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TECHNOLOGY NEEDS ASSESSMENT REPORT

Technology Action Plan

Adaptation

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TNA TECHNOLOGY
NEEDS
ASSESSMENT



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Foreword

Timor-Leste, classified as a Least Developed Country (LDC) and a member of the Small Island Developing States (SIDS), faces exceptional vulnerability to the impacts of climate change. The nation is experiencing adverse effects from extreme weather events, such as intense storms and rising sea levels. Additionally, certain current practices exacerbate Timor-Leste's susceptibility to climate change, hindering its development. Without addressing the root causes of climate change and providing support to the most vulnerable sectors, these impacts will only worsen.

Currently, Timor-Leste is conducting the Technology Needs Assessment (TNA) to mitigate climate change and enhance adaptation across the country. As part of this effort, national-level consultations with stakeholders were held to identify prioritized technologies under the TNA process. The Minister of Tourism and the Environment (MTE), through the General Directorate of Environment (DGE), recognizes that the TNA project represents the country's first comprehensive national initiative aimed at assessing its climate technology needs. This was followed by the completion of the Barrier Analysis and Enabling Framework (BAEF) as the second phase of the process.

The government of Timor-Leste proudly announces the completion of the third phase of the TNA, known as the Technology Action Plan (TAP). The TAP report for adaptation has been finalized with the support of relevant line ministries, international agencies, non-governmental organizations (NGOs), private sectors, academic institutions, and youth organizations. Through this collaborative effort, there is confidence that the implementation of the adaptation technologies outlined in the TAP report will enhance resilience in Timor-Leste. We hope that this document can also serve as a database for the relevant line ministries to mobilize resources to support the work in their respective ministries.

Lastly, I would like to extend my gratitude to the National Directorate for Climate Change (NDCC), particularly the TNA National Team, as well as to the United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC) and the Asian Institute of Technology (AIT) for their unwavering support and guidance throughout the implementation of the TNA project.



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Abbreviations

| | |
|-----------|---|
| ADA | Austrian Development Cooperation |
| CA | Conservation agriculture |
| CR | Crop rotation |
| BAEF | Barrier analysis and enabling framework |
| BTL, E.P. | Bee Timor-Leste Empresa Pública |
| CBNRM | Community-based natural resource management |
| CRB | Coastal Resilience Building |
| CTSP | Coral Triangle Support Programme |
| DGF | Directorate General of Forestry |
| EC | European Commission |
| FFS | Farmers Field School |
| GCF | Green Climate Fund |
| GoTL | Government of Timor-Leste |
| KFF | Konservasaun Flora & Fauna |
| MALFF | Ministry of Agriculture and Fisheries |
| MCA | Multi-Criteria Analysis |
| MPAs | Marine protected areas |
| MPW | Ministry of Public Works |
| MSA | Ministry of State Administration |
| MTE | Ministry of Tourism and Environment |
| NAP | National Adaptation Plan |
| NbS | Nature-based solutions |
| NRM | Natural Resource Management |
| NDC | National Determined Contribution |
| NETIL | Nova Esperanca Timor-Leste |
| PERMATIL | Permakultura Timor Lorosa'e |
| PI | Project Ideas |
| R&D | Research and development |
| RDTL | República Democrática de Timor-Leste |
| SALT | Slope agriculture land technology |
| SLM | Sustainable land management |
| SSE | Secretary of State for the Environment |
| TNA | Technology needs assessment |
| TAP | Technology Action Plan |
| UNTL | Universidade Nacional Timor Lorosa'e |

Executive Summary

Introduction

Technology Action Plan is the final step in the Technology Need Assessment (TNA) process which supports the implementation of the prioritised technologies, at the desired scale, within the country to achieve the climate and development benefits identified earlier in the TNA process. Built upon the measures identified in the Barrier Analysis and Enabling Framework (BAEF), TAP specifies how to implement these measures, whose responsibilities, when, and from where to secure funding. As such, a TAP serves as a bridge between the analysis of prioritised technologies and their implementation.

The process of preparing this TAP can be broken down into 7 steps. All the seven steps were conducted between November and December 2023 in a participatory manner where relevant stakeholders were consulted. In the first step, the stakeholders provided inputs on the scale and ambition for each TAP. In the following step, a set of actions to be included in the TAP were identified based on their effectiveness, efficiency, interactions with other measures, suitability within the country/sector, and benefits and costs. These actions were developed from proposed measures from the BAEF report. In the last few steps, stakeholders were identified, and tentative timelines were set along with identified needs and cost estimates, reporting, and tracking implementation status.

In the end, a total of sixteen (16) actions and fifty-two (52) activities were developed for sector 1 – sustainable land management in agriculture. Meanwhile, a total of eight (8) actions and twenty-five (25) activities were developed for sector 2 - infrastructure and natural methods to prevent erosion. The TAP for SALT technology, which is presented in the TAP for Mitigation report, is excluded from this report to avoid redundancy. Additionally, based on a set of selected actions and their respective activities, one project idea (PI) was developed for sector 1 and two PIs for sector 2.

Action plans for adaptation technologies

TAPs for adaptation technologies were developed from a set of common and differentiated measures in the two sectors. The TAP for each technology defines ambition, actions, activities, responsible entities, timeline, estimation of required resources, and management planning (risks, contingency plans and next steps). While most of the components vary from one technology to another, many of them tend to share a common timeline, risk categories, contingency plans, and next steps. In addition, it is proposed that all activities be co-funded by the GoTL's annual state budget and donor agency, particularly GCF.

The ambition set for CA targets that approximately 25,000 agricultural households in Ermera, Baucau, Viqueque, Aileu, Ainaro, and Bobonaro will adopt this technology by 2030. Two actions (extensive information campaign and capacity building) were selected for PI with an estimated cost of USD 1,100,000. The implementation of this TAP will need to be led by MALFF with support from UNTL-AI Com, World Vision Timor-Leste, Australian Centre for International Agricultural Research (ACIAR), and development partners.

The ambition set for 2030 for water management and conservation targets approximately 20,000 agricultural households who irrigate farmlands using surface water and underground water. Efforts to reach the set target are embedded into a total of 3 actions – integration of water restoration plans in water management system, capacity building, and connecting community groups with donor agencies

– and 10 activities which are all selected for the PI. The financial resource required for the implementation of the PI is estimated to be around USD 575,000. Led by the Ministry of Public Works (MPW) and BTL E.P., the implementation of this TAP will be supported by MALFF, Permatil, and Development Partners.

Targeting approximately 2,984 agriculture households, the 2030 ambition set for biochar is to be achieved through the implementation of three actions, namely expansion of research, campaign, and capacity building. It is recommended that MALFF-Directorate General of Agriculture lead this project with support from AI-Com, UNTL, and development Partners. The estimated cost for the PI is USD 1,360,000.

Similar to the ambition set for biochar, two actions, campaign and facilitating smallholder farmers' access to capital, were selected for PI for composting technology with an estimated cost of USD 1,360,000. Once again, MALFF- Directorate General of Agriculture is expected to lead the implementation of the PI with support from AI-Com, UNTL, TILOFE, and development partners.

The ambition set for soil bioengineering targets the application of this technology in approximately 40.000 ha of cultivated land in Timor-Leste. Two actions were selected for the PI with an estimated cost of USD 2,120,000. The implementation of the PI needs to be co-led by the Ministry of Public Works (MPW) and Ministry of State Administration (MSA) and supported by MALFF, UNTL – Engineering Department, and development agencies.

The ambition set for tarabandu is different from the ones set for other technologies in the sense that it targets all areas (*i.e.*, coastal and inland) where soil bioengineering, mangrove plantation and SALT technologies are applied. Efforts to reach this target are embedded into a total of 2 actions – Improving local governance of natural resource management and provision of alternative source of livelihood – for the PI with an estimated cost of USD 730,000. Led by the Ministry of Tourism and Environment (MTE) – Directorate General for Environment, the implementation of the PI needs to be supported by MSA, MALFF-Directorate General for Forestry, PNTL (Polícia Nacional de Timor-Leste) and development agencies.

The ambition set for mangrove plantation targets the application of this technology in around 2,500 Ha of coastal in eleven (11) coastal municipalities. To reach this goal, a total of 3 actions were selected for the PI with an estimated cost of USD 3,080,000. It is suggested that MALFF-Directorate General for Forestry and MTE- Directorate General for Environment co-lead the implementation of the PI with the support from local NGOs and development agencies.

In terms of management planning, the TAP has identified five potential risks, namely political, social, economic, scheduling, and financial risks. Contingency actions for each risk have been identified and presented in the TAP section for each technology.

Project Ideas (PI)

In concluding the TAP for each sector, three project ideas – one for sector 1 and two for sector 2 – were developed. Centred around CSA-related technologies, the project idea for sector 1 is formulated as “Scaling up Climate Smart-Agriculture (CSA) practices in Timor-Leste”. In principle, this PI combines selected actions and activities from the four relevant technologies to build on past and ongoing efforts to introduce CSA widely among the farmer communities in Timor-Leste.

In terms of its relevance to national development strategies and plans, PI for sector 1 is in line with the National Strategic Development Plan (SDP) 2011-2030 and the programme of Timor-Leste’s IX

Constitutional Government. Additionally, it is aligned with the draft National Agriculture Policy and Strategic Framework which aims to help farmers transition from subsistence farming to market-oriented agriculture through promotion of CSA practices and technologies.

It is estimated that the PI for sector 1 will require approximately USD 1,720,000 for the duration of 4 years (2024-2028). The project management unit is to be led by MALFF -- DG of Agriculture and DG of Forestry with support from MTE (DG of Environment), MPW (BTL, E.P.), development partners, research agencies, NGOs and private sector.

Two project ideas have been developed for sector 2. The title for the first one is “Scaling up Soil Bioengineering in Infrastructure Development in Timor-Leste”. The proposed PI builds on past and ongoing efforts to mainstream soil bioengineering in all infrastructure projects in the country. It will do so through strengthening regulatory frameworks and monitoring of infrastructure projects of all types (*i.e.*, roads, bridges, water, energy, housing, schools, and health centres) and sizes (small, medium, and large). Additionally, some portions of the project will focus on R&D partnership and capacity building for relevant actors.

The second PI, “Upgrading Coastal Resilience Building through Mangrove Ecosystem Restoration in Timor-Leste”, seeks to bridge the gaps and further enhance the resilience of communities residing in all coastal areas in the country. In terms of planning and coordination, the proposed project can capitalise on experience and lessons learned from the Coastal Resilience Building (CRB) project to maximise its outputs and sustainability of the outcome. Additionally, one project component features activities for *tarabandu* to enhance the natural resource management using a community-based approach.

Similarly, the two PIs for sector 2 are in line with Timor-Leste’s Second National Communication under the UNFCCC, the National Determined Contribution (NDC) 2022-2023, and National Adaptation Plan (NAP). These national documents highlight the importance of integrating NbS to reduce the impact of natural disasters on people and infrastructure. The outcome of the project will significantly reduce the high expenditure on infrastructure development from the state budget allocation in the long run.

The total cost for the first and second PI for the duration of 6 years (2024-2030) is USD 2,180,000 and USD 3,040,000. The PMU for the first PI is to be co-led by MPW and MALFF (DG of Agriculture and DG of Forestry). For the second PI, it is to be co-led by MALFF - DG of Forestry and MTE - DG of Environment.

Cross-cutting issues

The two sectors selected for adaptation are quite different in terms of their target beneficiaries and field of application. Sector one focuses on technologies that can support farmers while sector two targets a wide range of people who rely on public infrastructures (*i.e.*, roads, bridges, water and power, and building facilities). Moreover, sector one will mostly be applied in private/common properties while sector two will mostly be applied in common/public properties. Despite these differences, the PIs for both sectors have some common barriers. Therefore, it is recommended that measures and strategies to address these issues be integrated and mainstreamed.

Chapter 1: Technology Action Plan and Project Ideas for Sustainable Land Management in Agriculture Sector

1.1 TAP for SLM in agriculture sector

This chapter focuses on the Technology Action Plan (TAP) for the SLM in the agriculture sector which consists of the following technologies: conservation agriculture and crop rotation, water management and conservation, composting, and biochar.

1.1.1 Sector Overview

Agriculture is the primary livelihood for around 64% of Timor-Leste's population engaged in agricultural activities with a majority relying exclusively on low input and output subsistence farming (Lopes and Nesbitt, 2012). The farming system is based on shifting cultivation and shallow soils characterise the terrain. However, agriculture productivity is low due to limited access to and adoption of production increasing technologies (Tomak, 2016; Jensen et al., 2014; Lopes and Nesbitt, 2012), the use of low-quality seeds and fertilisers (Tomak, 2016; FAO, 2003), limited supply of irrigation (World Bank, 2019), and poor soil conditions (Paudel et al., 2022). Climate change is anticipated to have the biggest negative impact on agriculture. An increase in the frequency and intensity of extreme climatic events will further reduce agricultural productivity¹.

It is the goal of the IX Constitutional Government of Timor-Leste to enhance national food security, reduce rural poverty, support the transition from subsistence culture to business production of agriculture and promote environmental sustainability and conservation of the country's natural resources (GoTL, 2023). Furthermore, Timor-Leste's national climate adaptation² and strategic national development documents³ acknowledge that a key to more efficient production and enhanced competitiveness in agriculture sectors rests in the availability and utilisation of production inputs. It is in the interest of GoTL to increase the level of production of rice from 86,000 tons (2022 forecast) to around 114,650 tons to respond to 70% of the total national demand (which is around 160,412 tons). Therefore, introduction and adoption of production increasing technologies, including the four technologies selected for this sector, in Timor-Leste is seen as one of the tools to assist the Government in achieving the 2028 goal not only for maize and rice but also for other agriculture products.

1.1.2 Action plan for conservation agriculture and crop rotation

1.1.2.1 Introduction

Conservation agriculture (CA) is one of the SLM practices which applies three interrelated principles: minimum soil disturbance, biomass mulch soil cover, and crop diversification (FAO, 2022). Crop rotation is a traditional practice that involves the sequential planting of crops over time (McDaniel et al., 2013). CA has been widely promoted and implemented in croplands in a few countries worldwide,

¹ Typically, extreme climatic events in Timor-Leste are related to ENSO episodes. During the 2016 El Niño, government records suggest that maize and rice output declined by 40% and 57%, respectively (USAID, 2017); if ENSO events become more frequent and/or extreme, agricultural productivity and food supply disruptions would certainly grow in tandem.

² The National Action Plan for Climate Change

³ The Strategic Development Plan 2011-2038 and IX Constitutional Government Programme 2023-2028

including Timor-Leste. Combining CA & CR has the potential to improve soil properties, reducing soil erosion, mitigate pressure from weed, insect, and pathogen, and improving productivity (Bullock, 1992; Copeland & Crookston, 1992; Gurr et al., 2003; Smith et al., 2008; Macdaniel et al., 2013; Kassam et al., 2018; Haregeweyn et al., 2022).

The GoTL sees the importance of further promotion of CA & CR as a key strategy for future development of the agriculture sector in Timor-Leste. In 2013, MALFF in collaboration with FAO and NGO partners tested the CA techniques, including intercropping with legumes, through demonstration plots in the communities, as well as in MALFF research stations. This collaboration has led to the development of manuals for CA, with a dedicated section on crop rotation, for agricultural practitioners, researchers, and agriculture extension officers. According to data from MALFF, between 2013-2018, CA techniques were tested and adapted for different farm sizes, soils, crop types, and climatic zones. Farmers' reaction to those techniques has been overwhelmingly positive, particularly those with large farm sizes on flat lands. At least 4,000 farmers across seven municipalities (Baucau, Manufahi, Manatuto, Aileu, Ermera, Lautem and Atauro) have adopted and are practising CA technologies on a total of around 200 ha farm field. Their experience has shown increased yields of up to 125% and reduced labour costs by at least 50%.

1.1.2.2 Ambition for the TAP

According to the 2019 agriculture census, around 30% of 141,141 Timorese families (agricultural households) whose livelihood depends on agriculture practice land tillage. These agricultural households mainly reside in six (6) municipalities namely: Emera, Baucau, Viqueque, Aileu, Ainaro, and Bobonaro. Hence, the target for the adoption of CA & CR technology by 2030 is approximately 25,000 agricultural households in the six municipalities. As this is one of the first national-level efforts to scale up the introduction of this technology, it is fair to capture only 58% of the agriculture households who practise land tillage and leave the remaining target to other similar interventions in the future. Additionally, there could be resource constraint issues if the target is set high at this stage. In terms of its gender target in the six municipalities, it is possible that adoption of this technology at the recommended scale will benefit around 11,625 female-headed agricultural households or roughly 46% of the total target.

According to the Multi-Criteria Analysis (MCA) matrix, adopting this technology generates a wide range of benefits in general. From the environmental perspective, it minimises soil disturbance to reestablish healthy soil structure, creates biomass mulch soil cover which in turn reduces the needs for artificial fertilisers, and reduces the risk of the spread of pests and diseases. As such, it contributes to Timor-Leste's adaptation priorities in the agriculture sector which aims to promote climate resilient practices between 2026 and 2030. From the economic side, it increases productivity of the soil which in turn increases yields. It also lowers the input cost by reducing the use and purchase of artificial fertilisers. In addition, it increases their capacity and understanding of sustainable agriculture.

1.1.2.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

There are four financial and non-financial barriers that hinder the adoption of this technology. High capital cost limits farmers' capacity to purchase and maintain equipment. Farmers in Timor-Leste often find it difficult to access credit for funding agricultural activities and other needs. In addition, farmers in Timor-Leste face obstacles in terms of the availability of required inputs and services for CA tools such as plant seeder machines, jab planters, and rotavators. Most of them were distributed to

only a handful of farmers in Timor-Leste through some agriculture projects. The third barrier, strong attachment to slash and burn farming, entails farmers' reluctance to adopt CA & CR as they become accustomed to the same conventional, unsustainable farming techniques for many generations. Lastly, farmers' limited knowledge on methods and benefits of this technology due to limited access to information contributes to their reluctance to adopt this technology.

The five identified measures to overcome these barriers are facilitation of farmer's access to capital (*i.e.*, micro-loan and grants), improving supply chain for CA tools/equipment through domestic supplier, conducting extensive education and awareness raising campaign, providing farmers with more opportunities for capacity building, and promoting the practice of confined raising in livestock management.

b. Action selected for inclusion in TAP

The BAEF report identifies a list of barriers for adopting this technology in target locations and recommended measures to overcome them.

The list of actions in Table 1 is selected based on stakeholder consultation which highlight their effectiveness.

| Actions | Activities |
|---|--|
| <p>Action 1: Extensive education and awareness raising campaign on CA & CR</p> <p>This action is part of an investment in education and awareness raising campaigns at national and local level to increase access to credible information for farmers, including female-headed agricultural households, improving their knowledge of the technology. It can also clarify doubts and preconceived notions shared among the farmers' group about the benefits and drawbacks of CA & CR.</p> | <p>Activity 1.1: <i>Mapping out actors involved in agriculture sector in Timor-Leste</i></p> <p>Activity 1.2: <i>Development of CA & CR campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i></p> <p>Activity 1.3: <i>Dissemination of CA & CR in target sucos</i></p> <p>Activity 1.4: <i>Demo plot during the campaign involving farmers, including female-headed agricultural households</i></p> |
| <p>Action 2: Capacity building activities on CA & CR for target smallholder farmers and extensionists</p> <p>While some methods of CA & CR, such as the use of machetes to remove weeds and hoes to create mulching, has been practised by Timorese farmers for many generations, it is important to expose farmers to other methods (<i>i.e.</i>, crop rotation using mung beans and the application of herbicides) through capacity building programmes such as workshops and Farmer's Field Schools (FFSs). This is a good opportunity for farmers in rural areas which have not previously received capacity building programmes to learn new methods. There should be a quota for both male and female participants in training and related activities.</p> | <p>Activity 2.1. <i>Assessment of farmer's knowledge of CA & CR and extensionist's ability to deliver the training</i></p> <p>Activity 2.2. <i>Development of training materials for FFS on CA & CR</i></p> <p>Activity 2.3. <i>Implementation of FFS on CA & CR in demo plots and facilitating exchange visits</i></p> |

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| <p>Moreover, training modules should be gender-sensitive, acknowledging different roles attributed to male and female farmers.</p> | |
| <p>Action 3: Facilitate smallholder farmers’ access to capital in target municipalities</p> <p>Farmers in Timor-Leste, especially the ones residing in rural areas, are not aware of different micro-loan services available in the country apart from the saving-and-loan group/cooperatives. This can be the result of limited information in the municipalities as well as low level of literacy among the farmers groups. Additionally, access to loan services from financial institutions in the country is very limited to women who generally do not possess the right types of assets (<i>i.e.</i>, immobile property such as land) to pledge as collateral.⁴ Facilitating smallholder farmers’ access to financial services in the country is an important step to enable them to acquire capital which they can use to purchase the much-needed equipment and tools which can be used to increase quality and quantity of their production.</p> | <p>Activity 3.1. <i>Conducting assessment and surveys of smallholder farmer’s access to financial services in Timor-Leste</i></p> <p>Activity 3.2. <i>Organising information session between local financial services and target smallholder farmers, especially female-headed ones</i></p> <p>Activity 3.3. <i>Establishing help desks to assist smallholder farmers with application for loans and/or formation of saving-and-loan group</i></p> |
| <p>Action 4: Improve supply chain for CA tools/equipment through domestic supplier to reduce dependence on imports</p> <p>The outsourcing of CA tools/equipment (<i>i.e.</i>, manual crimper-roller, hoes, machetes, and long-handled sickles⁵) through local providers needs to be strengthened, especially in the case where they can be developed and maintained by local manufacturers and service providers. By doing so, the country can sustain the supply chain in the long run, strengthen local economy, and minimise the risk of being completely dependent on imports which can be easily disrupted by external events (<i>i.e.</i>, wars and global pandemics).</p> | <p>Activity 4.1. <i>Conducting assessment of supply chain for CA tools/equipment</i></p> <p>Activity 4.2. <i>Capacity building for local suppliers/firms</i></p> |

Table 1: List of actions and activities for CA & CR

Action 2: Capacity building activities on CA & CR for target smallholder farmers and extensionists will be implemented as a Project Idea (PI) in combination with Action 1: Extensive education and awareness raising campaign on CA & CR. During the barrier analysis and enabling framework consultations, stakeholders identified limited knowledge on methods and benefits of CA & CR and strong attachment to slash and burn farming as the major non-financial obstacles for widespread uptake of CA & CR. They proposed extensive education and awareness raising campaigns on CA & CR

⁴ Timor-Leste’s strong patriarchal culture is the underlying barrier for women to claim rights to land and property. Most land registry documents are signed by husbands.

⁵ While there are local industries to supply the last two tools, the market for the first two tools relies heavily on import.

and capacity building opportunities to farmers as key measures in overcoming this barrier. All activities under the two actions will be considered in the PI.

