

Impact assessment report

Project name: Mangroves Conservation

**Programme: Healthy mangroves for resilient planet
and communities**

Apple India

March 2026



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Abbreviations

Abbreviation	Full Form
AERF	Applied Environmental Research Foundation
IDI	In – Depth Interviews
IUCN	International Union for Conservation of Nature
CSR	Corporate Social Responsibility
CFR	Community Forest Resources
MCA	Mangrove Conservation Agreement
NGO	Non- Government Organisation
OECD DAC	Organization for Economic Cooperation and Development - Development Assistance Committee

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Executive Summary

Apple India in partnership with Applied Environmental Research Foundation (AERF) has been working towards conservation of the mangroves in the Western Coast of India in Maharashtra. The programme titled 'Healthy Mangroves for a Resilient Planet and Communities' was launched in 2021 in Raigad district, Maharashtra, with the vision of safeguarding one of the state's most vital coastal ecosystems.

Apple India engaged Grant Thornton Bharat LLP to conduct impact assessment study of the mangrove conservation programme. The study was conducted by visiting 12 villages across Raigad and Ratnagiri districts of Maharashtra to evaluate the impact and progress of the programme, and to gather insights from relevant stakeholders.

Key findings of the study:

Relevance: Mangroves hold immense ecological and socio-economic significance in India, which accounts for 2.66% of global mangrove cover (4,991.68 sq. km). Maharashtra alone contributes 6.31% (315.09 sq. km), making it a priority region for conservation. These ecosystems provide critical services such as shoreline stabilization, storm and flood protection, and safeguarding coastal villages from erosion and climate impacts. The programme is unique in its focus on privately owned mangrove lands, engaging communities where no other agencies are active. By combining conservation agreements with awareness building and livelihood support, including bio-stoves and diversified livelihood opportunities, the initiative reduces dependence on mangrove resources while simultaneously improving community resilience.

Effectiveness: The programme has proven effective in motivating conservation through financial incentives tied to land and tree agreements. In Ratnagiri, Sindhudurg, and Raigad districts, a total of 524 agreements across 83 villages have secured more than 2,854 acres of mangroves for periods ranging from three to ten years. A distinctive intervention has also protected 32,281 giant mangrove trees through 73 agreements, rewarding landowners INR 30 per tree annually, while enhancing carbon sequestration. Complementary measures such as distributing bio-stoves to 1,469 households have reduced reliance on mangroves for fuelwood, while improving household health by lowering smoke exposure.

Efficiency: Efficiency has been achieved through decentralized project teams strategically spread across districts and supported by community stewards, ensuring active engagement and smooth coordination with local stakeholders. Processes are inclusive and transparent, with agreements prepared and explained in Marathi and endorsed by local community leaders. Evidence-based decision making, including GIS mapping, socio-economic studies, and biodiversity assessments, has guided conservation strategies and optimized resource use. Scientific and market research precedes livelihood activities, while awareness sessions and peer motivation have created a multiplier effect, expanding conservation coverage efficiently across villages.

Impact: The programme has generated tangible ecological and social impacts by promoting mangrove restoration and safeguarding biodiversity. Conservation agreements

have secured thousands of acres and tens of thousands of trees, ensuring long-term resilience of these ecosystems. Mangroves now provide strengthened ecological services, acting as natural barriers against coastal hazards, improving water quality, and serving as nurseries for marine species and habitats for rare fauna. Community health has improved through reduced smoke exposure from bio-stoves. Importantly, surveys show that over 100% of agreement holders are willing to renew their conservation agreements, reflecting strong ownership and commitment to ecosystem stewardship.

Coherence: The initiative is well aligned with national priorities, complementing the Government of India's MISHTI programme to expand mangrove cover along coastlines and saltpans. It also contributes to global restoration goals under the UN Decade on Ecosystem Restoration (2021–2030), positioning itself within the international agenda to reverse ecosystem loss. By advancing multiple Sustainable Development Goals (SDG 13, 14, 15, 1, and 2), the programme demonstrates broad policy relevance through climate resilience, biodiversity conservation, poverty reduction, and food security.

Sustainability: Sustainability is evident in the steady shift from short-term agreements in 2021 to long-term commitments of five to ten years by 2025, reflecting growing awareness and willingness to safeguard mangroves. Trust has been built through consistent engagement, permissions from Gram Panchayats, recruitment of local stewards, and recognition of active participants, ensuring continued community support. Direct agreements with landowners and active involvement of local leaders have fostered strong local ownership, increasing the likelihood that conservation practices will endure beyond the project's duration and embedding resilience within both ecosystems and communities.

Group discussion with crab collectors in Mirya village



1. Introduction

1.1. About the programme

Apple India in partnership with Applied Environmental Research Foundation, a Non-Government Organisation has been working towards conservation of the mangroves in the Western Coast of India in Maharashtra. The programme titled 'Healthy Mangroves for a Resilient Planet and Communities' was launched in 2021 in Raigad district, Maharashtra, with the vision of safeguarding one of the state's most vital coastal ecosystems. Recognizing the ecological importance of mangroves in protecting shorelines, supporting biodiversity, and mitigating climate change, the initiative places conservation at its core. What makes this programme distinctive is its emphasis on a community-based approach, ensuring that residents are not just beneficiaries but active stewards of the mangrove forests. By embedding conservation practices within everyday life, the programme seeks to create a sustainable model that balances ecological preservation with community well-being.

Under this initiative, communities are encouraged to take direct responsibility for conserving mangrove areas and trees located on their privately owned lands. This participatory model empowers individuals to safeguard mangroves in their natural habitat, free from harmful human interference, while also fostering a sense of ownership and pride in environmental stewardship. By involving local people in decision-making and conservation activities, the programme strengthens resilience against climate risks, enhances livelihoods linked to healthy ecosystems, and builds a collective commitment to protecting these coastal guardians for future generations.

1.2. About AERF

Applied Environmental Research Foundation (AERF), a Pune-based NGO established in 1995, works on biodiversity conservation through community participation and stakeholder engagement. Its efforts focus on creating tangible benefits from conservation, ensuring local ownership and sustainability. AERF's core work is in the Northern Western Ghats, a global biodiversity hotspot, and has expanded to coastal Maharashtra for mangrove conservation and to Chhattisgarh for value chain-based projects since 2019. In central India, it partners with indigenous communities to restore and sustainably manage Community Forest Resources (CFRs), while also contributing nationally through research, training, and capacity building.

AERF's mission is to achieve biodiversity conservation on the ground through use of scientific tools, development of cutting-edge solutions and multi-stakeholder engagement.

1.3. About Mangroves

Mangroves are specialized coastal ecosystems composed of halophytic trees and shrubs uniquely adapted to the intertidal zones of tropical and subtropical regions. Their complex aerial root systems not only stabilize shorelines and reduce erosion but also create structurally diverse habitats that support a wide range of marine and estuarine organisms. These ecosystems are globally recognized as critical blue carbon sinks, with the Food and Agriculture Organization (FAO) and the International Union for Conservation of Nature

(IUCN) highlighting their role in carbon sequestration and climate regulation. Beyond ecological functions, mangroves provide provisioning services such as timber, fish, and non-timber forest products, thereby sustaining millions of coastal livelihoods. Protecting and restoring mangroves is therefore essential for maintaining ecological balance and enhancing the adaptive capacity of coastal communities in the face of climate change.

