महाराष्ट्र शासन

THE WORLD BANK

Results Overview

Project on Climate Resilient Agriculture (PoCRA)

Nanaji Deshmukh Krishi Sanjivani Prakalp

Project of Government of Maharashtra
in Partnership with the World Bank

Submitted by | SAMBODHI | teri | NABCONS

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Abbreviations

APIs: Application Programming Interfaces

ATMA: Agricultural Technology Management Agency

CHC: Custom Hiring Centers

CIC: Climate Innovation Center

CRAT: Climate-Resilient Agriculture Technology

CRIDA: Central Research Institute for Dryland Agriculture

DBT: Direct Benefit Transfer

EFA: Economic and Financial Analysis

EIRR: Economic Internal Rate of Return

FFS: Farmer Field Schools

FIG: Farmer Interest Group

FPC: Farmer Producer Company

FPOs: Farmer Producer Organizations

GAPs: Good Agricultural Practices

GHGs: Green House Gases

GoM: Government of Maharashtra

GSDA: Groundwater Survey and Development Agency

IASRI: Indian Agricultural Statistics Research Institute

ICAR: Indian Council of Agricultural Research

ICT: Information and Communications Technology

IIT: Indian Institute of Technology

IMD: India Meteorological Department

INR: Indian Rupee

IPCC: Intergovernmental Panel on Climate Change

IT: Information Technology

KVKs: Krishi Vigyan Kendras

MDI: Minimum Detectable Impact

MIS: Management Information System

MoPOP: Market-Oriented Package of Practices

MT: Metric Tonnes

NBSS: National Bureau of Soil Survey

NDCs: Nationally-Determined Contributions

NGOs: Non-Governmental Organizations

NPK: Nitrogen, Phosphorus, and Potassium

NPV: Net Present Value

NRM: Natural Resource Management

OECD-DAC: Organisation for Economic Co-operation and Development 's (OECD) Development Assistance Committee (DAC)

ONDC: Open Network for Digital Commerce

PMU: Project Management Unit

PoCRA: Project on Climate Resilient Agriculture

RoPA: Rest of Project Area

SAUs: State Agricultural Universities

SHGs: Self-Help Groups

SREPs: Supplement to Climate Resilient Agriculture Plans

TCM: Thousand Cubic Meters

USD: United States Dollars

VCRMCs: Village Climate-Resilience Management Committees

Executive Summary

Agriculture has been a driving force for India's economy, employing about 45.8% of the total workforce[1]. In such a situation, growing climate stressors have led to significant losses, with extreme weather events causing reduced crop yields and frequent crop failures.

For Maharashtra, India, the agriculture sector continues to grow, continually employing nearly 50% of the state's working population[2]. However, a large number of these farmers are smallholder farmers, relying heavily on rain-fed agriculture. Delayed, erratic, or insufficient rainfall due to climate change has significantly impacted their socio-economic well-being, which is why assistance to help alleviate these stressors is critical to ensure their survival and the state's overall growth.

In lieu of this, the Government of Maharashtra (GoM), with the support of the World Bank, established the Nanaji Deshmukh Krishi Sanjeevani Prakalp, also known as the Project on Climate Resilient Agriculture (PoCRA) in 2018-19. This project was created to help promote climate adaptation and mitigation strategies that would also help smallholder farmers generate climate co-benefits[3].

About the Project

PoCRA focuses on scaling climate-smart technologies and practices at the farm and watershed levels, which would contribute to drought-proofing and land management in the state's most drought- and salinity/sodicity-affected villages.

This achievement was realized by adopting a comprehensive, multi-sectoral approach aimed at fortifying agricultural systems against challenges. Key strategies included the use of technology to secure water resources on farms, the application of soil nutrient management practices to improve soil health, and the introduction of climate-resilient seed varieties to boost farm productivity and crop diversity. Furthermore, to secure farmers' incomes, market-oriented crops were promoted within emerging value chains through the support of Farmer Producer Organizations (FPOs), ensuring a cohesive advancement towards resilience and sustainability in agriculture.

The project worked with smallholder farmers, including marginal and women farmers from 670 mini watershed clusters covering 5220 villages in 16 districts of Maharashtra. These include:

- **Eight districts of Marathwada:** Chatrapati Sambhaji Nagar, Nanded, Latur, Parbhani, Jalna, Beed, Hingoli, Dharashiv,
- **Rest of Project Area (RoPA), consisting of six districts of Vidarbha:** Akola, Amravati, Buldana, Yavatmal, Washim, Wardha, and
- **Jalgaon and Nashik district** of Nashik division.

Furthermore, the project covered 932 salinity-affected villages in the Purna River basin, which is spread across the Akola, Amaravati, Buldhana, and Jalgaon districts.

Implemented between 2018 and 2024 in Maharashtra, with a total project cost of INR 4696.36 crores, the objectives of the project were operationalized through four key components, which are detailed in the section on findings.

1 Ministry of Labour and Employment, Government of India. "Periodic Labour Force Survey." Lok Sabha, https://sansad.in/getFile/loksabhaquestions/annex/1714/AS228.pdf. Accessed 10 Sept. 2024.

2 Maharashtra State Data Bank. "Agriculture and Allied Activities." Maharashtra Government, https://mahasdb.maharashtra.gov.in/DSP/agriAllied. Accessed 10 Sept. 2024.

3 World Bank. "What You Need to Know About Climate Co-Benefits." World Bank, 10 Mar. 2021, www.worldbank.org/en/news/feature/2021/03/10/what-you-need-to-know-about-climate-co-benefits. Accessed 10 Sept. 2024.

The project's interventions were designed in a way that covered both pre- and post-harvest activities for smallholder farmers and worked on addressing challenges faced during the process. It empowered the communities to democratically identify project beneficiaries: one of the major project components engaged around 50,000 members via close to 4000 Village-Climate Resilience Management Committees (VCRMCs) in 5220 villages. These members were engaged in planning natural resource management, disseminating resilient technologies, and resolving disputes. Furthermore, the project's approach to technology was geared towards auto prioritization of social categories and first-in-first-out systems that created an interesting mix of technology with social dimensions to deliver social justice and thereby encourage social inclusion.

