900	
2026	Yes	7,589	15,971	6,033,255	6,228,690	
2027	Yes	10,287	20,594	8,178,165	8,031,660	
2028	Yes	13,045	24,950	10,370,775	9,730,500	
DLI2.2: Percentage increase in treated and recycled livestock and poultry manure from large-scale and small-scale farms meeting effluent standards in the program counties (provincial level)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	%/year		71,700,000		20.8%
Period		Hubei	Hunan	Hubei 35,850,000	Hunan 35,850,000	40% for large-scale farms and 60% for small-scale farms

Disbursement- linked Indicators Matrix										
		Large farms	Small farms	Large farms	Small farms	Large farms	Small farms	Large farms	Small farms	In Hubei, 6% increase (baseline = 84%) from large-scale farms (1% = USD 2,390,000) and 11% increase (baseline = 74%) from small-scale farms (1% = USD 1,955,454.5) in the program counties In Hunan, 5% increase (baseline = 89%) from large-scale farms (1% = USD 2,440,000) and 10% increase (baseline = 74%)from small-scale farms (1% = USD 1,800,000) in the program counties
2024	Yes	1	2	1	2	2,390,000	3,910,909	2,868,000	4,302,000	
2025	Yes	1	2	1	2	2,390,000	3,910,909	2,868,000	4,302,000	
2026	Yes	1	2	1	2	2,390,000	3,910,909	2,868,000	4,302,000	
2027	Yes	1	2	1	2	2,390,000	3,910,909	2,868,000	4,302,000	
2028	Yes	2	3	1	2	4,780,000	5,866,364	2,868,000	4,302,000	

DLI3.1: Number of IVDPs approved by the program counties (provincial level)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	Number (371)		34,000,000		9.8%
Period		Hubei (171)	Hunan (200)	17,000,000	17,000,000	In Hubei, USD 99,415 per IVDP approved by the relevant county and provincial authorities; In Hunan, USD 85,000 per IVDP approved by the relevant county authorities
2024	Yes	0	0			
2025	Yes	50	50	4,970,760	4,250,000	
2026	Yes	60	70	5,964,912	5,950,000	
2027	Yes	50	60	4,970,760	5,100,000	
2028	Yes	11	20	1,093,567	1,700,000	

DLI3.2: Number of demonstration villages with newly-constructed or rehabilitated climate-resilient rural wastewater treatment facilities (WWTFs) and established solid waste collection, sorting, and transfer systems in the program counties meeting effluent standards (provincial level)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	Number (108)		105,200,000		30.5%
Period		Hubei (49)	Hunan (59)	Hubei 52,600,000	Hunan 52,600,000	In Hubei, USD 1,073,469.39 per demonstration village with newly-constructed or rehabilitated climate-
2024	Yes	0	0	0	0	

Disbursement- linked Indicators Matrix						
2025	Yes	12	15	12,881,632.7	13,372,881.4	resilient rural WWTFs and established solid waste collection, sorting, and transfer systems meeting effluent standards. In Hunan, USD 891,525.42 per demonstration village with newly-constructed or rehabilitated climate-resilient rural WWTFs and established solid waste collection, sorting, and transfer systems meeting effluent standards
2026	Yes	20	25	21,469,387.8	22,288,135.6	
2027	Yes	17	19	18,248,979.6	16,938,983.1	
2028		0	0	0	0	
DLI4.1: Percentage increase in comprehensive crop straw utilization in the program counties (provincial level)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	%/year		24,500,000		7.1%
Period		Hubei	Hunan	Hubei 12,250,000	Hunan 12,250,000	In Hubei, 3% increase (baseline = 93%) in comprehensive crop straw utilization in the program counties (1% = USD 4,083,333); In Hunan, 6% increase (baseline = 85%) in comprehensive crop straw utilization in the program counties (1% = USD 2,041,666.67)
2024		0.5	1	2,041,667	2,041,666.67	
2025		0.5	1	2,041,667	2,041,666.67	
2026		0.5	1	2,041,667	2,041,666.67	
2027		0.5	1	2,041,667	2,041,666.67	
2028		1.0	2	4,083,333	4,083,333.33	
DLI4.2: Number of hectares of treated aquaculture ponds meeting effluent discharge standards in the program countries (Hubei)						
Type of DLI	**Scalability**	**Unit of Measure**		**Total Allocated Amount (USD)**		**As % of Total Financing**
Output	Yes	ha/year		15,000,000		4.3%
Period						In total, 10,938 ha of aquaculture ponds will be treated. USD 1,371.37 per hectare disbursed if the treated aquaculture ponds meet effluent
2024	Yes	2,264		3,104,772.35		
2025	Yes	2,237		3,067,745.47		

