Report No: ICR00275

IMPLEMENTATION COMPLETION AND RESULTS REPORT

(Loan no. 88290)

ON A

LOAN

IN THE AMOUNT OF

US$ 420 MILLION EQUIVALENT

TO

India

FOR

the Maharashtra Project on Climate Resilient Agriculture

January 28, 2025

Agriculture and Food

South Asia

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CURRENCY EQUIVALENTS

Exchange Rate Effective December 31, 2024

Currency Unit =	US$
INR 85.60 =	US$1

FISCAL YEAR
April 1 – March 31

ABBREVIATIONS AND ACRONYMS

ATMA	Agriculture Technology Management Agency
DBT	Direct Beneficiary Transfer
DoA	Department of Agriculture
DPIU	District Project Implementation Unit
FIG	Farmer Interest Group
FPO/FPC	Farmer Producer Organization/ Farmer Producer Company
GHG	Greenhouse Gas
GoI	Government of India
GoM	Government of Maharashtra
ICAR	Indian Council of Agricultural Research
IPM	Integrated Pest Management
IRR	Internal Rate of Return
NIPHT	National Institute of Post Harvest Technology
NPV	Net Present Value
NRM	Natural Resource Management
PAD	Project Appraisal Document
PDO	Project Development Objective
PMU	Project Management Unit
PoCRA	Project on Climate Resilient Agriculture
SAU	State Agriculture University
SHG	Self Help Group
SMART	State of Maharashtra Agribusiness and Rural Transformation

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DATA SHEET

BASIC DATA

Product Information

Operation ID	Operation Name
P160408	Maharashtra Project on Climate Resilient Agriculture

Product	Operation Short Name
Investment Project Financing (IPF)	Maharashtra PoCRA

Operation Status	Approval Fiscal Year
Closed	2018

Original EA Category	Current EA Category
Partial Assessment (B) (Approval package - 27 Feb 2018)	Partial Assessment (B) (Restructuring Data Sheet - 07 Jul 2023)

CLIENTS

Borrower/Recipient	Implementing Agency
Republic of India	Department of Agriculture, Government of Maharashtra

DEVELOPMENT OBJECTIVE

Original Development Objective (Approved as part of Approval Package on 27-Feb-2018)

To enhance climate-resilience and profitability of smallholder farming systems in selected districts of Maharashtra.

FINANCING

Financing Source	Original Amount (US$)	Revised Amount (US$)	Actual Disbursed (US$)
World Bank Financing	420,000,000.00	420,000,000.00	419,937,418.93

IBRD-88290	420,000,000.00	420,000,000.00	419,937,418.93
Non-World Bank Financing	179,550,000.00	0.00	0.00
Borrower/Recipient	179,550,000.00	0.00	0.00
Total	**599,550,000.00**	**420,000,000.00**	**419,937,418.93**

RESTRUCTURING AND/OR ADDITIONAL FINANCING

Date(s)	Type	Amount Disbursed (US$M)	Key Revisions
07-Jul-2023	Portal	290.00	• Results • Reallocations

KEY DATES

Key Events	Planned Date	Actual Date
Concept Review	05-Jan-2017	31-Jan-2017
Decision Review	06-Nov-2017	06-Nov-2017
Authorize Negotiations	20-Nov-2017	02-Jan-2018
Approval	27-Feb-2018	27-Feb-2018
Signing		06-Apr-2018
Effectiveness		18-May-2018
ICR/NCO	30-Jan-2025	--
Restructuring Sequence.01	Not Applicable	07-Jul-2023
Mid-Term Review No. 01	16-May-2022	16-May-2022
Operation Closing/Cancellation	30-Jun-2024	Automatically populated from Loans System

RATINGS SUMMARY

Outcome	Bank Performance	M&E Quality
Satisfactory	Satisfactory	Substantial

ISR RATINGS

No.	Date ISR Archived	DO Rating	IP Rating	Actual Disbursements (US$M)
01	22-Jun-2018	Satisfactory	Satisfactory	0.00
02	22-Jan-2019	Satisfactory	Satisfactory	0.82
03	06-Nov-2019	Satisfactory	Satisfactory	4.37
04	28-Jun-2020	Satisfactory	Moderately Satisfactory	31.87
05	03-Feb-2021	Satisfactory	Moderately Satisfactory	49.40
06	01-Dec-2021	Satisfactory	Moderately Satisfactory	149.61
07	16-Jun-2022	Satisfactory	Satisfactory	210.49
08	14-Dec-2022	Satisfactory	Satisfactory	265.39
09	25-May-2023	Satisfactory	Satisfactory	290.00
10	29-Nov-2023	Satisfactory	Satisfactory	355.38
11	03-Apr-2024	Satisfactory	Satisfactory	415.43

SECTORS AND THEMES

Sectors

Major Sector	Sector	%	Adaptation Co-benefits (%)	Mitigation Co-benefits (%)
FY17 - Agriculture, Fishing and Forestry	FY17 - Agricultural Extension, Research, and Other Support Activities	25	64	18
	FY17 - Irrigation and Drainage	51	100	0
	FY17 - Public Administration - Agriculture, Fishing & Forestry	15	92	4
FY17 - Industry, Trade and Services	FY17 - Agricultural markets, commercialization and agri-business	9	81	8

Themes

Major Theme	Theme (Level 2)	Theme (Level 3)	%
	FY17 - Climate change	FY17 - Adaptation	88

FY17 - Environment and Natural Resource Management		FY17 - Mitigation	6
	FY17 - Renewable Natural Resources Asset Management	FY17 - Watershed Management	34
	FY17 - Water Resource Management		59
FY17 - Finance	FY17 - Finance for Development	FY17 - Agriculture Finance	41
FY17 - Urban and Rural Development	FY17 - Disaster Risk Management	FY17 - Flood and Drought Risk Management	100
	FY17 - Rural Development	FY17 - Rural Infrastructure and service delivery	38
		FY17 - Rural Markets	19

ADM STAFF

Role	At Approval	At ICR
Practice Manager	Kathryn Hollifield	Gayatri Acharya
Regional Director		Dina Umali-Deininger
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ICR Main Contributor	Jim Hancock, Ranjan Samantaray and Ademola Braimoh	

I. PROJECT CONTEXT AND DEVELOPMENT OBJECTIVES

CONTEXT AT APPRAISAL

1. At the time of appraisal, a resilient agricultural sector was important for India's and the State of Maharashtra's development, with the sector accounting for 18 percent of national GDP, and providing key livelihoods to more than half of the country's population, including a significant portion of the poor. Maharashtra has long been one of India's key economic growth engines and continues to hold this position. As the second largest state, it remains one of the most advanced in terms of development and growth rates. Although agriculture contributes 10 percent to the state's economy, it remains a primary source of livelihood for 50 percent of the population.

2. Maharashtra's agricultural sector grew at an average rate of 3.5 percent annually between 2004-05 and 2014-15, but growth was highly variable due to erratic rainfall and the presence of arid, drought-prone districts. Agriculture is the largest consumer of water, facing increasing pressure from competing demands. Dominated by small and marginal farmers with an average farm size of less than 2 hectares, most production is rain-fed. Although crop productivity has increased, significant yield gaps remain. Kharif dry spells and limited groundwater availability during the Rabi season further constrain productivity. While Maharashtra faces less groundwater depletion than other states, seasonal shortfalls are increasing.

3. In the years leading up to the project, severe consecutive droughts across large parts of Maharashtra significantly impacted agricultural performance and rural livelihoods. This led the state's top authorities to prioritize "drought-proofing" agriculture as a key development goal. A combination of climate shocks and economic pressures positioned Maharashtra as one of the states with high levels of farmer distress. Following the Government of India's release of the National Action Plan on Climate Change (NAPCC), Maharashtra developed the Maharashtra State Adaptation Action Plan on Climate Change (MSAAPCC). This plan included a comprehensive vulnerability assessment with climate projections, which predicted reduced productivity for key crops. It emphasized the need to integrate climate change considerations into the state's overall development strategy to build long-term climate resilience and support adaptation to climate risks, such as rising temperatures, more intense but shorter rainfall, and extreme weather events.

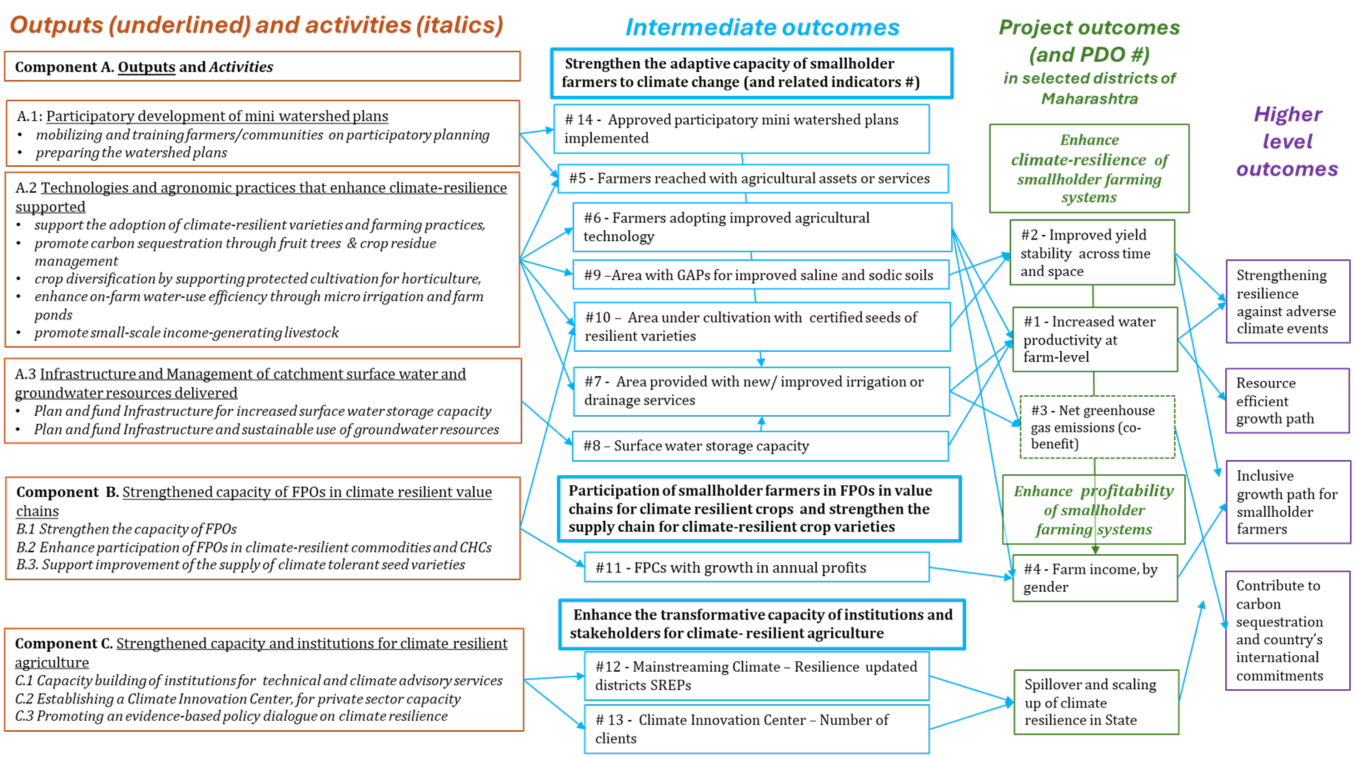
4. India showed strong commitment to both climate adaptation and mitigation, with agriculture being the second-largest contributor to its GHG emissions. Despite being one of the largest GHG emitters, India's per capita emissions remain among the lowest globally. The Government of India (GoI) has launched several policies and programs, including the National Initiative on Climate Resilient Agriculture (NICRA), promoting climate-resilient technologies, efficient water use, drought management, and integrated watershed development. India's Intended Nationally Determined Contribution (INDC) to the 2016 COP21 Paris Agreement emphasized carbon sequestration. These efforts are particularly critical as water stress poses a major challenge for agriculture and broader development in India.

5. During the design phase of the India 2017 Systematic Country Diagnostic (SCD) that informed the Country Partnership Framework (CPF), it was emphasized that the country's growth strategy must fully account for the significant constraints related to land and water resource availability. The strategy should shift towards a more resource-efficient growth path while ensuring inclusivity to prevent a widening urban-rural gap. Similarly, the project aligns with the Bank's Climate Change Action Plan (CCAP), which highlights climate-resilient agriculture and water management as key priorities for climate adaptation in the South Asia Region (SAR).

A. THEORY OF CHANGE (RESULTS CHAIN)

6. A Theory of Change (ToC) of the Maharashtra Project on Climate Resilient Agriculture (PoCRA) has been reconstructed as the originally designed ToC in the Project Appraisal Document (PAD) did not adequately capture all impact pathways of the project. The purpose of this reconstruction is to show causality within the project. The ToC suggests that the key objectives of the project depend on activities that address sectoral challenges to reduce farmers' vulnerability to climate change – to enhance their climate-resilience and livelihoods and incomes: profitability from farming systems. The investments focused on (a) fostering adoption of climate-resilient technologies by farmers; (b) promoting their participation in value chains and improving their market access; and (c) strengthening institutional capacity for climate-resilient agriculture.

Figure 1. Theory of Change (Results Chain)



B. PROJECT DEVELOPMENT OBJECTIVES (PDOs)

7. The PDO of PoCRA *is "to enhance climate-resilience and profitability of smallholder farming systems in selected districts of Maharashtra"*.

8. **Key Expected Outcomes and Outcome Indicators:** The expected outcomes based on the PDO statement and the associated PDO indicators (mentioned as Key Performance Indicators (KPI) in the PAD) are as follows:

(a) Expected Outcome-1: To enhance climate-resilience of smallholder farming systems, through greater resource use efficiency and production stability

- PDO Indicator #1: Increased water productivity at farm-level

- PDO Indicator #2: Improved yield stability (that is, across time and space)

(b) Expected Outcome-2: To enhance profitability of smallholder farming systems

- PDO Indicator #4: Increase in net farm income, by gender

9. These would be achieved by reaching 1.32 million farmers with agricultural assets or services (PDO Indicator #5) in the most vulnerable clusters across 15 drought-prone and mainly rainfed districts of Maharashtra. In relation to Expected Outcome-1 on enhancing climate resilience, the project was also expected to generate a *co-benefit* by contributing to carbon sequestration (implied in the higher-level outcome in the ToC). Although not explicitly mentioned in the PDO statement, this *co-benefit* was included in the PAD as PDO Indicator #3: Net greenhouse gas emissions [CRI].

C. COMPONENTS

10. The project aimed to achieve the stated PDO through four components. The various components and subcomponents are summarized in the following paragraphs.

Component A: Promoting Climate-resilient Agricultural Systems (IBRD: US$316.47 million)

11. The objective of this component was to strengthen the adaptive capacity of smallholder farmers to adjust and modify their production systems in order to moderate potential future impacts from climate events. The sub-components included: ***A.1: Participatory development of mini watershed plans*** to guide the design and implementation of multi-sector project interventions aimed at enhancing climate-resilience of the local agricultural systems.