During the growing phase, smallholder farmers often face challenges in irrigating their crops in the face of water shortages due to irregular rainfall, which is why the project worked on increasing the water use efficiency for its beneficiaries. Drip and sprinkler irrigation saw increased adoption within the community, covering an area of 4,88,747 hectares currently. Farmers have also experienced improved productivity of key crops such as soyabean and cotton, with 26% and 84% increases in productivity over baseline, respectively. The increasing cropping intensity in project areas indicates that more land is being brought under Rabi cultivation by farmers.

Agronomic practices have also seen wider adoption, with project farmers adopting technologies such as broad bed furrow and conservation tillage. Nearly 23% of respondent farmers adopted the former and experienced a 20-25% increase in crop yield as compared to flatbed sowing. This has led to in-situ moisture conservation during prolonged dry spells with effective drainage during high-intensity rainfall.

Economically, the cost of cultivation has also been reduced for smallholder farmers due to improved farming activities and resource management by the project. We also see a substantial increase in net farm incomes, with a 46% increase in project areas in contrast to the control area. Significantly, net farm income in women-headed households saw a 38% increase in project areas, while male-headed households saw a 50% increase, signifying economic growth alongside the gender component too. The project also contributed to amplifying the environmental impact in terms of the net Green House Gas (GHG) benefits on a per-hectare basis: an annual average CO_2 sequestration of 3228 ('000 ton/annum) is anticipated in the project area in the next two decades.

PoCRA's focus was also dedicated to mainstreaming techniques to deal with soil salinity and sodicity in the project areas. Area treatments such as graded bunding helped farmers in the Kharpan region to improve the soil quality, which enhanced the crop yield. Furthermore, the project invested in 932 villages in areas like the creation of farm ponds, micro-irrigation, seed treatment etc., to promote good agricultural practices. More and more farmers have adopted nutrient management services: over 98% of

beneficiaries have been initiated into this process and have taken up practices such as vermicomposting, reflecting the effect of knowledge dissemination by the project.

Even though pesticide remains the most common intervention, local remedies are on the rise. Notably, in both project and control groups, 90% of respondents reported bathing after spraying, while close to 75% covered with a face mask while working with pesticides.

The project's second component focused on building FPOs' capacity to reach more farmers and perform more effectively as aggregators. Alongside this, the project also worked to align income and growth levers, such as training in sustainable agricultural practices, providing infrastructure, and facilitating access to credit. As a result of such efforts, the project supported numerous Farmer Producer Companies (FPCs), farmer groups, and Self-Help Groups (SHGs), out of which 218 FPCs reported growth in annual profit. Furthermore, farm mechanization within the project intervention has helped farmers reduce time, labor, and drudgery, thereby reducing their cost of cultivation too. In order to improve the supply of seed varieties, 50,000 Metric Tonnes (MT) of certified seeds were produced during the project period, reflecting a higher usage by farmers.

The third component of PoCRA strengthened the institutions associated with the project. Reaching close to 77,000 farmers through training sessions, webinars, and workshops on climate-resilient technologies (CRATs), PoCRA ensured the sustainability of these practices. Notably, one-third of the participants in these trainings were female farmers. For wider dissemination and learning, Supplement to Climate Resilient Agriculture Plans (SREPs) were developed using evidence-based village adaptation plans by taking inputs from various technical institutions such as Krishi Vigyan Kendras (KVKs), universities, and Central Research Institute for Dryland Agriculture (CRIDA).

It has been observed that PoCRA can be visualized as a mini-Climate Innovation Center (CIC) to engage public and private sector capacities to scale technologies for a climate-resilient agri-food system in Maharashtra. This consortium also generated and disseminated cutting-edge knowledge on a range of issues related to climate-resilient agriculture and worked on providing analytical underpinnings to improve the policy and strategic framework required to enhance the ecosystem. Furthermore, the digitization of processes and activities has substantially improved implementation in the project region, as the Project Management Unit (PMU) helped the project bring efficiency and savings in management costs.

Approach and Methodology

The endline impact assessment report evaluates the project's overall performance, impact, and sustainability, having built on the mid-term review and compares outcomes with baseline data. The assessment identifies factors that contributed to or hindered achieving targets and measures community awareness. This section outlines the methodology for the endline impact assessment of the project focusing on its overall performance, impact, and sustainability. Using the Organisation for Economic Co-operation and Development's (OECD) Development Assistance Committee (DAC) framework, it includes details on the methodology and sampling techniques used to measure key outcomes, including physical infrastructure, socio-economic changes, environmental impacts, and institutional strengthening, while also covering field observations and asset verification.

Evaluation Design

A quasi-experimental design with a double-difference method was used for the impact evaluation. This design compares project clusters with control clusters using the climate change vulnerability index (as defined by Intergovernmental Panel on Climate Change (IPCC)-2011) to match similar groups. A robust a-priori matching matched project and control clusters to ensure strong attribution of project results. Villages were further selected from the matched clusters.

OECD-DAC Evaluation Criteria

Evaluation Framework

The impact assessment follows the World Bank Group Evaluation principles (2019), OECD-DAC framework[4]. The evaluation criteria include relevance, coherence, effectiveness, efficiency, impact, and sustainability. This framework helps analyze project objectives, input-output processes, cost-effectiveness, short- and long-term impacts, and sustainability. Using this framework, we have assessed PoCRA on each of these criteria through rigorous statistical analysis of primary and secondary data.

A one-to-one matching technique was used to find the closest match to every project cluster in the same district. Finally, the control cluster corresponding to the sampled project cluster was selected for the survey. Villages were further selected from the matched clusters. Households from each village were selected through systematic random sampling. The ratio of the project to control sample is maintained at 1:1 in the entire region.

4 Organisation for Economic Co-operation and Development (OECD). "DAC Criteria for Evaluating Development Assistance." OECD, www.web-archive.oecd.org/temp/2024-05-13/81829-daccriteriaforevaluatingdevelopmentassistance.htm. Accessed 10 Sept. 2024.