Disbursement- linked Indicators Matrix				
2026	Yes	2,204	3,022,490.40	discharge standards.
2027	Yes	2,133	2,925,123.42	
2028	Yes	2,100	2,879,868.35	
DLI4.3: Number of hectares of treated farmlands with a safe utilization rate in the Program Countries (Hunan)				
Type of DLI	**Scalability**	**Unit of Measure**	**Total Allocated Amount (USD)**	**As % of Total Financing**
Output	Yes	ha/year	15,000,000	4.3%
Period				In total, 8,029 ha of polluted farmlands will be treated. USD 1,868.23 per ha disbursed if the treated farmlands have a safe utilization rate (i.e., above 85% of crop sampling meeting food safety standards)
2024	Yes	1,479	2,763,108.73	
2025	Yes	1,540	2,877,070.62	
2026	Yes	1,640	3,063,893.39	
2027	Yes	1,697	3,170,382.36	
2028	Yes	1,673	3,125,544.90	

Annex 2 Green Agricultural and Rural Revitalization Program for Results Framework (Hunan and Hubei)

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
PDO	**To enhance the adoption of environmentally-sustainable agricultural and rural infrastructure development practices in selected areas in Hubei and Hunan**								
	Program Development Objective Indicators by Objective/Outcome								
1	Reduction in pollutant loads from agricultural production systems and rural domestic wastewater treatment facilities (WWTFs) (COD and NH_3-N) achieved under the PforR in program counties	metric tons/year	0	9,317	15,076	82,434	149,793	217,166	217,166
	COD		0	8,408	13,606	79,467	145,328	211,188	211,188
	NH_3N		0	909	1,470	2,968	4,465	5,977	5,977
2	Greenhouse gas (GHG) emissions reduction achieved under the PforR in the program counties (RA2, RA3, and RA4) ($mtCO_2e$)	$mtCO_2e$	0	0	0	1,192,561	0	0	1,987,602
3	Beneficiaries reached with assets or public services (Corporate Result Indicator)	number	0	0	1,430,163	2,860,326	4,290,488	5,720,651	7,150,814
	Of which, female		0	0	697,407	1,394,814	2,092,220	2,789,627	3,487,034
	Of which, ethnic minority		0	0	181,592	363,184	544,777	726,369	907,961
	Intermediate Results Indicator by Results Area								
	RA1. Strengthening institutional capacity for governance								
4	Number of program counties that have adopted the IT-based platform for mapping and M&E of rural infrastructure and public services	number	0	0	10	23	23	23	23
5	Number of agro-products certified and/or registered in the PforR counties as either green, organic, or GI using the approved provincial regulations, standards, and guidelines	number	0	0	95	189	278	357	357
	RA2. Greening of selected agricultural value chains								
6	Quantity of chemical fertilizer reduced due to the adoption of green technologies and	metric tons/year	0	8,107	15,994	23,560	30,880	37,995	116,537

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	sustainable practices in selected crop production systems in the program counties								
7	Quantity of organic fertilizer used in the program counties	metric tons/year	0	200,594	392,588	575,582	754,676	929,970	929,970
8	Quantity of formula fertilizer used in the program counties	hectare/ year	0	23,567	46,993	69,148	91,192	111,592	111,592
9	Area under fertigation in program counties	hectare/ year	0	1,964	3,975	6,081	8,115	10,059	10,059
10	Area under green manure in the program counties	hectare/ year	0	16,043	31,991	47,238	60,952	74,608	74,608
11	Beneficiaries who have been trained in green agricultural technologies and practices (farmers, input suppliers, enterprises/agri-businesses, extension staff), disaggregated by gender)	number	0	8,657	16,327	23,932	31,734	39,521	39,521
	Of which, female		0	2,921	5,659	8,415	11,194	13,953	13,953
12	Beneficiaries who have adopted green agricultural technologies and practices (farmers, input suppliers, enterprises/agri-businesses, extension staff), disaggregated by gender	percentage	0	15	30	45	60	70	70
	Of which, female		0	15	30	45	60	70	70
13	Quantity of livestock and poultry manure treated and recycled in the program counties	metric tons/year	0	411,888	823,777	1,235,665	1,647,554	2,059,442	6,178,327
14	Manure treated by large farms in the program counties	metric tons/year	0	162,693	325,386	488,080	650,773	813,466	2,440,398
15	Manure treated at centralized and small-scale manure treatment facilities constructed for small- and medium-scale farms in the program counties	metric tons/year	0	249,195	498,391	747,586	996,781	1,245,976	3,737,929
16	Centralized manure treatment facilities constructed for small -and medium-scale farms in the program counties	number	0	0	15	37	50	54	54