12. ***A.2: Promote the transfer of on-farm technologies and agronomic practices*** that enhance climate-resilience in the agricultural systems, for enhanced agriculture productivity, improved soil health, and increased water-use efficiency – and increased farm income. The project supported advisory systems and Farmer Field Schools (FFS) to promote the demonstration of climate-resilient varieties on field and provide matching grants to eligible individual farmers through a Direct Benefit Transfer (DBT) system. The component significantly contributes to climate co-benefits by mitigating GHG emissions through carbon sequestration, catchment improvement (A.3), horticulture, and soil agronomic practices

13. ***A.3: Enhance the management of surface water and groundwater resources*** in the catchment areas of the project's mini watersheds to help reduce agriculture's vulnerability to extended in-season dry spells and lower than normal annual rainfalls, through drainage line and catchment area treatment.

Component B: Post-harvest Management and Value Chain Promotion (IBRD: US$39.65 million)

14. The objective of this component was to support the participation of smallholder farmers in Farmer Producer Organizations (FPOs) and integration of these FPOs in value chains for crops relevant to the climate agenda, and to strengthen the supply chain for climate-resilient crop varieties in the project area. It included (i) developing smallholder-inclusive value chains for climate-resilient commodities, and (ii) overcome constraints in the seed supply chain and address shortages in the availability of stress-resistant seed varieties.

Component C: Institutional Development, Knowledge and Policies for a Climate-resilient Agriculture (IBRD: US$23.56 million)

15. The objective of this component was to enhance the transformative capacity of institutions and stakeholders to promote and pursue a more climate-resilient agriculture, with strategies and policies based on strong analytical underpinnings and cutting-edge climate, water and crop modelling. It would do so by: (i) strengthening the capacity of existing institutions to design and deliver agro-technical and climate advisory services, including the revision of Strategic Research and Extension Plans (SREP), promoting an evidence-based policy dialogue on climate resilience, as well as the

design and implementation of a comprehensive Information and Communication Technology (ICT) platform for the project, and (ii) establishing a Climate Innovation Center (CIC), to support local private sector capacity to scale-up technologies for a climate-resilient agri-food system in Maharashtra, with support the development and start-up phase.

Component D: Project Management (IBRD: US$39.27 million)

16. This component would ensure the efficient and effective overall management of the project through a Project Management Unit (PMU) set up by the Department of Agriculture, Govt. of Maharashtra (GoM), adequately staffed with technical specialists, cover the overall project Monitoring and Impact Evaluation (M&IE) and reporting activities, including the project impact evaluation, communication, public awareness and outreach, covering project incremental operating costs.

SIGNIFICANT CHANGES DURING IMPLEMENTATION

17. During project implementation, new information became available (through baseline and midline surveys) that suggested the initial baseline assumptions made during appraisal (based on secondary data) were not accurate for four indicators. In 2022-23, a restructuring was therefore conducted to adjust the results framework, primarily revising the baseline and, accordingly, the end-of-project targets without altering their scope and scale (see Annex-1.1).

Revised PDOs and Outcome Targets

18. There were no changes to the Project Development Objective (PDO) or the outcome indicators. During restructuring, targets for water productivity, yield stability (PDO level indicator), and seed supply (intermediate indicator) were updated based on baseline survey figures. The targets were modified, but only to ensure that the relative change remained consistent with the new baselines.

II. OUTCOME

RELEVANCE OF PDO

Rating: High

19. **The PDO was considered highly relevant during the appraisal and continued to maintain its significance throughout the project's implementation.** Its high relevance stems from its alignment with sectoral challenges, as well as the priorities and strategies of both the GoI and GoM in promoting agricultural resilience. Additionally, it was consistent with the World Bank's CPF. At the time of project closure, the core PDO of fostering resilience alongside growth remained highly relevant to the ongoing priorities of the GoI, the GoM, and the CPF, especially in addressing agricultural issues. In 2023, the state experienced severe drought, affecting 66 percent of the area, with 40 talukas in 15 districts officially declared as drought-hit. The drought was driven by a 13.4 percent reduction in monsoon rainfall, which resulted in higher temperatures and delayed sowing of rabi crops. Climate modeling suggests that future trends will include hotter conditions and erratic rainfall, further affecting agriculture (MSAAPCC, 2023). Thus, the continued relevance of the PDO is crucial for ensuring the long-term success, sustainability, and alignment of future projects with broader development goals in Maharashtra.

20. The project's objectives remain highly relevant given the increasing need for efficient use of agricultural resources. Nitrogen applications per unit area (hectare) in India continue to rise, albeit with low efficiency. Overall, India is the world's third-largest GHG emitter, with the agriculture sector contributing 13.5 percent of total emissions, which are also on the rise. The focus on agricultural value chains remains critical as well not only for supporting growth but also

for addressing efficiency in timely handling of agriculture produce. Efficiency gains in this area are crucial for achieving growth objectives.

21. **Agriculture remains a cornerstone of policy for both the State and the Government of India.** The GoM has set major agriculture sector targets in its Vision 2030, which include scaling up successful approaches from PoCRA on resilience, yield improvements, reducing cultivation costs, promoting water conservation for soil health, and enhancing value addition through strong science partnerships and digital tools. The Ministry of Agriculture and Farmers Welfare, GoI, is proposing to replicate the PoCRA approach in three hundred of the most vulnerable districts in the country, incorporating several key elements (see section on Institutions). The project is fully aligned with the country's international commitments, including the COP 21 Paris Agreement (2016) and the updates in the 2023 Third National Communication (TNC) and Initial Adaptation Communication (IAC).

22. **The Project Development Objective is well aligned with the India Country Partnership Framework** (FY2018-22), which emphasizes a resource-efficient, inclusive, and diversified rural sector, as well as improving disaster risk management and resilience to climate change. Additionally, the PDO supports the World Bank's commitment to Paris Agreement on climate change.

23. **Assessment of Relevance of PDOs and Rating:** The PDO remains fully consistent with critical national and state priorities, and focus areas of the current CPF, as well as current and future climate trends and farmer needs.

ACHIEVEMENT OF PDOs (EFFICACY)

Rating: Substantial

A. ASSESSMENT OF ACHIEVEMENT OF OUTCOMES

24. **Methodology**. The project's efficacy was evaluated by assessing the achievement of the Project Development Objectives (PDO) using PDO indicators in the Results Framework (Annex 1). The evaluation synthesized data from the project's Monitoring and Evaluation (M&E) system, mission documents, and studies by independent agencies. It focused on key PDO-level outcomes, analyzing activities and outputs linked to these outcomes, as outlined in the Theory of Change. To enrich the analysis, additional data from the Impact Assessment (IA) were integrated. The IA surveyed households in project villages and compared them to households in similar 'control' villages in the same districts. It used a Quasi-experimental design with the Difference-in-Difference approach, where farmers were randomly sampled at both the baseline and endline stages. Control villages and clusters were selected to match the resilience characteristics of the project villages. Socio-economic characteristics showed a good match. At baseline, the mean yield of key crops in the project area was 10.56 quintals per hectare, with a standard deviation of 3.22. In the control area, the mean yield was 10.97 quintals per hectare with a standard deviation of 3.00, showing no significant difference at the 5 percent probability level, indicating comparability before project activities. The impact assessment of PoCRA showed statistically significant greater adoption, improved input use, and higher income among project farmers compared to the control group. Findings are conservative in attribution, as control villages likely benefitted from some spillover effects. The GoM adopted several PoCRA-initiated activities, including the DBT system, integrated into the state's 'Maha-DBT' initiative. Furthermore, the promotion of Climate-Resilient Agriculture Technologies (CRAT) expanded to control villages within the same districts, with support from other government schemes. Some farmer producer companies supported by PoCRA also extended services to farmers outside the project villages.[1]

[1] The IA performed statistical tests on the differences between control beneficiaries (households), direct beneficiaries receiving DBT, and 'spillover' farmers in Project

Overview of outcomes

25. In summary, the project was notably successful in achieving its development objectives, with related indicators (see Annex 1), particularly in enhancing resilience through improved and more efficient use of resources, especially water, as well as soil and crop management. It also led to increased incomes and profitability by boosting productivity and reducing farming costs. This success was driven by highly effective processes (discussed in further sections) supported by a robust public enabling environment and a scalable program approach. PoCRA offered farmers a localized menu of options, supported by the DBT system, which ensured transparent and efficient funding (Box 1). This incentivized large-scale, demand-driven adoption. Additionally, the project provided targeted, science-backed advisory services and FFS on a very large scale.

Box 1: The Direct Benefit Transfer (DBT) Systems under POCRA

Dedicated DBT systems were developed to directly deliver funds to farmers for CRA technologies, communities for Natural Resource Management (NRM) interventions, and FPOs for machinery, storage, and processing. While other states have adopted DBT systems, PoCRA's systems are unique as they are UID (Aadhaar)-linked, provide farmers with a menu of options, are demand-driven rather than target-driven, are open to a range of vendors, and include mechanisms to prioritize special groups. Although the system took over a year to set up—resulting in low project disbursements at the start—once operational, it allowed farmers to access DBT with transparent, clear, and trackable online applications. Localized approval levels led to high disbursement rates and full fund releases with minimal leakage. This approach also strengthened due diligence in transfers, supported by geotagging and performance tracking to ensure financial accountability.

B. OUTREACH

26. The planning, advisory, and training systems, combined with access to finance and high awareness of the various project processes, enabled PoCRA to exceed its outreach target of 1.32 million farmers, reaching 1,365,233 (PDO Indicator #5 - unique beneficiary numbers). The project delivered substantial benefits on a very large scale in the most vulnerable villages, which were selected based on a multi-criteria vulnerability assessment developed by the Central Research Institute for Dryland Agriculture (CRIDA) and aligned with IPCC parameters. This scale and focus were unprecedented among World Bank agriculture and climate change projects globally. The number of women reached was slightly below target (26 percent), reflecting the proportion of lead women farmers and women-headed households in the project areas.

C. PDO OUTCOME 1 - ENHANCED CLIMATE RESILIENCE OF SMALL HOLDER FARMING SYSTEMS.

27. The project significantly enhanced the adaptive capacity of smallholder farmers, enabling them to adjust and modify their production systems to better cope with ongoing and anticipated climate impacts. This was achieved through more judicious use of critical resources, particularly water, which helped reduce yield variability while also increasing overall productivity. Additionally, these efforts yielded co-benefits by reducing GHG emissions.

PDO Outcome 1- Part 1: Water use efficiency

28. A principal measure of the efficient use of resources, crucial for farmers to reduce costs and expand their agriculture production, is water use efficiency (PDO Indicator #1). The project successfully achieved its target of a 20 percent increase in water use efficiency for four out of five crops, with an overall actual achievement of 25 percent (Annex 1). Notably, this improvement was relative to control villages, which experienced a reduction in productivity across most crops measured by the indicator (Annex 1.1 Table 1). This achievement is significant, as in

villagers who did not receive the DBT, finding positive significant differences on key parameters between the groups.

the endline year (2023-24), the districts faced severe dry spells and heavy precipitation events (Annex 1.1 Figure 1 on seasonal rainfall anomalies). Despite these challenges, project farmers were able to increase their water use efficiency.

29. The project significantly increased water use efficiency (Annex 1.1) by improving both crop productivity and water management practices. On the productivity side, yields in project areas saw a significant increase compared to control areas. On the efficiency side, the project implemented measures to optimize water use (drip and sprinkler irrigation systems) under Component A.2. Additionally, interventions like soil and water conservation practices, enhanced water retention through increased biomass and mulching, while intercropping reduced evaporation. Conveyance systems like pipes and precision pumps improved water distribution efficiency. Surface water availability was also improved through the construction of farm and community ponds, along with catchment area treatments that enhanced rainwater harvesting and groundwater recharge. Awareness campaigns educated stakeholders on sustainable water extraction limits. These efforts resulted in 4,315 watershed works creating 32,866 thousand cubic meters (TCM) of additional storage and 11,120 farm ponds contributing 30,375 TCM. Dug wells and recharge structures further boosted groundwater levels, strengthening water security in the project areas.

PDO Outcome 1, Part 2 - Reduced climate vulnerability and crop production

30. A key achievement of the project was its success in enhancing resilience, as reflected in PDO indicator #2, which measured the reduction in farm productivity variability by strengthening farmers' capacity to adapt to adverse climatic events. Farm productivity demonstrated greater stability, particularly in mitigating extreme yield fluctuations and reducing the incidence of low yields. For core indicator crops such as soybeans and pigeon peas, yield uniformity and stability improved significantly, as evidenced by a reduction in the Coefficient of Variation (CV) (PDO #2) both spatially and temporally. Midterm targets were revised to reflect updated baseline data (Annex 1.1, table 4). Spatial yield variability in farm productivity, assessed across districts and households within the project area, showed a CV reduction of approximately 17 percent (reduction in CV from 36 to 30) for soybeans and 21 percent (reduction in CV from 66 to 52) for pigeon peas (Annex 1). In comparison, control areas exhibited only minimal reductions or, in some cases, increases in CV, based on IA data. Temporal CV analysis utilized Department of Agriculture district data and covered non-comparable time periods. Despite this methodological differences, the spatial CV findings also captured temporal trends through a difference-in-difference (DiD) approach, demonstrating a significant improvement in yield stability for project households compared to control households from baseline to endline.

31. Further analysis of district-level data from 2017 to 2024 revealed fluctuations over time (Annex 1.1) but showed an overall decline in variability, especially in the final two years of the project for both soyabean and pigeon pea. This trend persisted despite significant drops in rainfall during critical months, such as August 2022 and 2023, in project districts. Interestingly, despite dry spells, overall productivity for soybean and pigeon pea in the project districts either increased or remained stable in 2023. The marked decline in CV especially for soybean over time aligns with survey findings, highlighting improved resilience in productivity.

32. Farmers in project areas reported higher productivity across all key crops compared to control areas, along with reduced yield variability. These outcomes were largely driven by extension services, capacity-building efforts, and DBT resources provided under Component A.2. Key practices included efficient water use through drip and sprinklers, increased intercropping, crop rotation, precise timing of inputs, enhanced soil management and soil water retention. These measures (like broad bed furrow) were particularly effective in mitigating losses during extreme weather events. Adoption of climate-resilient agricultural technologies (CRAT) was assessed through household surveys as part of Intermediate Indicator #6. Using a narrow definition, where training was directly linked

to technology uptake, IA estimated that 1,079,700 farmers adopted CRATs, representing 85 percent of the PAD target of 1,272,800. Overall adoption rates exceeded 80 percent, with spillover effects seen outside project villages. Although the IA survey found an adoption rate of 80 percent at the endline, the ICR team, in collaboration with the M&E team, PMU, and through field observations, estimated a more conservative adoption rate of 70 percent. This estimate accounted for 10 percent attrition over the long run and considered both the intensity and quality of adoption, based on existing practices and the field experience of the implementing and monitoring teams. This rate was used in EFA analyses, reflecting a balanced assessment of adoption (Annex 4).