Sampling Methodology

A mixed-method approach was adopted for the endline survey, combining quantitative and qualitative approaches to understand the project comprehensively. The quantitative survey included 4490 households each from project and control areas in Marathwada and RoPA regions, powered to have a Minimum Detectable Impact (MDI) of 5%. The qualitative component involved Focus Group Discussions (FGDs) and In-Depth Interviews (IDIs) with farmers, VCRMC representatives, FPO representatives and SHGs covering both project and control areas, thereby capturing a wide range of feedback on project benefits and challenges.

Field Observations and Asset Verification

Field observations by experts and research team members were conducted in sampled project villages to assess the status of project implementation. In addition, individual and community assets in 10% of the project clusters (67 in total) were physically inspected and documented to ensure compliance with technical specifications. A checklist of technical specifications for physical verification and a list of documents to be verified for each type of asset was provided by the PMU. In the case of community work, two assets in each cluster were randomly sampled from the list provided by the PMU and verified during the endline survey. The individual assets were verified during the household survey.

Key Findings

The project was structured into four key components, each with a different focal point:

Component A focused on promoting climate-resilient agricultural systems

Component B worked on promoting post-harvest and value-chain management

Component C focused on generating knowledge and policies on climate-resilient technologies

Component D worked on conducting effective project management via a Project Management Unit

Dedicated activities under each component led to key findings based on different thematic areas, which range from planning and coverage, promotion and adoption to impact and development of natural resource management, etc.

This section will provide insights based on the significant findings from each of these components. The detailed PoCRA report provides a more comprehensive analysis and description of these findings.

Component A: Promoting climate-resilient agricultural systems

Component A worked on strengthening the adaptative capacity of smallholder farmers to adjust and modify their production systems to navigate potential future impacts from climate events. This happened in three ways:

01 Develop mini-watershed and cluster development plans for improved local agricultural systems

Through people's participation, 138 cluster development plans and 5043 village development plans have been approved and implemented.

Participatory village-level microplanning process is coordinated by 3959 fully functional VCRMCs.

Through 3959 VCRMCs in 5220 villages, the project engaged around 50,000 members.

A decentralized approach has fostered a more democratic and people-centric decision-making process. By giving the first right of beneficiary identification to the VCRMC, transparency mechanisms and social audits were automatically triggered. The village community was empowered to choose beneficiaries, plan for Natural Resource Management (NRM), disseminate resilient techniques, and resolve disputes.

02 Promote transfer of on-farm technologies and agronomic practices for increased farm income

Promotion and adoption of benefits by PoCRA

Matching grants were transferred for on-farm technologies through the dedicated Direct Benefit Transfer (DBT) to 4,85,669 farmers.

More than 2 lakh participatory sessions were conducted in 4800 villages through 37,184 Farmer Field Schools (FFS) with interactive on-site learning approaches. Host farmers participating in FFS was 15,501, and guest farmers amounted to 4,90,780. 15% of the total host farmers and 13% of the total guest farmers trained were women.

Impact of adoption on farmers

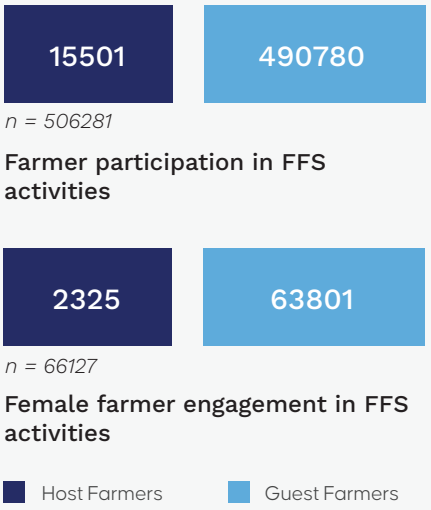
A total of 82% of farmers from project areas and 69% from control regions reportedly adopted at least one of the climate-resilient agriculture technologies.

About 61% of project farmers were found to be uniquely trained adopters of CRAT.

The project area's women farmers have an adoption rate of 56%, as evidenced by 1,53,560 women farmers, accounting for 14.22% of the total farmers adopting CRAT across all regions serviced by PoCRA.

The promotion of FFS within the project has significantly enhanced the adoption and dissemination of CRATs among farmers in the targeted region. Project areas show significant improvement in CRAT adopters, bringing efficiency, sustainability, and cost-effectiveness to agricultural operations. Additionally, the project reached a substantial number of female farmers as well.

Project's Management Information System (MIS) data highlights that its operations reached 12,65,233 farmers at endline, out of which 26% were female farmers who accessed assets and services.



Impact of micro-irrigation on agricultural growth

Average water productivity in all five crops (Soybean, Cotton, Pigeon pea, Green gram, and Black gram) in the project area (0.41 kg/m^3) is observed to be more than in the control area (0.34 kg/m^3).

PoCRA helped 4,31,328 beneficiaries of the micro-irrigation system.

About 83% of the survey sample who adopted drip irrigation in the project group at the endline reported a reduction in water consumption and wastage. On the other hand, 73% of those who adopted drip irrigation in the control group reported a reduction in water consumption and wastage.

The number of farmers leveraging drip irrigation was reported as 15% and 16% among project and control farmers, respectively, during baseline, which increased to 25% for project farmers and 19% for control farmers during the endline.

At the time of baseline, both project and control farmers reported an average use of sprinkler irrigation of 14%, which has now significantly increased to 31% among the project and 27% among control farmers, highlighting the project's impact in bringing more area under micro-irrigation.

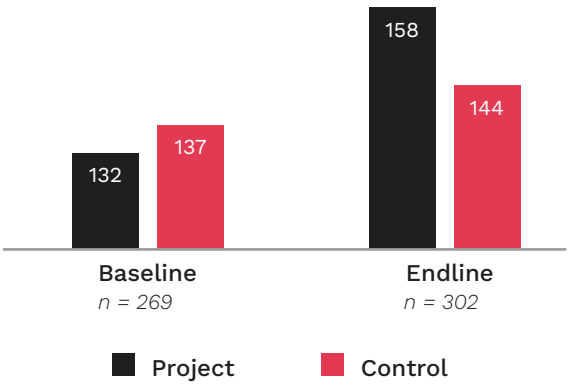
Impact of interventions on crop productivity

Project farmers growing soybeans saw a 26% increase in productivity over baseline, while control farmers reported only a 14% increase in soybean productivity.

