Green Climate Fund Concept Note
Development-Improved Waste Management System through Public-Private Partnership Model

Executive Summary

This concept note presents a Public-Private Partnership model for improved waste management through circular economy interventions in 50 school/institutional locations and two centralized facilities at SELWA Center. The intervention integrates decentralized composting, greenhouse-based sustainable agriculture, hydroponics, aquaponics, agrivoltaics, waste segregation, textile and PET recovery, production of recycled polyester products, waste display, awareness, inclusive livelihood development and market linkage.

The project cost is estimated at Nu. 638.60 million. The proposed financing structure consists of Nu. 575.00 million as GCF grant financing, representing 90% of the total project cost, and Nu. 63.60 million as co-financing, representing 10% of the total project cost. The financing ratio reflects the public-good nature of the investment and the limited commercial return from school-level waste, composting, awareness, and climate-smart agriculture activities.

The expected benefits include reduced methane emissions from organic waste, reduced landfill dependency, improved waste segregation at source, improved school nutrition, strengthened student learning, inclusive livelihood opportunities through SELWA, production of recycled textile and upcycled products, and demonstration of a scalable circular economy model for Bhutan.

The screening-level greenhouse gas assessment estimates annual emission reduction of approximately 899 tCO2e per year, or about 18,000 tCO2e over a 20-year project life. The largest share of reduction is expected from organic waste composting, followed by recycling and upcycling of PET, textiles, paper, bamboo, wood and other waste materials, local food production, and agrivoltaics integration.

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1. Introduction

1.1 Background Information

Bhutan conserves its natural environment through a holistic and policy-driven approach that integrates ecological protection with cultural values and sustainable development. Guided by the philosophy of Gross National Happiness (GNH), the country prioritizes environmental conservation as a key pillar of national development, ensuring a balance between human well-being and ecological integrity (Generis Global Legal Service, n.d). Bhutan, despite its strong commitment to environmental conservation and carbon neutrality, waste generation is steadily increasing, especially in urban centers.

Bhutan has seen a significant rise in solid waste, increasing from around 30 tons per day in 2008 to 170 tons per day in 2019, largely due to urbanization, population growth, and higher consumption. Urban residents generate more waste (0.7 kg/day) compared to rural residents (0.4 kg/day), with cities like Thimphu facing the greatest strain on waste management. While organic waste continues to make up the largest portion (45–50%), the share of plastics and other non-biodegradable materials is steadily growing. Waste collection remains limited, covering about 75% of urban households and only 15% of rural ones, with a significant portion still ending up in landfills or open dumping sites (Namgay, 2020).

In response to these challenges, this project proposes an integrated waste management approach through a Public–Private Partnership (PPP) model, focusing on composting and climate resilient agricultural system, recycling and upcycling of waste materials into value added products. By leveraging private sector efficiency, community engagement, and institutional support, the project aims to promote a circular economy there by reducing waste volume, reduce environmental impacts, and contribute to Bhutan's sustainable development goals.

Also, the proposed project on integrated waste management through a PPP model directly supports the NDC by reducing emissions from unmanaged waste, promoting resource recovery, and minimizing landfill dependency. At the same time, it enhances climate resilience by reducing environmental pollution while supporting sustainable agriculture through compost use (UNFCCC, 2025). By aligning with national priorities on mitigation, adaptation, circular economy, and private sector engagement, the project contributes meaningfully to the implementation of Bhutan's Third NDC and its broader goal of achieving climate-resilient and inclusive green growth.

1.2 Waste Management Challenges in Bhutan

Bhutan faces growing challenges in waste management due to rapid urbanization, increasing non-biodegradable waste, and limited infrastructure and institutional capacity. According to Bhutan Waste Accounts Report (2021), Bhutan faces significant gaps in understanding and managing its waste flows, primarily due to limited data, inadequate tracking systems, and informal practices, which hinder evidence-based policy and planning. Although the country conducted its first national waste inventory in 2019, the data lacked detailed information on waste collection, treatment, and disposal, making it difficult to accurately quantify how much waste is generated by different sectors and how it is ultimately managed.

The report also highlights challenges such as mixed waste streams that are hard to segregate once collected, limited infrastructure for recycling and composting, and the need for improved statistical systems that can support monitoring of national targets (e.g., waste recycled) under Bhutan's 12th Five-Year Plan. Collectively, these challenges point to weaknesses in data quality, institutional capacity, and waste management practices that must be addressed to inform more effective interventions and support sustainable waste management in Bhutan.

According to Zero Waste Bhutan (n.d), there is a large disparity in access to waste management services between urban and rural areas in Bhutan. While most urban households (over 75%) have some level of waste collection, the majority of rural households (around 85%) do not receive regular waste collection services, leaving them dependent on informal disposal methods such as open dumping, burning, or unmanaged composting. Lack of access to formal waste collection in rural areas highlights gaps in infrastructure, service coverage, and equity, showing that current waste management systems are insufficient to meet the needs of the entire population.

At the same time, low public awareness and poor waste segregation practices exacerbate illegal dumping and environmental pollution. The landfills in Bhutan are overflowing due to the minimal current practices of waste treatment, recovery and recycling with most of Bhutan's waste dumped in open, minimally engineered landfills without leachate

collection or treatment systems. The resulting toxic leachate can contaminate soil and water, posing risks to human health and ecosystems, but monitoring is limited. For example, leachate from the Memelakha landfill in Thimphu likely enters the Olarongchu stream, though its movement and composition are poorly understood. The situation calls for better site selection, baseline data, and leachate treatment systems to prevent environmental damage as waste volumes increase (Water Research Bhutan, 2022).

Thus, effective waste management requires a comprehensive approach that prioritizes reduction, reuse, and recycling, supported by robust collection, treatment, and safe disposal systems to protect the environment. It demands active public participation, strict enforcement of regulations, and investment in modern infrastructure and technology. By embracing sustainable practices and innovative solutions, societies can significantly reduce the environmental and health impacts of waste while advancing a circular economy and long-term ecological resilience.

1.3 Waste and Climate Impact

Waste significantly contributes to climate change through both direct and indirect greenhouse gas emissions. When organic waste such as food, paper, and yard materials decomposes in landfills without oxygen, it releases methane (CH_4), a highly potent greenhouse gas that traps far more heat than carbon dioxide. In addition, waste management processes like incineration emit carbon dioxide (CO_2, while composting and wastewater treatment can produce nitrous oxide (N_2O), another powerful greenhouse gas. Beyond these direct emissions, waste also contributes indirectly through the entire lifecycle of products including resource extraction, manufacturing, and transportation which generates substantial greenhouse gas emissions. (Climate Change Academy, 2024). Thus, waste plays a significant role in global warming by contributing to emissions at multiple stages of production, consumption, and disposal.

According to the World Meteorology Organization's Latest State of the Global Climate report (2025), the temperatures, greenhouse gas concentrations, and sea levels are all at historic highs, with some consequences likely to be irreversible for hundreds to thousands of years. The report stated that the last decade has been the warmest on record, with global warming approaching or exceeding **1.5 °C above pre-industrial levels**, a threshold government aimed to avoid under the **Paris Agreement**. It also highlights significant impacts on the oceans such as warming and rising of the sea levels, rapid melting and declining sea ice, and extreme weather events such as cyclones, floods, and droughts that are causing displacement, economic loss, food insecurity, and ecosystem damage. While the UN Secretary-General noted that limiting warming to 1.5 °C is still technically possible, the report stresses the need for much stronger climate action, including better early warning systems and emissions reductions.

Rising global temperatures and more frequent extreme weather events worsen the risks from land-disposed waste by damaging landfill infrastructure and increasing the release of leachate and methane. Heavy rainfall, storms, and sea-level rise can compromise liners, covers, and foundations, allowing toxic leachate to contaminate soil and water, while higher temperatures accelerate contaminant migration and methane emissions. These impacts threaten ecosystems, reduce biodiversity, and endanger human livelihoods, particularly in communities dependent on local natural resources (Fei, Fang, and Wang, 2021).

Waste management has emerged as a critical entry point for climate action, as unmanaged waste, particularly organic fractions generates significant amounts of methane through anaerobic decomposition in landfills. Recognizing this, at **COP29 (2024)** in Baku, over 30 countries committed to reducing methane emissions from organic waste, targeting roughly **30 % below 2020 levels by 2030.** The declaration highlights the climate, health, and biodiversity benefits of cutting methane from landfills and unmanaged organic waste. It emphasized scaling up climate finance and technical support to promote climate-resilient and low-emission waste management systems, particularly in developing countries, aligning mitigation and adaptation objectives within a circular economy framework inclusion in NDCs with equitable solutions for vulnerable populations affected by poor waste management (COP 29 Presidency, 2024).

1.4 Institutional and Policy Framework on Waste Management

Bhutan addresses waste management through a comprehensive policy and regulatory framework designed to reduce waste generation, promote recycling, and ensure environmentally sound disposal. Institutional mechanisms, led by the Waste Management Division under the National Environmental Commission, coordinate implementing and collaborating agencies,

monitor compliance, collect data, and ensure alignment with international obligations such as the Basel Convention. Together, these policies and regulations combine legal enforcement, technical guidelines, capacity building, and advocacy to address Bhutan's growing waste challenges systematically (National Environmental commission, n.d). In order to address the issue of waste, legislations and policies have been put in place which includes the following:

- **Waste Prevention and Management Act 2009**

Establishes a comprehensive legal framework to reduce waste generation and ensure environmentally sound waste management across the country. It covers all types of waste (solid, liquid, gaseous, hazardous and non-hazardous) from residential, industrial, agricultural, and medical sources, including their transport and disposal. The Act promotes key principles such as waste minimization at source, segregation, reuse, and recycling. It clearly defines the roles and responsibilities of government agencies, private sectors, and citizens, emphasizing that everyone has a duty to maintain a clean and healthy environment and that polluters are liable for environmental and health-related costs. The Act also introduces mechanisms such as waste management plans, financial instruments (fees and incentives), awareness programs, and research initiatives, along with provisions for penalties and enforcement to ensure compliance (National Environmental Commission, 2009).

- **Waste Prevention and Management Regulation 2012 and its amendment 2016**

Provides detailed rules to implement the 2009 Act by establishing a comprehensive system for managing all types of waste. It emphasizes proper collection, segregation, treatment, storage, transport, reuse, recycling, and safe disposal of solid, liquid, and gaseous waste, and applies to all waste sources across the country. It also introduces key measures including mandatory waste management plans, record-keeping, cost recovery through fees and fines based on waste volume or hazard level, and strict prohibition of illegal dumping. Additionally, it outlines responsibilities of individuals and organizations to handle waste safely, report violations, and comply with standards, while establishing enforcement mechanisms, penalties, and provisions for import/export control of waste (UNEP, 2012).

- **National Integrated Solid Waste Management Strategy 2019**

It aims to transform the country's waste management system by promoting a shift toward a circular economy and achieving the goal of **"Zero Waste Bhutan by 2030."** The strategy focuses on reducing waste generation at the source, maximizing reuse, recycling, and resource recovery, and minimizing landfill disposal through an integrated waste management approach. It emphasizes strengthening institutional coordination, improving waste collection and service delivery, ensuring proper treatment of all waste types, and encouraging active participation from government, private sector, and communities.

Key priorities include sustainable financing mechanisms, improved infrastructure such as collection systems and drop-off centers, and operationalizing existing laws. It seeks to address growing waste challenges driven by urbanization and consumption while reducing environmental and climate impacts, including greenhouse gas emissions from the waste sector (Royal Government of Bhutan, 2019).

- **National Zero Waste Hours**

Launched on June 2, 2019 by Her Majesty the Gyaltsuen, is a nationwide initiative that promotes responsible waste management and aims to achieve a zero-waste society by 2030. Observed on the second day of every month, citizens across the country dedicate at least one hour to cleaning their surroundings and practicing waste reduction activities

such as segregation, recycling, and composting. Guided by the principle "My Waste, My Responsibility," the program engages individuals, communities, and institutions, with coordination from the government and support from various stakeholders. It encourages behavioral change, strengthens public awareness, and contributes to reducing environmental pollution and climate impacts (Borgen Magazine, 2020).

- **Waste Management Flagship Program**

  Aims to deliver a comprehensive, end-to-end waste management system in Bhutan through a multi-pronged approach aligned with circular economy principles, with the overarching goal of achieving "Zero Waste Bhutan" by 2030. The programme seeks to drastically reduce waste sent to landfills from over 80% to below 20% by promoting 100% source segregation, establishing efficient waste collection, storage, and transportation systems, and developing essential infrastructure such as material recovery facilities, drop-off centres, sanitary landfills, and incineration plants. It also emphasizes public awareness and education, policy and financial mechanisms for sustainability, and strong private sector participation to create a self-sustaining and efficient waste management system across the country (PLEASE Project, n.d).

Despite Bhutan's comprehensive national policies, regulations, and frameworks on waste management, the country continues to face escalating waste challenges due to rapid urbanization, population growth, limited infrastructure for segregation and recycling, and low public awareness on sustainable waste practices. Landfills are expanding, organic and plastic waste generation is rising, and existing systems struggle to process increasing volumes efficiently, highlighting a critical gap between policy ambition and on-the-ground implementation. Strengthening institutional coordination, modernizing waste processing technologies, and promoting community engagement remain urgent priorities to achieve Bhutan's vision of sustainable and zero-waste management.

2. Problem Statement and Objective

2.1 Project Rational

Bhutan is increasingly facing significant waste management challenges, particularly in urban centers such as Thimphu experience rapid urbanization and changing consumption patterns. The rise in population and lifestyle shifts has led to a substantial increase in waste generation, especially non-biodegradable materials such as plastics. However, limited segregation of waste at the source results in mixed waste streams that are often disposed of in open dumping sites or poorly managed landfills. These practices contribute to environmental degradation, including soil and water contamination, as well as air pollution caused by the burning of waste.

According to the Bhutan Waste Accounts Report (2021) by the United Nations Economic and Social Commission for Asia and the Pacific, a major constraint is the lack of reliable and consistent data on waste generation and management which hampers effective tracking of waste flows and the development of evidence-based policies. In addition, Bhutan faces limited recycling and resource recovery infrastructure, weak institutional coordination, and insufficient financial and technical capacity at the local government level. Existing waste collection systems and drop-off centers are inadequate to cope with the increasing volume of waste. These challenges are further compounded by low public awareness and weak enforcement of regulations, underscoring the urgent need for improved infrastructure, stronger governance, and a transition toward circular economy approaches.

In response to these challenges, the Royal Society for the Protection of Nature (RSPN) proposes to strengthen Bhutan's waste management system through a circular economy approach supported by a Public–Private Partnership (PPP) model. This approach seeks not only to reduce waste volumes, but also to transform waste into valuable resources by promoting recycling, composting, and innovative reuse practices. By engaging the private sector, the PPP model introduces collaboration, technical expertise, and operational efficiency, while enabling risk-sharing and enhancing the financial sustainability of the interventions. It also supports the development of market-based solutions, strengthens accountability, and ensures the long-term viability of waste management systems beyond reliance on public funding.

In Bhutan, where waste generation is increasing and institutional capacity is limited, a Public–Private Partnership (PPP) approach provides a practical pathway to improve waste management, extend waste management services available to more people and area, and support national climate and environmental objectives, including the country's commitments under its Nationally Determined Contributions (NDCs) and National Adaptation Plan along with other related policy frameworks. The overall goal of the proposed intervention is to establish a scalable, climate-resilient, and inclusive waste management system in Bhutan through a Public–Private Partnership (PPP) model, which promotes circular economy practices by converting waste into valuable resources.

2.2 Objective

The main objective is to develop a GCF Concept Note on Waste Management through Public-Private Partnership Model incorporating a strong climate rationale, and ensure alignment with Bhutan's national policies, climate strategies, and the six thematic areas of RSPN.

The project aims to reduce greenhouse gas emissions from waste, enhance climate resilience, and generate sustainable livelihood opportunities by integrating composting, recycling, and waste-based initiatives, while aligning with national climate priorities and contributing to long-term environmental sustainability.

2.2.1 Specific Objectives

1. **To identify and develop innovative, climate-resilient waste management business models** (e.g., composting, recycling, and upcycling) that reduce landfill waste and greenhouse gas emissions.
2. **To design a Public-Private Partnership (PPP) framework** that enables collaboration between government, private sector, and communities for sustainable waste management solutions.
3. **To integrate circular economy principles into waste management practices** by promoting waste-to-resource approaches such as compost production, recycled textiles, and handicrafts.
4. **To quantify the climate mitigation and environmental benefits** of proposed waste management interventions, including reduction in methane emissions and improved resource efficiency.
5. **To promote inclusive socio-economic development** by creating green jobs and livelihood opportunities, particularly for women, youth, and persons with disabilities.
6. **To strengthen awareness and capacity on sustainable waste management practices**, including waste segregation, recycling, and composting at institutional and community levels.
7. **To ensure alignment of the concept note with national policies and climate strategies of Bhutan** as well as the Green Climate Fund (GCF) investment criteria and RSPN thematic areas.
8. **To develop scalable and replicable waste management models** that can be implemented across different dzongkhags, including both urban and rural contexts.
9. **To support the development of local green enterprises and markets** for recycled and upcycled products, ensuring long-term financial sustainability.
10. **To build technical capacity and skills** among stakeholders (students, local communities, institutions, and private sector actors) in innovative waste management technologies.

3. Overview of the Proposed Project Concepts.

3.1 Geographic Scope

The project will be implemented across selected urban and institutional settings in Bhutan, with an initial focus on:

- Educational and religious institutions (schools and monasteries) mainly in areas where waste generation is high.

- Civil Society Organization (SELWA) for display and marketing of the products, and private entity which are mainly associated with processing and producing of goods that requires high technical equipment and machineries.

The intervention will adopt a scalable approach, starting with pilot sites and gradually expanding to other dzongkhags and thromdes across the country mainly on voluntary basis. The model is designed to be replicable nationwide, enabling broader adoption of sustainable waste management practices across Bhutan.

3.2 Technical Scope of the Intervention

The project will implement an integrated waste management and resource recovery system combining multiple technical components:

a. Organic Waste Management and Composting

- Establish decentralized composting systems (e.g., Takakura method) in schools.
- Convert organic waste into nutrient-rich compost there by reducing methane emission from open dumping.

b. Integrated Sustainable Agriculture Systems

- Setup greenhouse-based agriculture using compost.
- Setup hydroponics, aquaponics, and agrivoltaics.
- Promote climate-resilient and nutrient rich food production.

c. Recycling and Upcycling of Waste Materials

- Recover and process discarded textiles, plastics (PET-bottles), and cement bags.
- Produce value-added products such as clothing, household items, and packaging materials from waste materials.
- Reduce demand for virgin materials and associated emissions.

d. Waste-Based Creative and Craft Initiatives

- Transform wood, bamboo, and paper waste into handicrafts and souvenirs.
- Promote eco-friendly products linked to local culture and identity.
- Promote tourism attraction.

e. Waste Segregation and Collection Systems

- Strengthen waste segregation at the source.
- Improve collection, storage, transportation and management of waste.

f. Capacity Building and Awareness on Proper Waste Management

- Train institutions, communities, and workers in waste management and circular economy practices.
- Promote behavioral change in waste segregation, resource use, and consumption patterns.
- Sensitize on proper waste management and impacts from unmanaged waste such as deterioration of health, environment and climate.

g. Inclusive Livelihood Development

- Create employment opportunities for women, youth, and persons with disabilities (e.g., through collaboration with SELWA)

- Support small-scale enterprises and PPP-based business models.

h. Climate and Environmental Outcomes

- Reduce greenhouse gas emissions (especially methane and carbon dioxide).
- Enhance resource efficiency and circular economy practices.
- Improve resilience to climate-related waste risks (e.g., landfill overflow, leachate)

3.3 Introduction to the Project Concept

The Pre-Feasibility Study on Waste Management conducted by the Royal Society for the Protection of Nature (RSPN) was undertaken to address the growing waste management challenges in Bhutan by identifying innovative business solutions that can be implemented through a Public–Private Partnership (PPP) model. The study assessed the potential for developing sustainable and inclusive waste management systems by analyzing waste generation trends, existing collection and disposal practices, institutional and policy frameworks, and opportunities for private sector engagement. It also explored business models that promote resource recovery and circular economy approaches.

The findings indicated that waste generation is steadily increasing, particularly in urban centers such as Thimphu, driven by rapid urbanization and changing consumption patterns. Despite progress through national policies efforts, the waste management system continues to face significant challenges, including limited segregation at source, inadequate recycling and resource recovery infrastructure, reliance on landfills, and financial and technical constraints. The study further highlights the climate implications of poor waste management, particularly methane emissions from decomposing organic waste, while emphasizing the potential of composting, recycling, and upcycling to reduce emissions and support climate goals.