Globally, mangrove forests cover approximately 14.72 million hectares across 113 countries, as reported in the FAO's Global Forest Resources Assessment 2020. Their distribution is uneven, with South and Southeast Asia accounting for more than 36% of the total cover, underscoring the regional importance of these ecosystems. India contributes 2.66% of the world's mangroves, with a total cover of 4,991.68 km² (0.15% of the country's geographical area), according to the India State of Forest Report 2023. Nationally, mangroves are concentrated in three broad regions: the East Coast, the West Coast, and the island systems of Andaman & Nicobar and Lakshadweep. On the West Coast, Maharashtra alone supports 315.09 km² of mangroves, representing 6.31% of India's total mangrove cover. These forests are distributed across Mumbai city, Mumbai suburban, Palghar, Raigad, Ratnagiri, Sindhudurg, and Thane districts, making Maharashtra a key state for mangrove conservation.

Institutional mechanisms have been established to strengthen conservation efforts in Maharashtra, including the creation of a dedicated Mangrove Cell to oversee management and protection. The state has also symbolically recognized the ecological importance of mangroves by declaring *Sonneratia alba* as its State Mangrove Tree. Despite these measures, mangroves remain under threat from anthropogenic pressures such as land conversion, aquaculture expansion, and pollution, leading to global declines in mangrove extent and associated biodiversity. This degradation undermines ecosystem services such as water filtration, coastal protection, and climate regulation, while jeopardizing food security and income sources for local communities. In response, international initiatives like the UN Decade on Ecosystem Restoration (2021–2030) and national programmes such as India's MISHTI scheme aim to reverse these trends by restoring mangrove habitats and expanding their cover along coastlines and salt pans.

1.4. About the impact assessment study

Grant Thornton Bharat LLP was appointed by Apple India to conduct an impact assessment study of their CSR programmes. To conduct the assessment, mixed study methodology was used. The study was conducted by conducting interviews and discussions with the beneficiaries and stakeholders of the programme. The following were the objectives of the assessment:

- To understand the impact of the initiatives on the beneficiaries
- To understand the perception of the stakeholders towards the programmes
- To document enablers and challenges with respect to planning and implementing
- To document relevant case studies / impact stories

Women sorting collected prawns



2. Approach and methodology

2.1. Approach for impact assessment study

The goal of the study was to understand the project, its outcomes and impact through discussions with relevant stakeholders, and documenting their perception and feedback about the project. The study also focused on capturing their suggestions.

For the assessment, some of the principles of Organization for Economic Cooperation and Development - Development Assistance Committee (OECD DAC) framework was used to analyze the programme. To gather data for each of the principles, stakeholders were mapped enabling robust data collection, analysis, and documentation of findings.

Table 1: Assessment parameters

Principles for assessment	About the principles
Relevance	• Need for conservation of the mangroves and giant mangrove trees in the private land owned by community members living around the mangroves • Need for alternate sources of energy for cooking needs of community members • Need for alternate livelihood options that are feasible in the study area.
Effectiveness	• Achievement of outputs / targets planned • Community willingness to execute agreements for conserving mangroves, changes in perceptions related to community-based conservation, use of bio-stoves and other programme deliverables
Efficiency	• Implementation of the activities based on the objectives of the programme • The extent of coverage of the activities across the programme locations, and inclusion of community members
Impact	• Increase in land area covered under conservation agreements • Positive change in the community's attitudes overall regarding protection of mangroves • Overall feedback of the beneficiaries on the programme
Sustainability	• Community engagement with key programme goals • Implementation of the goals in the long run • Exit strategy planned by the programme team

2.2. Methodology

The methodology followed to conduct the impact assessment study was spread across three stages. Each stage was designed with reference to context and location.

Table 2: Methodology

Stage I- Planning	Stage II- Data collection	Stage III- Reporting
		
• Understand project context / key stakeholders • Identify key indicators and focus areas • Review relevant documents, and reports • Develop study tools and field plan	• Orientation of the team members on the study tools and field plan • Conduct data collection through in-depth interviews with stakeholders • Interact with relevant stakeholders for case studies	• Collate information collected from all sources and conduct detailed analysis • Prepare draft narrative report, discuss report findings and recommendations with project team for relevant inputs for final report • Prepare and issue final report.

Stage I: Planning

Understanding the context

A kick-off meeting was held with Apple India's CSR team and the implementing partner (AERF) to develop an in-depth understanding about the nuances of the programme. Discussions were held to clearly articulate the expectations, identify the key stakeholders, areas of focus and assessment parameters. Post the initial discussion, an information request was shared with the implementation partner, listing the required programme documents, reports, other related data, etc.

Identifying focus areas

Key focus areas were identified through a review of existing data and stakeholder inputs, helping define priority areas for intervention. This ensured that the study framework was focused, relevant, and aligned with programme objectives.

Reviewing of documents

A desk review of the documents and reports was conducted. The understanding gained from the desk research was eventually fed into the identification of the key respondents and their respective areas of enquiry.

Stakeholder mapping, study tools, and field plan

As part of the preparatory phase, key stakeholders were identified through in-depth discussions with the programme team. A suitable evaluation framework was then designed, with stakeholders mapped to their respective areas of enquiry, to guide the development of data collection tools. Based on these inputs, study tools were developed for stakeholders.

Stage 2: Data collection

Preparation for data collection:

Data collection was strategically designed to align with the study's objectives and prepared data collection tools. Standardized protocols were followed to ensure consistency in methodology. The process incorporated clearly defined areas of enquiry with adherence to ethical policies.

Data collection:

Qualitative and Quantitative data collection was conducted through in-depth interviews (IDIs) and group discussions. These were aligned with the overall framework to ensure triangulation. Consultations with stakeholders such as agreement holders, fishers, community leaders and programme team, were conducted to gather insight into the current realities within selected locations. Throughout the study, ethical considerations were carefully upheld to ensure respectful, informed, and voluntary participation by all respondents.

Stage 3: Reporting

Data analysis

The qualitative and quantitative data analysis involved a careful review of responses. This helped identify common themes and experiences to gather valuable insights across various factors.

Draft report preparation

An initial draft report was prepared, incorporating the preliminary study findings and insights gathered through data collection. This version was shared with Apple team for review and feedback to ensure alignment with context, and to refine the key content areas.

Issue of final report

Following feedback from Apple team, a comprehensive report was developed that presented the finalized findings, and detailed inferences from stakeholder consultations.

3. Study coverage and limitations

3.1. Study coverage

This study was conducted through qualitative interactions with key stakeholders, such as agreement holders, community members, fishers, local leaders, and programme team. A total of **twelve (12) villages, across six (06) blocks from Ratnagiri and Raigad districts** of Maharashtra were visited and interactions were conducted with the stakeholders, as seen in Table 3.