1.1.2.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 2 play crucial roles in the implementation of actions and corresponding activities for the TAP.

| Stakeholder | Roles |
|---|---|
| MALFF | As the responsible Ministry for agricultural development programme and research, MALFF can contribute to coordinating, planning, and budgeting as well as mobilisation of existing resources to support actions identified in PI. |
| UNTL | As one of the research partners of AI-Com programme, UNTL can provide continuous support in research, information dissemination, and formulation of training modules on CA & CR to farmers. |
| World Vision Timor-Leste | As one of the research partners of AI-Com programme, World Vision TL can provide continuous support in information dissemination to farmers. |
| Australian Centre for International Agricultural Research | Having established a strong presence in Timor-Leste through funding and technical support for research activities, ACIAR can provide financial and technical (capacity building and research) support to scale up the adoption of CA & CR in Timor-Leste. |
| PMU of TOMAK Project | The PMU can lend their expertise in leading agriculture projects in Timor-Leste to smoothen the planning, coordination, and implementation of activities identified in PI. They can also share valuable lessons from the previous project (Tomak Phase 1), including the one on gender equality and social inclusion, to help the design of PI. |
| FAO | FAO can bring in valuable insights extracted from intensive research and lessons learned from past projects to improve the planning and design of activities. |

Table 1: List stakeholders responsible for the implementation of CA & CR

Timeline for the implementation of the actions and corresponding activities is presented in Table 3 below.

| Actions | Activities | Year | | | | |
|---|--|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 1: Extensive education and awareness raising | 1.1: <i>Mapping out actors involved in agriculture sector in Timor-Leste</i> | X | | | | |

| | | | | | | |
|--|---|---|---|---|---|---|
| campaign on CA & CR | 1.2: <i>Development of CA & CR campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | X | X | X | X | |
| | 1.3: <i>Dissemination of CA & CR in target sucos</i> | | X | X | X | X |
| | 1.4: <i>Demo plot during the campaign</i> | | X | X | X | X |
| 2: Capacity building activities on CA & CR for target smallholder farmers and extensionists | 2.1. <i>Assessment of farmer's knowledge of CA & CR and extensionist's ability to deliver the training</i> | | X | | | |
| | 2.2. <i>Development of training materials for FFS</i> | | X | | | |
| | 2.3. <i>Implementation of FFS in demo plots and facilitating exchange visits</i> | | X | X | X | X |

Table 2: Timeline for the implementation of CA & CR

1.1.2.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Costs (USD) |
|---|---|--------------------|
| 1.1: <i>Mapping out actors involved in agriculture sector in Timor-Leste</i> | Consultant fee | 20,000 |
| | Consultation activities | 30,000 |
| 1.2: <i>Development of CA & CR campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | Development of campaign materials | 50,000 |
| | Printing and publication fee | 200,000 |
| 1.3: <i>Dissemination of CA & CR in target sucos</i> | Socialisation in target areas | 60,000 |
| 1.4: <i>Demo plot during the campaign</i> | Activities in demo plot involve both male and female-headed agricultural households | 40,000 |
| 2.1. <i>Assessment of farmer's knowledge of CA & CR and extensionist's ability to deliver the training</i> | Farmer's knowledge assessment | 50,000 |
| 2.2. <i>Development of training materials for FFS</i> | Development of training modules that are gender-sensitive | 50,000 |
| | Printing of modules and handbooks | 200,000 |
| 2.3. <i>Implementation of FFS in demo plots and facilitating exchange visits</i> | Implementation of FFS in target areas for both male and female-headed agricultural households | 400,000 |
| Total cost | | 1,100,000 |

Table 3: Resource estimation for the implementation of actions and activities from CA & CR

1.1.2.6 Management planning

Risks and Contingency Plans

Table 5 provides an overview of three risk types (political, social, and scheduling) and their contingency actions for the implementation of CA & CR.

| Type of risk | Description | Contingency actions |
|-----------------|---|---|
| Political risk | Lack of support from relevant actors due to political differences | Establish a common objective among all the actors and an environment of non-bipartisanship |
| | Excessive interventions from senior managers in the Government in project implementation due to political interest (<i>i.e.</i> , sending too many representatives on field trip missions, giving special treatment to certain municipalities/sucos, etc.) | Clearly define the roles of project managers and partners from the onset |
| Social risk | Limited participation from target beneficiary groups, specifically women and youth, due to lack of interest and socio-cultural barrier | Community clearly project's objective with target groups, especially women, and conduct proper consultation to learn about their challenges and needs |
| Scheduling risk | Gang conflict between youth groups limits mobility and delays implementation of field activities in target sites | Maintain close communication and coordination with community policy, leaders and youth representatives |
| | Natural disasters (<i>i.e.</i> , flash flood and erosion) damage road conditions in rural areas, limiting access to target sites do conduct some activities | Carefully plan field activities and if possible, avoid their implementation during month of extreme rainy season |
| | Delays in recruiting qualified experts to develop and deliver training materials | Establish a consultant roster which has a list of qualified candidates |

Table 4: List of risks and contingency plans for the implementation of CA & CR

Next steps

| Immediate Requirements | Critical Steps |
|--|--|
| DG of Environment and NDCC and should organise a stakeholder's workshop to communicate the TAP | Get the stakeholders buy-in, specially from MALFF and partners |
| MALFF to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MALFF's 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 5: List of next steps for the implementation of CA & CR

TAP Overview table

| Sector | Sustainable land management (SLM) in agriculture | | | | | | | |
|---|---|-------------------|--|-----------|---|--|--|--------------|
| Technology | Conservation agriculture and crop rotation | | | | | | | |
| Ambition | Conservation agriculture and crop rotation will be widely adopted by around 25,000 agricultural households in Ermera, Baucau, Viqueque, Aileu, Ainaro, and Bobonaro | | | | | | | |
| Benefits | Improving soil properties, reducing soil erosion, mitigating pressure from weed, insect, and pathogen, and improving productivity | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point (Stakeholders & Roles) | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget (USD) |
| Action 1: Extensive education and awareness raising campaign on CA & CR | Activity 1.1: <i>Mapping out actors involved in agriculture sector in Timor-Leste</i> | GoTL/GCF | Consultant | 2024-2028 | Delays in recruiting qualified experts | All actors are mapped out, including female farmers | Gender disaggregated report on number of actors being mapped out | 50,000 |
| | Activity 1.2: <i>Development of CA & CR campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | GoTL/GCF | MALFF, AI COM, UNTL, Tomak | 2024-2028 | Delays in recruiting qualified experts | Campaigns materials are effective in conveying the message | Variety of campaign materials | 250,000 |
| | Activity 1.3: <i>Dissemination of CA & CR in target sucos</i> | GoTL/GCF | MALFF | 2024-2028 | Gang conflict between youth groups, Natural disasters, limited participation from target beneficiary groups | Target sucos learn about CA & CR and are convinced about its effectiveness | Number of people being aware of CA & CR technology | 60,000 |
| | Activity 1.4: <i>Demo plot during the campaign</i> | GoTL/GCF | | 2024-2028 | | Farmers learn from training activities | Number of male and female-headed agricultural households who can | 40,000 |

| | | | | | | | | |
|--|--|----------|--------------------|-----------|--|---|---|---------|
| | | | | | | | practise CA technology methods | |
| Action 2: Capacity building activities on CA & CR for target smallholder farmers and extensionists | Activity 2.1. <i>Assessment of farmer's knowledge of CA & CR and extensionist's ability to deliver the training</i> | GoTL/GCF | MALFF, FAO | 2024-2028 | Delays in recruiting qualified experts, limited participation from target beneficiary groups | All level of knowledge and capacity are captured in the assessment | Report on the extent of farmers' knowledge of CA technology | 50,000 |
| | Activity 2.2. <i>Development of training materials for FFS</i> | GoTL/GCF | MALFF, FAO | 2024-2028 | Limited participation from target beneficiary groups | Training materials are effective and user friendly/ Training materials are gender-sensitive | The number of thematic areas covered in training materials, including the one on gender | 250,000 |
| | Activity 2.3. <i>Implementation of FFS in demo plots and facilitating exchange visits</i> | GoTL/GCF | MALFF Extensionist | 2024-2028 | Limited participation from target beneficiary groups | Farmers learn new techniques | The level of knowledge/skill improvement post-training; Number of female farmers participating in training activities | 400,000 |
| Action 3: Facilitate smallholder farmers' access to capital in target municipalities | Activity 3.1. <i>Conducting assessment and surveys of smallholder farmers' access to financial services in Timor-Leste</i> | GoTL/GCF | Consultant, MALFF | 2024-2028 | Delays in recruiting qualified experts | Survey's findings help improve farmers' access to financial services | The depth of analysis of assessment and survey data | 30,000 |

| | | | | | | | | |
|---|--|----------|------------------------|-----------|--|--|--|--------|
| | Activity 3.2. <i>Organising information session between local financial services and target smallholder farmers, especially female-headed ones</i> | GoTL/GCF | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | More farmers know about difference micro loan and financial services | Number of male and female participants and improvement in level of understanding | 10,000 |
| | Activity 3.3. <i>Establishing help desks to assist smallholder farmers with application for loans and/or formation of saving-and-loan group</i> | GoTL/GCF | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | More farmers can access micro loan and financial services | Number of male and female farmers who access financial services | 20,000 |
| Action 4: Improve supply chain for CA tools/equipment through domestic supplier to reduce dependence on imports | Activity 4.1. <i>Conducting assessment of supply chain for CA tools/equipment</i> | GoTL/GCF | Consultant, MALFF, FAO | 2024-2028 | Delays in recruiting qualified experts | Better understanding of existing supply chain system | The depth of analysis of assessment | 30,000 |
| | Activity 4.2. <i>Capacity building for local suppliers/firms</i> | GoTL/GCF | Consultant, MALFF. FAO | 2024-2028 | Delays in recruiting qualified experts | Suppliers acquire new skills and knowledge to improve local market | Number of participants; Level of improvement of capacity | 20,000 |

Table 6: TAP overview for CA & CR technology

1.1.3 Action plan for water management and restoration

1.1.3.1 Introduction

The management of water resources in Timor-Leste fell under the responsibility of Directorate General of Water and Sanitation of the Ministry of Public Work (MPW). It also involves the National Directorate for Management of Forestry, Watershed and Mangrove Area of the Ministry of Agriculture, Livestock, Fisheries and Forestry (MALFF). Enhancing water management requires important investments in the development of infrastructure, institutions, and management capacity. Nevertheless, investment in water management in Timor-Leste tends to focus heavily on irrigation and distribution of clean water for household consumption, leaving out conservation and restoration of springs and aquifers.

The water management and restoration technology refers to the promotion of a holistic approach in managing water resources and restoring water catchment/springs that have otherwise been degraded or disappeared due to unsustainable use or adverse effect of climate change. It is done through planting water retaining trees around the periphery of the catchment or springs and builds the capacity of the members of the community on how to manage the catchment.

Fortunately, water management and restoration technology is not completely new to Timor-Leste. In the last ten years, partnership and collaboration between GoTL (*i.e.*, MALFF, SEA, and MPW), development institutions (World Bank, ADB, and UNDP) and local NGOs (*i.e.*, Permatil, Raebia, and Netil) has increased efforts to introduce water restoration practices in different parts of the country. However, a large-scale adoption of this technology needs to be promoted in Timor-Leste's agricultural sector. The reason being irrigation accounts for 90% of the water use from total annual freshwater withdrawals⁶ from free or unregulated river intakes. Additionally, as climate continues to prolong drought and increase the frequency of extreme rainfall days, this technology can help alleviate the pressure on surface water and groundwater.

1.1.3.2 Ambition for the TAP

In setting the ambition for TAP for water management and restoration technology, it is crucial to look at data from the 2019 Agricultural Census which highlight the number of agricultural households in Timor-Leste who irrigate farmlands. Out of the total number of 28,965 agricultural households who use irrigation for agriculture, around 68% use surface water only, 11% rely on underground water only, 14% use both surface and underground water and the remaining 7% use other sources. To reflect an attainable target in TAP, it is necessary to narrow down the number of target beneficiaries for the adoption of this technology to 20,000 agricultural households. Target locations for adoption of this technology are all 13 municipalities in Timor-Leste provided that this technology is already implemented in the country at a small scale. Since parcel size (ha of area) operated by male farmers is slightly lower than that of female farmers,⁷ it is important to ensure that both male and female-headed agricultural households are equally benefited from this technology adoption. Hence, at least 10,000 female-headed agricultural households should be the target beneficiary.

⁶ Approximately 1,071 Mm³ /yr (91%) was used for irrigation and livestock, 99 Mm³ /yr for domestic use (9%), and only 2 Mm /yr for industrial use.

⁷ According to the 2019 agriculture census, the parcel size of male operated parcels is 1.01 ha and of female operated parcels 1.02 ha.

This technology promotes a holistic approach in managing water resources and restoring water catchment/springs that have otherwise been degraded or disappeared due to unsustainable use or adverse effects of climate change. As such, it contributes to the Timor-Leste National Adaptation Plan which highlights climate-smart water management as one of the priority programmes in water sector adaptation between 2026 and 2030.

1.1.3.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

Three barriers have been identified regarding the adoption and implementation of this technology. Initially, without significant efforts to bridge the financial gap, community-led initiatives aimed at water source restoration are likely to wane. Secondly, many rural communities lack sufficient knowledge about restoration techniques and their efficacy due to limited access to relevant information. Lastly, in Timor-Leste, water management institutionalisation primarily focuses on clean water supply and distribution systems. Water restoration receives less priority, mainly because of a consumption-oriented approach that prioritises extraction over restoration activities.

To address the financial barrier, one potential solution is to facilitate connections between communities and external stakeholders (such as national and municipal governments, development partners, and civil society organisations) who can offer funding for restoration efforts. In overcoming non-financial barriers, the initial measure involves integrating water restoration plans into the water management system, altering the existing water management paradigm in Timor-Leste. The second measure entails providing community groups with more exposure to water restoration methodologies through practical field exercises and site visits.

b. Action selected for inclusion in the TAP

The list of actions in Table 8 is developed using enabling measures proposed in the BAEF report on water management and restoration. These actions are developed based on the fact that they are the most feasible and cost-effective actions that contribute to tackling relevant barriers for the wide scale adoption and deployment of the corresponding technology.

| Actions | Activities |
|---|---|
| <p>Action 1: Integration of water restoration plans in water management system</p> <p>Integrating restoration and conservation activities in the water management system in Timor-Leste aims to change the status quo. It brings together relevant actors (<i>i.e.</i>, BTL and MALFF) to work together and strengthen the institutionalisation of water management through introduction of rules and regulations that promote groundwater restoration in areas prone to drought and groundwater deficits.</p> | <p>Activity 1.1: <i>Assessment (and mapping) of sustainable water management and conservation in Timor-Leste</i></p> <p>Activity 1.2: <i>Review of existing water consumption/use rules and regulations</i></p> <p>Activity 1.3: <i>Public consultations on integration of water restoration in existing water management system</i></p> <p>Activity 1.4: <i>Enforcement of updated rules and regulations</i></p> |
| <p>Action 2: Capacity building on various water restoration methods</p> <p>It is important to introduce community groups to and provide them with training on different water restoration methods. Field practice and site visits will</p> | <p>Activity 2.1: <i>Assessment of farmer's knowledge of water restoration methods</i></p> <p>Activity 2.2: <i>Development of training materials</i></p> |

| | |
|---|---|
| <p>expose them to other new methods that might be more effective, cost-efficient and durable than the ones they are already familiar with. This action has the tendency to encourage peer-to-peer learning and increase farmers' buy-in for the technology. Since female operated parcels of land are slightly higher than that of male operated ones, it is important to establish a quota of 30% (minimum) for female farmers for all capacity building activities.</p> | <p>Activity 2.3: <i>Implementation of FFS on water restoration methods in demo plots and facilitating exchange visits</i></p> |
| <p>Action 3: Connecting community groups with external support (donors and implementing agencies)</p> <p>Empirical evidence shows that the community's commitment to perform reforestation and bioengineering works tends to diminish in the absence of funds. Hence, connecting them with relevant external actors (<i>i.e.</i>, national and municipal governments, development partners, and CSOs) helps break the financial barrier.</p> | <p>Activity 3.1. <i>Establish community groups for water conservation</i></p> <p>Activity 3.2: <i>Mapping out community water conservation groups and their respective supporting agency at suco/aldeia level</i></p> <p>Activity 3.3: <i>Sharing/presenting the maps to potential donors</i></p> |

Table 7: List of actions and activities for the implementation of water management and restoration

Action 1 and its activities are seen as an important starting point for a wide scale introduction and adoption of water management and restoration technology. Hence, it is worth considering their inclusion in the PI for the TAP under sector 1. As activities under action 2 and 3 are closely interwoven with the ones in action 1, it is necessary to combine them in the TAP for this technology.

1.1.3.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 9 play crucial roles in the implementation of actions and corresponding activities for the TAP for water management and restoration technology.

| Stakeholder | Roles |
|---------------------------------|---|
| <p>Ministry of Public Works</p> | <p>MPW plays a crucial role in shaping the future of water management and restoration of the country. As a member of the Council of Ministers, it can endorse sustainable governance of water resources in the country at the ministerial level. Also, its National Directorate for Water Regulation and Sanitation (DNA), the unit responsible for ensuring the sustainable management and integrated use of water resources, plays a role in shaping the future of water governance in the country.</p> |
| <p>BTL E.P.</p> | <p>BTL E.P. is a public utility service provider for water supply systems and sanitation in the whole country. As the agency that supports GoTL in executing the national policy in the area of water and sanitation and its administration, they can contribute significantly to a wide scale adoption of water management and restoration technology provided that it will also improve the effectiveness of their water supply distribution service and efficient use of aquatic resources in the country.</p> |

| | |
|----------------------|--|
| MALFF | As the government agency responsible for managing forest, hydrological basins, and mangrove areas, MALFF holds a crucial role in water governance. Together with MPW, they can conduct strategic and policy level discussion at the ministerial level to accommodate the adoption of water management and restoration technology. Its National Directorate of management of forests, hydrological basins and mangrove areas will provide technical support in the process. |
| Permatil | Permatil is a leading actor in community-based water conservation that aims to restore the natural ecology of catchment areas, conserve water resources, and reduce the risk of natural disasters such as flood and landslides. As a local NGO with strong field presence, they can lend in extensive knowledge and valuable technical skills to help introduce methods for water conservation in target communities. They can also draw on years of field experience in maintaining a gender-balanced community-based natural resource management group. |
| Development Partners | There are few agencies in the country (<i>i.e.</i> , Water Aid, UNDP, Conservation International, IOM and others) that commit to strengthening water governance in the country. Tapping on their eligibility to access donor funds, they design projects, provide technical and financial support, and work with community groups to conduct field activities. These partners also emphasise gender balance in their country programmes; hence, their participation can further strengthen involvement of women in community-based natural resource management. |
| Simile | Simile is a private sector specialising in real-time weather, water, early warning, and climate data collection using scalable monitoring technologies. They have partnered up with various agencies to expand the water resources management network in the country. They can use their technical know-how to help monitor the effectiveness of various water restoration methods in recharging groundwater level. |

Table 8: List of responsible stakeholders for the implementation of water management and restoration

Timeline for the implementation of the actions and corresponding activities is presented in Table 10 below.

| Action | Activities | Year | | | | |
|---|--|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 1: Integration of water restoration plans in water management system | 1.1: <i>Assessment (and mapping) of sustainable water management and conservation in Timor-Leste</i> | X | X | | | |
| | 1.2: <i>Review of existing water consumption/use rules and regulations</i> | X | X | | | |
| | 1.3: <i>Public consultations on integration of water restoration in existing water management system</i> | | X | | | |

| | | | | | | |
|--|---|---|---|---|---|---|
| | 1.4. <i>Enforcement of updated rules and regulations</i> | | X | X | X | X |
| | 2.1: <i>Assessment of farmer's knowledge of water restoration methods</i> | X | X | | | |
| | 2.2: <i>Development of training materials</i> | | X | | | |
| | 2.3: <i>Implementation of FFS in demo plots and facilitating exchange visits</i> | | X | X | X | X |
| | 3.1. <i>Establish community groups for water conservation</i> | | X | | | |
| | 3.2: <i>Mapping out community water conservation groups and their respective supporting agency at suco/aldeia level</i> | X | X | | | |
| | 3.3: <i>Sharing/presenting the maps to potential donors</i> | | X | X | X | X |

Table 9: Timeline for the implementation of water management and restoration

1.1.3.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Costs (USD) |
|--|---|-------------|
| 1.1: <i>Assessment (and mapping) of sustainable water management and conservation in Timor-Leste</i> | Consultant fee | 50,000 |
| | Field visits | 20,000 |
| 1.2: <i>Review of existing water consumption/use rules and regulations</i> | | |
| 1.3: <i>Public consultations on integration of water restoration in existing water management system</i> | Consultant fee | 50,000 |
| | Field visits | 20,000 |
| 1.4. <i>Enforcement of updated rules and regulations</i> | Monitoring and enforcement of rules and regulations | 20,000 |
| 2.1: <i>Assessment of farmer's knowledge of water restoration methods</i> | Consultant fee | 50,000 |
| | Field visits | 20,000 |

| | | |
|---|--|----------------|
| 2.2: <i>Development of training materials</i> | Consultant fee | 50,000 |
| | Printing of training materials and manuals | 50,000 |
| 2.3: <i>Implementation of FFS in demo plots and facilitating exchange visits</i> | Training activities and exchange visits | 200,000 |
| 3.1. <i>Establish community groups for water conservation</i> | Coordination of meetings and groups activities | 15,000 |
| 3.2: <i>Mapping out community water conservation groups and their respective supporting agency at suco/aldeia level</i> | Consultations with water conservation groups in target areas | 20,000 |
| 3.3: <i>Sharing/presenting the maps to potential donors</i> | Coordination of meetings | 10,000 |
| Total cost | | 575,000 |

Table 10: Resources estimation for the implementation of actions and activities for water management and restoration

1.1.3.6 Management planning

Risks and Contingency Plans

The type of risks, description and contingency actions pertaining to TAP of water management and restoration technology are similar to the ones presented in Table 5. They consist of political, social and schedule risks and complemented with an additional risk on finance. The financial risk is related to termination of support from implementing agencies/donors due to lack of transparency and effectiveness in the project implementation. Designing and implementing a clear M&E plan to ensure that project stays on track is the recommended contingency action.

Next steps

| Immediate Requirements | Critical Steps |
|--|--|
| DG of Environment and NDCC and should organise a stakeholder's workshop to communicate the TAP | Get the stakeholders buy-in, specially from MPW, MALFF, and partners |
| MPW and MALFF to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MPW and MALFF's 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 11: List of next steps for the implementation of water management and restoration

1.1.3.7 TAP Overview table

| Sector | Sustainable land management (SLM) in agriculture | | | | | | | |
|--|---|-------------------|---------------------------------------|-----------|---|---|---|--------|
| Technology | Water management and restoration | | | | | | | |
| Ambition | Around 20,000 agricultural households who irrigate their land using surface water and underground water will adopt sustainable water management and restoration | | | | | | | |
| Benefits | Alleviating pressure on surface water and groundwater by limiting excessive withdrawal during dry season and allowing them to recharge during wet season | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget |
| 1: Integration of water restoration plans in water management system | 1.1: <i>Assessment (and mapping) of sustainable water management and conservation in Timor-Leste</i> | GCF/GoTL | Consultant, MALFF, BTL | 2024-2028 | Delays in recruiting qualified experts | In depth understanding of sustainable water management conservation | Level of analysis of data | 35,000 |
| | 1.2: <i>Review of existing water consumption/use rules and regulations</i> | GCF/GoTL | Consultant, MALFF, BTL | 2024-2028 | Delays in recruiting qualified experts | Strength and gaps of existing rules and regulations are identified | Level of analysis of data | 35,000 |
| | 1.3: <i>Public consultations on integration of water restoration in existing water management system</i> | GCF/GoTL | BTL, Suco | 2024-2028 | Limited participation from target beneficiary groups, gang conflict between youth groups, natural disasters | Male and female-headed agricultural households are convinced to adopt this technology | Number of participants disaggregated by gender; level of behavioural change | 70,000 |
| | 1.4: <i>Enforcement of updated rules and regulations</i> | GCF/GoTL | Suco | 2024-2028 | Lack of support from relevant actors due to political differences | Community members comply with rules and regulations | Level of monitoring and enforcement system | 20,000 |

| | | | | | | | | |
|---|---|----------|-----------------------------|-----------|---|---|---|---------|
| 2: Capacity building on various water restoration methods | 2.1. <i>Assessment of farmers' knowledge of water restoration methods</i> | GCF/GoTL | Consultant, MALFF, Permatil | 2024-2028 | Delays in recruiting qualified experts | All level of knowledge and capacity are captured in the assessment | Report on the extent of farmers' knowledge of the technology | 70,000 |
| | 2.2. <i>Development of training materials</i> | GCF/GoTL | Consultant, MALFF, Permatil | 2024-2028 | Delays in recruiting qualified experts, termination of supports from implementing agencies/donors | Training materials are effective, user friendly, and gender sensitive | The number of thematic areas covered by training materials, including the one on gender | 100,000 |
| | 2.3. <i>Implementation of FFS in demo plots and facilitating exchange visits</i> | GCF/GoTL | Consultant, MALFF, Permatil | 2024-2028 | Termination of supports from implementing agencies/donors | Farmers learn new techniques | Number of female participants; The level of knowledge/skill improvement post-training | 200,000 |
| 3: Connecting community groups with external support (donors and implementing agencies) | 3.1. <i>Establish community group for water conservation</i> | GCF/GoTL | MALFF | 2024-2028 | Limited participation from target beneficiary groups | Community groups are established and committed to work | Level of participation of community group members; Number of female group leaders/members | 15,000 |
| | 3.2. <i>Mapping out community water conservation groups and their respective supporting agency at suco/aldeia level</i> | GCF/GoTL | Consultant | 2024-2028 | Delays in recruiting qualified experts | A clear map of relationship between community groups and supporting agencies is developed | Level of analysis of data | 20,000 |

| | | | | | | | | |
|--|---|----------|-------------|-----------|--|--|---|--------|
| | 3.3. <i>Sharing/presenting the maps to potential donors</i> | GCF/GoTL | MALFF, suco | 2024-2028 | Limited participation from target beneficiary groups | Donors indicate interest to support community groups | Number of MoU and donor support programmer to the communities | 10,000 |
|--|---|----------|-------------|-----------|--|--|---|--------|

Table 12: TAP overview table for water management and conservation technology

1.1.4 Action plan for biochar

1.1.4.1 Introduction

Biochar refers to carbon-rich material, produced by pyrolysis or heating of organic biomass in the absence of oxygen, used as a soil amendment to improve soil fertility (da Costa et al., 2021). Sources of feedstock for biochar products are mainly from agricultural and forest biomass residue. Interest in biochar application in agriculture stems from the potential increase in crop productivity, soil health and climate change mitigation. Another advantage of biochar production is that it can be operated at various scales, making it suitable for smallholder farmers to adopt.