Importantly, the study identified waste streams such as organic waste, plastics, textiles, paper, and wood residues as valuable resources that can be transformed into marketable products. Through a structured evaluation process, 22 potential waste-based business ideas were identified and subsequently narrowed down to eight promising options, which were further consolidated and refined into three priority interventions and demonstrates a replicable and scalable pathway for advancing circular economy practices and strengthening sustainable waste management systems across Bhutan as follows.

1. Integrated Composting and Sustainable Agriculture System, the
2. Production of Clothing and Household Items from Recyclable Materials, and
3. Arts and Crafts from Waste Materials.

3.3.1 Introduction to Project Concept 1: Integrated Composting and Sustainable Agriculture System in Schools

The proposed project concept on **Integrated Composting and Sustainable Agriculture System** is conceptualized as a holistic, circular model that integrates waste management with sustainable food production within institutional settings such as schools and monasteries. The initiative aims to address the growing challenge of organic waste by transforming it into valuable agricultural inputs, while simultaneously promoting the production of food varieties, nutrient rich, and locally grown organic food through climate-resilient farming practices.

At its core, the model integrates multiple complementary components, including decentralized composting systems which is going to be done within their institutions instead of sending food waste or biodegradable materials to a distant landfill or compost plant, greenhouse cultivation, hydroponics, aquaponics and agrivoltaics technologies such as installation of solar panel in green house roof. Organic waste generated within the institutions such as food scraps and biodegradable materials will be systematically collected and processed into compost using Takakura composting method.

This compost will then be utilized to enrich soil fertility in greenhouse-based agriculture, while hydroponic systems will enable efficient, soil-less crop production using minimal space while producing year-round crop varieties. The incorporation of agrivoltaics systems, where solar panels are installed on the greenhouse roof, will provide a renewable

energy source to support greenhouse operations, thereby enhancing energy efficiency and reducing reliance on conventional power sources.

In addition to the production of compost and nutrient-rich food, the project emphasizes sustainable packaging solutions such as the project proposes to utilize discarded textile materials by repurposing them into reusable bags for commercial purposes, thereby transforming waste that would otherwise contribute to environmental pollution into value-added products. This approach ensures that agricultural outputs are handled, stored, and distributed using environmentally friendly materials. By creating a closed-loop system in which waste is continuously reintegrated as a resource, the initiative significantly reduces the burden on landfill sites, minimizes greenhouse gas emissions from organic waste decomposition, and strengthens institutional nutrient rich and self-sufficiency in food production.

A key feature of this initiative is a strong commitment to social inclusion. The project proposes active collaboration with Civil Society Organizations such as SELWA, which supports persons with disabilities to create inclusive and meaningful livelihood opportunities. Individuals with disabilities will be engaged in various stages of the value chain including waste segregation, compost production, agricultural activities, and packaging. This not only promotes dignity and economic participation, but also ensures that the benefits of the project are equitably shared across communities.

Furthermore, the project concept is designed to be both scalable and replicable. Its implementation within institutional settings will serve as a practical demonstration of circular economy principles in action. The knowledge, systems, and best practices generated through this initiative can be readily adapted and expanded across schools, monasteries, and other institutions throughout Bhutan. In this way, the project holds strong potential to contribute to national priorities, including sustainable waste management, climate change mitigation, enhanced food security, and inclusive socio-economic development.

3.3.1.1. Objective

The Integrated Composting and Sustainable Agriculture System aims to establish a circular, sustainable, and inclusive model that transforms institutional organic waste into valuable agricultural inputs while supporting local food production sustainability and reduces environmental and climate change impact.

The key objectives of the initiative are:

- ✔ **To establish an integrated circular waste management system** that converts organic waste generated within institutions into nutrient-rich compost through decentralized composting methods.
- ✔ **To promote sustainable and climate-resilient agricultural production** through greenhouse cultivation, hydroponic farming, and the use of organic compost produced within the system.
- ✔ **To reduce the volume of organic waste sent to landfill sites**, thereby minimizing methane emissions and contributing to climate change mitigation.
- ✔ **To improve food security and nutrition within institutions** by producing fresh, locally grown vegetables that can supplement institutional meals.
- ✔ **To demonstrate the practical application of circular economy principles** by linking waste management, sustainable agriculture, renewable energy, and sustainable packaging solutions.
- ✔ **To create inclusive livelihood and engagement opportunities** for persons with disabilities through collaboration with the SELWA, particularly in composting, packaging, and agricultural activities.
- ✔ **To build environmental awareness and practical skills** among students, institutional staff, and communities in waste segregation, composting, and sustainable agriculture practices.
- ✔ **To develop a scalable and replicable model** that can be adopted by schools, monasteries, and other institutions across Bhutan.

Figure 1.1Integrated Composting and Agriculture system through Greenhouse, Aquaponics and Hydroponics.

3.3.1.2. Project Concept Implementation and Operational Framework

1 Creating Awareness on Impact of Improper Waste Management.

During the stakeholder consultation meeting for GCF Concept Note Development held on 16th March, 2026, one of the key issues raised was the lack of awareness regarding proper waste management practices among institutions and the broader community. Participants noted that improper disposal and limited understanding of the impacts of organic and non-biodegradable waste contribute significantly to environmental pollution, increased landfill pressure, and greenhouse gas emissions. Addressing this knowledge gap is therefore critical to the success of any waste management initiative. Thus, the proposed project concept aims to include awareness-raising activities to the students and staffs alongside composting and sustainable agriculture efforts to foster a culture of responsible waste handling within the institution.

To raise awareness and implement proper organic waste management within the institution, the school administration jointly with waste private sectors can organize dedicated awareness sessions for all including teachers, non-teaching staff, students, parents, and even the community people. It is important to include non-teaching staff as mentioned in the last stakeholder consultation meeting that in schools, it is usually the cooks who clean while the students assist in cleaning especially the food waste. These sessions will explain on types of waste, the importance of proper waste segregation at the source, the environmental and climate impacts of waste, and composting as a practical solution for reducing the organic waste with other benefits including income generation, enriching soil and health benefits from rich nutrients. It can be done as follows;

1.1 Interactive Workshops and Demonstrations

Organize structured, practical workshops in which students, teaching staff, and non-teaching staff actively engage in the process of segregating organic and non-organic waste. These sessions should demonstrate proper techniques for separating biodegradable materials from plastics, metals, and other non-compostable items, emphasizing the importance of proper segregation for efficient compost production and environmental sustainability.

Provide detailed, stepwise demonstrations of composting methods, such as the Takakura composting method, and greenhouse gardening including hydroponics and aquaponics techniques. These demonstrations should illustrate each stage of the process, from collection and preparation of organic waste to compost maturation or plant cultivation, thereby allowing participants to observe and understand practical applications, improve skills, and reinforce theoretical knowledge through experiential learning.

1.2. Educational Visual Displays

Strategically place posters, banners, and infographics throughout the school to clearly illustrate the different types of waste, the benefits of composting, and the environmental consequences of improper disposal. These materials serve to educate and continuously reinforce sustainable waste management practices among students, teachers, and staff. These prompts encourage consistent and proper waste segregation, ensuring that environmentally responsible behaviors are practiced in daily school routines.

1.3. Community Engagement Through Interactive Sessions

Invite parents, local farmers, and waste management experts to participate in interactive sessions at the school. These sessions aim to connect school-based waste management and composting activities with broader community practices, fostering collaboration, knowledge exchange, and practical insights into sustainable environmental practices.

Organize field trips to local composting facilities, recycling centers, or organic farms to provide students with direct exposure to real-world waste management and agricultural practices. These visits enhance experiential learning, allowing students to observe practical applications of composting and sustainable farming, and reinforce theoretical concepts taught within the school.

1.4 Disseminate Updates and Success Stories via Digital Platforms

Regularly share project updates, achievements, and practical tips on the school's social media accounts or in school Facebook page. Produce short videos, infographics, or other digital materials that clearly demonstrate techniques for waste reduction, composting, and school gardening projects. These initiatives serve as engaging educational tools, reinforcing learning, providing visual guidance, and motivating students and staff to adopt sustainable practices.

1.5 Celebrating Special Days in the Schools

Actively observe events such as World Environment Day, Earth Day, or Zero Waste Day by organizing within the school focusing on activities that emphasize sustainable environmental practices such as waste segregation, composting, and sustainable gardening. The students can participate in interactive workshops, poster-making competitions, or hands-on demonstrations in the composting and greenhouse areas. These events provide opportunities to reinforce learning, engage the entire school community, and promote a culture of environmental responsibility.

2 Proper Waste Collection and Segregation at Source

Based on the issues raised during the stakeholder consultation, it becomes evident that improper waste handling particularly the lack of segregation and irregular collection has significantly contributed to growing waste management challenges in schools. These challenges highlight the urgent need for a structured system of waste segregation and collection. Waste segregation is essential to address the current inefficiencies and environmental concerns identified in schools.

The absence of proper dumping sites and low frequency of waste collection has resulted in waste being left unattended, leading to foul odors, unhygienic conditions, and potential health risks. When organic waste such as leftover food is mixed with non-biodegradable materials like plastics and metals, it becomes difficult to process or reuse, thereby increasing the volume of waste sent to disposal sites. Furthermore, the lack of awareness and personal responsibility among students as stated by the teachers, has led to indiscriminate disposal of food waste, often wherever meals are consumed.

This not only contributes to environmental pollution, but also results in the loss of valuable organic material that could otherwise be converted into compost. As schools face challenges such as limited access to organic food, high food costs, and significant food wastage due to limited menu variety, segregating organic waste presents an opportunity to recycle nutrients through composting and support school-based agriculture initiatives. Segregation also enables more efficient waste management systems. For instance, in areas where there is no separate collection for wet and dry waste, proper segregation at the source becomes even more critical to ensure that waste can still be processed effectively despite logistical limitations.

To improve waste management in schools, a systematic approach to both collection and segregation must be established:

2.1 Segregation at Source

- ✔ Introduce clearly labeled bins for organic (wet) and non-biodegradable (dry) waste in key locations such as dining areas, school kitchens, and hostels.
- ✔ Use color-coding and visual guides to help students easily identify the correct bins.
- ✔ Ensure that all students, teachers, and staff are trained on proper segregation practices.

2.2 Designated Collection Points

- ✔ Establish a central collection area within the school where segregated waste is temporarily stored before further processing or disposal.
- ✔ Even in the absence of formal dumping sites, a simple, well-maintained space can prevent waste from being scattered.

2.3 Regular Collection System

- ✔ Develop a fixed schedule for collecting waste from different parts of the school (e.g., daily after meals as reduce the risks of food waste smelling, and littering by the animals).
- ✔ Assign responsibility to school leader, trained student groups, club members, or non-teaching staff to oversee collection and ensure consistency.

2.4. Minimizing Food Waste at Source

- ✔ Encourage students to take only the amount of food they can consume.
- ✔ Track leftover food to identify patterns (e.g., unpopular vegetables or repetitive meals) and inform improvements in menu planning.

3. Implementation of Takakura Composting with Roles and Responsibilities

Segregated organic waste will be processed on-site using the Takakura composting method, a simple and effective small-scale composting technique suitable for schools and monasteries. The method involves layering organic waste in bins, maintaining moisture balance, and promoting aerobic decomposition.

This decentralized approach reduces the need for transporting waste to distant facilities and enables institutions to manage their organic waste locally. The Takakura composting method through a well-organized system involving students, teachers, and non-teaching staff. This ensures effective management, accountability, and sustainability of the composting process. The following provides a detailed and structured explanation of the implementation of the Takakura composting process in schools, outlining clear roles and responsibilities.

1. Establishment of Composting Unit

- ✔ A designated composting area will be set up within the school premises, preferably near the garden or greenhouse for easy utilization of compost.
- ✔ Composting bins (Takakura baskets or containers) will be prepared with starter culture, dry materials (such as husk or sawdust), and proper aeration.
- ✔ The school administration will oversee the setup and ensure availability of required materials and space.

2. Roles and Responsibilities.

a. School Administration

- ✔ Provide institutional support, allocate space, and ensure availability of composting materials and infrastructure.
- ✔ Facilitate training programs for teachers, students, and non-teaching staffs on the Takakura composting method.
- ✔ Monitor overall implementation and integrate the activity into school programs or clubs.

b. Teacher-in-Charge (Club-Coordinator)

- ✔ Supervise and guide all composting activities.
- ✔ Develop a schedule for waste collection, composting, and maintenance.
- ✔ Ensure proper training of student groups and monitor adherence to procedures.
- ✔ Maintain records of compost production, usage, and challenges.

c. Student Volunteers / Club Members

- ✔ Take primary responsibility for periodic composting operations under supervision.
- ✔ Assist in collecting segregated organic waste from designated areas and transport it to the composting site.
- ✔ Add waste to compost bins in layers, ensuring proper mixing with dry materials.
- ✔ Monitor moisture levels, aeration, and temperature to maintain optimal composting conditions.
- ✔ Rotate responsibilities among members to ensure active participation and learning.

d. Student Leaders (Component Heads)

- ✔ Assign leaders for specific roles such as waste collection, compost management, and monitoring.
- ✔ Coordinate among student volunteers and report progress or issues to the teacher-in-charge/ Club Coordinator.
- ✔ Ensure proper segregation practices are followed across the school.

e. Non-Teaching Staff (Especially in Boarding Schools)

- ✔ Collection and transportation of organic waste, particularly from kitchens and dining areas.
- ✔ Assist in maintaining cleanliness of the composting site.
- ✔ Provide continuity during weekends or school breaks when students may not be available.

3. Monitoring and Maintenance

- ✔ Regular checks are conducted to maintain appropriate moisture levels (not too wet or dry).
- ✔ Student teams maintain a logbook recording the quantity of waste added, compost progress, and any issues observed.
- ✔ The teacher-in-charge reviews records and provides guidance for improvement.

4. Outcome

This process establishes a closed-loop system in which organic waste is transformed into a valuable resource, thereby supporting sustainable food production within the school. By clearly defining roles and responsibilities, the Takakura composting system becomes organized, participatory, and sustainable. It not only addresses the issue of unmanaged organic waste but also serves as a practical educational tool, promoting environmental awareness, responsibility, and hands-on learning among students and the wider school community.

3.3.1.3. Compost Utilization in Agriculture

The compost produced will be nutrient-rich and will be systematically utilized to enhance soil fertility in the greenhouse and other agricultural activities within the school. Its application improves soil structure which contribute to healthier plant growth and higher agricultural productivity. By reducing reliance on chemical fertilizers, the use of compost also supports environmentally sustainable farming practices and minimizes potential soil and water contamination.

Furthermore, the reintegration of organic waste into agricultural production establishes a circular resource management system within the institution. In this system, organic waste generated from daily school activities is transformed into valuable compost, which is then reused to cultivate crops. This closed-loop approach not only reduces the volume of waste requiring disposal, but also enhances resource efficiency by converting waste into productive inputs. The crops produced (vegetables and fruits) are more nutritious, contributing to improved dietary quality for students, particularly in boarding schools.

3.3.1.4 Greenhouse and Hydroponic Setup

The challenges identified during the stakeholder consultation meeting such as increasing food waste, limited access to fresh and local produce, dependence on imported food, and lack of dietary variety highlights the need for a more sustainable and controlled food production system within the schools. Establishing a greenhouse integrated with hydroponics offers an efficient and practical solution to address these issues.

Firstly, a greenhouse combined with hydroponic systems enables year-round production of vegetables under controlled environmental conditions. This reduces reliance on external suppliers and imported vegetables particularly in regions where seasonal availability is limited. Hydroponics, which allows crops to be grown without soil using nutrient-rich water solutions, further enhances productivity by enabling faster plant growth and efficient use of space, making it highly suitable for school settings with limited land (National Park Services, n.d). As mentioned by the Executive Director of the SELWA, the schools can also grow ornamental plants such as orchid which can beautify the school as well as attract the customers.

Secondly, this integrated system supports the production of fresh, safe, and high-quality vegetables, improving the nutritional value of meals provided to students. As highlighted in the consultation, schools often receive lower-quality or preserved food due to cost constraints. By producing vegetables on-site, schools can ensure better quality food, reduce dependence on chemically preserved produce, and promote healthier eating habits among students.

Thirdly, greenhouse and hydroponic systems contribute to greater crop diversity, which helps address the issue of repetitive meals and student dissatisfaction. A wider range of vegetables, including leafy greens, herbs, and other nutrient-rich crops can be cultivated efficiently using hydroponics. This diversity makes meals more appealing and can significantly reduce food waste caused by leftover foods.

Lastly, the system offers economic advantages. By reducing the need to procure vegetables externally, schools can lower food costs. Any surplus produce can be sold, and the income generated can be reinvested to support the maintenance and operational costs of the greenhouse and hydroponic system.

3.3.1.5 Aquaponics System Setup

Aquaponics allows schools to raise fish such as tilapia, carp, or catfish alongside vegetables and herbs. Fish produce nutrient-rich waste in the water, which is converted by beneficial bacteria into nitrates, serving as a natural fertilizer for plants. The plants, in turn, absorb these nutrients, helping to clean and recycle the water back to the fish tanks. This symbiotic

system simultaneously produces protein-rich fish and nutrient-rich vegetables, addressing both dietary diversity and nutritional needs within the school (Purdue University, n.d).

By maintaining controlled environmental conditions in aquaponic units, schools can produce fresh vegetables and fish throughout the year, independent of seasonal limitations. This ensures a steady supply of high-quality food for students and reduces dependence on imported vegetables, which are often costly and less fresh.

Producing fish and vegetables on-site improves food quality and safety. Unlike imported or preserved produce, aquaponics provides fresh, chemical-free vegetables and protein-rich fish, contributing to a balanced and nutritious diet for students. This directly addresses concerns raised during the consultation about poor-quality food, repetitive meals, and low acceptance by students.

Besides, students gain hands-on experience in sustainable agriculture, aquaculture, and environmental management. Managing for fish and plants teaches responsibility, teamwork, and awareness of food systems. Observing the interaction between fish, plants, and bacteria reinforces concepts in biology, ecology, and sustainability. Also, the surplus produce may be sold, generating additional income to maintain the system or support other school activities. This approach supports long-term sustainability and demonstrates how waste, food production, and learning can be integrated effectively.

3.3.1.6. Management of Greenhouse and Hydroponics and Aquaponic System: Roles and Responsibilities

The successful operation of a greenhouse integrated with hydroponics and aquaponics in schools requires a well-defined management structure with clearly assigned roles and responsibilities. This ensures efficiency, accountability, and long-term sustainability of the system.

a. School Administration

- ✔ Provide overall institutional support, including allocation of space, budget, and infrastructure for the greenhouse, aquaponics and hydroponics system.
- ✔ Facilitate procurement of materials such as greenhouse structures, hydroponic equipment, seeds, and tools.
- ✔ Approve operational plans, schedules, and integration of activities into school programs or clubs.

b. Teacher-in-Charge (Club Coordinator)

- ✔ Oversee the daily management of the greenhouse and hydroponics system.
- ✔ Develop operational plans, including crop selection, planting schedules, and maintenance routines.
- ✔ Guide and supervise students and non-teaching staff involved in activities.
- ✔ Ensure proper use of compost in soil-based components and correct preparation of nutrient solutions in hydroponics.
- ✔ Maintain records of production, input usage, and system performance.
- ✔ Coordinate and ensure safety protocols are followed**.**

c. Non-Teaching Staff

- ✔ Prepare planting beds, sow seeds, and transplant seedlings.
- ✔ Water plants (for soil-based systems) and monitor plant health.
- ✔ Apply compost and manage soil fertility.
- ✔ Prepare and monitor nutrient solutions under teacher supervision.

- ✔ Check water levels, and cleanliness of hydroponic systems.
- ✔ Ensure proper functioning of pipes, containers, and circulation systems. Monitor the use of compost and ensure efficient resource utilization.

d. Student Leaders (Team Heads)

- ✔ Lead specific teams (greenhouse, hydroponics, monitoring, etc.) and coordinate activities at regular period.
- ✔ Ensure tasks are completed according to schedule.
- ✔ Report progress, challenges, and maintenance needs to the teacher-in-charge.
- ✔ Promote discipline and teamwork among members

d. Daily Operational Activities

- ✔ Watering, nutrient preparation, and system checks are carried out on a daily schedule by non-teaching staff.
- ✔ Plants are monitored for growth, pests, or diseases.
- ✔ Compost is applied where necessary, and hydroponic systems are cleaned and maintained regularly.
- ✔ Harvesting is done based on crop maturity and school consumption needs.