Limitations of the study

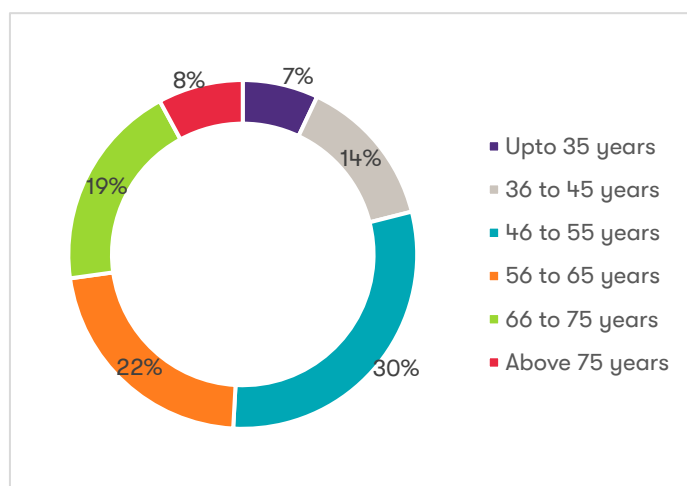
During the field visit to the programme locations, some of the stakeholders (community members) could not be interviewed. They worked as fishers / daily wage earners and were unavailable for interactions.

Table 3: Study coverage

S/N	District	Block	Villages	Number of stakeholders interacted
1	Ratnagiri	Ratnagiri	Basani & Chinchikar	4
2	Ratnagiri	Ratnagiri	Mirya & Undi	7
3	Ratnagiri	Mandangad	Mandangad	6
4	Raigad	Mhasala	Vicharewadi	10
5	Raigad	Shrivardhan	Karivane	25
6	Raigad	Shrivardhan	Kalinje	15
7	Raigad	Alibag	Diviparangi	13
8	Raigad	Alibag	Bahirichpada	16
9	Raigad	Pen	Odhanggi	11
10	Raigad	Pen	Shirkichal	7
11			Project team	13
	TOTAL			127

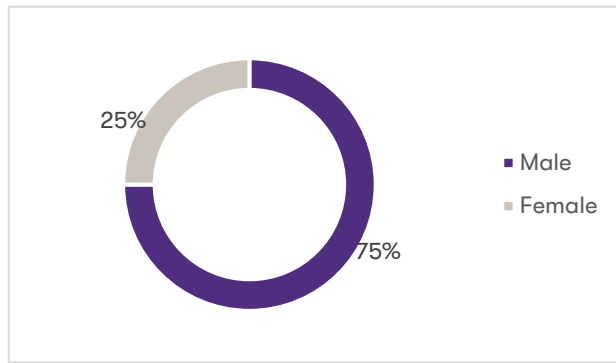
Profile of the respondents

Figure 1: Age-wise distribution of respondents



The age distribution shows that majority respondents were in the mid-to-senior age group, with **30% falling between 46–55 years** and another 49% aged 56 and above. 22% were between 56–65 years, 19% between 66–75 years, and 8% above 75 years. In comparison, younger respondents were fewer, with only 7% up to 35 years and 14% between 36–45 years, making a combined 21% under 45 years.

Figure 2: Gender-wise distribution of respondents



The gender distribution among respondents showed that **75% were male and 25% were female**. Male respondents were primarily engaged in **agreement-related activities**, while female respondents were mainly involved in **cookstove-related activities**. However, all the women were involved in decisions related to conservation agreements made by the men in their families.

Mangroves growing around the freshwater creeks



4. Key findings

In the coastal villages of Ratnagiri, Raigad and Sindhudurg, lands privately owned by farmers or fishers are covered with mangroves. While some of these mangroves have grown recently, most have existed for several decades. Some of the common threats for privately owned mangroves in these areas are:

- **Aquaculture expansion:** Landowners clear mangroves to create ponds for prawn, crab, and fish cultivation.
- **Commercial land use:** Mangrove areas are sold to commercial entities for aquaculture development.
- **Fuelwood extraction:** Community members cut down entire trees or branches for firewood and domestic needs.
- **Infrastructure development:** Government and community bund-building projects reduce water salinity, eventually causing mangrove die-off.

List of documents required for agreement:

- ✓ Aadhar Card
- ✓ Letter of 'No Objection' from siblings
- ✓ Land ownership records (7/12 extract)
- ✓ Bank account details

The programme has developed several unique solutions to address the threats including - mangroves land conservation agreements, giant mangrove tree conservation agreements, distribution of cook stoves, awareness sessions on mangroves, socio-economic surveys, research studies on biodiversity, distribution of saplings of mangroves and salt-tolerate species, and alternative livelihood opportunities. These interventions are carried out across three districts as tabled below:

Table 4 : Project locations

Sl. No.	District Name	Blocks covered
1	Raigad	Alibag, Roha, Pen, Shrivardhan, Mhasla and Mahad
2	Ratnagiri	Ratnagiri and Madangad
3	Sindhudurg	Vengurla and Devgad

A. Mangroves land conservation agreements

Under the programme, mangrove landowners are encouraged to sign an agreement with AERF to conserve the land covered with mangroves. Before signing the agreement, the AERF team conducts awareness sessions with landowners to explain the importance of mangrove conservation and the benefits of participating in the programme.

The terms and conditions of the agreement are clearly communicated and made fully understandable to the landowners, ensuring transparency and informed consent. This process helps build trust and confidence among landowners, enabling them to make an informed decision about joining the conservation initiative. In total, **across 83 villages from 3 districts**, through **524 conservation agreements**, **2854.07 acres** of privately owned mangroves has been covered under the programme.

Ownership and Coverage

The lands brought under conservation agreements are privately owned by individual landowners. These lands are not included in any existing conservation programs or schemes by the Forest Department. The agreements ensure that mangroves on these lands are protected and safeguarded for specific periods, preserving them from internal and external threats.

The agreements between private landowners and AERF are voluntary and written in Marathi. They guarantee a mutually agreed sum of money as an incentive. Land areas under one acre receive INR 500 per year, while those over one acre receive INR 800 per acre per year. This financial incentive encourages landowners to preserve and restore mangroves, thereby protecting the flora and fauna within these areas. If landowners wish to break the agreement, they are required to repay the amount received for the agreed term. This clause reassures landowners that they continue to retain ownership of their land while participating in the conservation initiative.

Awareness and Community Impact

Through these agreements, landowners become aware of the biodiversity present on their land, which fosters a sense of pride and ownership toward the local environment. A few landowners have even inspired their neighbors to sign similar agreements, creating a positive ripple effect in conservation efforts.

100% respondents said that they would like to renew the agreement after the term is completed.

Coverage

Table 5: Conservation agreement details

Sl. No.	District	Block	Total area under agreement (in acres)	Total number of agreements	Total villages covered
1	Raigad	Alibag	1331.21	233	29
2	Raigad	Roha	141.21	15	7
3	Raigad	Pen	207.35	48	13
4	Raigad	Shrivardhan	66.23	29	7
5	Raigad	Mhasla	67.28	19	6
6	Raigad	Mahad	191	103	2
7	Ratnagiri	Ratnagiri	24.05	6	3
8	Ratnagiri	Mandangad	786	68	14
9	Sindhudurg	Vengurla	39.34	1	1
10	Sindhudurg	Devgad	0.4	2	1
	TOTAL		2854.07	524	83

B. Giant mangrove trees conservation agreements

Overview of Mangrove Species

Mangroves consist of salt-tolerant trees and shrubs that grow in the intertidal zones of tropical and subtropical coastlines. They thrive in regions where freshwater mixes with seawater and where the soil contains thick layers of accumulated mud deposits. Globally, 69 true mangrove species have been identified, spanning 27 genera and 20 families.