Since 2017, a collaborative research program to improve agricultural productivity and profitability in Timor-Leste between MALFF and partners (AI-Com and UNTL), supported by the Australian Centre for International Agricultural Research (ACIAR), has been using rice-hull biochar as the main type of biochar in their research across the country. Different biochar treatments⁸ have been used on rice, horticultural crops, legumes, and tubers during the dry and rainy seasons. Their research has concluded that treatment of rice-hull biochar with other materials (organic and inorganic) has shown large positive responses with a greater economic return from the horticultural crops in some plots.

To date, the application of biochar is still limited to research purposes. As more research programmes start to explore the potential benefits of biochar for Timor-Leste's agriculture, it is crucial to take a look at actions that can break barriers for wide-scale adoption and deployment of this technology.

1.1.4.2 Ambition for the TAP

The 2019 Agriculture Census reports that only 8,468 agriculture households holding across Timor-Leste use fertilisers. As the census does not disaggregate the data based on municipalities and gender, it is difficult to identify the targets. However, it can be assumed that farmers in the six (6) target municipalities for CA & CR (i.e. Ermera, Baucau, Viqueque, Aileu, Ainaro, and Bobonaro) can also be considered as potential target groups for this technology. The reason being organic fertilisers such as biochar has become an integral part of CA practices in the country as it can serve as mulch, fertilising the soil and retaining its humidity. Hence, the target for the adoption of biochar technology by 2030 in the six municipalities is like that of CA & CR which is around 25,000 agricultural households.⁹ Around 46% of the beneficiaries are female-headed agriculture households.

Biochar is a way of turning a waste product into an effective soil amendment that neutralises acid soils and makes nutrients in the soil available to the crops. Its application has a significant impact on reducing the level of acidity in soils and increasing the level of phosphorus for crops. This in turn can boost crop productivity by 30%. Hence, it contributes to achieving Timor-Leste's National Food and Nutrition Security Policy which envisions that by 2030 the country carefully manages its agro-ecosystem to significantly improve and increase food production.

⁸ Treatments consisted of rice-hull biochar, combining rice-hull biochar with animal manure as well as combining rice-hull biochar with inorganic fertilisers (N, P and K).

⁹ This is almost four times higher than the number of fertiliser users reported in the 2019 Agriculture Census.

1.1.4.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

The primary barrier lies in the high costs and time-intensive nature of gathering raw materials like wood shavings, coffee husks, and rice husks in large quantities. Also, the biochar market in Timor-Leste remains underdeveloped because farmers lack awareness of its agricultural benefits, resulting in a lack of demand. Additionally, limited information on biochar production and its advantages for farmers serves as a significant barrier, compounded by a lack of expertise in biochar production techniques. Furthermore, the scarcity of specific organic materials for biochar production restricts access, mainly benefiting individuals in industries such as carpentry, coffee production, and rice farming.

To address these barriers, the first step is to enhance farmers' access to capital through avenues like micro-loans and grants. This financial support can help farmers invest in mobile and immobile assets, boosting production quality and quantity. Conducting a market assessment for biochar production comes next, aiding farmers in deciding whether to adopt the technology and determining their scale of production. Providing information on production techniques and benefits aims to create awareness through various platforms, conveying research findings, best practices, and success stories to the target audience. Lastly, training farmers in biochar production methods aims to fill the capacity gap in farming communities in Timor-Leste.

b. Action selected for inclusion in the TAP

The following list of actions Table 14 are developed using enabling measures proposed in the BAEF report on biochar. They are considered to be the most feasible, contextualised and cost-effective actions that can contribute to tackling barriers for the wide scale adoption and deployment of the corresponding technology.

| Actions | Activities |
|--|--|
| <p>Action 1: Expansion of research on biochar</p> <p>Expanding R&D in biochar in Timor-Leste offers various benefits. Firstly, it provides opportunity for collaboration between line ministries (MALFF and MPW) and academia/research institutions to explore different biochar techniques through a scientific approach and identify the ones that suit Timor-Leste's context. Additionally, findings and recommendations from the research will be a basis for developing local biochar markets.</p> | <p>Activity 1.1: <i>Consultation and mapping out relevant stakeholders (i.e. donors, research institutes, academia, and beneficiary groups)</i></p> <p>Activity 1.2: <i>Development of research plans and implementation of research activities</i></p> <p>Activity 1.3: <i>Dissemination of research findings</i></p> |
| <p>Action 2: Biochar campaign at national and local level</p> <p>Investment in education and awareness raising campaigns at national and local level to increase farmers' access to credible information and improve their knowledge of the technology. It can be realised through establishing new platforms or using existing ones to disseminate information on research findings, best practices, and success stories to target groups. It can also clarify doubts and preconceived notions that might exist.</p> | <p>Activity 2.1: <i>Development of biochar campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i></p> <p>Activity 2.2: <i>Dissemination of biochar as alternative fertiliser in target sucos</i></p> |

| | |
|---|--|
| <p>Action 3: Capacity building on the production of biochar</p> <p>Investment in educational and awareness raising campaigns at national and local level can improve farmers’ access to credible information as well as increasing their knowledge of biochar production technique and its benefits as organic fertiliser. This measure can capitalise on new or existing media platforms to disseminate information on research findings, best practices, and success stories to target groups. There should be a quota for both male and female participants in training and related activities. Moreover, training modules should be gender-sensitive, acknowledging different roles attributed to male and female farmers.</p> | <p><i>Activity 3.1: Assessment of farmers’ knowledge of biochar production</i></p> <p><i>Activity 3.2: Development of training materials for biochar production by rice miller and coffee producers</i></p> <p><i>Activity 3.3: Implementation of FFS on biochar production in selected sites</i></p> |
| <p>Action 4: Market research and development for biochar production</p> <p>While the use of charcoal in agriculture is known to some farmers, there is no market for biochar in the country. Nevertheless, research on this technology and its effectiveness in increasing agriculture production coupled with extensive campaigns can pave the way for the development of a market. Further studies which assess biochar’s demand and supply at the national or municipality level can help inform farmers about where potential suppliers of raw materials and buyers of the final products are. The information will help them decide on whether to invest in the technology and the scale of production that they would like to reach as well as providing them with a rough estimate of their profit margins.</p> | <p><i>Activity 4.1: Mapping out biochar producers, potential sources of raw material, buyers, and consignment stores</i></p> <p><i>Activity 4.2: Information dissemination to each target group (i.e., producer, supplier of raw materials, buyers, and stores)</i></p> <p><i>Activity 4.3: Facilitate farmers with the establishment of collection system for raw materials</i></p> <p><i>Activity 4.4: Facilitate the distribution system to consignment stores and/or buyers/users</i></p> <p><i>Activity 4.5: Business and marketing training for target group</i></p> |
| <p>Action 5: Facilitate smallholder farmers’ access to capital</p> <p>Farmers in Timor-Leste, especially the ones residing in rural areas, are not aware of different micro-loan services available in the country apart from the saving-and-loan group/cooperatives. This can be the result of limited information in the municipalities as well as low level of literacy among the farmers groups. Additionally, access to loan services is very limited to women who generally do not possess the right types of assets (<i>i.e.</i>, immobile property such as land) to pledge as collateral. Facilitating smallholder farmers’ access to financial services in the country is an important step to enable them to acquire capital. Farmers can use the capital to invest in mobile (<i>i.e.</i>, mini trucks, motor bikes and tools/equipment) and immobile assets (<i>i.e.</i>, land and mini warehouse) which can be used to increase quality and quantity of their production.</p> | <p><i>Activity 5.1: Conducting assessment and surveys of smallholder farmer’s accessibility to financial services in Timor-Leste</i></p> <p><i>Activity 5.2: Organising information session between local financial service providers and target smallholder farmers</i></p> <p><i>Activity 5.3: Establishing help desks to assist smallholder farmers with application for loans and/or formation of saving-and-loan group</i></p> |

Table 13: List of actions and activities for the implementation of biochar

Actions 1, 2, and 3 are to be included in the PI for the TAP under sector 1 provided that their activities are closely interlinked. Together, they can pave the way for a wide scale introduction and adoption of biochar in Timor-Leste. The other two actions (i.e. 4 and 5) are not suitable at this stage when biochar technology is not well-known and under-studied.

1.1.4.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 15 play crucial roles in the implementation of actions and corresponding activities for the TAP for biochar technology in the country.

| Stakeholder | Roles |
|--|---|
| MALFF- Directorate General of Agriculture | As the government agency responsible for the agriculture sector in the country, MALFF-DGA plays a big role in introducing technologies that can increase food production. DGA, in collaboration with Directorate General of Cooperation and Institutional Development (DGCID) provides essential services such as formulation of policies and programmes, ensuring collection of reliable data, and managing capacity building for farmers, to mention a few. MALFF can conduct strategic and policy level discussion at the Council Ministry level to accommodate the wide scale adoption and deployment of biochar. |
| AI-Com | AI-Com, a collaborative research program improving agricultural productivity and profitability in Timor-Leste between MALFF, UNTL, World Vision Timor-Leste and the University of Western Australia, has been conducting biochar research in Timor-Leste since 2018. The programme is supported by the Australian Centre for International Agricultural Research (ACIAR) Hence, the programme can tap on its existing resources to continue paving the way for a wide-scale introduction and adoption of biochar in Timor-Leste through collaborative research and capacity building. |
| UNTL | UNTL, a public university in Timor-Leste, is part of AI-Com’s collaborative research program. It brings in expertise in research and agriculture techniques to further expand research on biochar in the country. |
| Development Partners | There are few agencies in the country (i.e., World Vision and ACIAR) that commit to strengthening agriculture research and development. Tapping on their eligibility to access donor funds, they design projects, provide technical and financial support, and work with national agencies and community groups to conduct field activities. These partners also emphasise gender balance in their country programmes; hence, their participation can further strengthen involvement of women in community-based natural resource management. |

Table 14: List of responsible stakeholders for the implementation of biochar

Timeline for the implementation of the actions and corresponding activities is presented in Table 16 below.

| Action | Activities | Year | | | | |
|--|--|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 1: Expansion of research on biochar | 1.1: Consultation and mapping out relevant stakeholders (i.e. donors, research institutes, academia, and beneficiary groups) | X | | | | |
| | 1.2: Development of research plans and implementation of research activities | X | X | X | | |
| | 1.3: Dissemination of research findings | | X | X | X | |
| 2: Biochar campaign at national and local level | 2.1: Development of biochar campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies | | X | | | |
| | 2.2: Dissemination of biochar as alternative fertiliser in target sucros | | X | X | X | X |
| 3: Capacity building on the production of biochar | 3.1: Assessment of farmers' knowledge of biochar production | | X | | | |
| | 3.2: Development of training materials for biochar production by rice miller and coffee producers | | X | X | X | X |
| | 3.3: Implementation of FFS on biochar production in selected sites | | X | X | X | X |

Table 15: Timeline for the implementation of biochar

1.1.4.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Costs (USD) |
|--|--|-------------|
| 1.1: Consultation and mapping out relevant stakeholders (i.e. donors, research institutes, academia, and beneficiary groups) | Hiring consultants | 20,000 |
| | Consultation in target areas | 30,000 |
| 1.2: Development of research plans and implementation of research activities | Logistics arrangements for research activities | 200,000 |
| 1.3: Dissemination of research findings | Dissemination of information in target areas | 60,000 |

| | | |
|---|--|------------------|
| 2.1: <i>Development of biochar campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | Development of campaign materials | 50,000 |
| | Printing/publication of campaign materials | 200,000 |
| 2.2: <i>Dissemination of biochar as alternative fertiliser in target sucos</i> | Socialisation in target areas | 100,000 |
| 3.1: <i>Assessment of farmers' knowledge of biochar production</i> | Farmers' knowledge assessment | 50,000 |
| 3.2: <i>Development of training materials for biochar production by rice miller and coffee producers</i> | Development of training modules | 50,000 |
| | Printing of modules and handbooks | 200,000 |
| 3.3: <i>Implementation of FFS on biochar production in selected sites</i> | Implementation of FFS in target areas | 400,000 |
| Total cost | | 1,360,000 |

Table 16: Resources estimation for the implementation of actions and activities from biochar

1.1.4.6 Management planning

Risks and Contingency Plans

The type of risks, description, and contingency actions pertaining to TAP of biochar technology are similar to the ones presented in Table 5. They consist of political, social, schedule, and financial risks.

Next steps

| Immediate Requirements | Critical Steps |
|--|---|
| DG of Environment and NDCC and should organise a stakeholder's workshop to communicate the TAP | Get the stakeholders buy-in, specially from MALFF and partners (<i>i.e.</i> , UNTL, ACIAR, World Vision TL etc.) |
| MALFF to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MALFF's 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 17: List of next steps for the implementation of biochar

1.1.4.7 TAP Overview table

| Sector | Sustainable land management (SLM) in agriculture | | | | | | | |
|---|---|-------------------|--|-----------|---|---|--|---------|
| Technology | Biochar/biochar | | | | | | | |
| Ambition | Around 2,000 agriculture households who are dependent on inorganic fertiliser will add biochar into their fertiliser use | | | | | | | |
| Benefits | Restoring soil nutrients, provision of affordable organic fertiliser in the long run | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point (Stakeholders & Roles) | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget |
| 1: Expansion of research on biochar | 1.1: <i>Consultation and mapping out relevant stakeholders (i.e. donors, research institutes, academia, and beneficiary groups)</i> | GCF/GoTL | Consultant | 2024-2028 | Delays in recruiting qualified experts | A clear map of relevant actors is developed; actors' roles/responsibilities are well-understood | Level of analysis of data | 50,000 |
| | 1.2: <i>Development of research plans and implementation of research activities</i> | GCF/GoTL | MALFF, AI COM, UNTL | 2024-2028 | Termination of supports from implementing agencies/donors | Research findings are verifiable | Level of relevance of research findings and recommendations | 200,000 |
| | 1.3: <i>Dissemination of research findings</i> | GCF/GoTL | MALFF, AI COM, UNTL | 2024-2028 | Gang conflict between youth groups, Natural disasters, limited participation from target beneficiary groups | Target sucos learn about biochar and are convinced about its effectiveness | Number of people adopting biochar techniques disaggregated by gender | 60,000 |
| 2: Biochar campaign at national and local level | 2.1: <i>Development biochar campaign materials (leaflet, videos, radio shows,</i> | GCF/GoTL | MALFF, AI COM, UNTL | 2024-2028 | Delays in recruiting qualified experts | Campaigns materials are effective in conveying the message | Variety of campaign materials | 250,000 |

| | | | | | | | | |
|--|--|----------|--|-----------|---|--|---|---------|
| | <i>plays) based on findings from research/studies</i> | | | | | | | |
| | 1.2: <i>Dissemination of biochar as alternative fertiliser in target sucos</i> | GCF/GoTL | MALFF, AI COM, UNTL | 2024-2028 | Gang conflict between youth groups, natural disasters, limited participation from target beneficiary groups | Target sucos learn about biochar and are convinced about its effectiveness | Number of people adopting biochar techniques disaggregated by gender | 100,000 |
| 1003: Capacity building on the production of biochar | 3.1: <i>Assessment of farmers' knowledge of biochar production</i> | GCF/GoTL | Consultant, MALFF, AI COM, UNTL | 2024-2028 | Limited participation from target beneficiary groups | All level of knowledge and capacity are captured in the assessment | Report on the extent of farmers' knowledge of biochar technology | 50,000 |
| | 3.2: <i>Development of training materials for biochar production by rice miller and coffee producers</i> | GCF/GoTL | Consultant, MALFF, AI COM, UNTL | 2024-2028 | Delays in recruiting qualified experts; Termination of supports from implementing agencies/donors | Training materials are effective, user friendly, and gender-sensitive | The number of thematic areas covered in training materials including the one on gender | 250,000 |
| | 3.3: <i>Implementation of FFS on biochar production in selected sites</i> | GCF/GoTL | Consultant, MALFF, AI COM, UNTL, farmers Consultant, MALFF, AI COM, UNTL, farmers | 2024-2028 | Limited participation from target beneficiary groups | Farmers learn new techniques | Number of participants disaggregated by gender; The level of improvement of knowledge/skill post-training | 400,000 |
| 4: Market research and development for | 4.1: <i>Mapping out biochar producers, potential sources of</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from | A clear map showing all actors is developed | Level of analysis of data | 20,000 |

| | | | | | | | | |
|---------------------------|--|----------|-------------------|-----------|---|---|--|--------|
| biochar production | <i>raw material, buyers, and consignment stores</i> | | | | target beneficiary groups | and their relationship is well-understood | | |
| | <i>4.2: Information dissemination to each target group (i.e., producer, supplier of raw materials, buyers, and stores)</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | Target groups are well aware about biochar market | Number of producers, suppliers, consignment stores, and sales | 20,000 |
| | <i>4.3: Facilitate farmers with the establishment of collection system for raw materials</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | A collection system is up and running | Number of collection system; frequency of operation | 80,000 |
| | <i>4.4: Facilitate the distribution system to consignment stores and/or buyers/users</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | Products are sold in stores/markets | Number of sales in a given period | 80,000 |
| | <i>4.5: Business and marketing training for target group</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups; termination of supports from implementing agencies/donors | Target groups' knowledge and skills are improved | Number of participants disaggregated by gender; Level of knowledge and skill post-training | 50,000 |
| 5: Facilitate smallholder | <i>5.1: Conducting assessment and surveys of</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Delays in recruiting qualified experts | Survey's findings help improve farmers' | The depth of analysis of | 30,000 |

| | | | | | | | | |
|----------------------------|--|----------|-------------------|-----------|--|--|---|--------|
| farmers' access to capital | <i>smallholder farmer's accessibility to financial services in Timor-Leste</i> | | | | | access to financial services | assessment and survey data | |
| | <i>5.2: Organising information session between local financial service providers and target smallholder farmers</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | More farmers know about difference micro loan and financial services | Number of participants disaggregated by gender; Level of improvement of understanding | 10,000 |
| | <i>5.3: Establishing help desks to assist smallholder farmers with application for loans and/or formation of saving-and-loan group</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | More farmers can access micro loan and financial services; More female-headed agricultural household have access micro loan and financial services | Number of farmers who access financial services disaggregated by gender | 10,000 |

Table 18: TAP overview table for biochar technology

1.1.5 Action plan for composting

1.1.5.1 Introduction

Composting is the natural process of biological decomposition and stabilisation of organic waste which turns organic materials such as crop residues and other wastes with animal manures into humus (Oppliger & Duquenne, 2016; Dollhofer & Zettl, 2017; UNDP, 2020). Its final product comes in the form of cheap and effective organic mulch that can be used as an alternative to commercial fertilisers to improve the soil nutrient status and other properties. Nutrient recycling embedded in the concept of composting supports the idea of transitioning to a circular economy, which is currently being discussed in many international circles (Hettiarachchi et al., 2020).

A 2013 data from ADB estimates that the 352,553 inhabitants of the capital city, Dili, generates around 250 tons of waste. Only about 55% of it is disposed of in the dump site while the rest are dumped into rivers, sea, burned and buried. Organic waste constitutes 98% of the municipal waste (Ximenes & Maryono, 2021). Although there is no available literature on the practice of composting or other technology in Timor-Leste, it is safe to say the practice is still not common at household level due to various reasons, including lack of space, proper knowledge, incentives. Nevertheless, there are a few youth-led organisations in Timor-Leste that have tapped into the composting market, producing humus to supply local demand. One of them is TILOFE which started its operation in 2018. Their annual humus production level has reached up to 65 tons. It is worth exploring actions and activities that can break barriers for the adoption of this technology in Timor-Leste.

1.1.5.2 Ambition for the TAP

Target group for composting technology is the same as that of biochar. Farmers can use both technologies as alternative fertilisers. The target group consists of around 25,000 from a total of 45,000 agricultural households in Ermera, Baucau, Viqueque, Aileu, Ainaro, and Bobonaro reported in the 2019 Agriculture Census to practise unsustainable farming technique (land tillage). This figure is almost four times higher than the number of fertiliser users reported in the 2019 agriculture census.¹⁰ Around 46% of the target beneficiary is female-headed agriculture households.,

Composting is a natural process of recycling organic matter, such as leaves and food scraps that can turn into organic and natural fertilisers to enrich and replenish the soil. Apart from that, recycling organic waste into compost conserves water to avoid shortage of water resources during prolonged droughts caused by climate change. In doing so, this technology can contribute to Timor-Leste's effort to improve soil fertility and conserve water which are highlighted in the National Adaptation Plan (NAP).

1.1.5.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

One of the primary barriers to the adoption of this technology is the initial high costs and time-consuming nature of compost production, making it less attractive to farmers. Another barrier is the space required for compost production, as it is more feasible in larger spaces to handle the decomposition of significant amounts of organic material and avoid potential issues such as unpleasant odours. The third barrier involves the lack of market information regarding compost, which hinders farmers from expanding production and engaging in off-farm sales due to inadequate guidance. Lastly, inadequate integration of composting in urban waste management systems discourages households from separating organic waste from non-organic materials.

¹⁰ Only 8,468 agriculture households use fertilisers. This is roughly 6% of the total agriculture household listed in the 2019 agriculture survey.