Project farmers growing cotton reported an 84% increase in productivity over baseline, while control farmers reported a 57% increase in cotton productivity.

Cropping intensity in the project areas improved as it is reported at 158% (as compared to 132% during baseline), and that in the control area is 144% (as compared to 137% during baseline and 138% during midline).

Spatial yield variability for soybean and Pigeon pea at household level is 30% and 52%, respectively, which is less than the baseline value of 36% and 66%, respectively, in the project village.



Impact on cropping intensity from baseline to endline

With a nearly 21% increase in water productivity in comparison to the beginning of the project, farmers experienced a reduction in water consumption and wastage. They also saved 60-70% of energy in comparison to traditional flood and furrow systems. Additionally, an increase in crop intensity in the project region implies that more land was brought under Rabi cultivation by farmers in the project region.

Impact of adopting protected cultivation

PoCRA implemented this activity on 1658.3 hectares with a total assistance of INR 651.44 crores to the farmers.

The project has supported the horticulture plantation on 29,270 hectares and agroforestry activity on 613 hectares of land in project areas.

Impact of adopting agronomic practices

More than 18% of respondent farmers adopted contour cultivation.

More than 22% of respondent farmers adopted land preparation and furrow opening.

Nearly 23% of respondent farmers are adopting Broad Bed Furrow technology and have experienced a 20-25% increase in crop yield as compared to flatbed sowing.

Technology Coordinators have conducted dedicated FFS to promote zero tillage practice, which was later adopted by over 3000 farmers in project districts.

Protected cultivation helped farmers achieve controlled farming conditions with a very low incidence of diseases and pests, resulting in assured and high crop productivity. Furthermore, with other technologies and techniques, there's less soil erosion, conservation of soil moisture during dry spells, and reduced cost of cultivation in light soil.

Impact of using integrated farming systems

The project has promoted sericulture as a resilient practice through individual entrepreneurship under dryland conditions, which has generated 12,361 applications from villages.

Adaptation strategy has enhanced the livelihood resilience among the 5391 beneficiaries of small ruminants, 21,53 beneficiaries of inland fisheries, 362 beneficiaries of apiculture, and 234 beneficiaries of backyard poultry.

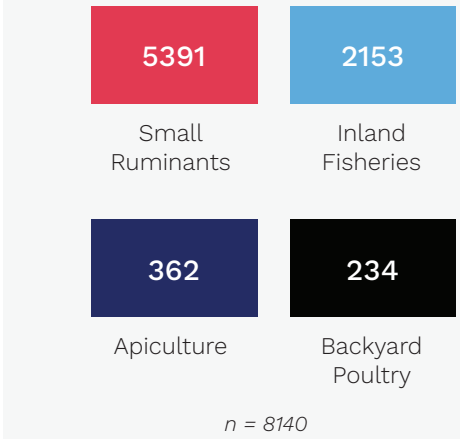
Economic and environmental impact of interventions

The gross farm cost for households in the control group is 10% higher than that of households involved in the project.

The average net farm income for FY 2022-23 in the project area is INR 75,395, compared to INR 51,701 in the control area.

The project shows an increase of 38% (INR 61,001 in project, INR 44,155 in control) in net farm income in women-headed households and an increase of 50% (INR 77,084 in project, INR 51,468 in control) in male-headed households in project areas.

The net GHG benefit on a per-hectare basis for the project area is estimated to be 20.7 tCO_2 over the period of 20 years and 1.0 tCO_2/ hectares/year.



Distribution of integrated farming activities supported by PoCRA

Over 80% of farmers in the project using integrated farming systems have seen increased incomes, largely due to lower cultivation costs and better resource management. Net income for farmers has gone up by 46%, with significant benefits for women-led households. Environmentally, the project is expected to sequester around 3228 thousand tons of CO_2 annually over the next 20 years.

03 Enhance surface water management and groundwater resources in the project's mini watersheds

Impact of developing natural resource management practices

In order to reduce vulnerability to extended in-season dry spells and lower rainfall, the project built 4315 water conservation works, which led to 32,866 Thousand Cubic Meters (TCM) surface water storage.

PoCRA constructed 1884 water conservation works like cement nala bund and rejuvenation of old structures which helped in storing 6209 TCM of water.

Through new/improved irrigation or drainage services, the project covered 6,67,902 hectares, which was more than the targeted 6,24,000 hectares.

Close to 11,120 new individual and community farm ponds were created, generating 30,375 TCM of surface water storage capacity.

Area treatment like graded bunding has helped nearly 7% of farmers in project areas cope with the problem of salinity.

Impact of adopting Good Agricultural Practices (GAPs)

The project invested in 932 villages to promote GAPs such as the creation of farm ponds, micro-irrigation, seed treatment, adoption of intercropping, vermicomposting, growing legumes, and mulching.

GAPs have been adopted on 1,46,826 hectares against the target of 1,27,600 hectares.

Water conservation and harvesting activities under the project has improved the water storage capacity in targeted areas, thereby improving water availability. In fact, area treatment like graded bunding has helped farmers in the Kharpan region to improve the quality of soil, enhancing the crop yield.

Impact of using integrated nutrient and pest management practices

Out of the farmers surveyed, 18% indicated the application of a balanced dose of Nitrogen, Phosphorus, and Potassium (NPK), 16% adopted micro-irrigation techniques, 14% used micronutrients, and 12% used gypsum and fly ash to deal with soil salinity.

On average, 98% of the beneficiaries are practicing integrated nutrient management, including biofertilizers (vermicompost).

Around 40% of farmers in the project region, compared to 34% in the control region, have adopted climate-friendly pest management practices, including neem extract, dashaparni, etc.