In Maharashtra, a detailed study documented the presence of **20 typical mangrove species, 10 halophytic species, 13 borderline mangroves, and 15 mangrove associates** across mangrove-dominated districts.

Commonly found mangrove species

Avicennia marina
Avicennia officinalis
Rhizophora mucronata
Sonneratia alba
Sonneratia apetala
Excoecaria agallocha
Rhizophora apiculata
Aegiceras corniculatum
Acanthus ilicifolius

Mangroves in Ratnagiri district



Agreement for Giant Mangrove Trees and their importance

Many mangrove trees in the programme area have been growing for several decades, particularly on privately owned lands. In some locations, the protection of specific individual trees becomes especially critical. These are referred to as **giant mangrove trees**, which thrive in brackish water environments and form strong, interlinked root systems that play a vital role in safeguarding coastlines from erosion and degradation during extreme weather conditions.

Mangrove trees are classified as **giant when they exceed 12 feet in height and have a Girth at Breast Height (GBH) greater than 25 cm**. Under the programme, landowners who sign the giant tree conservation agreements commit to safeguarding these trees from felling or any form of degradation. As part of the agreement, each landowner receives INR 30 per tree per year as an incentive for conserving these ecologically important giant mangrove trees.

Giant mangrove trees are particularly valuable because they can sequester **up to ten times more carbon** than typical terrestrial trees.

Coverage

Under the programme, in Alibag block of Raigad district

Number of agreements signed – **73**

Number of giant mangrove trees brought under agreements – **32,281**

Unique Adaptations of Mangroves

Mangrove trees possess several specialized adaptations that enable them to survive in harsh coastal conditions. These include:

- ✓ **High salinity tolerance**, allowing them to grow in seawater-influenced environments.
- ✓ **Pneumatophores**, also known as breathing roots, which protrude from the soil to facilitate gas exchange in waterlogged conditions
- ✓ **Prop and stilt roots**, which provide stability in soft, marshy soils.
- ✓ **Salt glands**, which help the trees expel excess salt absorbed from the surrounding environment.
- ✓ Mangroves have adapted to **vivipary**, where the seeds germinate and turn into seedlings and stay attached to the tree.

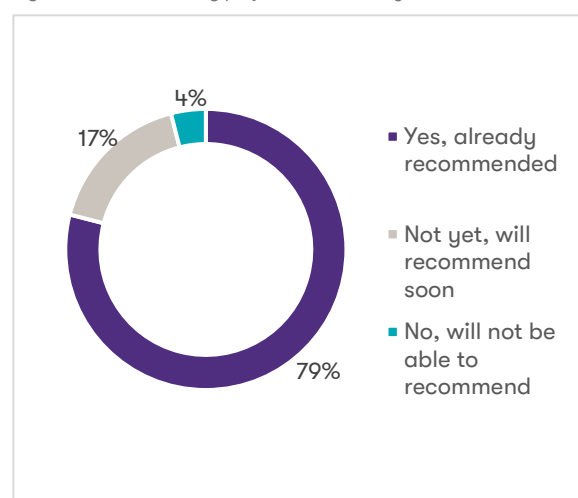
These adaptations collectively support the resilience and ecological function of mangrove ecosystems.

Support for Birdlife

Mangrove ecosystems provide important nesting, roosting, and feeding spaces for a range of resident and migratory bird species. The dense foliage and complex root systems offer protection from predators and strong winds. Common bird species that depend on mangrove habitats include the **Eurasian Curlew, Black-headed Ibis, Curlew Sandpiper, Painted Stork, White-bellied Sea Eagle, and Lesser Flamingo**. These species rely on mangroves for multiple reasons such as safe breeding sites, rich feeding grounds and resting spaces, further emphasizing the ecological importance of conserving mangrove forests.

Project recommendation to community members

Figure 3: Recommending project to community members



A strong majority of **79% have already recommended the project and its activities to their friends and neighbors**. This demonstrates both confidence in the initiative and satisfaction with its outcomes. Additional 17 % of the respondents reported that they have not yet recommended the project but intend to do so in the near future, suggesting further potential for community engagement. Only 4% of respondents stated that they would not be able to recommend the project

C. Eco-friendly bio-cook stoves distribution

Mangrove ecosystems play a vital role in supporting coastal communities, yet they are increasingly threatened by human activities such as firewood extraction. Through the programme, efforts were made to reduce this pressure by introducing sustainable alternatives and promoting community awareness.

Pressure on Mangrove Ecosystems Due to Firewood Extraction

One of the major threats to mangrove ecosystems arises from the community's dependence on mangrove wood for firewood. Households in villages surrounding the estuaries traditionally relied on mangrove twigs and timber for cooking, heating water, and other domestic purposes. Over time, this consistent extraction placed considerable pressure on the mangroves, and in certain areas, led to unsustainable over-extraction. In addition to removal of wood, frequent human movement within these fragile ecosystems resulted in disturbance to local flora and fauna and contributed to the degradation of the natural habitat. Such disturbances weakened the ecological balance and the regenerative capacity of the mangrove forests.

Promoting Eco-Friendly Alternatives Through Bio-Stoves

To reduce the community's dependence on firewood and mitigate the resulting pressure on mangroves, the programme introduced eco-friendly Bio-Stoves as a sustainable alternative. Community members were encouraged to procure these stoves from AERF. In response to the need for cleaner and more efficient cooking options, the AERF team developed a low-smoke, low-input, eco-friendly cooking stove designed to significantly reduce the amount of firewood required for domestic use. By adopting these stoves, households were able to meet their daily energy needs while contributing to the long-term conservation of the mangrove ecosystem.

100% respondents affirmed that they had started using the cook stoves.

Coverage

Under the programme a total of **1469 Bio cook-stoves** were distributed among the community members since 2021. During community meetings, a detailed demonstration of how to use the stoves was given. This helped them understand the usage and benefits of the stoves.

Table 6: Distribution of Bio cook-stoves

Sl. No.	District	Block	Total Number of Bio-stoves distributed
1	Raigad	Alibag	1250
2	Raigad	Pen	
3	Raigad	Roha	
4	Raigad	Shrivardhan	204
5	Sindhudurg	Vengurla	15
	TOTAL	5 blocks	1469

Woman demonstrating use of Bio cook-stove



Impact of Bio-Stoves

The bio-stove initiative has brought multiple benefits to the community, addressing health, environmental, and economic challenges. The following points highlight the key outcomes observed from its usage:

Reduced Fuelwood Consumption: It requires a significantly lesser amount of fuelwood, when compared to similar traditional stoves. The stoves are designed to harness heat from lesser quantity of burning wood. It requires about 500-600 grams of dried fuelwood for a cooking a one-time meal for a family of 4-5 members. This has reduced the consumption of fuelwood by more than 75%.