Measures to overcome these barriers consist of facilitating farmer’s access to capital, conducting market assessment on compost, information dissemination, and proper integration of waste separation into urban waste management.

b. Action selected for inclusion in the TAP

The list of actions in Table 20 is derived from enabling measures proposed in the BAEF report on composting technology. They were developed based on the fact that they are the most feasible, contextualised and cost-effective actions that address barriers for the wide scale adoption and deployment of the corresponding technology.

| Actions | Activities |
|--|---|
| <p>Action 1: Campaign on compost at national and local level</p> <p>Investment in education and awareness raising campaigns at national and local level to increase farmers’ access to credible information and improve their knowledge of the technology. It can be realised through establishing new platforms or using existing ones to disseminate information on research findings, best practices, and success stories to target groups. It can also clarify doubts and preconceived notions that might exist.</p> | <p>Activity 1.1: <i>Developing composting campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i></p> <p>Activity 1.2: <i>Information dissemination on composting as alternative fertiliser in target sucos</i></p> <p>Activity 1.3: <i>Distribution of organic compost bin</i></p> |
| <p>Action 2: Capacity building on composting techniques</p> <p>Investment on capacity building at national and local level can enhance farmers’ knowledge and skills in the application of compost production techniques that is affordable, efficient, and practical. This can be realised through close collaboration with different actors such as technical staff from MALFF, research agencies, and farmers. It can draw lessons learned and references from existing research and field activities that have already started in the country in the last 10 years. There should be a quota for both male and female participants in training and related activities. Moreover, training modules should be gender-sensitive, acknowledging different roles attributed to male and female farmers.</p> | <p>Activity 2.1: <i>Assessment (Pre-test) of farmers’ knowledge of composting technique</i></p> <p>Activity 2.2: <i>Development of training materials for composting</i></p> <p>Activity 2.3: <i>Implementation of FFS on different composting techniques in demo plots</i></p> |
| <p>Action 3: Market research and development for compost production</p> <p>Although the use of compost in agriculture is common in Timor-Leste, there are limited studies on the compost market. Existing research is mostly limited to the effectiveness of this technology in increasing agriculture production. Studies which assess compost’s demand and supply at the national or municipality level</p> | <p>Activity 3.1: <i>Mapping out compost producers, potential sources of raw material, buyers, and consignment stores)</i></p> <p>Activity 3.2: <i>Information dissemination to each target group (i.e., producer, supplier of raw materials, buyers, and stores)</i></p> <p>Activity 3.3: <i>Facilitate the establishment of a collection system for raw materials at</i></p> |

| | |
|---|---|
| <p>can help inform farmers about where potential suppliers of raw materials, buyers of the final products, and consignment stores are. The information will help them decide on whether to invest in the technology and the scale of production that they would like to reach as well helping them estimate the profit margins.</p> | <p><i>household and communal level (i.e., residential areas, schools, offices, markets, restaurants, etc.)</i></p> <p><i>Activity 3.4: Facilitate the distribution system to consignment stores and/or buyers/users</i></p> |
| <p>Action 4: Facilitate smallholder farmers’ access to capital</p> <p>Farmers in Timor-Leste, especially the ones residing in rural areas, are not aware of different micro-loan services available in the country apart from the saving-and-loan group/cooperatives. This can be the result of limited information in the municipalities as well as low level of literacy among the farmers groups. Additionally, access to loan services is very limited to women who generally do not possess the right types of assets (<i>i.e.</i>, immobile property such as land) to pledge as collateral. Facilitating their access to financial services in the country is an important step to enable them to acquire capital. Farmers can use the capital to invest in mobile (<i>i.e.</i>, mini trucks, motor bikes and tools/equipment) and immobile assets (<i>i.e.</i>, land and mini warehouses) which can be used to increase quality and quantity of their production.</p> | <p><i>Activity 4.1: Conducting assessment and surveys of smallholder farmer’s access to financial services in Timor-Leste</i></p> <p><i>Activity 4.2: Organising information session between local financial service providers and target smallholder farmers</i></p> <p><i>Activity 4.3: Establishing help desks to assist smallholder farmers with application for loans and/or formation of saving-and-loan group</i></p> <p><i>Activity 4.4: Providing business plan trainings to farmers</i></p> |

Table 19: List of actions and activities for the implementation of composting

The closely interlinked actions 1 and action 3 are to be included in the PI for the TAP under sector 1. When combined, they provide a strong basis for a wide scale adoption and deployment of these technologies at both household and market level. At the household level, action 1 can boost behavioural change through the practice of waste segregation which is a great starting point in developing a compost market in the country. Action 3 directly responds to the need to understand the dynamic between demand and supply of compost products in the country prior to developing a market for it.

1.1.5.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 21 play crucial roles in the implementation of actions and corresponding activities for the TAP for composting in Timor-Leste.

| Stakeholder | Roles |
|---|--|
| MALFF- Directorate General of Agriculture | As the government agency responsible for the agriculture sector in the country, MALFF-DGA plays a big role in introducing technologies that can increase food production. DGA, in collaboration with Directorate General of Cooperation and Institutional Development (DGCID) provides essential services such as formulation of policies and programmes, ensuring collection of reliable data, and managing capacity building for farmers, to mention a few. MALFF can conduct strategic and policy level discussion at the Council Ministry level to accommodate the wide scale adoption and deployment of composting. |

| | |
|---------------------|---|
| AI-Com | AI-Com, a collaborative research program improving agricultural productivity and profitability in Timor-Leste between MALFF, UNTL, World Vision Timor-Leste and the University of Western Australia, has been conducting composting research in Timor-Leste since 2018. The programme is supported by the Australian Centre for International Agricultural Research (ACIAR). Hence, the programme can tap on its existing resources to continue paving the way for a wide-scale introduction and adoption of organic fertilisers in Timor-Leste through collaborative research and capacity building. |
| UNTL | UNTL, a public university in Timor-Leste, is part of AI-Com’s collaborative research program. It brings in expertise in research and agriculture techniques to further expand research on organic fertilisers in the country. |
| TILOFE | Specialising in agribusiness, LIFE is a small-scale, youth-led organisation that has been operating in compost production and agrotourism since 2020. Their business model aims to improve the livelihood of local residents, especially youth who work in the collection of raw material, production and distribution. TILOFE has been supplying composts to various customers, including the national Forestry Directorate and households in Dili. |
| Development Partner | There are few agencies in the country (<i>i.e.</i> , WFP, FAO, World Vision and ACIAR) that commit to strengthening agriculture research and development. Tapping on their eligibility to access donor funds, they design projects, provide technical and financial support, and work with national agencies and community groups to conduct field activities. These partners also emphasise gender balance in their country programmes; hence, their participation can further strengthen involvement of women in community-based natural resource management. |

Table 20: List of responsible stakeholders for the implementation of composting

Timeline for the implementation of the selected actions and their corresponding activities is presented in Table 22 below.

| Action | Activities | Year | | | | |
|--|--|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 1: Campaign on compost at national and local level | 1.1: <i>Developing composting campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | X | X | | | |
| | 1.2: <i>Dissemination of composting as alternative fertiliser in target sucos</i> | X | X | X | X | X |
| | 1.3: <i>Distribution of organic compost bin</i> | X | X | X | X | X |
| 3: Market research and development for compost production | 3.1: <i>Mapping out compost producers, potential sources of raw material, buyers, and consignment stores)</i> | | | X | | |

| | | | | | | |
|--|---|--|--|---|---|---|
| | 3.2: <i>Information dissemination to each target group (i.e., producer, supplier of raw materials, buyers, and stores)</i> | | | X | X | X |
| | 3.3: <i>Facilitate the establishment of a collection system for raw materials at household and communal level (i.e., residential areas, schools, offices, markets, restaurants, etc.)</i> | | | X | X | X |
| | 3.4: <i>Facilitate the distribution system to consignment stores and/or buyers/users</i> | | | X | X | X |

Table 21: Timeline for the implementation of composting

1.1.5.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Costs (USD) |
|---|--|----------------|
| 1.1: <i>Developing composting campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | Development of campaign materials | 50,000 |
| | Printing/publication of campaign materials | 50,000 |
| 1.2: <i>Information dissemination on composting as alternative fertiliser in target sucos</i> | Information dissemination in target areas | 60,000 |
| 1.3: <i>Distribution of organic compost bin</i> | Procurement of compost bins | 90,000 |
| 3.1: <i>Mapping out compost producers, potential sources of raw material, buyers, and consignment stores)</i> | Mapping activity | 30,000 |
| 3.2: <i>Information dissemination to each target group (i.e., producer, supplier of raw materials, buyers, and stores)</i> | Information dissemination in target areas | 50,000 |
| 3.3: <i>Facilitate the establishment of a collection system for raw materials at household and communal level (i.e., residential areas, schools, offices, markets, restaurants, etc.)</i> | Establishment of collection system for raw materials | 20,000 |
| | Transportation service for collection system | 200,000 |
| 3.4: <i>Facilitate the distribution system to consignment stores and/or buyers/users</i> | Establishing distribution system in local market | 10,000 |
| Total cost | | 560,000 |

Table 22: Resources estimation for the implementation of actions and activities for composting

1.1.5.6 Management planning

Risks and Contingency Plans

The type of risks, description and contingency actions pertaining to TAP of composting technology are similar to the ones presented in Table 5. They consist of political, social, schedule, and financial risks.

Next steps

| Immediate Requirements | Critical Steps |
|--|---|
| DG of Environment and NDCC and should organise a stakeholder's workshop to communicate the TAP | Get the stakeholders buy-in, specially from MALFF, MSA and partners (<i>i.e.</i> , WFP, UNTL, ACIAR, World Vision TL etc.) |
| MALFF and MSA to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MALFF and MSA's 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 23: List of next steps for the implementation of composting

1.1.5.7 TAP Overview table

| Sector | Sustainable land management (SLM) in agriculture | | | | | | | |
|--|--|-------------------|--|-----------|---|---|---|---------|
| Technology | Composting | | | | | | | |
| Ambition | Around 2,000 agriculture households who are dependent on inorganic fertiliser will add compost to their fertiliser | | | | | | | |
| Benefits | Improving the soil nutrient, reducing the issue of municipality waste, and supporting the transition to a circular economy | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point (Stakeholders & Roles) | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget |
| 1: Campaign on compost at national and local level | 1.1. <i>Developing composting campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | GCF/GoTL | Consultant, MSA | 2024-2028 | Delays in recruiting qualified experts | Campaigns materials are effective in conveying the message | Variety of campaign materials | 100,000 |
| | 1.2. <i>Information dissemination on composting as alternative fertiliser in target sucos</i> | GCF/GoTL | Consultant, MSA | 2024-2028 | Gang conflict between youth groups, Natural disasters; Limited participation from target beneficiary groups | Target sucos learn about composting and are convinced about its effectiveness | Number of people being aware of CA technology disaggregated by gender | 60,000 |
| | 1.3. <i>Distribution of organic compost bin</i> | GCF/GoTL | Consultant, MSA | 2024-2028 | Limited participation from target beneficiary groups | Target suco start to segregate waste, especially organic waste | Number of households that start composting disaggregated by gender | 90,000 |
| 2: Capacity building on composting techniques | 2.1. <i>Assessment (Pre-test) of farmers' knowledge of composting techniques</i> | GCF/GoTL | Consultant, MALFF, AI COM, UNTL | 2024-2028 | Limited participation from target beneficiary groups | Farmers' pre-test knowledge is well understood | Level of data analysis | 30,000 |

| | | | | | | | | |
|---|---|----------|--|-----------|--|---|---|---------|
| | 2.2. <i>Development of training materials for composting</i> | GCF/GoTL | Consultant, MALFF, AI COM, UNTL | 2024-2028 | Limited participation from target beneficiary groups | Training materials are effective, user friendly, and gender sensitive | The number of thematic areas covered in training materials, including the one on gender | 50,000 |
| | 2.3. <i>Implementation of FFS on different composting techniques in demo plots</i> | GCF/GoTL | Consultant, MALFF, AI COM, UNTL, farmers | 2024-2028 | Limited participation from target beneficiary groups | Farmers learn new techniques | Number of participants disaggregated by gender; The level of knowledge/skill improvement post-training | 100,000 |
| 3: Market research and development for compost production | 3.1: <i>Mapping out compost producers, potential sources of raw material, buyers, and consignment stores)</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | A clear map showing all actors is developed and their relationship is well-understood | Level of analysis of data | 30,000 |
| | 3.2: <i>Information dissemination to each target group (i.e., producer, supplier of raw materials, buyers, and stores)</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | Target groups are aware about biochar market | Number of producers (disaggregated by gender); Number of suppliers; Number of consignment stores; Number of sales | 50,000 |
| | 3.3: <i>Facilitate the establishment of a collection system for raw materials at household and communal level (i.e., residential areas, schools, offices,</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | A collection system is up and running | Number of collection system; frequency of operation | 220,000 |

| | | | | | | | | |
|--|---|----------|-------------------|-----------|--|--|---|--------|
| | <i>markets, restaurants, etc.)</i> | | | | | | | |
| | <i>3.4: Facilitate the distribution system to consignment stores and/or buyers/users</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | Products are sold in stores/markets | Number of sales in a given period | 10,000 |
| 4: Facilitate smallholder farmers' access to capital | <i>Activity 4.1. Conducting assessment and surveys of smallholder farmer's access to financial services in Timor-Leste</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Delays in recruiting qualified experts | Survey's findings help improve farmers' access to financial services | The depth of analysis of assessment and survey data | 30,000 |
| | <i>Activity 4.2. Organising information session between local financial service providers and target smallholder farmers</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | More farmers know about difference micro loan and financial services | Number of participants disaggregated by gender; Level of understanding improved | 10,000 |
| | <i>Activity 4.3. Establishing help desks to assist smallholder farmers with application for loans and/or formation of saving-and-loan group</i> | GCF/GoTL | Consultant, MALFF | 2024-2028 | Limited participation from target beneficiary groups | More farmers can access micro loan and financial services | Number of farmers who access financial services disaggregated by gender | 20,000 |

| | | | | | | | | |
|--|--|----------|------------|-----------|--|--|---|--------|
| | 4.4: <i>Providing business plan trainings to farmers</i> | GCF/GoTL | Consultant | 2024-2028 | Delays in recruiting qualified experts | Survey's findings help improve farmers' access to financial services | The depth of analysis of assessment and survey data | 80,000 |
|--|--|----------|------------|-----------|--|--|---|--------|

Table 24: TAP overview table for composting technology

1.2 Project Ideas for SLM in Agriculture Sector

1.2.1 Brief summary of the project ideas for SLM in agriculture sector

According to the 2019 Agricultural Census, around 66% of Timorese families depend heavily on agriculture. The country's agricultural landscape is mostly characterised by subsistence farming, with staple crops such as maize, rice, cassava, sweet potatoes, and diverse vegetables grown in different agro-ecological zones. Despite being the main source of livelihood to many Timorese, especially those residing in rural areas, the development of the agriculture sector in Timor-Leste still faces numerous challenges mainly due to limited access to modern farming techniques, inadequate infrastructure, land degradation, and vulnerability to climate change. Moreover, traditional agriculture practices have led to deforestation and soil degradation.

There have been ongoing efforts to address these challenges. The Ministry of Agriculture, Livestock, Fisheries and Forestry (MALFF), in collaboration with development partners, has taken steps to support low-income smallholder farmers by helping them manage risks and adopt effective climate change adaptation strategies. One crucial step is the introduction of CSA practices and technologies that incorporate sustainable natural resource management. To maintain this momentum, the proposed project idea for implementation of Timor-Leste's TAP in Sustainable Land Management in Agriculture Sector is centred on CSA-related technologies. The project "Scaling up Climate Smart-Agriculture (CSA) practices in Timor-Leste" combines selected actions and activities from the four relevant technologies. They are highly interconnected and are proved to be more effective when implemented as a package deal rather than as an individual project.

1.2.2 Specific project Idea

1.2.2.1 Specific Project Idea: Scaling up Climate Smart-Agriculture (CSA) practices in Timor-Leste

| | |
|--------------------------|---|
| Introduction /Background | <p>Based on the 2019 Agricultural Census, around 141,141 Timorese families' lives depend on agriculture. This is equivalent to 66% of the total number of households in the country. Around 15% agricultural household holdings are female-led. The farming system is based on shifting cultivation and shallow soils characterise the terrain. Agriculture productivity is low due to limited access to and adoption of production increasing technologies, the use of low-quality seeds and fertilisers, limited supply of irrigation, and poor soil conditions. Climate change is anticipated to have the biggest negative impact on agriculture, reducing agricultural productivity. It is imperative that alternative farming practices that are sustainable, climate resilient and adaptable to local context be introduced.</p> <p>Many literatures highlight the effectiveness of CSA and SLM's in preventing land degradation. By adapting to biophysical and socio-economic conditions, these practices promote protection, conservation, and sustainable use of resources (<i>i.e.</i>, soil, water, and biodiversity) and the restoration of degraded ecosystem functions. Promoting wide scale adoption and deployments of CSA technologies (<i>i.e.</i>, CA, water restoration, biochar, and composting) which enhances SLM in Timor-Leste is crucial. The combination of different techniques embedded in the four technologies has the potential to address barriers in increasing agriculture productivity and enhancing climate resilience of the sector.</p> |
|--------------------------|---|

| | |
|--|---|
| | <p>There have been ongoing efforts to address these challenges. The Ministry of Agriculture, Livestock, Fisheries and Forestry (MALFF), in collaboration with development partners, has taken steps to support low-income smallholder farmers by helping them manage risks and adopt effective climate change adaptation strategies. This measure is aligned with the draft National Agriculture Policy and Strategic Framework which aims to facilitate farmers transition from subsistence farming to market-oriented one through promotion of CSA practices and technologies. The document also outlines the government's plan to mitigate the impacts of climate change while enhancing agricultural productivity, resilience, and adaptation to climate change. In addition, the first programmes for adaptation priorities in the agriculture sector in Timor-Leste's National Adaptation Plan highlights the need to improve research and knowledge management to support CSA practices and resilient land management.</p> |
| <p>Objectives</p> | <ol style="list-style-type: none"> 1. To increase agriculture productivity of Timorese farmers in target municipalities through wide scale adoption and deployment of CSA technologies 2. To enhance the resilience of agriculture sector in Timor-Leste towards the negative impact of climate change |
| <p>Outputs</p> | <ol style="list-style-type: none"> 1. CSA technologies and their components are incorporated into policy and programmes of relevant ministries (<i>i.e.</i>, MALFF, MSA, and MPW) and budgeted by 2025 2. Trained technical staff (<i>i.e.</i>, extensionists) and farmers in the four CSA technologies by 2028 3. Farmers are well-informed about the effectiveness and potential benefits of the four technologies 2026 4. Volume of local agriculture produces for both household consumption and market supply is increased by 2028 5. Farmer's source of livelihood is diversified, and their income increased by 2028 6. Interministerial working groups and stakeholder partnerships in agriculture sector is strengthened by 2025 |
| <p>Relevance to Timor-Leste's sustainable development priorities</p> | <p>The project idea is in line with the National Strategic Development Plan (SDP) 2011-2030 and the programme of Timor-Leste's IX Constitutional Government which aim to enhance national food security, reduce rural poverty, support the transition from subsistence culture to business production of agricultural and promote environmental sustainability and conservation of the country's natural resources. It is also aligned with the draft National Agriculture Policy and Strategic Framework which aims to help farmers transition from subsistence farming to market-oriented agriculture through promotion of CSA practices and technologies. In addition, it contributes to Programme 1 for adaptation priorities in the agriculture sector in Timor-Leste's National Adaptation Plan which aims to improve research and</p> |

| | knowledge management to support CSA practices and resilient land management. | | | | | | | | | | | | | | | | |
|--|---|------------------------|--------------|--|--------|---|--------|--|--------|---|--------|---|---------|--|--------|---|---------|
| Project deliverables (values/benefits) | <ol style="list-style-type: none"> 1. More wide scale adoption/deployment of the four technologies and additional farming technique 2. Expanded research on farming technologies/techniques 3. Increased level of quality of seeds and fertiliser, access to irrigation water, and soil quality 4. Improved land/forest/soil biodiversity 5. Improved coordination among relevant line ministries, implementing agencies, research institutes, and farmers 6. Improved data quality on sustainable land management | | | | | | | | | | | | | | | | |
| Project scope, possible implementation | The project can be implemented under the National Agriculture Policy and Strategic Framework (currently a draft) during the ruling period of the XI Constitutional Government of Timor-Leste. Most of the project targets are well reflected in the framework and the programme. Additionally, it can also be implemented within the scope of the National Adaptation Plan and the country programme of corresponding implementing agencies (both local and international). | | | | | | | | | | | | | | | | |
| Activities & budget resource requirements | <table border="1"> <thead> <tr> <th>Activities/budget line</th> <th>Budget (USD)</th> </tr> </thead> <tbody> <tr> <td>Conducting stakeholder meetings to gather information for the development of programmes on all proposed activities</td> <td>20,000</td> </tr> <tr> <td>Establishment of an Inter-ministerial working group to plan and coordination activities</td> <td>20,000</td> </tr> <tr> <td>Assessment of the practice of CA, water restoration, biochar and composting in Timor-Leste</td> <td>50,000</td> </tr> <tr> <td>Review of existing policies on CSA related technologies</td> <td>30,000</td> </tr> <tr> <td>Research collaboration with relevant agencies</td> <td>500,000</td> </tr> <tr> <td>Linking existing/new community-based water conservation groups with donors</td> <td>80,000</td> </tr> <tr> <td>Development of modules for capacity development</td> <td>250,000</td> </tr> </tbody> </table> | Activities/budget line | Budget (USD) | Conducting stakeholder meetings to gather information for the development of programmes on all proposed activities | 20,000 | Establishment of an Inter-ministerial working group to plan and coordination activities | 20,000 | Assessment of the practice of CA, water restoration, biochar and composting in Timor-Leste | 50,000 | Review of existing policies on CSA related technologies | 30,000 | Research collaboration with relevant agencies | 500,000 | Linking existing/new community-based water conservation groups with donors | 80,000 | Development of modules for capacity development | 250,000 |
| Activities/budget line | Budget (USD) | | | | | | | | | | | | | | | | |
| Conducting stakeholder meetings to gather information for the development of programmes on all proposed activities | 20,000 | | | | | | | | | | | | | | | | |
| Establishment of an Inter-ministerial working group to plan and coordination activities | 20,000 | | | | | | | | | | | | | | | | |
| Assessment of the practice of CA, water restoration, biochar and composting in Timor-Leste | 50,000 | | | | | | | | | | | | | | | | |
| Review of existing policies on CSA related technologies | 30,000 | | | | | | | | | | | | | | | | |
| Research collaboration with relevant agencies | 500,000 | | | | | | | | | | | | | | | | |
| Linking existing/new community-based water conservation groups with donors | 80,000 | | | | | | | | | | | | | | | | |
| Development of modules for capacity development | 250,000 | | | | | | | | | | | | | | | | |