33. The project made a significant contribution to resilience by promoting certified climate-resilient seed varieties developed by local universities for key crops. This initiative aimed to improve seed replacement rates with high-quality seeds. The adjusted interim target of 86 percent adoption was exceeded, reaching 89 percent (Intermediate Indicator #10). These resilient seed varieties effectively addressed challenges such as late rainfall, dry spells, pests, and diseases, while also offering shorter maturity periods. Additionally, they delivered higher yields and improved market quality. The project further strengthened the certified seed system (Box-2) by collaborating with farmers to grow and market these seeds through farmer producer companies (subcomponent B3), reducing dependency on external suppliers.

Box 2: Certified Seed System Support

The project could depend on locally developed seeds by State Agriculture Universities (SAU), that were certified stress tolerant – short maturity duration and pest tolerant.

- The project supported farmers to own their production – and in turn developing them as entrepreneurs supplying state seed corporation, and to sell to other farmers.
- A total of 24,200 farmers were involved in seed production across 58,510 hectares, producing 956,255 quintals under a buy-back arrangement with the state seed corporation. Farmers were actively engaged through FPCs, contributing to localized agribusiness development.

34. The project also set specific targets for promoting Good Agricultural Practices (GAP) in areas with saline and sodic soils. Through an advisory and support system, farmers in 932 villages adopted GAPs across 146,826 hectares, surpassing the Intermediate Indicator #9 target by 16 percent. A variety of practices helped farmers manage soil salinity, including balanced fertilizer application, micronutrient dosing, micro-irrigation, and improved cropping techniques. Notably, only 2 percent of farmers surveyed in these areas did not adopt any of the recommended treatments.

35. The widespread adoption of new practices and technologies in the project was driven by integrated planning and decision-support systems, combining FFS with an ICT-based advisory program. This system reached all farmers registered with the DBT. Localized, targeted information was delivered through the extension network, including Agriculture Officers, local assistants, and ‘Krishi Tai’ extension workers. The DBT system facilitated adoption by offering a transparent application process with fast local approvals and fund disbursement. This user-friendly system allowed farmers to secure upfront funds from banks while awaiting DBT disbursements. Even in areas with established extension systems, project farmers had significantly better access to advisory services and mobile apps, highlighting the project’s success in bridging technology gaps.

Climate co-benefit through carbon sequestration and reduction in GHG emissions

36. While not part of the PDO statement, the project’s promotion of climate-resilient agricultural technologies and practices was also expected to deliver co-benefits by contributing to carbon sequestration and reducing emissions (KPI #3). These results were anticipated through activities such as tree planting in upper catchments, cultivating fruit trees, incorporating crop residues (biomass) into the soil, and adopting conservation agriculture practices like reduced tillage.

37. A rapid review of the original GHG assessment and target setting, based on data from the PAD Annex and using EX-ACT, indicated that initial targets were likely overestimated, particularly regarding afforestation and the projected increase in soil biomass intensity. As a result, the original target was not met. No direct measurements were taken for soil carbon changes or emissions impacts from irrigation and fertilizer use; these effects were estimated. An updated calculation (Annex 5), incorporating endline data, revised cropping patterns, adjusted input assumptions, and a review of potential impact areas, revealed significant emissions reduction potential through climate-resilient agricultural practices. Although the original target was not achieved, reductions were primarily due to increased horticulture, improved soil management, reduced water usage per unit area, and optimized fertilizer application. These gains occurred alongside the expansion of cropping areas, increasing cropping intensity, consistent with emissions reductions seen in other CRA projects (FAO, pers. comm.).

38. Annex 5, Table 2 illustrates the impact of project activities on the GHG balance. The EX-ACT analysis indicates a significant positive environmental effect, with a total carbon balance of -27,639,069 tCO2-eq over 20 years, equivalent to -1,381,953 tCO2-eq annually. Based on the total project area, this translates to -0.5 tCO2-eq per hectare per year. These findings confirm that PoCRA interventions resulted in net GHG emission reductions compared to the baseline or "without-project" scenario, highlighting a key co-benefit of the project. Additionally, alternative scenarios with lower adoption rates of improved management practices were evaluated. Even at a 30 percent adoption rate, the net carbon balance remains robust at -23,729,538 tCO2-eq.

D. PDO OUTCOME 2 - ENHANCED PROFITABILITY OF SMALLHOLDER FARMERS

39. **The project was built on a critical and perhaps unique premise: resilience in agriculture must include farmer profitability, as income resilience is essential to broaden agricultural resilience efforts**. This is particularly crucial because, for farmers to adopt CRA practices and technologies, they need assurance that these measures will not lead to income loss or increased risks—especially in a "farmer distress" state like Maharashtra. Increasing farmers' income strengthens their livelihood and household resilience, enabling them to better withstand economic and climatic shocks. This financial security also enhances farmers' confidence to diversify their livelihoods, whether through on-farm or off-farm activities, further bolstering resilience.

40. The project, alongside the government and science partners, invested significant effort in understanding models for calculating the cost of cultivation, coupled with a strategic vision focused on achieving medium-input, medium-return outcomes with lower risks, rather than high-input, high-return models with greater risks. This approach played a key role in driving notable increases in net farm income in project areas. Annual Net farm income in project areas rose from approximately INR33,000 (adjusted to endline prices) at the start of the project to INR75,000 by the end—a 128 percent increase. In contrast, as a comparator (PDO Indicator #4), control areas saw a much smaller increase, from INR 38,000 to INR51,000, representing only a 35 percent increase. The calculated difference-in-differences (DiD) showed an 88 percent increase in project areas, significantly exceeding the 50 percent PDO target for income growth. For female-headed households, the findings of the impact assessment, comparing endline differences between project and control areas, indicated a 38 percent greater increase in net farm income in project areas compared to control areas, slightly below the PDO target.

41. Several factors contributed to the significant net income increase, both through higher income and reduced costs for farmers (nearly one-third reduction). On the income side, farmers were able to increase cropping intensity, achieving higher productivity due to improved practices and use of better seeds (Component A2). Additionally, participation in FPOs (Subcomponent B1) enabled farmers to secure preferential prices for their products. On the cost-reduction side, farmers benefited from access to Custom Hiring Centers (CHCs), which allowed use of machinery

more quickly and at lower costs (Subcomponent B2). They also adopted practices with support from Subcomponent A2, both through training and advisory services, as well as the DBT incentive, which integrated nutrient and pest management more efficiently, reducing the inputs cost. Irrigation costs were significantly lowered through the widespread adoption of drip and sprinkler systems, minimizing conveyance losses. These improvements spanned multiple crops. These combined efforts led to enhanced profitability and overall economic benefits for the farmers.

42. **Participation of smallholder farmers in FPOs enhanced farm incomes.** It significantly contributed to income improvements and provided broader resilience support to farmers. The FPO initiative was highly successful, reaching 232,000 direct farmer members, including 110,000 in the project's cluster villages and an additional 125,000 in non-cluster villages within the project districts. Furthermore, a large but underestimated number of non-member farmers also benefited from the FPOs' services and inputs, often in numbers far exceeding direct members, potentially contributing to spillover effects in control areas. The FPOs were notably inclusive, with 77 percent of members being small and marginal farmers, and over a quarter of the members being women. This inclusivity strengthened the FPOs' role in enhancing both economic and social resilience among project area farmers.

43. The project successfully disbursed 4,701 proposals for FPOs through the FPO-dedicated DBT mechanism, with two-thirds in PoCRA clusters, totaling INR501.7 million. The FPOs financed INR780 crore and raised INR112 crore (around US$13 million) in institutional credit. About 200 out of 345 FPCs showed growth and profitability, surpassing intermediate indicator #11, indicating strong business orientation. The initiative supported climate-resilient agriculture through certified stress-tolerant seeds and CHCs, covering 833,700 hectares across multiple seasons. It reduced costs, improved labor efficiency, and helped farmers secure better prices through timely grading and marketing. FPOs also provided access to lower-cost inputs and supported diversification efforts like sericulture. Storage facilities, with a capacity of 180,836 metric tons, reduced storage losses from 20 to 5 percent. Additionally, food and grain processing units were established, covering 41,000 metric tons. FPOs generated around 26,000 new jobs, including full- and part-time positions, leading to 3 million person-days of work per year and an estimated INR 1 billion in wages, based on scaled estimates from 50 FPOs.

ASSESSMENT OF EFFICIENCY
Rating: Substantial

44. **Financial analysis:** The stream of net incremental income generated by the project over a 20-year period, using a financial discount rate of 12 percent, yields a financial net present value (NPV) of INR8,919 million (2018 prices) (US$139.6 million) and a financial internal rate of return (IRR) of 17 percent. The benefit-cost ratio stands at 1.29. These results were estimated using the farm incomes reported by the households across all activities. Details of financial analysis are found in Annex 4.

45. **Economic analysis:** Adjusting for economic values with a standard conversion factor of 0.9 for project costs, PoCRA demonstrates an economic IRR of 19 percent and an NPV of INR38,985 million (US$612 million), confirming high economic profitability. The benefit-cost ratio is 1.43. During appraisal, the projected IRR was 22 percent with an NPV of US$415 million (2018 prices). The project's performance aligns closely with appraisal expectations.

46. **Sensitivity analysis:** The sensitivity analysis tested the robustness of results under several adverse scenarios, including (1) reductions in net project benefits by 30, 50, and 70 percent, (2) external price or climate shocks reducing benefits by 50 percent every 2-3 years, and (3) delays in project benefits by 1-2 years. Despite these challenges, the NPV remains positive with an EIRR of 19 percent, even with a 70 percent decline in project benefits. Thus, the economic returns on project investments remain robust under severely adverse scenarios.

47. **Design and Implementation**: Several factors contributed to the project's efficiency, including its flexible, demand-driven approach and the use of the DBT system. Although it took over a year to establish the DBT system, once operational, it became a transparent and efficient funding mechanism, enabling high disbursement rates, full fund utilization, minimal leakages, and low transaction costs. The robust project design facilitated timely delivery of activities. All Components progressed as planned, enhancing direct benefits to beneficiaries. The demand-driven approach allowed for scaling up resilience technologies with greater impact. Integrated within the Ministry of Agriculture, GoM, the project maintained satisfactory progress despite challenges like COVID-19 restrictions, achieving full disbursement and meeting its intended outcomes, demonstrating implementation efficiency.

JUSTIFICATION OF OVERALL OUTCOME RATING

Rating: Satisfactory

48. The project achieved **satisfactory** overall outcomes, demonstrating significant and growing relevance in both its design and implementation (see Table 1). The project demonstrated a strong linkage between resilience building and profitability, including farmer engagement in local value chains and the development of strong service delivery systems. Additionally, the project yielded important implicit outcomes related to the institutional mainstreaming of CRA, as referenced in the PAD. The co-benefit related to GHG mitigation, though not explicitly an expected outcome of the PDO statement, had a PDO level indicator (KPI #3). Although its over-optimistic target for GHG mitigation was not reached, this resilience-focused project nevertheless demonstrated a significant reduction in emissions. Furthermore, the project excelled in terms of economic and financial efficiency, and it was implemented in a highly efficient manner, fully disbursing funds on time. These achievements collectively highlight the project's effectiveness and its positive impact on the agricultural sector.

Table 1: Outcome Rating

	Rating
Relevance of PDO	High
Efficacy (PDO)	Substantial
Efficiency	Substantial
Outcome rating	**Satisfactory**

A. OTHER OUTCOMES AND IMPACTS

49. **Gender.** Although the percentage of women reached in terms of outreach and adoption rates was slightly lower than the project targets, these figures were more aligned with current land ownership and head-of-household patterns. The project recognized at the outset that participation rates among women were relatively low and implemented specific initiatives to enhance their involvement. Attendance and participation rates were notably high in the Village Community Resource Management Committees (VCRMCs) and village-level planning activities. A special cadre of 4,135 women, known as *Krishi Tai* (for grassroots mobilization), was nominated by the VCRMC and trained to increase awareness and build capacity within their communities around planning processes. They played a key role in facilitating links to extension services and DBT access. Additionally, focused efforts were made to enhance digital literacy and implement FFS specifically for women. As a result of these initiatives, 22 percent of the total amount disbursed under the project to farmers was allocated to women. The membership of women in FPOs reached 64,000, with 137 dedicated women-led FPOs and self-help groups (SHGs) also actively engaged in the project.

50. **Institutional Strengthening.** Nationally, PoCRA was the first large-scale national initiative aimed at enhancing agricultural resilience, distinguished by its robust institutional capacity and process-driven approach. The project prioritized capacity-building for extension services, farmer groups, and individual farmers, focusing on agroclimatic awareness, digital tools, exposure visits, FFS, and personalized training and advisory support. These efforts were carried out in collaboration with leading science and training institutions at both the state and national levels, exemplifying a highly effective "lighthouse approach." This approach set a benchmark for innovation and best practices, making it a model for replication and scaling. To support FPOs and FPCs, the project provided direct assistance and enhanced systems via the Agricultural Technology Management Agency (ATMA), including an FPO rating tool for monitoring and evaluation. Emphasizing collaboration with existing institutions, particularly those linked to the MoA, the project strengthened systems rather than creating a project-specific approach, ensuring sustainability and continued capacity beyond project completion.

51. **A key strategy of the project was localizing systems to improve efficiency and provide direct support to communities and farmers.** This was achieved by strengthening district and sub-district agricultural support staff and developing the new VCRMC, anchored in the local Gram Panchayat system, which was institutionalized statewide, including the Gram Krishi Vikas Samity (GKVS) from 2020. PoCRA supported the creation of SREPs with a climate resilience focus for 15 districts, in collaboration with scientific partners. These plans enhanced understanding of climate-related issues and developed comprehensive solutions, along with institutional monitoring frameworks. They also laid the groundwork for rolling out village adaptation plans, accessible online to guide local support. Additionally, the project established workflow systems to improve efficiency and due diligence in delivering CRA services, particularly through DBT. This approach enhanced targeting and efficiency, fostering a shift toward a work culture focused on institutional performance, flexibility, and responsiveness to local needs.

52. PoCRA aimed to establish a Climate Innovation Centre (CIC) as a knowledge hub to foster partnerships between government, scientific agencies, and the private sector. While a proposal outlining financing modalities was prepared by the project’s conclusion, these were not fully established. Nonetheless, PoCRA functioned effectively as a "mini-CIC," demonstrating substantial institutionalization within the state. The project played a catalytic role in leveraging existing institutions, coordinating with various departments, and engaging the private sector. PoCRA also established an in-house Digital Innovations Lab that developed IT applications, including DBT systems and a comprehensive Management Information System (MIS). These efforts enhanced state delivery by improving efficiency and data accessibility. The project's strong focus on mainstreaming led to significant scaling up, notably through the state government’s adoption of Maha-DBT and the institutionalization of Maha-IT, which became vital for delivering applications and enhancing services statewide.