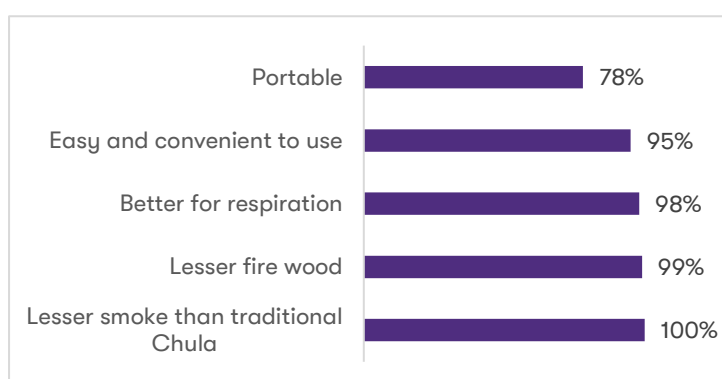
Portability and Ease of Use: The bio-stoves are smaller and portable. They are light weight and can be carried by the farmers and fishermen, when they travel for work. They can also be used on boats or in farms where they work.

Affordable and Subsidised Cost: To encourage the community members to procure and use the stoves, they were delivered at very low cost. The bio-stoves are made available at INR 500 per stove, while the manufacturing cost was INR 3500 approximately (including transport costs from manufacturing unit to the villages).

Reduced Time for Fuelwood Collection: The women who are primarily engaged in collecting fuelwood for cooking and heating purposes travel about 1-5 kms regularly. Since these bio-stoves require lesser fuelwood, their frequency of collection has reduced. This gives them time to focus on other domestic and income-generating activities in their households.

Improved Health Outcomes: The Bio-stoves produce significantly lesser smoke than traditional ones. This has led to improved respiratory health for women and elderly individuals who cook. Since these stoves have been distributed, the number of reported cases of glaucoma and other eye conditions has decreased.

Benefits of Eco-friendly cook stoves



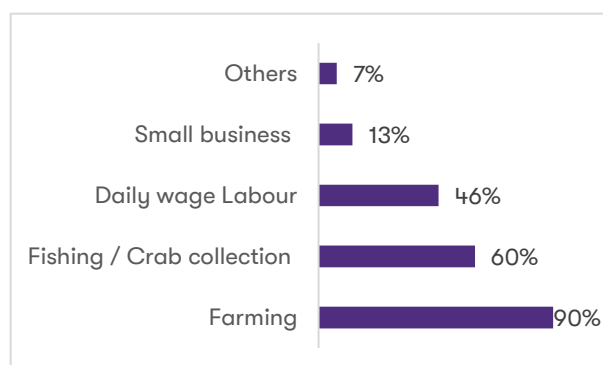
The findings demonstrate strong positive feedback regarding the cooking stove compared to the traditional *chula* (stove). 100% of the respondents reported that the stove produces less smoke. Additionally, 99% observed reduced firewood consumption, highlighting its potential for environmental sustainability.

98% of users stated that the bio-cook stove is better for respiration. Ease of use was emphasized by 95% of respondents, confirming its practicality in daily cooking. 78% appreciated the stove's portability, suggesting added convenience for households needs.

D. Alternate livelihoods opportunities

Community Occupation

Figure 5: Primary household occupations



Majority of respondents were engaged in **farming, with 90% reporting it as their primary occupation**. Fishing and crab collection was the second most common activity, involving 60% of respondents. Daily wage labor accounted for 46%, indicating a significant reliance on daily wages. Around 13% of the respondents were involved in small businesses, while 7% reported other occupations. This distribution highlights that farming and fishing are the major sources of livelihood in the community

Plantation of mangroves and salt-tolerant species

As part of the restoration and livelihood enhancement efforts, a diverse mix of mangrove and salt-tolerant species with ecological and economic value were distributed across selected villages. Saplings of *Pongamia pinnata* (Karanj), *Calophyllum inophyllum* (Undi), *Rhizophora mucronata*, and *Kandelia candel* were provided to community members. These species contribute to shoreline stabilization and biodiversity conservation. Karanj and Undi also offer long-term economic benefits such as biofuel potential, medicinal uses. Together they enable enhanced carbon sequestration. The distribution covered three villages of Jawale, Ambavali, and Sakhri in the Mandangad block, thereby strengthening local participation in conservation while simultaneously promoting sustainable resource use.

Table 7: Details of saplings distribution

Sl. No.	Plant species Name	Number of saplings distributed
1	<i>Pongamia pinnata</i> (Karanj)	500
2	<i>Calophyllum inophyllum</i> (Undi)	500
3	<i>Rhizophora mucronata</i>	400
4	<i>Kandelia candel</i>	500

Waste Management

In villages located around mangrove ecosystems, community members are being actively trained in improved waste management practices to safeguard both their environment and livelihoods. Awareness sessions emphasize the importance of segregating waste at source, with particular focus on removing plastics that can obstruct the breathing roots (pneumatophores) of mangroves and severely damage their growth. Alongside this, the programme is introducing simple, low-cost methods to convert wet organic waste into compost, which can be directly applied to agricultural fields, reducing dependence on chemical fertilizers. These efforts not only protect the fragile mangrove ecosystems from pollution but also create a circular system where household waste is transformed into a resource, strengthening both ecological health and community resilience.

E. Studies and reports on mangroves

As part of the programme, the team has been encouraged to systematically explore the mangrove landscape through a combination of advanced tools and community-based approaches. This includes GIS mapping to document the spatial extent of mangroves, physical field studies conducted in collaboration with local communities to understand socio-economic dynamics, and biodiversity assessments to capture ecological variations across sites. Together, these multi-layered studies provide a robust evidence base that enables informed decision-making and the design of context-specific conservation solutions. By integrating ecological data with socio-economic realities, the programme ensures that interventions are both scientifically grounded and socially relevant, thereby strengthening long-term resilience of mangrove ecosystems and the communities that depend on them.

Understanding Community Perspectives on Mangrove Conservation: A detailed study was carried out as a post-Mangrove Conservation Agreement (MCA) survey in Raigad district, assessing community perceptions and the impact of financial incentives on conservation attitudes. It was observed that before signing the agreements, mangroves were viewed negatively, due to loss of agricultural land. However, after the MCA was introduced, community received financial support, awareness sessions, and conservation activities that improved their understanding and participation. They recognized mangroves' role in protection against floods, cyclones, erosion, and others. Overall, the initiative fostered positive attitudes, strengthened community–mangrove relationships, and generated strong satisfaction with widespread willingness to continue conservation.

Money from Mud: A detailed Socio-economic assessment of Mud Crab–Based Livelihoods was conducted in Mandangad and Dapoli Blocks of Maharashtra. Mud crabs (*Scylla* spp.), commonly known as mangrove crabs, rank among the most economically significant crustaceans within India's coastal fisheries and aquaculture industry. This study covered several considerations such as traditional knowledge systems, economic benefits, challenges, risks and safety concerns, and access to market. It reported that 'most households earn between ₹5,001 and ₹10,000 per month from combined crab and fish selling activities, indicating that fisheries-based livelihoods provide a moderate but stable income for most families.' The study also explored potential for future interventions to support and encourage families engaging in mangrove-based livelihoods.