Adoption of nutrient management measures, specifically greater uptake of seed treatment inter-cropping, usage of farmyard manure, and legumes in the project areas, points to greater absorption of knowledge by the farmers relating to integrated nutrient management. With a 14% reduction in vulnerability to diseases in both the project and control area, pesticides are still the most common intervention. In both groups, approximately 90% bathed after spraying, while ~75% were covered with a face mask while spraying pesticides.

Component B: Post-harvest management and value chain promotion

Component B worked on developing the absorptive capacity of stakeholders in the selected commodity of value chains to prepare for and help recover from the negative impacts of climate events. This happened in three ways:

01 Strengthen FPOs' capacity through project-promoted activities

Planning and coverage under project activities

PoCRA supported 3235 unique entities, consisting of 1187 FPCs, 1173 Farmer Groups, and 875 SHGs.

Growth in annual profit was reported by 218 FPCs.

02 Promote the participation of FPOs in emerging value chains for climate-resilient commodities

Impact of building infrastructure capacities

PoCRA developed 2779 Custom Hiring Centers (CHCs).

FPOs could cope with the climate and market variabilities by use of improved storage facilities achieved through 960 godowns, processing capacities through 417 units, and 545 other agri-business activities implemented by the project.

CHCs can reduce nearly 6% of the cost of renting farm machinery in the project villages and about 29% in the control villages.

About 62% of the CHC users expressed a reduction in drudgery, 85% of them saved on labor costs, and 81% of them saved time on critical farm operations.

03 Improve the supply of seed varieties for small and marginal farmers in project area

Impact of adoption on farmers

Around 24,205 farmers have successfully taken up seed production programs on nearly 58,510 hectare of land in the project area.

A total of 50,000 MT of certified seeds were produced due to this exercise during the project period.

The introduction of farm mechanization through the CHC initiative has significantly helped farmers by reducing the time, labor, and effort involved in cultivation, thereby decreasing their costs. Providing access to storage facilities has improved the quality of farm produce and helped farmers secure better market prices. Moreover, the project has enhanced processing capacity, allowing farmers to add value to their produce, cut transportation costs, and gain stronger bargaining power.

Diverse projects such as essential and neem oil extraction, cattle feed, sericulture, vermicompost, goat breeding operations, and refrigerated transport have broadened the scope of agribusiness. Furthermore, it has bolstered FPCs, enabling them to supply high-quality, viable seeds of desired varieties, thus transforming them into dependable sources within the project area.

Component C: Institutional development, knowledge, and policies for climate-resilient agriculture

Component C focused on enhancing the transformative capacity of institutions and stakeholders to promote and pursue a more climate-resilient agriculture, with sector strategies and policies based on strong analytical underpinnings and cutting-edge climate, water and crop modelling. This happened in three ways:

01 Strengthen project-related institutions at all levels to support agricultural and rural growth in Maharashtra

Planning and coverage for capacity building

Throughout the project timeline, 76,966 capacity-building events like training, webinars, and workshops were conducted for project beneficiaries.

These benefitted 72% of male and 28% of female participants.

The project has developed the capacity of around 50,000 VCRMC members and *Krishi Tais* on roles, skills, conservation, planning, inclusion, and technology.

More than 6000 farmers were trained in protected cultivation.

A total of 205 exposure visits on regenerative farming for 4218 farmers were conducted.

The 15 SREPs prepared in collaboration with the Project Director of the Agricultural Technology Management Agency (ATMA) and KVKs incorporating scientific consultation with various project stakeholders from the district have been guiding the work of climate-resilient agriculture extension workers.

PoCRA has taken significant steps to promote gender sensitivity and sustainability in agriculture. It guarantees that one-third of its capacity-building session participants on CRATs are female farmers. Additionally, the SREP for 15 districts adopts a science-based approach to climate resilience, integrating strategies from technical institutions such as KVKs, universities, and CRIDA to ensure a comprehensive and scientifically supported enhancement of agricultural resilience.

02 Establish a CIC to scale climate-resilient agri-food systems in Maharashtra

Impact of developing technologies for the program

PoCRA used many Application Programming Interfaces (APIs) from various agriculture and weather stakeholders.

Various Information Technology (IT) based digital Apps, including DBT, FFS, water budget, etc., and services were developed to streamline the implementation process.

Impact of collaborations between stakeholders

On average, 60% of farmers are following the agro-advisory services delivered through various social media outreach platforms.

Project collaborated with institutions like the Indian Council of Agricultural Research (ICAR) agencies, State Agriculture Universities (SAUs), Indian Institute of Technology (IIT) Bombay, Groundwater Survey and Development Agency (GSDA), Yashada and Vanamati.

Impact of innovation on project goals

PoCRA functioned as a mini-CIC through a robust consortia approach for knowledge dissemination

The project used agriculture-related APIs and collaborated with ICAR agencies such as National Bureau of Soil Survey (NBSS), CRIDA, and Indian Agricultural Statistics Research Institute (IASRI) to develop and disseminate knowledge products based on the needs of farmers.

SAUs were also engaged to develop the crop coefficients (Kc) values of various crops by conducting Lysimetric studies.

A water budget tool was developed and disseminated with IIT Bombay.

PoCRA collaborated with start-ups like Kheti Buddy to handhold the farmers for regenerative agriculture.

Language learning models were used to try and develop a farmers' chatbot.

Project engaged in capacity building and exposure visits for farmers and worked with FPCs for the establishment of agribusinesses.

The project showcased how critical digitization is to agricultural success, notably through agro-advisories that enabled farmers to mitigate climate risks and enhance their income and output. PoCRA harnessed an innovative Information and Communications Technology (ICT) system through its innovation lab, facilitating training on a user-friendly mobile app for beneficiaries. This initiative led to the creation of the Maha DBT portal by the Agriculture Department, reflecting the project's achievements in promoting transparency and efficiency via DBT systems.

Additionally, PoCRA acts as a mini-CIC, collaborating with both public and private sectors to expand climate-resilient agricultural technologies across Maharashtra.

03 Generate and disseminate cutting-edge knowledge for ecosystem building in the state and beyond

Knowledge development under project activities

Consortia's approach to the project helped develop robust partnerships with knowledge-based institutions in various fields, such as water budgeting crop Kc values, soil parameter assessment, and many more.

