BHUCAT

Bhutan Soil and Water Conservation Approaches and Technologies

A Compilation of Selected Sustainable Land Management (SLM) Best Practices Promoted on Steep to Very Steep Slopes of Bhutan

National Soil Services Centre

College of Natural Resources

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United Nations Convention to Combat Desertification

WOCAT World Overview of Conservation Approaches and Technologies

UNIVERSITY OF BERN CDE CENTRE FOR DEVELOPMENT AND ENVIRONMENT

National Soil Services Centre

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A Compilation of Selected Sustainable Land Management (SLM) Best Practices Promoted on Steep to Very Steep Slopes of Bhutan

2025

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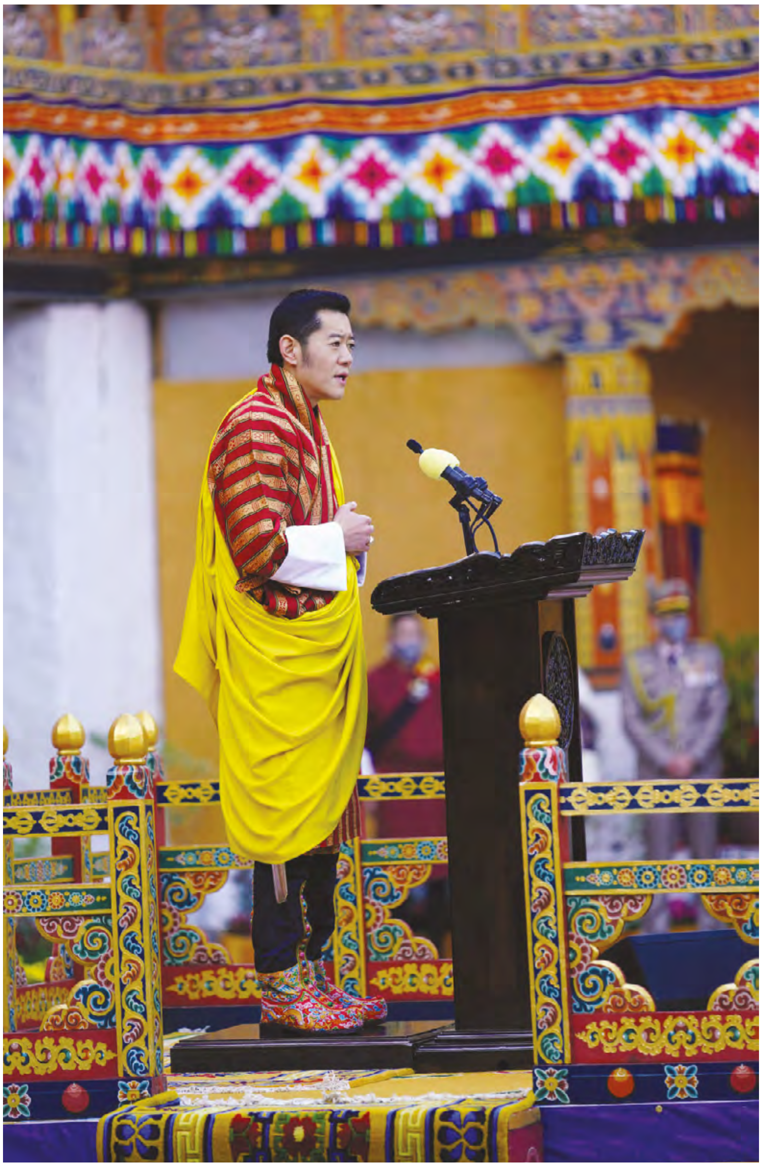
Cover photo: Dryland terracing following landscape approach at Namlaythang, Tsangkha gewog (Block) under Dagana Dzongkhag (District).

Table of contents



"Bhutan's difficult terrain means that only 7 percent or 664,000 acres of our total land is usable. Many of our people continue to depend directly on land for their livelihood. In addition, land is traditionally considered a precious inheritance to be bestowed to our children. We must do everything to ensure that our limited land is of greatest benefit to the people and their children. Land must bring social, economic, and political strength to the people."

His Majesty the King of Bhutan

Acknowledgement

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The College of Natural Resources (CNR), under the Royal University of Bhutan, led this compilation and data collection as per the Tripartite Contract Agreement signed between the NSSC, CNR and the World Overview of Conservation Approaches and Technologies (WOCAT). The SLM best practices documented here, using WOCAT Questionnaires, were implemented through funding support from different projects financed by GEF, GEF-LDCF, Bhutan Trust Fund for Environmental Conservation (BTFEC), UNDP-SGP, IFAD, GCF, AF and the Royal Government of Bhutan. All the lecturers and students who were engaged in this documentation are greatly acknowledged for their dedication, hard work and enthusiasm despite difficulties faced in the field.