3.3.1.7 Harvesting, Utilization, and Marketing

Harvested products are first allocated for school consumption (e.g., kitchen room), while the surplus agricultural products and compost can be recorded and may be sold locally to generate income by collaborating with private marketing entity. Proper storage (e.g., cold room if available) is maintained to reduce spoilage.

3.3.1.8 Monitoring and Evaluation

- ✔ Regular reviews are conducted by the teacher-in-charge and school administration.
- ✔ Student teams submit reports on production, challenges, and improvements.
- ✔ Feedback is used to improve efficiency, crop selection, and system management.

3.3.1.9. Agrivoltaics Integration (Solar Panel Installation)

The installation of solar panels on greenhouse roofs (agrivoltaics) can be effectively implemented through a structured approach that combines technical setup with clearly defined roles and responsibilities. This ensures efficient energy generation, proper utilization, and long-term sustainability of the system within the school.

Roles and Responsibilities

a. School Administration

- ✔ Provide overall approval, funding, and institutional support for the installation.
- ✔ Coordinate with technical experts or service providers for system design and installation.
- ✔ Ensure compliance with safety standards and long-term maintenance planning.
- ✔ Monitor overall performance and cost savings.

b. Teacher-in-Charge (Project Coordinator)

- ✔ Oversee daily operation of the solar-powered systems within the greenhouse.
- ✔ Ensure energy is used efficiently for temperature maintenance and lighting.
- ✔ Coordinate with student teams to monitor system performance.
- ✔ Maintain records of energy generation, usage, and any operational issues.

c. Student Committees / Eco-Club Members

- ✔ Record solar energy generation and usage periodically.
- ✔ Observe system performance and report any irregularities (e.g., reduced output)
- ✔ Ensure proper use of solar-powered irrigation, ventilation, and lighting systems.
- ✔ Adjust usage based on crop needs and environmental conditions.

d. Non-Teaching Staff

- ✔ Assist in routine cleaning and maintaining surrounding areas.
- ✔ Support minor maintenance tasks and ensure safe operation of electrical systems.
- ✔ Help manage operations during weekends or school breaks.

4. Monitoring and Maintenance

- ✔ Panels should be cleaned regularly to remove dust and ensure maximum efficiency.
- ✔ System performance (energy output and usage) should be recorded and reviewed periodically.
- ✔ Any technical faults should be reported immediately to trained personnel or service providers.
- ✔ Periodic inspections ensure safety and long-term functionality.

3.3.1.9 Sustainable Packaging (Textile-Based Reusable Bags)

To complement sustainable production, the project will repurpose discarded textiles into reusable bags for packaging of agricultural products. This initiative reduces textile waste, prevents environmental pollution, and promotes the use of eco-friendly alternatives to single-use packaging. It also creates additional income-generating opportunities.

Step-wise Process for Repurposing Textile Waste into Reusable Bags in Schools

Step 1: Collection of Discarded Textiles within the School Community

The school will initiate a discarded textile collection drive where students and teachers bring used clothes, old uniforms, and leftover fabric. Collection boxes can be placed within the school premises.

Roles and Responsibilities:

- ✔ School Administration: Organize collection drives and provide space for collection.
- ✔ Teachers: Guide and encourage student participation.

- ✔ Students: Bring textile waste from home and dormitories, and support collection activities.
- ✔ Non-Teaching Staff: Contribute used textiles.

Step 2: Sorting and Cleaning of Materials

Collected textiles will be sorted to select strong and usable fabrics such as cotton and denim. These materials will be washed and dried to ensure they are clean and safe for reuse.

Roles and Responsibilities:

- ✔ Eco-Club/Student Groups: Sort and clean the materials.
- ✔ Teachers (Supervisors): Ensure proper hygiene and selection of suitable fabrics.

Step 3: Design and Planning of Bags

Simple and practical bag designs will be developed specifically for packaging compost and fresh vegetables, with a focus on functionality, durability, and branding. The bags will be designed using strong, breathable fabrics (e.g., cotton or denim) to safely hold compost and allow ventilation for fresh products. Different sizes can be created based on purpose, for example, smaller bags for vegetables and slightly larger bags for compost.

To create a unique identity, each bag will feature a school-specific logo, label, or printed message that reflects environmental sustainability and the project's values. This may include the school's name, eco-club identity, or a simple slogan such as "Made from Waste" or "Eco-Friendly Product." Students can participate in designing the logo and visual elements, ensuring ownership and creativity. It promotes awareness on sustainable management, helping the bags serve both as functional items and as tools for environmental education and outreach.

Roles and Responsibilities:

- ✔ Teachers (Art/Design/Technical): Develop and guide bag designs.
- ✔ Students: Participate in designing and suggesting ideas.

Step 4: Training and Skill Development

Basic training sessions will be conducted to teach students how to cut, stitch, and finish the bags. This can be integrated into club activities or practical learning sessions. Students will produce bags by cutting and stitching the prepared textiles. Work can be done during club hours or designated practical sessions. The finished bags will be checked for strength, cleanliness, and usability before being used.

Roles and Responsibilities:

- ✔ Teachers/Local Tailors: Provide training and demonstrations.
- ✔ Students: Actively participate and learn stitching skills.
- ✔ School Management: Arrange tools and materials (e.g., sewing machines).

3.3.1.10 Collaboration with Private Partners for Marketing and Sale of Surplus Products

To ensure the sustainability and economic viability of the project, strategic collaboration with private partners will be established for the marketing and sale of surplus products including compost and agricultural products. While the primary objective of production is to support school consumption, any excess output will be systematically channeled to local markets

through private sector engagement to generate additional income for the institutions which can then use for various purposes such as maintenance work, incentivization of students, or for the administration purposes.

The school will partner with local vendors, Agri-retailers, cooperatives, and small businesses to create reliable market linkages for surplus compost and fresh vegetables. These partnerships will help ensure that products are not only produced, but also efficiently distributed and sold, reducing waste and generating income to sustain project activities. Through this collaborative model, the project not only promotes sustainable production, but also ensures that outputs are effectively utilized and economically valued, reinforcing the principles of a circular and self-sustaining system.

Roles and Responsibilities

a. Private Partners (Vendors, Retailers, Cooperatives)

- ✔ Procure surplus compost and agricultural products from the school at agreed quantities and prices.
- ✔ Support in marketing and distribution of products to local consumers.
- ✔ Provide feedback on product quality, packaging, and market preferences to improve competitiveness.

b. School Administration

- ✔ Establish formal agreements and arrangements with private partners.
- ✔ Oversee pricing strategies to ensure fairness and affordability.
- ✔ Ensure transparency and accountability in sales and revenue management.

c. Teachers

- ✔ Coordinate with private partners for regular supply and communication.
- ✔ Supervise product preparation, quality control, and packaging.
- ✔ Maintain records of production, sales, and income generated.

d. Students (Eco-Club/Entrepreneurship Groups)

- ✔ Assist in sorting, packaging, and labeling of compost and agricultural produce.

e. Non-Teaching Staff

- ✔ Support harvesting, storage, and transportation of products.
- ✔ Assist in maintaining product quality during handling and distribution.

3.3.1.11. Inclusion of Person with Disabilities (SELWA)

SELWA, as a Civil Society Organization supporting with persons with disabilities (PWDs), will play a critical and context-sensitive role in the implementation of the Integrated Composting and Sustainable Agriculture System. While the project promotes inclusive participation, it also recognizes the physical limitations that some people with disabilities may face, particularly in labor-intensive activities such as compost handling, greenhouse operations, and field-based agricultural work. Therefore, the engagement of SELWA will be strategically aligned with tasks that are accessible, safe, and suited to the capacities of its members.

In this regard, PWDs engaged through SELWA will primarily contribute to components that are less physically demanding yet equally valuable to the overall system. These include awareness-raising activities and waste segregation practices at source, where they can actively support the dissemination of knowledge on waste segregation, composting, and sustainable practices within schools and communities. Their involvement in such initiatives not only strengthens outreach efforts, but also promotes visibility, confidence, and social inclusion.

A key area of engagement will be in the production of reusable textile-based bags, where PWDs can contribute through activities such as cutting, stitching, finishing, and quality checking. This component provides a suitable livelihood opportunity as it is skill-based, and can be performed in a controlled environment and allows for flexible participation. It also aligns with the project's objective of promoting sustainable packaging while creating income-generating avenues.

Furthermore, during the stakeholder consultation meeting for the GCF Concept Note development, the Executive Director of SELWA highlighted the organization's potential role in supporting the marketing and sale of project outputs, including compost and agricultural products. Through its networks and community linkages, SELWA can facilitate access to local markets and buyers. However, it was emphasized that successful market engagement is contingent upon maintaining consistent product quality. This underscores the need for the project to establish clear quality standards, proper packaging, and reliable production processes to ensure that products meet market expectations.

3.3.1.13 Scalability and Replication Strategy

The project concept is designed to be scalable and replicable across multiple schools, monasteries, and institutional settings in Bhutan. Lessons learned, operational guidelines, and best practices will be documented to facilitate expansion, enabling broader adoption of circular economy principles and contributing to national goals of sustainable waste management, climate resilience, and inclusive development.

It is important to note that this project concept will be implemented solely through schools that demonstrate interest and willingness to participate. The adoption of the Integrated Composting and Sustainable Agriculture System will therefore be voluntary, ensuring that only committed institutions will be engage in the initiative. This approach is intended to enhance ownership, accountability, and long-term sustainability of the project.

Schools expressing interest will be selected based on their readiness, including availability of space, administrative support, and willingness of teachers and students to actively participate in project activities. By focusing on motivated institutions, the project can ensure more effective implementation, better maintenance of systems, and stronger integration of activities into the school environment.

3.3.1.13 Climate and Environment Impact

Converting organic waste into valuable compost not only reduces the amount of organic waste discarded into landfills, but also provides numerous environmental, agricultural, and climate benefits. According to the United States Environmental Protection Agency (2025), composting lowers methane emissions which is a potent greenhouse gas by diverting organic waste from landfills, while recycling food scraps, plant residues, and other organic materials into nutrient-rich compost enhances soil fertility. Additionally compost application can also reduce soil erosion, decrease reliance on chemical fertilizers, improve water quality by limiting nutrient runoff, and promote biodiversity by supporting beneficial soil organisms.

Furthermore, composting plays a significant role in climate change mitigation. The United States Composting Council (2020) reports that compost applied in United State in 2020 sequestered approximately 333,839 metric tonnes of CO_2-equivalent in soils, and studies show that compost can increase soil organic carbon by up to 46% compared to untreated soils, further improving soil health and carbon storage. Thus, by recycling organic waste materials into nutrient rich compost, this initiative will support sustainable agriculture while simultaneously reducing the greenhouse gas concentration in the atmosphere.

3.3.1.14 Economic and Social Benefit

Composting of organic waste using Takura method can not only reduce the waste volume, but also contribute to the capacity building of students and the staff. Through composting, they can grow more organic and nutrient rich vegetables that

can be sold in good quantity and quality generating high income. The surplus compost as well as the agricultural products can be sold in the market for additional income.

The compost produced through the Takakura composting method is rich in essential nutrients such as nitrogen, phosphorus, potassium and organic carbon which are important for healthy plant growth (Azlanzadeh, Kho, and Sitepu, 2020). These help vegetables grow stronger and healthier as a result, schools and monasteries can consume a fresh and variety of nutrient-rich vegetables that contribute to a healthier and more balanced diet for students, monks, and staff. Together, integrated composting and agriculture through greenhouse, hydroponics, and aquaponics can strengthen food security, improve nutrition, and promote environmentally sustainable agricultural practices within schools and monasteries.

Table 1.1 Materials and Resources Required for the Project Concept 1: Integrated Composting and Sustainable Agriculture System

Category	Material Required	Purpose
Composting Infrastructure	Compost bins / Takakura baskets	Container for layered organic waste
	Rice bran / dry organic starter	Supports microbial activity for decomposition
	Sawdust, rice husk, dry leaves	Absorbs moisture and balances compost
	Watering cans / spray bottles	Maintain proper moisture levels
	Gloves & aprons	Safety and hygiene during compost handling
	Thermometer / moisture meter	Monitor temperature and moisture
	Shovels / hand trowels	Mixing and layering compost materials
Greenhouse Infrastructure	Greenhouse frame & covers	Controlled environment for crop growth
	Shade nets / curtains	Temperature and light regulation
	Pots, trays, raised beds	Soil-based planting and crop support
	Soil / organic substrate	Growing medium for plants
Hydroponic System	Hydroponic containers / channels	Soil-less crop cultivation
	Nutrient solution / fertilizer	Provides essential nutrients for plants
	Pumps & pipes	Circulate water and nutrients efficiently
	pH & EC meter	Monitor nutrient solution quality
	Grow lights (if needed)	Supplement light for indoor growth
Aquaponic System	Fish tanks	Housing for fish and nutrient source
	Water pumps / aerators	Maintain water flow and oxygenation
	Fish feed	Nutrition for fish production
	Biofilters / beneficial bacteria	Convert fish waste into plant nutrients
	Netting / covers	Prevent fish escape and protect crops
Agrivoltaics (Solar Integration)	Solar panels	Renewable energy source for greenhouse
	Mounting hardware	Secure panels to greenhouse roof
	Inverters / wiring	Convert and manage electricity supply
	Energy monitoring devices	Track power generation and usage
Sustainable Packaging	Discarded textiles / fabric scraps	Produce reusable eco-friendly bags

	Sewing machines / hand tools	Cutting, stitching, and assembling bags
	Threads, needles, scissors	Basic materials for bag creation
	Labels / branding materials	Identify and promote school products
Soft Skills & Capacity Building	Training manuals & guides	Teach composting, hydroponics, aquaponics
	Posters / banners / infographics	Visual aids for awareness and education
	Workshop materials (charts, markers)	Interactive demonstrations and exercises
	Digital devices (camera, laptop, projector)	Document and share project updates
	Logbooks / record sheets	Track compost production, crop growth, and sales
	Safety kits (first aid, gloves, masks)	Ensure safe participation for students & staff
	Reference books / videos	Learning resources for sustainable agriculture

3.3.2. Introduction to Project Concept 2: Clothing and Household Items from Recyclable Materials

Discarded textiles and plastic-based materials represent a growing waste stream in Bhutan. Improper disposal of these materials contributes to environmental pollution, landfill congestion, and resource inefficiency including poor waste handling causing sanitation issues that increases health risks for the community (Bhutan Ecological Society, n.d.). From the stakeholder consultation on Development of GCF Concept Note, it was found that many students discard the clothes when they leave for vacation, and people are very much less aware on repurposing of the products after single use which ultimately leads to more textiles waste. By recovering and processing these materials into new products, the proposed intervention aims to reduce waste generation while supporting sustainable production and consumption practices.

The proposed project concept 2 focuses on the production of clothing and household items from recyclable materials particularly from the discarded textiles, cement bags, and polyethylene terephthalate (PET-bottles). The initiative adopts a circular economy approach, transforming waste materials that would otherwise end up in landfills into value-added products such as school and desuup uniforms, socks, foot mats, carpets, reusable bags, and polyester-based textiles which is more durable and stronger than other fibers.

According to the Bhutan Trade Statistic (2024), the import data for Section 11 (textiles and textile articles) highlights Bhutan's significant dependence on external sources, with a total import value of Nu. 2.09 billion. A large proportion of these imports consists of finished apparel, indicating a strong domestic demand for ready-made garments rather than locally produced clothing. Additionally, the substantial import of worn clothing and textile waste under Chapter 63

suggests a growing presence of second-hand textiles in the market, which presents considerable opportunities for recycling and upcycling initiatives.

Furthermore, the relatively lower import of raw textile materials compared to finished goods points to limited domestic manufacturing capacity in the textile sector. Thus, these trends underscore the urgent need for sustainable waste management practices and highlight the potential for developing local value-added industries, particularly in textile upcycling and eco-friendly production which aligns closely with the objectives of the proposed project.

Building on this framework, the concept establishes clear objectives to minimize waste, enhance resource efficiency, and support sustainable production practices. The process follows a systematic approach, beginning with the collection of raw materials such as discarded textiles, cement bags, and PET bottles. These materials are subsequently sorted, cleaned, and processed before being converted into new products. The expected outcome is the production of high-quality, durable goods suitable for both domestic consumption and potential export markets. The marketing strategy will emphasize forming strategic partnerships with relevant institutions, engaging local markets, and promoting products that highlight environmental sustainability and eco-friendly practices.

The initiative delivers both environmental and social benefits by reducing landfill waste through the repurposing of textile and plastic materials, thereby minimizing pollution, conserving natural resources, and lowering greenhouse gas emissions by decomposing and decreasing reliance on virgin materials. At the same time, it promotes inclusive livelihoods by creating income-generating opportunities for women and persons with disabilities, while supporting skill development, entrepreneurship, and social empowerment. It contributes to a resource-efficient, low-emission economy and strengthens community resilience through active participation in the circular economy.

3.3.2.1. Main Objectives

The Clothing and Household Items from recycled materials initiative aims to establish a sustainable and circular production system that transforms discarded textiles, cement bags, and plastic waste into value-added clothing and household products. The initiative seeks to reduce waste generation, promote resource efficiency, and create inclusive livelihood opportunities while supporting environmentally responsible manufacturing practices.

The key objectives of the initiative are:

1. **To reduce textile and plastic waste** by recovering discarded materials such as used textiles, cement bags, and PET bottles and converting them into usable products.
2. **To promote circular economy practices** by transforming waste materials into value-added clothing and household items, thereby extending the lifecycle of materials that would otherwise end up in landfill sites.
3. **To support sustainable local manufacturing and enterprise development** through the establishment of small-scale recycling and production units that produce environmentally responsible goods.
4. **To create livelihood and income-generating opportunities** particularly for women, community groups, and marginalized populations by engaging in recycling, sewing, weaving, and designing the products.
5. **To promote inclusive employment opportunities for persons with disabilities** through collaboration with the SELWA, enabling participation in sorting, packaging, product finishing, and quality control activities.
6. **To strengthen skills and capacity in textile recycling and sustainable product manufacturing** through training in material sorting, upcycling, sewing, weaving, and product design.
7. **To encourage environmentally responsible consumption** by promoting eco-friendly products made from recycled materials to consumers, institutions, and markets in Bhutan.
8. **To contribute to climate change mitigation** by reducing the demand for virgin textile and plastic materials and lowering emissions associated with waste disposal and manufacturing processes.

3.3.2.2. Project Concept Implementation and Operational Framework

1.Creating Awareness on Proper Waste Management.

The Stakeholder Consultation on the Development of the GCF Concept Note, held on 16th March 2026, identified a lack of awareness and improper waste management as key challenges, enhancing a deeper comprehension on effective waste management has emerged as a key necessity for the school and the community as a whole. The stakeholder mentioned that a lot of cloths are discarded by the students when they leave the school on vacation. Also, the single use of plastic and the use plastic bag contribute to significant amount of plastic waste despite enforcing a strict plastic ban policy of Bhutan 1999.

People tend to be largely indifferent to the environmental impacts of waste and often prefer readily available textile products over locally manufactured ones. Stakeholders mentioned that when used or recycled textiles are repurposed for different applications, they are frequently criticized and initiatives such as Bhutan's Gola-Gola project are undervalued or misunderstood as merely handling the "waste of others," reducing public acceptance of recycled materials.

Therefore, creating an awareness in essential because discarded textiles and PET bottles contribute significantly to environmental pollution when not properly managed. Without understanding the impacts, students and community members may continue to discard materials indiscriminately causing landfill overflow, soil and water contamination, and increased greenhouse gas emissions. By raising awareness, schools can encourage responsible disposal, promote recycling and upcycling practices, and foster a culture of environmental responsibility that extends from students to families and the wider community. It can be done as follow;

Conduct Waste Audits:

- ✔ Set up collection bins specifically for discarded textiles and PET bottles.
- ✔ Track the amount collected weekly or monthly.
- ✔ Display results on notice boards or digital screens to show the volume of waste generated.

Organize Interactive Demonstrations:

- ✔ Show students how PET bottles and old clothes degrade in landfills over time.
- ✔ Demonstrate simple upcycling techniques, e.g., turning old uniforms into bags.
- ✔ Mentor students on proper disposal and upcycling practices.
- ✔ Create student-led posters, videos, or short skits highlighting the importance of recycling textiles and PET bottles, visual storytelling and initiatives such as "4Rs" campaigns, poster competitions, or waste art projects that can motivate students to engage creatively with proper waste management.
- ✔ Extend awareness beyond school by involving parents and community members in collection drives, workshops, or fairs showcasing upcycled products.

Establishing collection and recycling systems within schools

- ✔ Schools can serve as collection points for discarded textiles and plastics, fostering a culture of reuse and responsible disposal.