Roots of Resistance: A study was conducted to document the presence and challenges of Salt-Tolerant *Pongamia pinnata* along Maharashtra's Western Coast. It covered *Pongamia* Habitats around Savitri and Bharja river systems. The study also included co-occurrence of diverse biodiversity, including apex species such as the Smooth-coated Otter and Mugger Crocodile, alongside a wide assemblage of birds and reptiles, in the *Pongamia*-rich landscapes. The infestation of *Etiella zinckenella* within *Pongamia* seeds introduced a critical ecological dimension, demonstrating that species considered "resistant" could also be subject to evolving interactions and latent vulnerabilities.

5. OECD-DAC based analysis

As part of this impact assessment study, the evaluation framework was guided by the principles of the **Organization for Economic Cooperation and Development – Development Assistance Committee (OECD-DAC)**. These internationally recognized criteria provide a systematic approach to assessing development programmes, ensuring that activities are examined not only for their immediate outputs but also for their alignment with broader ecological and social objectives. Applying this framework allowed the study to critically analyse the design, implementation, and outcomes of the mangrove conservation initiative in Maharashtra.

The assessment focused on six key OECD-DAC parameters: **relevance, coherence, effectiveness, efficiency, impact, and sustainability**. Relevance considers the alignment of programme goals with community needs and environmental priorities; coherence examines how well the intervention complements other policies and initiatives; effectiveness evaluates the achievement of intended objectives; efficiency assesses the optimal use of resources in delivering results; impact explores the wider ecological, social, and economic changes resulting from the intervention; and sustainability gauges the likelihood that benefits will endure beyond the project's duration. The findings for each of these parameters are presented below.

Relevance

- **Significance of mangroves in India and Maharashtra:** India holds 2.66% of global mangrove cover (4,991.68 sq. km), with Maharashtra contributing 6.31% (315.09 sq. km), making the state a critical region for mangrove conservation.
- **Ecological importance:** Mangroves provide vital ecosystem services, including shoreline stabilization, protection against storms, cyclones, tsunamis, and flood surges, while safeguarding coastal villages from erosion and extreme climate impacts.
- **Community owned mangroves:** AERF uniquely focuses on privately owned lands with mangroves, engaging local communities where no other agencies are active.
- **Community engagement and livelihood support:** The programme raises scientific awareness, secures conservation agreements to prevent degradation, and promotes sustainable alternatives such as bio-stoves and livelihood diversification, reducing dependence on mangrove resources while improving health outcomes.

Effectiveness

- **Financial incentives for conservation:** Land and tree agreements provided direct monetary benefits to landowners, motivating them to protect mangrove ecosystems.
- **Private land conservation:** In Ratnagiri, Sindhudurg and Raigad districts, 524 agreements across 83 villages safeguarded 2,854 acres of mangroves, ensuring undisturbed growth for 3–10 years.
- **Protection of giant mangrove trees:** A unique scheme conserved 32,281 individual trees through 73 agreements, with landowners receiving INR 30 per tree annually; these trees sequester ten times more carbon than terrestrial species.

- **Reduction in fuelwood dependency:** Distribution of bio-stoves and LPG cylinders to 1469 households decreased reliance on mangroves for firewood, while also improving health outcomes by reducing smoke emissions.

Efficiency

- **Decentralized project teams and local stewards:** Teams are strategically spread across two districts, supported by community stewards who ensure active engagement and smooth coordination with local stakeholders.
- **Inclusive and accessible processes:** Community meetings are conducted with Gram Panchayat approval, and agreements are prepared in Marathi and clearly explained to landowners, ensuring transparency and ease of understanding.
- **Evidence-based decision making:** Detailed mapping of mangrove spread on private lands, along with socio-economic and biodiversity studies, provides robust data to guide conservation strategies and optimize resource use. Scientific and market research studies are conducted before deploying livelihood activities.
- **Community-driven expansion:** Awareness sessions build scientific understanding, while participating members encourage others to join, creating a multiplier effect that expands conservation coverage efficiently.

Impact

- **Enhanced conservation and biodiversity protection:** Land and tree agreements promote mangrove restoration and growth, safeguarding unique ecosystems and ensuring long-term resilience.
- **Critical ecological services:** Mangroves act as natural coastal barriers, reduce erosion, trap sediments, improve water quality, and serve as nurseries for diverse marine species, while also providing nesting and breeding habitats for rare flora and fauna.
- **Improved community health and livelihoods:** Adoption of bio-stoves has reduced dependence on mangrove fuelwood and lowered smoke exposure, while livelihood innovations such as stingless beekeeping, seaweed cultivation, and mangrove apple products offer new income opportunities.
- **Strengthened community awareness and participation:** Local communities have shown high willingness to conserve mangroves, with over 95% expressing readiness to enter agreements, reflecting growing ownership and commitment to ecosystem stewardship.

Coherence

- **Alignment with national priorities:** The project complements the Government of India's MISHTI programme (Mangrove Initiative for Shoreline Habitats & Tangible Incomes), which aims to expand mangrove cover along coastlines and saltpans, thereby reinforcing national commitments to ecosystem restoration.
- **Contribution to global restoration goals:** It supports the UN Decade on Ecosystem Restoration (2021–2030) by directly addressing mangrove degradation and promoting restoration, positioning the project within a broader international agenda for reversing ecosystem loss.

- **Synergy with Sustainable Development Goals (SDGs):** The initiative advances multiple SDGs, including SDG 13 (Climate Action), SDG 14 (Life Below Water), SDG 15 (Life on Land), and SDG 1 & 2 (No Poverty, Zero Hunger) through climate resilience, biodiversity conservation, and livelihood enhancement.
- **Policy coherence and institutional collaboration:** By engaging with local governance structures (Gram Panchayats) and complementing efforts of the Mangrove Cell under MoEFCC, the project ensures coherence between community-based conservation and formal government mechanisms, strengthening institutional synergy.

Sustainability

- **Long-term conservation commitments:** Since 2021, there has been a steady increase in agreements with landowners, shifting from short-term (1–3 years) to long-term (5–10 years) contracts by 2025. This reflects growing awareness and willingness to safeguard mangroves and their ecosystems over extended periods.
- **Community trust and institutional support:** Consistent engagement through meetings, permissions from Gram Panchayats, recruitment of local stewards, and recognition of active participants has built strong trust. This trust ensures continued community backing and leadership support for conservation efforts.
- **Strengthened local ownership:** Direct agreements with landowners and active involvement of local leaders have fostered a sense of responsibility and ownership, increasing the likelihood that conservation practices will be maintained beyond the project's duration.

