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TECHNOLOGY NEEDS ASSESSMENT REPORT

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TECHNOLOGY NEEDS ASSESSMENT REPORT

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Foreword

Timor-Leste is a member of Small Island Developing States (SIDS) and the Least Developed Country (LDC) which is very vulnerable to the effects of climate change and has been experiencing the negative impacts of extreme weather events, including intense storms and sea-level rise. The impacts of climate change are already undermining its development. Hence, without addressing the drivers of climate change and providing support for the most vulnerable sectors, these impacts will continue to worsen.

As a party to the UNFCCC, the government of Timor-Leste is fully committed to developing and implementing to make its major development sectors climate-resilient and also to mitigate greenhouse gas from the potential sectors. For example, the Nationally Determined Contribution (NDC) listed a number of mitigations and adaptation measures to enable sustainable low-carbon development and to build climate risk resilience in Timor-Leste. To support the implementation of its NDC and other national strategies, Timor-Leste is currently conducting a Technology Needs Assessment (TNA) to identify priority technology transfer investments and determine which environmentally sound technologies (EST) are the most effective in adapting and mitigating climate change.

The Secretary of State for the Environment (SSE) acknowledges that the TNA project is the first thorough national exercise undertaken toward assessing our needs for climate change technology. It was carried out by SSE through National Directorate for Climate Change (NDCC) in collaboration with the United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC) and the Asian Institute of Technology (AIT) and was funded by the Global Environment Facility (GEF). The Climate Change Working Groups (CCWG), key stakeholders, and local experts were all consulted during the TNA process.

Timor-Leste is proud to have completed the first phase of the TNA with the assistance of other line ministries, international agencies, non-governmental organizations, private sectors, academia, and youths. Through this collaboration, various technologies have been identified for both mitigation sectors (Transportation, and Agriculture, Land Use and Forestry) and adaptation sectors (Sustainable Development Land Management in Agriculture, and Infrastructure and Natural Methods to Prevent Erosion). The prioritized technologies are indeed aligned with the Timor-Leste Climate Change Policy (CCP), National Adaptation Plan (NAP), and NDC for climate mitigation and adaptation in Timor-Leste.

I look forward to seeing findings, recommendations, and implementation in deploying and diffusing the prioritized technologies.

Demétrio do Amaral de Carvalho
Secretary of State for the Environment

List of abbreviations

CCCB	Center for Climate Change and Biodiversity
CCWG	Climate Change Working Group
CO14	Fourteenth Conference of the Parties
EBL	Environmental Basic Law
ENSO	El Niño Souther Oscillation
FAO	Food and Agriculture Organization
GCF	Green Climate Fund
GHG	Greenhouse Gas
HSO	Human Security Objectives
INDC	Initial Nationally Determined Contribution
IVA	Intergrated Vulnerability Assessment
LGBTQ	Lesbian, Gay, Bi-sexual, Transgender, Queer
MAF	Ministry of Agriculture and Fisheries
MCA	Muti-Criteria Analysis
NAP	National Adaptation Plan
NCEVT	National Center for Education and Vocational Training
NCCP	National Climate Change Policy
NDC	Natioanlly Determined Contribution
NDCC	National Directorate for Climate Change
NSDP2011 - 2030	National Strategic Development Plan
RDTL	Republic Democratic of Timor-Leste
SNC	Second National Communication
SSE	Secretary of State for the Environment
SSYS	Secretary of State for Youth and Sport
TFS	Technology Factsheets
TNA	Technology Needs Assessment
UNCCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	The United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
USGS	United States Geology Survey
USP	University of South Pacific

VA Vulnerability Assessment

Table of Contents

List of tables

List of figures

Executive Summary

Timor-Leste conducted its first Technology Needs Assessment in 2023 to identify and analyze technology priorities for adaptation and mitigation of developing such as Timor-Leste. The objective of the TNA process is for the developing countries to identify their climate technology priorities for adaptation and mitigation through analysing existing policies, programmes, short to long-term plans and strategies of the country. The TNA process is very much country-driven and through participatory approach, encouraging participation from relevant government ministries, youth, women and marginalized groups, the private sector, NGOs, International Organizations and other development actors. The project will be divided into 3 stages, the descriptions are as follow:

1. **Identify and prioritize technologies for mitigation and adaptation.**
2. **Identify barriers and develop an Enabling Framework for transfer, deployment, and diffusion of prioritised technologies.**
3. **Prepare a Technology Action Plan (TAP).**

This TNA report focuses specifically on two sectors of adaptation. The selected sectors are to ensure that the Timor-Leste is adapting to the impacts of climate change by ensuring that it the population will engage is sustainable agriculture practices for their livelihoods and mitigate landslides and erosion. Additionally, based on extensive analysis from key documents such as NSDP2011-2030, INDC, SNC, NAPA, NAP, NDC which all indicates that climate change will have severe impact on agriculture. The selected sectors are as follow:

1. **Sustainable land management in agriculture;**
2. **Infrastructure and natural methods to prevent erosion.**

Under both sectors, the national consultants identified a long list of technology options for the sustainable land management for agriculture through analysis of national documents such as NAP, MAF Strategic Plan, SNC and other project documents that had been implemented by national and international agencies. A national consultation with key stakeholders from relevant ministries, non-governmental agencies, youth groups were held to conduct prioritization exercise following the Multi-Criteria Analysis (MCA) model that is design for TNA project globally. The MCA is an 8-step process involving: (1.) providing decision context on the sectors; (2.) identifying technologies; (3.) identifying objectives and criteria; (4.) scoring; (5.) weighting of criteria; (6.) combing scores and weights; (7.) examination and validation of results; and (8.) sensitivity analysis based on the social, economic and environmental aspects needed for the successful implementation of the technology. To validate the results, the outcomes of the MCA underwent a sensitivity analysis repeating steps 4 to 7 of the MCA.

Following the MCA, the technologies from the long-list were examined and four technologies from each sector under adaptation were considered priorities as it has lowest associated cost, and provide highest economic, environmental and social benefits, and it is highly acceptable by communities to implement as it has been implemented in other parts of the country. The technologies identified are not new technologies, however an upscale and expansion of the same technologies.

Based on the latest Agricultural Census, 66% of the Timorese population engage in agriculture activities, however, the country is considered to be in the 10 most vulnerable countries facing the adverse impacts of climate change, and with

no exception, agriculture sector will be severely impacted. Therefore, the technologies that are prioritized aims to deliver both increase in productivity, higher yield but also adaptative and resilient to the changes in climate. The technologies listed below are for sustainable land management in agriculture and are listed in highest to lowest order:

1. **Conservation Agriculture (CA) and Crop Rotation**
2. **Water Management and Restoration**
3. **Green Char**
4. **Composting**

The technologies and natural methods to prevent agriculture sector are also prioritized based on MCA process that were done during the same consultation workshop. Timor-Leste's soil characteristics and unsustainable land use practice such as slash-and-burn, and nomadic agriculture practices have been the primary factors of erosion. Therefore, the technologies prioritized address both suitable for the soil condition and mitigate the issue of unsustainable land use pratices. The technologies that derived from the MCA are listed below:

1. **Soil bioengineering**
2. **Tarabandu**
3. **Mangrove plantation**
4. **Sloping Agriculture Land Technology**

Barrier analysis for the technologies listed above will be conducted and create action plans for these priority technologies to represent the need for such technology actions in the different industries and subsectors.

CHAPTER 1 - Introduction

1.1 About the TNA project

The Technology Needs Assessment (TNA) process was established during the Fourteenth Conference of the Parties (CO14) to the United Nations Framework Convention on Climate Change (UNFCCC) under Poznan Strategic Programme on Technology Transfer, which was held in Poznan, Poland. The objective of the TNA process is for the developing countries to identify their climate technology priorities for adaptation and mitigation through analysing existing policies, programmes, short to long-term plans and strategies of the country.

The TNA conducted in Timor-Leste is officially endorsed by the Secretary of State for the Environment (SSE) to be implemented by the National Directorate for Climate Change with close collaboration with United Nations Office for Project Services (UNOPS). The project commenced in December 2022 and will end in December 2023 after the completion and submission of all the reports and relevant documents. The TNA process is very much country-driven and through participatory approach, encouraging participation from relevant government ministries, youth, women and marginalized groups, the private sector, NGOs, International Organizations and other development actors. This is to ensure that the document reflects the real situation and the necessity of the country in terms of technology and technological assistance to mitigate and adapt to the adverse effects of climate change. The project will be divided into 3 stages, the descriptions are as follow:

1. **Identify and prioritize technologies for mitigation and adaptation.**
   The objective of this exercise is to identify appropriate technologies in consultation with the relevant working group, to the sector and targets set in national documents and characterise them in terms of their costs and sustainability impacts (environmental, social, and economic). The technologies identified must also contribute to the national sustainable development goals and priorities.

2. **Identify barriers and develop an Enabling Framework for transfer, deployment, and diffusion of prioritised technologies.**
   The objective of this exercise is to find barriers and challenges that could potentially arise during the transfer, deployment and/or diffusion of the technology and find effective, appropriate solutions and methods to overcome the barriers. It will be done in a consultative matter, specially engaging with entities who have previously implemented similar technologies.

3. **Prepare a Technology Action Plan (TAP).**
   Based on the technologies and the barriers identified in the previous documents, this exercise aims to develop an action plan for deployment and diffusion of prioritised technologies in the country. The document must also contain enabling framework, ideas for projects and project proposals that derived from the selected technologies.

1.2. Existing national policies related to technological innovation, adaptation to climate change and development priorities

1.2.1. National Circumstances

Timor-Leste is situated at the eastern end of the Lesser Sunda Islands of the Indonesian archipelago and North of West of Australia. The country only occupies the eastern half of the Timor Island. The land consists primarily of mountains and is surrounded by a relatively narrow, flat plain. Timor-Leste has a land area of approximately 15,000 km^2 of which nearly half has a slope of 40% or more. The highest point is Mount Ramelau which rises to 2,963 m above sea level.

Timor-Leste is the youngest nation in Southeast Asia; however, its population has increased significantly during the past decade. In 1990, the country's population was just 0.75 million, but by 2015 it had increased to 1.18 million. According to the most recent data from World Bank, the current population is estimated to be 1.32 million[1]. Agriculture is the primary source of income in the majority of rural areas and accounts for around a quarter of the gross domestic product. The cultivation of primary food crops, such as rice, corn, cassava, and sweet potatoes, is mostly for subsistence, whereas smallholder coffee is an important income crop. Soybeans, cabbage, mangoes, bananas, vanilla, mung beans, swamp and upland taro, onions, peanuts, sago, coconuts, and tobacco are among the additional agricultural goods. Based on the data from Poverty and Equity by World Bank in 2019, "poverty rate at the national poverty line declined from 50.4 percent in 2007 to 41.8 percent in 2014" (World Bank, 2019).

Rainfall in Timor-Leste is strongly influenced by monsoon in the north and south of the island. Rainfall varies from as low as 500 mm/annum along the northern coast to as high as 2000 mm/annum in mountains. Most areas receive maximum rainfalls during the northwest monsoon in December or January extending to April in some years. Areas in the east and southeast also have a secondary wet season during the southwest monsoon in May or June. Extreme drought years, which are commonly associated with El Niño also cause serious drought. Extreme heavy rainfall in the wet season influenced particularly by tropical cyclones, and also by the MJO may result in heavy flooding and also landslides (Barnett, et al., 2007).

Timor-Leste's seasonal variations in temperature are mainly minimal. During rainy season, the average temperature ranges from 29° to 35°C. Between May and November, the average dry season temperature ranges from 20° to 33°C. In mountainous regions, daytime temperatures range from moderate to hot, while nights are cool to cold.

[1] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=TL

1.2.2. National Strategies

1.2.2.1. National Strategic Development Plan (NSDP) (2011 – 2030)

The NSDP serves as a foundational document that guides numerous other strategies, policies, and programmes. The three main pillars of the SDP are: 1) Social Capital, 2) Infrastructure Development, and 3) Economic Development. The SDP acknowledges that Timor-Leste faces significant environmental and political risks as a result of issues, such as, increasing sea levels, more frequent cloud cover, forest fires, and food shortages.

1.2.2.2. Integration of Climate Change Adaptation and Sustainable Development Goals

Timor-Leste has created a plan for carrying out the Sustainable Development Goals and the 2030 Agenda. A Working Group was created in 2015 to find methods to align the SDGs and the 2030 agenda with the NSDP2011- 2030 (The Government of Timor-Leste, 2011) in order to harmonize nation's efforts to achieve SGDs.

1.2.2.3. Environmental Basic Law (Environmental Framework Law 26/2012)

The basic rights of the people of Timor-Leste are safeguarded by this legislation, which lays forth the principles and regulations governing environmental conservation and protection, the sustainable use of natural resources, and environmental management from an overall and integrated viewpoint. The Law requires the State to "implement all measures necessary for climate change adaptation and mitigation in terms of reducing greenhouse gas emissions into the atmosphere and/or removing them by sinks and minimizing the adverse effects of climate change impacts on biophysical and socioeconomic systems" (Secretariat of State for the Environment, 2021).

In Chapter 2 of the present Law, Article 9 to Article 12, it outlines the responsibilities of different entities responsible in executing, implementing, and monitoring the implementation of the Law. Article 9 states that the establishment of a Government department responsible for environment with the competence to coordinate with other public entities on a national, municipal and local level on policies, programs, plans or projects related to the environment (Governo de Timor-Leste, 2012). Article 10 emphasize on the collaboration, and outlines the different layers of responsibilities on all levels on matters pertaining to development and environment (Governo de Timor-Leste, 2012). In Article 10 and 11 of the present Law, outlines the responsibilities and the importance of the local authorities and local communities' participation in the decision-making process on environmental protection and preservation and also the use of natural resources (Governo de Timor-Leste, 2012).

1.2.2.4. Legal Regime for the Protection and Conservation of Biodiversity (Decree Law 6/2020, 6th of February)

The law aims to protect Timor-Leste's extensive biodiversity, which is located in one of the areas with the highest biodiversity in the world and is home to several unique species of flora and fauna. At the

institutional level, the also promotes the integration of biodiversity considerations into various sectoral policies on an institutional level, outlines the roles and responsibilities of the various governmental actors, and simultaneously calls for active participation from all spheres of society in the preservation of biodiversity and the sustainable use of its components in a participatory, collaborative, and consultative manner. It is important to note that, in Article 8 of the Law, it outlines the importance of the *Tara Bandu*, which is the traditional justice system between human-to-human and human-to-nature.

1.2.2.5. Ministry of Agriculture and Fisheries Strategic Plan 2014 – 2020.

This document shows that agriculture sector is taking climate change issues seriously since it is the sector that is severely affected by the adverse effects of climate change. The plan includes strategic and detailed goals that are in line with the priorities and recommendations made in the NAP, such as:

- Boost agricultural research's contribution to stable agricultural output, food security, and a reduction in hunger and poverty. This specific goal emphasises the importance of publicly supported research in developing new technologies, practices, and business models for traditional and emergent crops. This research will include climate change considerations and analysis.
- Develop and enhance the capacity for better decision-making during planning and budgeting process by providing precise and up-to-date climatic information and analysis.
- The plan recommends MAF to take climate change into account while setting objectives and planning.

1.2.2.6. Timor-Leste's National Action Programme to Combat Land Degradation

This document is a part of the requirement of UNCCD which Timor-Leste is a member state. NAPs outline all the steps, procedures through a participatory process for combating land degradation in order to meet the target set out under UNCCD framework. The set of programmes and actions identified in NAP provide variety of measures which will enhance and improve the overall institutional, legal and operational environment related to sustainable land management in Timor-Leste. The NAP outlined two proposed categories: 1) preventative measures and 2) mitigating measures. Under the preventative there are 4 action programmes, and under mitigation measures, there are 3 action programmes. Additionally, the document also emphasized on the importance of capacity development for land-use planning and management and local capacity development for sustainable upland farming.