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	RA3. Increasing access to rural solid waste and wastewater services								
17	Spatial integrated village development plans (IVDPs) approved by the relevant program counties' authorities	number	0	0	110	240	355	413	413
18	Counties implementing the approved guidelines for wastewater and solid waste management in rural villages in the program counties	number	0	0	10	23	23	23	23
19	Beneficiaries trained in the operations and maintenance (O&M) of rural villages' wastewater and solid waste management systems (SWMS) in program counties	number	0	4,666	8,506	12,389	16,258	20,191	20,191
	Of which, female		0	1,526	2,889	4,266	5,642	7,033	7,033
20	Demonstration villages with newly- constructed or rehabilitated climate-resilient WWTFs and established solid waste collection, sorting, and transfer systems	number	0	0	11	50	94	108	108
21	Rural domestic wastewater facilities in demonstration villages meeting effluent discharge standards	percentage	36.5		40	50	65	70	70
22	Newly created and upgraded jobs held by women in the transformation of the agricultural value chain and in rural waste management and environmental rehabilitation	percentage	0	40	41	42	43	44	45
	RA4. Restoring and protecting degraded agricultural ecosystems								
23	Quantity of crop straw (rice, wheat, rapeseed) returned to the soil in farmlands in the program counties	metric tons/year	5,964,305	6,048,764	6,133,223	6,217,682	6,302,141	6,386,599	6,386,599
24	Regulations, technical guidelines, and standards on the treatment of aquaculture tailwater issued by provincial authorities and implemented by the program counties	number	0	0	8	10	10	10	10

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
25	Area of large-scale aquaculture farms (ponds) with tailwater treatment systems in the program counties	hectare	0	2,264	4,501	6,705	8,838	10,938	10,938
26	Regulations, technical guidelines, and standards developed for degraded agricultural land restoration and protection issued by the provincial authorities and implemented by the program counties	number	0	0	10	13	13	13	13
27	Area of agricultural farmland polluted with heavy metals that are treated and protected in the program counties	hectare	0	1,479	3,019	4,659	6,356	8,029	8,029

Annex 3 Green Agricultural and Rural Revitalization Program for Results Framework (Hunan: 13 Program Counties)

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	To enhance the adoption of environmentally-sustainable agricultural and rural infrastructure development practices in selected areas in Hubei and Hunan								
	Program Development Objective Indicators by Objectives/Outcomes								
1	Reduction in pollutant loads from agricultural production systems and rural domestic wastewater treatment facilities (WWTFs) (COD and NH_3N) achieved under the PforR in program counties	metric tons/year	0	5,370	8,690	47,247	85,804	124,378	124,378
	COD		0	4,847	7,843	45,534	83,225	120,915	120,915
	NH_3N		0	524	847	1,714	2,580	3,463	3,463
2	Greenhouse gas (GHG) emissions reduction achieved under the PforR in the program counties (RA2, RA3, and RA4)	$mtCO_2e$/year	0			744,164			1,240,273
3	Beneficiaries reached with assets or public services	CRI, number	0	0	678,178	1,356,356	2,034,535	2,712,713	3,390,891
	Of which, female		0	0	345,687	691,374	1,037,060	1,382,747	1,728,434
	Of which, ethnic minority		0	0	131,399	262,798	394,196	525,595	656,994
	Intermediate Results Indicator by Results Area								
	RA1. Strengthening institutional capacity for governance								
4	Number of program counties piloting the green budget tagging system	number	0		6	13	13	13	13

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
5	Number of program counties that have adopted the IT-based platform for mapping and M&E of rural infrastructure and public services.	number	0	0	6	13	13	13	13
6	Number of agro-products certified and/or registered in the PforR counties as either green, organic, or GI using the approved provincial regulations, standards, and guidelines	number	0	0	55	109	158	200	200
	RA2. Greening of selected agricultural value chains								
7	Quantity of chemical fertilizer reduced due to the adoption of green technologies and sustainable practices in selected crop production systems in the program counties	metric tons/year	0	5,651	11,010	15,971	20,594	24,950	78,176
8	Quantity of organic fertilizer used in the program counties	metric tons/year	0	143,394	276,988	400,582	518,276	631,070	631,070
9	Quantity of formula fertilizer used in the program counties	hectare/ year	0	17,580	34,926	50,908	66,679	80,692	80,692
10	Area under fertigation in program counties	hectare/ year	0	1,338	2,645	3,965	5,165	6,249	6,249
11	Area under green manure in the program counties.	hectare/ year	0	10,163	19,978	28,758	35,705	42,361	42,361