Group discussion with beneficiaries of cook-stoves and agreement holders



6. Programme Progress

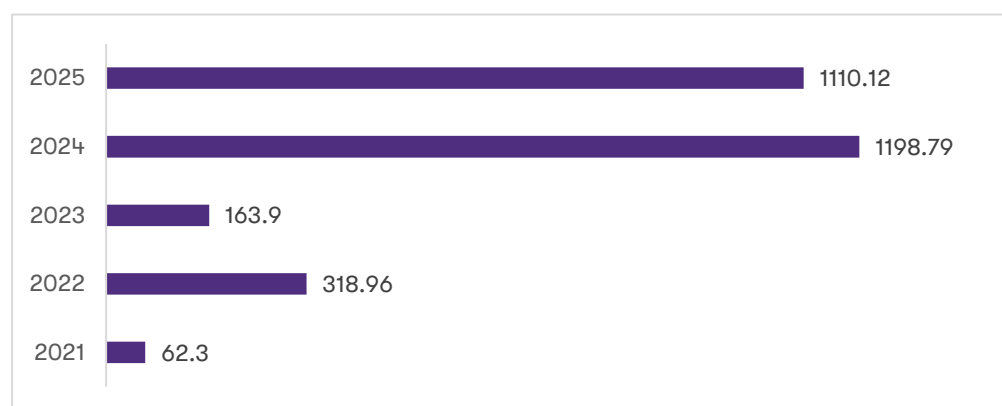
Geographical spread

The programme has been operational since 2021 in Maharashtra, with the primary focus on conserving the mangroves. It began in Raigad district, and now covers three districts – Raigad, Ratnagiri, and Sindhudurg. Communities from various villages and backgrounds have been actively engaged in the programme in differing capacities.

Mangrove Land agreements

The mangrove land agreements have increased significantly, covering a total of 2854.07 across all three districts. In 2021 the area brought under agreement was only 62.3 acres in Raigad district. In 2025 it rose to **1110.12 acres across Raigad, Ratnagiri, and Sindhudurg** districts. This shows that the programme has been working consistently towards increasing the privately-owned mangrove areas. It is to be noted that this is despite many issues within the community, industries, and government. This has been possible due to scientific planning and consistent community engagement.

Figure 6: Year-wise mangroves land covered under agreements (in acres)



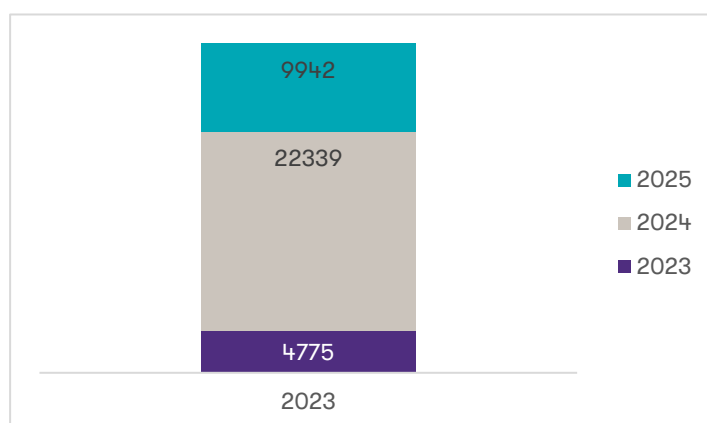
Tenure of agreements

The tenure of conservation agreements has shown a clear progression over time, reflecting growing confidence and commitment among landowners. In 2021, all agreements were limited to a one-year duration. From 2022 onwards, however, contracts began to extend to three, five, and even ten years, with payments structured accordingly to the length of the pledge. This shift toward longer-term agreements demonstrates increased **trust, awareness, and willingness within communities** to safeguard mangrove habitats, ensuring more sustained protection of these critical ecosystems.

Mangrove Giant Tree agreements

The giant mangroves trees that are brought under conservation agreements have reached a total of **32,281 trees**. Till 2024, there were a total of 27,114 trees and in 2025, about 9,942 trees were conserved through agreements.

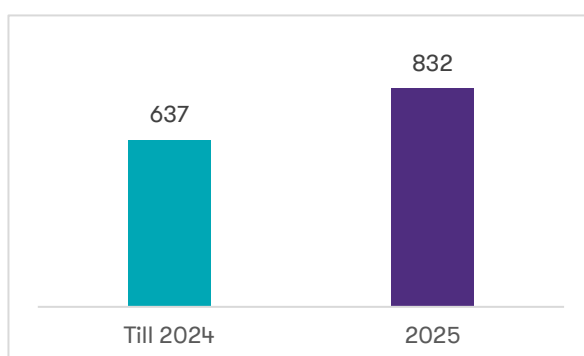
Figure 7: Giant mangrove trees brought under agreements



Distribution of Bio-stoves

It was noted during the assessment that there was a significant increase in the number of Bio-stoves distributed in 2025. Till 2024, about 637 stoves were distributed across all the programme's locations. **In 2025, 832 stoves were distributed.** This indicates increased awareness amongst the community members, specifically the women. During interactions it was seen that the women were aware of the benefits of bio-stoves and how their dependency on firewood from mangroves had significantly reduced.

Figure 8: Distribution of bio cook-stoves



Community involvement and awareness

Active engagement with local governance structures, particularly community leaders and Gram Panchayat members, has enabled the programme team to better understand the socio-cultural context and ecological significance of mangroves, ensuring smoother implementation with strong community support. The appointment of community stewards and other local representatives to lead village-level activities has further strengthened ownership, accountability, and trust within the community. These efforts, combined with awareness sessions and participatory initiatives, have significantly enhanced conservation consciousness among farmers, fishermen, crab collectors, and women, as reflected in their willingness to commit longer durations under land and tree conservation agreements. Importantly, the active involvement of women and the multiplier effect created by community stewards have broadened participation, embedding mangrove conservation deeply into local social and cultural practices.

7. Case Studies



Vijay Bolkar,
Chinchkari village, Ratnagiri

Vijay Bolkar, 50 years old, has been living in Ratnagiri most of his life, with his family of four members. His primary occupation is farming. Vijay's family also runs a small grocery store for the village.

"I have been growing up seeing mangroves in our family-owned land. Although we grow mangoes and cashews, some of our land was not used due to saltwater and mangroves. In 2023, I signed the agreement to conserve the mangroves land for a term of 5 years. I am happy to see that our mangroves will stay as they are and grow further. I have been encouraging many of our village members to enter into similar agreements. We understand the importance of these trees, which help reduce the ill effects of extreme weather conditions."



Milind Lele,
Basni village, Ratnagiri

Milind Lele's family was awarded the entire village by the Peshwa's several decades ago. His family owns large areas of land where they grow rice, mangoes, and several others.

"We have been blessed with a large piece of land in our village. And fortunately, I was able to sign 11 acres of mangroves land through the mangrove conservation agreement for 5 years to begin with. I am willing to extend the term much longer when I renew the agreement. I have seen how the landscape has evolved over the years. I have seen how the mangroves support the unique biodiversity of other species of birds and fishes."



Damodar,
Diviparangi village, Raigad

Damodar is a senior community member (aged 73 years). He lives with family of 8 members and has been actively leading the village with 300 households.

“Since I was young boy, we have been seeing the mangroves. The mangroves spread has increase gradually. Earlier we had used mangroves as firewood; now we have stopped. In our village already 30 families have signed agreements, because we see its importance in sustaining life here. We have seen wildlife such as otters, palm civets, jackals, snakes of various species. We catch crabs and mudskippers sometimes in the mangroves as well.”



Anandi Tondkar,
Kalinje village, Raigad

Anandi is a young 33-year-old active community member. She has been engaging with the SHG members of the villages and leading them in various activities.