1.2.3. National policies and actions related to climate change

1.2.3.1. Timor-Leste's National Adaptation Plan

This document serves as Timor-Leste's first National Adaptation Plan (NAP) as a part of the requirement of UNFCCC. The NAP process has two main objectives:

- *To reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; and*
- *To facilitate the integration of climate c change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning*

processes and strategies, within all relevant sectors and at different levels, as appropriate (UNFCCC decision 5/CP.17, para. 1).

This NAP identifies main climate-related hazards, key impacts, vulnerabilities, risks and adaptation priorities which are categorized policies and projects and programmes. The document also outlines adaptation priority actions in short, medium, and long terms.

1.2.3.2. National Climate Change Policy

The primary objective of NCCP is to produce a clear statement for how laws, regulations, and other legal documents should be read and understood, as well as to coordinate and clarify how RDTL responds to climate change. The National Climate Change Policy provides a unified framework that, for the first time, reconciles Timor-Leste's wide array of existing adaptation and mitigation strategies across many economic sectors. The National Climate Change Policy also paves the way for the creation of the envisioned National Climate Change Strategy and Action Plan (NCCSP), which will help the government efficiently carry out, finance, and oversee the implementation of the measures outlined in this national policy.

1.2.3.3. Nationally Determined Contribution (2011-2030)

This document is a revised and updated version of Initial Nationally Determined Contribution (INDC) to the UNFCCC Paris Agreement. Additionally, it states that the country intends to incorporate climate risk management into all sectoral policies, planning procedures, implementation strategies, and investments in order to protect the country's well-being from the growing direct and indirect risks posed by anthropogenic climate change. This revised NDC reflects a more developed approach for addressing food and water security, social cohesion, livelihood assistance, environmental integrity protection, scaling up access to funding, and providing the foundation for diversifying economic activity in order to create a green economy. Below are the 4 commitments areas expanding from INDC which are outlined in the document:

- *Climate Risk Governance;*
- *Nature-Positive Growth and Transition;*
- *Low-Carbon Development;*
- *Climate Change Adaptation and Resilience Building.*

1.2.3.4. Second National Communication to the UNFCCC (SNC)

This document submitted this document to the UNFCCC in November 2020 as part of the requirement as a member state of UNFCCC. To ensure that the information contained in this report are the most recent data and information available, various studies and assessments were conducted, including, vulnerability assessment, and an updated Trend and Scenario Analysis. The document also contains National GHG Inventory, measures to mitigate climate change, measures to facilitate adequate adaptation to climate change and other information related to technologies, research and capacity building.

Within this document, it states that Timor-Leste is ranked 9th most vulnerable country in the world because of its geographic location, topography, and socioeconomic conditions. There are 61 villages that have been classified as being vulnerable to highly vulnerable to climate change based on the vulnerability

assessment at the village (suco) level. The vulnerable and very vulnerable sucos are characterized by high level of exposure and sensitivity and low adaptive capacity. The level of exposure, sensitivity and adaptive capacity of the sucos are represented by socio economic and bio-physical condition. The western region of the country is home to the majority of the most vulnerable sucos. The effects of climate change will be more severe on these vulnerable and very vulnerable communities than on less vulnerable ones. In these vulnerable sucos, it should be given top priority to undertake adaptation measures. The occurrence of the El Nio and La Nia phenomena, which are typically linked to catastrophic climatic events, has caused significant damages and disasters that have affected many socioeconomic sectors of the nation. The mentioned circumstance increases the likelihood of vector-borne and respiratory infections as well as the risk of natural disasters such droughts, floods, high winds, landslides, erosion, soil degradation, coastal erosion, flooding, and ocean acidification.

1.3. Vulnerability assessments in the country

Over the years, Timor-Leste has undergone various vulnerability assessments. Increased efforts have been made recently to apply standardized methodology and to scale up vulnerability assessments to the national and sectoral levels. Some of the vulnerability assessments and conclusions that may be relevant to TNA are as follow.

1.3.1 Integrated Vulnerability Assessment (IVA) at the village (*suco)* level

Since 2018, the National Directorate for Climate Change (NDCC), have been conducting IVA at the *suco* level with the goal to reach 35% of the total sucos in Timor-Leste, and so far, it has implemented IVA activities in more than 50 *sucos* countrywide. The objective of the IVA is to gather information and data on climate change in selected sucos by obtaining community observations and harnessing communities' own experiences. The findings of the report will help to coordinate various priorities and help to design appropriate programmatic interventions by the various institutions both at national and international level as well as community-based organizations. The tool used in the field work were developed by USP) which identify indicators that measure exposure, sensitivity, and adaptative capacity of the community to climate change. Based on the IVA report of 50 sucos, it can be concluded that environmental damages and water security are the most vulnerable HSOs followed by security of place and food security. The environmental and water security vulnerability have been primarily caused by human activities which causes environmental damages and low water volume. Although some members of the communities have attended training to increase their knowledge on environmental safeguards and on ecology management, due to economic pressure, destruction, largely deforestation is unavoidable. Additionally, traditional farming practices such as slash-and-burn and shifting agriculture are also continued to be applied by farmers. The majority of 50 sucos are highly vulnerable to scarcity since they rely on springs, rivers, and groundwater for their daily necessities, and only a small number of them have access to piped clean water. The climate variability particularly during extended dry season and widespread deforestation around water sources contribute substantially to low water volume. The energy sector, health and income security have been assessed as less vulnerable. In the report, it also proposed several recommendations such as developing inventory of available agencies working the suco and define each of their area of expertise,

provide training to the members of the communities on environmental protection and emergency response, and strengthen the coordination between communities, Government and agencies in the field.

1.3.2. Second National Communication vulnerability assessment

As part of the commitment to UNFCCC, Timor-Leste has produced INDC and SNC which both documents contain information and data regarding vulnerability assessment. The information and data of the SNC are build-up from INC by examining the root causes of vulnerability to determine what makes various social groups vulnerable to the effects of climate change. To address the processes at various dimensions, this VA combines the top-down approach analysis of biophysical drivers of vulnerability with bottom-up analysis of socioeconomic factors of vulnerability. Based on the assessment from INC and SNC, it indicates that, presently, Timor-Leste is ranked among the world's top 10 most vulnerable countries to the effects of climate change and have the highest world risk index. The risk index is determined through integrating the exposure to natural hazards with vulnerability of a society, which in turn combines its susceptibility and its coping and adaptive capacities. The key causes of the country being among of the top 10 nation with the highest risk is due to its high-risk exposure to hazards, and relatively high vulnerability and susceptibility and lack of coping and adaptive capacity. Through this assessment, it has concluded that, based on biophysical, social and economic data of 2010, most of the *sucos* in Timor-Leste could be categorized as quite vulnerable 44.7%, and about 2.7% vulnerable and 11.5% very vulnerable, making only 18.6% *sucos* less or not vulnerable. It is also recognized in all areas that extreme weather events are becoming more frequent and intense, and that prolonged dry seasons are causing pervasive droughts. All communities reported that the poor are being impacted disproportionately by the impacts of climate change, and significant contributing factors include the lack of access to a more resilient building materials, alternative source of income, and livelihood diversification strategies.

As a part of the effort to lessen the vulnerability in the *sucos*, it is necessary to improve the capacity of the *sucos* to manage climate risks specially in sectors such as agriculture and water sectors. The increased ability to manage the impacts of climate change on these key sectors will reduce their vulnerability. Huge losses in agricultural output caused by climate change, for instance, will raise the poverty rate in the sucos and enhance their vulnerability. In order to help identify possible adaptation strategies, it is essential to examine how climate change will affect the important sectors. Most of the vulnerable *sucos* are located in the western part of the island, therefore, these sucos could be prioritized for adaptation actions and projects.

1.3.3. National Coastal Vulnerability Assessment

In 2017, the Government conducted a countrywide assessment of coastal vulnerability in 121 sucos located in 11 different municipalities with the support of UNDP as a part of the “Building Shoreline Resilience of Timor-Leste to Protect Local Communities and their Livelihoods” project, funded by Global Environmental Facility. The assessment uses a modified version of the Coastal Vulnerability Index Methodology created by the USGS. The tool combines the role of socio-economic factors, infrastructure, and ecosystem services in determining the vulnerabilities in the coastal zones. The assessment concluded that, 16 sucos were classified as having “very high vulnerability”, with 40 additional sucos classified at

the "high vulnerability" level (UNDP and Ministry of Agriculture and Fisheries, 2018). 10 of these 56 sucos are located in the southern coast. Here are some of the key findings:

- Severe coastal erosion is causing significant damages to the roads that being built in close proximity to the coast.
- As the economically more productive population migrates to Dili, out-migration to urban areas reduces the resilience of coastal communities overall and leaves behind particularly vulnerable population, including children, the elderly and poor women.
- Strong winds and waves are becoming more intense and common according to the reports from all communities which is negatively affecting the fishing productivity as most of the fisherfolks use small boats, which are more vulnerable under heavy wind and wave conditions. Coastal communities also reported that fish stocks are falling, and this is due to both coral reef destruction and illegal fishing (to some extent overfishing, the use of unregulated fishing methods as well).

1.3.4. Adaptation Priorities Identified in NAP

This first NAP document is a build of NAPA that was produced in 2010. NAP document outlines the national circumvents, recommended institutional arrangements and coordination a structure for iterative NAP formulation and execution, laying the groundwork for country's medium to long term adaptation programme. The two documents serve as the national Adaptation Communication to the Paris Agreement which Timor-Leste has also ratified. The overall vision of the NAP for Timor-Leste is "to build a climate resilient development trajectory for the country and its people". The document is aligned with the national policies and strategies of the country's adaptation response to climate change. The NAP follows as general "NAP Prototype" outline by the Least Developed Countries Expert Group (LEG). The document gathers all the adaptation efforts in the country, including those that are currently underway and those that have recently been completed by different entities. In the document, it has identified adaptation priorities grouped into two categories: 1) policies, and 2) adaptation priority projects and programs. Under category 2) projects and programs, there are other various sub-categories such as the following:

A. Strengthening the capacity of national, local institutions and communities in managing climate risks (floods, drought, landslides).
B. Addressing the needs of vulnerable communities and groups.
C. Using ecosystem-based DRR in coastal areas and coral reefs.
D. Improving water resources management under climate change.
E. Promoting sustainable land management under climate change.
F. Improving public health services to deal with climate related public health issues.
G. Building climate-resilient livelihoods.

The key documents above which have outlined vulnerabilities across various sectors in the country. In SNC, it clearly defines how to measure vulnerability which is through the exposure to natural hazards and the society or the country's coping and adaptive capacities. This is crucial to understand because Timor-Leste is ranked as top 10 most vulnerable due to its exposure to the adverse impacts of climate change and due to its very weak and high poverty rate (World Bank data mentioned above) makes it harder to adapt and cope with the changing climate. After conducting the assessment, it is concluded that that

extreme weather events are becoming more frequent and intense, and that prolonged dry seasons are causing pervasive droughts (Secretariat of State for the Environment, 2020).

Based on the IVA, the communities in the rural areas have identified environmental damages such as damages to infrastructure and water scarcity as the most vulnerable sector which is due to human activities causing environmenta destruction and low water volume (Secretaria de Estado do Ambiente, 2022, p. 111). Additionally, since Timor-Leste is an island, based on the coastal assessment, it shows that Timor-Leste is suffering from sea level rise and coastal erosion negatively impacting approximately 56 sucos (UNDP and Ministry of Agriculture and Fisheries, 2018, p. xxii).

Understanding the importance the and urgency to the respond to the impacts of climate change, Government of Timor-Leste had identified short-term or immediate adaptation actions which was outlined in NAPA in 2011 and has progressed to a long-term plan which is outlined in NAP (Secretariat of State for the Environment, 2021).

1.4. Sector selection Process

1.4.1. An overview of climate change projection and its impacts in sectors vulnerable to climate change

Over the past years, the science of climate change projection modelling and impact assessment modelling has considerably improved. The information provided in this section are derived primarily from NAP (section 4.1.3.), however, originally from 2015 report on Current and Future Climate Tof Timor-Leste, developed by the Commonwealth Scientific and Industrial Research Organization (CSIRO) (PACCSAPP 2015).

The information in this section is critically important to TNA as it describes the projections of climate change and its impacts of vulnerable sectors which is important for sector selection process.

1.4.1.1. Climate Change Projections

1.4.1.1.1. Temperature

Since 1950, Timor-Leste's average temperatures have risen by 0.16°C each decade, based on the data that is available. Regardless of future emission scenarios, annual mean temperatures and daily maximum temperatures will continue to increase in the future. The temperature is expected to rise between 0.4 and 1.0 degrees Celsius by 2030, accompanied by an increase in the frequency of hot days and warm nights (Secretariat of State for the Environment, 2021, p. 26). By 2050, temperature increases are anticipated to reach 1.25C-1.75C, accompanied by an increase in heat waves (Secretariat of State for the Environment, 2021).

1.4.1.1.2. Rainfall

Every decade of 1901 to 2009, there has been an overall increase in the average rainfall by 6.4mm, however, based on the report from USAID in 2017, it has mentioned that rainfall trends have decreased in much of the country since 1990. It is anticipated that there would be a general decrease in dry season rainfall and an increase in wet season rainfall, with an increase in the frequency of

extreme rainfall days (Secretariat of State for the Environment, 2021). By 2050, the average annual precipitation may increase by 4-10%, with an increase of 100-120mm in coastal regions and 260-300mm in the highlands (Secretariat of State for the Environment, 2021).

1.4.1.1.3. Tropical cyclones

Future projections indicate that the frequency of tropical cyclones striking Timor-Leste would decrease, but their severity will increase, suggesting that wind speeds and precipitation will be greater, affecting bigger regions (Secretariat of State for the Environment, 2021, p. 26).

1.4.1.1.4. Patters of variability (ENSO and other oscillations)

While it is certain that ENSO and other oscillations will continue to influence Timor-Leste's climate in the future, there is no clarity as to whether the intensity or frequency of these occurrences will vary. This uncertainty is not specific to Timor-Leste; there is no global consensus on if and how ENSO and other oscillations will change in the future.

1.4.2. Impacts of climate change in Sectors Vulnerable to Climate Change

1.4.2.1. Agriculture Sector

Agriculture sector is the largest non-petroleum sector in Timor-Leste comprising of 80% of the population who rely on agriculture activities for their livelihoods; however, it is mainly dominated by smallholders and subsistence level. Generally, yields for all agricultural products are very poor, and less than 10% of farmers use fertilizer. The contributing factors to low yield are the low usage of chemical fertilizers, the use of poor-yielding local varieties, geographic conditions such as poor soil and steep slopes, and high rainfall variability. Conventional agricultural methods have not changed much since the beginning of the 20th century and shifting cultivation and bush fallow cycles are still frequently utilized, especially in the highlands.

Based on the climate change projections identified in the previous section, Timor-Leste will experience major increases in both temperature and rainfall intensity which could significantly cause negative impacts on the livelihoods and food security of the population (Secretariat of State for the Environment, 2021). Government records suggest that during the 2016 El Niño, maize and rice output fell by 40% and 57%, respectively. If ENSO events grow more frequent and/or extreme, disruptions to agricultural productivity and food supply would undoubtedly rise in parallel.