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
12	Beneficiaries who have been trained in green agricultural technologies and practices (farmers, input suppliers, enterprises/agri-businesses, extension staff), disaggregated by gender)	Number	0	5,100	10,200	15,300	20,400	25,500	25,500
	Of which, female		0	2,295	4,590	6,885	9,180	11,475	11,475
13	Beneficiaries who have adopted green agricultural technologies and practices (farmers, input suppliers, enterprises/agri-businesses, extension staff), disaggregated by gender).	percentage	0	15	30	45	60	70	70
	Of which, female		0	15	30	45	60	70	70
14	Quantity of livestock and poultry manure treated and recycled in the program counties	metric tons/year	0	247,572	495,143	742,715	990,287	1,237,859	3,713,576
15	Manure treated by large farms in the program counties	metric tons/year	0	90,962	181,923	272,885	363,846	454,808	1,364,424
16	Manure treated at centralized and small-scale manure treatment facilities constructed for small- and medium-scale farms in the program counties	metric tons/year	0	156,610	313,220	469,830	626,441	783,051	2,349,152
17	Centralized manure treatment facilities constructed for small- and medium-scale farms in the program counties	number	0	0	5	12	15	16	16
	RA3. Increasing access to rural solid waste and wastewater services								

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
18	Spatial integrated village development plans (IVDPs) approved by the relevant program counties' authorities	number	0	0	60	120	175	213	213
19	Counties implementing the approved guidelines for wastewater and solid waste management in rural villages in the program counties	number	0	0	6	13	13	13	13
20	Beneficiaries trained in the O&M of rural villages' wastewater and solid waste management systems (SWMS) in program counties.	number	0	2,150	4,300	6,450	8,600	10,750	10,750
	Of which, female		0	968	1,935	2,903	3,870	4,838	4,838
21	Demonstration villages with newly-constructed or rehabilitated climate-resilient WWTFs and established solid waste collection, sorting, and transfer systems	number	0	0	6	30	54	59	59
22	Rural domestic wastewater facilities in demonstration villages meeting effluent discharge standards	percentage	32	0	40	50	65	70	70
23	Newly- created and upgraded jobs held by women in the transformation of agricultural value chains and in rural waste management and environmental rehabilitation	percentage	0	40	41	42	43	44	45
	Restoring and protecting degraded agricultural ecosystems								

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
24	Quantity of crop straw (rice, wheat, rapeseed) returned to the soil in farmlands in the program counties	metric tons/year	3,486,761	3,532,934	3,579,107	3,625,280	3,671,453	3,717,625	3,717,625
25	Regulations, technical guidelines, and standards on the treatment of aquaculture tailwater issued by provincial authorities and implemented by the program counties	number	0	0	6	13	13	13	13
26	Area of large-scale aquaculture farms (ponds) with tailwater treatment systems in the program counties	hectare	0	1,479	3,019	4,659	6,356	8,029	8,029
27	Regulations developed and technical guidelines and standards developed for degraded agricultural land restoration and protection issued by the provincial authorities	number							
28	Area of agricultural farmland polluted with heavy metals that are treated and protected in the program counties	hectare	0	1,472	3,003	4,635	6,324	7,989	7,989

Annex 4 Green Agricultural and Rural Revitalization PforR Results Framework (Hubei: 10 Program Counties)

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	To enhance the adoption of environmentally- sustainable agricultural and rural infrastructure development practices in selected areas in Hubei and Hunan								
	Program Development Objective Indicators by Objectives/Outcomes								
1	Reduction in pollutant loads from agricultural production systems and rural domestic wastewater treatment facilities (WWTFs) (COD and NH_3N) achieved under the PforR in program counties	metric tons/year	0	3,946	6,386	35,187	63,988	92,788	92,788
	COD		0	3,562	5,763	33,933	62,103	90,273	90,273
	NH_3N		0	385	623	1,254	1,885	2,515	2,515
2	Greenhouse gas (GHG) emissions reduction achieved under the PforR in the program counties (RA2, RA3, and RA4)	$mtCO_2e$/year	0			448,397			747,329
3	Beneficiaries reached with assets or public services	CRI, number	0	0	751,985	1,503,969	2,255,954	3,007,938	3,759,923
	Of which, female		0	0	351,720	703,440	1,055,160	1,406,880	1,758,600
	Of which, ethnic minority		0	0	50,193	100,387	150,580	200,774	250,967
	Intermediate Results Indicator by Results Area								
	RA1. Strengthening institutional capacity for governance								
4	Number of program counties piloting the green budget tagging system	number	0		6	10	10	10	10
5	Number of program counties that have adopted the IT-based platform for mapping and M&E of rural infrastructure and public services	number	0	0	6	10	10	10	10
6	Number of agro-products certified and/or registered in the PforR counties as either green, organic, or GI using the approved provincial regulations, standards, and	number	0	0	40	80	120	157	157