53. Additionally, advanced discussions are underway regarding planning a subsequent phase of the project to further scale up efforts. Initiatives under PoCRA are also influencing national strategies, forming a model for agricultural data hubs in the country, referred to as the Agri-Stack. The POCRA model is being closely examined in the conceptualization of a nationwide CRA program targeting 310 vulnerable districts and 10,000 villages.

54. **Mobilizing Private Sector Financing.** A key focus of the project, as discussed under PDO Outcome 2, was engaging private-sector institutions by strengthening FPOs and FPCs to connect with agribusiness actors. To access resources via the DBT system, FPOs established links with banks and secured credit as pre-payment. They successfully achieved this on a large scale, demonstrating their ability to leverage financial resources effectively.

55. **Poverty Reduction and Shared Prosperity.** Although not an explicit outcome, the project prioritized support for marginal and small-scale farmers with less than 2 hectares of land, many of whom were near or below the poverty

line. This focus addressed the vulnerability of rainfed farmers in the state. With the poverty line set at INR20,000 in 2005, baseline incomes averaged INR35,000 in 2019 (as noted in PDO indicator 4). The significant increase in income likely helped reduce income poverty for many. The project also generated employment through FPOs, improving productivity and creating new agricultural opportunities, which encouraged reverse migration in some areas. However, qualitative feedback highlighted that the poorest Scheduled Castes (SC) and Scheduled Tribes (ST) farmers, a smaller group in the project area, faced challenges accessing prepayment finance, particularly from formal channels. This may have limited their access to benefit transfers compared to other farmer groups

56. **Inclusion** was central to the community-led planning processes, ensuring broad participation in decision-making, from women to SC, ST, and specific tribal groups. Reservations ensured their involvement in leadership roles, fostering transparency in planning and delivery. The VCRMC conducted social audits on DBT benefit distribution, with results available online. The DBT system also prioritized access for landless and women-headed households through a first-in, first-out system, enabling them to access schemes such as livestock production first. This approach ensured that marginalized groups were actively included and had equal access to project benefits.

B. OTHER UNINTENDED OUTCOMES AND IMPACTS

57. While the project effectively implemented and achieved its comprehensive, ambitious, yet flexible design, some of the mainstreaming accomplishments exceeded expectations. Notably, the successful integration of the VCRMC and the DBT system showcased significant progress. Additionally, there was a notable increase in the adoption of various innovations both within the state and beyond, reflecting the project's positive influence on broader agricultural practices and policies.

III. KEY FACTORS AFFECTED IMPLEMENTATION AND OUTCOME

58. The project successfully achieved its major outcomes, including institutional objectives, to a significant extent and did so efficiently. This success can be attributed to a robust and flexible project design, coupled with a results-oriented implementation approach. The project leveraged and localized key capacities within the state, employing participatory village planning and an effective support and delivery system. Furthermore, the integration of a strong digital architecture enhanced transparency and streamlined transactions for end users, contributing to the overall effectiveness of the project.

KEY FACTORS DURING PREPARATION

59. The project design effectively integrated lessons from existing expertise, leveraging the national science base through CRIDA and practices identified by NICRA. It embraced a multisectoral approach to resilience, incorporating water management, soil and land practices, and farm economics, with a focus on enhancing profitability through farmer organization engagement with markets. The State team collaborated closely with key science partners to design the project, emphasizing climate-resilient agriculture (CRA), water use efficiency, soil management, and seed strategies. Insights from World Bank projects in India and internationally further enriched the design, ensuring a comprehensive and adaptive approach. The design also included significant flexibility to address diverse farmer demands and emerging opportunities under changing climatic conditions. The project’s objectives were pioneering in their focus on resilience and were robust and realistic. The M&E system, designed with comprehensive methods from the outset, emphasized MIS and data systems to effectively monitor progress.

KEY FACTORS DURING IMPLEMENTATION

Factors within the Government’s Control

60. The GoM demonstrated consistent and dedicated leadership, characterized by a strong focus on delivering practical tools grounded in scientific decision-making and innovation. Its engagement with science partners further refined processes and methodologies, such as micro-planning with water budgeting and the integration of advanced technologies. Throughout the project, the state maintained a results-oriented approach, effectively addressing management challenges and adapting to changing contexts ensuring the project's overall satisfactory performance.

61. The GoM took the initiative to internalize systems for mainstreaming and scaling out, focusing on utilizing existing local agriculture extension and advisory systems while consistently deputizing staff. The state implementing agency demonstrated a strong results focus, achieving 100 percent disbursement within the original project timeframe and meeting key outcome targets. It supported science-based decision-making, establishing transparent, demand-driven, and efficient processes for resource delivery. The use of ICT and localized approval mechanisms streamlined operations, reducing management costs and ensuring sustainability. A key strength of the project was its focus on digital solutions, particularly through the in-house lab, which developed 16 Application Programming Interfaces (APIs) for various functions, including micro-planning, water budgeting, DBT systems, extension, advisory, financial tracking, and staff time management. These APIs enabled end-to-end digital solutions, reducing paper use and providing one-stop access for functionaries and farmers. Additionally, the emphasis on M&E, MIS, and collaboration with related agencies allowed for effective analysis and timely adjustments, refining baselines, targets, and methodologies during the Mid-Term Review.

(ii) Factors subject to the World Bank's control

62. Quality supervision and reporting by the World Bank: The World Bank consistently provided supervision and technical guidance, with Aide Memoires and technical annexes tracking all agreed actions and recommendations. This regular and reliable support allowed the World Bank to offer frequent oversight, empowering the state with the confidence and flexibility to lead and innovate. (See further below under Bank performance)

(iii) Factors outside control of government

63. The COVID-19 pandemic in 2020 resulted in a shift of government budgets towards the health sector, causing a minor slowdown in the release of counterpart funds and delays in providing support, such as FFS. However, the project leveraged its ICT capabilities to quickly develop online training and meeting systems, including the E-gram Sabha (online village sessions), to facilitate approvals. Due to established local contacts between the district agriculture department and village authorities, agricultural officers were able to obtain permits to verify project assets on the ground, even during the pandemic.

IV. BANK PERFORMANCE, COMPLIANCE ISSUES, AND RISK TO DEVELOPMENT OUTCOME

QUALITY OF MONITORING AND EVALUATION (M&E)

64. **M&E Design.** The M&E design, including the results framework (RF) effectively reflected deeper concepts of resilience and metrics around CSA efficiency, making it one of the first major projects to do so. Furthermore, the design of M&E covering all areas of baseline and impact assessment surveys, concurrent monitoring, and MIS, was implemented.

65. **M&E Implementation.** The project engaged capable and reliable teams to manage M&E, covering all aspects of surveys and concurrent monitoring to ensure high-quality, frequent reporting and tracking of progress across all project activities. At MTR, the project was able to adjust results framework targets based on updated survey data,

refine the methodology for cost-of-cultivation data collection and analysis, and further integrate the IPCC AR6 resilience framework. Overall, the end-of-project IA reports, along with other materials derived from the project MIS and reporting systems, provided a comprehensive assessment of project outcomes and the factors contributing to its achievements. However, during implementation, the project could have clarified the status and methodology of the indicator on GHG (refer to paragraph 37 and Annex 5).

66. **M&E Utilization.** With strong results-oriented project management and World Bank supervision, key actions were taken using the M&E system, along with close tracking of progress, activities, and expenditures, including a comprehensive Mid-Term Review (MTR). The project utilized DBT, MIS, and other IT systems to foster positive competition among district teams through a performance index. Project reporting and evaluations helped teams draw lessons, explore scaling-up opportunities, and identify key themes for future programs. The comprehensive IA provided valuable insights for future state and national programming. While the project did not track GHG emissions in the field, it could have more systematically monitored key parameters like soil carbon, fertilizer, and energy use.

Overall Rating of Quality of M&E and Justification

Rating: Substantial

67. **Justification**. The M&E system, as designed and implemented, was robust and effective, providing more than adequate tools to assess the achievement of objectives and validate the links in the results chain. It was extensively utilized to guide project direction, inform strategy development, and shape future initiatives. The comprehensive approach to measuring resilience and its connection to profitability stands out as a model for other programs. However, despite its high overall quality, the M&E system did not include detailed monitoring or data collection to support an updated GHG analysis.

ENVIRONMENTAL, SOCIAL, AND FIDUCIARY COMPLIANCE

68. The project was fully compliant with all World Bank Operational Policies (OP) and had robust safeguards in place. It also had a number of built-in project-related outcomes and processes that directly contributed to environmental and social safeguards. On the environmental side, the core objectives of the project included greater efficiency in the use of water through improved water management, targeting climate vulnerability, and encouraging integrated nutrient and pest management (INM and IPM) as integral means of building farm resilience, along with specific efforts and targets to address sodic and saline lands.

69. As noted above under inclusion, there were a number of built-in mechanisms for social safeguards, including participatory watershed planning, the inclusion of women, and specific processes for the most marginalized groups.

70. On the fiduciary side, the project experienced no negative audits or misprocurement. Despite the many levels of institutional transactions identified as risks in the design, the development of refined digital processing systems enabled financial management to operate with considerable efficiency and effectiveness.

BANK PERFORMANCE

(i) Quality at Entry

71. **Preparation**. The World Bank team worked closely with the State, offering vital support in designing and implementing project structures. Drawing on national and state-level experience, including insights from other World Bank projects, the team ensured a robust design. Successful watershed projects in Karnataka and agricultural commercialization initiatives across India served as key references, especially for participatory local watershed

planning and agricultural extension. Furthermore, the team incorporated lessons from global resilience-building projects, such as large-scale development initiatives in Brazil, strengthening the project's design and impact.

72. **Risk assessment**. The project design incorporated a thorough risk assessment, particularly in selecting proven technologies and integrating the best available science. The overall risk rating was moderate. Although fiduciary and institutional capacity risks were substantial, the World Bank closely collaborated with the State to streamline the design, enhance efficiency, optimize resources, and support the development of a strong institutional architecture with scientific partners, ensuring effective project implementation and risk management.

(ii) Quality of Supervision

73. The World Bank conducted regular implementation support missions, involving technical scientific experts to assist with project execution and provide guidance. Between these missions, frequent meetings monitored progress against agreed actions. The World Bank organized thematic workshops, focusing on MIS and Digital system. Confident in the State's leadership, the World Bank encouraged innovation and provided flexibility, supporting mechanisms such as using state norms for training to build systems suitable for future mainstreaming and sustainability.

Justification of Overall Rating of Bank Performance

Rating: Satisfactory

74. The World Bank's performance is rated Satisfactory for its overall support in the preparation and development of a high-quality design that stood the test of implementation, as well as its technical support, supervision, M&E, safeguards, and fiduciary management.

RISK TO DEVELOPMENT OUTCOME

75. The project's outcomes in CRA focus on reducing risks from current and future climate extremes while generating income to buffer against shocks, with FPOs playing a key role in ensuring long-term sustainability. Twenty-nine resilience-enhancing production technologies, supported by ICT platforms, significantly boosted adoption rates. Institutional support mechanisms were established at various levels—from state to district, FPOs, and village institutions—ensuring both technical knowledge and delivery systems for continued future activities. The mainstreaming and planned scaling-up of PoCRA further strengthened confidence in sustained support, inspiring the MoA, GoI to develop a national-level program for different states, now in an advanced stage. This higher form of resilience is also captured by the state government through Project on Climate Resilient Agriculture- Phase II (P505563).

V. LESSONS AND RECOMMENDATIONS

76. The project aligned with catalytic approaches outlined in agricultural policy frameworks in several ways: (i) by involving globally renowned research institutes in designing, implementing, and monitoring interventions, it leveraged the strength of the private sector; (ii) by investing in capacity building for project staff and allied departments, it strengthened public sector institutions to replicate learnings and diffuse advanced technology across the State; and (iii) by generating novel operational knowledge on productivity enhancement and reducing greenhouse gas emissions in smallholder agriculture, it produced valuable good practice notes. Additionally, the project generated significant Climate Co-Benefits and implemented recommendations from the forthcoming Country Climate and Development Report (CCDR).

77. The adoption of climate-resilient practices is successful when they offer clear economic benefits to farmers, enhancing resilience against shocks and enabling further adaptation. A demand-driven, incentivized technology package can boost both resilience and productivity, generating profits in the short, medium, and long term. PoCRA has made significant progress but could benefit from deeper collaboration, particularly with FPOs, to strengthen economic resilience. Strengthening price stabilization mechanisms, enabling vulnerable farmers to access upfront finance, and leveraging DBT resources are crucial to overcoming investment barriers. Partnerships with progressive private sector players will be key to advancing these efforts.

78. Resource use efficiency will be critical for climate resilience, especially as climate extremes increase. Addressing soil and water efficiency is key, with PoCRA demonstrating how CSA enhances productivity, mitigation, and profitability. Future collaborations should focus on watershed and groundwater management, deepening analysis, monitoring, and participatory local planning. Understanding water reliance at the farm level is essential for identifying vulnerabilities. Efficiency improvements must include better soil management, optimized fertilizer use, precision agriculture, and enhanced value chain efficiency to reduce waste, improve monitoring, and strengthen resilience while mitigating GHG emissions.

79. A transparent and efficient resource access system like DBT builds farmer confidence, enabling timely adoption of the right technology. Supported by a robust ICT platform, DBT facilitates large-scale resilience efforts, offering science-based solutions. Reliable systems allow farmers to secure counterpart funds, while strong advisory and extension services guide decision-making. Investments in IT systems promote transparency and streamline approvals, requiring budget flexibility, adaptability, and a commitment to results. These investments lay the foundation for future innovation and opportunities in agriculture. Additionally, extending the functionality of the M&E system for continuous monitoring is vital for understanding the resilience dynamics of agricultural systems. Scientific monitoring, focused on precision and evidence-based insights, is crucial for tracking climate impacts, resource efficiency, and adaptation outcomes, supporting trend identification, management, and refinement,

80. Decentralization and programmatic approaches are vital for sustained large-scale impact. The project showed that investing in existing capacities and integrating them with state and local structures creates lasting effects. This approach allows for local adaptations to evolving needs, focusing on the most vulnerable, especially the poorest. Collaboration between farmers and FPOs bridges farm-level practices with scientific research. Institutionalizing this approach, with continuous improvements in data analysis, ICT infrastructure, and monitoring tools, requires strong state commitment and stakeholder engagement.

81. Timely access to services and inputs in agriculture is crucial for ensuring the adoption and sustainability of interventions. Given the project's scale, a smart procurement approach was essential, with many procurement activities decentralized, involving thousands of contracts. The project's digital and DBT systems ensured that all committed funds were disbursed two months before closure, reflecting the efficiency of the procurement system and the state government's commitment.

82. The highly decentralized PoCRA project covered 16 districts, involving 3,800 VCRMCs across 5,043 villages, with 5,043 village development plans and 138 community development plans valued at INR8,030 crore, achieving INR 4,489.46 crore. The PMU, guided by the World Bank, monitored procurement activities through a dedicated Procurement MIS, integrating data from platforms like DBT and enhancing the DBT portal for the entire procurement lifecycle. Regular independent reviews, e-tendering for NRM works, and multilingual procurement manuals ensured transparency. Extensive capacity-building efforts trained over 10,000 stakeholders, supported by interns and advanced tools, reducing errors and enhancing efficiency.