1.4.2.2. Water Resource

Historically, Timor-Leste has abundant of freshwater resources, which comprises of surface water and groundwater. However, vulnerability to water security is considerable due to the high level of dependence of the people on ecosystem services as the basis of their livelihoods (Secretariat of State for the Environment, 2021). There is yet no assessment of the possible effects of climate change on the supply of clean water. The assessment which has been done for soil water balance in the INC shows that the pattern of soil water pattern and period of surplus and deficit. This is helpful in identifying which regions of Timor-Leste will face greater drought and/or flood risks in the future as a result of climate change. It can therefore serve as a guide for deciding which areas in Timor-Leste should receive priority for the construction of irrigation projects to reduce the danger of drought, as well as reservoir and dam developments for hydropower and flood control.

1.4.2.3. Coastal and Marine Resources

Timor-Leste's coastal area extends over 700km which comprised of special resources on land and in the sea. The natural resources present in the coastal zone are essential for the economy of coastal inhabitants, which make up around 66% of the population and are concentrated in lowlands and coastal regions below 500 metres. Marine and coasts areas provide habitat for mangroves, coral reefs and sea grasses. Additionally, Timor-Leste is known for its rich marine biodiversity, and it is claimed that there may be in excess of 500 species of coral occurring in its waters (Veron et al, 2000 in SNC, p. 52). The severity of the impacts of climate change on the coastal and marine sector remains unclear. The main concern in relation to the coastal zone is the combination of more frequent and intense storms and a potential rapid rise in sea level.

1.4.2.4. Infrastructure

According to Maplecroft's Hazard Risk Index (Cook et al, 2009 in NAP, 2021), Timor-Leste infrastructure is classified as sixth most vulnerable in the world in 2013. Rising trends of flash floods, destructive winds and landslides exacerbate the effects on infrastructure in the future. The fact that the infrastructure in Timor-Leste was severely damaged by the fighting in 1999 makes this baseline vulnerability worse. Each of the 442 sucos in the nation at the time had between 50 and 90% of their homes destroyed by fire. The GoDRTL believes that adaptation is crucial to safeguarding the investments it has made and will make in the future.

A recently approved GCF Project, an evaluation of the effects of climate-induced hydrometeorological hazards in Timor-Leste under baseline and climate change scenarios was carried out. It was concluded that, at least a doubling of hazard-affected areas in percentage terms is expected. For landslides, floods, and drought risk, accordingly, the average national increase in impact of each hazard between the baseline and climate change scenarios is 26.3%, 21%, 55.4%, and 55.8%. The potential financial losses as a result of climate change are in the range of US$203 million, US$37 million, US$10 million, and US$12.5 million, respectively. The government and the impacted people will face enormous new financial obligations as a result of these losses. The government and the impacted people will face enormous new financial obligations as a result of these losses. The table below demonstrates the hazards, the increased impacts and potential economic losses, accordingly.

Table 1. Potential increase in hazard occurrence and economic losses due to climate change (source: NAP 2021, GCF 109)

Hazard	Increased Impacts (%)	Potential Economic Losses
Landslides	26.3	US$203 million
Flooding	21	US$37 million
Erosion	55.4	USD$10 million
Drought	55.8	US$12.5 cimmion

Floods, landslides and drought all affect rural infrastructure; as a result, impacts of intensified extreme events on critical rural infrastructure will result in the degradation and damage of assets

like water supply and drainage structures, embankments and river protections, and feeder/access roads and bridges at the community level. Rural communities may suffer from these effects and become completely isolated and without access to basic services. Drought-related effects include decreased water yields, contaminating unprotected water sources, and flooding of residential areas due to insufficient flood infrastructure defences.

1.5. Process and results of sector selection

The Secretary of State for the Environment (SSE), through the NDCC under Department of Mitigation, as the TNA Project coordinator, conducted an internal consultation for sector selection. The consultation consisted of the NDCC, the Timor-Leste's Ambassador for Climate Change, Chief of Department of Mitigation and other technical staff. Based on extensive analysis from key documents such as NSDP2011-2030, INDC, SNC, NAPA, NAP, NDC which all indicates that climate change will have severe impact on agriculture and around 66% of the population engage in agriculture (The Government of Timor-Leste, 2019). It is also mentioned in Timor-Leste's National Action Programme to Combat Land Degradation that the unsustainable agriculture practices in the country contribute to soil degradation, loss of nutrients in the soil and damage in the soil structure causing loss in agriculture productivity and soil erosion. Therefore, the selected sectors are to ensure that the Timor-Leste is adapting to the impacts of climate change by ensuring that it the population will engage is sustainable agriculture practices for their livelihoods and mitigate landslides and erosion. Therefore, the sector selected for the TNA are as follow:

- **Sustainable Land Management in Agriculture; and**
- **Infrastructure and Natural Methods to Prevent Erosion.**

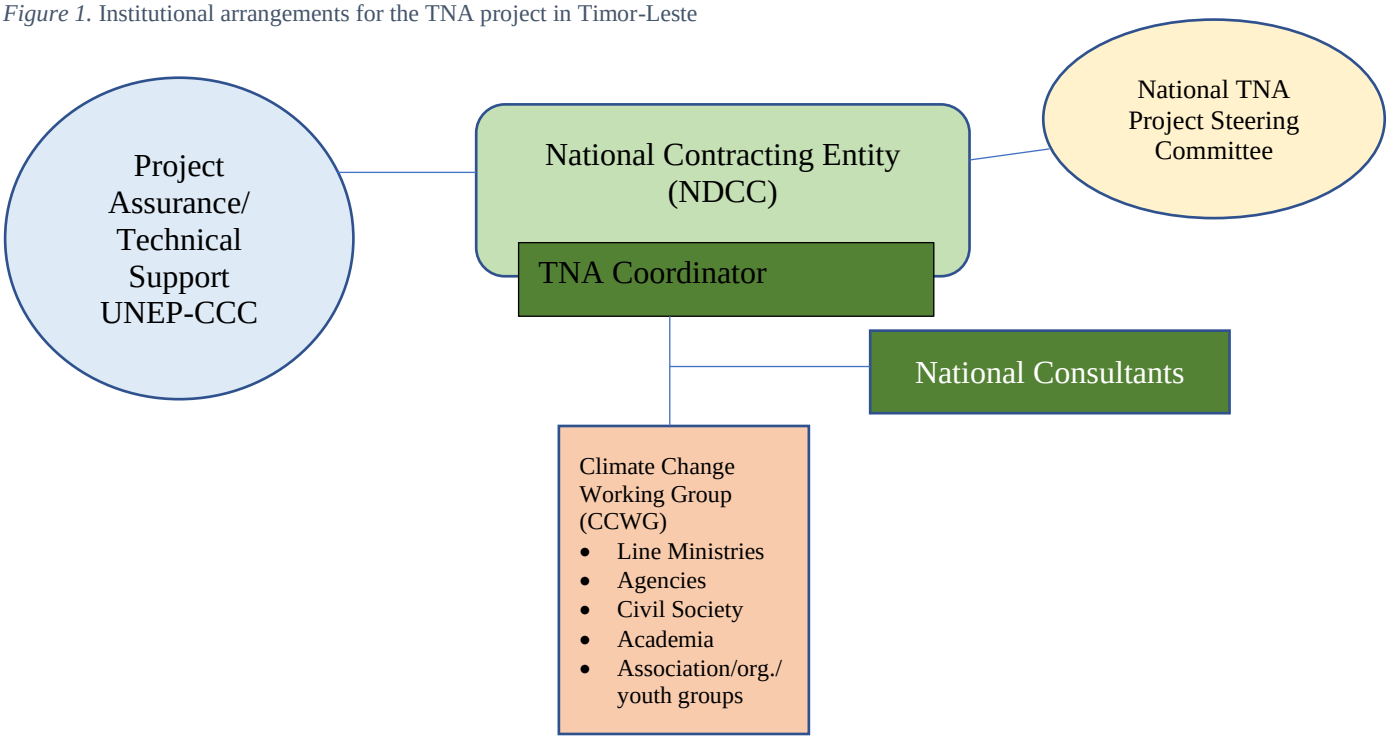
CHAPTER 2 – Institutional arrangements for the TNA and the stakeholder involvement

2.1. Institutional arrangement for the TNA

The VIII Constitutional Government of RDTL established the Secretariat of State for the Environment (SSE), under Coordinating Minister for Economic Affairs, with its clear mandates to protect and conserve the environment and develop and promote regulations and sustainable use natural resources to achieve targets stated in National Strategic Development Plan 2011 - 2030. The legal basis and the organizational structure of SSE and its competences are outlined in Decree-Law No. 15/2019 (Organic Law of SSE).
Under the SSE, the NDCC is responsible for implementing all projects, programs and activities related to climate change, such as mitigation and adaptation.

For various elaboration of key documents in the past, such as NAPA, INDC, SNC, NDC, and others, NDCC had serve the role as the technical coordinating body and secretariat. For that reason, NDCC had been chosen as the contracting entity for this TNA project with the objective to oversee the progress of the project and provide overall guidance and political advice during the implementation of the project. Additionally, NDCC's role in this project also serves the purpose of ensuring that the project is country-driven, align with country's plans and priorities and encourage a higher participating from various stakeholders.

Figure 1. Institutional arrangements for the TNA project in Timor-Leste



2.2. National TNA team

The national TNA team is crucial component of this project as it ensures that the TNA project is aligned with the government's plans and priorities and a true reflection of the national needs. The high-level designated institution to lead the TNA project is the Secretariat of State for the Environment where NDCC is its subordinate.

The key elements of the institutional arrangement of the national TNA process include National Contracting Entity (NCE) – TNA Coordinator, Climate Change Working Group (CCWG), National Consultants/Experts, National TNA Project Steering Committee, and Project assurance and Technical Support (UNEP-DTU and USP PaCe – SD). The roles and responsibilities of each elements are described below.

2.2.1. National TNA Project Steering Committee

The National TNA Steering Committee was selected based on the selected sectors under the adaptation. The role of the Steering Committee is to provide high-level guidance to the national TNA processes, including contributing their technical expertise and inputs to the technology options and prioritization exercise. The senior government representative from key institutions based on the sectors are a part of the Steering Committee, such as:

1. Directora-General of Agriculture;
2. Director-General for Forests, Coffee and Industrial Plant;
3. Director-General for the Environment;

2.2.2. National TNA Coordinator

Mr. Abraão Joaquim de Sá was appointed by the contracting entity, NDCC, as the TNA National Coordinator with the role as the focal point of Timor-Leste to communicate the progress and raise questions of concerns with the regional centre.

Mr. Abraão is the Chief of Department for Mitigation what been working under the NDCC for many years. As a focal point, he the National TNA coordinator also has the responsibility to provide administrative support for coordinating with the TNA key stakeholders and facilitating the consultation meeting or workshop. He is in charge of the overall management of the TNA project providing daily leadership and vision for the TNA process. Due to time constraints, the roles and responsibilities of the National TNA coordinator are also supported by the Assistant TNA Coordinator.

2.2.3. National TNA Consultants

The TNA national consultants were recruited by the National TNA Coordinator in close consultantion with the Director of NDCC, including UNEP- UDP to carry out work for TNA process in the country. National consultants are in charge of finalizing the TNA Report after rigorous identification and prioritization of technologies for the two sectors listed under climate change adaptation and mitigation. This is done after extensive consultation with the pertinent stakeholders and experts. The National

Consultants also lead the consultation workshop and drive the process of Multi Criteria Analysis (MCA), as well as facilitating the process of technology prioritization.

2.2.4. The Climate Change Working Group (CCWG)

The Ministerial Diploma No.2/2017, the 25th of January 2017, Establishment of the Working Group on Climate Change, is a legitimate government mechanism for consulting stakeholders on climate change matters (The Government of Timor-Leste, 2017). The mentioned Ministerial Diploma, in Article 3, the Mission and the Objectives of the CCGW, to support NDCC and the CCCB on data collection on climate change adaptation and mitigation activities, platform for collective learning and identify opportunities for collaboration to implement projects on climate change, organize meetings and events to raise awareness on issues pertaining to climate change and act as a consultative body for issues and topics related to climate change. In Article 4 of the Diploma, also states that superintendence of CCWG is NDCC. In Articles 6-10 outlines the Structure, the Responsibilities, and Management and Supervision. The membership of the CCGW is based on the agencies' projects and programs related to climate change, some agencies conclude their membership with in CCWG once the project has ended, and some agencies become a member once they start to implement project on climate change. Therefore, the membership is flexible and cannot be generalized.

2.3. Stakeholder Engagment Process in the TNA Process – Overall Assessment

The stakeholder engagement is guided by the principles defined in NCCP, thus it must consider national ownership, equity and social inclusion, informed and impactful participation commitment to sustainable development, and science and technology based. These guiding principles encourage a participation from various stakeholders, such as government agencies, non-governmental agencies, youth groups and marginalised groups (refer to Annex II for the complete list of stakeholders present during the consultation and verification workshop).

To ensure a maximum participation from all the stakeholders, the national consultants conducted two types of consultations: 1) one-on-one meeting and consultation, 2) a participatory workshop. A detailed description of the engagement are below.

- The national consultation identified all relevant line ministries and agencies for adaptation sector, which are Ministry of Agriculture and Fisheries, the Secretary of State for the Environment and Ministry of Public Works, RAEBIA and Permatil . Then the consultants identified specific Director Generals, National Directorates, Agency Directors, Departments to schedule a meeting with them to obtain information on their technology needs. The consultant was able to meet with the following senior Government and agency staff:
    - Director General for Agriculture;
    - National Director for Agriculture Research;
    - National Director for Food Security;
    - Director of Permatil;

    - Country Director of RAEBIA;
- Following the one-on-one meeting, a Consultation and Validation Workshop was conducted on the 10th of January 2023 with all the relevant stakeholders with the objective to identify and prioritize adequate technologies related to mitigation and adaption sectors, including validating the prioritized technologies. List of participants is the Annex II. During the consultation workshop, the consultants shared the purpose of the TNA project and the long list of technologies which the consultants have identified through an extensive process of analysing national documents and obtaining from one-on-one meetings and consultations. The consultants also explained the Multi-Criteria Analysis (MCA) to the participants to understand how to prioritize the identified technologies and shared with the participants the TFS to increase their knowledge of the technology. Most of the technologies shared are very familiar to the participants, and they were able to proceed with the exercises confidently.
- The workshop ended with a verification of the prioritized technologies and all the participants agreed to the list that was presented (which are in Chapters 3 and 4 of the TNA Report).

2.4. Consideration of Gender Aspects in the TNA process

The Constitution of the Republic Democratic of Timor-Leste, in Article 16 defines that all citizens must enjoy the same rights and duties, and nobody should be discriminated based on colour, race, civil status, gender and so on (República Democrátia de Timor-Leste, 2002). Article 17 of the Constitution also stated that men and women are subjected to the same rights and obligations in all the domain of family, culturally, socially, economically, and politically (República Democrátia de Timor-Leste, 2002). Key climate change documents, such as NAP and SNC emphasizes on gender role and inclusivity in the document formulation process to ensure that the output reflects the needs of women and the marginalized groups (Secretariat of State for the Environment, 2021, p. 21).

In relation to the TNA project, the national consultants put effort in involving women and marginalized groups during the workshop by sending invitation Secretariat of State for Social Inclusion, a government arm responsible for social inclusion matters, gender-based organization such as Fokupers, youth groups and LGBTQ organization, Hatutan.

During the workshop, all the participants were given equal opportunities to engage, youth group representatives were given additional information to ensure that their participation is impactful, and women and youth were encourage to engage with the best of their abilities.