Project activities have generated and disseminated cutting-edge knowledge on climate-resilient technologies, which has improved the policy and strategy framework required to further enhance resilience and sustenance in the agri-food system in Maharashtra.

Component D: Project Management

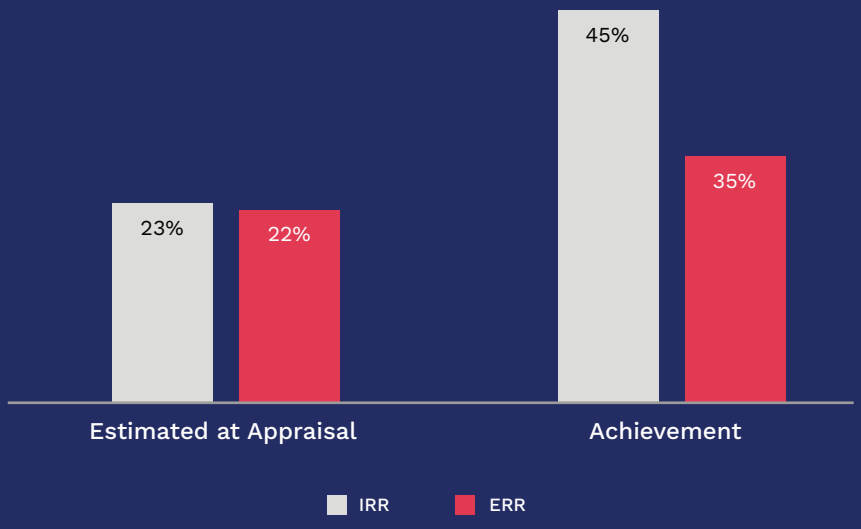
In Component D, activities of the PMU set up by the GoM during the project preparation phase have been covered.

The project's focus on collaboration and digitization led to substantial financial efficiencies which helped keep the management cost as low as less than 5% of the project costs. The PMU has functioned on the back of a digital backbone which has helped it to bring efficiency and saving in management costs.

Economic and Financial Analysis

The Economic and Financial Analysis (EFA) compared the cost invested in the project and the financial implications of the interventions undertaken during the project implementation. EFA of the PoCRA analyzes activity-wise distribution of the resources and the economic impact generated by these activities. With the cost-benefit analysis approach, the analysis was based on a monetary valuation of the project's costs and benefits, focusing on the targeted crops and using 'with project' and 'without project' comparative variations.

The project has obtained an Economic Internal Rate of Return (EIRR) of 45% as against 23% during the appraisal phase, with a corresponding Net Present Value (NPV) of USD 4789 million as against the appraisal figures of USD 461 million. The NPV is estimated at USD 3995 million, at a 6% discount rate as per World Bank guidelines, compared to USD 415 million at appraisal, where a 6% discount rate was used. The NPV becomes USD 1685 million when a discount rate of 10% is used for analysis.



Comparison of IRR and ERR: Estimated at Appraisal vs. Achievement

Results and Key Recommendations:

Today, with frequent climate events impacting the socio-economic fabric of our society, comprehensive and long-term strategies are essential to adapt to our changing realities. Given the climate projections that indicate a severe impact on the agriculture and water sectors in Maharashtra, a new paradigm addressing climate adaptation and mitigation in agriculture and food systems is essential.

This realization underscores the fact that, through its triple-win solutions (enhanced water security at the farm level, improved soil health, and increased farm productivity and crop diversification), PoCRA has significantly improved the profitability of small-scale farming operations in project areas.

By developing mini watersheds through comprehensive micro-level village development plans, the project improved the adoption rate of micro-irrigation systems, treatment of catchment areas for water security, use of drought-tolerant varieties of seeds, crop diversification, agronomic practices including both pest and nutrient management, and carbon sequestration in the project region. In fact, landless households also benefitted from the project through activities under integrated farming systems, suggesting a spillover effect of growing awareness and knowledge about climate-resilient techniques.

It also strengthened post-harvest management and promoted value chain agribusiness activities in farmers' producer organizations involving small and marginalized farmers. Through this intervention, the project facilitated access to farm machinery through custom hiring centres at affordable rates, the establishment of storage and processing units for agricultural produce, the production and use of certified seeds, and other relevant agribusiness activities with an emphasis on climate resilience.

Stakeholders, including project staff, VCRMC members, *Krishi Tais,* etc., were trained through training sessions, workshops, and exposure visits to promote a climate-resilient agricultural system. Strategic partnerships have been formed with both state and academia and research institutions to promote technological solutions for farmers. While these components have yielded positive results, implementing certain recommendations related to them will have an even greater impact on the ground.

In studying these result areas, we have understood the positive results yielded from the project impact. To supplement these wins, the following is a list of recommendations for the project to continue positively impacting farmers' lives and build on the success that PoCRA has had for all involved stakeholders.

Strengthening institutional and individual capacity to sustain impact

While capacity building has been a central part of PoCRA success in bringing climate-resilient technology to rural areas, the administrative capacity of VCRMCs must be further enhanced to plan, implement, monitor, and strengthen the project. This can ensure better collaboration between block and district-level offices alongside efficient local resource allocation and support to communities. Furthermore, communication can be streamlined, and decision-making can be informed at the village level.

Krishi Tais or female farmer friends who mobilize women farmers on vital information on climate-resilient agricultural practices need further attention on their roles, working hours, and honorarium.

FPCs, SHGs, and Farmer Interest Groups (FIGs) are other key institutions that must be encouraged to access and implement agribusiness activities. Regular and refresher training sessions should be conducted to ensure that these stakeholders are up to date with the latest techniques and best practices. By focusing on exposure visits, social relationship-building, weather advisory, and market information, farmers can be better prepared to face the changing climate.

Leveraging digital technology to increase farmer outreach

The digital approach to the project has led to the widespread reach of knowledge and skills required to mainstream climate-resilient agriculture. Taking this forward within the project scope can help disseminate information on emerging technologies, application methods, and their social, economic, and environmental benefits.