ANNEX 1. RESULTS FRAMEWORK AND KEY OUTPUTS

A. RESULTS FRAMEWORK

PDO Indicators by Outcomes

To enhance clmate-resilience and profitability of smallholder farming sytems in selected districts								
Indicator Name	Baseline		Closing Period (Original)		Closing Period (Current)		Actual Achieved at Completion	
	Result	Month/Year	Result	Month/Year	Result	Month/Year	Result	Month/Year
1. Climate resilient agriculture: Increase in water productivity at farm level (Number)	0.38	Oct/2017	20	Jun/2024	0.45	Jun/2024	25 % (0.41)	Jun/2024
	Comments on achieving targets		Comments: Water productivity increased from 0.38 to 0.41 kg/m3 i.e. 7.9% for 5 key crops (unweighted) in project villages households, compared to a decrease of 0.41 to 0.34 kg/m3, or reduction by 17.1% in control areas. The percentage increase in treatment (over control) therefore is 25%. However, the closing target was set at 20% hence target achieved. Source of data impact assessment. Definition: It is measured as a ratio of agricultural production (in kg) over evapotranspiration (in m3). It is measured from Year 3 onwards and for kharif season only (as per PAD). Evapotranspiration data for the equation are modelled by IIT, based on localised data.						
2. Climate resilient agriculture: Improved yield uniformity and stability (Percentage)	0.00	Oct/2017	0	Jun/2024	0.00	Jun/2024	0	Jun/2024
	Comments on achieving targets		Definition : This indicator measures the Coefficient of Variation (CV) for yields of soybean (for oilseeds) and pigeon pea (for pulses) across project districts (spatial variability: CV-S) and over time (temporal variability: CV-T). The CV-S was measured comparing survey households across districts in project areas. These showed consistent decline, compared to control households which only had marginal decline or even slight increase in variability Comments (achievements against targets): The indicator has been considerably achieved.						
Spatial yield variability for oilseeds (soybean) - coefficient of variability (Percentage)	36.00	Oct/2017	23	Jun/2024	29.00	Jun/2024	30.00	Jun/2024
	Comments on achieving targets		The Coefficient of Variation for Spatial Variability in soyabean reduced from CV 36 to CV 30. This represents a 17% decrease in variability. [The baseline value for spatial yield variability (soybean) was revised from 30 to 36						

		post baseline survey. And the endline target was also revised accordingly.] The indicator has been considerably achieved.						
Temporal yield variability for oilseeds (soybean) - coefficient of variability (Percentage)	52.00	Oct/2017	38	Jun/2024	38.00	Jun/2024	30.00	Jun/2024
	Comments on achieving targets		The Coefficient of Variation for Temporal Variability in soyabean reduced from CV 52 to CV 30. This represents a 42.3% decrease in variability The indicator has been considerably achieved.					
Spatial yield variability for pulses (pigeon pea) - coefficient of variability (Percentage)	66.00	Oct/2017	30	Jun/2024	51.00	Jun/2024	52.00	Jun/2024
	Comments on achieving targets		The Coefficient of Variation for Spatial Variability in pigeon pea reduced from CV 66 to CV 52. This represents a 21.2% decrease in variability The baseline value for spatial yield variability (pigeon pea) was revised from 39 to 66 post baseline survey. And the endline target was also revised accordingly. The indicator has been considerably achieved.					
Temporal yield variability for pulses (pigeon pea) - coefficient of variability (Percentage)	44.00	Oct/2017	36	Jun/2024	36.00	Jun/2024	42.00	Jun/2024
	Comments on achieving targets		The Coefficient of Variation for Temporal Variability in pigeon pea reduced from CV 44 to CV 42. This represents a nearly 5 % decrease in variability The indicator has been partially achieved.					
Net greenhouse gas emissions (Tones/year)	-232,398.00	Oct/2017	-4,789,515	Jun/2024	-4,789,515.00	Jun/2024	-1,382,000.00	Jun/2024
	Comments on achieving targets		Based on Impact Assessment and end of project area data (on land and crop use changes, crop practices, inputs use) GHG emissions were estimated to have reduced as a result of climate-resilient agricultural technologies and agronomic practices introduced by the project. Achievement: The indicator was not achieved in relation to the projects PAD assumptions. Details: Project net greenhouse gas (GHG) emissions are calculated using an annual average of the difference between project gross (absolute) emissions aggregated over the economic lifetime of the project and the emissions of a baseline (counterfactual) scenario aggregated over the same time horizon. The indicator and results calculation is based on an ex-ante estimation using GHG accounting with FAO's EX-ACT tool.					
Annual farm income (Number)	1.00	Oct/2017	1.50	Jun/2024	1.50	Jun/2024	1.88	Jun/2024
	Comments on achieving targets		This indicator tracks the annual farm income of project beneficiaries. It measures how the income of landholders evolves with project activities, compared to the income of landholders that do not benefit from project interventions. Achievement: This indicator is achieved. Based on IA field surveys: Net income in project areas increased from Rs. 33,000 to Rs. 75,000 (128% increase), while control areas saw a smaller rise from Rs. 38,000 to Rs. 51,000 (35% increase). The Difference-in-Difference (DiD) analysis showed an 88% increase in project areas, surpassing the 50% PDO target for income growth. For female-headed households, the income increase was 38% greater in project areas compared to control, slightly missing the target. [According to the PAD, a ratio of 1.20 means that the average income of project beneficiaries is 20% higher than that of comparable landholders outside of the project area.]					
	1.00	Oct/2017	1.50	Jun/2024	1.50	Jun/2024	1.38	Jun/2024

Farm income (ratio of farm income for women-headed HH with/without PoCRA) (Number)	Comments on achieving targets		Achievement: The indicator is partially achieved in relation to the projects PAD assumptions.					
Farmers reached with agricultural assets or services (Number)	0.00	Oct/2017	1,320,000	Jun/2024	1,320,000.00	Jun/2024	1,365,233	Jun/2024
	Comments on achieving targets		Definition PAD : (corporate results indicator) This indicator measures the number of farmers who were provided with agricultural assets or services as a result of project support. This used the project DBT and MIS data to calculate direct beneficiaries, with a downward adjustment for possible double counts. Comments: Achievement: The indicator was achieved for overall. Targets for women were only partially achieved.					
Farmers reached with agricultural assets or services - Female (Number)	0.00		462,000		462,000.00		354,960	
	Comments on achieving targets		Targets for women were partially achieved					

Intermediate Indicators by Components

Comp. A: Promoting Climate-resilient Agricultural Systems								
Indicator Name	Baseline		Closing Period (Original)		Closing Period (Current)		Actual Achieved at Completion	
	Result	Month/Year	Result	Month/Year	Result	Month/Year	Result	Month/Year
Farmers adopting improved agricultural technology (Number)	0.00	Oct/2017	1,272,800	Jun/2024	1,272,800.00	Jun/2024	1,079,700	Jun/2024
	Comments on achieving targets		Definition PAD : (corporate results indicator) This indicator measures the number of farmers who have adopted an improved agricultural technology promoted by activities supported by the project. Comments (achievements against targets): Achievement: The indicator has been partially achieved. Using a relatively narrow definition of adoption (training linked to adoption), the IA estimated 1,079,700 versus Original PAD target 1,272,800 adopted CRA technologies (CRAT) indicating target was not achieved (85%). Source Impact Assessment.					
Farmers adopting improved agricultural technology - Female (Number)	0.00		446,000		446,000.00		153,560	
	Comments on achieving targets		The target was partially achieved.					
Area provided with new/improved irrigation or drainage services (Hectare(Ha))	0.00	Oct/2017	624,000	Jun/2024	624,000.00	Jun/2024	667,902.00	Jun/2024
	Comments on achieving targets		Definition PAD : (corporate results indicator) This indicator measures in ha the total area of land provided by the project with new or improved irrigation or drainage services, here focusing on drip and sprinkler. Source MIS. Achievement: The indicator has been achieved.					
	0.00	Oct/2017	83,900,000.00	Jun/2024	83,900,000.00	Jun/2024	30,375.21	Jun/2024

Climate resilient agriculture: Improved availability of surface water for agriculture (from new farm ponds) (Cubic Meter(m3))	Comments on achieving targets		Definition PAD : The surface water storage capacity created with project supported farm and community ponds. Source MIS. Comments (achievements against targets): Achievement: The indicator has not been achieved.					
Climate resilient agriculture: Area with GAPs for improved management of saline and sodic soils (enhanced soil health) (Hectare(Ha))	0.00	Oct/2017	127,600.00	Jun/2024	127,600.00	Jun/2024	146,826.00	Jun/2024
	Comments on achieving targets		Definition PAD : The farm production area in hectare where Good Agricultural Practices (GAP) are applied by farmers for improving management of saline and sodic soils in relevant project villages was assessed through household survey (IA) along with MIS data reported by cluster coordinators. Comments (achievements against targets): Achievement: The indicator has been achieved.					
Share of crop production area (pulses and oilseeds) under cultivation with climate-resilient varieties (Percentage)	64.00	Oct/2017	35	Jun/2024	86.00	Jun/2024	89	Jun/2024
	Comments on achieving targets		Definition PAD : This indicator measures the share of production area in the project with oilseeds and pulses, that is cultivated using certified seeds of improved varieties. Data from IA and MIS Comments (achievements against targets): Achievement: The indicator has been achieved.					

Comp. B: Post-harvest Management and Value Chain Promotion

Indicator Name	Baseline		Closing Period (Original)		Closing Period (Current)		Actual Achieved at Completion	
	Result	Month/Year	Result	Month/Year	Result	Month/Year	Result	Month/Year
Project-supported Farmer Producer Companies with growth in annual profits (Number)	0.00	Oct/2017	200	Jun/2024	200.00	Jun/2024	218	Jun/2024
	Comments on achieving targets		Definition PAD : This indicator reports the number of project-supported Farmer Producer Companies with growth in annual profit. Based on information from 200 audited FPCs, and extrapolated to all FPCs supported by project. Comments (achievements against targets): Achievement: The indicator has been achieved.					

Comp. C: Institutional Development, Knowledge and Policies for a Climate-resilient Agriculture

Indicator Name	Baseline		Closing Period (Original)		Closing Period (Current)		Actual Achieved at Completion	
	Result	Month/Year	Result	Month/Year	Result	Month/Year	Result	Month/Year
Strategic Research and Extension Programs (SREP) with internalized climate resilience agenda (Number)	0.00	Oct/2017	15	Jun/2024	15.00	Jun/2024	15.00	Jun/2024
	Comments on achieving targets		Definition PAD : This indicator reports on the number of districts-level, multi-year, Strategic Research and Extension Plan (SREP) that have mainstreamed climate-resilience. Comments (achievements against targets): Achievement: The indicator has been achieved.					
Clients receiving services from the MH Climate Innovation Center (Number)	0.00	Oct/2017	200	Jun/2024	200.00	Jun/2024	0.00	Jun/2024
	Comments on achieving targets		Definition The PAD indicator tracks the number of clients (Farmer Producer Organizations, SMEs, …) that receive services from the Climate Innovation Center. Status: Not measured. The CIC has been designed but not established. The POCRA unit, consortium partnership with science institutions, and its Digital Innovation Lab,					

		have been acting as 'mini-CIC' (see Institutions section in ICR main text) Comments (achievements against targets): Achievement: The indicator has not been achieved.

Comp. D: Project Management

Indicator Name	Baseline		Closing Period (Original)		Closing Period (Current)		Actual Achieved at Completion	
	Result	Month/Year	Result	Month/Year	Result	Month/Year	Result	Month/Year
Beneficiary participation and civic engagement: approved participatory mini watershed plans implemented or under implemenation (Number)	0.00	Oct/2017	790	Jun/2024	670.00	Jun/2024	5,043.00	Jan/2024
	Comments on achieving targets		Definition PAD : The original target Number focused on approved participatory mini watershed plans implemented/under implementation. 138 of these plans were prepared in the first phase of project, however, upon review, it was noted that village development plans (VDP), approved by Gram Sabha, would provide more detailed and formal guidance. Hence, 5043 VDPs covering nearly all villages and watershed areas were prepared. Comments (achievements against targets): Achievement: The indicator has been achieved.					

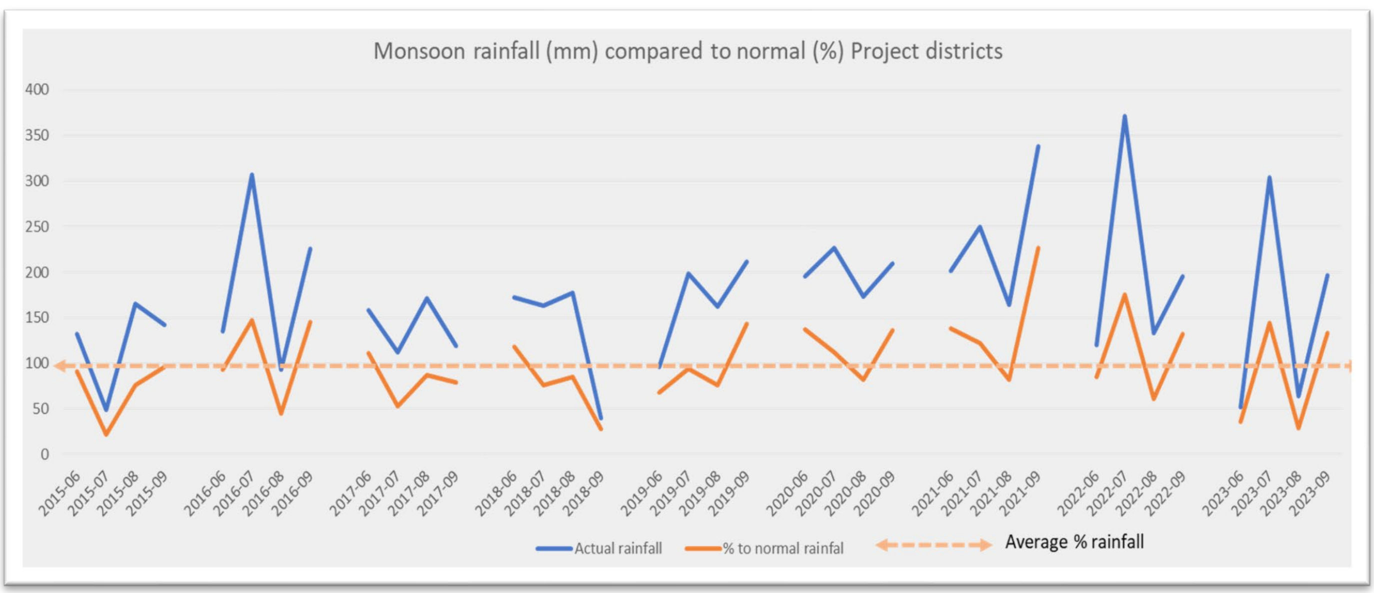
ANNEX 1.1 – DETAILS ON RESULTS INDICATORS