CHAPTER 3 – Technology Prioritization for Sustainable Land Management in Agriculture

3.1 Key climate change vulnerabilities in agriculture sector

3.1.1. Agriculture sector

Agriculture dominates economic activity in Timor-Leste. It is an agriculture of subsistence with low inputs and outputs. Low productivity in paddy farming is also a result of limited access to better technologies, the use of high-quality seeds and fertilisers, limited supply of irrigation, and poor soil conditions. More than 75% of Timorese are employed in the agricultural sector, which includes crop and animal production, fishing, and forestry. Maize, rice, and cassava are the staple crops, while sweet potato, potato, mung bean, peanut, and soya bean are extensively produced on steep slopes, with the exception of rice, which is typically found on flat plains or terraces with moderate slopes. In select areas of Timor-Leste, cashcrops such as, coffee, coconut, and candlenut trees are cultivated. In some districts, such as Ermera, Aileu, and Ainaro, coffee plants are located in cool, high-elevation regions, whereas coconut plants are found in coastal regions of districts such as Baucau and Viqueque. The table below shows the data of food and crops producting in Timor-Leste based

Figure 2. *Food and crop production in Timor-Leste.*

Toneladas/Tons

	2010	2011	2012	2013	2014	2015	
Arroz	112,925	71,594	119,166	X	X	71,541	Rice
Milho	148,323	49,783	62,839	X	X	142,361	Maize
Mandioca	94,834	22,197	94,834	X	X	130,670	Cassava
Vegetais	78,605	X	34,012	36,332	X	106,435	Vegetables

Source: SNC, p.19

Coffee production estimated at 10,000 metric tons accounting for 85-90% of Timor-Leste annual non-oil merchandise exports since the 2002 (Ministry of Agriculture and Fisheries, 2019). The production area is approximately 54,000 hectares, and annual output ranges from 10,000 to 15,000 tonnes (Timor-Leste Census, 2010). The United States of America (USA) and Germany are the primary export markets for Timorese coffee, with yearly export earnings of roughly US$ 15 million (approximately 1% of non-oil GDP).

3.1.2. Expected impact of climate change on Timor-Leste's agriculture sector

An increase in the frequency and intensity of extreme climatic events will reduce agricultural productivity. Climate change is anticipated to have the biggest negative impact on agriculture. Increased variability and more frequent/severe ENSO occurrences might have substantial effects on agriculture productivity.

Typically, extreme climatic events in Timor-Leste are related with 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.

Approximately 78% of households were badly impacted by drought as a result of delayed planting, crops not growing, and animals falling ill or dying due to limited availability to water and fodder. Drought-affected families decreased their output of staple crops (by 3% for rice and 2% for maize compared to the previous year), and the majority of farmers planted less than one hectare of crops, which might be a reason for concern for future agricultural production.

Increasing cropping intensity in the future will be more challenging without additional irrigation facilities, as agricultural and food cropping regions become increasingly scarce. In addition, Timor-most Leste's significant cash crop is coffee, which is extremely susceptible to variations in rainfall pattern (intensity and frequency) and temperature rises.

Figure 3. Potential impact of climate change on agricultural sector

Climate change related phenomena and events	Climate change impacts
Increased air temperature	Warmer condition can reduce crop yields/live stock productivity by preventing pollination Current knowledge and practice may no longer be effective Altered patterns of crop/live stock pests and diseases Increased of water shortages for agriculture as well as rising demand through increased evapotranspiration
Changes in rainfall patterns and intensity	Increased crop loss from floods and droughts Increased damage to agricultural infrastructure and agricultural productivity caused by storm Increased degradation and loss of agricultural land and soil fertility
Sea level rise	Saltwater intrusion and seawater flooding of coastal agricultural lands Rise in food imports to compensate for insufficient domestic production Increased soil erosion, runoff and landslides

Source: SNC, p.143

3.2. Decision context

Prioritization of sectors was based on the policies and national development plans covered in section 1.2. Based on the vulnerability assessments conducted in previous documents such as SNC, it has concluded that agriculture is one of the key sectors which will be greatly affected by the adverse effects of climate change. As stated previously, more than 66% of the population (Ministry of Agriculture and Fisheries, May 2021) engage in some form of agricultural activities; however, the input and output are relatively low due to various factors such as, changing in climate, access to appropriate technology, enhanced knowledge and proper supply of irrigation.

In 2012, the Ministry of Agriculture and Fisheries developed its own Strategic Plan 2014 – 2020 which serves as a key document guiding the development of agriculture and fisheries sectors, including forestry sector in the country. Under this MAF Strategic Plan, there are 5 Strategic Objectives coupled with Mega Program, respectively. Under the first Strategic Objective which focuses on "sustainable increase in productivity and production of selected crops, livestock, fisheries and forestry sub-sectors". The key to more efficient production and enhanced competitiveness rests in the availability and utilisation of production inputs, as well as improved production and post-harvest technologies that decrease losses. Enhanced productivity and efficiency rely heavily on the application of advanced technology. The Specific Objective under Strategic Objective 1 are as follow:

1. Specific objective 1.1: To enhance the contribution of agricultural research to sustainable agricultural productivity, food security and reduced poverty and malnutrition.
2. Specific objective 1.2: To increase farmers' access to relevant information, knowledge, technology, and build the skills to apply them through effective, efficient, sustainable and decentralized extension services.
3. Specific objective 1.3: To reduce losses through improved control of weeds, pests, vectors and disease.
4. Specific objective 1.4: To develop water resources for agricultural pro- duction on the basis of sustainable irrigation, water for livestock and aquaculture.
5. Specific objective 1.5: To increase the use of technologies that enhance labor productivity including appropriate mechanization and other farm management related practices.
6. Specific objective 1.6: Accelerate production of selected strategic enter- prises on the basis of specialization and agro-zoning.

Additionally, under NAP, agriculture sector is also considered one of the most the vulnerable sector to the negative impacts of climate change. In NAP section 7.2: Priority Adaptation Programs for physical investments, it identifies 6 Programs related to agriculture:

1. Improve Research and Knowledge Management Capacities to Support Climate-Smart Agriculture and Resilient Land Management
2. Incorporate Climate Change in Agriculture Sector Planning and Management Practices
3. Mainstream Climate Change Considerations into Agriculture Sector Regulatory Frameworks
4. Support Private Sector and MSME Climate-Smart Agriculture and Aqua/Mariculture
5. Promote Climate-Smart Livestock Practices
6. Implement Community-Centric Climate-Smart Agriculture and Resilient Land Management Program

From key adaptation and agriculture documents such as NAP and MAF Strategic Plan, it demonstrates that technologies for sustainable land management for agriculture is critical for farmers to adapt to changes in the climate as well as increasing productivity to ensure food security. Therefore, through TNA, it is important to implement technologies that are aligned with national priorities and circumstances.

Understanding the impacts of climate change on agriculture sector and developing strategies and plans to address it, MAF in collaboration with FAO promoted "climate-smart agriculture" (CSA) which is a focus

in *MAF's Draft Agriculture Policy and Strategic Framework* to increase productivity with minimum damage to the soil and the environment whilst adapting to the changes in the climate (Ministry of Agriculture and Fisheries, May 2021). Examples of technologies that have been identified and introduced to the farmers are listed the in Agriculture Compendium which is produced by MAF and FAO partnering with other local and international agencies (Ministry of Agriculture and Fisheries, May 2021). In close collaboration between the MAF, SSYS, NCEVT and FAO, also implemented a project on sustainable agriculture mechanization to" improve agriculture productivity across the agrifood chains in the country" (Food and Agriculture Organization Timor-Leste, 2022). The MAF, FAO and USAid also implemented projects to promote Conservation Agriculture in Timor-Leste working together with at least 4000 farmers across 7 municipalities since 2013, and the experience has shown increasing yields up to 125% reduce labor costs by at least 50% (Ministry of Agriculture and Fisheries, 2018). Timor-Leste was also impacted by El Niño in 2015/16 where agriculture productivity dropped drastically 13% and 71% respectively in 2016 (Food and Agriculture Organization of the United Nations, 2019). Some 48 percent of drought-affected households (around 60 382 households) reported an animal death, while 21 percent (around 29 050 households) reported sick animals, due to shortages of water and food (Food and Agriculture Organization of the United Nations, 2019). The efforts were made to provide sticks of fast-growing, high-nutrient, disease and drought-resistant leguminous fodder trees, training on Conservation Agriculture practices, and provide grain storage package (Food and Agriculture Organization of the United Nations, 2019).

3.3. Adaptation technology options for sustainable land management for agriculture and their main adaptation benefits

The table below (Table 4.) presents the long list of technology options for the sustainable land management for agriculture that were identified through analysis of national documents such as NAP, MAF Strategic Plan, SNC and other project documents that had been implemented by national and international agencies. Additionally, some of the technologies that are listed below derived from consultation with key stakeholders during the prioritization exercise that were conducted. The national consultants encourage the participants to provide feedback on the long list of technologies and make changes to the list wherever necessary.

The table is arranged by: i) type of technology that is mentioned in the existing national document; ii) the description of each technology, iii) climate change adaptation benefits and iv) the linkage with the existing national policies. The TFS for each technology listed below are attached in Annex, which contains: Introduction, Features, Cost to Implement including Initial Set-up, Operations and Maintenance, Environmental, Economic and Social Benefits, Institutional Arrangement, National Status of the Technology or Coherence with National Policies and Acceptability to Local Stakeholders.

Table 2. Adaptation Technology Options for Sustainable Land Management for Agriculture with its description, adaptation benefits and coherence with national policies.

Adaptation Sector 1: Sustainable Land Management for Agriculture				
No.	**Technology**	**Description of the technology**	**Climate Change Adaptation Benefit**	**Coherence with national development policies and priorities**
1.	**Agro-forestry (Policy or Strategy for Agroforestry)**	Different types of agroforestry practices such as agrosilviculture, silvopasture, agrosilvopasture, forest farming, etc. are adopted by farmers that provide different types of ecosystem services that include provisioning services: food fiber, freshwater, raw materials, fuelwood, non- timber forest products (NTFPs), medicinal resources, genetic resources, and ornamental resources; regulating ecosystem services such as erosion control, climate change modera-tion, nutrient retention, carbon storage and sequestration, and pest control; and habitat services including biodiversity enhancement and climate regulation (Paudel, et al., 2022). Common agroforestry models in Timor-Leste: 1. Alley cropping pattern; 2. Tree along border pattern; 3. Alternate row pattern;	Agroforestry method can improve the resilience of agricultural productions against these changes through the plantation of woody perennials which intensifies, diversifies, and acts as buffer for farming systems. Trees are less susceptible than annual crops to inter-annual variability or short-lived extreme events like droughts or floods. Woody perennials conserves water during droughts and increase infiltration rates during monsoons.	NSDP 2011 – 2030, MAF Strategic Plan, National Biodiversity, Strategic and Action Plan, Project implemented by Ho Musan Ida in Baguia, COTI in Laclubar, Dili to Anairo Road Development Corridor (DARDC) project implemented from 2014 – 2019, FAO Compendium.

		4. Irregular pattern.		
2.	**Conservation Agriculture (CA) and Crop Rotation**	The technology aims to reduce soil disturbances, minimize permanent soil cover and crop rotation that, in turn, can achieve a sustainable and profitable agriculture and consecutively improve farmer livelihoods (Ministry of Agriculture and Fisheries, 2018, p. 19). 1. No burning of crop residues and weeds; 2. The use of organic mulches, leguminous cover crops, and green manures; 3. Hand jab planters, li seeders and rolling injector planters, long-handled sickles, and hand crimpers; 4. Two-wheel tractor-drawn roller/crimpers, no-till rippers and direct seeders; 5. Liquid organic fertilizers, knapsack sprayers and wheelbarrow-sprayer There are variety of Crop Rotation implemented in the country, such as, inter-cropping maize with velvet bean, cultivating velvet bean prior	Information withdrawn from MAF Compendium and SNC: i) *Increase crop resilience to drought*: During the 2015/16 El Nino event, CA farmers had maize 40- 95% survival rate whereas farmers using traditional practices had survival rates ranging between 0-40%. ii) Soil fertility increases and the practices allowed for the permanent cultivation of agricultural land. iii) After four years using CA, the report shows that 74% of the CA field has more rapid soil water infiltration rates compared than conventional practices. iv) CA is a solution for reducing soil degradation, conserving water and boosting yield stability, and limiting the risks connected to droughts.	Final Country Report of the Land Degradation Neutrality Target Setting Programme in Timor-Leste 2018 (p.19). Refer also to SNC Box 4.1 and Box 4.2. MAF Compendium 2.1.01 (CA FAO MAF)

		to food crop, mung beans after rice plantation. Velvet bean (*Lehe*) is the main high biomass cover crop used in Timor-Leste. Lehe performs well in low land where rainfall is higher.		
3.	**Fixed and permanent agriculture**	Fixed and permanent agriculture is a practice by people who settle down and undertake cultivation of crops both for home and for commercial purposes. The farmers do NOT move around from one land to another practicing slash-and-burn.	Promote sustainable agricultural practices and adaptive to the changing in climate and the circumstance of the farmers.	SNC Table 5-2, No. 1, p.161
4.	**Composting (Manual or guide)**	Composting is a natural process of recycling organic matters, such as leaves and food scraps that can turn into organic and natural fertilizers to enrich and replenish the soil.	Recycling organic waste into compost helps to improve soil quality, increase nutrients in the soil, and conserves water to avoid shortage of water resources during prolonged droughts caused by climate change.	Information provided by Director General for Agriculture during one-on-one consultation.
5.	**Community-Centric Agriculture of Agricultural Extensionist**	Community-Centric Agriculture is defined by the action of communities to work collaboratively and make decision on what is the best use of the land that they belong to. 'Agricultural extension' describes the services that provide rural people with the access to knowledge and	Increase farmers' access to relevant information, knowledge, technology and build the skills to adapt to the adverse impacts of climate change.	MAF Strategic Plan (2014-2020) Specific Objective 1.2. (p. 20)

		information they need to increase productivity and sustainability of their production systems and improve their quality of life and livelihoods [2].		
6.	**Water Resource Management and Restoration**	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 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. Holistic approach using traditional knowledge.	It restores water catchment or springs that have dried up which can increase water quantity during prolonged drought caused by climate change.	PERMATIL and 400+ communities

[2] https://www.ctc-n.org/technologies/community-based-agricultural-extension

7.	**Use of greenhouse /*estufa***	A greenhouse is an outdoor construction built mostly of transparent materials such as glass or polycarbonate. Professional agriculture uses them to cultivate large amounts of crops, as well as backyard gardening hobbyists. A consistent, warm temperature indoors makes fruit and vegetable cultivation considerably simpler throughout the year.	Provide condition for the growing seasons even during extreme weather events caused by climate change.	DG Agriculture
8.	**Animal Power Plowing**	Animal power is used for land preparation, weed control, grain threshing, and transportation. aribou or buffalo are the most common sources of animal power for agricultural production and are employed for transportation in many nations.	It creates minimum disturbance to the soil.	Decided during the first consultation period.
9.	**Green Char**	Rice hull biochar is a way of turning a waste product into an effective soil amendment that neutralizes acid soils and make nutrients in the soil available to the crops. In testing biochar plus in Laleia at low rates of application (1t/ha), biochar plus increased yields by 93%, turning 1kg of biochar plus to $8.2 of product, across four species.	Biochar application has a significant impact on reducing acidity of acid soils. In an acid red soil from the Baucau plateau, the application of 5 t/ha of rice hull biochar lifted soil pH from a very acid 4.6 to much higher levels. The availability of Phosphorous also increased with added biochar application.	MAF Compendium

3.4. Identifying criteria to assess the technology options for prioritization

The first national TNA consultation workshop was held on the 10th of January 2023 with the objective to invite all relevant stakeholders to analyse and prioritize technologies against the criteria that have been identified according to the national context and development priorities.