Proper Waste Collection and Segregation at Source

- ✔ Place separate bins for discarded textiles and PET bottles in classrooms, dormitories, and common areas.
- ✔ Organize weekly or monthly collection sessions to gather, weigh, and record the number of textiles and PET bottles collected.
- ✔ Involve students in sorting and handling the materials to teach the importance of proper waste management.

- ✔ Encourage responsible disposal habits and highlight the environmental benefits of segregation, reuse, and recycling.

2. Professional Support

- ✔ Invite local craft experts, tailors, and artisans who have experience in working with textiles, plastics, and other recycled materials to conduct hands-on training sessions for students and teachers.
- ✔ Professionals can demonstrate proper techniques for cutting, stitching, weaving, and assembling household items such as reusable bags, storage containers, and decorative items.
- ✔ Organize periodic workshops led by professionals where students and staff actively participate in upcycling processes
- ✔ Professionals can help establish quality standards for upcycled products to ensure they are suitable for school use or local market sale.
- ✔ They can also advise on packaging, labeling, and minor marketing strategies, providing students with practical exposure to product commercialization.
- ✔ Professionals can assist schools in identifying and sourcing appropriate tools, machines (like sewing machines or cutting tools), and safe workspaces for upcycling activities.
- ✔ Their involvement ensures the upcycling projects are efficient, safe, and scalable

Waste Collection and Segregation in Schools.

During the stakeholder consultation, it was observed that schools are enthusiast in initiatives to upcycle discarded textiles, cement bags, and concert PET-bottles in polyester fibers into useful clothing such as school uniform, socks, bags made from cement and rice bags, and other useful household items as they recognize it not only as environmentally friendly, but sustainable and potential for upskilling. However, due to the need for heavy machinery, technical expertise, and the significant workload involved, directly managing the upcycling process would be challenging for schools. Instead, schools expressed a preference to collaborate with the private sector, providing their collected waste as raw materials, and also to purchase the processed uniform from the discarded materials.

This approach would reduce the volume of waste sent to landfills, decrease methane emissions from decomposing materials, and contribute to the mitigation of climate impacts, while still actively supporting the circular economy. Here is the detailed, structured plan on how schools can collect, segregate, and manage discarded textiles, cement bags and PET bottles, including timing and roles/responsibilities:

1. Waste Collection and Segregation Plan for Schools

a. Collection of Waste

What to collect:

- ✔ Discarded textiles (old uniforms, discarded pants and shirts, shawl, scarfs, towels, and blanket).
- ✔ cement and rice bags.
- ✔ PET bottles.

How to collect:

- ✔ Encourage students to deposit discarded textiles, PET bottles, cement and rice bags daily.

- ✔ Place clearly labeled bins in classrooms, dormitories, canteens, and school campus separately for PET bottles.
- ✔ Collect the textiles waste from dormitories, staff quarter and canteens during the social work hours.
- ✔ Collect the rice bags from school kitchen during social work hours and store it in safe place.
- ✔ Students and teachers can also bring the old and unwanted textiles from home to school.
- ✔ Conduct pre-vacation collection drives to gather materials before students leave for holidays especially in boarding schools.

b. Segregation of Waste

Process:

- ✔ Separate textiles by type such as reusable clothes, damaged cloths, and scraps suitable for upcycling.
- ✔ PET bottles should be cleaned (rinsed if needed) and sorted by size or type (transparent, colored).
- ✔ Materials unsuitable for upcycling can be prepared for recycling by collaborating with private partnerships.

Timing:

- ✔ Segregation should occur once a week or during scheduled collection drives.

Responsible:

- ✔ Club members and assigned students under the supervision of a teacher can manage sorting and storage of the collet waste materials.

c. Documentation and Awareness

- ✔ Record the quantity of discarded textiles, rice and cement bags, and PET bottles collected and segregated weekly.
- ✔ Display charts or boards showing collected volumes, highlighting environmental benefits of proper disposal or announce it in the morning assemble, or update in school social media page.
- ✔ It is the responsibilities of the club members and teachers to maintain records and update displays.

d. Collaboration with the Private Sectors

Schools can actively contribute to upcycling initiatives by partnering with private sector and Non-Governmental Organizations that have the machinery, technical expertise, and capacity to process discarded textiles, cement bags, and PET bottles. Potential partners may include local recycling companies, textile upcycling entities, small-scale manufacturing units, and Eco-Waste sectors.

- ✔ Collected materials are to be delivered periodically (e.g., monthly or pre-vacation) to the private partners as raw inputs for processing into fibers, clothing, and household items.
- ✔ Private partners handle sorting, cleaning, and converting the materials into usable products using their technical resources.

Roles and Responsibilities

- ✔ **School Administration:** Approve the program, provide storage space, and coordinate with recycling/upcycling partners.
- ✔ **Teachers:** Supervise collection, segregation, and awareness activities and also guide students on proper disposal methods.
- ✔ **Club/Student Volunteers:** Lead collection drives, segregate waste, maintain records, and organize awareness campaigns.
- ✔ **Students:** Participate actively by depositing materials properly, assisting in segregation, and spreading awareness in school and the society.
- ✔ **Parents/Community:** Support pre-vacation collection and encourage students to practice responsible disposal at home.

f. Schedule/Timeline Example

- ✔ **Daily:** Students deposit discarded textiles and PET bottles into designated bins.
- ✔ **Twice a week:** Student volunteers segregate collected materials.
- ✔ **Monthly:** Club members present the total collected volumes, and demonstrates potential upcycling or recycling uses.
- ✔ **Before vacations:** Special collection drive to gather materials from classrooms and dormitories for upcycling projects.

3.3.2.3 Role of Private Sector in Processing Collected Waste

Given the operational limitations faced by schools, private sector partners will play a critical role in processing the collected waste materials in line with environmental and social management principles. Once discarded textiles, cement bags, and PET bottles are collected and segregated at the school level, these materials will be periodically transferred (monthly or at the end of each school term) to designated private sectors that are well equipped with the necessary machinery and technical expertise.

Upon receipt, private partners will undertake secondary sorting, cleaning, and preprocessing to ensure that the materials meet required quality standards. PET bottles will be processed through shredding and conversion into flakes, followed by transformation into polyester fibers, while textiles and cement bags will be assessed and directed towards appropriate recycling or upcycling streams. The partners will ensure that all processes adhere to environmental safeguards, including proper waste handling, emission control, and occupational health and safety measures guided by ESMP.

In addition, private partners will be responsible for product development and manufacturing converting discarded textiles, PET bottles, and cement and rice bags into value-added products such as school uniforms, socks, household items, and other marketable goods. They will also provide technical feedback and capacity support to schools to improve the quality of collected materials and strengthen the supply chain. This collaborative approach establishes an efficient and sustainable value chain where schools act as collection and supply nodes, and private partners serve as processing and producing units thereby reducing landfill waste, minimizing greenhouse gas emissions, and contributing to climate change mitigation and circular economy development.

The similar project is currently taken up by the Circular Bhutan Innovations Project that aims to convert the PET bottles waste into polyester fibers carried out in an environmentally sound and socially responsible manner. The objective of this project is to recycle plastic waste into useful products such as fibers for cushions and textiles, while minimizing negative environmental impacts such as pollution, waste accumulation and emissions. It also identifies potential social impacts, including opportunities for job creation and the need to ensure worker safety and community well-being. Additionally, the

Environmental and Social Safeguard Management Plan establishes mitigation measures, monitoring mechanisms, and compliance requirements to guide safe project implementation (Clean Bhutan, 2025).

3.3.2.4 Process of Converting PET-bottles in to Fibers

The process involves collection and cleaning of post-consumer polyethylene terephthalate (PET) bottles which are then melted and extruded to form continuous synthetic fibers. These fibers can subsequently be utilized in the production of textiles, yarns, or other value-added materials, thereby providing an effective method for converting plastic waste into reusable industrial resources while contributing to environmental sustainability (Simon and Milad, 2019).

1. Collection and Preparation of PET Bottles: Used PET bottles are collected and sorted to remove non-PET items and contaminants. They are then cleaned to remove labels and residues.
2. Cleaning and Preparation: Once sorted, the collected materials will undergo cleaning and preparation processes to ensure hygiene and usability. This stage is critical to ensure that recycled materials meet basic quality standards before further processing.
3. Shredding into PET Flakes: The clean bottles are shredded into small flakes, which serve as the basic raw material for recycling. These flakes are suitable for melting and further processing.
4. Plastic Extrusion: The PET flakes are fed into an extrusion machine where the thermoplastic PET is heated and melted. PET's thermoplastic nature allows it to be remelted and reshaped repeatedly.
5. Air Stretching to Form Fiber: As the molten PET exits the extruder, compressed air is blown through the melt to pull and stretch it into continuous synthetic fibers.
6. Cooling and Solidification: The extruded fibers are cooled and solidified, resulting in synthetic fibers that can be used as stuffing, packaging material, or further processed into yarn in spinning mills.
7. Post-Processing (Optional): Depending on the intended product, the fibers can be processed in textile facilities to make polyester yarn or blended with other materials.
8. Manufacturing and Product Development: The processed materials will then be used to produce a range of clothing and household products as follows.

    - ✔ School and desuup uniforms.
    - ✔ Socks and textile accessories made from recycled polyester
    - ✔ Foot mats and carpets produced through weaving recycled fibers
    - ✔ Reusable household bags made from repurposed cement bags
    - ✔ Rugs, carpets, and mats made from shredded textile fibers

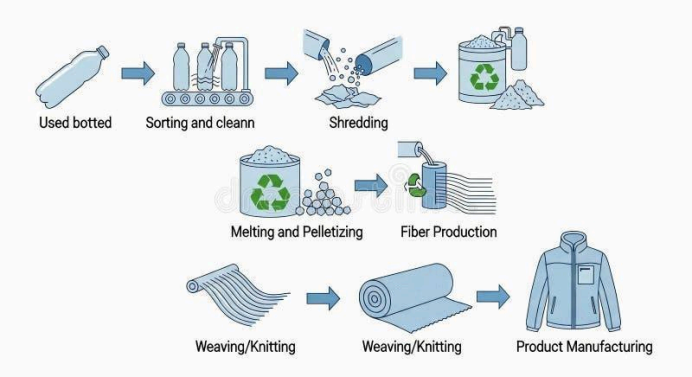

Figure 2.1The process of transforming PET-bottles into polyester fibers and then woven into desired cloths.

Similarly, old textiles can be renewed through mechanical or chemical recycling processes. Mechanically, fabrics can be shredded and re-spun into new yarns or repurposed into non-woven products such as insulation, mats, or stuffing for cushions. While this is cost-effective, repeated mechanical recycling can weaken fibers making it more suitable for sturdy, single-material fabrics like cotton.

Chemically, fibers from old textiles can be broken down to their basic molecular components and then regenerated into new fibers of quality similar to virgin material which works even for blended fabrics like cotton-polyester mixes. Additionally, old textiles can be upcycled into new products without breaking them down for example, by redesigning worn garments into bags, mats, or other household items (United State Government Accountability Office, 2024). These methods allow textiles to have a second life, reducing waste and supporting a circular economy.

Figure 2.2 Bags and Uniforms made from discarded cloths and polyester fibers

3.3.2.4 Role of Civil Society Organization-SELWA

A Civil Society Organization such as SELWA can play a significant role in the renewal and recycling of old textiles by functioning as a facilitator, educator, and implementer. SELWA could raise awareness among communities, schools, and households regarding the environmental impacts of textile waste, and the importance of recycling and upcycling practices. It

can organize collection initiatives to gather discarded clothing and textiles, ensuring proper sorting based on fiber composition to support efficient mechanical or chemical recycling processes.

Furthermore, SELWA can provide training to local communities including students with Special Educational Needs (SEN), single mothers, and unemployed youths on upcycling techniques, enabling the transformation of waste textiles into value-added products such as school uniforms, bags, mats, and household items. This not only contributes to environmental sustainability, but also creates opportunities for livelihood generation.

In addition, SELWA can establish partnerships with private sectors such as recycling units to direct non-reusable textiles toward appropriate industrial recycling systems. Through a combination of awareness-building, capacity development, and practical implementation, SELWA can serve as a vital link between communities and the broader textile recycling units, thereby promoting a circular and sustainable textile economy.

3.3.2.5 Operational Framework for SELWA in Textile Renewal and Recycling

SELWA can operationalize textile renewal and recycling through an integrated, phased implementation model that combines awareness generation, material recovery, skill development, production, and market linkage. Each component requires clearly defined institutional roles, stakeholder engagement, and a structured timeline to ensure effectiveness and sustainability.

1 Awareness Raising and Behavioral Change Interventions

The first step involves cultivating behavioral change by increasing awareness about textile waste, environmental impacts, and sustainable consumption practices. SELWA can design context-specific Information, Education, and Communication (IEC) materials and deliver them through schools, community centers, and public campaigns and posting through social media reaching wider audience.

Nationwide Media Campaigns

Use mass media platforms to reach a broad audience across the nation.

Action Plan.

- ✔ Broadcast short awareness messages on television and other social media platform.
- ✔ Publish articles and success stories in various media platform.
- ✔ Use social media platforms for campaigns, storytelling, and impact sharing.
- ✔ Partner with local influencers, educators, and community leaders

Monitoring and Visibility of Impact

Make results visible to sustain engagement. Builds transparency, trust, and motivation for participation.

Action Plan.

- ✔ Publish data on textiles collected and recycled
- ✔ Share success stories from communities and SEN participants
- ✔ Create simple dashboards or reports accessible to the public

2 Strategic Partnerships with Private Entities

Not all collected textiles can be reused or upcycled into products. Apart from engaging in the production of value-added items, SELWA can also contribute by facilitating the proper management of non-reusable textile waste. In this

regard, SELWA can establish partnerships with private recycling centres to channel such materials into appropriate mechanical or chemical recycling processes.

SELWA can collaborate and form a partnership with the private entities to channel textile waste into productive use such as sale of raw materials and selling in markets of the finished goods produced by the people with disabilities and community people there by supporting sustainable practices and creating opportunities for livelihood.

1. **Identify and engage private partners**: Map and approach companies interested in sourcing textile waste or selling finished goods.
2. **Channel textile waste to productive use:** Collect, sort, and supply textile waste to private partners for recycling or production. Ensure quality and consistency of raw materials to meet market needs.
3. **Support production of finished goods**: Collaborate with private partners to process textile waste into marketable products. Provide technical guidance and training to people with disabilities and community members.
4. **Market and sell finished goods**: Facilitate access to local, regional, and online markets. Partner on branding, packaging, and promotion of products made by the community.

3. Capacity Building and Upcycling Production Units

SELWA can facilitate small-scale, inclusive production activities by engaging differently abled individuals in the creation of value-added products from processed textile materials such as shredded fibers and recycled polyester fibers. Rather than focusing on labor-intensive and machinery-dependent operations, SELWA can collaborate with external partners or recycling units to supply semi-processed materials, which can then be used by participants to produce items such as uniforms, socks, and other household products. This approach allows differently abled individuals, including those with special educational needs (SEN), to participate in manageable, skill-appropriate tasks such as sorting, simple stitching, assembling, and finishing.

SELWA promotes livelihood opportunities, enhances skill development, and ensures social inclusion without requiring heavy machinery or highly technical expertise. This model emphasizes accessibility, adaptability, and empowerment while still contributing to the broader objective of textile recycling and circular economy practices.

Key Activities:

- ✔ Conducting hands-on training in sewing, stitching, weaving, and product design
- ✔ Establishing small-scale production units equipped with basic tools.
- ✔ Developing standardized product lines (e.g., bags, mats, uniforms, household items)

Roles and Responsibilities:

- **Technical Trainers and Experts:** Deliver skill-based training and ensure quality standards
- **SEN Participants and Local Communities:** Engage in production activities according to their capacities.
- **SELWA Supervisors:** Monitor, maintain quality control, and manage the workflow
- **Design and Innovation Partners:** Enhance product that are more aesthetics and functionality

3.3.2.6 Product Marketing, Distribution, and Revenue Generation

To ensure financial sustainability, SELWA can develop a structured marketing and distribution system for upcycled products by establishing clear channels for sales, partnerships, and customer engagement. This involves identifying both local markets (such as community shops, local fairs, and small retailers) and institutional buyers (such as schools, offices, and organizations) that can purchase products in bulk, including uniforms, bags, and household items. SELWA can create a

simple, but consistent branding strategy that highlights the environmental and social value of the products, particularly their contribution to waste reduction and the empowerment of differently abled individuals.

By establishing reliable market linkages and maintaining consistent product quality, SELWA can create a steady revenue stream that supports ongoing activities, including training, material collection, and community engagement. This approach not only strengthens financial sustainability but also reinforces the long-term viability of the textile recycling initiative.

Key Activities:

- ✔ Branding and packaging of products
- ✔ Participation in local markets, exhibitions, and trade fairs
- ✔ Establishing institutional buyers (e.g., schools, offices, organizations)
- ✔ Exploring online platforms promoting environmentally friendly products.

3.3.2.7 Climate and Environmental Impact of Upcycling textile waste and polyester fibers.

According to (Kiron, 2024), the textile industry has a major environmental footprint, largely due to high waste generation and resource use. Globally, about 92 million tons of textile waste are produced each year, much of which ends up in landfills causing land and soil pollution, and using up valuable landfill space. Only around 60% of this waste is recycled, while a significant portion still goes to waste disposal, highlighting how textile production contributes directly to environmental degradation if not managed sustainably. Recycling and upcycling help mitigate this by diverting waste from landfills and conserving natural resources that would otherwise be consumed in new production

Recycling discarded clothes and plastics significantly reduces the textile and plastic industry's climate footprint. Recycling diverts these materials, reducing the need for new production, which is highly energy-intensive and emits large amounts of Carbon Dioxide up to 10 to 20 kg CO_2 per kg of new textile produced. Similarly, repurposing plastic-based fibers like polyester reduces reliance on fossil fuels and prevents additional emissions from production and incineration. Overall, recycling textiles and plastics can cut carbon emissions by up to 50 to 90% per unit of material, conserve water, and lower pollution, contributing significantly to climate change mitigation (Planet Aid, 2024).

3.3.2.8 Socio-Economic Impact

This initiative offers comprehensive socio-economic benefits by fostering inclusive employment, entrepreneurship, and community empowerment. By involving women, marginalized groups, and persons with disabilities in activities such as sorting, upcycling, sewing, weaving, packaging, and quality inspection, the project generates sustainable income opportunities while enhancing skill development and capacity building in environmentally responsible manufacturing.

Collaboration with SELWA ensures that vulnerable populations can actively participate in production processes, creating a socially inclusive model. The establishment of local recycling and production units reduces Bhutan's dependence on imported textiles, strengthens local supply chains, and stimulates small-scale enterprise development. Schools and communities, by acting as collection points, contribute raw materials to private partners, linking education, local labor, and industry in a circular economy framework. Additionally, the production and marketing of upcycled clothing and household items support local markets, increase community awareness of sustainable consumption, and promote entrepreneurship, thereby creating long-term, resilient socio-economic impacts that align with sustainable development goals.

3.3.2.9 Gender and Social Inclusion

The initiative is designed to be **gender-inclusive and socially inclusive**, creating opportunities for women and marginalized groups. Activities such as sewing, weaving, sorting, and packaging are particularly suitable for **community-based women's groups and small enterprises**. Collaboration with **SELWA** will enable persons with disabilities to participate in various aspects of production, including:

- Sorting and preparation of recyclable materials
- Packaging and product finishing
- Quality inspection and inventory management

This inclusive approach ensures that the benefits of the initiative are shared across different social groups.

3.3.2.10 Potential Risks and Considerations

While the initiative presents significant opportunities, several potential risks must be considered and managed.

1. **Microplastic Pollution**

Processing synthetic materials such as PET bottles may generate **microplastic particles**, which can pose environmental and health risks if not properly managed. Appropriate filtration systems and safe processing practices should be adopted to minimize this risk.

2. **Material Quality and Contamination**

Collected waste materials may vary in quality and may contain contaminants. Proper sorting and cleaning procedures will be necessary to maintain product quality.

3. **Market Demand Uncertainty**

The market demand for recycled products may fluctuate depending on consumer preferences and competition with conventional products.

4. **Operational and Technical Capacity**

The success of the initiative will depend on the availability of technical expertise, proper equipment maintenance, and effective management of production processes. Addressing these risks through proper planning, training, and quality control mechanisms will be essential for the sustainability of the initiative.