1. PDO #1 - Climate resilient agriculture: Increase in water productivity at farm level

Table 1: Water productivity for 5 key crops

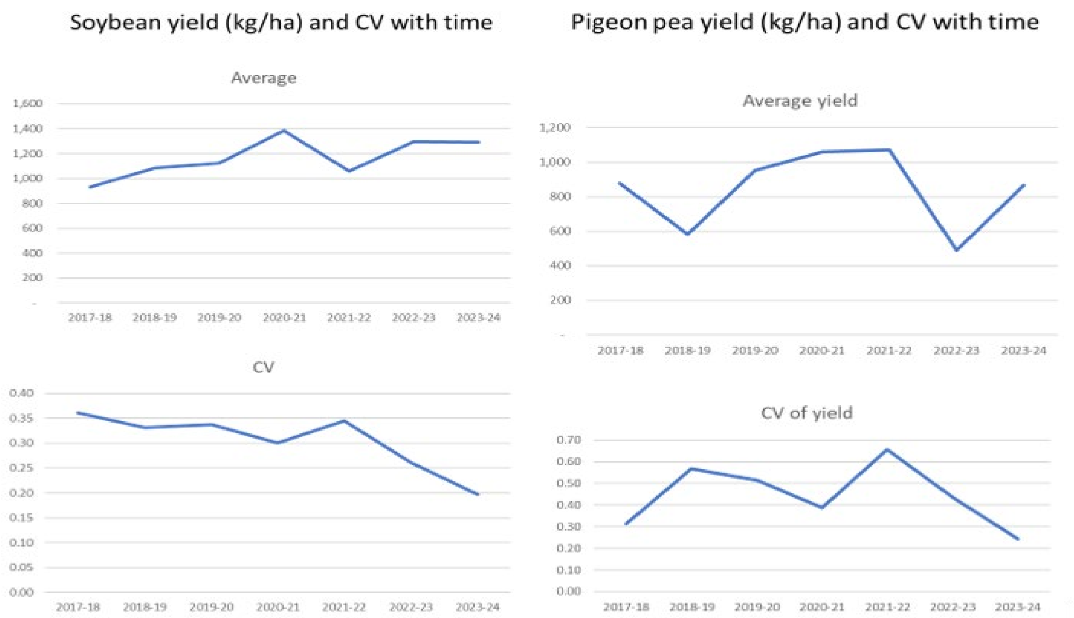
Crops	Baseline Survey		Endline Survey		
	Project	Control	Project	Control	
Cotton	0.33	0.36	0.35	0.28	
Pigeon Pea	0.31	0.34	0.39	0.32	
Soybean	0.49	0.52	0.47	0.40	
Green Gram	0.27	0.27	0.41	0.29	
Black Gram	0.23	0.31	0.30	0.29	
Overall	0.38	0.41	0.41	0.34	
			+7.9%	-17.1%	Difference 25%

Figure 1: Rainfall Data



2. PDO #2 - Climate resilient agriculture: Improved yield uniformity and stability

Figure 2 : Coefficient of Variation of yield with time (CV-T) for Soybean and Pigeon Pea, and monsoon rainfall seasonal anomalies



3. PDO #5 - Farmers reached with agricultural assets or services

Figure 3: Estimating direct unique beneficiaries of the project

RF.5 Direct Project Beneficiares

	Total Records	Unique	Training-FFS	DBT-Training	DBT-FFS	DBT-FFS-Training	DBT_Beneficiary	Registered	Unique Benificiares: Mobile not valid	Unique Benificiares: SMS Service Provided
DBT	1,225,055		42	81,327	162,276	6,188	387,684	587,580	3,618	583,962
	Total Records	Unique								
Training	89,645	2,088								
	Total Records	Unique								
FFS	551,096	382,590								
Total Unique Beneficiary		**1,606,157**								
Considered 85% of Final Unique Beneficaries	16,06,157*85%	1,365,233	RF.5							
Percentage of Female	13,65,233*26%	354,960	26	RF.5 Female						

Note:To find out unique beneficiaries across DBT, FFS, training, and SMS advisories, name matching exercise was done with 85% confidence .

PAD Target 1.320 million

Conservative 1.365 million

77% of 1.77m

Additional FPO members in outside project areas 140,000 estimate

26% Female

To reduce risk of double counting an 85% adjustment made

4. Revised RFID Indicators and Targets (under first project restructuring in 2022-23)

Indicator	Original baseline value (As per PAD)	Revised baseline value (post survey)	Original endline target (As per PAD)	Revised endline target
Increase in Water Productivity at farm level in Percentage (Kg.m-3)	0.23	0.38	0.276	0.45
Improved yield uniformity and stability in Percentage (CV)-Spatial-Soybean	30	36	23	29
Improved yield uniformity and stability in Percentage (CV)-Spatial-Pigeon pea	39	66	30	51
Seed supply: Promotion of climate-resilient crop varieties (%)	28	64	35	86

ANNEX 1.2 – KEY OUTPUT BY COMPONENT

Comp. A: Promoting Climate-resilient Agricultural Systems	
Intermediate Results Indicators	2. Farmers adopting improved agricultural technology 4. Area provided with new/improved irrigation or drainage services 5. Climate resilient agriculture: Improved availability of surface water for agriculture (from new farm ponds) 6. Climate resilient agriculture: Area with GAPs for improved management of saline and sodic soils (enhanced soil health) 7. Share of crop production area (pulses and oilseeds) under cultivation with climate-resilient varieties
Key Outputs (linked to the achievement of the Component)	1. CRAT focused farmer field schools (FFS): 37,184, with more than 200,000 sessions, in 4800 villages 2. 15501 host FFS farmers, and 490,780 'guest' farmers attending, with 13 % women. 3. Matching grants transferred through DBT to 485,669 farmers 4. 431,328 beneficiaries of micro-irrigation, mainly drip and sprinkler 5. Creation of 11,120 new farm ponds 6. Supported 29,270 ha of horticulture plantation, and 613ha of agroforestry 7. 5337 farmers supported on sericulture 8. Supported 8140 marginal and landless farmers for enahnced livelihiids resilience in small rumiannats, fishieres, apiculture, poultry 9. Catchment water security intervetions on 59,387ha of land, and 1884 water conservation works.
Comp. B: Post-harvest Management and Value Chain Promotion	
Intermediate Results Indicators	8. Project-supported Farmer Producer Companies with growth in annual profits
Key Outputs (linked to the achievement of the Component)	1. Supported 4701 agribusiness proposals (through FPO DBT) of 1698 Farmer producer companies (FPCs – of which 1187 unique groups), 1799 farmer interst groups (FIGs, 1173 unique groups) and 1204 women Self help groups (SHGs. 875 unique groups) 2. Supported 237 of the FPOs were women led. 3. Supported 2779 custom hiring center (CHCs), 960 storage gowons, 417 processing units, and 545 other agribusiness 4. 24,205 farmer taking up certified seed production program, on over 58,500 ha of land 5. 8250 training programs on sustainable agribusiness practices
Comp. C: Institutional Development, Knowledge and Policies for a Climate-resilient Agriculture	
Intermediate Results Indicators	9. Strategic Research and Extension Programs (SREP) with internalized climate resilience agenda 10. Clients receiving services from the MH Climate Innovation Center

Key Outputs (linked to the achievement of the Component) – NB the outputs here form part of the wider capacity building deliver by this component, also supporting Comp A directly	1. 76,966 cappacity building events coducted for project benenficairies, for 1,488,567 participant stakeholders (28% female participants) 2. Capacity building of more than 50,000 Village Climate Resilient Agriculture Management Committees (VCRMC) members and Krishi Tais 3. 205 exposure visits conducted, including on regenerative agriculture 4. Specialised trainings (in addition to main FFS) on for example protected cultivation to 6000 farmers, and exposure visitis on regenrative farming 4218 farmers 5. Key parters with direct particaption in design and implemementation: a. Indian Institute of Technology, Bombay for science based tools, especially on water budgeting b. NBSS-LUP (National Bureau of Soil Survey – Land Use Planning for preparing Land Resource Inventory c. Indian Council for Agriculture Research (ICAR), on vulernaribility and resilent technologies as well as training. d. State Agriculture Universities (SAUs) on crops coefficients and varieties, Groundwater Survey and Development Agency (GSDA) on groundwater technical support, Gokhale Institute of Politics and Economics (GIPE) on M&E advisory, and other traingin institutions.
Comp. D: Project Management	
<u>Intermediate Results Indicators</u>	11. Beneficiary participation and civic engagement: approved participatory mini watershed plans implemented or under implemenation
Key Outputs (linked to the achievement of the Component)	1. 3959 VRMCs in 5220 villages 2. 138 cluster development plans, and 5043 Village Development plans – covering 670 minwatershed clsuters. 3. ICT including DBT (3 main systems), and 5 other field planning and monitoring apps. 4. Geoagraphic information system (GIS) with dashboard supporting resource assessment, miniwatershed planning and village profiling, intervention monitoring, weather tracking

ANNEX 2. BANK LENDING AND IMPLEMENTATION SUPPORT/SUPERVISION

A. TASK TEAM MEMBERS

Name	Role
Ranjan Samantaray	Team Leader
Saumya Srivastava	Team Leader
Tanuj Mathur	Financial Management Specialist
Priti Jain	Procurement Specialist
Sharlene Jehanbux Chichgar	Environmental Specialist
Varun Singh	Social Specialist
Akankshita Dey	M&E Consultant
Juan Carlos Alvarez	Counsel
Rocio Mariela Malpica Valera	Counsel
Radha Narayan	Procurement Team
Mohammad Ilyas Butt	Procurement Team
Victor Manuel Ordonez Conde	Team Member
Genevieve Connors	Team Member
Jonathan d'Entremont Coony	Team Member
Leena Malhotra	Team Member
Satya Priya LNU	Team Member
Jacqueline Julian	Team Member
Ama Esson	Team Member
Ammini Menon	Team Member

B. STAFF TIME & COST

Stage of Project Cycle	Staff Time & Cost	
	No. of Staff Weeks	US$ (including travel and consultant costs)
Preparation		

FY17	52.342	370,388.38
FY18	39.197	236,965.62
Total	91.54	607,354.00
Supervision/ICR		
FY18	4.977	35,357.06
FY19	22.550	123,823.33
FY20	29.945	155,526.18
FY21	27.955	113,178.06
FY22	30.390	132,687.61
FY23	28.920	141,998.40
FY24	28.504	160,232.59
FY25	6.298	48,434.41
Total	179.54	911,237.64

ANNEX 3. PROJECT COST BY COMPONENT

Component	Amount at Approval (US$M)	Actual at Project Closing (US$M)
Comp. A: Promoting Climate-resilient Agricultural Systems	452.1	496.6
Comp. B: Post-harvest Management and Value Chain Promotion	56.6	70.17
Comp. C: Institutional Development, Knowledge and Policies for a Climate-resilient Agriculture	33.7	3.48
Comp. D: Project Management	56.1	26.73

ANNEX 4. EFFICIENCY ANALYSIS

1. This annex presents the efficiency analysis of the Maharashtra Project on Climate Resilient Agriculture (POCRA). It assesses the project's development impact at closure through an ex-post economic and financial analysis (EFA) based on a standard cost-benefit analysis.

Overview of the Project

2. The overall project development objective (PDO) of this project was to "to enhance climate-resilience and profitability of smallholder farming systems in selected districts of Maharashtra". To that effect, the project promoted the transfer of already proven and field-tested agricultural technologies and agronomic practices that enhance climate resilience at farm and catchment level while ensuring financial profitability of farming activities. The project also strengthened Farmer Producer Companies (FPCs) and supported seed supply chains for climate-resilient crop varieties. These were complemented by interventions at the institutional and policy levels for mainstreaming of climate resilience in rural institutions as well as generation of cutting-edge knowledge on climate change and its impact on key sectors in order to ensure sustainability of outcomes.

3. The project was launched in 2018 and implemented over a period of six years in 15 districts of the Marathwada and Vidarbha regions in Maharashtra[2], covering 4,210 villages affected by droughts, and 932 villages affected by saline and sodic soils. The total area covered by project interventions is approximately 3.1 million hectares (of which approximately 2.5 million hectares is cultivable land). Direct project beneficiaries, estimated at 1.7 million, are primarily small and marginal farmers whose livelihood is impacted by the changing climatic conditions and growing climatic uncertainties.

4. The project comprised four main components: (1) Component A – Promoting Climate-resilient Agricultural Systems; (2) Component B – Post-harvest Management and Value Chain Promotion; (3) Component C – Institutional Development, Knowledge and Policies for a Climate-resilient Agriculture; and (4) Component D – Project Management. Through the various interventions, the project aims to develop and promote agricultural production systems that can cope with changing climatic conditions, while enhancing farm productivity and facilitating the participation of small and marginal farmers in agricultural value chains.

Economic and Financial Analysis

5. This section presents the ex-post economic and financial analysis for the POCRA project. It provides calculations of the Internal Rate of Return (IRR), Net Present Values (NPV) and Benefit Cost Ratio (BCR) for the entire project and presents details regarding project costs, benefits, methodology and lists the data and assumptions used for the EFA.

Project costs:

6. At appraisal, total project costs were estimated at US$599.55 million, co-funded by IBRD credit of US$420 million (70 percent) and State Government's contribution of US$179.55 million (30 percent). Table 1 below shows the original project costs by component.

[2] These two regions account for about 60 percent of the area under agriculture in Maharashtra.

Table 1: Project costs at appraisal, by component and financier

	Cost (USD, millions)			Share (%)
	Govt.	Bank	Total	
Component A – Promoting Climate-resilient Agricultural Systems	135.63	316.47	452.10	75.4 %
Component B – Post-harvest Management and Value Chain Promotion	16.99	39.65	56.64	9.4 %
Component C – Institutional Development, Knowledge and Policies for a Climate- resilient Agriculture	10.10	23.56	33.65	5.6 %
Component D – Project Management	16.83	39.27	56.10	9.4 %
Front-end fees		1.05	1.05	0.2 %
Total Project Cost	179.55	420.0	599.55	100 %

7. Table 2 presents the actual expenditure (at the time of project completion) by financier, in local currency. As can be seen from the last column, there was a shift in project expenditure from Component C and D towards Component A and B during project implementation.

Table 2: Project costs at completion, by component and financier

	Cost (INR, crore)			Share (%)
	Govt.	Bank	Total	
Component A – Promoting Climate-resilient Agricultural Systems	1173.42	2737.97	3911.39	83.29 %
Component B – Post-harvest Management and Value Chain Promotion	165.80	386.86	552.66	11.77 %
Component C – Institutional Development, Knowledge and Policies for a Climate- resilient Agriculture	7.85	18.31	26.15	0.56 %
Component D – Project Management	61.85	144.31	206.15	4.39 %
Total Project Cost	1408.91	3287.45	4696.35	100 %

8. Data on actual year-by-year project costs (by component) are presented in Table 3. There are minor differences between the two tables (Table 2 and 3) due to the time at which the numbers were reported. For the EFA, the analysis uses the data from Table 3, the latest data obtained from the Project Management Unit during the completion mission in August 2024.