| | Capacity development for target group through FFS | 400,000 | | | | | | | | | | | | | | | |
|--|---|---|----------|----------------------|------------------|---|---|---|---|---|--|--|--|--|---|--|---|
| | Development of campaign materials on the four technologies and socialisation in target sucos | 300,000 | | | | | | | | | | | | | | | |
| | Distribution of organic compost bin | 90,000 | | | | | | | | | | | | | | | |
| | Total cost | 1,740,000 | | | | | | | | | | | | | | | |
| | The GoTL, GCF, and other agencies (DFAT, WFP and FAO) can be the ideal actors to co-finance the project. Aside from GCF, all other actors have worked together to implement relevant CSA projects in Timor-Leste. | | | | | | | | | | | | | | | | |
| Timelines | End of 2024 – End of 2028 | | | | | | | | | | | | | | | | |
| Measurement /Evaluation | <table border="1"> <thead> <tr> <th>Activity</th> <th>Monitoring indicator</th> <th>Success criteria</th> </tr> </thead> <tbody> <tr> <td>Development of the programme on all proposed activities</td> <td> <ul style="list-style-type: none"> Minutes of stakeholder meetings Minutes of Inter-Ministerial Quarterly/annual </td> <td>Programmes approved and budgeted in the annual state budget</td> </tr> <tr> <td>Establishment of an Inter-ministerial working group to plan and coordinate activities</td> <td> <ul style="list-style-type: none"> Minutes of Inter-Ministerial meetings </td> <td>Planned activities are implemented and properly reviewed</td> </tr> <tr> <td>Assessment of the practice of CA, water restoration, biochar and composting in Timor-Leste</td> <td> <ul style="list-style-type: none"> Consultant assessment reports Quarterly/annual Working group meetings </td> <td>Assessments are thoroughly conducted within the timeline and all relevant actors are properly consulted in the process</td> </tr> <tr> <td>Review of existing policies on CSA related technologies</td> <td> <ul style="list-style-type: none"> Working group meetings Quarterly/annual reports </td> <td>All relevant policies are reviewed within the proposed timeline and all relevant actors are properly consulted in the process</td> </tr> </tbody> </table> | | Activity | Monitoring indicator | Success criteria | Development of the programme on all proposed activities | <ul style="list-style-type: none"> Minutes of stakeholder meetings Minutes of Inter-Ministerial Quarterly/annual | Programmes approved and budgeted in the annual state budget | Establishment of an Inter-ministerial working group to plan and coordinate activities | <ul style="list-style-type: none"> Minutes of Inter-Ministerial meetings | Planned activities are implemented and properly reviewed | Assessment of the practice of CA, water restoration, biochar and composting in Timor-Leste | <ul style="list-style-type: none"> Consultant assessment reports Quarterly/annual Working group meetings | Assessments are thoroughly conducted within the timeline and all relevant actors are properly consulted in the process | Review of existing policies on CSA related technologies | <ul style="list-style-type: none"> Working group meetings Quarterly/annual reports | All relevant policies are reviewed within the proposed timeline and all relevant actors are properly consulted in the process |
| Activity | Monitoring indicator | Success criteria | | | | | | | | | | | | | | | |
| Development of the programme on all proposed activities | <ul style="list-style-type: none"> Minutes of stakeholder meetings Minutes of Inter-Ministerial Quarterly/annual | Programmes approved and budgeted in the annual state budget | | | | | | | | | | | | | | | |
| Establishment of an Inter-ministerial working group to plan and coordinate activities | <ul style="list-style-type: none"> Minutes of Inter-Ministerial meetings | Planned activities are implemented and properly reviewed | | | | | | | | | | | | | | | |
| Assessment of the practice of CA, water restoration, biochar and composting in Timor-Leste | <ul style="list-style-type: none"> Consultant assessment reports Quarterly/annual Working group meetings | Assessments are thoroughly conducted within the timeline and all relevant actors are properly consulted in the process | | | | | | | | | | | | | | | |
| Review of existing policies on CSA related technologies | <ul style="list-style-type: none"> Working group meetings Quarterly/annual reports | All relevant policies are reviewed within the proposed timeline and all relevant actors are properly consulted in the process | | | | | | | | | | | | | | | |

| | | | |
|--|--|--|--|
| | Research collaboration with relevant agencies | <ul style="list-style-type: none"> ● Working group meetings ● Project board meetings ● Quarterly/annual reports | MoUs are signed |
| | Linking existing/new community-based water conservation groups with donors | <ul style="list-style-type: none"> ● Working group meetings ● Field reports | Groups received technical and/or financial support from donors |
| | Development of modules for capacity development | <ul style="list-style-type: none"> ● Working group meetings ● Quarterly reports/annual reports | Modules are effectively developed, user friendly, and gender sensitive |
| | Capacity development for target group through FFS on CSA | <ul style="list-style-type: none"> ● Working group meetings ● Quarterly reports/annual reports ● Field reports | <ul style="list-style-type: none"> ● More than 70% of FFS activities are implemented involving both male and female farmers ● Post-test assessments show farmers' knowledge and skill are improved |
| | Development of campaign materials on the four technologies and socialisation in target sucos | <ul style="list-style-type: none"> ● Working group meetings ● Quarterly reports/annual reports ● Field reports | <ul style="list-style-type: none"> ● All campaign materials are developed and printed ● Information disseminations are conducted in more than 70% of target areas |
| | Distribution of organic compost bin | <ul style="list-style-type: none"> ● Working group meetings ● Quarterly reports/annual reports | <ul style="list-style-type: none"> ● All compost bins are distributed in target areas |

| | |
|------------------------------------|--|
| | <ul style="list-style-type: none"> ● Field reports ● Farmers start to use compost bin |
| Possible complications /Challenges | <ul style="list-style-type: none"> ● Failure to secure buy-in from relevant actors, specially MALFF ● Over politicisation of project activities ● Limited participation from target beneficiary groups, specifically women and youth, due to lack of interest and socio-cultural barrier ● Local conflict between youth groups which limits mobility and delays implementation of field activities in target sites ● Natural disasters (<i>i.e.</i>, flash flood and erosion) damage road conditions in rural areas, limiting access to target sites do conduct some activities ● Delays in recruiting qualified experts to develop and deliver training materials ● Financial support from implementing agencies/donors is terminated due to lack of transparency and ineffective management |
| Responsibilities and Coordination | MALFF (DG of Agriculture and DG of Forestry), MTE (DG of Environment), MPW (BTL, E.P.), development partners (FAO, UNDP, DFAT, World Vision, IOM, and Conservation International), research agencies (AI-Com, UNTL, and ACIAR), NGOs (Permatil, Juventude Hadomi Natureza), and private sector (TILOFE) |

Table 25: Project idea for sector 1: Sustainable Land Management in Agriculture

Chapter 2: Technology Action Plan and Project Ideas for Infrastructure and Natural Methods to Prevent Erosion Sector

2.1 TAP for Infrastructure and Natural Methods to Prevent Erosion Sector

This chapter focuses on the Technology Action Plan (TAP) for infrastructure and natural methods to prevent erosion sector which consists of the following technologies: soil bioengineering, *tarabandu*, mangrove plantation and sloping agricultural land technology (SALT). As TAP for SALT technology has been elaborated in TAP for Mitigation report, this chapter will focus only on the first three technologies.

2.1.1 Sector overview

High-quality road and bridge infrastructures provide solutions to many rural parts of Timor-Leste where landslides and floods regularly interrupt road connections in the country, restricting mobility of people and goods (GoTL, 2011). To address this infrastructure challenge, the SDP 2011-2030 has prioritised significant investments in road rehabilitation, repair, and improvement. Nevertheless, the strategic document neither factors in climate change impacts on road and other infrastructures development nor considers nature-based solutions. As a result, the quality and sustainability of some infrastructures remains questionable. This creates a problem of inefficiency in the use of financial resources (*i.e.*, state budget, grants, and loans) in a country where infrastructure contributes to 16 % of the total annual state budget allocation between 2008 -2013 (USD 1,584.8 million).

Timor-Leste's Second National Communication under the UNFCCC, the National Determined Contribution (NDC) 2022-2023, and National Adaptation Plan (NAP) elaborate the importance of integrating nature-based solutions (NbS) such as mangrove ecosystem protection and bioengineering into climate adaptation efforts to combat both inland and coastal erosion. These documents reflect on past and ongoing efforts to introduce simple, low-cost, and effective nature-based solutions in the country. For example, between 2016 –2021, MALFF in collaboration with UNDP and other national stakeholders implemented a GEF-funded project, Coastal Resilience Building (CRB), which restored and protected the mangrove ecosystem in the country. Literature reviews and stakeholder consultations show that introduction of sloping agriculture slope technology (SALT) in different parts of the country has occurred as early as 2007¹¹ through Local Initiatives for Food-security Transformation (LIFT) Project¹². Similarly, soil bioengineering has been prevalent in various infrastructure projects funded by GoTL and development agencies (*i.e.*, GEF, GCF, World Bank, and ADB). In 2012, the World Bank even developed a field guide on soil bioengineering for slope stabilisation in Timor-Leste.

Tarabandu is quite distinguished from other selected technologies in this sector due to its nature and origin. Having the State recognition of customary systems' significance, such as that of *saraband's*, in local governance renders plentiful opportunity to promote the potentiality of hybrid management model for natural resource management as seen in the case of forest protection and marine protected areas (MPAs) which adopt community-based approach.

¹¹ It is possible that SALT might have been introduced in Timor-Leste earlier than that; However, literature review only shows the LIFT project's documentation of the introduction of this technology in Timor-Leste. No national stakeholder provided information on one earlier introduction of this technology.

¹² Funded by the European Commission and Austrian Development Cooperation (ADA)

2.1.2 Action plan for soil bioengineering

2.1.2.1 Introduction

Soil bioengineering is the use of living plant materials to construct structures that perform an engineering function (World Bank, 2012). Deemed as a useful and effective technology for slope stabilisation and soil conservation, soil-bioengineering is simple, low cost, and effective, requires little to no maintenance, is environmentally friendly, and sustainable. It is also a complementary addition to conventional hard engineering approaches that use rock-based and concrete physical structures (ADB,2018).

There have been numerous efforts to introduce and enhance adoption of soil bioengineering in Timor-Leste. In 2012, the World Bank developed a field guide on soil bioengineering for slope stabilisation in Timor-Leste for upland and coastal areas as part of capacity building for the Ministry of Public Works (MPW), forestry department of MALFF and relevant practitioners. This has contributed to mainstreaming of soil bioengineering in many other projects in the country, including the UNDP's Strengthening the Resilience of Small-Scale Rural Infrastructure and Local Government Systems to Climatic Variability and Risks (SSRI) project, the ADB's Road Network Upgrading Project, and the World Bank's Timor-Leste Road Climate Resilience Project¹³.

2.1.2.2 Ambition for the TAP

According to a study on flooding and landsliding in Timor-Leste, there is a strong coincidence of rainfall with high topography and of landsliding with topography of more than 1,500 mm/year particularly in the south coast. Consequently, infrastructures around this part of the country are more prone to the impact of climate change. Hence, it is recommended that the technology be adopted in infrastructure projects in seven (7) municipalities, namely Covalima, Bobonaro, Ainaro, Manufahi, Manatuto, Viqueque and Baucau, covering a total area¹⁴ of 9,958 Km². It will improve access to infrastructure and mobility for around 578,901 individuals, 49% of whom are female.

Soil-bioengineering is a simple, low cost, effective, environmentally friendly, and sustainable technology for slope stabilisation and soil conservation that requires little to no maintenance. The technology can significantly reduce the risk of erosion by establishing vegetation in combination with timber and/or rock-based engineering structures to anchor and protect shallow-seated earth masses, preferably as soon as possible after cutting the slope. It is particularly important for roads in Timor-Leste, where adjacent slopes have a plethora of stability problems.

2.1.2.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

The primary barrier lies in the lack of financial allocation from the state budget on soil bioengineering activities. The allocation of the state budget for infrastructure tends to centralise on developing hard engineering structures. As such, soil bioengineering is only considered as an optional element in infrastructure development. Also, there is a lack of investment in research and development (R&D) for bioengineering. Lastly, there is still limited public information on this technology's benefits even if it has already been introduced and integrated into Timor-Leste's infrastructure planning and development since 2012.

¹³ Implemented by Ministry of Public Works of Timor-Leste

¹⁴ Since this figure only captures the total area for each municipality, the actual total area where this technology is required is smaller. Further assessment on sites prone to erosion and landslide in each municipality is needed to narrow down the scale of intervention.

To address these barriers, the first step is to commit a budget line in national allocations for soil bioengineering activities for infrastructure projects that require the combination of both soft and hard engineering. It can be further strengthened through investments in R&D on soil bioengineering, extensive campaigns on its benefits, and capacity building.

b. *Actions selected for inclusion in the TAP*

The list of actions in Table 27 below is derived from a few enabling measures proposed in the BAEF report on soil engineering. They are considered as the most practical, contextualised and cost-effective actions to overcome the barriers.

| Actions | Activities |
|---|--|
| <p>Action 1: Campaign on soil bioengineering at national and local level</p> <p>This action is part of an investment in education and awareness raising campaigns to increase access to credible information for technical staff (<i>i.e.</i>, engineers, supervisors from contracting companies, and workers) and improve their knowledge of the technology. It can also clarify doubts and preconceived notions about the benefits and drawbacks of soil bioengineering.</p> | <p>Activity 1.1: <i>Developing soil bioengineering campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i></p> <p>Activity 1.2: <i>Dissemination of soil bioengineering as nature-based solutions for erosion in target sucos</i></p> |
| <p>Action 2: Conducting R&D on soil bioengineering</p> <p>The BAEF for adaptation for this technology reveals that The Ministry of Public Work – the government entity responsible for the development, construction, and maintenance of the vital infrastructure of the country – has established three civil engineering laboratory facilities (in Dili, Baucau and Liquiça) in 2017. While the laboratory is used to test the quality of hard engineering such as roads and bridges, it does not include soil bioengineering work. As a result, there are not many R&D activities on soil bioengineering.</p> <p>Conducting R&D in soil bioengineering in Timor-Leste offers various benefits. Firstly, it provides opportunity for collaboration between line ministries (MPW, MSA, and MALFF), academic/research institutions agencies to explore different soil-bioengineering methods and identify the ones that suit different terrains in Timor-Leste’s highland and low-land areas. Additionally, findings and recommendations from the research can be the baseline for updating the World Bank’s field guide for soil bioengineering.</p> <p>It is important to provide equal opportunities for both male and female technical/staff, engineers and community members in all R&D activities.</p> | <p>Activity 2.1: <i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i></p> <p>Activity 2.2: <i>Establishing research partnership among civil engineering laboratory, engineering department of local universities, and community groups</i></p> <p>Activity 2.3: <i>Conducting research on demo plots for soil bioengineering</i></p> |

| | |
|---|--|
| <p>Action 3: Integrating soil bioengineering into infrastructure development project manuals/guidelines</p> <p>In 2012, the World Bank developed a field guide on soil bioengineering for slope stabilisation in Timor-Leste for upland and coastal areas. It is meant to introduce NbS as a complementary addition to hard-engineering works in the country. However, the application of soil bioengineering Timor-Leste has not been widespread and is only seen in a limited number of projects. Therefore, integrating soil bioengineering into relevant infrastructure project manuals/guidelines can help facilitate the widespread deployment of this technology. Additionally, it brings together relevant actors (<i>i.e.</i>, Forestry of MALFF and MPW) to work together and improve the quality and durability of infrastructure development projects through introduction of rules and regulations that promote NbS approach.</p> | <p>Activity 3.1: <i>Review of existing infrastructure development manual and guidelines</i></p> <p>Activity 3.2: <i>Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines</i></p> <p>Activity 3.3: <i>Establishing mandatory budget item for soil bioengineering in infrastructure development projects</i></p> |
|---|--|

Table 26: List of actions and activities for the implementation of soil bioengineering

Action 2 is selected for Project Idea (PI) for TAP due to the fact that it responds directly to the need to develop more technical studies of soil bioengineering in Timor-Leste. Action 2 will be combined with some activities under Action 3 to facilitate the integration of soil bioengineering into infrastructure development project manuals/guidelines.

2.1.2.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 28 play crucial roles in the implementation of actions and corresponding activities for the TAP.

| Stakeholder | Roles |
|--|--|
| Ministry of Public Works (MPW) | MPW is the government entity responsible for the development, construction, and maintenance of the vital, large-scale infrastructures in the country. In 2017, it established three civil engineering laboratories in Dili, Baucau and Liquiça which aim to improve the quality of infrastructure. Their facilities can be designed as centres for R&D in soil bioengineering. Additionally, they have the power to influence policy and strategies that promote NbS approaches, including soil bioengineering and SALT. |
| Ministry of State Administration (MSA) | MSA is responsible for integrated development plans for medium and small-scale infrastructure projects in Timor-Leste through its PDIM (Integrated Development Plan for Municipality) and PNDS (National Suco Development Plan). The PDIM technical teams directly supervise contractors through regulation monitoring and quality control activities. |
| MALFF | As the government agency responsible for managing forest, hydrological basins, and mangrove areas, MALFF holds a crucial role in land and freshwater governance. The Directorate General of Forest, Coffee and Industrial Plants manages nursery centres for different species of trees and plants in different |

| | |
|-------------------------------|--|
| | parts of the country. They can provide support to TAP in the form of selecting species and managing seedlings to be used for soil bioengineering activities. |
| UNTL – Engineering Department | UNTL has the potential to collaborate with MPW and relevant stakeholders to improve efficiency and quality of civil engineering and bioengineering works in the country through R&D. Its Faculty of Engineering, Science and Technology can provide human resources and facilities to conduct research activities. |
| Development Agencies | Agencies which have been managing vital, climate resilient infrastructures projects in Timor-Leste such as ILO, World Bank and UNDP can support the implementation of TAP for soil-bioengineering through donor-funded projects and various technical supports. These agencies also emphasise gender balance in their country programmes; hence, their participation can further strengthen involvement of women in community-based natural resource management. |

Table 27: List of responsible stakeholders for the implementation of soil bioengineering

Timeline for the implementation of the actions and corresponding activities is presented in Table 29 below.

| Actions | Activities | Year | | | | |
|--|---|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 2: Conducting R&D on soil bioengineering | Activity 2.1: Review of outcomes from different soil bioengineering projects in Timor-Leste | X | | | | |
| | Activity 2.2: Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups | | X | X | X | X |
| | Activity 2.3: Conducting research on demo plots for soil bioengineering | | X | X | X | X |
| 3: Integrating soil bioengineering into infrastructure development project manuals/guidelines | Activity 3.1: Review of existing infrastructure development manual and guidelines | X | | | | |
| | Activity 3.2: Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines | X | X | X | | |
| | Activity 3.3: Establishing mandatory budget item for soil bioengineering in infrastructure development projects | | | | X | X |

Table 28: Timeline for the implementation of soil bioengineering

2.1.2.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Cost (USD) |
|---|--|------------------|
| Activity 2.1: Review of outcomes from different soil bioengineering projects in Timor-Leste | Consultant fee | 40,000 |
| | Consultations and site visits | 10,000 |
| Activity 2.2: Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups | Technical meetings | 20,000 |
| | Support for research collaborations | 480,000 |
| Activity 2.3: Conducting research on demo plots for soil bioengineering | Field research activities in demo plots | 1,500,000 |
| Activity 3.1: Review of existing infrastructure development manual and guidelines | Consultant fee | 40,000 |
| | Consultations and site visits | 10,000 |
| Activity 3.2: Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines | Logistic arrangements for stakeholder consultations | 10,000 |
| Activity 3.3: Establishing mandatory budget item for soil bioengineering in infrastructure development projects | Regular coordination meeting and monitoring activities | 10,000 |
| Total cost | | 2,120,000 |

Table 29: Resources estimation for the implementation of actions and activities for soil bioengineering

2.1.2.6 Management planning

Risks and Contingency Plans

The type of risks (*i.e.*, political, social, schedule, and financial risks), description, and contingency actions pertaining to TAP of soil bioengineering technology are similar to the ones presented in Table 5. One additional risk description for “scheduling” and a new risk related to “technical” are added to the list.

The new scheduling risk is linked to land disputes with communities which can potentially delay project implementation. To minimise this risk, it is important to conduct intensive consultation to verify the status of land and ensure that there is proper compensation system for affected communities. The technical risk is linked to the suitability of selected plant species for local climate. It can be minimised by ensuring that plant species are properly tested before being selected.

Next steps

| Immediate Requirements | Critical Steps |
|--|---|
| DG of Environment and NDCC and should organise a stakeholder’s workshop to communicate the TAP | Get the stakeholders buy-in, specially from MPW, MSA and partners (<i>i.e.</i> , World Bank, UNDP, UNTL, etc.) |

| | |
|---|--|
| MPW and MSA to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MPW and MSA's 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 30: List of next steps for the implementation soil bioengineering

2.1.2.7 TAP Overview table

| Sector | Infrastructure and natural methods to prevent erosion | | | | | | | |
|--|---|-------------------|--|-----------|---|--|--|---------|
| Technology | Soil bioengineering | | | | | | | |
| Ambition | Soil bioengineering will be implemented in approximately 40.000 ha of total cultivated land in Timor-Leste | | | | | | | |
| Benefits | Strengthening the resilience of public infrastructures in the country, especially during extreme weather events | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point (Stakeholders & Roles) | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget |
| 1: Campaign on soil bioengineering at national and local level | 1.1. <i>Developing soil bioengineering campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | GCF/GoTL | Consultant, MSA, MPW | 2024-2028 | Delays in recruiting qualified experts | Campaigns materials are effective in conveying the message | Variety of campaign materials | 100,000 |
| | 1.2. <i>Dissemination of soil bioengineering as nature-based solutions for erosion in target sucos</i> | GCF/GoTL | Consultant, MSA, MPW | 2024-2028 | Gang conflict between youth groups, natural disasters, limited participation from target beneficiary groups | Target sucos learn about soil bioengineering and are convinced about its effectiveness | Number of people adopting soil bioengineering techniques | 60,000 |
| 2: Conducting R&D on soil bioengineering | 2.1. <i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i> | GCF/GoTL | Consultant, MSA, MPW | 2024-2028 | Delays in recruiting qualified experts | Challenges and lesson learned from past project are captured | Level of data analysis and relevance of recommendations | 50,000 |
| | 2.2. <i>Establishing partnership among civil engineering laboratory, engineering department of</i> | GCF/GoTL | Consultant, MSA, MPW | 2024-2028 | Lack of support from relevant actors | Research team is composed of representative | Number of MoU; number of research activities | 500,000 |

| | | | | | | | | |
|---|--|----------|----------------------|-----------|--|---|---|-----------|
| | <i>local universities, and community groups</i> | | | | | from different agencies | | |
| | <i>2.3. Conducting research on demo plots for soil bioengineering</i> | GCF/GoTL | Consultant, MSA, MPW | | Lack of support from relevant actors; Termination of supports from implementing agencies/donors | Research findings are published | Number of research participants disaggregated by gender; Number of research publications; Relevance of findings | 1,500,000 |
| 3: Integrating soil bioengineering into infrastructure development project manuals/guidelines | <i>3.1. Review of existing infrastructure development manual and guidelines</i> | GCF/GoTL | Consultant, MSA, MPW | 2024-2028 | Delays in recruiting qualified experts | Delays in recruiting qualified experts | Strength and gaps of existing manual and guidelines are identified | 50,000 |
| | <i>3.2. Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines</i> | GCF/GoTL | Consultant, MSA, MPW | | Delays in recruiting qualified experts; lack of support from relevant actors | Target groups are convinced to integrate this technology into relevant national documents | Number of documents recommending soil bioengineering | 10,000 |
| | <i>3.3. Establishing mandatory budget item for soil bioengineering in infrastructure development projects</i> | GCF/GoTL | Consultant, MSA, MPW | 2024-2028 | Lack of support from relevant actors | Budget line for soil bioengineering is established | Portion of state budget allocation for soil-bioengineering activities | 10,000 |

Table 31: TAP overview table for soil bioengineering technology

2.1.3 Action plan for Tarabandu

2.1.3.1 Introduction

Tarabandu is quite distinguished from other selected technologies due to its nature and origin from a customary system. Having the State recognition of its significance in local governance renders a plentiful opportunity to promote the potentiality of a hybrid management model for natural resource management. This is seen in the case of forest protection and marine protected areas (MPAs) which adopt a community-based approach. In other programmes, such as the Coral Triangle Support Programme (CTSP), community members, under the guidance of suco council and local conservation group, designed their own *tarabandu* rules and regulations and sanctions for the marine protected areas. The same process was replicated during the process of establishing the MPAs in Ataúro. Moreover, it is the community members themselves who voluntarily enforce and monitor the *tarabandu* in their MPA.

The effectiveness of *tarabandu* rules in the current community-based natural resource management (CBNRM) remains a challenge. While it is deemed as an effective, conflict sensitive, and locally owned tool concerning CBNRM, it is not a panacea for various environmental and social issues in the country. Timor-Leste's sixth national report to UNCBD highlights that monitoring and assessment of the *tarabandu* enforcement and outcomes is lacking mainly due to limited fundings and technical staff. In addition, empirical evidence shows that Timor-Leste continues to face a suite of environmental challenges including ongoing deforestation and biodiversity loss even in areas where *tarabandu* rules have been enacted. Therefore, it is important to devise action plans and activities that can address barriers to a widespread adoption and successful deployment of this technology.