Table 2.1 Materials Required for the Project Concept 2: Clothing and Household Items from the Recyclable Waste Materials

Category	Materials/Equipment	Purpose
Raw Materials	Discarded textiles (clothes, uniforms, blankets, towels)	Main input for producing clothing, mats, bags, and other household items
	Cement and rice bags	Used to create durable reusable bags and storage products
	PET bottles	Converted into polyester fibers for textiles and stuffing materials
Collection & Segregation	Labeled waste collection bins	Ensure proper segregation of textile and plastic waste at source
	Storage sacks/containers	Store and transport collected materials safely

	Gloves and protective gear	Maintain hygiene and safety during handling
	Weighing scale	Measure and track quantities of collected waste
Cleaning & Preparation	Water supply and washing facilities	Clean collected materials before processing
	Detergents/cleaning agents	Remove dirt and contaminants to improve material quality
	Drying racks/lines	Dry materials after washing
Processing Equipment (Private Sector)	Shredding machines	Break down textiles and PET bottles into smaller pieces/flakes
	Extrusion machines	Convert PET flakes into polyester fibers
	Cutting tools/machines	Prepare materials for further production
Production Tools (SELWA/Community)	Sewing machines	Stitch clothing, bags, and textile products
	Hand tools (scissors, needles, thread, measuring tape)	Support stitching and finishing work
	Weaving frames/looms	Produce mats, carpets, and woven items
	Worktables/workspace setup	Provide safe and organized production environment
Packaging & Marketing	Packaging materials (bags, labels, tags)	Pack finished products for sale
	Branding and labeling materials	Communicate product identity and sustainability value
	Display materials (racks, banners)	Showcase products in markets and exhibitions
Training & Capacity Building	Training manuals and guides	Provide technical instructions for upcycling and production
	Demonstration kits/sample products	Support practical learning and skill development
Monitoring & Documentation	Record books/digital systems	Track collection, production, and sales data
	Reporting templates/dashboards	Monitor progress and project impact

3.3.3 Introduction to the Project Concept 3: Arts and Craft from Waste Materials.

The Arts and Crafts from Waste Materials initiative focuses on converting discarded natural and recyclable materials into value-added handicraft products, thereby promoting environmental sustainability and cultural innovation. The initiative aims to recover materials such as waste wood, bamboo, and paper that are typically discarded during construction, carpentry, packaging processes, and everyday household activities.

These materials can be transformed into a variety of handcrafted products such as papier-mâché masks, religious statues for puja, decorative souvenirs, wind chimes, food doom and other craft items. The initiative is rooted in traditional Bhutanese craftsmanship while integrating contemporary sustainable design approaches.

The intervention aligns with circular economy principles by extending the lifespan of materials that would otherwise be discarded as waste. By transforming these materials into both artistic and functional products, the initiative not only reduces waste generation, but also creates new income-generating opportunities for artisans and local communities.

The initiative not only delivers environmental benefits but also strengthens inclusive livelihood opportunities, particularly for women, youth, artisans, and persons with disabilities through partnerships with organizations such as SELWA. Craft production and decorative item making can be carried out through community-based enterprises or small workshop settings, enabling flexible engagement while building practical skills and supporting income generation. Furthermore, Bhutan's strong tourism sector provides an opportunity to market these products as **eco-friendly and culturally inspired handicrafts**, appealing to both domestic and international consumers.

3.3.3.1 Main Objectives

The Arts and Crafts from Waste Materials initiative aims to promote environmental sustainability, cultural creativity, and inclusive livelihood opportunities by transforming discarded natural and recyclable materials into value-added handicraft products. The initiative seeks to reduce waste while supporting local craftsmanship and small-scale enterprise development.

The key objectives of the initiative are:

1. **To reduce waste generation** by recovering and repurposing discarded materials such as waste wood, bamboo, and paper into functional and decorative handicraft products.
2. **To promote circular economy practices** by extending the life cycle of natural and recyclable materials through creative reuse and sustainable craft production.
3. **To support the preservation and promotion of traditional craftsmanship** by combining Bhutanese artistic heritage with innovative approaches to recycling and sustainable product design.
4. **To create livelihood and income-generating opportunities** for artisans, community groups, women, and youth through small-scale handicraft production.
5. **To promote inclusive employment opportunities for persons with disabilities** through collaboration with the SELWA, enabling participation in craft production, packaging, and quality control activities.
6. **To strengthen local skills and capacities in craft-making and sustainable product design** through training programs focused on paper mache production, wood and bamboo crafting, and textile-based craft techniques.
7. **To develop market opportunities for eco-friendly handicraft products** by promoting them in local markets, tourism outlets, cultural exhibitions, and retail platforms across Bhutan.
8. **To contribute to climate change mitigation and environmental conservation** by reducing the demand for virgin raw materials and minimizing waste disposal through recycling and creative reuse practices.

3.3.3.2 Project Concept Implementation and Operational Framework

Creating Awareness in Schools: Implementation Approach and Roles and Responsibilities

Creating awareness in schools for the Arts and Crafts from Waste Materials initiative requires a structured implementation strategy supported by clearly defined roles and responsibilities among stakeholders. This structured approach ensures effective awareness creation by combining education, participation, and community engagement while clearly defining responsibilities for sustainable implementation.

a. Integration into School Activities

Schools can incorporate waste-to-craft concepts into art, environmental studies, and extracurricular lessons. Teachers or the artist can design practical assignments where students use waste materials such as paper, bamboo, and wood to create simple craft products.

Roles and Responsibilities:

- **School Administration:** Approve curriculum integration and provide necessary materials.
- **Teachers/Artist:** Design lesson plans and guide students in craft-making activities.
- **Students:** Actively participate and apply learning through practical work.

b. Establishment of Art and Craft Club/Unit in Schools.
Form student-led eco-clubs responsible for organizing awareness activities, collection drives, and regular craft-making sessions.

Roles and Responsibilities:

- **School Administration:** Facilitate the formation of clubs and assign teacher coordinators.
- **Teachers:** Supervise and mentor club activities.
- **Students (Club Members):** Lead initiatives, organize events, and promote recycling practices.

c. Conducting Hands-on Workshops
Invite local artisans or trained facilitators to conduct workshops demonstrating how waste materials can be transformed into useful and decorative items.

Roles and Responsibilities:

- **School Administration:** Coordinate with external experts and arrange logistics.
- **Artisans/Experts:** Provide technical knowledge and demonstrations.
- **Students:** Participate actively and learn practical skills.

d. Organizing Competitions and Events
Conduct competitions such as "Best Out of Waste," exhibitions, and craft fairs to showcase student creations.

Roles and Responsibilities:

- **Teachers:** Plan and organize events and evaluation criteria.
- **Students:** Create and present innovative craft products.
- **School Management:** Provide space, recognition, and incentives.

e. Awareness Campaigns and Presentations.
Conduct awareness sessions through morning assemblies, posters, and presentations highlighting the importance of recycling and sustainable practices.

Roles and Responsibilities:

- **Teachers:** Guide content development and presentations.
- **Students:** Deliver presentations, create posters, and lead campaigns.
- **School Administration:** Allocate time and platform (assemblies, notice boards).

f. Engagement of Parents and Community
Organize exhibitions, workshops, and awareness events involving parents and community members to extend impact beyond the school.

Roles and Responsibilities:

- **School Administration:** Coordinate events and invite stakeholders.
- **Parents/Community Members:** Participate and support initiatives.
- **Students and Teachers:** Showcase products and share knowledge.

3.3.3.3 Collection and Sorting of Waste Materials for Arts and Craft

During the stakeholder consultation for the development of the GCF Concept Note, stakeholders highlighted that while raw materials are readily available, adequate equipment and appropriate technology are crucial, particularly for scaling up production. The identified waste materials include discarded wood and bamboo, PET bottles, plastics, textiles, kitchen waste, high-density polyethylene (HDPE), low-density polyethylene (LDPE), as well as aluminum and glass bottles.

They further stated that schools generate a significant amount of paper waste, which is typically handed over to private sector entities rather than being processed within the schools, as such activities may be inconvenient and could divert attention from their primary focus on teaching and learning. A teacher from Wangsel mentioned that a vocational program is already established. Furthermore, schools can promote art and craft clubs by training interested teachers and students, setting aside small workspaces, and using locally sourced materials, enabling students to create products for sale through SELWA and generate income. To improve waste management in schools, a systematic approach to waste collection and segregation should be established through clear procedures and scheduled activities.

a. Segregation at Source

✔ Provide clearly labeled bins for organic (wet) and non-biodegradable (dry) waste in key areas such as classrooms, dining halls, kitchens, and hostels.

- ✔ Use color-coding and visual guides to support correct waste disposal practices.
- ✔ Conduct basic orientation for students, teachers, and staff to ensure proper segregation at the source.

b. Designated Collection Points

- ✔ Set up a central collection area within the school for temporary storage of segregated waste.
- ✔ Maintain the area properly to avoid littering, odor, and pest-related issues.

c. Regular Collection System

- ✔ **Daily:** Waste segregation and disposal after classes and meals (especially to prevent odor and animal disturbance).
- ✔ **Weekly:** Collection of waste from classrooms and common areas during club or activity periods.
- ✔ Assign responsibilities to designates student teams to ensure consistency monitored by teachers.

d. Sorting and Preparation

- ✔ At the central collection point, paper waste can be further sorted into categories such as reusable paper, recyclable paper, and unusable waste.
- ✔ Remove non-paper materials (e.g., plastic covers, bindings) to maintain quality.
- ✔ Bundle or stack paper neatly for storage and easy handling.

Implementation with Roles and Responsibilities

A well-organized system involving students, teachers, and non-teaching staff is essential to ensure efficient paper waste collection and management.

a. Establishment of Collection System

- ✔ Set up paper collection bins and a central storage area within the school premises.
- ✔ Provide basic materials such as sacks, boxes, or shelves for storage.
- ✔ The school administration ensures proper setup and availability of resources.

Roles and Responsibilities

a. School Administration

- ✔ Allocate space and provide necessary materials for collection and storage.
- ✔ Support awareness and training initiatives.
- ✔ Monitor overall implementation.

b. Teacher-in-Charge (Club Coordinator)

Supervise the paper collection system.

- ✔ Develop schedules for collection and monitoring.
- ✔ Ensure students follow proper segregation practices.

c. Student Volunteers / Club Members

- ✔ Collect paper waste from classrooms and common areas on a weekly basis.
- ✔ Transport and organize collected paper at the storage point.
- ✔ Assist in sorting and maintaining cleanliness.

d. Student Leaders (Class Monitors / Heads)

- ✔ Ensure daily segregation of paper waste within classrooms.
- ✔ Coordinate with student volunteers during collection.
- ✔ Report issues to the teacher-in-charge.

e. Non-Teaching Staff

- ✔ Assist in collecting paper waste from offices and administrative areas.
- ✔ Help maintain the storage area.
- ✔ Provide support during non-school days if required.

Monitoring and Maintenance

- ✔ Maintain a simple record of the quantity of paper waste collected weekly.
- ✔ Conduct regular checks to ensure bins are used correctly and not contaminated with other waste.
- ✔ Teachers review progress and provide feedback for improvement.

Outcome

This system ensures organized collection and proper management of paper waste within the school. It reduces litter, promotes responsible behavior among students, and creates a foundation for further reuse or recycling initiatives while supporting a clean and sustainable school environment.

3.3.3.4 Safety Measures for Making Arts and Craft from Waste Materials

- ✔ **Personal Protective Equipment:** Students and staff should be provided with gloves, masks, aprons, and eye protection, particularly when handling materials such as plastics, metals, glass, or adhesives.
- ✔ **Safe Workspaces:** Crafting should take place in well-ventilated, organized areas with clearly marked zones for cutting, painting, gluing, and assembly. Adequate space reduces the risk of accidents.
- ✔ **Proper Tools:** Only age-appropriate and safe tools should be used. Sharp tools must be handled under supervision, and safe cutting, stitching, and shaping techniques should be demonstrated.
- ✔ **Hygiene Practices:** Regular handwashing and workspace cleanliness are essential, especially when handling discarded wood and bamboos that may contain dirt and other stains.
- ✔ **Emergency Preparedness:** First aid kits should be accessible, and staff trained in basic first aid to respond promptly to any accidents.

3.3.3.5 Technical and Professional Support

The stakeholders emphasized the importance of skill training stating that, professional guidance from experts is necessary even in the private sector. For small-scale initiatives in schools, teachers would require training to effectively mentor and guide students. Additionally, opportunities could be offered to single parents, homemakers, and individuals with a strong interest in arts, crafts, or entrepreneurship, allowing them to participate based on their motivation and passion.

- ✔ **Training Workshops:** Experts and artisans can conduct workshops demonstrating techniques for upcycling, molding, stitching, cutting, or painting.
- ✔ **Teacher Capacity Building:** Selected teachers should be trained to supervise activities safely, provide guidance on proper techniques, and monitor adherence to safety protocols.
- ✔ **Guidelines and Protocols:** Simple manuals or visual guides should outline safe handling procedures, tool usage, and step-by-step production methods.
- ✔ **Monitoring and Supervision:** Continuous supervision ensures correct technique, prevents accidents, and helps maintain consistent product quality.

Outcomes

By combining structured guidance, professional mentorship, safety equipment, and well-organized workspaces, schools can create a secure and productive environment for crafting from waste materials. This approach ensures participant well-being, maintains the quality of products and fosters creativity, confidence, and skill development among students and community of interest.

3.3.3.6 Arts and Craft Production from Waste Materials

After the collection and sorting of waste materials, and the formation of an Art and Craft Club based on students' interests, professional guidance is essential to transform these materials into creative and functional products. The professional artist/ instructor can conduct workshops and training sessions, demonstrating techniques and supervising hands-on practice. Under such guidance, students can explore various crafting processes while learning to safely and efficiently handle the materials and equipment.

a) Paper Craft Production

Waste paper can be repurposed into paper mache products such as traditional masks and decorative statues used in puja or religious ceremonies. The paper mache process typically involves soaking the waste paper, mixing it with binding agents, shaping the mixture using molds, and allowing it to dry before painting and finishing. This technique not only recycles paper but also encourages artistic expression and creativity (Vaessen-Creative, n.d.).

This table provides a complete list of materials and a detailed step-by-step procedure to create an animal face mask using paper-mâché. From preparing the base form and making the paste to shaping features, painting, and adding decorative touches, these instructions guide crafters of all ages to make interesting and durable masks (Vaessen-Creative, n.d.).

Table 3.1 Materials and detailed procedure for making a paper mache mask

Materials Required	Procedure
• Newspaper or scrap paper • Flour and water (for homemade paste) or craft glue	**1.Prepare the Base Form** Inflate a balloon or use a pre-shaped mold to create the basic face shape of your animal mask. This will act as the structure for your mask.

• Balloon, bowl, or a pre-made mask form • Paints (acrylic or tempera) • Brushes • Scissors or cutter • Decorative materials (feathers, felt, googly eyes, yarn, etc.) • Varnish or sealant (optional)	**2.Make the Paper-Mâché Paste** Mix **1 part flour with 2 parts water** until smooth, or dilute craft glue with a little water. This paste will hold the paper layers together. **3.Tear Paper Strips** Tear newspaper or scrap paper into strips about **2–3 cm wide**. Torn edges help the paper adhere better than cut edges. **4.Apply the First Layer** Dip paper strips into the paste, remove excess paste, and place them on the mold. Cover the entire surface evenly, smoothing each strip as you go. **5.Add More Layers** Apply **3–5 layers** of paper, letting each layer dry completely before adding the next. This strengthens the mask and ensures durability. **6.Shape Animal Features** Once dry, cut out eye holes. Add details like ears, snouts, horns, or other characteristic features by layering additional paper strips or using lightweight craft materials. **7.Paint the Mask** Paint the mask to match your chosen animal (e.g., brown for a bear, orange with stripes for a tiger). Allow paint to dry completely. **8.Decorate and Finish** Add decorative elements: felt for ears, yarn for whiskers, feathers for a mane, or googly eyes for extra fun. Seal with varnish or craft sealant for durability (optional).

Waste paper materials can be used to create **paper mache products**, including:

Figure 3.1 Traditional Masks and Religious Statue from Paper Mache Arts

Figure 3.2 Decorative Ornamental and Souvenirs

b) Bamboo and Wood Crafting

Discarded bamboo and wood can be transformed into decorative and functional items, including wind chimes, home décor accessories, small furniture, and craft souvenirs. The crafting process involves cutting, shaping, sanding, assembling, and finishing the materials to produce durable and aesthetically appealing products.

This guide outlines the essential materials and step-by-step process for creating decorative and functional items from discarded bamboo and wood. Following these instructions ensures durable, attractive, and practical craft products suitable for home décor, souvenirs, and small furniture.

Table 2.2 Materials required and procedures for creating arts and craft from bamboo and wood waste

Materials Required	Procedure
✔ Discarded bamboo poles or wooden planks ✔ Saw (hand saw, jigsaw, or hacksaw) ✔ Sandpaper (coarse and fine grit) ✔ Wood glue or strong adhesive ✔ Nails, screws, or clamps ✔ Paint, wood stain, or varnish ✔ Brushes or cloths for finishing	**1.Select and Prepare Materials** – Choose bamboo or wood pieces that are strong, clean, and free of rot. Cut them to the desired size for your project. **2. Cutting and Shaping** – Use a saw to cut the bamboo or wood into required shapes. For rounded edges or intricate designs, sand or carve as needed. **3. Sanding-Smooth** all surfaces and edges to remove splinters and roughness. Coarse grit first, then fine grit for a polished finish. **4**. **Assembling Parts** – Join bamboo or wood pieces using glue, nails, screws, or binding techniques depending on the product. Ensure joints are stable. **5. Detailing** – Add extra features such as hooks for wind chimes, shelves for small furniture, or decorative carvings. **6. Finishing-** Apply paint, stain, or varnish to protect the wood and enhance its appearance. Let it dry completely. **7. Final Touches-** Attach decorative elements (beads, feathers, metal pieces) or assemble functional components (strings for wind chimes, hinges for small items)

Waste bamboo and wood can be used to produce various decorative and functional items, such as:

Figure 3.3 Wind Chimes and Food Dome made from bamboo and woods.

Figure 3.4 Key Chains made from discarded wood and leathers.

Figure 3.5 Craft Souvenirs made from discarded woods.

c) Textile-Based Craft Items

Waste fabrics and textile scraps can be turned into household and decorative items, such as table runners, quilted décor, and other fabric-based craft products designed by quilting enthusiasts. These items are produced through processes like cutting, stitching, and applying decorative designs, allowing for both functionality and artistic creativity. This guide presents the materials required and step-by-step process for transforming waste fabrics and textile scraps into functional and decorative item.

Table 3.3 Materials Required for textile-based craft items

Materials Requires	Procedure
Waste fabrics and textile scraps (cotton, linen, etc.) Scissors or rotary cutter Needle and thread or sewing machine Pins or clips Measuring tape or ruler Fabric glue (optional) Decorative items (buttons, lace, embroidery thread, etc.)	1. Collection and Sorting – Gather fabric scraps and sort them by color, size, and material type to plan your design effectively. 2. Cutting Fabric Pieces – Cut fabrics into desired shapes (squares, strips, or patterns) depending on the product (e.g., quilt or table runner). 3. Arranging the Design – Lay out the fabric pieces in a pattern or design before stitching to visualize the final product. 4. Stitching Pieces Together – Sew the fabric pieces together using hand stitching or a sewing machine to form a larger panel. 5. Layering (for Quilted Items) – Add a backing fabric and optional padding (batting) to create thickness and structure. 6. Quilting and Securing Layers – Stitch through all layers to hold them together and create decorative patterns. 7. Finishing Edges – Hem or bind the edges neatly to prevent fraying and give a clean finish. 8. Decoration and Final Touches – Add embellishments like embroidery, appliqué, or buttons, and press the finished item for a polished look.

Waste fabrics and textile scraps may be repurposed into **decorative and household products**, including:

Figure 3.6 Table runner and tote bags made from discarded cloths.

Figure 3.7 Quilted Decorative Items

d) Finishing and Quality Control

Finally, all products undergo finishing processes to enhance their appearance, durability, and overall quality. This may include painting and decorative finishing for paper crafts, polishing or varnishing for bamboo and wood items, and ensuring the design integrity of textile products. Quality control checks are conducted to maintain consistency, meet market expectations, and uphold high craftsmanship standards.

Through this structured approach, the Art and Craft Club provides students with an opportunity to creatively reuse waste materials, develop practical artistic skills, and produce high-quality products all under the mentorship of experienced artists.

3.3.3.7 Marketing and Distribution Strategy

Finished products will be packaged using sustainable and environmentally friendly materials such as recycled paper or reused textiles to maintain consistency with the waste-to-craft approach. In terms of marketing, all finished products will be displayed at the SELWA Center, which will play a key role in promoting and assisting in the sale of surplus products. To ensure market acceptance and avoid generating further waste, only products that meet optimum quality standards will be selected for display and sale.