Table 3: Project costs at completion, by component and year

Component/Year	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24***	**Total (INR Lakhs)**	**Share (%)**
Component A – Promoting Climate-resilient Agricultural Systems	1054,9	18243,3	59788,3	114556,6	91041,0	106467,6	391151,7	**83,19%**
Component B – Post-harvest Management and Value Chain Promotion	14,7	382,8	2430,8	13969,7	18366,7	20089,2	55253,9	**11,75%**
Component C – Institutional Development, Knowledge and Policies for a Climate- resilient Agriculture	346,6	413,9	384,0	360,7	542,8	693,8	2741,9	**0,58%**
Component D – Project Management	1685,7	3243,0	3874,4	3877,0	3877,4	4513,0	21070,5	**4,48%**
Total	**3101,9**	**22283,1**	**66477,5**	**132764,0**	**113828,0**	**131763,6**	**470218,0**	**100%**

Project benefits:

9. As anticipated at the time of appraisal, the main project benefits for the targeted smallholder farmers are expected to come from: (a) improved *stability* in agricultural output and increased *productivity* of traditional crops through farmers' adoption of climate-resilient agriculture technologies and agronomic practices – such as short-duration or drought-tolerant varieties, intercropping, and better management of soil and water resources at the farm and watershed levels (the latter also contributed to increases in *cropping intensity* due to improved availability of water and increases water-use efficiency through micro-irrigation systems); (b) *diversification* into new, suitably adapted, higher-value, climate resilient agriculture (this includes protected cultivation, fruit tree cultivation and other livelihood-diversification activities); and (c) improved *post-harvest value-addition*. In addition, findings from the impact assessment survey reveal a significant reduction in costs of cultivation and better price realization for farmers. Together with improvements in productivity, these have led to increase in the household farm incomes. The economic and financial analysis captures those benefits that can be easily quantified and consequently focuses on changes in farmer incomes on account of the project interventions. Apart from direct benefits to farmers, project benefits will also include a reduction in GHG emissions through on-farm carbon sequestration and the adoption of green technologies in agri-food processing. These are incorporated in the economic analysis using the social cost of carbon. More details on project benefits are included in subsequent sections.

Methodology:

10. A standard cost-benefit analysis of the project interventions is conducted to demonstrate that the project is financially and economically viable. The analysis considers all project costs and benefits, to the extent possible, and assesses the causal impact of the project by comparing the 'with project' and 'without project' situations.

11. To provide a quantitative assessment of benefits that are directly or indirectly attributable to the POCRA project, the analysis relies on the comparison of a set of beneficiaries (treatment group) with a set of non-beneficiaries (comparison group) that represent the counterfactual. Data for the treatment group reflect the 'with project' scenario, while data for the comparison group reflect the 'without project' scenario – thereby allowing isolation of the causal effects of the project interventions from the effects of other factors over time on the overall population. The ideal approach to evaluate the causal impact of the project is to use a Differences-in-Differences (DiD) method which compares the *change in outcomes* for the treatment group viz. a viz. the *change in outcomes* for the control group. [3] That is, *Change in income due to the project = (Income of treatment at endline – income of treatment at baseline) - (Income of control at endline – income of control at baseline)*

12. The analysis in this section, however, compares the post-project outcome for the treatment group relative to the control group. This assumes that the two groups are ex-ante similar[4] and in the absence of the project, would have had similar outcomes. The analysis considers two types of beneficiary households – those that benefitted from DBT and those that benefitted only from other project interventions but did not receive direct transfers.

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[3] Note that the income of the control group could change during the project period due to various factors. For instance, this group might have benefited from another project or scheme or there could be spillovers from the POCRA project. In case of positive spillovers, there would be an increase in the income of control households due to the project and DiD would provide a lower estimate of net incremental benefits.

[4] The IA drew a sample size powered to have an MDI of 5 percent. A number of socio-economic and demographic factors (source of income, education, land ownership etc.) across the project and control study area were assessed to check if the respondents across the project and control arm are balanced (pre-intervention).

13. Given the nature of project interventions, the primary specification uses 'total farm income' to calculate the incremental impact of the project. This includes net income from crops (gross income from selling all crops i.e., total quantity of each crop sold multiplied by the average price received minus the total cost incurred through the agriculture life cycle in production and selling of crops) and net income from agriculture-allied activities (gross income from sale of value-added products minus costs of production).

Data sources:

14. The analysis is based on data collected from the following sources:

Impact assessment survey: The quantification of project benefits is based on household survey data that was collected at baseline and endline. The surveys collected detailed quantitative information on costs and returns for selected activities within a household as well information about total farm and non-farm income. This was collected for both POCRA beneficiaries (direct beneficiaries or "treatment" group) and non-beneficiaries/indirect beneficiaries (or "control" group). The survey encompassed a total of 7,940 households from 1588 villages.[5]

15. M&E data: The analysis also relies on data available from the Project Management Unit regarding the number of project beneficiaries as well as findings from other studies conducted over the project period to evaluate the impact of the project. Data on actual project costs was also obtained from the PMU.

Assumptions:

16. Time frame: For the computation of rates of return and net present values (financial and economic), a 20-year horizon is used. The opportunity cost of capital is assumed. For the economic analysis,

17. Discount rate: The opportunity cost of capital is assumed at 12 percent for the financial analysis. For the social opportunity costs of capital or social discount rate, the analysis has adopted a rate of 6 percent[6,7], which is the suggested social discount rate for developing countries by the World Bank.

18. Phasing and realization of benefits: Based on the disbursement rate of the project and discussions with the project team, the analysis makes conservative assumptions for the realization of project benefits (see table below for phasing of beneficiaries). The analysis assumes that farmers realize the 50 percent of the benefits of interventions in the year following the investments and 100 percent of the benefits after two years.

[5]Baseline and endline data were collected from treatment and control villages. However, at the endline, additional questions were added to assess details on income and cost, intervention intensity, and adoption, along with the administration of qualitative instruments. To rule out any cost mismatch driven by additional variables added in the endline survey, the analysis in this section compares the post-project outcomes for the treatment group relative to the control group. This comparison provides a more conservative estimate of the intervention's effect. Given that the control and treatment samples were matched at baseline, as per the norms we assume that both groups would have followed parallel trends in the absence of the intervention, making it possible to attribute differences in the post-project outcomes to the PoCRA intervention.

[6] The social discount rate used for the economic analysis is based on World Bank's estimations, proposed by a standardized methodology. See Discounting Costs and Benefits in Economic Analysis of World Bank Projects, OPSPQ. May 9, 2016. "Where no country-specific growth projections are available, we suggest using 3 percent as a rough estimate for expected long-term growth rate in developing countries. Given reasonable parameters for the other parameters for the other variables in the standard Ramsey formula linking discount rates to growth rates, this yields a discount rate of 6 percent."

[7] The financial and social discount rates are in line with the discount rates used in similar projects in the country.

Table 4: Phasing of benefits

Year	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Phasing of benefits	0 %	5 %	10 %	30 %	25 %	30 %
Cumulative phasing of benefits	0 &	5 %	15 %	45 %	70 %	100 %

19. Adoption: Based on standard practices, the analysis assumes that 70 percent of project beneficiaries are adopters[8] who continue to reap the benefits from the project interventions in the long-term.

20. Inflation**:** All prices are adjusted to constant 2018 prices to allow comparison with estimates at appraisal. Adjustments for inflation are based on data obtained from the IMF (see table below).

Table 5: Year wise Inflation

Year	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Inflation (percent)	5.90	5.40	5.80	5.50	5.60	5.60	6.10	8.60

21. Spillovers: As can be seen from the household surveys, and by design, some households in the control areas also benefitted from the project. These could be through potential exposure to the farmers field schools which exposed them to new technologies and led to adoption, or benefits through activities in Component B of the project. Nonetheless, any benefits accruing to households in the control areas were not included in the analysis. This is because attribution of such benefits to the project alone is not straightforward as these households could have benefited under other schemes/projects. Thus, the analysis yields conservative estimates of project impacts.

22. **Quantification of project benefits:**

(a) *Cropping pattern and cropping intensity.* Household data from the impact assessment surveys suggests an increase in cropping intensity from 132 percent to 158 percent in project areas and from 137 percent to 144 percent in control areas. That is, cropping intensity increased by 26 percentage points among the project sample farmers, while it improved only marginally, by 7 percentage points, for the control farmers. Along with the expansion of micro irrigation facilities, the main reason behind this is the increase in cultivated area during Rabi season (primarily chickpea, followed by sorghum and wheat) as well as increased cultivation of annual and horticulture crops (albeit in smaller areas), which has in turn affected cropping patterns in project areas.[9]

Table 6: Cropping Intensity

Particular	Baseline	Midline	Endline
Net Cropped Area (Hectares)			
Project	2822	5982	7204
Control	1509	4449	7449
Gross Cropped Area (Hectares)			

[8] The impact assessment survey found an adoption rate of 80 percent at endline. The economic and financial analysis is conservative and estimates an adoption rate of 70 percent, allowing for 10 percentage point attrition in the long-run. A sensitivity analysis was conducted with a 20-percentage point attrition as well. Both financial and economic returns were found to be robust. That said, given the nature of interventions and current policy landscape in the state of Maharashtra, risk of attrition is not expected to be very high'.

[9] The randomisation of sample and comparison of the treatment and control areas (pre and post project) helps rule out effects of potential biases and confounding variables. Cropping intensity = Gross Cropped Area/Net Sown Area x 100.

Project	3732	8233	11457
Control	2062	6161	10770
Cropping Intensity (Percentage)			
Project	132	138	158
Control	137	138	144

(b) *Crop yield/productivity*. The project has significantly impacted crop yields through enhanced mechanization, improved irrigation techniques, adoption of drought-tolerant and climate-resilient, pest and disease resistance seed varieties and better integrated nutrient management measures. The table below presents productivity of major crops across project and control farmers.

Table 7: Crop wise yield (quintal per hectare)

Crop	**Project**	**Control**
Soybean	16.51 (13.09)	15.24 (13.34)
Cotton	19.11(10.37)	17.84 (11.36)
Pigeon Pea	16.85 (10.13)	14.52 (10.62)
Chickpea	16.26 (9.14)	13.95 (8.89)
Sorghum	13.36 (5.68)	12.69 (6.67)
Wheat	20.90 (14.97)	18.55 (14.97)

** Values in bracket are baseline yield values*

(c) *Reduced cost of cultivation and gross/net margins*. As part of the endline study, the average per hectare cost of cultivation was computed for six key crops under the main seasons of Kharif and Rabi. The assessment found a significant difference in the cost of cultivation in the intervention areas compared to the control geographies. This aligns with the project's key objective of increasing the profitability of farmers in the selected districts of Maharashtra and minimizes risk associated with adverse climate scenarios. These benefits are likely on account of Custom Hiring Centres (CHCs) which have lowered the cost for machinery rentals (and consequently labor costs). Together with introduction of certified seeds, micro-irrigation which have increased resilience and reduced expenditures on pest management, and these have translated to increase returns per hectare.

Table 8: Crop wise return calculation

	Cost of cultivation (Rs/ha)		**Gross margin (Rs/ha)**		**Net margin (Rs/ha)**	
Crop	**Project**	**Control**	**Project**	**Control**	**Project**	**Control**
Cotton	68,538	70,020	131,056	114,275	62,518	44,255
Soybean	56,289	58,403	74,695	66,626	18,406	8,223
Pigeon Pea	51,863	60,498	69,125	62,859	17,262	2,361
Chickpea	51,317	55,500	76,343	66,643	25,026	11,143
Sorghum	53,814	57,677	55,689	52,552	1,875	-5,125
Wheat	46,476	54,523	51,971	49,318	5,495	-5,205

(d) *Farmer incomes.* The overall effect of these improvements is reflected in net farmer incomes (calculated using household ownership of land, cultivated area for the different crops, net margins per ha to arrive at net income from crops plus net income from agriculture-allied activities. The table below shows the net farm income for the two types of beneficiary households as well as the control farmers. The estimated household incomes are used for estimating the project impact.

Table 9: Household income (in INR)

Beneficiary DBT	***Beneficiary non-DBT***	**Control**
78985	56710	*51701*

Results:

23. Financial analysis: The stream of net incremental income generated by the project over a 20-year period, using a financial discount rate of 12 percent, yields a financial net present value **(NPV) of INR8,919 million** (2018 prices) (US$139.6 million) and a financial internal rate of return **(IRR) of 17 percent**. The benefit cost ratio stands at **1.29**. These results are estimated using the farm incomes reported by the households across all activities.

24. Economic analysis: For the economic analysis, the financial stream of net incremental income was adjusted into economic values. A standard conversion factor of 0.9 was applied for project costs. Overall project analysis (before integrating the benefits from carbon sequestration) suggests an economic internal rate of return (IRR) of 19 percent, with an estimated NPV of INR38,985 million (US$612 million) suggesting a high economic profitability of the project investments. The benefit-cost ratio stands at 1.43. During appraisal, the IRR had been estimated at 22 percent with an NPV of US$415 million (2018 prices). The project's performance at completion is in line with what was expected at appraisal.

Greenhouse Gas Accounting:

25. The economic analysis was also conducted after incorporating the social value of carbon. Based on a net balance of -27,639,068 tCO_2-eq and a social value of carbon starting at INR2,197 (US$34.4 at an exchange rate of US$1 = INR63.87 in 2018, to allow comparison with estimates at appraisal), the ERR was estimated at **52 percent.**

Sensitivity analysis:

26. The sensitivity analysis tested the robustness of results to several adverse scenarios. This includes a (1) reduction in net project benefits by 30 percent, 50 percent and 70 percent (stemming from a wide range of factors including lower adoption/higher attrition, higher input costs, lower output prices etc.), (2) external price or climate shocks that reduce the benefits every 2 or 3 years by 50 percent, and (3) delay in project benefits by one and two years. Table 9 below presents the main results of the sensitivity analysis. As can be seen, the NPV remains positive under the different scenarios with an EIRR of 19 percent even with a 70 percent decline in project benefits. Thus, the economic returns to project investments remain robust in even severely adverse scenarios.

Table 10: Sensitivity analysis

Scenarios	Description	EIRR (%)	NPV (INR million)
Base scenario (with GHG)		52.3 %	252.793
Reduction in net benefits (due to higher input cost/ lower output prices/ attrition etc.)	30 %	38.8 %	166.423
	50 %	29.5 %	108.843
	70 %	18.9 %	51.264
	Every 3 years	44.7 %	208.334

External shocks: price or climate (50 % of benefits)	Every 2 years	41.0 %	178.178
Delay in project benefits	One-year delay	39.4 %	216.651
	Two-year delay	32.3 %	183.605

Annex 5. GHG BALANCE ACCOUNTING FOR PoCRA USING EX-ACT

Corporate Mandate

1. The World Bank Environment Strategy (2012) adopted a corporate mandate to conduct greenhouse gas (GHG) emissions accounting for investment lending in relevant sectors. The quantification of GHG emissions is an important step in managing and ultimately reducing emissions, as it provides an understanding of the project's GHG mitigation potential, and it is becoming a common practice for many international financial institutions.[10]

2. The agriculture sector is one of the dominant sectors contributing to GHG emissions in India and globally. It thus provides opportunities for reducing GHG emissions and enhancing carbon stocks. Enhancing carbon stocks in semi-arid soils will also have a positive co-benefit on crop yields and in building resilience to moisture stress. Consequently, there are likely to be synergies between enhancing carbon stocks and climate-resilient agriculture development.