2.1.3.2 Ambition for the TAP

The long-term impact of technologies such as soil bioengineering, mangrove planting and SALT is frequently hindered by lack of proper monitoring and enforcement of rules. In most cases, enforcement systems and resources to reduce human encroachment and exploitation of natural resources in project/protected sites are not available. Hence, *tarabandu* can be devised to enhance management of land and coastal areas in which those technologies are applied. Also, a Timorese customary rule that enforces peace and reconciliation through the power of public agreement (Belun & The Asia Foundation, 2013), *tarabandu* can potentially prevent community conflicts in project/protected sites.

2.1.3.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

Three barriers have been identified regarding the adoption and implementation of this technology. Firstly, the lack of financial allocation from the state budget on *tarabandu* enforcement makes it impossible to ensure that rules and regulations are enforced. Secondly, limited opportunities to diversify household's sources of income forces many rural communities to continue extracting natural resources (*i.e.*, soil, water, forest products, and animal products) unsustainably due to economic pressure. Lastly, a weak governance stemming from the failure to incorporate *tarabandu* into natural resources management means that the established rules and regulation will be neglected.

To address the financial and economic barriers, potential solutions are to commit budget lines for *tarabandu* enforcement and establish alternative sources of livelihood. In overcoming the non-financial barrier, one recommended measure is to strengthen local governance of natural resource management through proper integration, monitoring, and enforcement of established rules and regulations.

b. Actions selected for inclusion in the TAP

The list of actions in Table 33 is derived from a few enabling measures proposed in the BAEF report on soil engineering. They are considered as the most practical, contextualised and cost-effective actions to overcome the barriers.

| Actions | Activities |
|--|---|
| <p>Action 1: Improving local governance of natural resource management (NRM)</p> <p>Normally, <i>tarabandu</i> rules are designed through a participatory process involving local actors. During the process, individuals are required to work collectively to set “rules of the game” regarding access to and extraction of common pool resources and the enforcement mechanism. When locally based rules have gained widespread community support and legitimacy, the entire community can become part of the eyes and ears of the local regime’s enforcement. Unfortunately, this is not the case when national and local governments fail to incorporate <i>tarabandu</i> as part of NRM and prioritise state regulations over customary practices. Oftentimes, the problem stems from a lack of coordination and collaboration between national and local actors in setting, socialising, and enforcing the rules and regulations.</p> <p>This measure calls for improvement in coordination between national and local actors to ensure that all relevant actors are involved in setting, socialising, and enforcing the rules and regulations. It ensures that <i>tarabandu</i>, being a customary law, is fully incorporated into NRM and is regularly monitored.</p> | <p>Activity 1.1: <i>Review of existing tarabandu rules and regulations and their effectiveness</i></p> <p>Activity 1.2: <i>Consultation with relevant actors to improve local governance of NRM</i></p> <p>Activity 1.3: <i>Establishing mandatory budget item for tarabandu monitoring activities</i></p> |
| <p>Action 2: Provision of alternative source of livelihood in areas where tarabandu is enforced</p> <p>Oftentimes, <i>tarabandu</i> rules were merely enacted to limit access to common pool resources (<i>i.e.</i>, soil, water, forest products, and animal products) without providing alternative solutions. Empirical evidence shows that community members are likely to show compliance with the rules and regulations when they are provided with alternative solutions. Following this logic, this action emphasises the need to establish alternative activities that will generate income and sustain a community's livelihood. It ensures the basic needs of community members living in areas where the <i>tarabandu</i> system is enacted.</p> <p>In many rural settings in Timor-Leste, women and girls are involved intensively in labour tasks such as collecting firewood, fetching water, farming, and small-scale home-based businesses (<i>i.e.</i>, selling vegetables and food items).</p> | <p>Activity 2.1. <i>Assessment of alternative source of livelihoods</i></p> <p>Activity 2.2. <i>Technical training on specific areas that can generate alternative income</i></p> <p>Activity 2.3: <i>Linking produce/products to local market</i></p> <p>Activity 2.4. <i>Facilitating access to financial service providers</i></p> |

| | |
|---|--|
| It is important to provide them with opportunities to diversify alternative sources of incomes in areas where <i>tarabandu</i> rules are enacted. | |
|---|--|

Table 32: List of actions and activities for the implementation of *tarabandu*

Action 1 and 2 are selected for Project Idea (PI) for TAP due to the fact they are closely interconnected and contribute to strengthening the efforts to activate community based NRM in the country. All activities listed in the table will be considered in the TAP.

2.1.3.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 34 play crucial roles in the implementation of actions and corresponding activities for the TAP.

| Stakeholder | Roles |
|---|---|
| Ministry of Tourism and Environment (MTE) | MTE is the National Government agency responsible for managing tourism and environmental matters. Its Directorate General for Environment, through the National Directorate for Biodiversity, also oversees the implementation of <i>tarabandu</i> rules in target areas. Hence, MTE plays a crucial role in shaping the governance of natural resources. It can use its membership in the Council of Ministers to endorse relevant policy and programmes. |
| Ministry of State Administration (MSA) | MSA, through its Municipality Authorities and Suco Council, plays an important role in strengthening municipality and local governance, including the NRM. Specifically, the Suco Council and its constituents have the power in both designating areas where <i>tarabandu</i> should be enforced and monitoring of the enforcement. In fact, <i>tarabandu</i> ceremony is usually led by <i>lia nain</i> (traditional leaders) and the elders which are also members of the suco council. |
| MALFF | The management of watersheds, lands, coastal, forests and protected areas falls under the responsibility of MALFF's Directorate General of Forestry. They work with the community to safeguard sustainable use of the above-mentioned natural resources. Their forest guards which are stationed in different parts of the national territories can strengthen the enforcement of <i>tarabandu</i> rules. |
| PNTL (Polícia Nacional de Timor-Leste) | As a national police institute, PNTL can strengthen the enforcement of <i>tarabandu</i> rules through its community policing programme which exists in different parts of the country. They can collaborate with suco council and forest guards to minimise potential conflicts and ensure harmony in target areas. |
| Development Agencies | Agencies such as UNDP and Conservation International are committed to support and strengthen <i>tarabandu</i> rules in NRM. They can tap on their eligibility to access donor funds, design projects, provide technical and financial support, and work with communities to harness the effectiveness of <i>tarabandu</i> rules. These agencies also emphasise gender balance in their country programmes; hence, their participation can further strengthen involvement of women in community-based natural resource management. |

Table 33: List of responsible stakeholders for the implementation of *tarabandu*

Timeline for the implementation of the actions and corresponding activities is presented in Table 35 below.

| Actions | Activities | Year | | | | |
|--|--|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 1: Improving local governance of natural resource management (NRM) | Activity 1.1: Review of existing tarabandu rules and regulations and their effectiveness | X | | | | |
| | Activity 1.2: Consultation with relevant actors to improve local governance of NRM | | X | | | |
| | Activity 1.3: Establishing mandatory budget item for tarabandu monitoring activities | | X | X | X | X |
| 1: Provision of alternative source of livelihood in areas where tarabandu is enforced | Activity 2.1. Assessment of alternative source of livelihoods | | X | | | |
| | Activity 2.2. Technical training on specific areas that can generate alternative income | | X | X | X | X |
| | Activity 2.3: Linking produce/products to local market | | X | X | X | X |
| | Activity 2.4. Facilitating access to financial service providers | | X | X | X | X |

Table 34: Timeline for the implementation of tarabandu

2.1.3.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Cost (USD) |
|---|--|----------------|
| 1.1: Review of existing tarabandu rules and regulations and their effectiveness | Consultant fee | 20,000 |
| | Site visits | 10,000 |
| 1.2: Consultation with relevant actors to improve local governance of NRM | Consultation activities (interviews and focus group discussions) | 20,000 |
| 1.3: Establishing mandatory budget item for tarabandu monitoring activities | Regular coordination meeting and monitoring activities | 10,000 |
| 2.1. Assessment of alternative source of livelihoods | Consultant fee | 20,000 |
| | Site visits | 10,000 |
| 2.2. Technical training on specific areas that can generate alternative income | Development of training manual | 20,000 |
| | Implementation of training activities | 100,000 |
| 2.3: Linking produce/products to local market | Consultation activities (interviews and focus group discussions) | 20,000 |
| 2.4. Facilitating access to financial service providers | Grants to livelihood groups | 500,000 |
| Total cost | | 730,000 |

Table 35: Resources estimation for the implementation of actions and activities for tarabandu

2.1.3.6 Management planning

Risks and Contingency Plans

The type of risks (*i.e.*, political, social, schedule, and financial risks), description, and contingency actions pertaining to TAP for *tarabandu* technology are similar to the ones presented in Table 5. One additional risk type, economic, and a new risk description for “scheduling” is added to the list.

The economic risk is linked to the fact that alternative sources of livelihood might not be profitable, forcing communities to use natural resources unsustainably. Minimising the scale of this risk requires a thorough assessment of activities that can potentially generate sustainable income and provision of proper capacity building as well as proper financial support to target groups.

The additional scheduling risk stems from potential land disputes between communities which can delay project implementation. It is critical that an intensive consultation be conducted to verify status of land and ensure a proper compensation system for affected communities.

Next steps

| Immediate Requirements | Critical Steps |
|--|--|
| DG of Environment and NDCC and should organise a stakeholder’s workshop to communicate the TAP | Get the stakeholders buy-in, specially from MTE, MALFF MSA and partners |
| MTE, MALFF and MSA to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MTE, MALFF, and MSA’s 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 36: List of next steps for the implementation of *tarabandu*

2.1.3.7 TAP Overview table

| Sector | Infrastructure and natural methods to prevent erosion | | | | | | | |
|---|--|-------------------|--|-----------|---|---|---|---------|
| Technology | Tarabandu | | | | | | | |
| Ambition | Tarabandu will be reinforced in coastal and upland forest areas | | | | | | | |
| Benefits | Natural resources, which are protected using community-based approaches, become more resilient | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point (Stakeholders & Roles) | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget |
| 1: Improving local governance of natural resource management (NRM) | 1.1. <i>Review of existing tarabandu rules and regulations and their effectiveness</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Delays in recruiting qualified experts | Strength and gaps of existing rules and regulations are identified | Level of analysis of data | 30,000 |
| | 1.2. <i>Consultation with relevant actors to improve local governance of NRM</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Lack of support from relevant actors | Strength and gaps of existing rules and regulations are identified | Number of modifications in NRM documents | 20,000 |
| | 1.3. <i>Establishing mandatory budget item for tarabandu monitoring activities</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Lack of support from relevant actors | Budget line for tarabandu is established | Portion of state budget allocation for tarabandu activities | 10,000 |
| 2: Provision of alternative source of livelihood in areas where tarabandu is enforced | 2.1. <i>Assessment of alternative source of livelihoods</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Delays in recruiting qualified experts | Relevant, feasible alternative sources of livelihood are identified | Level of analysis of data | 30,000 |
| | 2.2. <i>Technical training on specific areas that can generate alternative income</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Delays in recruiting qualified experts; limited participation from target beneficiary | Target groups' gain new skill sets; | Number of female beneficiaries; Number of new livelihood activities in target sucos | 120,000 |

| | | | | | | | | |
|--|--|----------|-----------------|-----------|---|---|---|---------|
| | | | | | groups; termination of supports from implementing agencies/donors | | | |
| | <i>2.3. Linking produce/products to local market</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Limited participation from target beneficiary groups | Products are sold in stores/markets | Number of sales in a given period; changes in income level | 20,000 |
| | <i>2.4. Facilitating access to financial service providers</i> | GCF/GoTL | Consultant, MTE | 2024-2028 | Limited participation from target beneficiary groups; termination of supports from implementing agencies/donors | More farmers can access micro loan and financial services | Number of male and female farmers who access financial services | 500,000 |

Table 37: TAP overview table for tarabandu technology

2.1.4 Action plan for mangrove plantation

2.1.4.1 Introduction

Timor-Leste's extensive coastline, approximately 747 km, in both the northern and southern part is home to around 9,000 ha of mangrove forests. An important habitat for the coastal ecosystem, mangrove forests provide ideal breeding grounds for many aquatic species (*i.e.*, fish, shrimp, crabs, and other shellfish) and protects coastal zones against natural hazards (*i.e.*, storms, tsunamis, and coastal erosion). Unfortunately, mangrove forests' coverage area in Timor-Leste has declined to 4,000 Ha in 1982 due to overharvesting for timber and firewood. A 2020 data from MALFF-UNDP Coastal Resilience Building (CRB) project shows that the area has increased to 4,831 Ha with around 35 species of mangroves and associate species.

There have been increasing efforts to protect and restore the mangrove ecosystem in Timor-Leste partly due to more acknowledgement of the effectiveness of nature-based solutions (NbS) to adapt to the impacts of climate change. Timor-Leste's Sixth National Report to UNCBD lists mangrove reforestation as a strategic action aimed at rehabilitation of critical and damaged habitats and ecosystems. The CRB project is the first large-scale mangrove restoration project in the country to date. Unfortunately, the survival rate of mangrove seedlings planted by the project was relatively low due to failure to select suitable species, limited technical knowledge, livestock grazing, and lack of government buy-in. Nevertheless, the project has paved the way for more restoration and learning activities on the mangrove ecosystem. A local NGO, Konservasaun Flora & Fauna (KFF), is currently managing a mangrove learning facility in Dili municipality.

It is important to devise action plans and activities that can address barriers to a widespread adoption and successful deployment of mangrove plantations in Timor-Leste. The following sections will provide in more detail actions to be taken, stakeholders, timelines, estimation of financial resources required, and risk management plan for a successful adoption and deployment of this technology.

2.1.4.2 Ambition for the TAP

The CRB project implemented by MALFF-UNDP between 2016-2021 has identified a total of 4,831 Ha of mangrove areas in Timor-Leste. However, the project only covered around 2,271 Ha, leaving the rest in unprotected conditions. Hence, the ambition set for this technology should be 53% of total mangrove area (2,500 Ha) which was not covered by CRB project in the eleven (11) coastal municipalities, namely Dili, Liquiça, Bobonaro, Oecussi, Covalima, Ainaro, Manufahi, Manatuto, Viqueque, Baucau, and Lautem.

Approximately 40% of the Timorese population live in coastal and lowland areas of the country. Although there is no gender-disaggregated data for these coastal inhabitants, the 2022 Population Census data shows that around 49% of the population inhabiting the 11 coastal municipalities are female.¹⁵ Around them are women and girls. Many of them rely on farming and gleaning as means of subsistence and source of income. Hence, they can be benefited from the projects activities that aim to protect their sources of foods and diversify their sources of income.

¹⁵ The figure is not a true representation of the female population in coastal municipalities in Timor-Leste because not all population in each municipality lives in coastal and lowland areas.

Planting mangrove in degraded coastal areas contributes to prevention of coastal erosion and restoration of coastal and marine biodiversity. Additionally, it also reduces the damage caused by waves and sediments.

2.1.4.3 Actions and activities selected for inclusion in the TAP

a. Summary of barriers and measures to overcome barriers

The primary barrier lies in the lack of financial allocation from the state budget on mangrove protection. Only a small fraction of the budget is allocated for MALFF Forestry Directorate; however, the budget is not sufficient for crucial activities such as establishing community nursery groups, monitoring the condition of planted seedlings, building fences, and establishment of alternative sources of livelihood for the local community. In addition, the rapid progression of urban sprawl in coastal areas in Timor-Leste coupled with aquaculture and major infrastructure development poses a negative impact on the mangrove ecosystem. Lastly, the practice of free grazing exposes vegetation in wetland areas and mangrove forests to livestock grazing.

To address these barriers, the first step is to commit a budget line in national allocations for restoration of the mangrove ecosystem. It can be further strengthened with spatial planning for coastal areas to mitigate unsustainable rapid urbanisation and industrialization. Additionally, promoting the practice of confined raising in livestock management is essential to reduce the risk of loss of mangrove forests from livestock free grazing.

b. Actions selected for inclusion in the TAP

The list of actions in Table 39 is derived from a few enabling measures proposed in the BAEF report on mangrove plantations. They are seen as the most practical, contextualised and cost-effective actions to overcome the barriers. They built on previous and existing efforts to scale up mangrove plantations in the country.

| Actions | Activities |
|--|--|
| <p>Action 1: Campaign on the importance of mangrove ecosystem at national and local level</p> <p>This action is part of an investment in education and awareness raising campaigns at national and local level to increase community's access to credible information and improve their knowledge of the technology. Since the CRB project already developed a range of campaign materials (digital, printed, plays, and radio shows), it is more cost-efficient to use them as reference for the campaign.</p> | <p>Activity 1.1: <i>Developing campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i></p> <p>Activity 1.2: <i>Dissemination of mangrove plantation as nature-based solutions for erosion in target coastal areas</i></p> |
| <p>Action 2: Community-based mangrove ecosystem restoration/protection</p> <p>This action aims to put the coastal community at the centre of mangrove restoration efforts by involving them in planning, preparation of nursery centres (including collection of seedlings and construction of fences), planting activities, and monitoring.</p> | <p>Activity 2.1: <i>Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection</i></p> <p>Activity 2.2: <i>Developing concept notes/proposal for community-based</i></p> |

| | |
|---|---|
| <p>During the CRB project, a financial incentive (USD 1.00/seedling) was used to encourage more participation. However, this incentive did not translate into a successful restoration activity in the long run as many community members became inactive after the project concluded. To address this sustainability issue, it is recommended to couple the financial incentive with activities that generate incomes such as ecotourism, aquaculture, and horticulture. To address gender issues, the CRB project also set a 30% quota for female participation and membership in community groups.</p> | <p><i>mangrove ecosystem restoration/protection</i></p> <p>Activity 2.3: <i>Implementation of community-based mangrove ecosystem restoration/protection</i></p> <p>Activity 2.4: <i>Regular monitoring of restored/protected mangrove ecosystem</i></p> |
| <p>Action 3: Provision of alternative source of livelihood for coastal communities</p> <p>Many households in coastal areas frequently extract natural resources such as firewood, timber, and animal protein from mangrove forest for subsistence. They also develop aquaculture and salt production in areas where the mangrove ecosystem thrives. Hence, the adoption of this technology will face backlash when no alternative source of livelihood is provided. Following this logic, this action emphasises the need to establish alternative activities that will generate income and sustain a community's livelihood. It ensures the basic needs of community members living in areas where this technology is introduced. To address gender issues, the CRB project also provided a 30% quota for female beneficiaries and training participants.</p> | <p>Activity 3.1: <i>Assessment of alternative source of livelihoods</i></p> <p>Activity 3.2: <i>Technical training on specific areas that can generate alternative income</i></p> <p>Activity 3.3: <i>Linking produce/products to local market</i></p> <p>Activity 3.4: <i>Facilitating access to financial service providers</i></p> |

Table 38: List of actions and activities for the implementation of mangrove plantation

All actions listed under this technology are selected for Project Idea (PI) for TAP due to the fact they are closely interconnected and contribute to strengthening the efforts to introduce community-based mangrove plantation in the country.

2.1.4.4 Stakeholders and timeline for implementation of TAP

As identified in the BAEF report, the following stakeholders in Table 40 play crucial roles in the implementation of actions and corresponding activities for TAP for mangrove plantation.

| Stakeholder | Roles |
|---|---|
| MALFF | <p>The management of watersheds, lands, coastal, forests and protected areas falls under the responsibility of MALFF's Directorate General of Forestry. They work with the community to safeguard the above-mentioned natural resources from unsustainable use. Their nursery centres in municipalities can support community-based mangrove nurseries while their forest guards which are stationed in different parts of the national territories can strengthen the monitoring of mangrove areas. Additionally, the DG of Agriculture and Fisheries can provide support to community-based livelihood groups in their respective activities.</p> |
| Ministry of Tourism and Environment (MTE) | <p>MTE is the National Government agency responsible for managing tourism and environmental matters. Its Directorate General for Environment, through the National Directorate for Biodiversity, also oversees the implementation of mangrove plantation activities. Hence, MTE plays a crucial role in shaping the</p> |

| | |
|-------------------------------|--|
| | governance of natural resources. It can use its membership in the Council of Ministers to endorse relevant policy and programmes. |
| Development Agencies and NGOs | Agencies such as UNDP, Blue Ventures, Conservation International, KFF, Nafofila, and Timor Verde are committed to support efforts to restore coastal ecosystem in Timor-Leste by accessing funds from donors (GEF and GCF), working closely with community, and providing capacity building. They can work together to harness the potential effect of mangrove plantation in preventing coastal erosion. These agencies also emphasise gender balance in their country programmes; hence, their participation can further strengthen involvement of women in community-based natural resource management. |

Table 39: List of responsible stakeholders for the implementation of mangrove plantation

Timeline for the implementation of the actions and corresponding activities is presented in Table 41 below.

| Actions | Activities | Year | | | | |
|--|--|------|------|------|------|------|
| | | 2024 | 2025 | 2026 | 2027 | 2028 |
| 1: Campaign on the importance of mangrove ecosystem at national and local level | 1.1: Developing campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies | X | | | | |
| | 1.2: Dissemination of mangrove plantation as nature-based solutions for erosion in target coastal areas | | X | X | X | X |
| 2: Community-based mangrove ecosystem restoration/protection | 2.1: Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection | | X | X | | |
| | 2.2: Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection | | X | X | | |
| | 2.3: Implementation of community-based mangrove ecosystem restoration/protection | | | X | X | X |
| | 2.4: Regular monitoring of restored/protected mangrove ecosystem | | | X | X | X |
| 3: Provision of alternative source of livelihood for coastal communities | 3.1: Assessment of alternative source of livelihoods | | X | X | | |
| | 3.2: Technical training on specific areas that can generate alternative income | | | X | X | X |

| | | | | | | |
|--|--|--|--|---|---|---|
| | 3.3: <i>Linking produce/products to local market</i> | | | X | X | X |
| | 3.4: <i>Facilitating access to financial service providers</i> | | | X | X | X |

Table 40: Timeline for the implementation of mangrove plantation

2.1.4.5 Estimation of resources needed for action and activities

| Activities | Sub-activities | Cost (USD) |
|---|--|------------------|
| 1.1: <i>Developing campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | Development of campaign materials | 50,000 |
| | Printing/publication of campaign materials | 50,000 |
| 1.2: <i>Dissemination of mangrove plantation as nature-based solutions for erosion in target coastal areas</i> | Socialisation in target areas | 80,000 |
| 2.1: <i>Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection</i> | Consultant fee | 50,000 |
| | Site visits | 20,000 |
| 2.2: <i>Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection</i> | Consultant fee | 30,000 |
| | Consultations/meetings | 10,000 |
| 2.3: <i>Implementation of community-based mangrove ecosystem restoration/protection</i> | Preparation of nursery centres and fencing | 500,000 |
| | Planting of mangrove seedlings | 1,500,000 |
| 2.4: <i>Regular monitoring of restored/protected mangrove ecosystem</i> | Field monitoring activities | 80,000 |
| 3.1: <i>Assessment of alternative source of livelihoods</i> | Consultant fee | 50,000 |
| | Site visits | 20,000 |
| 3.2: <i>Technical training on specific areas that can generate alternative income</i> | Development of training manual | 20,000 |
| | Implementation of training activities | 100,000 |
| 3.3: <i>Linking produce/products to local market</i> | Consultation activities (interviews and focus group discussions) | 20,000 |
| 3.4: <i>Facilitating access to financial service providers</i> | Grants to livelihood groups | 500,000 |
| Total cost | | 3,080,000 |

Table 41: Resources estimation for the implementation of actions and activities for mangrove plantation

2.1.4.6 Management planning

Risks and Contingency Plans

The type of risks (*i.e.*, political, social, economic, scheduling, and financial risks), description, and contingency actions pertaining to TAP for mangrove plantation are similar to the ones presented in tarabandu.