The prioritisation exercise conducted during the consultation workshop used Multi-Criteria Analysis framework which was developed by the MCA4Climate project. The participants were divided into groups according to their area expertise and their working experience. Each sectoral groups had members from government line ministries, national and international agencies, youth groups and civil society. Due to the mixture of participants, the discussion sessions were rich and informative, as well as sharing best practices amongst them. Table below showed the criteria, indicators, description, and the scoring scale. Below is a table of the number of criteria, indicators and its respective description and scoring scale to rank the technologies against the criteria.

Table 3. The criteria, indicators, description and scoring scales use in the prioritisation in sustainable land management for agriculture sector.

Criteria	Indicators	Description	Scoring Scale
Cost of Technology	Initial cost (USD)	This criterion looks at the cost of set-up of the technology.	0 - Very High Cost
			25 - High Cost
			50 - Moderate
			75 - Low Cost
			100 - Very Low Cost
	Operation and maintenance cost (USD)	This criterion looks at running cost of the technology and maintenance. Handling. Transportation.	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
Economic Benefits	Employment opportunities and increased income	Increased income per capita Affect the welfare	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
	Improve economic performance	Increase yield Changes in the market Quantity of product available in the market	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
Social Benefit	Food Security	Food security	0 - Very low
			25 - Low

			50 - Moderate
			75 - High
			100 – Very High
	Reduction in inequity	Technology should aim to reduce inquity between social classes, gender, ethnic groups etc.	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
Environmental Benefit	Restore, conserve and protect the landscape	Restore, conserve and protect the landscape	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
Climate-related	Increase resilience towards the adverse effects of CC	Increase resilience towards the adverse effects of CC	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
Institutional/implementation	Replicability and acceptability	Can this technology be applied anywhere else in the country? Will the farmers accept this technology?	0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High
Political	Coherence with national development policies and priority		0 - Very low
			25 - Low
			50 - Moderate
			75 - High
			100 – Very High

3.5. Weightings used for prioritisation and sensitivity analysis

The participants from each group determined the weightings for each indicator. The table below shows the weightings used in the MCA analysis and were agreed by members of the group. The participants ranked initial cost to the most important with the highest weight (15%), followed by all the other criteria (10%) and the lowest rank is reduction in inequity (5%).

There were no changes during Sensitivity Analysis therefore it remained as it is.

Table 4. Weightings used for prioritization and sensitivity analysis

No.	Criteria Category	Weighting Criteria		*Sensitivity Analysis*	
		Rank	**Weight**	***Re-rank***	***Re-weight***
1.	Initial cost (USD)	1	15%	1	15%
2.	Operation and maintenance cost (USD)	2	10%	2	10%
3.	Employment opportunities and increased income	2	10%	2	10%
4.	Improve economic performance	2	10%	2	10%
5.	Food Security	2	10%	2	10%
6.	Reduction in inequity	3	5%	3	5%
7.	Restore, conserve and protect the landscape	2	10%	2	10%
8.	Increase resilience towards the adverse effects of CC	2	10%	2	10%
9.	Replicability and acceptability	2	10%	2	10%
10.	Coherence with national development policies and priority	2	10%	2	10%
Total Weight (should be 100):		-	**100%**	**-**	**100%**

3.6. Results of technology prioritisation for Sustainable Land Management in Agriculture

The result of the MCA exercise for technology priorities for sustainable land management for agriculture sector is presented below (Table 7). The detailed TFS for each other technology as attached in the Annex I. From this exercise, it is concluded the top four technologies with the highest score are as follow:

- **Conservation Agriculture (CA) and Crop Rotation**
- **Water Management and Restoration**
- **Green Char**
- **Composting**

Table 5. Result of the prioritization exercise using MCA framework.

Decision Matrix: Weighted Scores

		Costs		Benefits						Local Context		Total score	Technology
				Economic		Social		Environmental	Climate related	Institutional/ Implementation	Political		
No.	Technology	Initial cost (USD)	Operation and maintenance cost (USD)	Employment opportunities and increased income	Improve economic performance	Food Security	Reduction in inequity	Restore, conserve and protect the landscape	Increase resilience towards the adverse effects of CC	Replicability and acceptability	Coherence with national development policies and priority		
1	***Agroforestry***	750	500	750	750	750	250	1000	1000	250	1000	7000	5

2	***Conservation Agriculture (CA) and Crop Rotation***	1125	750	750	750	1000	375	1000	1000	500	1000	8250	1st
3	***Fixed and Permanent Agriculture***	1125	250	250	500	250	375	1000	1000	500	1000	6250	6th
4	***Composting***	750	500	750	750	1000	125	1000	1000	1000	1000	7875	4th
5	***Community-Centric Agriculture or Agricultural Extensionist***	375	250	500	500	500	250	500	500	1000	1000	5375	9th
6	***Water Management and Restoration***	750	500	500	1000	1000	375	1000	1000	1000	1000	8125	2nd
7	***Greenhouse***	375	250	500	750	750	250	500	1000	500	1000	5875	7th

8	***Animal Power Plowing***	750	750	500	750	750	125	500	750	250	500	5625	8th
9	***Green Char***	1125	1000	750	750	1000	500	1000	1000	500	500	8125	2nd
	Criterion weight	15	10	10	10	10	5	10	10	10	10	100	

CHAPTER 4 - Technology Prioritisation for Infrastructure and Natural Methods to Prevent Erosion

4.1. Key climate change vulnerabilities in forestry sector

Erosion in Timor-Leste are caused by several direct causes such as deforestation, mal-agricultural practices and indirect causes such as poverty and demographic pressures, to name a few. It is important to understand the real causes of erosion, forestry sector and soil condition in Timor-Leste in order to identify appropriate technologies to prevent erosion.

4.1.1. Forestry sector

In 2012, around 869,000 hectares or 58% of the nation was covered by forest. Between 2003 and 2010, around 180,000 hectares (ha) of Timor-forest Leste's cover are believed to have been lost to deforestation. Widespread deforestation was discovered in all districts, both thick and sparse forest types. Most people in rural and urban areas rely on natural forests as their primary supply of fuelwood and timber. This eventually occurs in over exploitation, which is becoming increasingly noticeable in a number of regions, notably those in the country's north. According to research conducted by Nippon Koei, the rate of conversion of thick forest and sparse forest to various land uses was 2.18 percent each year (Secretariat of State for the Environment, 2020).

The Government of Timor-Leste (GoTL) recognizes the importance of combating land degradation to achieve sustainable agriculture development and maintain ecosystem integrity. This was realized through the accession to the UNCCD in August 2003 and its ratification in April 2006.

4.2. Decision context

4.2.1 Causes of land degradation and erosion

The UNCCD defines land degradation as *reduction or loss of the biological or economic productivity and complexity of rain fed crop land, or large, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patern, such as: i) soil erosion caused by wind and/or water; ii) deterioration of physical, chemical and biological or economic properties of soil; and iii) long term loss of natural vegetation*[3].

Land degradation in Timor-Leste is widespread and severe in certain regions. Timor-Leste's land degradation manifested as bare lands, deforestation, soil degradation, overgrazing, weed invasion, landslides, gullies, and siltation of streams. The causes might be both natural and man-made. Although unsustainable agriculture practices, illegal logging of native wood species, regularly occurring wildfires, firewood extraction,

[3] Training Handbook: Global Environment Facility's Sustainable Land Management Approach

uncontrolled grazing, and cultivation of marginal lands are frequently cited as the primary causes of land degradation, no comprehensive research has been conducted on this issue.

4.2.1.1. Direct causes

4.2.1.1.1 Deforestation and illegal logging of important tree species

Deforestation is the most significant land issue in Timor-Leste, especially in mountainous regions. It is also seen in several arid lowland regions. Timor-Leste's natural forests and grasslands were overharvested between 1972 and 1999, according to many studies. Approximately 25% and 26% of the region, respectively, consisted of primary and secondary forests. In 1999, this percentage decreased to 16% of primary forests and 19% of secondary forests, or around 30%[4].

A study on vegetation cover recorded that the most significant change was experienced in woodland area as indicated in the following table.

Cover type	Area (km^2) 1989	Percent Area 1989	Area (km^2) 1999	Percent of area 1999
Dense forest	410.5	5	265.02	3
Forest	833.3	10	758.78	9
Plantation	260.57	3	421.43	5
Forest/coffee	467.19	6	575.05	7
Woodland	2555.64	31	1497.56	19
Woodland (poor)	568.48	7	1749.06	22
Heath/shrub	213.45	3	401.69	5

Bouma & Cobryn, 2002, pg.4

It is estimated that the rate of deforestation during this period was equivalent to 1.1% per year, four times higher than the global average of 0.3%. Within this period, it was estimated that about 114,000 hectares (35%) of dense forest were lost and 78,000 hectares (24%) of sparse forest were destroyed. Most alarming was an increase of more than 200,000 hectares of open areas.

4.2.1.1.2. Shifting cultivation

The majority of the population is engaged in upland farming using shifting cultivation practices. Based on the survey conducted by NDF, each family occupies 1 – 2 hectares depending on the available labor in the family. Most of the farmed areas are located in the fertile soil along the river or creek within the watershed areas but there are lots on the hillside areas as well. NDA estimated that approximately 70.000 ha of the total land area of Timor-Leste is cultivated each year and 60% from this total is found on

[4] Sundland, et. al., 2001. *Assessing Environmental Needs and Priorities in East Timor*. Final Report – UNDP, Dili and Norwegian Institute for Nature Research, Throndeim.

sloping areas. Crops that are commonly planted include corn, cassava, beans and some vegetables. The cultivation phase lasts around three years, following which the land is left fallow for a number of years before being cultivated without sufficient conservation measures.

This can lead to the deterioration of land and watersheds and the loss of biodiversity. However, the issue is currently poorly understood, and further research is required to determine if the shifting agriculture practice is responsible for land and watershed degradation.

4.2.1.1.3. Forest fire and slash-and-burn practices

Unintentional or accidental forest fires in Timor-Leste is frequently exacerbated by climate conditions. The majority of the time, however, the fires are caused by local animal husbandry, shifting agriculture, and hunting activities. In the northern region of the country, grazing areas are burnt towards the end of the dry season so that fresh pasture may grow. This practice often leads to soil erosion and loss of soil fertility due to lack of ground cover. In a couple of local villages, fire is also used to hunt wild animals, such as the ground bird (Kiukai in Maliana) and deer in Manatuto and Natarbora. Fire is also often used in shifting agriculture when slash-and-burn techniques are regularly used prior to the crop preparation time during the rainy season.

In regions dominated by grasses, eucalyptus, bamboo, casuarina, and teak, forest fires are common. Based on statistics from 1994, a total of 60,301 hectares were burned in 1994 alone. Forest fires occur in the dry season thereby leaving the ground uncovered at the beginning of the wet season and prone to erosion before ground cover can be formed.

4.2.1.1.4. Uncontrolled grazing

Uncontrolled grazing becomes one of the factors of land degradation although the data is not well documented in the country. According to NAP Land Degradation, intensive grazing affects the regeneration of humus causing mineralization of soil over the years. Overgrazing could also result in destruction of the soil structure which reduces water infiltration and could cause poor regeneration of grass that protect the soil from water and wind erosion.

4.2.1.2. Other underlying causes

It is also important to note that other underlying causes such as poverty, demographic pressures and ineffective law enforcement contributes to the degradation of land which consequently causes Loss of vegetation and soil leads to the degradation of the catchment and decrease in the amount and quality of water.

Consequently, the direct and indirect causes listed above contribute to increased runoff and sediment deposition in coastal regions, especially during the severe rainfall and flash flooding that occurs in practically every municipality. In addition, the longer-term effects include soil degradation and landslides in the uplands and catastrophic flooding in the lowlands. This is made worse by excessive grazing (mainly by goats) (Asian Development Bank, 2022). During the 1970s, forest cover has rapidly decreased, and the current deforestation

rate is estimated to be 1.3% per year (Asian Development Bank, 2022). The conversion of woodland to agricultural land is a significant factor. The expected rural population expansion is a hazard, since it might increase land clearance and result in an annual deforestation rate of 1.8% (Asian Development Bank, 2022).

To mitigate this loss of forest and unsustainable land use, through the NSDP2011-2030, the Government has committed to plant one million trees national wide annually through community nursery-based (The Government of Timor-Leste, 2011). Additionally, a Forestry Management Plan has also been prepared to promote reforestation and sustainable land management practices in the country, by 2020 no families will be using wood as their primary fuel for cooking (The Government of Timor-Leste, 2011) and a National Bamboo Policy and Marketing Strategy is also in place to include the promotion of bamboo cultivation for reforestation and erosion control purposes (The Government of Timor-Leste, 2011). Erosion mitigation is also mitigated through using sustainable agriculture practices since it is stated above that the primary factor for erosion is caused by land clearing and unsustainable agriculture practices. Therefore, MAF and its pratner development agencies such as FAO have promoted extensively the use of Conservation Agriculture with minimum tillage and also other agricultural techniques to ensure that the activities are causing minimum impacts to the soil structure, increase fertility and maintain soil moisture. Since Timor-Leste is a newly developed country, there are various public infrastructure such as roads and highways are being constructed in the slope and steep hillsides. From 2012, the government has acknowledged soil bioengineering as part of road project requirements with ADB and other development partners (Asian Development Bank, 2018, p. 27). Contracts for road improvement use soil bioengineering as a major aspect of slope stabilization design (Asian Development Bank, 2018, p. 27). In Timor-Leste, where nearby hillsides provide a multitude of stability issues, soil bioengineering is crucial for road construction (Asian Development Bank, 2018, p. 27). Establishing vegetation in conjunction with wood and/or rock-based engineered structures to anchor and preserve shallow-seated earth masses, especially immediately after cutting the slope, may considerably minimize the danger of erosion (Asian Development Bank, 2018).

Additionally, due to alongshore sediment movement, the coastal erosion danger would have a significant impact on shoreline modifications; saltwater flooding would have an important role in extending the effect inland, depending on coastal geomorphological conditions (Global CAD, 2018). Hence, shoreline changes are strongly associated with sea level rise, waves, and sediment supply and loss in particular coastal regions (Global CAD, 2018). Moreover, rising of sea level also plays a role in the exacerbated rate of coastal erosion (Global CAD, 2018). Therefore, planting mangroves in along the shoreline is necessary to mitigate coastal erosion and nearby marine ecosystem.

4.3. Adaptation technology options for sustainable land management for agriculture and their main adaptation benefits

Table 6. Adaptation Technology Options for Infrastructure and Natural Method to Prevent Erosion.