Low participation rates in FFS hinder the transfer of knowledge and technical know-how of project-relevant technologies. More focus on trainer training, content creation and delivery, schedule, venue, and remuneration can help mobilize guest farmers, especially women farmers, to participate in FFS sessions. In fact, considering farmers' increased accessibility and digital literacy, we recommend crafting digital modules and approaches that reach the target audience with relevant content.

Offering tailored agro-advisory services to expand knowledge and skillsets through continuous learning

It is recommended that relevant departments such as the Indian Meteorological Department (IMD) and KVK offer tailed weather forecasts, data related to management of crops, irrigation, pests, nutrients, soil and water conservation, agribusiness, market, finance and contingencies through the project's website, as well as via various IT systems like SMS, WhatsApp, mobile apps, and a phone-in help provision.

Apart from generalized location-specific and crop-specific agro-advisories, there is also scope to explore possibilities for providing customized/need-based and farmer-specific agro-advisory services through different digital modes such as mobile/web applications. This can also be expanded to WhatsApp, subject matter experts, and e-consultations using advanced technologies such as Artificial Intelligence and Machine Learning.

Ensuring sustainability of CRATs' adoption to establish climate-resilient practices further

It is evident that the project regions have improved the impact on the cost of cultivation, cropping intensity, and yields than the control region. To keep the momentum going and sustain the same in the long run, scaling CRATs to other districts can be investigated. The continuing dissemination of CRATs as a Market-oriented Package of Practices (MoPoP) through capacity-building activities in the near future can help establish climate-resilient practices further. Given a longer gestation period, it can lead to behavior changes among farmers on their agronomic practices for sustenance of CRATs adoption.

Additionally, GoM must review the adoption of interventions with low adoption rates, such as backyard poultry, apiculture, agroforestry, and protected cultivation techniques. By providing more technical and financial support and increasing capacity building for CRAT adoption, its uptake can be increased. These steps will enhance the climate resilience of farmers by diversifying their income sources and reducing their dependency on traditional cropping systems.

Promoting renewable energy initiatives to create access to consistent and sufficient energy needs

Farmers have reported concerns about the inconsistent and insufficient electricity supply, which restricts pumping hours and negatively affects crop production. This irregular power supply hinders timely water application from available wells, leading to inefficiencies. Additionally, electricity being supplied during nighttime in certain weeks proves inconvenient for optimal system operation and poses safety risks for farmers. Considering these challenges, it is recommended to explore the use of renewable sources of electrical energy, such as solar pumps, by the farmers.

Fostering community-driven sustainability to make farmers self-reliant in climate-resilient technologies

PoCRA's long-term success relies on a strong focus on community-driven sustainability. Prioritizing community-based NRM along with individual efforts is crucial for a balanced approach to water resource management. A village-level micro-plan of the water balance defines the need for the development of community-based NRM works in that region.

Through these soil and water conservation works, farmers can become self-reliant and climate-resilient. In the future, it is critical that the GoM adopt an approach that focuses on community-based NRM works that improve the region's water balance to ensure the availability of surface and subsurface water, drainage, and soil health, including treatment of saline and sodic soils.

Improving focus on farmer producer organizations to strengthen supply chains

With an augmented smallholders' participation, the project strives to integrate these FPOs in the input supply and commodity value chains and strengthen the supply chain for seeds inputs and then climate-resilient crops produced. It is recommended that GoM supports the supported FPOs to pay stringent attention to environmental and social guidelines, participation of women farmers, and expansions in their market-oriented agribusiness activities.

It is also recommended that FPOs and extension activities focus on the use of resilient inputs and emphasize more on market-oriented production, strengthening value chains establishing sustainable and efficient market linkages, and making quality produce available for consumers at a fair price.

Enhancing financial linkages to promote farmers' long-term financial stability

To overcome the issues of capital investments and high interest rates from private investors faced by FPOs, support from the relevant line departments is crucial to establish strong linkages between their member farmers and formal financial institutions. By facilitating access to loans with lower interest rates, the member farmers can secure the necessary funds to invest in their FPOs and ensure sustainable growth.

Financial constraints faced by small and marginal farmers in investing upfront costs for project benefits are a continuous challenge. The paucity of credit availability to the vulnerable sections on account of their limited asset ownership, lack of formal documents, and mortgageable properties require the project's support to access institutional finance.

By partnering with financial institutions, GoM can facilitate easier access to essential resources, such as seeds, fertilizers, and credit. These measures will not only support farmers in their immediate needs but also promote long-term financial stability and resilience.

Enhancing market linkages, including digital marketplaces to support efficient marketing strategies

In wholesale markets, FPOs struggle to compete on pricing due to a lack of scale, while in retail markets, brand image and visibility pose significant hurdles. Moreover, the lack of demand creation for FPOs' core products further hinders their market penetration. To overcome these obstacles, it is essential that the project helps FPOs develop robust institutional mechanisms that support efficient marketing strategies.

One effective approach is to leverage emerging marketplaces such as the Open Network for Digital Commerce (ONDC) to make these platforms accessible to FPOs. By integrating FPOs into ONDC and similar digital marketplaces, we can enhance their visibility, expand their reach, and create demand for their products. This integration will allow FPOs to benefit from the scale and efficiency of digital commerce, levelling the playing field in both wholesale and retail markets.
Furthermore, project-supported FPOs should be encouraged to collaborate and synergize their efforts rather than compete against each other. Collaborative efforts can lead to the development of collective brands, shared resources, and unified marketing strategies, ultimately strengthening their market presence and improving competitiveness. By fostering a cooperative environment, FPOs can achieve greater economies of scale, enhance their bargaining power, and effectively penetrate new markets.

Achieving net zero to promote agricultural sustainability and achieve India's broader conservation goals

To align with India's Nationally Determined Contributions (NDCs) and achieve the ambitious goal of net zero, the project must emphasize raising awareness about carbon emissions and the opportunities within carbon credit markets. By incentivizing sustainable practices, GoM can enhance both environmental sustainability and the income of beneficiary farmers. Encouraging farmers to adopt sustainable agricultural practices is crucial.