Next steps

| Immediate Requirements | Critical Steps |
|--|--|
| DG of Environment and NDCC and should organise a stakeholder's workshop to communicate the TAP | Get the stakeholders buy-in, specially from, MALFF, MTE, and partners |
| MALFF and MTE to include TAP implementation budget to its 2025 budget | Integrate TAP implementation plans into MALFF and MTE's 2025 work plan |
| Development of an Inter-Ministerial Technical Working Group to oversee the TAP implementation | DGE should urgently get all major stakeholders on board |

Table 42: List of next steps for the implementation mangrove plantation

2.1.4.7 TAP Overview table

| Sector | Infrastructure and natural methods to prevent erosion | | | | | | | |
|---|---|-------------------|--|-----------|--|--|--|---------|
| Technology | Mangrove plantation | | | | | | | |
| Ambition | Around 2,500 Ha of mangrove ecosystem in Baucau, Lautem, Ataúro, Ainaro and Oecussi will be restored and protected | | | | | | | |
| Benefits | Coastal ecosystem is protected to enhance the resilience of coastal infrastructure | | | | | | | |
| Actions | Activities to be implemented | Source of funding | Responsible institution & focal point (Stakeholders & Roles) | Timeframe | Risks | Success criteria | Indicator for Monitoring and Implementation | Budget |
| 1: Campaign on the importance of mangrove ecosystem at national and local level | 1.1: <i>Developing campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> | GCF/GoTL | MALFF, MTE, NGO | 2024-2028 | Delays in recruiting qualified experts; termination of supports from implementing agencies/donors | Campaigns materials are effective in conveying the message | Variety of campaign materials | 100,000 |
| | 1.2: <i>Dissemination of mangrove plantation as nature-based solutions for erosion in target coastal areas</i> | GCF/GoTL | MALFF, MTE, NGO | 2024-2028 | Gang conflict between youth groups, natural disasters, limited participation from target beneficiary groups; termination of supports from implementing agencies/donors | Target sucos learn about mangrove plantation and are convinced about its effectiveness | Number of community groups adopting mangrove plantation techniques | 80,000 |
| 2: Community-based mangrove ecosystem restoration/protection | 2.1: <i>Assessment of condition of mangrove ecosystem in target areas, including recommendation</i> | GCF/GoTL | MALFF, MTE, NGO | 2024-2028 | Delays in recruiting qualified experts | Strength and gaps of existing rules and | Level of analysis of data | 70,000 |

| | | | | | | | | |
|---------------------------------------|---|----------|-----------------|-----------|--|--|--|---------|
| | <i>of best practice for mangrove ecosystem restoration/protection</i> | | | | | regulations are identified | | |
| | <i>2.2: Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection</i> | GCF/GoTL | MALFF, MTE, NGO | 2024-2028 | Limited participation from target beneficiary groups | Concept notes/proposals are approved | Number of approved concept notes/proposals | 40,000 |
| | <i>2.3: Implementation of community-based mangrove ecosystem restoration/protection</i> | GCF/GoTL | MALFF, MTE, NGO | 2024-2028 | Gang conflict between youth groups; natural disasters; limited participation from target beneficiary groups; termination of supports from implementing agencies/donors | High survival rates of mangrove plantation | Number of area coverage | 200,000 |
| | <i>2.4: Regular monitoring of restored/protected mangrove ecosystem</i> | GCF/GoTL | MALFF, MTE, NGO | 2024-2028 | Limited participation from target beneficiary groups | There is a strong monitoring system in place; Restored areas are protected from destructive encroachment | Number of area coverage | 80,000 |
| 3: Provision of alternative source of | <i>3.1: Assessment of alternative source of livelihoods</i> | GCF/GoTL | MALFF, NGO | 2024-2028 | Delays in recruiting | Relevant, feasible alternative | Level of analysis of data | 70,000 |

| | | | | | | | | |
|------------------------------------|---|----------|------------|-----------|---|---|---|---------|
| livelihood for coastal communities | | | | | qualified experts | sources of livelihood are identified | | |
| | 3.2: <i>Technical training on specific areas that can generate alternative income</i> | GCF/GoTL | MALFF, NGO | 2024-2028 | Delays in recruiting qualified experts; limited participation from target beneficiary groups; termination of supports from implementing agencies/donors | Target groups' gain new skill sets; | Number of female beneficiaries in target sucos; Number of new livelihood activities in target sucos | 120,000 |
| | 3.3: <i>Linking produce/products to local market</i> | GCF/GoTL | MALFF, NGO | 2024-2028 | Limited participation from target beneficiary groups | Products are sold in stores/markets | Number of sales in a given period; changes in income level | 20,000 |
| | 3.4: <i>Facilitating access to financial service providers</i> | GCF/GoTL | MALFF, NGO | 2024-2028 | Limited participation from target beneficiary groups; termination of supports from implementing agencies/donors | More farmers can access micro loan and financial services | Number of farmers who access financial services disaggregated by gender | 500,000 |

Table 43: TAP overview table for mangrove plantation

2.2 Project ideas for Infrastructure and Natural Methods to Prevent Erosion Sector

2.2.1 Brief summary of the project ideas for infrastructure and natural methods to prevent erosion sector

Timor-Leste is highly exposed to weather hazards and recurrent disasters due to heavy monsoon rains, steep topography, widespread deforestation and land degradation, cyclones, and strong winds. In 2019, the World Risk Index identified Timor-Leste as the 20th country most at risk in the world for natural disasters due to its geographical location and very limited capacity to prepare for and recover from climate-related shocks (FAO, 2021). Climate-induced hazards frequently impact families' lives and livelihoods while also damaging critical rural infrastructure including water supply and drainage, embankments, roads, and bridges (UNDP, 2024). These damages leave rural populations without basic services and often in full isolation.

High-quality road and bridge infrastructures provide solutions to many rural parts of Timor-Leste where landslides and floods regularly interrupt road connections, restricting mobility of people and goods (*i.e.*, inputs for agriculture production and agriculture produces) (GoTL, 2011). To address this infrastructure challenge, the SDP 2011-2030 has prioritised significant investments in road rehabilitation, repair, and improvement. Nevertheless, the strategic document neither factors in climate change impacts on road and other infrastructures development nor considers nature-based solutions such as soil bioengineering, terracing, and mangrove plantation.

To respond to the above-mentioned situations, this TAP proposed two project ideas for sector 2. The first one is "Scaling up Soil Bioengineering in Infrastructure Development in Timor-Leste", which aims to enhance the resilience of public infrastructures to the impacts of climate change through wide scale adoption and deployment of soil bioengineering. The second project, "Upgrading Coastal Resilience Building through Mangrove Ecosystem Restoration in Timor-Leste", aims to reduce erosion in the coastal area of Timor-Leste through extensive mangrove plantations. This project can be looked at as the second phase of the GEF-funded project, Coastal Resilience Building (CRB), which was implemented by MALFF and UNDP between 2016-2021. The two proposed projects will help improve the quality of life of both urban and rural communities (both inland and in coastal areas) through improved accessibility and connectivity to public infrastructures and economic diversifications.

2.2.2 Specific project Idea

2.2.2.1 Project idea 1: *Scaling up Soil Bioengineering in Infrastructure Development in Timor-Leste*

The following table provides detailed information on the first project idea for sector 2 such as background, objective, outputs, relevance, benefit, scope, activities, resources, timeline, risks, evaluation, and stakeholders.

| | |
|--------------------------|--|
| Introduction /Background | Climate-induced hazards frequently impact families' lives and livelihoods while also damaging critical rural infrastructure including water supply and drainage, embankments, roads and bridges (UNDP, 2024). These damages leave rural populations without basic services and often in full isolation. Timor-Leste's Second National Communication under the UNFCCC, the National Determined Contribution (NDC) 2022-2023, and National Adaptation Plan (NAP) call for an integration of nature-based solutions (NbS) such as mangrove ecosystem protection and bioengineering into climate adaptation efforts to reduce the impact of natural disasters on both people and infrastructure. |
|--------------------------|--|

| | |
|------------|--|
| | <p>Deemed as a useful and effective technology for slope stabilisation and soil conservation, soil-bioengineering is simple, low cost, environmentally friendly, sustainable, and effective technology which requires little to no maintenance. It is also a complementary addition to conventional hard engineering approaches that use rock-based and concrete physical structures (ADB,2018). It is particularly important for roads in Timor-Leste, where adjacent slopes have a plethora of stability problems. The technology can significantly reduce the risk of erosion by establishing vegetation in combination with timber and/or rock-based engineering structures to anchor and protect shallow-seated earth masses.</p> <p>There have been numerous efforts to introduce and enhance adoption of soil bioengineering in Timor-Leste. In 2012, the World Bank developed a field guide on soil bioengineering for slope stabilisation in Timor-Leste for upland and coastal areas as part of capacity building for the Ministry of Public Works (MPW), forestry department of MALFF and relevant practitioners. This has contributed to mainstreaming of soil bioengineering in other projects in the country, including the UNDP’s Strengthening the Resilience of Small-Scale Rural Infrastructure and Local Government Systems to Climatic Variability and Risks (SSRI) project, ADB’s Road Network Upgrading Project, and Word Bank’s Timor-Leste Road Climate Resilience Project¹⁶.</p> <p>The proposed project idea will build on past and ongoing efforts to mainstream soil bioengineering in all infrastructure projects in the country. It will do so by strengthening regulatory frameworks and monitoring of infrastructure projects of all types (<i>i.e.</i>, roads, bridges, water, energy, housing, schools, and health centres) and sizes (<i>i.e.</i>, small, medium, and large). Additionally, some portions of the project will focus on research and development (R&D) partnership and capacity building for relevant actors.</p> |
| Objectives | <ol style="list-style-type: none"> 1. To enhance the resilience of public infrastructures to the impacts of climate change through wide scale adoption and deployment of soil bioengineering 2. To enhance improve the quality of life of both urban and rural communities through improved accessibility and connectivity |
| Outputs | <ol style="list-style-type: none"> 1. Soil bioengineering technology is integrated into infrastructure development plans of relevant ministries (<i>i.e.</i>, MPW and MSA) and is budgeted in the annual programme by 2025 2. Partnership and investment in R&D for soil bioengineering is initiated by 2025 3. Soil bioengineering manual is updated with more recent findings and lesson learned by 2026 4. Engineers, contractors, and labours are familiar with different type of soil bioengineering techniques |

¹⁶ Implemented by Ministry of Public Works of Timor-Leste

| | 5. Interministerial working groups and stakeholder partnerships in climate-resilient infrastructure development are strengthened by 2025 | | | | | | | | | | | | |
|--|---|------------------------|--------------|--|--------|--|---------|---|-----------|--|--------|---|--------|
| Relevance to Timor-Leste's sustainable development priorities | The project is in line with Timor-Leste's Second National Communication under the UNFCCC, the National Determined Contribution (NDC) 2022-2023, and National Adaptation Plan (NAP) which highlight the importance of integrating NbS to reduce the impact of natural disaster on people and infrastructure. Additionally, it will contribute to Timor-Leste's SDP 2011-2030 which prioritises significant investments in road rehabilitation, repair, and improvement. Moreover, it will significantly reduce the high expenditure on infrastructure development from the state budget allocation in the long run. | | | | | | | | | | | | |
| Project deliverables (values/benefits) | <ol style="list-style-type: none"> 1. The frequency of road closures due to natural disasters, especially in rainy season, is reduced 2. Significant reduction of expenditure for infrastructure development from the annual state budget 3. Rural communities, especially women and children, have improved access to basic facilities (<i>i.e.</i>, clean water, electricity, education, and health) 4. More awareness about alternative, cost-efficient, environmentally friendly NbS technologies | | | | | | | | | | | | |
| Project scope, possible implementation | The project can be implemented under the umbrella of the Programme of the XI Constitutional Government of Timor-Leste which seeks to assure quality infrastructure projects. Additionally, it can also be implemented within the scope of the country programme of corresponding implementing agencies (both local and international). | | | | | | | | | | | | |
| Activities & budget resource requirements | <table border="1"> <thead> <tr> <th>Activities/budget line</th> <th>Budget (USD)</th> </tr> </thead> <tbody> <tr> <td><i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i></td> <td>50,000</td> </tr> <tr> <td><i>Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups</i></td> <td>500,000</td> </tr> <tr> <td><i>Conducting research on demo plots for soil bioengineering in different project type and scales</i></td> <td>1,500,000</td> </tr> <tr> <td><i>Review of existing infrastructure development regulatory frameworks, policies, manual, and guidelines</i></td> <td>50,000</td> </tr> <tr> <td><i>Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines</i></td> <td>10,000</td> </tr> </tbody> </table> | Activities/budget line | Budget (USD) | <i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i> | 50,000 | <i>Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups</i> | 500,000 | <i>Conducting research on demo plots for soil bioengineering in different project type and scales</i> | 1,500,000 | <i>Review of existing infrastructure development regulatory frameworks, policies, manual, and guidelines</i> | 50,000 | <i>Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines</i> | 10,000 |
| Activities/budget line | Budget (USD) | | | | | | | | | | | | |
| <i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i> | 50,000 | | | | | | | | | | | | |
| <i>Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups</i> | 500,000 | | | | | | | | | | | | |
| <i>Conducting research on demo plots for soil bioengineering in different project type and scales</i> | 1,500,000 | | | | | | | | | | | | |
| <i>Review of existing infrastructure development regulatory frameworks, policies, manual, and guidelines</i> | 50,000 | | | | | | | | | | | | |
| <i>Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines</i> | 10,000 | | | | | | | | | | | | |

| | <table border="1"> <tr> <td><i>Establishing mandatory budget item for soil bioengineering in infrastructure development projects</i></td> <td>10,000</td> </tr> <tr> <td><i>Conducting regular monitoring of soil-bioengineering applications on project sites</i></td> <td>60,000</td> </tr> <tr> <td style="text-align: right;">Total cost</td> <td>2,180,000</td> </tr> </table> <p>The GoTL and GCF can be the ideal actors to co-finance the project provided that they both have co-funded a project which aims to enhance the resilience of small-scale infrastructure in rural parts of Timor-Leste.</p> | <i>Establishing mandatory budget item for soil bioengineering in infrastructure development projects</i> | 10,000 | <i>Conducting regular monitoring of soil-bioengineering applications on project sites</i> | 60,000 | Total cost | 2,180,000 | | | | | | | | | |
|--|--|--|----------------------|---|--|---|--|--|---|---|---|---|--|--|---|--|
| <i>Establishing mandatory budget item for soil bioengineering in infrastructure development projects</i> | 10,000 | | | | | | | | | | | | | | | |
| <i>Conducting regular monitoring of soil-bioengineering applications on project sites</i> | 60,000 | | | | | | | | | | | | | | | |
| Total cost | 2,180,000 | | | | | | | | | | | | | | | |
| Timelines | End of 2024 – End of 2028 | | | | | | | | | | | | | | | |
| Measurement /Evaluation | <table border="1"> <thead> <tr> <th>Activity</th> <th>Monitoring indicator</th> <th>Success criteria</th> </tr> </thead> <tbody> <tr> <td><i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i></td> <td> <ul style="list-style-type: none"> • Consultant reports • Minutes of Inter-Ministerial meetings </td> <td> <ul style="list-style-type: none"> • All outcomes of different soil-bioengineering techniques are captured along with common challenges and lessons learned </td> </tr> <tr> <td><i>Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups</i></td> <td> <ul style="list-style-type: none"> • Minutes of Inter-Ministerial and stakeholder meetings </td> <td> <ul style="list-style-type: none"> • An MoU for research partnership is signed </td> </tr> <tr> <td><i>Conducting research on demo plots for soil bioengineering in different project type and scales</i></td> <td> <ul style="list-style-type: none"> • Field reports • Quarterly/annual reports </td> <td> <ul style="list-style-type: none"> • Research activities are regularly conducted in laboratory and fields • Publication of research findings </td> </tr> <tr> <td><i>Review of existing infrastructure development regulatory frameworks, policies, manual, and guidelines</i></td> <td> <ul style="list-style-type: none"> • Consultant reports • Minutes from technical working group meetings </td> <td> <ul style="list-style-type: none"> • Recommendations from findings are used to improve regulatory frameworks, policies, manual and guidelines </td> </tr> </tbody> </table> | Activity | Monitoring indicator | Success criteria | <i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i> | <ul style="list-style-type: none"> • Consultant reports • Minutes of Inter-Ministerial meetings | <ul style="list-style-type: none"> • All outcomes of different soil-bioengineering techniques are captured along with common challenges and lessons learned | <i>Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups</i> | <ul style="list-style-type: none"> • Minutes of Inter-Ministerial and stakeholder meetings | <ul style="list-style-type: none"> • An MoU for research partnership is signed | <i>Conducting research on demo plots for soil bioengineering in different project type and scales</i> | <ul style="list-style-type: none"> • Field reports • Quarterly/annual reports | <ul style="list-style-type: none"> • Research activities are regularly conducted in laboratory and fields • Publication of research findings | <i>Review of existing infrastructure development regulatory frameworks, policies, manual, and guidelines</i> | <ul style="list-style-type: none"> • Consultant reports • Minutes from technical working group meetings | <ul style="list-style-type: none"> • Recommendations from findings are used to improve regulatory frameworks, policies, manual and guidelines |
| Activity | Monitoring indicator | Success criteria | | | | | | | | | | | | | | |
| <i>Review of outcomes from different soil bioengineering projects in Timor-Leste</i> | <ul style="list-style-type: none"> • Consultant reports • Minutes of Inter-Ministerial meetings | <ul style="list-style-type: none"> • All outcomes of different soil-bioengineering techniques are captured along with common challenges and lessons learned | | | | | | | | | | | | | | |
| <i>Establishing research partnerships among civil engineering laboratory, engineering department of local universities, and community groups</i> | <ul style="list-style-type: none"> • Minutes of Inter-Ministerial and stakeholder meetings | <ul style="list-style-type: none"> • An MoU for research partnership is signed | | | | | | | | | | | | | | |
| <i>Conducting research on demo plots for soil bioengineering in different project type and scales</i> | <ul style="list-style-type: none"> • Field reports • Quarterly/annual reports | <ul style="list-style-type: none"> • Research activities are regularly conducted in laboratory and fields • Publication of research findings | | | | | | | | | | | | | | |
| <i>Review of existing infrastructure development regulatory frameworks, policies, manual, and guidelines</i> | <ul style="list-style-type: none"> • Consultant reports • Minutes from technical working group meetings | <ul style="list-style-type: none"> • Recommendations from findings are used to improve regulatory frameworks, policies, manual and guidelines | | | | | | | | | | | | | | |

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| | | | |
| | <i>Consultation with relevant agencies on the integration of soil bioengineering into infrastructure development project manuals/guidelines</i> | <ul style="list-style-type: none"> ● Consultant reports ● Minutes from technical working group meetings | <ul style="list-style-type: none"> ● Recommendations from findings are used to improve regulatory frameworks, policies, manual and guidelines |
| | <i>Establishing mandatory budget item for soil bioengineering in infrastructure development projects</i> | <ul style="list-style-type: none"> ● Minutes from technical working group meetings | <ul style="list-style-type: none"> ● Soil bioengineering is included in the budget line for infrastructure and reforestation programme for the consecutive years |
| | <i>Conducting regular monitoring of soil-bioengineering applications on project sites</i> | <ul style="list-style-type: none"> ● Field reports ● Quarterly/annual reports | <ul style="list-style-type: none"> ● Emerging technical challenges are addressed, and lesson learned are captured to improve future plans |
| Possible complications /Challenges | <ul style="list-style-type: none"> ● Failure to secure buy-in from relevant actors, specially MPW and MALFF Forestry ● Over politicisation of project activities ● Limited participation from target beneficiary groups, specifically women and youth, due to lack of interest and socio-cultural barrier ● Local conflict between youth groups which limits mobility and delays implementation of field activities in target sites ● Natural disasters (<i>i.e.</i>, flash flood and erosion) damage road conditions in rural areas, limiting access to target sites do conduct some activities ● Delays in recruiting qualified experts to develop and deliver training materials ● Financial support from implementing agencies/donors is terminated due to lack of transparency and ineffective management | | |
| Responsibilities and coordination | MPW, MALFF (DG of Agriculture and DG of Forestry), MTE (DG of Environment), Development partners (UNDP, CI, ILO) and research agencies (UNTIL Engineering Department), NGOs (Permatil) | | |

Table 44: Project idea 1 - Scaling up soil bioengineering in infrastructure development in Timor-Leste

2.2.2.2 Project idea 2: Upgrading Coastal Resilience Building through Mangrove Ecosystem Restoration in Timor-Leste

The following table provides detailed information on the first project idea for sector 2.

| | |
|--------------------------|---|
| Introduction /Background | <p>Timor-Leste’s 706 Km coastline is prone to the impact of climate-induced hazards such as sea level rise, inundation, salt-water intrusion, storm surge, and erosion. These damages threaten the safety and livelihood of many communities residing in coastal and low-lying areas as well as the conditions of public infrastructures. According to Timor-Leste’s Second National Communication to UNFCCC, stretches of coast in the south of the island are more vulnerable to erosion than the ones in the north.</p> <p>The biggest effort to enhance the resilience of coastal areas to the impact of climate change was manifested in the form of a GEF-funded project, Coastal Resilience Building, implemented by MALFF and UNDP between 2016-2021. Strengthening the resilience of coastal communities through the introduction of NbS to coastal protection, the main project component includes a focus on mangroves and coastal wetlands ecosystem protection and restoration. There is also another component which focuses on strengthening alternative livelihoods options, especially for women, and integrated approaches to coastal adaptation. Raising public awareness about the importance of coastal ecosystems in shoreline protection and climate change is an integral part of the programme.</p> <p>The CRB project has resulted in the protection and restoration of around 2,271 Ha of the 4,831 Ha. Communities living around the remaining 2,560 Ha of mangrove forest did not receive support from the project intervention, creating gaps for awareness of the importance of the mangrove ecosystem and restoration of the total mangrove areas in the country. It is the main objective of the proposed project to bridge the gaps and further enhance the resilience of communities residing in all coastal areas in the country. In terms of planning and coordination, the proposed project can capitalise on experience and lessons learned from the CRB project to maximise its outputs and sustainability of the outcome.</p> <p>The project is in line with the Timor-Leste’s NAPA, NDC and the campaign programme of “Ha’u nia Tasi, Ha’u nia Timor” of the IX Government of Timor-Leste.¹⁷</p> |
| Objectives | <ol style="list-style-type: none"> 1. To restore and rehabilitate mangrove forests in coastal areas of Timor-Leste through community-led mangrove planting activities 2. To diversify the source of livelihood for coastal community through eco-tourism, aquaculture, and horticulture and improve their access to market |

¹⁷ The GoTL attributes mangrove restoration and conservation under the responsibility of the Forestry Directorate of MALFF

| | |
|---|---|
| Outputs | <ol style="list-style-type: none"> 1. Communities residing in coastal areas, especially children and youth, have improved understanding of the benefits of mangrove ecosystem services by 2028 2. Around 2,500 Ha of mangrove forest is restored and rehabilitated through community-led plantation programme by 2028 3. Mangrove plantations and coastal livelihood supports are included in the budget line of relevant ministries (<i>i.e.</i>, MALFF, SECOOP, and SEFOPE) by 2025 4. 80% of coastal community residing in project areas, especially women and youth, have alternative source of income and improved access to markets by 2026 5. Interministerial working groups and stakeholder partnerships in coastal resilient building are strengthened by 2025 |
| Relevance to Timor-Leste’s sustainable development priorities | <p>The proposed project is in line with Timor-Leste's NAPA which recommends mangrove restoration and conservation as one of the nine priority areas. It will also contribute to the campaign of “Ha'u nia Tasi, Ha'u nia Timor” of the IX Government of Timor-Leste¹⁸ which aims to preserve and promote mangrove reforestation. Additionally, it will be closely linked to Timor-Leste’s National Determined Contribution (NDC) which highlights mangrove restoration as one of the innovative NbS to support the development of new livelihoods, build resilience to climate and disaster risks, and contribute to climate repair. At the global level, the project will contribute to Timor-Leste’s attainment of SDG goal 15 (life on land), 13 (climate action), 11 (sustainable cities and communities) and SDG 1 (zero poverty)</p> |
| Project deliverables (values/benefits) | <ol style="list-style-type: none"> 1. The level of coastal erosion is reduced 2. Coastal villages become more resilient to climate-induced disasters 3. A reduction of expenditure for infrastructure development in coastal area from the annual state budget 4. Rural communities, especially women and children, have improved quality of life 5. Species diversity in coastal and wetland areas are maintained 6. More awareness about alternative, cost-efficient, environmentally friendly NbS technologies |
| Project scope, possible implementation | <p>The project can be implemented under the umbrella of the Programme of the XI Constitutional Government of Timor-Leste as they recently launched a campaign, “Ha'u nia Tasi, Ha'u nia Timor”, which seeks to also preserve and promote mangrove reforestation. Additionally, it can also be implemented within the scope of the country programme of corresponding</p> |