Adaptation Sector 2: Infrastructure and natural methods to prevent erosion				
No.	**Technology**	**Description of the technology**	**Climate Change Adaptation Benefit**	**National Document**
1.	Tarabandu	Tara Bandu is a Timorese customary rules that enforces peace and reconciliation through the power of public agreement (Asia Foundation 2013) and generally involves some aspect of reducing or preventing community conflict, protecting the environment, managing natural resources, and improving community welfare.	Strengthen cultural system to implement adaption projects.	Identified in NAP (p. 20)
2.	Community-based nursery program and community forestry on degraded lands	Through this program, 400,000 to 500,000 seedlings of forest plant, fruit and bamboo are produced every year and 800.000 of coffee plant is distributed to the community.	Avoid erosion.	Identified in SNC (p. 154)
3.	Soil bioengineering where adjacent slopes have plethora of stability problems (Vetiver Grass)	Tech1: Mixed grasses-shallow 1:1 Cut Slope Tech 2: Using Rock-Vegetation Based Reinforcement (Slope remodeling, palisades, brush payers, live stakes, check damns, and gabios-steep 1:2 cut slope.	Avoid erosion.	Identified in TL Transport Operations (p. 29)
4.	Check dams (infrastructure)	Check dams are physical structures built across channels to reduce erosion by lowering the velocity of water flow. It is an ancient technique to reduce sedimentation and to evenly distribute water across the land.	Restore plains that otherwise would be dried up due to drought caused by climate change.	Information received from DG of Agriculture during one-to-one consultation meeting.
5.	SALT (Sloping Agricultural Land Technology)	SALT is a system in which dense hedgerows of fast-growing perennial nitrogen-fixing tree (*Acacia confuse*) or shrub (vetiver grass) species	The hedgerows markedly reduce soil erosion and contribute to	SNC, TL Natiomal Action Programme to combat land

		are planted along contour lines thus creating a living barrier that traps sediments and gradually transforms the sloping land to terraced land.	improving and/or maintaining soil fertility by acting as a source of organic matter. SALT has emerged as one of the main approaches used to control soil erosion in mountainous region	degradation revised draft 2008 (page 18)
6.	Bamboo cultivation for reforestation and erosion control prupose	Bamboo has biological characteristics such as high vegetative propagation ability (making its reproduction very easy) and a rapid growth (allowing for a quick effect on soil cover and root consolidation). Moreover, the structural and physical characteristics of the stems of certain bamboo species turn them into a very effective contruction material for complimentary soil bioengineering supports structure[5]. There are more than 40 types of bamboos in Timor-Leste	Reduce erosion.	NSDP 2011-2030 (page 56)
7.	Mangrove reforestation and rehabiliation		Planting mangrove in degraded coastal areas to prevent coastal erosion and restore coastal and marine biodiversity. Additionally, it also reduces the damage caused by waves and sediments.	National Action Programme Priority Activity #18

[5] Tardio, Guillermo (et. al). *The Use of Bamboo for Erosion Control and Slope Stabilization: Soil Bioengineering Works.* https://www.intechopen.com/chapters/60430. 2018

4.4. Criteria and process of technology prioritisation for technology and natural methods to prevent erosion

The prioritization exercise for technology for infrastructure and natural method to prevent erosion was conducted during the consultation meeting held on the 10th of January 2023. The criteria and indicators (including the description) used in MCA were pre-determined by the national consultants, and further discussed with the participants. The prioritisation exercise conducted during the consultation workshop used Multi-Criteria Analysis framework which was developed by the MCA4Climate project. The participants were divided into groups according to their area expertise and their working experience. Each sectoral groups had members from government line ministries, national and international agencies, youth groups and civil society.

Initially, the indicators that were determined were agreed by the participants; however, during the examination of the results participants raised the issue of waste in the county, which they recommended to be one of the criterions under economic benefits. The reason to add waste as a criteria is due to the current environmental degradation caused by waste and impacting across various sectors such as health, tourism, and infrastructure due to littering. The participants highlighted Dili is suffering immensely from waste and ineffective waste management, therefore, the new technology must not add to the current burden that it Dili is facing, rather, to also reduce production of waste since Government lacks the creativity to absorb waste for recycling and other purposes. The technology should aim to reduce the use of non-recyclable materials and targets to source all the materials locally. The suggestion was accepted by the group, therefore, added to the list of criterions which could be seen in the table below.

Table 7. The criteria, indicators, description and scoring scales use in the prioritization in infrastructure and natural methods to prevent erosion.

Criteria	Indicators	Description	Scoring Scale
Cost of Technology	Initial cost (USD)	This criterion looks at the cost of set-up of the technology.	0 – Very High Cost
			25 – High Cost
			50 – Moderate
			75 – Low Cost
			100 – Very Low Cost
	Operation and maintenance cost (USD)	• This criterion looks at running cost of the technology and maintenance. • Handling. • Transportation.	0 – Very Low
			25 - Low
			50 - Moderate
			75 – High
			100 – Very High
Economic Benefits			0 – Very Low

	Employment opportunity	Employment opportunity from implementing this technology	25 - Low
			50 - Moderate
			75 – High
			100 – Very High
	Waste Management	Will this technology assist with reducing?	0 – Very Low
			25 - Low
			50 - Moderate
			75 – High
			100 – Very High
Social Benefit	Reduced disasters caused by erosion	Reduced disasters caused by erosion.	0 – Very Low
			25 - Low
			50 - Moderate
			75 – High
			100 – Very High
Environmental Benefit	Restore, conserve and protect the landscape	Restore, conserve and protect the landscape	0 – Very Low
			25 - Low
			50 - Moderate
			75 – High
			100 – Very High
Climate-related	Increase resilience towards the adverse effects of CC	Increase resilience towards the adverse effects of CC	0 – Very Low
			25 - Low
			50 - Moderate
			75 – High
			100 – Very High
Institutional/implementation	Replicability and acceptability	• Can this technology be applied anywhere else in the country? • Will the farmers accept this technology?	0 – Very Low
			25 - Low
			50 - Moderate
			75 – High
			100 – Very High
Political	Coherence with national development	• Is it aligned with the policies, plans and strategies?	0 – Very Low
			25 - Low
			50 - Moderate

	policies and priority	• Has there been previous funding or commitments?	75 – High
			100 – Very High

4.7. Weightings used for prioritisation and sensitivity analysis

The participants from each group determined the weightings for each indicator.
The table below shows the weightings used in the MCA analysis and were agreed by members of the group.
The participants ranked indicator restore, conserve and protect the landscape with the highest weight (17%), followed by employment opportunity (15%) and the lowest rank is replicability and acceptability (7%).

Table 8. List of criteria category, weightings and sensitivity analysis for MCA.

No.	Criteria Category	Weighting Criteria		*Sensitivity Analysis*	
		Rank	**Weight**	***Re-rank***	***Re-weight***
1.	Initial cost (USD)	3	13%	2	12%
2.	Operation and maintenance cost (USD)	3	13%	2	12%
3.	Employment opportunities	2	15%	2	12%
4.	Waste generated	0	0%	1	12.5%
5.	Reduced disasters caused by erosion	3	13%	1	12.5%
6.	Restore, conserve and protect the landscape	1	17%	2	12%
7.	Increase resilience towards the adverse effects of CC	3	13%	3	10%
8.	Replicability and acceptability	5	7%	3	10%
9.	Coherence with national development policies and priority	4	9%	4	7%
Total Weight (should be 100):		-	**100**	-	**100**

4.8. Results of technology prioritisation for Infrastructure and Natural Methods to Prevent Erosion

The result of the MCA exercise for technology priorities infrastructure and natural methods to prevent erosion is presented below (Table 7). The detailed TFS for each other technology as attached in the Annex I. From this exercise, it is concluded the top technologies with the highest score are as follow:

- **Soil bioengineering**
- **Tarabandu**
- **Mangrove plantation**
- **Sloping Agriculture Land Technology (SALT)**

Table 9. Results of the prioritization exercise using MCA framework.

Decision Matrix: Weighted Scores

		Costs		Benefits					Other		Total score	Technology Rank
				Economic		Social	Environmental	Climate related	Institutional/Implementation	Political		
No.	Technology	Initial cost (USD)	Operation and maintenance cost (USD)	Employment oportunity	Waste Management	Reduced disasters caused by erosion	Restore, conserve and protect the landscape	Increase resilience towards the adverse effects of CC	Replicability and acceptability	Coherence with national development policies and priority		
1	***Tarabandu (law or policy)***	600	900	300	937.5	937.5	900	500	1000	700	6775	2
2	***Developing Manual for Community Forestry on Degraded Lands***	900	300	300	312.5	312.5	300	250	750	350	3775	
3	***Soil bioengineering***	900	900	900	625	937.5	900	500	750	525	6937.5	1
4	***Check dams (infrastructure)***	300	300	600	937.5	937.5	900	750	750	525	6000	

5	***SALT (large scale)***	300	300	900	937.5	937.5	900	750	750	525	6300	4
6	***Bamboo cultivation***	900	600	300	312.5	937.5	900	750	750	525	5975	
7	***Mangrove plantation***	300	325	1125	937.5	937.5	900	975	500	525	6525	3
8	***Carbon Farming***	300	300	900	312.5	937.5	900	750	500	525	5425	
Criterion weight		12	12	12	12.5	12.5	12	10	10	7	100	

CHAPTER 5 - Summary and Conclusion

The technology needs assessment was conducted through a participatory approach, nationally driven and inclusive process to ensure that the technologies identified respond to the real needs of the country. The two sectors identified for adaptation were decided based on the national priorities, strategies and align with the current projects and programs implement by the Government of Timor-Leste. The two sectors prioritised were prioritised were sustainable land management for agriculture and technology and natural methods for erosion prevention.

A long list of technologies was identified and obtained through extensive analysis of the national key documents related to climate change, agriculture, land management and forestry. Additionally, a one-on-one meeting was conducted with relevant ministries and agencies who are implementing activities that are a part of the long list of relevant to the two sectors under adaptation. During the one-on-one meeting, various other technologies were suggested to include in the list, or technologies are being planned to be implemented or scale up in the future, such as research on the use of biochar, Conservation Agricultural and Climate-Smart Agriculture practices. A consultation and validation workshop were also held inviting all relevant stakeholders from the government line ministries, national and international agencies, marginalized groups, and youth groups. On the 10th of January 2023, a consultation and validation workshop were held to do prioritization exercise with the stakeholders (refer to Annex II for the list of participants). During the workshop, the long list was presented to the participants, indicators were shared and the steps for the Multi-Criteria Assessment was conducted. The participants discussed about each technology from the long list and start to assess them based on the criteria provided. From that exercise, 4 technologies from each sector were considered top technology priorities:

1. **Sustainable land management in agriculture**
    - **Conservation Agriculture**
    - **Water Management and Restoration**
    - **Green Char**
    - **Composting**

2. **Infrastructure and Natural Methods to Prevent Erosions**
    - **Soil bioengineering**
    - **Tarabandu**
    - **Mangrove plantation**
    - **Sloping Agriculture Land Technology**

Barrier analysis for the technologies listed above will be conducted and create action plans for these priority technologies to represent the need for such technology actions in the different industries and subsectors.

List of References

Asian Development Bank. (2018). *Timor-Leste Transport Operations.* Dili: Asian Development Bank.

Asian Development Bank. (2022). *Asian Development Bank.* Retrieved from Environment Assessment (Summary) from Country Partnership Strategy 2016-2020: https://www.adb.org/sites/default/files/linked-documents/cps-tim-2016-2020-ena.pdf

Barnett, J., Dessai, S., & Jones, R. N. (2007, May). Vulnerability to climate variability and change in East Timor. *Working Paper Series*(05).

Bentrup, G., & MacFarland, K. (n.d.). *Agroforestry*. Retrieved from Climate Change Resource Center: https://www.fs.usda.gov/ccrc/topics/agroforestry#:~:text=Based%20on%20a%20recent%20scientific,greenhouse%20gas%20emissions%20(1).

Bettencourt, E. M., Tilman, M., Narciso, V., da Silva Carvalho, M. L., & de Sousa Henriques, P. D. (2015). *The Livestock Roles in the Wellbeing of Rural Communities of Timor-Leste.*

Food and Agriculture Organization of the United Nations. (2019). *Food and Agriculture Organization of the United Nations.* Retrieved from Rebuilding livelihoods in communities affected by El Niño in Timor-Leste: https://www.fao.org/3/ca5875en/CA5875EN.pdf

Food and Agriculture Organization Timor-Leste. (2022, June). *Food and Agriculture Organization of the United Nations.* Retrieved from Support to sustainable agriculture mechanization: https://www.fao.org/3/cc2485en/cc2485en.pdf

Global CAD. (2018). *National Coastal Vulnerability Assessment and Designing of Integrated Coastal Management and Adaptation Strategic Plan for Timor-Leste.* Dili: Ministry of Agriculture and Fisheries.

Governo de Timor-Leste. (2012). Decreto-Lei N.o 26 /2012 de 4 de Julho Lei de Bases do Ambiente. *Jornal da República* , 6015-6030.

Ministry of Agriculture and Fisheries. (2018). *Final Country Report of the Land Degradation Neutrality Target Setting Programme in Timor-Leste.* Dili: Government of Timor-Leste.

Ministry of Agriculture and Fisheries. (2018). *Food and Agriculture Oragnization of the United Nations.* Retrieved from Promoting Conservation Agriculture in Timor-Leste: https://www.fao.org/3/I8858EN/i8858en.pdf

Ministry of Agriculture and Fisheries. (2019). *National Coffee Sector Development Plan 2019-2030.* Dili: The Government of Timor-Leste.

Ministry of Agriculture and Fisheries. (May 2021). *Compendium - Adapted Technologies and Practices for Climate Resilient Agriculture.* Dili: Government of Timor-Leste.

Ministry of Commerce, Industry and Environment. (2016). *Intended Nationally Determined Contribution to the UNFCCC.* Dili: GoDRTL.

Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAPP). (2015). *Current and Future Climate of Timor-Leste.* CSIRO.

Paudel, S., Baral, H., Rojario, A., Bhatta, K. P., & Artati, Y. (2022). *Agroforestry: Opportunities and Challenges in Timor-Leste.* Forests.

República Democrátia de Timor-Leste. (2002). Constituição da República Democrática de Timor-Leste.

Secretaria de Estado do Ambiente. (2022). *Timor-Leste Integrated Vulnerability Assessment (IVA) Report.* Dili: Ministro Coordenador dos Assuntos Económicos.

Secretariat of State for the Environment. (2020). *Timor-Leste's Adaptation Plan.* Dili.

Secretariat of State for the Environment. (2020). *Timor-Leste's Second National Communication.* Dili.

Secretariat of State for the Environment. (2021). *Timor-Leste's National Adaptation Plan.* Dili: GoDRTL.

The Government of Timor-Leste. (2011). *Timor-Leste Strategic Development Plan 2011-2030.* Dili: The Government of Timor-Leste.

The Government of Timor-Leste. (2011). *Timor-Leste Strategic Development Plan 2011-2030.* Dili.

The Government of Timor-Leste. (2017). Ministerial Diploma No. 2 /2017 Establishment of the Working Group of Climate Change. *Jornal da Republica*, 101-105.

The Government of Timor-Leste. (2019). *National Report on Timor-Leste Agriculture Census 2012.* Dili: The Government of Timor-Leste.

UNDP and Ministry of Agriculture and Fisheries. (2018). *National Coastal Vulnerability Assessment and Designing of Integrated Coastal Management and Adaptation Strategic Plan for Timor-Leste* . Dili: UNDP and the Government of Democratic Republic of Timor-Leste.