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	guidelines								
	RA2. Greening of selected agricultural value chains								
7	Quantity of chemical fertilizer reduced due to the adoption of green technologies and sustainable practices in selected crop production systems in the program counties	metric tons/year	0	2,455	4,984	7,589	10,287	13,045	38,361
8	Quantity of organic fertilizer used in the program counties.	metric tons/year	0	57,200	115,600	175,000	236,400	298,900	298,900
9	Quantity of formula fertilizer used in the program counties	hectare/ year	0	5,987	12,067	18,240	24,513	30,900	30,900
10	Area under fertigation in the program counties.	hectare/ year	0	627	1,331	2,116	2,949	3,809	3,809
11	Area under green manure in the program counties	hectare/ year	0	5,880	12,013	18,480	25,247	32,247	32,247
12	Beneficiaries who have been trained in green agricultural technologies and practices (farmers, input suppliers, enterprises/agri-businesses, extension staff), disaggregated by gender)	number	0	3,557	6,127	8,632	11,334	14,021	14,021
	Of which, female		0	626	1,069	1,530	2,014	2,478	2,478
13	Beneficiaries who have adopted green agricultural technologies and practices (farmers, input suppliers, enterprises/agri-businesses, extension staff), disaggregated by gender)	percentage	0	15	30	45	60	70	70
	Of which, female		0	15	30	45	60	70	70
14	Quantity of livestock and poultry manure treated and recycled in the program counties	metric tons/year	0	164,317	328,634	492,950	657,267	821,584	2,464,751
15	Manure treated by large farms in the program counties	metric tons/year	0	71,732	143,463	215,195	286,927	358,658	1,075,974
16	Manure treated at centralized and small-scale	metric	0	92,585	185,170	277,755	370,341	462,926	1,388,777

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	manure treatment facilities constructed for small- and medium-scale farms in the program counties	tons/year							
17	Centralized manure treatment facilities constructed for small- and medium-scale farms in the program counties	number	0	0	10	25	35	38	38
	Increasing access to rural solid waste and wastewater services								
18	Spatial integrated village development plans (IVDPs) approved by the relevant program counties' authorities	number	0	0	50	120	180	200	200
19	Counties implementing the approved guidelines for wastewater and solid waste management in rural villages in the program counties	number	0	0	4	10	10	10	10
20	Beneficiaries trained in the O&M of rural villages' wastewater and solid waste management systems (SWMS) in program counties	number	0	2,516	4,206	5,939	7,658	9,441	9,441
	Of which, female		0	558	954	1,363	1,772	2,195	2,195
21	Demonstration villages with newly-constructed or rehabilitated climate-resilient WWTFs and established solid waste collection, sorting, and transfer systems	number	0	0	5	20	40	49	49
22	Rural domestic wastewater facilities in demonstration villages meeting effluent discharge standards	percentage	41	41	50	65	70	70	70
23	Newly- created and upgraded jobs held by women in the transformation of the agricultural value chain and in rural waste management and environmental rehabilitation	percentage	0	40	41	42	43	44	45
	RA4. Restoring and protecting degraded agricultural ecosystems								
24	Quantity of crop straw (rice, wheat, rapeseed)	metric	2,477,544	2,515,830	2,554,116	2,592,402	2,630,688	2,668,974	2,668,974

Item	Indicator Name	Unit of Measure	Baseline 2021	2024	2025	2026	2027	2028	End Target 2029
	returned to the soil in farmlands in the program counties	tons/year							
25	Regulations, technical guidelines, and standards on the treatment of aquaculture tailwater issued by provincial authorities and implemented by the program counties	number	0	0	6	10	10	10	10
26	Area of large-scale aquaculture farms (ponds) with tailwater treatment systems in the program counties	hectare	0	2,264	4,501	6,705	8,838	10,938	10,938