¹⁸ The GoTL attributes mangrove restoration and conservation under the responsibility of the Forestry Directorate of MALFF

| | implementing agencies (both local and international) which are linked to relevant SDG goals. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|------------|------------|--|---------|---|--------|--|--------|--|--------|--|-----------|---|--------|---|--------|---|--------|--|--------|--|--------|--|---------|--|--------|---|---------|-------------------|------------------|
| Activities & budget resource requirements | <table border="1"> <thead> <tr> <th>Activities</th> <th>Cost (USD)</th> </tr> </thead> <tbody> <tr> <td><i>Developing campaign materials (leaflet, videos, radio shows, plays) based on available findings from research/studies</i></td> <td>100,000</td> </tr> <tr> <td><i>Socialisation of mangrove plantation as nature-based solutions for erosion in target coastal areas</i></td> <td>80,000</td> </tr> <tr> <td><i>Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection</i></td> <td>70,000</td> </tr> <tr> <td><i>Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection</i></td> <td>40,000</td> </tr> <tr> <td><i>Implementation of community-based mangrove ecosystem restoration/protection</i></td> <td>2,000,000</td> </tr> <tr> <td><i>Review of existing tarabandu rules and regulations and their effectiveness</i></td> <td>30,000</td> </tr> <tr> <td><i>Consultation with relevant actors to improve local governance of NRM</i></td> <td>20,000</td> </tr> <tr> <td><i>Establishing mandatory budget item for tarabandu monitoring activities</i></td> <td>10,000</td> </tr> <tr> <td><i>Regular monitoring of restored/protected mangrove ecosystem</i></td> <td>80,000</td> </tr> <tr> <td><i>Assessment of alternative source of livelihoods</i></td> <td>70,000</td> </tr> <tr> <td><i>Technical training on specific areas that can generate alternative income</i></td> <td>120,000</td> </tr> <tr> <td><i>Linking farmers' produces to local market</i></td> <td>20,000</td> </tr> <tr> <td><i>Facilitating access to financial service providers</i></td> <td>500,000</td> </tr> <tr> <td style="text-align: right;">Total cost</td> <td>3,040,000</td> </tr> </tbody> </table> <p>The GoTL and GCF can be the ideal actors to co-finance the project provided that they both have co-funded a project which aims to enhance the resilience of small-scale infrastructure in rural parts of Timor-Leste.</p> | Activities | Cost (USD) | <i>Developing campaign materials (leaflet, videos, radio shows, plays) based on available findings from research/studies</i> | 100,000 | <i>Socialisation of mangrove plantation as nature-based solutions for erosion in target coastal areas</i> | 80,000 | <i>Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection</i> | 70,000 | <i>Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection</i> | 40,000 | <i>Implementation of community-based mangrove ecosystem restoration/protection</i> | 2,000,000 | <i>Review of existing tarabandu rules and regulations and their effectiveness</i> | 30,000 | <i>Consultation with relevant actors to improve local governance of NRM</i> | 20,000 | <i>Establishing mandatory budget item for tarabandu monitoring activities</i> | 10,000 | <i>Regular monitoring of restored/protected mangrove ecosystem</i> | 80,000 | <i>Assessment of alternative source of livelihoods</i> | 70,000 | <i>Technical training on specific areas that can generate alternative income</i> | 120,000 | <i>Linking farmers' produces to local market</i> | 20,000 | <i>Facilitating access to financial service providers</i> | 500,000 | Total cost | 3,040,000 |
| Activities | Cost (USD) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Developing campaign materials (leaflet, videos, radio shows, plays) based on available findings from research/studies</i> | 100,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Socialisation of mangrove plantation as nature-based solutions for erosion in target coastal areas</i> | 80,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection</i> | 70,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection</i> | 40,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Implementation of community-based mangrove ecosystem restoration/protection</i> | 2,000,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Review of existing tarabandu rules and regulations and their effectiveness</i> | 30,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Consultation with relevant actors to improve local governance of NRM</i> | 20,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Establishing mandatory budget item for tarabandu monitoring activities</i> | 10,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Regular monitoring of restored/protected mangrove ecosystem</i> | 80,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Assessment of alternative source of livelihoods</i> | 70,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Technical training on specific areas that can generate alternative income</i> | 120,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Linking farmers' produces to local market</i> | 20,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Facilitating access to financial service providers</i> | 500,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total cost | 3,040,000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Timelines | End of 2024 – End of 2028 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Measurement /Evaluation | Activity | Monitoring indicator | Success criteria |
|-------------------------|---|---|---|
| | Developing campaign materials (leaflet, videos, radio shows, plays) based on available findings from research/studies | <ul style="list-style-type: none"> ● Consultant reports | <ul style="list-style-type: none"> ● Campaign materials use facts and figures and are available in user-friendly format and languages |
| | Socialisation of mangrove plantation as nature-based solutions for erosion in target coastal areas | <ul style="list-style-type: none"> ● Field reports ● Quarterly/annual reports | <ul style="list-style-type: none"> ● Community members translate awareness into concrete actions (<i>i.e.</i>, participation in mangrove planting, building fences, and refrain from cutting mangrove trees) |
| | Assessment of condition of mangrove ecosystem in target areas, including recommendation of best practices for mangrove ecosystem restoration/protection | <ul style="list-style-type: none"> ● Consultant reports ● Quarterly/annual reports | <ul style="list-style-type: none"> ● Data Based on current conditions of mangrove forest are developed and recommendations can be translated into concrete, feasible, cost-effective actions and activities |
| | Developing concept notes/proposal for community-based mangrove ecosystem restoration/protection | <ul style="list-style-type: none"> ● Minutes of Inter-Ministerial and stakeholder meetings ● Quarterly/annual reports | <ul style="list-style-type: none"> ● Concept notes are approved, and activities are funded by more donors |
| | Implementation of community-based mangrove ecosystem restoration/protection | <ul style="list-style-type: none"> ● Field reports ● Quarterly/annual reports | <ul style="list-style-type: none"> ● Mangrove planting have high turnout and survival rates |
| | Review of existing <i>tarabandu</i> rules and regulations and their effectiveness | <ul style="list-style-type: none"> ● Minutes from technical working group meetings | <ul style="list-style-type: none"> ● Challenges and gaps of <i>tarabandu</i> rules are addressed |
| | Consultation with relevant actors to | <ul style="list-style-type: none"> ● Field reports | <ul style="list-style-type: none"> ● Challenges and gaps of <i>tarabandu</i> rules |

| | | | |
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| | improve local governance of NRM | <ul style="list-style-type: none"> Minutes from technical working group meetings | <ul style="list-style-type: none"> are addressed and integration of <i>tarabandu</i> into local rules/regulations |
| | Establishing mandatory budget item for <i>tarabandu</i> monitoring activities | <ul style="list-style-type: none"> Minutes from technical working group meetings | <ul style="list-style-type: none"> Budget lines to support enforcement of <i>tarabandu</i> are submitted and approved |
| | Regular monitoring of restored/protected mangrove ecosystem | <ul style="list-style-type: none"> Field reports | <ul style="list-style-type: none"> Monitoring reports are submitted regularly, addressing progress and challenges |
| | Assessment of alternative source of livelihoods | <ul style="list-style-type: none"> Consultant reports | <ul style="list-style-type: none"> Profitable small-scale business ideas for both men and women are identified |
| | Technical training on specific areas that can generate incomes | <ul style="list-style-type: none"> Consultant reports Field reports | <ul style="list-style-type: none"> Significant difference of results between post- and pre-training assessments |
| | Linking farmers' produces to local market | <ul style="list-style-type: none"> Consultant reports | <ul style="list-style-type: none"> Significant change of farmers' income |
| | Facilitating access to financial service providers | <ul style="list-style-type: none"> Consultant reports | <ul style="list-style-type: none"> Smallholder farmers, especially women, have access to loans and grants to develop/expand their business |
| Possible complications /Challenges | <ul style="list-style-type: none"> Failure to secure buy-in from relevant actors, specially MALFF and MTE Over politicisation of project activities Limited participation from target beneficiary groups, specifically women and youth, due to lack of interest and socio-cultural barrier as well as the outbreak of crocodile population Local conflict between youth groups which limits mobility and delays implementation of field activities in target sites | | |

| | |
|-----------------------------------|---|
| | <ul style="list-style-type: none"> ● Natural disasters (<i>i.e.</i>, flash flood, and erosion) damage road conditions in rural areas, limiting access to target sites do conduct some activities ● Delays in recruiting qualified experts to develop and deliver training materials ● Financial support from implementing agencies/donors is terminated due to lack of transparency and ineffective management |
| Responsibilities and coordination | MALFF (DG of Forestry), MTE (DG of Environment), Secretaria de Estado de Cooperativas (SESCOOP), Secretaria de Estado da Formação Profissional e Emprego (SEFOPE), Development partners (UNDP, CI, Blue Venture) and research agencies (UNTIL Coast and Marine Science Department), NGOs (KFF and Timor Verde) |

Table 45: Project idea 2 - Upgrading coastal resilience building through mangrove ecosystem restoration in Timor-Leste

Chapter 3: Cross-cutting issues

In the process of developing the TAPs, a number of actions and their subsequent activities have been proposed for each of the prioritised technologies. Each of the actions can be developed into a stand-alone project idea. The combination of actions selected from four technologies in sector 1 (Sustainable Land Management in Agriculture) is used to develop the first project idea, *Scaling up Climate Smart-Agriculture (CSA) practices in Timor-Leste*. Similarly, a set of actions are combined to develop the other two project ideas for sector 2 (Infrastructure and Natural Methods to Prevent Erosion) namely *Scaling up Soil Bioengineering in Infrastructure Development in Timor-Leste* and *Upgrading Coastal Resilience Building through Mangrove Ecosystem Restoration in Timor-Leste*. These actions were developed in response to a list of common barriers for technologies in both sector 1 (SLM in Agriculture) and sector 2 (Infrastructure and Natural Methods to Prevent Erosion). They are considered as the most practical, contextualised, gender sensitive, and cost-effective actions to overcome the barriers.

The two sectors selected for adaptation are quite different in terms of their target beneficiaries and field of application. Sector one focuses on identification and assessment of technologies which can support farmers while sector two targets a wide range of people who rely on public infrastructures (*i.e.*, roads, bridges, water and power, and building facilities). Moreover, sector one will mostly be applied in private/common properties while sector two will mostly be applied in common/public properties. Despite these differences, the PIs for both sectors have some common barriers.

Table 46 provides detail of these common barriers as well as measures, actions and activities that can help address the barriers. It shows that issues that stem common barriers for adoptions of almost all seven technologies are identified across both agriculture and infrastructure sectors. Therefore, it is recommended that measures and strategies to address these issues be integrated and mainstreamed.

| Common barriers | Actions | Activities |
|--|---|--|
| Lack of fundings and high capital cost | Facilitate beneficiary groups' access to capital in target municipalities | <ul style="list-style-type: none"> • <i>Conducting assessment and surveys of beneficiary groups' access to financial services in Timor-Leste</i> • <i>Organising information session between local financial services and target beneficiary groups</i> • <i>Establishing help desks to assist beneficiary groups application for loans and/or formation of saving-and-loan group</i> |
| | Connecting beneficiary groups with external support (donors and implementing agencies) | <ul style="list-style-type: none"> • <i>Establish community groups for respective NRM</i> • <i>Mapping out community groups and their respective supporting agency at suco/aldeia level</i> • <i>Sharing/presenting the maps to potential donors</i> |
| Lack of investment in R&D | Expansion of research on new technologies | <ul style="list-style-type: none"> • <i>Consultation and mapping out relevant stakeholders (i.e. donors, research institutes, academia, and beneficiary groups)</i> • <i>Development of research plans and implementation of research activities</i> • <i>Dissemination of research findings</i> |

| | | |
|------------------------------|---|---|
| Limited knowledge and skills | Extensive education and awareness raising campaign | <ul style="list-style-type: none"> ● <i>Development of campaign materials (leaflet, videos, radio shows, plays) based on findings from research/studies</i> ● <i>Socialisation in target sucos</i> |
| | Capacity building activities for target beneficiary groups | <ul style="list-style-type: none"> ● <i>Assessment of beneficiaries knowledge of relevant technologies</i> ● <i>Development of training materials</i> ● <i>Implementation of training in demo plots and facilitating exchange visits</i> |
| Poor governance | Integration of new technologies into national NRM plans | <ul style="list-style-type: none"> ● <i>Assessment of relevant manuals and guidelines or rules and regulations</i> ● <i>Public consultations on newly updated/proposed system</i> ● <i>Enforcement of updated rules and regulations</i> |

Table 46: List of common barriers and recommended actions and activities

Chapter 4: Conclusion

The Technology Action Plan (TAP) report signifies the culmination of the Technology Needs Assessment (TNA) process, which used a consultative methodology. This approach adhered to the guidelines outlined in the "Guidance for Preparing a Technology Action Plan" handbook, with the goal of enhancing the TNA process to facilitate improved project implementation. The necessity to offer guidance on translating TNA results, especially TAPs, into actionable projects was acknowledged.

The TAP for adaptation report outlines the final selection of seven technologies for the concluding phase of the TNA process, intended for government review. The first four sets of technologies – conservation agriculture and crop rotation, water management and restoration, biochar, and composting – provide solutions to address issues faced by farmers in increasing agricultural productivity and conserving critical natural resources (*i.e.*, soil and water). The other three technologies – soil bioengineering, *tarabandu*, and mangrove plantation – are infrastructure and natural methods to prevent erosion in both mountainous and coastal areas. It is essential that the responsible Government agency seek fundings to support the implementation of recommended TAPs and project ideas outlined in this report

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Annex I: List of Stakeholder involved and their contacts

1.1 One-on-One Consultation Stakeholders

| No. | Name | Institution | Position | Email Contact |
|-----|---|---|--|---|
| 1. | Mr. Rofino Soares Gusmão | National Directorate for Food Security and cooperation, Ministry of Agriculture and Fishery (MAF) | National Director | gerrandogusmao@gmail.com |
| 2. | Mr. Agustinus Bruno Halle | DNTT | | bruno_atta@yahoo.com |
| 3. | Mr. Profirio Fernandes Xavier | ADB | Technical Staff | konumalai@gmail.com |
| 4. | Mr. Zacarias Bosco & Mr. Mercuides de Sousa | The National Authority for Electricity (ANE, IP) | Technical Staffs | zacarias.bosco@ane.tl / desousamercuides@gmail.com |
| 5. | Mr. Mateus Maia | NGO Raebia | Deputy | xistomartins@raebia.org / smartins@up.edu.ph |
| 6. | Mr. Arlindo Silveiro | Environmental Planning and Management, National Directorate of Pollution Control | Chief Department | arlindosilveira642@gmail.com / silveiralindu@yahoo.co.id |
| 7. | Mr. Ego Lemos | Permatil | Executive Director | ego.lemos72@gmail.com |
| 8. | Mr. Alito Rosa | NGO KFF | Executive Director | |
| 9. | Ms. Joana Gusmao | Ho Musan Ida/With One Seed | Coordinator Hub Enterprise Baguia & Finance Officer. | joana@withoneseed.org.au |
| 10. | Ms. Leopoldina Joana | With One Seed/Rai Matak | Project Manager | leopoldinaj82@gmail.com |
| 11. | Mr. Moises Guterres De Sar | Environmental Legal Office | Chief Department | |
| 12. | Mr. Fernandino Xavier da Costa | MAF | Chief Department | |
| 13. | Mr. Adelino | MAF | Staff | |
| 14. | Mr. Zecky Carmo | TILOFE | Director | zeckyhironimos@gmail.com |
| 15. | Mr. Robert W. | AI-COM | Director | rob@livethedream.tl |
| 16. | Ms. Joaquina Barreto | AI-COM, Ministry of | Staff | quina.barreto@gmail.com |

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|-----|----------------------|-------------------------------|---------------------|---|
| | | Agriculture and Fishery (MAF) | | |
| 17. | Mr. Carlos das Neves | Habelun Ai-parapa | Group Leader | |
| 18. | Dulce Gusmão | EU | | Dulce-Maria.e-silva-gusmao@eeas.europa.eu |
| 19. | Expedito Belo | UNDP | Project Coordinator | expedito.belo@undp.org |

1.2. Participants of Consultation Workshop

| No. | Name | Institution | Type of Stakeholder |
|-----|---------------------------|--|----------------------------|
| 1. | Isaura Baptista Barros | Laudato Si Movement Timor-Leste (LSA-TL) | Youth group |
| 2. | Albino da S. Barbosa | MAPPF | Government Institution |
| 3. | Mercuides de Sousa | The National Authority for Electricity (ANE, IP) | Public Institution |
| 4. | Zacarias Bosco | The National Authority for Electricity (ANE, IP) | Public Institution |
| 5. | Liborio A. T. do Rosario | FCOTI | Foundation |
| 6. | Jose R. O. Fernandes | MAPPF | Government Institution |
| 7. | Armandina Clemencia | MPIE – DNOE | Government Institution |
| 8. | Evaristo D. C | ADTL | Association |
| 9. | Fernando Ronaldo da Costa | MPIE – DNOE | Government Institution |
| 10. | Eligio Soares | TROBAS | NGO |
| 11. | Antero Pinto Pereira | LCOY-TL | Youth Group |
| 12. | Profirio Fernandes Xavier | DNTT (ADB technical Staff) | Government Institution |
| 13. | Agustinus Bruno Halle | DNTT | Government Institution |
| 14. | Marcia e Silva | FAO | UN Agency |
| 15. | Apolonia Barreto | UNICEF | UN Agency |
| 16. | Dulce Gusmão | Delegation of the European Union to Timor-Leste | International Organization |
| 17. | Andre Neto da Silva | FCOTI | Foundation |

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| 18. | Martinho D. S da Costa | Laudato Si Movement Timor-Leste (LSA-TL) | Youth group |
| 19. | Luis dos Santos Belo | DNAC | Government Institution |
| 20. | Jose Barros | TOMAK - DFAT | Development Partner |
| 21. | Claudino Nabais | FAO | UN Agency |
| 22. | Graziela Xavier | Mercy Corps | INGO |
| 23. | Justina Aurea Belo | NDCC | Government Institution |
| 24. | Leonardo Rosa | NDCC | Government Institution |
| 25. | Sofia Sagram | NDCC | Government Institution |
| 26. | Mario Ximenes | NDCC | Government Institution |
| 27. | Sebastiao da Costa | ANAS, IP | Public Institution |
| 28. | Maria Resi | NDCC | Government Institution |
| 29. | Suzana Cunha | Rai Matak – With One Seed | NGO |
| 30. | Josafat de Araujo | CVTL | NGO |
| 31. | Augusto Pinto | NDCC | Government Institution |
| 32. | Zelia A. Maria | NDCC | Government Institution |
| 33. | Vicente Ximenes | NDCC | Government Institution |
| 34. | Roberto Amaral | NDCC | Government Institution |
| 35. | Armando Barreto | NDCC | Government Institution |
| 36. | Kassius Klei Ximenes | National Director Spatial Planning | Government Institution |

Annex II: List of barriers and enabling measures

2.1 List of barriers and measures for sector 1

| Technology | Barriers | Enabling Measures |
|---|--|---|
| Conservation agriculture (CA) and crop rotation | <ol style="list-style-type: none"> 1. High capital cost for purchase and maintenance of equipment 2. Strong attachment to slash and burn farming practices inherited from ancestors 3. Limited knowledge on methods and benefits of CA & CR 4. Limited availability of inputs and services | <ol style="list-style-type: none"> 1. Facilitating farmer's access to capital (<i>i.e.</i>, micro-loan and grants) 2. Conducting CA & CR campaign at national and local level 3. Increasing the frequency of capacity building activities on CA & CR for all farmers 4. Improving supply chain for CA tools and equipment through domestic suppliers to reduce dependence on imports |
| Water Management and restoration | <ol style="list-style-type: none"> 1. Lack of fundings to support local community's initiatives 2. Lack of an integrated approach in water management and governance 3. Limited knowledge on water conservation methods | <ol style="list-style-type: none"> 1. Linking community group with potential donors and/or investors 2. Integrating water restoration plans in water management system 3. Providing capacity building on water conservation techniques to community groups |
| Biochar | <ol style="list-style-type: none"> 1. Collection of raw materials is high cost and time consuming 2.1 No market for biochar yet 2.2 Limited access to raw materials 3. Limited information on biochar's production and benefits 4. Lack of technical skills | <ol style="list-style-type: none"> 1. Facilitating farmer's access to capital (<i>i.e.</i>, micro-loan and grants) 2. Conducting market assessment on biochar production to link farmers with potential supplier of raw materials (<i>i.e.</i>, wood shaving, coffee husk, and rice husk) 3. Providing information on the production technique and benefits of biochar 4. Providing training on biochar production to farmers |

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|------------|---|--|
| Composting | <ol style="list-style-type: none"> 1.1 Compost production is high-cost initially and time consuming 1.2 Space requirement for compost production 2. Lack of market information on compost 3. Poor integration of composting in urban waste management | <ol style="list-style-type: none"> 1. Facilitating farmer's access to capital (<i>i.e.</i>, micro-loan and grants) 2. Conducting research on market for compost 3. Providing market information to potential compost suppliers <p>Integrating of waste separation in urban waste management</p> |
|------------|---|--|

Table 47: List of barriers and enabling measures for technologies in sector 1

2.2. List of barriers and measures for sector 2

| Technology | Barriers | Enabling Measures |
|---------------------|---|---|
| Soil bioengineering | <ol style="list-style-type: none"> 1. Lack of financial allocation from state budget on bioengineering 2. Lack of investment in research and development (R&D) 3. Limited information on bioengineering's benefits | <ol style="list-style-type: none"> 1. Committed budget allocations for soil bioengineering activities 2. Conducting R&D in soil bioengineering 3.1 Conducting extensive campaign and socialisation on soil-bioengineering 3.2 Conducting trainings on soil-bioengineering |
| <i>Tarabandu</i> | <ol style="list-style-type: none"> 1. Lack of financial allocation from state budget on <i>tarabandu</i> enforcement 2. Limited opportunities to diversify household's source of income 3. Weak governance | <ol style="list-style-type: none"> 1. Committed budget for <i>tarabandu</i> enforcement 2. Establishment of alternative source of livelihood 3. Strengthening local governance |
| Mangrove plantation | <ol style="list-style-type: none"> 1. Lack of financial allocation from state budget on mangrove protection 2. Human encroachment of mangrove habitats 3. The practice of free grazing | <ol style="list-style-type: none"> 1. Committed budget for restoration of mangrove ecosystem 2. Spatial planning for coastal areas 3. Promoting the practice of fence livestock management |

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|-------------------------------------|--|---|
| | | |
| Sloping Agriculture Land Technology | <ol style="list-style-type: none"> 1. Constant pressure to provide for the family 2. Limited information on SALT techniques and benefits 3. Strong attachment to conventional farming practices 4. Lack of technical skills 5. The practice of free grazing | <ol style="list-style-type: none"> 1. Subsidies to support rural farmers' transition to sustainable farming practices 2. Conducting R&D in SALT 3. Extensive campaign and socialisation 4. Conducting training on SALT 5. Promoting the practice of fence livestock management |