World Bank. (2019, April). *Poverty & Equity Brief: Timor-Leste.* Retrieved from Poverty Data: https://documents1.worldbank.org/curated/en/716051560938636103/pdf/Timor-Leste-Poverty-and-Equity-Brief-Spring-2019.pdf

Annex I: Technology Factsheets for Selected Technologies

Sector I : Sustainable Land Management for Agriculture

Technology 1: Agroforestry	
Introduction	Agroforestry is land-use systems and technologies where woody perennials such as trees, shrubs, palms, bamboos, etc. are planted in agricultural landscape in some form of spatial arrangement or temporal sequence.
Features	According to FAO, there are three types of agroforestry systems: 1. Agrisilvicultural systems 2. Silvipastoral systems 3. Agrosylvopastoral systems FAO also defines that agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health while at the same time protect the soil and the biodiversity.
Cost to implement options/operation/maintenance cost	The cost of the technology depends on the scale of the implementation and the crops to cultivate. The implementation of this technology must consider land preparation, acquisition of seeds from community nurseries, provide training on maintaining the land, planting and equipment for planting, and maintenance of the planted trees and crops. Based on the information from Director of Carbon Offset Timor-Leste, it is estimated to cost approximately $3,000-$5,000 per hectare. The cost does not include maintenance which is approximately $10,000 - $15,000 annually.
Environmental Benefits	Climate change is causing droughts and changing in rainfall patterns. Agroforestry method can improve the resilience of agricultural productions against these changes through the plantation of woody perennials which intensifies, diversifies, and acts as buffer for farming systems. Trees are less susceptible than annual crops to inter-annual variability or short-lived extreme events like droughts or floods. Woody perennials conserves water during droughts and increase infiltration rates during monsoons.
Economic benefits	• Creates employment opportunities due to its diverse types of agricultural practices and suitability. • Employment starting from preparation of the seedlings, transportation, handling, planting. • Access to carbon market. • Increase income to the local communities through year-round harvesting of different crops.

Social Benefits	• 80% of Timorese population are farmers and majority are of smallholder farmers which own and operate small size lands for predominantly subsistence agriculture.
Institutional/implementation	The local extensionists are trained on the different agroforestry types and they go on to share their knowledge with farmers that they work with or provide technical assistance.
National status of technology/ Coherence with national development policies and priority	The technology already exists in the country through public and donor funding. There are currently ongoing successful projects and the Ministry of Agriculture and Forestry and the Secretary of State for the Environment are promoting and expanding these practices throughout the territory.
Acceptability to local stakeholders	The local farmers accept the technology and are being implemented in their land; however, there needs to be consistent assistance.

Technology 2: Crop Rotation in Conservation Agriculture	
Introduction	Crop rotation involves planting different crops in the same field or given location from year to year to replenish the soil. Conservation Agriculture is method in which aims to reduce and minimize soil disturbance, minimize loss of soil cover, and changes within soil structure and nutrient composition.
Features	The rotation is planned so that crops planted in different years complement each other in terms of nutrients requirements and soil composition and structure. It is ideal to alternate planting between deep rooted and shallow rooted crops. This method is suitable for all types of soil, altitudes, and climate conditions; and particularly appropriate in poor, eroded and exhausted soil from unsustainable agriculture practices such as mono-culture, intensive use of artificial fertilizers and increased intensity of climate events. According to Agriculture Compendium (Ministry of Agriculture and Fisheries, May 2021), an effective plant to use is velvet bean or locally known as *lehe* to plant prior to planting any other crops.
Cost to implement options/operation/maintenance cost	The exact cost of the technology is not determined. The cost to implement the technology is must consider: - Hand-held rolling injectors is approximately: $10,000 per unit including shipment to Timor-Leste (source: Tokopedia Indonesia) - Hand-held tractors found in Indonesia is approximately $8,000/unit including shipmet to Timor-Leste. (source: Tokopedia Indonesia) - Cost for purchasing food crops and *lehe*: $10.00/kg. - Installation of irrigation (purchase pipes and water tanks): $1,000 - Provide training to local farmers: $500/day for 20 participants - Labor cost is $15.00/person daily. The work may require 20 people for 1 month. The total cost is approximately: $25,000 in one location of approximately 5 - 10hectares.
Environmental Benefits	• Restore nitrogen into the soil to increase fertility. • Reduce the needs for artificial fertilizers. • Reduce the risk of the spread of pests and diseases. • Replenish soil condition and re-establish healthy soil structure.
Economic benefits	• Increase productivity of the soil which in turns increase in yields. • Reduce the use and purchase of artificial fertilizers.
Social Benefits	• 80% of Timorese population who are farmers and majority are of smallholder farmers which own and operate small size lands for predominantly subsistence agriculture. • Increase capacity and understanding of sustainable agriculture.

Institutional/implementation	The local extensionists are trained on the different agroforestry types and they go on to share their knowledge with farmers that they work with or provide technical assistance.
National status of technology/ Coherence with national development policies and priority	The technology already exists in the country through public and donor funding. There are currently ongoing successful projects and the Ministry of Agriculture and Forestry and the Secretary of State for the Environment are promoting and expanding these practices throughout the territory.
Acceptability to local stakeholders	This technology has been implemented throughout different villages in Timor-Leste.

Technology 3: Fixed and permanent agriculture	
Introduction	Fixed and permanent agriculture is a practice by people who settle down and undertake cultivation of crops both for home and for commercial purposes. The farmers do NOT move around from one land to another practicing slash-and-burn.
Features	It is an agricultural practice that is thought to be resilient, stable and sustainable production system. The goal is the produce and adapt to local conditions such as the temperature, humidity, and soil type. This system is primarily to promote sustainable use of the land protection of biodiversity around and on the farm.
Cost to implement options/operation/maintenance cost	The cost to implement this technology is not determined, however, it involves providing training to the farmers on how to use their land and provide them with seedlings and food crop to plant. The cost for training is approximately $500/day for 20 participants, not including logistics which can be another $1,000 - $1,500. The training can be divided into several days depending on the necessity. Cost to monitor proper implementation of the technology is approximately $15,000 including salary for the officers in the field to work with small landowner farmers annually. Total cost is approximately $30,000 including monitoring.
Environmental Benefits	• Promote sustainable agricultural practices.
Economic benefits	• Increased productivity. • Promotes circular-economy.
Social Benefits	• Promotes sustainable and self-efficient society and communities. • Suitable for all farmers, reduces inequity. • Use of local knowledge. • Increase health benefits for the local farmers since farmers do not have to travel far distances for farming. • Encourage participation of women and other groups.
Institutional/implementation	Ministry of Agriculture and Fisheries promote this sustainable agriculture practice.
National status of technology/ Coherence with national development policies and priority	Identified in NAPA 2010.
Acceptability to local stakeholders	Implemented by different communities.

Technology 4: Composting	
Introduction	Composting is a natural process of recycling organic matters, such as leaves and food scraps that can turn into organic and natural fertilizers to enrich and replenish the soil.
Features	This technology is to be implemented in a community level which households produce compost and use it to grow their crops and also other plants such as flowers (to sell).
Cost to implement options/operation/maintenance cost	The cost of implementing the technology includes 5 days training for 50-80 participants $5,000 including all the materials for the training and logistics. Maintenance cost of the compost area (contain the smell and flies) is approximately $1,000-$2,000 per location including labor and the materials required. Total cost is approximately $5,000 - $7,000.
Environmental Benefits	• Promotes healthier plant growth. • Reduces waste. • Improves soil health, physical and restore nutrients back in the soil. • Reduces GHG emissions to the atmosphere.
Economic benefits	• Spend less money on buying fertilizers. • Higher yields in agriculture. • Cuts the amount of expenses and waste sent to landfills.
Social Benefits	• Crops / plants grow with less composition of chemicals which is better for health. • Increase the consumption of organic food and vegetables.
Institutional/implementation	The Ministry of Agricultures and Fisheries is implementing this with small communities to reduce waste and increase soil fertility.
National status of technology/ Coherence with national development policies and priority	Information received from the Director General for Agriculture during our one-on-one meeting. DGA mentioned that MAF are considering to build check dams
Acceptability to local stakeholders	Small communities and various households are implementing it.

Technology 5: Community-Centric Agriculture or "Agricultural Extension"	
Introduction	Community-Centric Agriculture or "Agricultural Extension" offers agronomic technique and skills to the farmers and supplies them with necessary inputs and services to increase their productivity, food security and livelihoods.
Features	The 4 core elements of extensionists: 1. Transfer knowledge and skills; 2. Provide technical advice and information; 3. Gives motivation, involvement and self-confidence; 4. Farmers' and peoples' organisation for practice.
Cost to implement options/operation/maintenance cost	The cost to be considered in implementing this technology are as follow: 1. Labor (salary for the extensionists): minimum $150/monthly per person 2. Transportation (motorbike, fuel cost) - $50/montly per person 3. Materials for training: $1,000 (one time) 4. Cost to conduct training to the farms for 8 -10 people for 2 days: $500 5. Equipment and tools to support farmers: $500 The total cost for 1 extensionist to train and accompany farmers in one village for 8-10 landowners a month is approximately: $1,200 - $1,500
Environmental Benefits	• Sustainable use of the land.
Economic benefits	• Increase productivity and increase yield. • Sometimes, the introduced techniques are much more economical and affordable to the farmers. • Chance to upgrade. • Increase income.
Social Benefits	• Suitable for everyone; no discrimination in the requirement. • Local knowledge. • Community ownership.
Institutional/implementation	
National status of technology/ Coherence with national development policies and priority	NDC, NAP, NSDP 2011 – 2030
Acceptability to local stakeholders	Currently being implemented by MAF.

Technology 6: Water Management and Restoration	
Introduction	Holistic approach using traditional knowledge to conserve and restore water catchments and springs.
Features	Building small check dams, plant water retaining trees in the periphery of the water catchments or springs, provide capacity buildings through trainings for the community members involved.
Cost to implement options/operation/maintenance cost	Cheapest technology - All cost inclusive USD1,000 for 1 community = 1 *aldeia* - Monitoring & maintenance $200.00 – 1 or 2 days
Environmental Benefits	- Increase water infiltration - Reduce erosion - Increase water retention - Restore water catchments and springs, bring them back to live - Increase water quantity in soil
Economic benefits	- Trigger new economic activities since the soil is back to good condition and favourable for planting.
Social Benefits	- Health benefits - Tourism attraction - Increase and enhance tradition knowledge in conservation - Holistic approach
Institutional/implementation	Currently being implemented by Permatil,
National status of technology/ Coherence with national development policies and priority	
Acceptability to local stakeholders	400+ communities in Oecusse and Atauro , Ermera

Technology 7: Greenhouse	
Introduction	The use of greenhouse in agriculture is to optimize crop growth through a controlled microclimate.
Features	Greenhouse is a closed structure that is covered with translucent materials creating optimal and suitable microclimate, water use, pest and disease control, soil fertility, and so on for plants to reach its optimum growth and productivity with minimum impacts from outside environment. The materials, structure and the climate variability inside greenhouse are all controlled according to the purpose and stage of the plant growth. There are various issues to be considered in the installation of the greenhouse: 1. Fertility of the soil (the soil's physical, chemical and microbiological condition); 2. Drainage capacity 3. Availability and proximity of a source of water for irrigation; 4. Access to roads; 5. Ventilation requirements; 6. Light (avoid locations near high trees); 7. Slope; 8. Orientation (amount of solar radiation).
Cost to implement options/operation/maintenance cost	The cost to implement this technology is dependent on the scale of the project. The cost to be considered in the installation of the technology are as follow 1. Labor - $150 per person monthly 2. Materials (polyethylene rolls, planks, posts for the structure, pipes for irrigation) - $50 - $60 / m^3 3. Provide training to 20-30 farmers to understand the use of greenhouse for 2 days: $1,000 4. Purchase seeds and crops - $1,000 Must also consider maintenance of greenhouse is approximately $100-$200 monthly and for disposal in the future is approximately $5,000 for transportation and handling. Total cost is approximately: $70 - $80 per cubic meter including maintenance.
Environmental Benefits	• Preservation of soil structure and nutrients. • Efficient use of water and soil nutrients. • Resilient towards the negative impacts of climate change. • Soil remains protected, firm and is not eroded.
Economic benefits	• Increase crop yields by shortening growing cycles and raise crop quality through controlled indoor atmosphere. • Increased income for the farmers.
Social Benefits	• Suitable for everyone, reduce inequality.
Institutional/implementation	

National status of technology/ Coherence with national development policies and priority	Information received from the Director General for Agriculture during our one-on-one meeting.
Acceptability to local stakeholders	

Technology 8: Animal Power Plowing	
Introduction	The use of draught animal power for land preparation is mainly confined to rice while the use of animal manure to fertilize the soil is widely used in the different crops.
Features	Buffalos and horses are used in the preparation of the soil in rice fields. In the Baucau district, Silva (2011) found that around 52.1% of farmers use buffalos and 24% use horses in rice field preparation. In the suco of Tapo-tas, the households only use tools for land preparation, in Tapo-Memo, where the rice is an important culture, around 40.6% of households use animal draught power and, in Aidabaleten, 22.9% (Table 10). In these two sucos, the majority of the animals are owned by the households.
Cost to implement options/operation/maintenance cost	The cost to implement this technology much consider: 1. Labor: $150/person monthly 2. Cost to feed the animals: $20/daily 3. Cost to purchase each animal (cows): $800 - $1200 per head. Total cost to implement is estimated:$1,000 - $1,500 monthly.
Environmental Benefits	• Less disturbance to the soil. • Cow manure can be used for fertlizers. (Bettencourt, et al., 2015)
Economic benefits	• Less economic input to prepare the soil. • Added value to livestock. • Enhance trade between the villages.
Social Benefits	• Easily accessible by farmers in the remote area.
Institutional/implementation	• MAF and NGOs are currently implementing it.
National status of technology/ Coherence with national development policies and priority	• Information received from consultation workshop with the stakeholder.
Acceptability to local stakeholders	Communities in the remote area are using this practice to prepare the soil for plantation.