Accounting methodology

3. The World Bank has adopted the Ex-Ante Carbon-balance Tool (EX-ACT), developed by Food and Agriculture Organization of the United Nations (FAO) in 2010, to estimate the impact of investment lending in the Agriculture, Forestry and Other Land Use (AFOLU) sector on greenhouse gas (GHG) emissions and carbon sequestration in project areas. EX-ACT is a land-based appraisal system that allows the assessment of a project's net carbon-balance, defined as the net balance of CO_2 equivalent (tCO2-e) GHG that are emitted or sequestered because of project implementation compared to a no project or without project scenario.[11] It helps the decision makers to understand whether the planned agricultural interventions contribute to meeting climate change mitigation objectives. The EX-ACT appraisals, initially designed for ex-ante analysis, can be also conducted during the project implementation as well as ex-post for comprehensive monitoring and evaluation, both at a project and at a country level. EX-ACT estimates the carbon stock changes (emissions or sinks), expressed in equivalent tons of CO_2 per hectare and year.

4. The tool consists of seven topic modules that allow analysis of a range of agricultural and forestry activities including changes in land-use, crop production, land rehabilitation, forest management, livestock and pasture management among others. The tool calculates changes in carbon stocks and GHG emissions including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which once converted to CO_2 equivalent are used to derive the carbon balance that indicates the impact of the project: positive carbon balance indicates that the project leads to greater emissions, while negative carbon balance indicates that project contributes to emissions reduction.

Project description

5. The primary focus of the PoCRA project is building resilience in agriculture and allied sectors to climate variability, droughts and long-term climate change. To strengthen the capacity of

[10] Further, Paris Agreement also mandates reporting of assumptions and methodological approaches including those for estimating and accounting for anthropogenic greenhouse gas emissions to achieve the goals of Article 2.

[11] The version of EX-ACT used in this analysis is primarily based on the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2006) and IPCC 2013, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC 2014), complemented by another scientific research. GHG emissions for farm operations, inputs, transport and irrigation systems implementation are based on Lal (2004). Emissions factors for the fishery sector are derived from Parker & Tyedmers (2014), Winther et al. (2009) and Irribaren et al. (2010 & 2011). These references provide EX-ACT with recognized default values for emission factors and carbon values, the so-called Tier 1 level of precision.

smallholder farming systems in the project area to cope with adverse climate events, the project has helped scale-up improved agronomic, water and soil nutrient management practices to build resilience in agriculture, while reducing the GHG emissions and enhancing carbon stock. In doing so, the project has helped enhance climate resilience and profitability of small holder farming systems in the drought prone semi-arid regions of Maharashtra.

6. The project was launched in 2018 and implemented over a period of six years in 15 districts of the Marathwada and Vidarbha regions in Maharashtra[12], covering 4,210 villages affected by droughts, and 932 villages affected by saline and sodic soils. The total area covered by project interventions is approximately 2.5 million ha. The project has four main components: (1) Component A – Promoting Climate-resilient Agricultural Systems; (2) Component B – Post-harvest Management and Value Chain Promotion; (3) Component C – Institutional Development, Knowledge and Policies for a Climate- resilient Agriculture; and (4) Component D – Project Management.

7. Detailed information on project activities from each component were used to inform the assumptions and data needed for the EX-ACT tool. These are presented in the consecutive sections.

Key assumptions for the GHG Balance estimation

8. The tool requires data for three specific points in time: initial situation, with project scenario and without project or BAU. It is assumed that the *'without-project'* situation is the same as the '*start*' situation.[13] Tier-1 coefficients are used throughout, and linear dynamic of change is assumed. The primary data sources used for the analysis were the impact assessment surveys, and information obtained from the PMU during the completion mission in August 2024.

9. **Accounting Period:** Total accounting period for the analysis is assumed to be 20 years – this includes 6 years of implementation phase and 14 years of capitalization phase of the project, which is common in the use of EXACT and aligned with the economic and financial analysis.

10. **Land Use Change[14]:** The analysis assumes introduction of agroforestry (predominantly teak and bamboo) on 600 Ha of previously degraded land. In addition, horticultural fruit trees and perennial crops are introduced in an area of approximately 29,300 ha. It is assumed that 50 percent of this is on previously fallow land, while the remaining 50 percent is on previously cultivated areas.

11. **Crop Production:** It is expected that improved agronomic practices, better soil nutrient and water management (through drip and sprinkler irrigation), increased application of organic inputs and manures and improved residue management practices will be adopted under the project scenario. This module captures the impact on carbon fluxes because of increases in cropping intensity, changing cropping patterns as well as improvements due to adoption of various climate resilient agricultural technologies and agronomic practices proposed under the project (especially related to tillage management, input of organic materials, and crop residue management).

12. Cropping patterns in the selected districts of the project area that were used for the analysis are presented in the table below. This includes area under different crops for Kharif and Rabi for both

[12] These two regions account for about 60 percent of the area under agriculture in Maharashtra.
[13] As assumed in the PAD: 'the area under different crops, especially under rainfed agriculture, varies from year to year depending on the monsoon rainfall, which is highly variable. There is therefore no clear trend that can be observed in the area under different crops.
[14] The analysis at completion differs from that at appraisal. The latter considered afforestation activities (degraded land to tropical forest) to the tune of 35,000 ha.

the 'without' and 'with' project situation.[15] The analysis assumes adoption rates of 70 percent for improved practices under the 'with' project scenario.

Table 1: Project area considered for the analysis

	Without Project		With Project	
	Kharif	**Rabi**	**Kharif**	**Rabi**
Soybean	1083657		1158657	
Cotton	1208469		1133469	
Pigeon pea	125941		125941	
Maize	60564		75565	
*Others - Kharif	40188		25188	
Chickpea		540035		978813
Sorghum		112843		204528
Wheat		120903		219137
Others - Rabi		32241		58437
Total	**2518819**	**806022**	**2518819**	**1460915**

**This includes paddy, millets, sorghum, sugarcane, oilseeds*

13. **Livestock and Grassland:** No major interventions under management of livestock and management of grassland/fodder or grazing land were undertaken under the project. The number of households with increase in livestock ownership due to the project is not very significant. Consequently, this module was not considered for the EX-ACT analysis.

14. **Inputs and Investments:** Based on data available from the household surveys, it is observed that the current rate of consumption of chemical fertilizers has declined under the project situation, despite increases in the area brought under cultivation, due to adoption of IPN management practices. Similarly, it is expected that pesticide usage would have decreased under the project scenario due to adoption of IPN management practices as well. However, due to lack of accurate data, this has not been included in the tool for estimation of carbon balances. For phase 2 of the project, collection of detailed information on input usage will greatly help improve the accuracy of the Ex-ACT analysis. The analysis also considers introduction of drip and sprinkler irrigation systems on over 500,000 ha.

Results of the GHG Balance Analysis[16]

15. Table 2 presents the impact of the project activities on the GHG balance. Overall EX-ACT results show a positive environmental impact due to the implementation of the project's activities, quantified **at a total carbon balance of – 27,639,069 tCO_2-eq over a period of 20 years**, or - 1,381,953 tCO_2-eq per year. Knowing the total area under focus, this would amount to a carbon balance of -0.5 tCO_2-eq per hectare and per year. **The negative carbon balance estimated using EX-ACT shows that the PoCRA project interventions will lead to net GHG emission reductions compared to the baseline or *'without-project'* scenario and** is an important *co-benefit* of the project.

[15] The current version of the EX-ACT tool does not include an option for 'seasonal fallow' in the land-use type. Consequently, the intensification of cultivation in the Rabi season is captured in the Tier 2 section with crop-duration weighted coefficients.
[16] For more details, refer to the EX-ACT tool.

Table 2: Results of the ex-post Ex-ACT analysis: Annual and total GHG emissions, with and without project, by category of emission ($tCO_2eq.$)

		Total Emissions (tCO_2-eq) (over 20 years)			Annual Emissions (tCO_2-eq.yr^{-1})		
COMPONENTS		WITHOUT	WITH	BALANCE	WITHOUT	WITH	BALANCE
Land use changes	Deforestation	0	0	0	0	0	0
	Afforestation	0	0	0	0	0	0
	Other land-use	0	-64.347	-64.347	0	-3.217	-3.217
Cropland	Annual	14.162.900	7.351.332	-6.811.567	708.145	367.567	-340.578
	Perennial	0	-6.282.854	-6.282.854	0	-314.143	-314.143
	Flooded rice	0	0	0	0	0	0
Grasslands & Livestock	Grasslands	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Forest mngt.	0	0	0	0	0	0
	Inland wetlands	0	0	0	0	0	0
	Coastal wetlands	0	0	0	0	0	0
	Fisheries and aquaculture	0	0	0	0	0	0
	Inputs & Invest.	64.375.995	49.895.695	-14.480.300	3.218.800	2.494.785	-724.015
Total emissions, tCO_2-e		**78.538.895**	**50.899.826**	**-27.639.069**	**3,926,945**	**2.544.991**	**-1.381.953**
Total emissions, tCO_2-e/ha		**30,8**	**20,0**	**-10,8**			
Total emissions, tCO_2-e/ha/yr		**1,5**	**1,0**	**-0,5**			

+ = Source / - = Sink

Uncertainty level	tCO2-e/yr	%
WITHOUT	3.926.945	35 %
WITH	2.544.991	35 %
BALANCE	- 1.381.953	34 %

Note: Negative (-) values indicate Net GHG benefits or CO_2 sequestration; Positive values indicate net GHG or CO_2 emissions

16. In addition, other scenarios with lower levels of adoption rates for different improved management practices were also considered. The results are robust, with net carbon balance at – 23,729,538 tCO_2-eq for an adoption rate as low as 30 percent.

Figure 1: Detailed Ex-ACT results

DETAILED RESULTS

Project name	POCRA	**Project duration (in years)**		**Total area (ha)**	2.548.702	**Global warming potential**	
Continent	Southern Asia	Implementation Phase	6	Mineral soil	2.548.702	CO_2	1
Country	India	Capitalization Phase	14	Organic soil	0	CH_4	28
Climate	Tropical	Total Duration of Accounting	20	Waterbodies	0	N_2O	265
Moisture	Dry						

GROSS FLUXES (In tCO2-e over the whole period analysis) | SHARE PER GHG OF THE BALANCE (In tCO2-e over the whole period analysis) — Tier 2 Specific GHG fluxes | AVERAGE ANNUAL EMISSIONS (In tCO2-e/yr) — Tier 2 Annual emissions

PROJECT COMPONENTS		GROSS FLUXES: WITHOUT	WITH	BALANCE	SHARE PER GHG: CO2 BIOMASS	CO2 SOIL	N_2O	CH_4	ALL NON-AFOLU EMISSIONS*	AVERAGE ANNUAL: WITHOUT	WITH	BALANCE
Land use changes	Deforestation	0	0	0	0	0	0	0		0	0	0
	Afforestation	0	0	0	0	0	0	0		0	0	0
	Other land-use	0	-64.347	-64.347	125.771	-190.119	0	0		0	-3.217	-3.217
Cropland	Annual	14.162.900	7.351.332	-6.811.567	0	-4.290.770	-378.008	-2.142.789		708.145	367.567	-340.578
	Perennial	0	-6.282.854	-6.282.854	-5.579.019	-703.835	0	0		0	-314.143	-314.143
	Flooded rice	0	0	0	0	0	0	0		0	0	0
Grasslands & Livestock	Grasslands	0	0	0	0	0	0	0		0	0	0
	Livestock	0	0	0			0	0		0	0	0
Forest mngt.		0	0	0	0	0	0	0		0	0	0
Inland wetlands		0	0	0	0	0	0	0		0	0	0
Coastal wetlands		0	0	0	0	0	0	0		0	0	0
Fisheries and aquaculture		0	0	0	0	0	0	0	0	0	0	0
Inputs & Invest.		64.375.995	49.895.695	-14.480.300		0	-2.138.227		-12.342.073	3.218.800	2.494.785	-724.015
Total emissions, tCO2-e		**78.538.895**	**50.899.826**	**-27.639.069**	**-5.453.248**	**-5.184.724**	**-2.516.235**	**-2.142.789**	**-12.342.073**	**3.926.945**	**2.544.991**	**-1.381.953**
Total emissions, tCO2-e/ha		**30,8**	**20,0**	**-10,8**	**-2,1**	**-2,0**	**-1,0**	**-0,8**	**-4,8**			
Total emissions, tCO2-e/ha/yr		**1,5**	**1,0**	**-0,5**	**-0,1**	**-0,1**	**0,0**	**0,0**	**-0,2**			

+ = Source / - = Sink

Results presented here include GHG fluxes on mineral and organic soils

See further down for detailed results on organic soils

* Includes fisheries, acquaculture and inputs & investments that are not included in the AFOLU definition.

Uncertainty level	tCO2-e/yr	Percent
WITHOUT	3.926.945	35%
WITH	2.544.991	35%
BALANCE	-1.381.953	34%

ANNEX 6. BORROWER, CO-FINANCIER AND OTHER PARTNER/STAKEHOLDER COMMENTS

A detailed “Borrower Completion Report” with all comments, submitted separately by the Borrower.

ANNEX 7. SUPPORTING DOCUMENTS (IF ANY)

Concurrent Monitoring – Round IX Report (For the period of 1st October 2022 to 31st March 2023) Monitoring and Evaluation for Project on Climate Resilient Agriculture (PoCRA) In Marathwada Region, Maharashtra. Nanaji Deshmukh Krishi Sanjivani Prakalp, submitted by Sambodhi, TERI

Impact Assessment Report - Monitoring & Evaluation (M&E) for Project on Climate Resilient Agriculture (PoCRA). Nanaji Deshmukh Krishi Sanjivani Prakalp, Submitted June 2024. Sambodhi, TERI, NABCONS

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Maharashtra State Adaptation Action Plan on Climate Change, MSAAPCC 2023. Available online at
https://moef.gov.in/uploads/2017/09/Maharashtra-Climate-Change-Final-Report.pdf

POCRA Digitizing Agriculture for Climate Resilience June 2021 https://docslib.org/doc/1712979/digitizing-agriculture-for-climate-resilience (downloaded October 2024)

World Bank 2023 Restructuring Paper on a Proposed Project Restructuring of the Maharashtra Project on Climate Resilient Agriculture Approved on February 27, 2018. REPORT NO.: RES52634 Maharashtra POCRA website https://mahapocra.gov.in/