In addition to centralized marketing through the SELWA center, schools can actively participate in selling their products within the school premises and local communities. This can be done through school exhibitions, local markets, and partnerships with other organizations, retail outlets, or community groups. Broader distribution channels may include local handicraft markets, souvenir shops, tourism markets, cultural exhibitions, community festivals, and online platforms that promote sustainable handicrafts. This multi-channel approach helps reach diverse costumer while encouraging community engagement.

3.3.3.8 Potential Risks and Considerations

While the initiative offers multiple benefits, certain risks must be considered.

Material Supply Variability: The availability of waste materials such as wood and bamboo may fluctuate depending on construction and carpentry activities.

Market Competition: Handcrafted products may face competition from mass-produced goods that are cheaper but less environmentally sustainable.

Product Quality Standards: Maintaining consistent product quality will be important to ensure customer satisfaction and maintain market competitiveness.

Skill and Training Requirements: Artisans and participants may require training in both traditional craftsmanship and modern product design to produce high-quality items suitable for broader markets. Addressing these risks through capacity

building, design innovation, and market development strategies will be important for the long-term sustainability of the initiative.

3.3.3.9 Economic and Social Impact

This initiative will initially be implemented in schools, providing students with hands-on opportunities to engage in arts and craft production using waste materials. By introducing skills such as sewing, painting, carving, and assembling at an early stage, the project intervention builds creativity, environmental awareness, and practical knowledge within a structured learning environment. At the same time, it is designed with a long-term vision for sustainability and scalability, allowing successful practices to be expanded beyond schools into communities and small-scale enterprises.

The craft production sector offers significant opportunities for women, youth, and marginalized groups to participate in income-generating activities. Many of these activities can be carried out in small workshops or home-based settings, making them especially accessible to women and individuals with limited mobility. As the initiative grows, it can be replicated at the community level, creating broader livelihood opportunities.

The stakeholder highlighted that one of the key issues was it is difficult for private sector to actively collaborate with schools as many schools give less importance to such initiatives as they are mainly focused on academic achievement. They are looking forward to collaborate with schools in future through Dzong Education. This also provide a means to generate income for the schools through providing raw materials. Collaboration with SELWA will further strengthen inclusivity by ensuring that persons with disabilities are actively engaged in suitable roles. This inclusive and scalable approach not only promotes equitable participation, but also supports the development of resilient, community-based livelihoods while advancing environmental sustainability.

3.3.3.10 Environment and Climate Impact

Recycling plays a critical role in environmental conservation and climate change mitigation by reducing resource extraction, minimizing waste, conserving energy, and lowering pollution. The process involves the collection and reprocessing of waste materials such as paper, discarded cloths, discarded wood and bamboos, and metals which reduces the need for virgin resources, including timber, fossil fuels, and minerals. This in turn, helps preserve ecosystems, protect biodiversity, and prevent environmental degradation caused by mining, deforestation, and industrial manufacturing.

Recycling also diverts large volumes of waste from landfills and incinerators, thereby reducing the release of methane a potent greenhouse gas, and preventing the leaching of toxic substances into soil and groundwater. From an energy perspective, recycling can be highly efficient; for instance, recycling paper can save up to 40% of energy and 50% of water compared to virgin production processes (IERE, 2025)

These reductions in energy consumption directly translate to lower carbon dioxide and other greenhouse gas emissions, contributing to climate change mitigation. Furthermore, recycling supports the transition to a circular economy, where materials are retained in productive use for longer periods, thereby promoting sustainable production and consumption patterns. By combining waste reduction, resource efficiency, and emissions mitigation, recycling represents a highly effective strategy for achieving long-term environmental sustainability.

Table 3.4 Materials required for the Arts and Crafts from Waste Materials Including their Purposes.

Category	Material	Purpose
Paper-Based Materials	Waste paper (newspapers, scrap paper, cartons), scissors, and brushes	Paper mâché masks, statues, frames and decorative items. Cutting papers into shapes, and other paper crafts, applying glue, paste, paint and finishing on paper products.
Natural Materials	Discarded wood and bamboo	Carving, making souvenirs, keychains, small furniture, wind chimes, food dome, and décor

Plastic and Synthetic Materials **Textile Materials**	PET bottles, buckets, mixing bowls, molds or ballon and Jerry can. Waste fabrics (cotton, linen, old clothes), yarn and threads, strong adhesive	Containers, base for molds, decorative items, soaking papers, mixing adhesives, shaping molds and sculptures. Stitching items like table runners, tote bags, quilts, assembling wood, bamboo, and mixed crafts.
Wood and Bamboo tools	Handsaw, nails, screws, and screwdriver, Measuring tape and rulers	Cutting wood and bamboos, securing nails or pins, holding fabrics, measurements, and marking of fabrics.
Binding and Adhesive Materials	Glue and paste (flour paste, craft glue), strong adhesive	Assembling wood, bamboo, and mixed-materials craft. Also, used for bonding materials in paper mache and other craft productions
Finishing Materials	Paints (acrylic, tempera), wood paints, varnish, and sand paper	Coloring, decorating, and finishing craft products. Used for protecting and improving the durability of finished products.
Decorative Materials	Feathers, beads, lace, buttons for fabric embellishments.	To enhance visual appeal and artistic design of products
Personal Protective Equipment	Gloves, Aprons, Masks, and protective clothing	Protects hands when cutting, sanding, or handling adhesives, protects clothing from paint, glue, and dust, prevent inhalation of dust.

4. Theory of Change

4.1. Problem Statement

Bhutan is experiencing a rapidly growing waste management challenges that not only reflects changing consumption patterns and urbanization, but also further exacerbates the impacts of climate change. The increasing generation of both organic and non-biodegradable waste, coupled with inadequate systems for segregation, treatment, and recycling has led to a higher reliance on open dumping and poorly managed landfills. These conditions significantly intensify environmental degradation and climate risks.

Improperly managed waste contributes directly to climate change through the release of greenhouse gases, particularly methane from decomposing organic waste. A large portion of waste especially the organic waste is disposed of in the open dumping areas or unmanaged landfills leading to methane emission (potent greenhouse gas contributing to climate change), soil and water contamination through leachate, air pollution from open burning of waste and pungent odor from decaying of organic waste that increases the vulnerability of the ecosystems and communities to climate risks.

In addition, climate change exacerbates waste-related risks such as increased rainfall, flooding, and extreme weather events further aggravate waste-related problems by dispersing pollutants, contaminating water sources, and overwhelming already fragile waste management systems (Fei, Fang, and Wang, 2021). This creates a reinforcing cycle, where poor waste management accelerates climate change, and climate change, in turn, worsens the impacts of unmanaged waste. The core

problem was that an inefficient and unsustainable waste management systems in Bhutan are contributing to increased greenhouse gas emissions, environmental degradation, and reduces climate mitigation and resilience.

4.2. Barrier Analysis

Without targeted and strategic intervention, Bhutan's waste management challenge will continue to intensify, driven by a complex set of deeply interlinked barriers that reinforce one another. Therefore, a transformative approach that simultaneously addresses institutional, financial, technological, and behavioral barriers is not only necessary but urgent to break this cycle and shift toward an innovative, sustainable, and climate-resilient waste management system.

I. Institutional Barriers

- **Weak coordination among agencies**

  Waste management in Bhutan involves multiple institutions, including the National Environment Commission and local governments (thromdes and dzongkhags). However, coordination among these entities remains fragmented with overlapping mandates, unclear roles, and weak communication. This leads to gaps in planning, duplication of efforts, and inefficiencies in service delivery, ultimately weakening the overall effectiveness of the waste management system.

- **Limited capacity of local governments to manage waste systems**

  Local governments, particularly in smaller thromdes and rural dzongkhags, face significant capacity constraints including limited technical expertise, insufficient human resources, and lack of infrastructure for waste collection, segregation, and treatment. Financial limitations further restrict their ability to invest in improved waste management systems, resulting in irregular or inadequate waste management services.

- **Insufficient enforcement of waste regulations**

  Despite having a strong policy framework, including the Waste Prevention and Management Act 2009, enforcement remains weak due to limited manpower, inadequate monitoring systems, and low institutional capacity. As a result, compliance with waste segregation and disposal regulations is inconsistent, allowing unsustainable practices to persist.

II. Financial Barriers

- **Limited investment in waste infrastructure (composting, recycling facilities)**

  Investment in waste management infrastructure in Bhutan remains low, resulting in a shortage of essential facilities such as composting plants, recycling centers, and material recovery facilities. As waste generation increases, the absence of adequate infrastructure limits the country's ability to process and recover resources efficiently, leading to continued reliance on landfills and open dumping.

- **Lack of sustainable financing mechanisms**

  Waste management in Bhutan lacks long-term, sustainable financing models to support operation, maintenance, and expansion of services. Existing systems rely heavily on limited government budgets, with minimal cost recovery mechanisms such as user fees or revenue generation from waste-based products. This makes it difficult to scale up or sustain improved waste management solutions over time.

- **Dependence on public funding with minimal private sector participation**

The waste sector in Bhutan is largely driven by public institutions, with limited involvement from the private sector. This dependence restricts access to additional investment, innovation, and operational efficiency that private actors can provide. Without stronger public–private partnerships, the sector struggles to develop financially viable and scalable waste management solutions.

III. Technological Barriers

- **Absence of limited composting, recycling, and waste processing technologies.**

Bhutan's waste management system is constrained by the limited composting, recycling, and waste processing technologies. As a result, much of the waste is not efficiently treated or recovered, leading to continued reliance on landfills and missed opportunities for resource recovery and emission reduction.

Also, decentralized and small-scale waste management solutions remain limited, particularly at the community and institutional levels. Technologies such as Takakura composting, hydroponics, and localized recycling systems are not widely adopted, restricting the potential for on-site waste treatment, resource efficiency, and climate-resilient practices.

IV. Social and Behavioral Barriers

- **Low awareness and poor waste segregation practices**

Many communities and institutions in Bhutan have limited awareness of proper waste management, resulting in inadequate segregation of waste at the source. This hinders efficient recycling, composting, and resource recovery, and increases the burden on disposal sites.

- **Limited participation in circular economy practices**

Engagement in circular economy practices such as reusing materials, resource recovery, and sustainable consumption is generally low. This constrains the potential for reducing waste generation and optimizing resource efficiency.

V. Market Barriers

- **Weak market linkages for recycled and compost products**

The market for recycled and compost products in Bhutan is underdeveloped, with limited distribution channels and weak linkages between producers and consumers. This restricts the commercialization of waste-derived products and reduces incentives for investment in recycling and composting initiatives.

- **Low demand and perception issues for recycled goods**

Recycled products face low demand due to perception challenges, including doubts about quality, safety, or aesthetics. This limits consumer adoption, discourages producers, and slows the growth of circular economy practices.

VI. Gender and Social Inclusion Barriers

- **Limited livelihood opportunities for women and persons with disabilities**

Women and people with difficulties often face challenges in their livelihoods because they have less access to

education, skills, and job opportunities. They also experience social barriers and discrimination which limit their ability to earn income and participate fully in economic activities. This limits their economic empowerment and participation in sustainable waste initiatives, reducing the social inclusiveness of circular economy practices.

4.3. Long-Term Vision (Impact Statement)

The long-term vision of the project is to establish a climate-resilient, low-emission, and circular waste management system in Bhutan through an inclusive Public–Private Partnership model that transforms waste into value added products, reduces greenhouse gas emissions, and enhances sustainable livelihoods.

This vision directly contributes to:

- Bhutan's **Nationally Determined Contributions (NDCs)**
- Transition toward a **low-carbon and climate-resilient development pathway**
- Promotion of **circular economy and green growth**
- Strengthening **climate adaptation and mitigation outcomes**
- Balancing environmental conservation with socio-economic development which is a key component of **Gross National Happiness**

At its core, the project aims to shift Bhutan from a linear **"take-make-dispose"** waste system to a circular, resource-efficient system where waste is systematically reduced, reused, recycled, and reintegrated into productive use. Through the adoption of an integrated Public–Private Partnership (PPP) model, the project envisions a future where waste is no longer treated as an environmental burden, but as a valuable resource that contributes to economic development, environmental and climate protection, and social well-being.

The project directly aligns with Bhutan's NDC 3.0 by positioning waste management as a strategic contributor to climate mitigation and sustainable development for which the core goal of the Bhutan's Third Nationally Determined Contribution is to **continue its commitment to remain carbon neutral while pursuing sustainable, inclusive, and climate-resilient economic growth through 2035**. This commitment builds on Bhutan's long-term development vision and aligns climate action with national priorities, including low emissions development and adaptation to climate change impacts (Royal Government of Bhutan, 2025).

The initiative supports reductions in greenhouse gas emissions from landfills and organic waste, which is a key focus of the NDC. The integrated PPP approach enhances institutional coordination, mobilizes private sector collaboration, and fosters community participation, reflecting the NDC's emphasis on policy coherence, inclusive engagement, and innovative solutions. By promoting composting, recycling, and circular economy practices, the project not only advances Bhutan's goals of carbon neutrality and resource efficiency, but also supports climate resilient development, generate socio-economic benefits, and create equitable livelihood opportunities across the waste value chain.

The initiative advances global climate action by addressing both mitigation and adaptation priorities under the Paris Agreement. By reducing greenhouse gas emissions from organic waste and promoting composting, recycling, and circular economy practices, it supports carbon reduction and sustainable resource management. Simultaneously, it enhances community resilience through climate-smart agriculture and waste management. By generating equitable livelihoods and supporting inclusive participation, the project demonstrates how local climate action can deliver both environmental and socio-economic co-benefits, contributing to the global transition toward low-carbon, sustainable societies.

4.3.1 Contribution to a Low-Carbon Development Pathway (Mitigation).

The proposed project contributes to climate change mitigation by addressing key sources of greenhouse gas (GHG) emissions within Bhutan's waste and production systems through an integrated circular economy approach. The project will contribute significantly to Bhutan's low-emission development as follows;

1. Reducing methane emissions

The project significantly reduces methane emissions from landfills by diverting organic waste into decentralized composting systems. Organic waste, when disposed of in unmanaged landfills, decomposes anaerobically and releases methane, a greenhouse gas far more potent than carbon dioxide. By implementing Takakura composting within institutions such as schools and monasteries the project prevents methane formation at the source while transforming waste into nutrient-rich compost. This not only reduces emissions but also enhances soil carbon sequestration when compost is applied in agricultural systems.

2. Minimizing plastic and textile waste
   The project mitigates greenhouse gas emissions by reducing plastic and textile waste through recycling and upcycling interventions. By recovering and processing PET bottles, discarded textiles, and other materials into value-added products such as uniforms, bags, and household items, the project reduces the demand for virgin material production.

   The manufacture of new plastics and textiles is highly energy-intensive and relies heavily on fossil fuels. Industry accounts for about 34 % of global GHG emissions from manufacturing, power, and heat generation (IPCC, 2023), so substituting recycled materials significantly reduces lifecycle emissions. Diverting waste from landfills further prevents emissions from decomposition, burning, and long-term environmental impacts.

3. Promoting resource efficiency
   The project promotes resource efficiency and circular economy practices, which further contribute to emission reductions. By extending the lifecycle of materials through reuse, recycling, and upcycling, the project minimizes extraction, processing, and transportation of raw materials. This reduces emissions associated with industrial production. The circular model ensures that waste is continuously reintegrated into productive use, thereby lowering the overall carbon footprint of consumption systems.

   In addition, the arts and crafts initiative using waste materials contributes indirectly to mitigation by reducing demand for virgin natural resources such as timber and processed materials. By repurposing wood, bamboo, paper, and textiles into handicrafts and functional products, the project lowers emissions associated with raw material extraction, processing, and manufacturing, while also preventing waste accumulation.

4. Encouraging renewable energy integration

   The integration of renewable energy solutions, particularly agrivoltaics in greenhouse systems, contributes directly to emission reduction. By installing solar panels on greenhouse roofs, the project further enhances renewable energy sources for agricultural operations such as lighting and temperature control. This transition to clean energy decreases carbon emissions while enhancing energy efficiency within the system.

4.3.2 Contribution to Climate-Resilient Development (Adaptation)

The project also strengthens Bhutan's resilience to climate change by:

1. **Climate-resilient sustainable agriculture practices.**
   The project promotes climate-resilient and sustainable agricultural practices through the integration of composting, greenhouse farming, hydroponics, and aquaponics systems. The use of compost derived from organic waste improves soil quality making agricultural systems more resilient to climate stresses such as droughts and erratic rainfall. At the same time, hydroponics and aquaponics enable controlled, resource-efficient food production that is less dependent on climatic conditions beside rich nutrients, thereby ensuring consistent yields throughout the year. This contributes to enhanced food security and reduces the vulnerability of institutions and communities to climate variability.

2. **Reduce environmental pollution (soil, water, air)**

   The project reduces environmental pollution and associated climate risks by improving waste management practices. By diverting organic and non-biodegradable waste away from open dumping and unmanaged landfills, the project

minimizes soil contamination, water pollution from landfill leachate, and air pollution from waste burning. This directly contributes to healthier ecosystems and reduces the exposure of communities to environmental hazards,

3. **Builds adaptive capacity of communities and institutions**

   The project builds adaptive capacity at both institutional and community levels through awareness, skills development, and participatory engagement. Through structured training, awareness campaigns, and hands-on involvement in waste segregation, composting, recycling, and sustainable agriculture, students, teachers, and community members gain practical knowledge and skills that enhance their ability to respond to environmental and climate challenges.

4. **Supports localized food production systems**

   The project supports localized and self-sufficient food production systems within schools. By producing vegetables and fish through greenhouse, hydroponic, and aquaponic systems, institutions can reduce reliance on external food supply chains, which are increasingly vulnerable to climate-induced disruptions such as extreme weather events, transportation challenges, and market fluctuations. This localized approach enhances food system resilience and ensures a stable supply of nutritious food even under changing climatic conditions.

4.4. Pathway of Change (Outcomes and Causal Linkages)

Using a back-casting approach, the project defines a clear causal pathway from early interventions to long-term transformational impact. The pathway demonstrates how targeted activities lead to systemic changes in waste management, resource use, and climate mitigation and adaptation.

Early Outcomes (Preconditions)	Intermediate Outcome	Ultimate Outcome
The success of the pathway depends on achieving the following enabling conditions: ✔ Awareness and sensitization programs are effectively implemented ✔ Functional waste segregation systems are established at source ✔ Partnerships with private sector are formalized ✔ Infrastructure for composting, recycling, and upcycling is installed and operational.	**1: Improved Waste Management Systems** ✔ Increased waste segregation at source across institutions and communities ✔ Establishment of decentralized composting and recycling systems **2: Increased Resource Recovery and Circular Economy** ✔ Organic waste converted into nutrient-rich compost ✔ Plastics and textiles recycled and upcycled into value-added products ✔ Waste transformed into economic resources. **3: Strengthened Public–Private Partnership (PPP) Engagement**	The project contributes to the following long-term impacts. ✔ Reduced greenhouse gas (GHG) emissions from the waste sector through landfill diversion and resource recovery. ✔ Improved climate resilience of communities and ecosystems through sustainable practices. ✔ Transition toward circular economy systems that promote resource efficiency and sustainability.

	✔ Increased private sector collaboration in waste value chains. ✔ Establishment of market linkages for recycled and upcycled products. **4: Enhanced Climate-Resilient Agriculture** ✔ Application of compost to improve soil health and productivity. ✔ Adoption of greenhouse farming, hydroponics, aquaponics, and agrivoltaics systems. **5: Increased Awareness and Behavioral Change** ✔ Improved waste segregation and management practices at source. ✔ Adoption of sustainable consumption and production behaviors **6: Inclusive Livelihoods Created** ✔ Employment opportunities generated for women and persons with disabilities ✔ Skills development in recycling, upcycling, and sustainable agriculture.	

4.4.1. Activities Linked to Outcomes and Associated Risks

This section outlines the specific activities required to achieve each identified outcome, ensuring that all enabling conditions are met for successful implementation. The design of activities takes into account key barriers such as limited technical capacity, weak waste segregation practices, market constraints, and low private sector engagement. In addition, potential risks are identified and assessed based on their likelihood and impact, along with indicative mitigation measures.