“When I first came to know about the bio-cook stoves, I was extremely excited to understand how it worked. It is well-designed to emit minimal smoke and requires very less quantity of firewood. It has a fan that helps in blowing air when kept in low ventilation areas. The best part is that is portable! I have been encouraging the women of our village to try this *chula* (stove). The demonstration helped them in deciding positively. In our village, 66 of us have already got it.”



Bindita,
Diviparangi village, Raigad

Bindita is a Sarpanch (leader of the Panchayat) from Diviparangi village. In her Panchayat there are a total of 1200 persons.

“The AERF team approached us with this unique request to conserve the mangroves. Initially we were hesitant and fearful of losing our land. When they explained in detail, we were convinced about the benefits of conserving mangroves that we own. We as a community discussed and decided to support them.

In our area, fishing is one of the most important occupations. However, these days we face a lot of issues due to pollution – fish output has reduced due to contaminated water. The mudskippers have reduced too!”



Ananta Patil,
Odhangi village, Raigad

Ananta Patil is 67 years old. He lives in Odhangi village which has 125 households with a population of 1,280.

“In 1989, there was a cyclone which caused a lot of damage, eventually led to severe in graze of saltwater. In our childhood we had seen fewer mangroves. After the cyclone, it has increased significantly. We, as a family have entered into an agreement with AERF team to conserve a total of 152 giant mangrove trees. They explained how the mangrove trees are especially important to conserve the agricultural lands that we own. Also, from our mangrove areas we also collect mud crabs for self-consumption and sometimes for sale.”

Village Case Study: Vicharewadi Village in Mhasla Block

Socio-Demographic Profile of the Village

Vicharewadi village, located in the Mhasla block, is a small coastal settlement where livelihoods are closely linked to the surrounding mangrove ecosystem. During the field visit, it was observed that the village population largely consisted of elderly residents, as many younger individuals had migrated to Mumbai for employment and educational opportunities. This demographic shift has resulted in limited availability of labour in the village.

Threats to Mangroves and Livelihood Challenges

Mangroves in these areas face multiple threats that have contributed to their degradation. Landowners used to remove mangroves to create ponds for commercial cultivation of prawns, crabs, and fish. In some instances, mangrove-covered land was sold to commercial entities for aquaculture development. These activities had exerted sustained pressure on the mangrove ecosystem, leading to habitat disturbance and ecological imbalance.

Agriculture has traditionally been the primary occupation in Vicharewadi. However, it has been significantly impacted by the expansion of mangroves, resulting in very limited agricultural activity at present. To sustain their livelihoods, villagers increasingly depend on crab collection within the mangroves. This dependence has been further challenged by the village's proximity to the MIDC industrial area, where environmental contamination has led to deterioration in the quality of crabs and fish, with chemical residues being detected. As a result, both household income and food security are adversely affected.

Role of the Mangrove Conservation Agreement

The mangrove land conservation agreement introduced under the programme has provided crucial support to the community. Through awareness sessions conducted by the AERF team, landowners were informed about the ecological importance of mangroves. The agreement offered a supplementary source of income, helping households cope with declining agricultural opportunities and reduced returns from crab collection. This incentive amount discouraged further degradation of mangroves.

Beyond financial support, the agreement contributed to increased awareness and a sense of stewardship among landowners regarding the biodiversity on their lands. By aligning conservation objectives with livelihood needs, the programme enabled the community to navigate economic challenges while ensuring long-term protection of the mangrove ecosystem.

Mangroves with their breathing roots



8. Conclusion

The programme has demonstrated noteworthy progress in advancing mangrove conservation through a multi-layered approach that combines ecological restoration, socio-economic engagement, and community empowerment. The expansion of conservation agreements, moving from short-term commitments in 2021 to long-term tenures of five and ten years by 2024, reflects a growing trust and willingness among landowners to safeguard mangrove ecosystems. This shift highlights not only increased awareness of the ecological importance of mangroves but also a strengthened sense of responsibility to ensure long-term resilience.

Community involvement has been central to this success. By actively engaging local leaders, community members, appointing community stewards, and fostering women's participation, the programme has embedded conservation within local governance and social structures. Awareness sessions, participatory activities, and recognition of active beneficiaries have built trust and ownership, resulting in broader acceptance of conservation agreements. The willingness of 100% of agreement holders to renew their agreements with AERF underscores the depth of this transformation and the strong social legitimacy of the initiative.

Ecological and livelihood innovations have further reinforced sustainability. Distribution of mangrove and salt-tolerant species such as *Pongamia pinnata*, *Calophyllum inophyllum*, *Rhizophora mucronata*, and *Kandelia candel* across villages in Mandangad block has strengthened biodiversity while offering future economic value. Complementary activities including adoption of bio-stoves have reduced pressure on mangroves, and improved health outcomes. Waste management initiatives, focusing on segregation, removal of plastics harmful to mangrove roots, and composting of wet waste, have added a circular dimension to conservation, linking ecological health with agricultural productivity.

Finally, the programme's coherence with national and international frameworks such as the MISHTI initiative, the UN Decade on Ecosystem Restoration, and the Sustainable Development Goals ensure that local actions contribute to global priorities. The integration of GIS mapping, socio-economic studies, and biodiversity assessments has provided a robust evidence base for context-specific solutions. Together, these efforts have restored community-mangrove relationships, enhanced resilience against climate risks, and created pathways for sustainable livelihoods.

Annexures

Caveats

- This report is with restrictive circulation and has been prepared exclusively for Apple India as part of the impact assessment of their CSR projects. It should not be used, reproduced, or circulated for any other purpose, in whole or in part, without prior written consent if used or referred for any other inference / study as an input or reference document. Grant Thornton Bharat LLP would only give such consent after full consideration of circumstances.
- The information collected for this study is through field visits, meeting with various stakeholders, information shared by respondents and backend data provided by Apple India/ Partners. We have relied on the information shared by these sources. The scope of work here does not constitute an audit or due diligence of the information shared; hence information received from the various sources was believed to be accurate.
- Our scope of work here includes assessment of the various aspects of a social / development intervention through the methodology described in this report. The scope of work does not include commenting on the validity of the said intervention as a CSR project / project as per the CSR Rules and Regulations.
- This report should not be considered as an expression of opinion on any form of assurance on the financial statements of or on its financials or other information.
- The recommendations provided as part of the assessment exercise may be implemented after an analysis of prioritization. The decision to implement the recommendations is the responsibility of the management of Apple. Field visits were conducted in cognizance with Apple, the implementing partner and field teams with prior acceptance on approach, methodology, coverage plan, survey, and tools.
- Owing to communication gap and the inherent human instinct to report everything as above-expectations and glitch-free, it was challenging to make interviewees understand the purpose of the survey and ensure that correct data was accordingly gathered. In the absence of baseline data, responses for retrospective questions are based on the respondents' ability to recall past information.
- Grant Thornton Bharat LLP holds no responsibility on accuracy or sanctity, or authenticity of information provided by company or implementing partner or stakeholders covered or any other party involved, and results / references drawn basis the same.

Field Pictures

Group discussion at Shirkichal



Group discussion at Diviparangi



Group discussion at Bahirichapada



Group discussion at Mandangad field station



Interview with Sarpanch of Undi



Interview with Community leader at Odhangi