The project should educate them on the benefits of carbon sequestration, which can open up carbon credit markets and provide an additional income stream. Integrating these environmental initiatives into PoCRA will not only promote agricultural sustainability but also contribute significantly to India's broader environmental conservation goals and NDC commitments. It is necessary that awareness about carbon emissions and carbon credit opportunities to incentivize is raised among farmers.

Converging with other government schemes to achieve enhanced impact

GoM is recommended to explore the convergence with other government schemes which can lead to a multiplier effect towards the target. Through convergence, they can achieve financial efficiency, integrated approach, and enhanced impact. By aligning efforts and pooling resources along with diverse initiatives, various stakeholders can work together towards a common goal of enhancing resilience and sustainability in agriculture.

Strengthening partnerships and collaborations to enhance reach and impact

GoM is recommended to enhance the strengthening of partnerships with various stakeholders, including government agencies, non-governmental organizations (NGOs), research institutions, and the private sector, including startups, to facilitate the transfer of knowledge and innovations to farmers. Engaging with NGOs and community-based organizations can enhance the reach and impact of project interventions at the grassroots level. Private sector partners can provide access to advanced technologies, financial resources, and market linkages.

Enhancing policy support and advocacy to establish sustainable practices and support rural development

Advocacy for supportive policies and regulations is essential to create an enabling environment for climate-resilient initiatives under PoCRA. Engaging with policymakers to promote policies that support sustainable agriculture, climate resilience, and farmer welfare can drive long-term change. This includes advocating for policies that provide financial incentives for sustainable practices, ensure fair market access, and support the development of rural infrastructure.

Furthermore, promoting the inclusion of climate resilience and sustainability in agricultural education and extension services can ensure that future generations of farmers are well-equipped to face the challenges of climate change. By enhancing policy support and advocacy, GoM can create a conducive environment for sustainable agricultural development.

RFID Matrix

Result Framework Matrix			
Indicator Name	Baseline Value	Endline Target	Endline Achievement
PDO Level Indicators			
1. Climate Resilient Agriculture: Increased Water Productivity: Water Productivity - kg. m^{-3}: Ag. Production/ Water Consumption (Change relative to baseline: %)			
	0.38	0.45	0.41
2. CRA: Improved Yield Uniformity and Stability: Spatial and Temporal Yield Variability for Oilseeds and Pulses (%)			
Soybean	CV-S: 36 CV-T: 52	CV-S: 29 CV-T: 38	CV-S: 30 CV-T: 37
Pigeon Pea	CV-S: 66 CV-T: 44	CV-S: 51 CV-T: 36	CV-S: 52 CV-T: 48
3. GHG Accounting: Carbon Sequestration and Greenhouse Gas Emissions Reduced: Net GHG Emissions (in '000 tCO_2eq/yr)			
	-233	-4789	-3228
4. Annual farm income: Farm Income Comparator (Total; Male & Female landholders) (As ratio with/without project)			
Total	1.00	1.50	1.46
Male	1.00	1.50	1.50
Female	1.00	1.50	1.38
5. Direct Project Beneficiaries			
Number of Farmers reached with Agricultural Assets or Services (% Female)			
	0	1320000 (35%)	1365233 F- 354960 (26%)
Intermediate Outcome Indicators- Component A: Promoting Climate-Resilient Agricultural Systems			
6. CRA: Farmers Adopting Improved Agricultural Technology			
Farmers adopting improved agricultural technology promoted (% female)	0	1272800 F: 446000 (35%)	1079700 F: 153560 (14%)
7. CRA: Improved Water Use Efficiency at Farm Level			
Area provided with new/ improved irrigation or drainage services (in ha)	0	624000	667902
8. CRA: Improved Availability of Surface Water for Agriculture			
Surface water storage capacity from new farm and community ponds (in $1000m^3$)	0	83900	30375
9. CRA: Enhanced Soil Health at the Farm Level			
Area with GAPs for improved management of saline and sodic soils (in ha)	0	127600	146826
Intermediate Outcome Indicators- Component B: Climate-Smart Post-Harvest Management and Value Chain Promotion			
10: Seed Supply: Promotion of Climate-Resilient Crop Varieties			

Result Framework Matrix			
Indicator Name	**Baseline Value**	**Endline Target**	**Endline Achievement**
Production area under cultivation w/certified seeds for Oilseeds (Soybean), and Pulses (Pigeon Pea, and Chickpea) of improved varieties (share %)	64	86	89
11. Farmers Producer Companies: Strengthened and Financially Sustainable FPCs			
Number of project-supported FPCs with growth in annual profits	0	200	218
Intermediate Outcome Indicators- Component C: Institutional Development, Service Delivery, and Knowledge for Climate-Resilient Agriculture			
12. Research and Extension: Mainstreaming Climate-Resilience in Agriculture Research and Technical Advisory Services.			
Number of updated districts SREPs with internalized climate resilience agenda (Out of 15)[5]	0	15	15
13. Climate Innovation Center: Private Sector Participation[6]			
Number of clients (FPOs, SMEs) receiving services from the CIC	0	200	
Cross-Cutting Indicators			
14. Beneficiary Participation and Civic Engagement			
Number of approved participatory mini watershed plans implemented/under implementation.	0	670	138 CDP (5043 VDP)[7]

5 The document is prepared by the Project Director (ATMA) in consultation with the field functionary of the Department of Agriculture, State Agriculture Universities (SAUs), Krushi Vigyan Kendra's (KVKs), Farmers, Farmer Producer Organizations from the district. The SREP supplement contains an account of weather analysis, information about cropping pattern, impact of climate change on crop yields, coping mechanisms adopted by the farmers, adoption level of climate resilient technologies, constraints in marketing of agriculture produce and scope for value chain development. The SREP supplement ends with comprehensive template for village adaptation plan which will act as guide for the agricultural extension workers. It will be helpful carrying out extension of climate resilience technologies.

6 PoCRA functioned as a mini-CIC and detailed explanation given in the above section.

7 Total of 138 CDP was prepared during the first phase of the project. Participatory micro level planning conducted at village level and the total number of 5043 village development plans prepared, duly approved by District Coordination Committee chaired by District Collector.

Results Overview

Project on Climate Resilient Agriculture (PoCRA)

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