Expected Outcomes	Key Activities	Risks Associated	Mitigation Measures

1. Improved Waste Management Systems	✔ Establish waste segregation systems at source (schools, institutions, communities) with clearly labeled bins and guidelines. ✔ Conduct hands-on training on waste segregation and decentralized waste management practices ✔ Provide training on decentralized composting systems (Takakura method) for organic waste composting. ✔ Set up basic infrastructure for collection, sorting, and storage of recyclables ✔ Develop operational guidelines and monitoring systems for waste management.	Low adoption of waste segregation practices Operational challenges in composting systems (odor, maintenance issues) Limited institutional ownership and accountability	Create awareness campaigns, behavior change incentives, and institutional enforcement mechanisms. Regular technical support, training, and standardized operating procedures. Assign clear roles and responsibilities within institutions and integrate into existing management systems.
2. Increased Resource Recovery and Circular Economy	✔ Establish recycling and upcycling units for plastics (e.g., PET bottles) and textiles Promote arts and crafts initiatives using waste materials (bamboo, paper, textiles, wood) ✔ Train stakeholders in recycling, upcycling, and product development skills ✔ Facilitate collection and aggregation systems for recyclable materials ✔ Support innovation in waste-to-resource product design	Low market demand for recycled/upcycled products Inconsistent supply of segregated waste materials Limited technical skills for upcycling and product development	Product quality improvement, branding, and awareness campaigns to promote eco-friendly products Strengthen segregation systems and ensure steady collection mechanisms Provide continuous capacity building and partner with technical experts
3. Strengthened Public–Private Partnership (PPP) Engagement	✔ Identify and engage private sector partners in waste collection, recycling, and product marketing ✔ Develop PPP frameworks, agreements, and incentive structures	Low private sector interest due to perceived low profitability	Provide financial incentives, risk-sharing mechanisms, and demonstrate viable business models Establish clear governance structures

	✔ Facilitate investment in waste processing and recycling infrastructure ✔ Create linkages between waste generators (schools/communities) and private sector processors ✔ Organize stakeholder platforms for collaboration and coordination	Weak coordination between public and private stakeholders Policy or regulatory constraints	and regular coordination platforms Align project with national policies and engage relevant authorities early
4. Enhanced Climate-Resilient Agriculture	✔ Promote the use of compost in school and community agriculture ✔ Establish greenhouse systems for controlled environment farming ✔ Introduce hydroponics and aquaponics systems for efficient food production ✔ Integrate agrivoltaics (solar energy + agriculture) in pilot sites ✔ Provide technical training on climate-resilient agricultural practices	Limited technical knowledge for system operation and maintenance Climate-related risks such as extreme weather affecting infrastructure	Provide training, technical support, and user-friendly system design. Climate-resilient design and site selection.
5. Increased Awareness and Behavioral Change	✔ Conduct awareness campaigns on waste management, climate change, and circular economy. Integrate waste and sustainability education into school activities. ✔ Organize community engagement programs, demonstrations, and campaigns. ✔ Use behavior change communication strategies (nudges, incentives, peer learning)	Resistance to behavior change and cultural habits Short-term engagement without long-term retention	Use participatory approaches and continuous engagement Institutionalize practices within schools and communities
6. Inclusive Livelihoods Created	✔ Provide skill development programs in recycling, upcycling, composting, and sustainable agriculture ✔ Partner with organizations such as SELWA to support women and persons with disabilities Facilitate small-scale enterprises and income-generating activities	Limited participation of vulnerable groups Market barriers for products	Targeted outreach and inclusive program design Produce quality products and collaborate with private sector. Use online platform to reach wider audience.

	✔ Develop market linkages for products created by vulnerable groups		

4.4.2. Assumptions

The successful implementation and impact of the project depend on a set of key assumptions, which are external conditions necessary for the project to progress from activities to outputs, outcomes, and ultimately long-term impact. The risk–assumption linkage table identifies key external conditions required for success and translates them into potential risks, along with appropriate mitigation measures. Together, these tables demonstrate the project's technical robustness, feasibility, and preparedness to manage uncertainties, ensuring effective delivery of results and long-term sustainability.

Assumption (Positive)	**Risk (Negative Form)**	**Likelihood / Impact**	**Mitigation Measures**
Communities are willing to participate	Low participation in waste segregation	Medium / High	Continuous awareness campaigns, incentives, school-led enforcement
Training is effective	Skills not applied in practice	Medium / Medium	Hands-on training, follow-up mentoring
Infrastructure installed on time	Delays in procurement/installation	Medium / High	Advance planning, phased implementation
Technical expertise available	Poor operation of systems	Medium / Medium	Technical support and capacity building
Private sector willing to engage	Low private sector interest	Medium / High	Incentives, viable business models, PPP frameworks
Waste segregation maintained	Mixed waste reduces efficiency	Medium / High	Monitoring systems and accountability mechanisms
Supply of recyclable waste available	Insufficient material for recycling	Medium / Medium	Strengthen collection systems
Products meet quality standards	Poor quality reduces demand	Medium / High	Standardization and quality control
Consumers accept eco-products	Low demand for recycled products	Medium / High	Branding, awareness, eco-labeling
Policy supports PPP	Regulatory barriers emerge	Low / High	Policy alignment and stakeholder engagement
Agriculture systems function well	System failure or misuse	Medium / Medium	Training and technical support
Awareness leads to behavior change	Temporary or no behavior change	Medium / High	Long-term engagement strategies
Vulnerable groups participate	Low inclusion of target groups	Low / Medium	Targeted outreach and inclusive design

Market demand exists	Products remain unsold	Medium / High	Market linkages and diversification
No major disasters occur	Climate events disrupt project	Low / High	Climate-resilient infrastructure design
Funding is timely	Delayed funding affects progress	Medium / High	Financial planning and buffer mechanisms
Strong stakeholder coordination	Poor coordination among actors	Medium / Medium	Governance structures and coordination platforms

4.5 Alignment of the Project with GCF Investment Criteria

4.5.1 Paradigm Shift Potential

The project demonstrates a strong potential to deliver a paradigm shift by fundamentally transforming Bhutan's waste management system from a conventional linear model **"take–make–dispose"** into a circular, resource-efficient, and climate-resilient system. This transformation is not limited to isolated interventions, but promotes systemic change across the entire waste value chain.

By integrating composting, recycling, upcycling, and climate-resilient agricultural practices, the project addresses both mitigation and adaptation objectives. Organic waste is diverted from landfills and converted into compost, significantly reducing methane emissions which is a major greenhouse gas while improving soil health and agricultural productivity. At the same time, recycling and upcycling activities reduce resource extraction and energy use, contributing to a low-carbon economy while generating green livelihood opportunities.

The introduction of a **Public–Private Partnership (PPP) model** further strengthens the transformational nature of the project by institutionalizing private sector engagement in waste management. This approach:

- Enhances efficiency and innovation through private sector expertise
- Mobilizes additional financial and technical resources through collaboration with the private sectors
- Establishes sustainable business models that ensure long-term viability beyond project support

Importantly, the project is designed to be replicable and scalable across other dzongkhags, creating a nationwide model for integrated waste management based on interest. By demonstrating a successful circular economy framework, the project contributes to Bhutan's transition toward a low-emission, climate-resilient development pathway aligned with national priorities and global climate commitments.

4.5.2. Grant-Equivalent Financing and Transparency

The project adopts a structured and transparent financing approach that enables GCF funding to be clearly accounted for in grant-equivalent terms and compared across different financial instruments.

GCF resources will be strategically utilized for **public-good components** such as infrastructure development, institutional strengthening, and capacity building, while leveraging additional contributions from the private sector such as revenue generated from selling of products to reallocate for incentivizing or more maintenance and operational purposes.

This combination ensures that financial resources are used efficiently and directed toward activities that generate the highest climate and socio-economic returns.

The PPP framework strengthens financial governance and accountability by:

- Clearly defining the roles and responsibilities of public institutions and private entities
- Establishing mechanisms for monitoring financial flows, outputs, and outcomes
- Ensuring transparency in procurement, implementation, and reporting processes

Furthermore, the project incorporates robust monitoring and evaluation systems to track measurable climate impacts (e.g., emission reductions) as well as socio-economic benefits (e.g., job creation, income generation). This ensures alignment with international best practices and GCF standards for transparency and accountability.

4.5.3. Minimum Concessionality

The project follows the GCF principle of **minimum concessionality,** meaning it only asks for the support needed to make the project viable. GCF funding will mainly support initial investments and important activities that private investors are less likely to fund including:

- Development of waste management infrastructure (segregation systems, composting facilities, recycling units)
- Capacity building and technical training for communities, institutions, and enterprises
- Awareness campaigns to promote behavioral change and waste segregation practices

At the same time, the project incorporates several **revenue-generating components** that will gradually enhance financial sustainability and reduce reliance on concessional finance. These include:

- Sale of compost and organic agricultural inputs
- Production and marketing of upcycled textile and craft products
- Establishment of market-driven recycling systems

As these revenue streams mature, they will improve cost recovery and attract further private investment, thereby minimizing the long-term need for concessional support.

iv. Blended Finance and Leveraging Additional Resources

The project actively promotes **blended finance** by combining GCF funding with **private sector investment and other institutional resources** through the PPP model.

Private sector partners will play a critical role by contributing:

- Advanced technologies and machinery for waste processing and recycling
- Capital investment in infrastructure and operational systems which are difficult in school settings.
- Market access and commercialization channels for recycled and upcycled products

This blended financing structure not only increases the total volume of investment available for the project, but also enhances overall efficiency and innovation. By reducing risks and improving returns, GCF funding acts as a catalyst to mobilize additional capital, thereby amplifying the project's scale and impact. The approach ensures that concessional finance is used strategically to leverage larger flows of public and private investment, in line with GCF's objective of maximizing impact over capital invested.

4.5.4. Avoidance of Crowding Out (Ensuring Investment Additionality)

The project is carefully designed to **ensure investment additionality and avoid the displacement of existing or potential public and private investments**.

Rather than replacing existing actors, the project complements and strengthens them by:

- Fostering collaboration between local communities and private enterprises
- Creating new business opportunities in recycling, composting, and green product development
- Strengthening value chains for waste-derived products through improved infrastructure and market access

By addressing key market barriers such as inadequate infrastructure, limited technical capacity, and low private sector participation the project creates an enabling environment for investment. This encourages new entrants and stimulates innovation in the waste management sector.

As a result, GCF funding acts as a catalyst for additional investment, rather than substituting for it, ensuring a sustainable and competitive market ecosystem.

4.5.5. Financial Soundness of Revenue-Generating Activities

All revenue-generating components of the project are designed to be **financially viable, market-oriented, and scalable**.

Key revenue streams include:

- Production and sale of compost and surplus agricultural products to support sustainable agriculture (operation and maintenance).
- Producing and marketing of upcycled textile and eco-friendly products
- Collaborate with private sector and of generate income from selling of raw materials (waste) and upcycled products.

The project enhances financial viability through:

- Establishment of strong market linkages and branding strategies to increase product demand
- Implementation of quality control and standardization measures to ensure competitiveness
- Strategic partnerships with private sector actors for efficient marketing, distribution, and scaling

These measures ensure that business models developed under the project are **economically sustainable and environmentally friendly.** By ensuring that all revenue-generating activities are intrinsically sound, the project aligns with GCF requirements and contributes to long-term financial independence and resilience. The project demonstrates strong alignment with all six GCF investment criteria by delivering a **transformational, financially sustainable, and scalable intervention**. It effectively integrates climate mitigation, adaptation, and socio-economic development while leveraging private sector participation and ensuring efficient use of concessional finance.

6. Justification for Green Climate Fund (GCF) Funding Request

This section provides the justification for seeking support from the Green Climate Fund (GCF) to implement a project which is a climate-resilient waste management transformation in Bhutan. While the country has established a robust policy and regulatory framework, significant systemic barriers continue to hinder effective implementation at scale. These include market uncertainty, limited financial instruments, weak public-private sector collaboration, and a persistent gap between policy commitments and on the ground implementation.

GCF support is therefore critical to address these constraints by providing catalytic and concessional financing that can unlock large-scale investments, enable public–private partnerships, and drive a transition toward a circular economy. The proposed intervention is designed to deliver transformational impact by scaling integrated waste management systems across the country, reducing greenhouse gas emissions, and strengthening climate resilience, while establishing an enabling environment that facilitates and progressively attract private sector participation over time.

6.1 Absence of Funding Alternatives

Despite Bhutan's strong policy framework on waste management, there is a **significant financing and implementation gap at the national level**. Waste management systems, particularly those aligned with circular economy and climate objectives are not yet commercially viable nor adequately financed through existing sources.

Key barriers include:

- **Systemic market failure**: Waste management, especially decentralized composting, recycling, and upcycling, generates high public environmental benefits (methane reduction, climate resilience) but low private financial returns, discouraging the investment.
- **High upfront investment needs**: Nationwide infrastructure for segregation, composting, recycling, and resource recovery requires substantial capital, which exceeds available public budgets.
- **Limited domestic financing instruments**: Existing initiatives in Bhutan demonstrate growing efforts toward a circular economy transition, supported by partners such as the United Nations Development Program and donor-funded projects. However, these remain small-scale, grant-dependent, and fragmented, reflecting the absence of sustained financing mechanisms. Limited national capacity to access green finance further constrains expansion, underscoring the need for catalytic support from the Green Climate Fund.
- **Underdeveloped private sector market**: Waste-to-resource business models are still emerging in Bhutan, facing high perceived risks, underdeveloped value chains, and uncertain demand for recycled products. These factors limit private sector engagement and constrain investment in circular economy initiatives, making it difficult to scale operations or achieve nationwide impact without targeted support and catalytic financing.

- **Public funding constraints**: Government resources are limited and prioritized toward core sectors such as health, education, and infrastructure, leaving insufficient allocation for large-scale waste system transformation.

Available public and private financing is limited and insufficient to enable a nationwide, climate-resilient waste management transition, making catalytic support from the Green Climate Fund essential. Therefore, support from the Green Climate Fund is critical to bridge this gap and enable transformational change.

6.2 Adequacy of Financial Instruments

The proposed grant-based financing is fully aligned with the project's national-scale objectives and addresses the key barriers to a climate-resilient waste management transition. Private sector actors can collaborate through a Public–Private Partnership (PPP) model, providing technical expertise and operational support, but are unable to provide direct funding. The GCF grant is therefore essential to bridge the financing gap, de-risk the PPP approach, and enable transformational, system-wide interventions. This structure ensures that financial resources are adequate, targeted, and catalytic, maximizing both climate impact and private sector engagement.
At the national level, a significant portion of project activities are non-revenue-generating but critical for system transformation, including:

- Nationwide awareness campaigns and behavioral change initiatives
- Capacity building of the stakeholders and communities.
- Establishment of enabling infrastructure and systems

Given that these components cannot generate sufficient financial returns, government and private sector actors are unable to provide direct funding. Instead, private sector engagement will occur through **technical collaboration, and service delivery**, leveraging their expertise without direct financial contribution. The grant from the Green Climate Fund is therefore essential to enable these transformative activities at scale.

6.3 Long-Term Financial Sustainability of the Project

The GCF funding is critical for the initial establishment and startup phase of the project, providing the necessary financial support to set up infrastructure, procure materials, and implement foundational activities. Once operational, the project is designed to generate its own income streams, which will be reinvested to cover ongoing operation and maintenance costs, ensuring long-term financial sustainability without further reliance on external funding.

At the project is designed to become financially sustainable through:

- **Development of waste-based value chains** (compost, recycled materials, upcycled products)
- **Private sector participation through PPP models**, ensuring operational efficiency
- **Cost recovery mechanisms** (e.g., service fees, product sales)
- **Reduced public expenditure** on landfill management and waste disposal.

6.4 Exit Strategy

6.4.1 Internal Sustainability

To ensure the long-term continuity of the project beyond GCF support, internal sustainability will be achieved through several key measures:

- **Institutionalization of Waste Management Systems:** The project will embed waste management practices and protocols within existing national and local governance frameworks, ensuring that responsibilities, standards, and monitoring mechanisms are formally recognized and enforced by relevant authorities.

- **Capacity Building of Stakeholders:** Technical, managerial, and operational capacities of stakeholders, including schools and community groups, will be strengthened through collaboration with private entities via targeted training programs, knowledge transfer, and hands-on mentorship. This approach ensures that stakeholders can independently manage waste systems and effectively address operational challenges.
- **Established Infrastructure and Systems:** Durable waste processing facilities, collection networks, and resource recovery systems will be put in place, along with operational guidelines, maintenance plans, and monitoring frameworks. This foundation allows ongoing functionality without continuous external funding.

6.4.2 External Sustainability (Scaling and Replication)

To maximize the impact and replication potential of the project, external sustainability measures will focus on expansion and integration:

- **Replication of PPP-Based Models:** The public–private partnership (PPP) approach piloted in initial locations will be documented, standardized, and scaled across all dzongkhags, enabling other districts to adopt similar sustainable waste management practices with minimal startup risk.
- **Expansion of Markets for Recycled and Upcycled Products:** By developing and formalizing supply chains for recycled, composted, and upcycled materials, the project will stimulate demand, foster entrepreneurship, and create income-generating opportunities that reinforce the financial viability of waste management operations.
- **Integration into National Policies and Development Plans:** Successful approaches, guidelines, and lessons learned will be integrated into national strategies, policy frameworks, and long-term development plans. This ensures that waste management improvements become a core component of Bhutan's sustainable development trajectory, facilitating ongoing support, regulatory reinforcement, and scaling potential.

Through this combination of institutional, technical, and market-oriented strategies, the project is designed to sustain its environmental, social, and financial impacts well beyond the initial GCF investment.

7 Environmental and Social Safeguards (ESS) and Gender Integration

The proposed project will adhere to the Green Climate Fund's (GCF) Environmental and Social Safeguards (ESS), which form part of the broader Environmental and Social Management System (ESMS). The ESS ensures that social and environmental considerations are fully integrated into project design, decision-making, and operations. The ESS framework is based on the International Finance Corporation's (IFC) eight Performance Standards (PS1–PS8), including one overarching standard on assessment and management of environmental and social risks (PS1), and seven standards addressing specific issues such as labor conditions (PS2), resource efficiency and pollution prevention (PS3), community health and safety (PS4), land acquisition and resettlement (PS5), biodiversity conservation (PS6), indigenous peoples (PS7), and cultural heritage (PS8).

Assessment and Management of Environmental and Social Risks (PS1)

The project will conduct comprehensive environmental and social risk assessments prior to implementation. Risks associated with waste handling, composting, recycling, and upcycling activities will be identified, and mitigation measures integrated into project design. Operational protocols, monitoring systems, and accountability mechanisms will ensure that environmental and social safeguards are implemented effectively at all project stages.

Labor and Working Conditions (PS2)

The project will prioritize safe and equitable working conditions for all participants, including students, school staff, community members, and persons with disabilities engaged through SELWA. Occupational health and safety measures will be applied in waste handling, composting, hydroponic, aquaponic, and recycling operations. Training, protective equipment, and structured supervision will minimize hazards and promote safe work practices.

Resource Efficiency and Pollution Prevention (PS3)

Through circular economy principles, the project minimizes waste generation, prevents environmental pollution, and optimizes resource use. Organic waste is composted on-site using the Takakura method, while textiles, PET bottles, and cement bags are processed into reusable products. Energy efficiency measures, including greenhouse-integrated solar systems (agrivoltaics), reduce dependence on conventional electricity, while proper handling of chemical inputs ensures minimal environmental impact.

Community Health, Safety, and Security (PS4)

By establishing safe collection points, segregated waste streams, and hygienic composting practices, the project mitigates risks to community health. Awareness campaigns in schools and communities will educate participants about the hazards of unmanaged waste, reducing exposure to pollutants, vectors, and methane emissions. Safety protocols for equipment and operational areas will protect students, staff, and workers.

Land Acquisition and Involuntary Resettlement (PS5)

The project does not involve land acquisition or resettlement. All activities will be implemented within existing institutional spaces, ensuring no displacement or disruption of communities.

Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6)

By promoting organic composting and climate-smart agricultural practices, the project enhances soil fertility, conserves local biodiversity, and avoids harmful agrochemical inputs by eliminating the use of chemical fertilizers. Sustainable agricultural systems, including hydroponics, aquaponics, and greenhouse cultivation, minimize ecological disturbance and support environmental resilience.

Indigenous Peoples (PS7) and Cultural Heritage (PS8)

The project is designed to respect Bhutanese cultural practices and the rights of local communities. Educational and institutional programs will integrate traditional knowledge especially in the project concept 3 where waste materials are made into traditional masks and religious statue from paper mache arts that promote awareness of local environmental and cultural heritage. Engagement with stakeholders ensures inclusive decision-making while safeguarding cultural values.