Technology 9 : Bio Char	
Introduction	Rice hull biochar is a way of turning a waste production into an effective soil amendment that neutralizes acid soils and makes nutrients in the soil available to the crops.
Features	Rice hulls can be easily converted into rice hull biochar by "half burning" the rice hulls until they are black, but stopping before the charcoal burns to ash. The simplest way is by lighting a fire in a chimney in the centre of a pile of rice hull. As the fire front moves from the centre, the hulls are burnt to the charcoal, but due to low levels of oxygen, the charcoal does not burn to ash.
Cost to implement options/operation/maintenance cost	Based on the experience in Laleia (Baucau) at low rates of application (1t/ha), biochar plus increased yield by 93%, turning 1kg of biochar plus to USD $8.20 of product, across four species. The cost of production of biochar plus is less than 50c/kg.
Environmental Benefits	Biochar application has a significant impact on reducing acidity of acid soils. In an acid red soil from the Baucau plateau, the application of 5 t/ha of rice hull biochar lifted soil pH from a very acid 4.6 to much higher levels. The availability of Phosphorous also increased with added biochar application.
Economic benefits	• Increase yields for crops with low economic input.
Social Benefits	• The farmers can do it from their backyard so they do not have to walk long distances. • Less exposure to highly chemical substances. • Promotes social equity.
Institutional/implementation	Currently being implemented by MAF Division of Research and UNTL Department of Agronomy.
National status of technology/ Coherence with national development policies and priority	Information received from Director General for Agriculture in one-to-one consultation meeting and further information from Agriculture Compendium MAF.
Acceptability to local stakeholders	

Sector II : Infrastructure and Natural Methods to Prevent Erosion

Technology 1: Tarabandu	
Introduction	Tarabandu is a traditional law enforcement mechanism and manages the relationship between humans and natural resources in Timor-Leste.
Features	It is traditional practice that have been around for centuries and it is applicable up t date. It uses local powers, authority and knowledge, and also promotes cultural preservation.
Cost to implement options/operation/maintenance cost	The cost to implement this technology includes: 1. Cost for gathering all the local leaders together. 2. Events cost. 3. Supervision cost. 4. Implementation of what has been banned cost. Based on the information from SSE, the total cost is approximately $3,000 for one event of Tarabandu in one location.
Environmental Benefits	• The land is managed using traditional and local knowledge which the ancestors have used for centuries.
Economic benefits	• Expenses for the implementation goes directly to the communities. • Valuing local knowledge and customs. • The implementation of this technology will not generate additional waste, all the required materials will be source locally.
Social Benefits	• Strengthening traditional custom in environmental conservation. • Inclusive process, taking into local knowledge and practices. • Preservation of traditional and customary practices. • Reduce disasters caused by erosion.
Institutional/implementation	Tarabandu is currently being implemented by SSE.
National status of technology/ Coherence with national development policies and priority	NAP, NSDP 2011 – 2030
Acceptability to local stakeholders	

Technology 2: Developing Manual or Guide for Community Forestry on Degraded Lands	
Introduction	Community forestry is a strategy which encourages the participation of rural and local people in sustainable forest management.
Features	• Understanding key concepts of community forestry • Framework for participation of local communities in the forest management, understanding their rights and responsibilities for managing, benefiting and interest. • Guide the mobilization and strengthens of community-based organizations • Portal for introducing new and locally appropriate techniques for forest management. The features of the manual or guide is further discussed or identified based on the necessities, context, local knowledge etc.
Cost to implement options/operation/maintenance cost	The cost to implement this technology includes: 1. Expert to assist in developing the manual - $15,000 - $20,000 2. Training materials - $5,000 3. Training and awareness raising activities cost - $2,000 - $3,000 Total cost is approximately: $27,000 - $30,000.
Environmental Benefits	• Sustainable management of forest
Economic benefits	• Inexpensive method of management. • Employment for the local people. • Chance of involving unemployed youth. • The implementation of this technology will not generate additional waste, all the required materials will be source locally.
Social Benefits	• Community ownership. • Reduce inequity. • Reduce disasters caused by erosion. • Local knowledge and cultural preservation. • Community participation and involvement.
Institutional/implementation	
National status of technology/ Coherence with national development policies and priority	
Acceptability to local stakeholders	

Technology 3: Soil bioengineering	
Intruduction	According to ADB, 'soil bioengineering is a complimentary and cost-effective addition to conventional engineering approaches that use rock-based and concrete physical structure'. This method is suitable for adjacent slopes that are susceptible to erosion and landslides and unpredictable seismic circumstances.
Features	There are various methods of soil bioengineering, however, the most common ones used in Timor-Leste for road projects are: 1. Using live stakes method – the stakes are planted close together (50-60cm apart) in rows starting at the bottom of the slope working its way up. Close planting gives immediately physical reinforcement to the slope and to interlock rapidly through the roots. The stake used were local *Indian Ash*. 2. Mixed Grasses-Shallow 1:1 Cut Slope – easy to plant grass species (such as Vetivera, Kans Grass, Elephant Grass) that gives rapid ground cover, live stakes are also inserted at 4-meter intervals to provide reinforcement, light compaction before planting to prevent erosion between plants in the preliminary stages as growth commences. 3. Slope remodelling, mixed grasses, palisades, brush layers, live stake, check dams, and gabions-steep 1:2 cut slope (Using rock and vegetation)
Cost to implement options/operation/maintenance cost	The cost to consider in implementing this technology are as follow: 1. Labor: $150/ per person montly. 2. Materials (rocks for gabions, barb wires): $50 per m^2 The total cost per square meter is $55 - $60.
Environmental Benefits	• Re-strengthen soil structure to avoid erosion and landslide. • Minimize sedimentation.
Economic benefits	• Most of the materials used for the implementation of this technology are locally sources, which means it will incur minimum cost. • This technology will not generate any further waste as most of the materials used will be sourced locally.
Social Benefits	• Less erosion/land slide near road side to avoid traffic accidents and destruction to infrastructures (roads). • Reduce disasters caused by erosion.
Institutional/implementation	
National status of technology/ Coherence with national development policies and priority	This technology is being implemented by ADB-Timor-Leste in road projects across Timor-Leste.

Acceptability to local stakeholders	

Technology 4: Check dams	
Introduction	Check dams are physical structures built across channels to reduce erosion by lowering the velocity of water flow. It is an ancient technique to reduce sedimentation and to evenly distribute water across the land.
Features	There are two categories of check dams: 1. Temporary check dams – small to medium size structures, build to last only few years to restore vegetation cover and or restore the condition of the land. Can be built with brushwood, wooden posts, sandbags. 2. Permanent check dams – medium to large size structure, implemented in land that are severely degraded. Can be built with cement, rocks, It is mandatory to do a proper feasibility study and consultation with the community prior to the construction of the dam to ensure that it serves of the purpose. Must also take into consideration different land types, river flow and surrounding communities can only accommodate certain volume of water and construction.
Cost to implement options/operation/maintenance cost	Cost for construction of a medium size temporary check dams is approximately $5,000 - $5,000 since most of the materials will be sourced locally, such as, wood, wooden posts and sandbags. The maintenance for this infrastructure is around $500 - $1,000 monthly. Cost for construction of large-scale check dams are much higher which will require technical drawings, labor, materials and logistic which is approximately $300,000 - $500,000. Must also consider maintenance of the dams such as removing and treat the sediments which is approximately $5,000 - $10,000 depending on how severe the sediments are.
Environmental Benefits	• Soil restoration and replenishment • Increase soil fertility • Reduce sedimentation • Increase water infiltration into the soil and help to recharge water table in the area. • Provide more lands in which to plant crops.
Economic benefits	• More land to plant crops to sell in the market. • The construction of small to medium size check dams will source all the materials locally which means will not generate additional waste.
Social Benefits	• Construction of dams do no cause displacement in the communities and cause other natural disasters. • Community involvement and ownership during the process of construction.

	• Reduce disasters caused by erosion.
Institutional/implementation	
National status of technology/ Coherence with national development policies and priority	Information received from the Director General for Agriculture during our one-on-one meeting. DGA mentioned that MAF are considering to build check dam in Laclo River.
Acceptability to local stakeholders	

Technology 5: SALT	
Introduction	SALT is agroforestry model farming system which helps to control erosion, stabilize slopes, improve terrace and improve soil fertility.
Features	SALT is a system in where dense hedgerows of fast perennial nitrogen-fixing tree or shrubs are planted along the identified contour lines. The best NFTS to plant are: *Flemingia Macrophylla, Desmodium rensonii, Gliricidia sepium* and *Calliandra calothyrsus*. This method of agriculture also allows to plant permanent shrubs such as coffee, cacao, citrus and other fruit trees throughout the farm. On the strips that are not occupied by permanent trees, can alternatively plant corn, sorghum, sweet potatoes, melon, pineapple and other legumes. There are 4 types of SAL, such as : 1. SALT 2 – Simple Agro-Livestock Technology 2. SALT 3 – Sustainable Agroforestry *Land* Technology 3. SALT 4 – Small Agrofruit Livelihood Technology The implementation of SALT on different locations is dependent on the necessity and the suitability of the land and communities.
Cost to implement options/operation/maintenance cost	The cost required for the implementation of this technology includes: 1. Labour 2. Materials (seedlings, NFTS seedlings, equipment to identify the contour lines) 3. Transportation Must also consider cost associated to the provide training to the local farmers to understand the implement process, benefit and maintenance of SALT. Total cost to implement is approximately $25,000 - $30,000 depending on the type of SALT.
Environmental Benefits	• Planting NFTS will restore forest cover to watersheds, slopes and other lands that been denuded of trees. • Minimize and control erosion. • Enrich, fertilize and restore soil structure. • The technology is applicable to most of the hillside of the farm.
Economic benefits	• Higher yields of variety of crops to sell in the market. • Economically feasible • The implementation of the technology will not generate any additional waste in the area.
Social Benefits	• Can be easily replicated due to the characteristic of the land (mountainous) of the country. • Farmers gain understanding about different methods of agriculture that is appropriate for different land and soil types. • Reduce disasters caused by erosion.
Institutional/implementation	

National status of technology/ Coherence with national development policies and priority	Information received from DNPA.
Acceptability to local stakeholders	

Technology 6: Bamboo cultivation	
Introduction	Planting bamboo as natural method for erosion prevention on the slopes and along riverbanks where water flow is high has been around for a long time. It has been proven effective and inexpensive solution to control erosion and preserve terrain in a wide variety of situations.
Features	Bamboo plants are well suited for restauration of degraded and eroded land because it has long root systems that can reach down deep, drawing nutrients where other plants would struggle, so they can grow on poor soil or on steep slopes. The roots also bind the soil together and prevent from further erosion, with a single bamboo plant able to bind six cubic metres of dirt. It is also a very resilient plant because if can build up large amount of biomass underground, which quickly recover from damage, if it is badly damaged or burned. There are more than 1,200 types of bamboo, however, can be categorized into two: running bamboo and clumping bamboo. o Running bamboo – the roots have rhizome roots grow horizontally and outward. Usually takes two to three years for the roots to start reaching out across the soil and underground. This is ideal for slopes, uneven terrain and varying topography. o Clumping bamboo – grows in a tight and dense pack. The Rhizome roots are mostly u-shaped and upwards.
Cost to implement options/operation/maintenance cost	The cost to implement this technology include: 1. Labour for preparing the land and all the process leading up to planting: $150/ per person montly 2. Materials (preparation of seedlings): $1/one bamboo tree 3. Transportation (renting cars to transport the seedlings): $10,00 - $12,000 (one time cost) 4. Maintenance cost: $200 Total cost to plant 1 bamboo tree is: $1.50 - $2.00 including maintenance.
Environmental Benefits	• Consolidate topsoil to prevent runoff and erosion. • Stabilize slopes. • Preserve riverbeds • Reduce evaporation • The plant is resilient to the adverse effects of climate change. • Plant takes little from soil, requiring minimal nutrients. • Fallen leaves build up, decompose, and fortify the topsoil with humus. • Dense foliage absorbs CO2 and provides shades for other seedlings.
Economic benefits	• Reduce the cost to restore soil erosion.

	• The implementation of the technology will not generate additional waste or potential contamination.
Social Benefits	• Reduce disasters caused by erosions. • Participation at all levels, including students from school.
Institutional/implementation	
National status of technology/ Coherence with national development policies and priority	
Acceptability to local stakeholders	

Technology 7: Mangrove Plantation	
Introduction	Mangroves are a natural infrastructure that helps to stabilize and prevent erosion on the coastline.
Features	Mangroves also physically protect coastlines by breaking the sea waves during storm surges and help shield seagrass beds and coral reefs from the effects of siltation. In addition, the mangrove ecosystem is a source of food and a nursery ground for a number of fish species that are important to local fisheries.
Cost to implement options/operation/maintenance cost	The cost to implement this technology include, labour, Mangrove seedlings, maintenance (create fences around mangrove nurseries or new planted mangroves. Total cost for 20,000 mangrove plant is $20,000 - $30,000.
Environmental Benefits	• Mangroves helps to slow down water flows, encourage deposition of sediments and reduce erosion. • Sequestrate GHG.
Economic benefits	• Inexpensive method of erosion prevention. • The implementation of the technology will not generate additional waste or potential contamination.
Social Benefits	• Reduce disasters caused by erosion.
Institutional/implementation	
National status of technology/ Coherence with national development policies and priority	SNC
Acceptability to local stakeholders	Many communities along the coast-line have already implemented this technology.

Technology 8: Carbon Farming	
Introduction	It is a vital part of the Emissions Reduction Fund (ERF) and allows landowners to earn carbon credits by modifying land use or management techniques to store carbon or decrease glasshouse gas emissions.
Features	
Cost to implement options/operation/maintenance cost	• The cost to implement this project should consider labor, training to the farmers or landowners, acquisition of tools for carbon calculations, certification fees and maintenance of the location. The total cost is approximately $75,000 - $100,000.
Environmental Benefits	• Less erosion and soil loss; • Better soil structure and fertility; • Less soil salinity; • Attracts animals and vegetation to grow; • Serves as buffer against drought and greater water efficiency.
Economic benefits	• Provide employment opportunities to the farmers and able to use their land for additional revenue. • Can trade carbon unit in the carbon market.
Social Benefits	• Engage in national and international carbon market. • Promotion of climate justice.
Institutional/implementation	SSE and MAF.
National status of technology/ Coherence with national development policies and priority	NSDP2011-2030
Acceptability to local stakeholders	Various communities are currently implementing this project.

Annex II: List of stakeholders involved and their contacts

TNA Consultation Workshop – List of Participants

JL Villa, 10 Jan 2023

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TNA Consultation Workshop – List of Participants

JL Villa, 10 Jan 2023

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JL Villa, 10 Jan 2023

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TNA Consultation Workshop – List of Participants

JL Villa, 10 Jan 2023

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TNA Consultation Workshop – List of Participants

JL Villa, 10 Jan 2023

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JL Villa, 10 Jan 2023

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JL Villa, 10 Jan 2023

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TNA Consultation Workshop – List of Stakeholders

JL Villa, 10 Jan 2023

I. Adaptation

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TNA Consultation Workshop – List of Stakeholders

JL Villa, 10 Jan 2023

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Annex III: Scoring Matrix for the Technology Prioritization

Sector I: Sustainable Land Management for Agriculture

Scoring Matrix

		Costs		Benefits						Local Context	
				Economic		Social		Environmental	Climate related	Institutional/ Implementation	Political
No.	Technology	Initial cost (USD)	Operation and maintenance cost (USD)	Employment opportunities and increased income	Improve economic performance	Food Security	Reduction in inequity	Restore, conserve and protect the landscape	Increase resilience towards the adverse effects of CC	Replicability and acceptability	Coherence with national development policies and priority
1	*Agroforestry*	50	50	75	75	75	50	100	100	25	100
2	*Conservation Agriculture (CA) and Crop Rotation*	75	75	75	75	100	75	100	100	50	100

3	***Fixed and Permanent Agriculture***	75	25	25	50	25	75	100	100	50	100
4	***Composting***	50	50	75	75	100	25	100	100	100	100
5	***Community-Centric Agriculture or Agricultural Extensionist***	25	25	50	50	50	50	50	50	100	100
6	***Water Management and Restoration***	50	50	50	100	100	75	100	100	100	100
7	***Greenhouse***	25	25	50	75	75	50	50	100	50	100
8	***Animal Power Plowing***	50	75	50	75	75	25	50	75	25	25
9	***Bio Char***	75	100	75	75	100	100	100	100	50	50

Criterion weight	15	10	10	10	10	5	10	10	10	10	100

Sector II: Infrastructure and Natural Methods to Prevent Erosion

Scoring Matrix

		Costs		Benefits					Local Context	
				Economic		Social	Environmental	Climate related	Institutional /Implementation	Political
No.	Technology	Initial cost (USD)	Operation and maintenance cost (USD)	Employment oportunity	Waste Management	Reduced disasters caused by erosion	Restore, conserve and protect the landscape	Increase resilience towards the adverse effects of CC	Replicability and acceptability	Coherence with national development policies and priority
1	*Tarabandu (law or policy)*	50	75	25	75	75	75	50	100	100
2	*Developing Manual for Community Forestry on Degraded Lands*	75	25	25	25	25	25	25	75	50
3	*Soil bioengineering*	75	75	75	50	75	75	50	75	75
4	*Check dams (infrastructure)*	25	25	50	75	75	75	75	75	75

5	***SALT (large scale)***	25	25	75	75	75	75	75	75	75	
6	***Bamboo cultivation***	75	50	25	25	75	75	75	75	75	
7	***Mangrove plantation***	25	25	75	75	75	75	75	50	75	
8	***Carbon Farming***	25	25	75	25	75	75	75	50	75	
Criterion weight		13	13	15	0	13	17	13	7	9	100
Criterion weight, sensitivity analysis		12	12	12	12.5	12.5	12	10	10	7	100