8 Gender Policy and Integration

Gender equality is central to project design, implementation, and monitoring. The project aligns with GCF's Gender Policy and Gender Action Plan to promote equitable participation, access, and benefits. Key measures include:

- **Inclusive Participation:** Women, youth, and persons with disabilities will actively participate in composting, recycling, upcycling, and agricultural activities. The collaboration with SELWA ensures accessible roles for persons with disabilities in skill-based tasks such as textile upcycling, packaging, and product finishing.
- **Capacity Building:** Technical and operational capacities of schools, community groups, and stakeholders will be strengthened through training, knowledge transfer, and hands-on training in collaboration with private sector partners. This empowers participants to independently manage waste systems and adopt climate-resilient practices.
- **Equitable Access to Benefits:** Income generated from sale of surplus compost, agricultural produce, and upcycled products will benefit the stakeholders from institutions and communities, ensuring fair distribution and reinforcement of economic opportunities for women and marginalized groups.
- **Gender-Sensitive Monitoring:** Project indicators will track gender-disaggregated participation, access to training, livelihood opportunities, and decision-making roles. Awareness campaigns and behavioral change programs will address gender-related barriers to participation in waste management and circular economy practices.

Through adherence to GCF ESS and gender policies, the project ensures that environmental, social, and gender considerations are systematically addressed, risks are minimized, and positive impacts maximized. By integrating these safeguards with inclusive, capacity-building, and participatory approaches, the project promotes environmentally sustainable,

socially equitable, and economically empowering outcomes, while contributing to Bhutan's national climate priorities and commitments under its NDCs.

9. GCF Financing Rationale, Economic Analysis and Investment Assessment

9.1 Executive Summary

This chapter presents the proposed financing requirement, economic justification, investment cost structure, expenditure assumptions, expected benefits, and financial and economic indicators for the proposed Improved Waste Management System through Public-Private Partnership Model.

The project covers 50 school and institutional locations, each serving approximately 200 students, and establishes two centralized facilities at SELWA Center: a polyester textile production facility from recycled waste and a waste display, interactive center and sales counter. The total project cost is estimated at Nu. 638.60 million. The proposed GCF grant request is Nu. 575.00 million, representing 90% of total cost, with Nu. 63.60 million, or 10%, as co-financing.

Financing Source	Amount (Nu.)	Share
GCF grant financing	575,000,000	90%
Co-financing from government, RSPN, SELWA, schools, communities and private partners	63,600,000	10%
Total project cost	638,600,000	100%

The economic analysis shows that the project is not financially attractive as a purely commercial investment. The project has a long payback period, low annual return, negative NPV, and a benefit-cost ratio below 1.0 when measured only through direct financial income. However, the project generates strong public-good benefits, including methane reduction, reduced landfill pressure, circular economy development, improved school nutrition, youth education, inclusive employment for persons with disabilities, and institutional capacity building.

9.2 Funding Request and Financing Rationale

The project requires substantial upfront investment in decentralized school-level waste management, composting, greenhouse agriculture, hydroponics, aquaponics, agrivoltaics, awareness and capacity building. These activities generate strong climate and social benefits but limited direct financial return. Therefore, grant financing is required to overcome market failure and enable implementation at meaningful scale.

Sl.	Component	Proposed GCF Allocation (Nu.)	Share of GCF Request
1	School-level circular waste management and climate-smart agriculture pilots in 50 locations	450,000,000	78.3%
2	School-level training, awareness, eco-clubs, IEC and behavior change	40,000,000	7.0%
3	SELWA polyester textile recycling facility	70,000,000	12.2%
4	SELWA waste display, interactive center and sales counter	10,000,000	1.7%
5	Project management, safeguards, gender, M&E, audit, reporting and knowledge products	5,000,000	0.9%
	Total GCF request	575,000,000	100%

9.3 Details of the Economic Analysis Carried Out

The economic analysis was carried out to assess whether the proposed investment is financially viable, economically justified, and suitable for GCF support. The analysis considered capital investment, annual operating costs, expected annual income, in-kind benefits, and economic value generated by the project. Costs and revenue assumptions were anchored in the pre-feasibility study and adapted to the final project design.

The analysis separated school-level public-good benefits from the revenue-generating SELWA Center activities. School-level benefits include both cash income and in-kind savings from vegetables, fish, compost, reusable bags, crafts, recyclables and eco-events. The SELWA Center activities include commercial revenue from polyester textile production, upcycled products, workshops, sponsorships and display/sales activities.

Economic Parameter	**Result**
Total capital investment	Nu. 512,600,000
Annual gross benefits / income value	Nu. 218,160,000
Annual operating cost	Nu. 205,440,000
Annual net economic benefit	Nu. 12,720,000
Simple payback period	40.3 years
Annual ROI	2.5%
NPV at 8%, 20 years	Nu. -385,186,264
IRR, 20 years	-5.3%
Benefit-cost ratio	0.85x

9.4 Investment Cost Estimates

The total project cost is estimated at Nu. 638.60 million. This includes school-level capital investment and operating costs for 50 locations, as well as centralized SELWA Center investments for polyester textile production and the waste display, interactive center and sales counter.

Sl.	**Budget Component**	**Unit Cost (Nu.)**	**Quantity / Locations**	**Total Cost (Nu.)**
1	Initial capital investment for school/location-level pilot activities	7,800,000	50	390,000,000
2	First-year operating cost for school/location-level activities	2,520,000	50	126,000,000
3	Polyester textile production from recycled waste at SELWA Center	111,000,000	1	111,000,000
4	Waste display, interactive center and sales counter at SELWA Center	11,600,000	1	11,600,000
	Total project cost			638,600,000

9.5 Expenses Considered

The expenses considered include capital costs for awareness materials, training, waste segregation systems, Takakura composting units, greenhouse infrastructure, hydroponic systems, aquaponic systems, agrivoltaics, sustainable packaging units, arts and craft demonstration units, monitoring tools, product handling, market linkage and contingency. Operating expenses include coordinator allowances, support staff, seeds, seedlings, nutrients,

fish feed, compost starter replenishment, utilities, maintenance, transport, awareness activities, packaging and miscellaneous costs.

9.6 Benefits Considered

The annual income and savings from one school are estimated at Nu. 1.26 million. For 50 schools, the annual school-level benefit is estimated at Nu. 63.00 million. The SELWA polyester textile facility is estimated to generate annual gross revenue of Nu. 147.00 million and annual net income of Nu. 61.80 million. The SELWA waste display, interactive center and sales counter is estimated to generate annual gross revenue of Nu. 8.16 million and annual net income of Nu. 3.12 million.

Project Component	Annual Gross Income / Value (Nu.)	Annual Net Income / Value (Nu.)
50 school locations	63,000,000	63,000,000 economic value, including savings
SELWA polyester textile production facility	147,000,000	61,800,000
SELWA waste display, interactive center and sales counter	8,160,000	3,120,000
Total	218,160,000	127,920,000

9.7 Conclusion

The analysis confirms that the project has a strong case for GCF grant financing. The direct financial indicators are weak because the project is designed to deliver climate, environmental, education, nutrition, and inclusion benefits that are not fully monetized. The proposed 90:10 financing structure reflects the public-good nature of the project while demonstrating national ownership, institutional participation and private sector engagement.

Annexure 9: Economic Analysis, Cost Estimates and Benefits

Annex Table 9.1: Economic Analysis Summary

Sl.	Parameter	Value
1	Total capital investment	Nu. 512,600,000
2	Total first-year project cost including school operating cost	Nu. 638,600,000
3	Annual gross benefits / income value	Nu. 218,160,000
4	Annual operating cost	Nu. 205,440,000
5	Annual net economic benefit	Nu. 12,720,000
6	Simple payback period	40.3 years
7	Annual ROI	2.5%
8	NPV at 8%, 20 years	Nu. -385,186,264
9	IRR, 20 years	-5.3%
10	Benefit-cost ratio	0.85x

Annex Table 9.2: Proposed Co-Financing Allocation

Sl.	Co-financing Source / Type	Amount (Nu.)	Possible Form
1	RGoB / MoESD / local governments	15,000,000	School space, coordination, staff time
2	RSPN	5,000,000	Technical support, coordination, reporting

3	SELWA	8,600,000	Center space, staff, inclusion support
4	Private sector / recycling partners	25,000,000	Machinery support, buy-back arrangements, logistics
5	Schools and communities	10,000,000	In-kind labour, eco-club time, local materials
	Total co-financing	63,600,000	

Annex Table 9.3: Capital Investment per School / Location

Sl.	Component	Cost per Location (Nu.)	Total for 50 Locations (Nu.)
1	Awareness and IEC materials	100,000	5,000,000
2	Training and capacity building	400,000	20,000,000
3	Waste segregation and collection system	200,000	10,000,000
4	Takakura composting unit	300,000	15,000,000
5	Greenhouse infrastructure	3,000,000	150,000,000
6	Hydroponic system	600,000	30,000,000
7	Aquaponic system	600,000	30,000,000
8	Agrivoltaics / solar integration	1,000,000	50,000,000
9	Sustainable packaging unit	300,000	15,000,000
10	Arts and craft demonstration unit	300,000	15,000,000
11	Monitoring and documentation	200,000	10,000,000
12	Product handling and market linkage	300,000	15,000,000
13	Miscellaneous and contingency	500,000	25,000,000
	Total capital investment	7,800,000	390,000,000

Annex Table 9.4: First-Year Operating Cost per School / Location

Sl.	Operating Cost Item	Cost per Location (Nu.)	Total for 50 Locations (Nu.)
1	Part-time school project coordinator / focal teacher allowance	360,000	18,000,000
2	Support staff / caretaker allowance	240,000	12,000,000
3	Seeds, seedlings, nutrients, fish feed, compost starter replenishment	240,000	12,000,000
4	Utilities and solar system maintenance	360,000	18,000,000
5	Maintenance of greenhouse, hydroponics, aquaponics and tools	240,000	12,000,000
6	Transport and local market linkage	240,000	12,000,000
7	Continued awareness and outreach	360,000	18,000,000
8	Packaging and labels	240,000	12,000,000

9	Miscellaneous operating cost	240,000	12,000,000
	Total first-year operating cost	2,520,000	126,000,000

Annex Table 9.5: Annual Income and Savings per School / Location

Sl.	Income / Benefit Stream	Monthly Estimate (Nu.)	Annual Estimate (Nu.)	Type
1	Vegetables from greenhouse and hydroponics used in school meals	30,000	360,000	Savings / in-kind value
2	Surplus vegetable sales	20,000	240,000	Cash income
3	Fish from aquaponics used in school meals	10,000	120,000	Savings / in-kind value
4	Surplus fish sales	5,000	60,000	Cash income
5	Compost used in school greenhouse/garden	6,000	72,000	Savings / in-kind value
6	Surplus compost sales	4,000	48,000	Cash income
7	Reusable textile bags from discarded clothes	10,000	120,000	Cash income
8	Arts and crafts from paper, bamboo, wood and waste materials	10,000	120,000	Cash income
9	Sale of segregated recyclables to private partners	5,000	60,000	Cash income
10	School eco-events, demonstrations and small training fees	5,000	60,000	Cash income
	Total per school/location	105,000	1,260,000	

Annex Table 9.6: SELWA Polyester Textile Facility Income Estimate

Sl.	Product / Revenue Stream	Monthly Revenue (Nu.)	Annual Revenue (Nu.)
1	Uniforms	4,000,000	48,000,000
2	Sportswear and fashion apparel	4,500,000	54,000,000
3	Home textiles	3,750,000	45,000,000
	Total gross revenue	12,250,000	147,000,000

Annex Table 9.7: Net Income Estimate for SELWA Textile Facility

Item	Monthly (Nu.)	Annual (Nu.)
Gross revenue	12,250,000	147,000,000
Operating cost	6,200,000	74,400,000
Gross operating surplus	6,050,000	72,600,000
Less tax/depreciation allowance	900,000	10,800,000
Estimated net income	5,150,000	61,800,000

Annex Table 9.8: SELWA Waste Display, Interactive Center and Sales Counter Income Estimate

Sl.	Revenue Stream	Monthly Revenue (Nu.)	Annual Revenue (Nu.)
1	Sales of upcycled products	500,000	6,000,000
2	Workshop and training fees	100,000	1,200,000
3	Grants and government support	50,000	600,000
4	Sponsorships / corporate partnerships	30,000	360,000
	Total gross revenue	680,000	8,160,000

10. Greenhouse Gas Emission Reduction Estimate

10.1 Executive Summary

This chapter presents a screening-level estimate of greenhouse gas emission reduction expected from the proposed project activities. The estimate covers 50 school/institutional locations and the centralized SELWA Center facilities. The calculation is intended for concept-note level assessment and will require refinement during full proposal preparation using site-specific waste audits, actual quantities of organic waste, PET and textile processing volumes, energy generation data, and approved GHG accounting methodologies.

The project is estimated to reduce approximately 899 tCO2e per year under the base case. Over a 20-year project life, this equals approximately 17,980 tCO2e, rounded to 18,000 tCO2e. The largest reduction is expected from the diversion of organic waste from landfills through composting, followed by PET and textile recycling, school-level recyclable recovery, local food production, upcycling, and agrivoltaics.

Scenario	Annual Reduction (tCO2e/year)	20-Year Reduction (tCO2e)
Conservative case	650	13,000
Base case	899	17,980
Higher case	1,300	26,000

10.2 Scope of the Estimate

The estimate covers the main mitigation pathways created by the project: decentralized composting of organic waste, recycling of PET into polyester textile products, transfer and recycling of segregated materials, upcycling of textiles, paper, bamboo, wood and other waste materials, local vegetable and fish production, and small-scale renewable energy generation through agrivoltaics.

The calculation does not include all possible lifecycle benefits. It excludes avoided emissions from reduced landfill expansion, broader household behavior change, long-term market transformation, and upstream emissions avoided through wider circular economy adoption beyond the 50 participating schools. Therefore, the estimate should be considered conservative at concept-note stage.

10.3 Methodology

The GHG estimate applies activity-based calculation. For each project activity, the quantity of waste diverted, material recycled, product substituted, or energy generated is multiplied by an indicative emission reduction factor. The approach follows the logic of waste-sector lifecycle accounting and material management comparisons, similar to the U.S. EPA Waste Reduction Model (WARM), which provides high-level estimates of potential GHG emissions, energy savings and economic impacts for materials managed through source reduction, recycling, composting, anaerobic digestion, combustion and landfilling (U.S. EPA, 2025).

For PET recycling, the calculation uses lifecycle evidence from the Association of Plastic Recyclers, which compares post-consumer recycled plastic pellets with virgin plastic pellets and finds that recycled plastic is generally less energy intensive and has lower environmental burden than virgin plastic production (APR, 2020).

10.4 Emission Reduction Pathways

The project reduces emissions through seven main pathways. The most significant is the diversion of organic waste from landfill disposal through Takakura composting and use of compost in school greenhouse systems. Additional reductions are generated through PET and textile recycling, sale and transfer of segregated recyclables, production of reusable textile bags, arts and crafts from waste materials, local food production in schools, and solar energy integration for greenhouse operations.

Sl.	Activity	Basis of Calculation	Estimated Annual Reduction (tCO2e/year)
1	Organic waste composting in 50 schools	900 tonnes organic waste/year x 0.60 tCO2e/tonne	540
2	Recycling of PET into polyester textiles at SELWA Center	75 tonnes/year x 1.32 tCO2e/tonne	99
3	School-level sale and transfer of segregated recyclables	Mixed recyclables diverted from landfill and sent to private recyclers	75
4	Reusable textile bags and textile upcycling	Avoided textile disposal and partial replacement of new bags/products	25
5	Arts and crafts from waste materials	Avoided paper, bamboo, wood and small material disposal/replacement	20
6	Local vegetable and fish production in schools	Reduced external procurement, transport, storage and food loss	120
7	Agrivoltaics / solar energy for greenhouse operations	Solar energy replacing grid/imported/backup energy use	20
	Total estimated annual GHG reduction		899

10.5 Results and Interpretation

The estimated annual GHG emission reduction is approximately 899 tCO2e per year. Organic waste composting accounts for approximately 60.1% of the total estimated annual reduction. PET/polyester recycling and other recyclables account for about 19.4%, local food production accounts for about 13.3%, textile upcycling and arts/crafts account for about 5.0%, and agrivoltaics accounts for about 2.2%.

Activity Category	Annual Reduction (tCO2e/year)	Share
Organic waste composting	540	60.1%
PET/polyester recycling and recyclables	174	19.4%
Local food production	120	13.3%
Textile upcycling and arts/crafts	45	5.0%
Agrivoltaics / solar energy	20	2.2%
Total	899	100%

10.6 Monitoring Requirements

The estimate should be refined during implementation using measured data. Monitoring should include organic waste collected and composted per school, compost produced and used, quantity of PET and textiles collected, quantity of recycled polyester produced, quantity of reusable bags and upcycled products produced, amount of vegetables and fish produced and consumed, quantity of surplus products sold, solar electricity generated, and actual operating data from SELWA Center.

10.7 Conclusion

The project is expected to achieve meaningful emission reductions while also creating climate education, circular economy, school nutrition, and inclusive livelihood benefits. The base-case estimate of approximately 899 tCO2e per year is conservative and reflects only the main quantifiable pathways. Further refinement through project preparation and implementation monitoring is required for final GCF reporting.

Annexure 10: Assumptions, Calculations and Source Matrix for GHG Estimate

Annex Table 10.1: Key Assumptions Used for GHG Estimate

Sl.	Parameter	Assumption Used	Source / Justification
1	Number of locations	50 schools/institutional locations	Project investment design and economic analysis chapter
2	Students per location	200 students	Project investment design and school pilot cost assumption
3	Total students covered	10,000 students	50 locations x 200 students/location
4	Organic waste composted per school	18 tonnes/year	Concept-stage assumption based on school dining/hostel organic waste generation and composting activity design
5	Total organic waste composted	900 tonnes/year	50 schools x 18 tonnes/year
6	Avoided landfill methane and compost benefit	0.60 tCO2e/tonne organic waste	Concept-stage factor derived from WARM-style landfill diversion and composting comparison; to be validated using approved GHG methodology during proposal preparation
7	Recycled polyester production input	75 tonnes/year	Concept-stage operating assumption for SELWA recycled polyester facility
8	PET recycling emission saving	1.32 tCO2e/tonne PET	Derived from lifecycle comparison of virgin and recycled PET; APR (2020)
9	Local vegetables and fish replacing external procurement	120 tCO2e/year	Conservative screening estimate based on school production and reduced external procurement
10	Agrivoltaics / solar energy	20 tCO2e/year	Small-scale greenhouse solar integration screening estimate; to be refined using actual PV capacity and generation
11	Project life	20 years	Common concept-stage economic and mitigation assessment period

Annex Table 10.2: Annual GHG Emission Reduction Calculation

Sl.	Activity	Annual Reduction (tCO2e/year)	Source / Basis
1	Organic waste composting in 50 schools	540	900 tonnes/year x 0.60 tCO2e/tonne
2	PET/polyester recycling at SELWA Center	99	75 tonnes/year x 1.32 tCO2e/tonne
3	School-level segregated recyclables	75	Concept-stage mixed recyclable diversion estimate
4	Reusable textile bags and textile upcycling	25	Avoided product/material replacement estimate
5	Arts and crafts from waste materials	20	Avoided waste disposal and material replacement estimate
6	Local vegetable and fish production	120	Reduced external procurement and food loss estimate
7	Agrivoltaics / solar energy	20	Small-scale renewable energy generation estimate

	Total	899	

Annex Table 10.3: Scenario Range

Scenario	Assumption	Annual Reduction (tCO2e/year)	20-Year Reduction (tCO2e)
Conservative case	Lower organic waste collection, lower SELWA facility utilization, and lower market replacement effects	650	13,000
Base case	Expected implementation across 50 locations and SELWA Center	899	17,980
Higher case	Higher organic waste generation, higher PET/textile throughput and additional community collection	1,300	26,000

Annex Table 10.4: Source Matrix

Source	Data / Assumption Supported	Use in GHG Estimate
Draft Concept Note, 5 April 2026	Project activities including composting, greenhouse, hydroponics, aquaponics, agrivoltaics, recycling, upcycling, awareness and SELWA engagement	Defines mitigation activities and implementation scope
Pre-Feasibility Study on Improved Waste Management, 27 March 2025	Business models, cost and income benchmarks, polyester textile production and waste interactive center assumptions	Supports project design, investment and income assumptions
U.S. Environmental Protection Agency, Waste Reduction Model (WARM), 2025	WARM provides high-level estimates of GHG emissions, energy savings and economic impacts across recycling, composting, anaerobic digestion, combustion and landfilling	Supports use of waste diversion and composting comparison approach
Association of Plastic Recyclers / Franklin Associates, 2020	Lifecycle comparison of recycled plastic pellets and virgin plastic pellets; recycled plastics generally require less energy and have lower environmental burden	Supports PET recycling emission saving factor
Project economic analysis	50 locations, 200 students per location, income and production assumptions	Supports scale and project coverage assumptions

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