The WOCAT team members led by Nicole Harari have been very instrumental right from training the data compilers through reviewing and editing to uploading the finished products on the WOCAT Global SLM Database. Their contributions are duly acknowledged.

The NSSC also acknowledges the support and cooperation received from the Dzongkhag (district) and Gewog (block) administrations and various other institutions and agencies during the data compilation in the field. Special mentions are also made of those national experts from different agencies who have contributed immensely to validating the SLM approaches and technologies.

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Foreword

Soil and water conservation lies at the heart of Sustainable Land Management (SLM) in Bhutan. With more than 70 percent of our agricultural land located on steep to very steep slopes, farming communities face unique challenges in maintaining soil fertility, reducing erosion, and ensuring sustainability. Starting in 2005 until today, a wide range of conservation approaches and technologies have been promoted and adapted to Bhutan's diverse agro-ecological settings.

The Bhutan Soil and Water Conservation Approaches and Technologies (BHUCAT) brings together these experiences into a single reference. It documents best practices – ranging from time-tested traditional systems rooted in local knowledge to innovative measures – that have been successfully applied across the country. BHUCAT serves not only as a technical reference, but also as a platform for knowledge sharing and capacity building. It offers practical guidance for farmers, field practitioners, planners, and policymakers in their pursuit of making decisions based on evidence and scale out good practices for resilient and sustainable land use systems.

It is my hope that BHUCAT will serve as a living resource – continuously updated and enriched – and inspire wider adoption and scaling out of SLM practices across the country and beyond, and contribute to Bhutan's commitment to land degradation neutrality (LDN), climate resilience and biodiversity conservation.

Tashi Wangdi

Program Director/NFP UNCCD
National Soil Services Centre
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1 Introduction

Bhutan is located in the Eastern Himalayas with a total land area of about 38,394 km^2. Due to rugged mountain terrains, its elevation ranges from 160 meters to more than 7,000 meters above sea level. As per the land use land cover assessment of 2020, 69% of the total land area is under forest (DoSAM, 2023). Bhutan has limited arable land owing to its difficult terrain and altitude, which is estimated to be about 7% or 664,000 acres of the total geographical area (NLCS, 2023). The actual cultivated agricultural land area is only 2.96% or 281,186.29 acres (DoSAM, 2023). This sustains the livelihoods of 61% of the rural population and contributes 14.15% to the country's GDP (NSB, 2025).

Since 70% of the agricultural lands are located on steep slopes, soil and land degradation is a serious issue. The soil erosion rate assessment carried out by the NSSC in 2008 and 2009 shows annual soil loss of 6.42 t/ha from the traditional farming practices where no Sustainable Land Management interventions are adopted (NSSC, 2009). In terms of land degradation, the National Report 2022 estimates 13.5% of the total land area as degraded (RGoB, 2023). These problems will be further aggravated by the impacts of climate change, as the mountain environments are extremely sensitive to climate change.

Notwithstanding the above facts, Bhutan is still well placed in the international stage. Bhutan is known for Gross National Happiness (GNH) philosophy that guided the country's overall socio-economic development followed by global biodiversity hotspot and lately as the only carbon negative country in the world.

Photos: Typical rill erosion in maize field (L) and gullies (R).

2 Sustainable Land Management Initiatives in Bhutan

Sustainable Land Management (SLM) as defined by the World Overview of Conservation Approaches and Technologies (WOCAT) is the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. In Bhutan, the Royal Government recognized the vulnerabilities of mountain agriculture as early as the 5th Five Year Plan (1981-1986) and promoted SLM technologies by providing cash incentives to the farmers. For instance, the Government paid Nu. 300 and Nu. 200 per acre for land terracing and for construction of contour stone bunds, respectively. However, due to a shift in the Government's development priorities over the years, SLM incentives were stopped and, along with this, farmers' land management efforts dwindled slowly by the 7th FYP (1992-1997).

With the devastating impacts of the 2004 flash flood incidence in the eastern region of the country, the focus on SLM was heightened and, starting in 2005, the national level Land Management Campaign (LMC) was initiated. The main objectives of LMC were to create awareness on the importance of protecting land resources by sensitizing and mobilizing communities, planners and policy makers on soil conservation and to push for mainstreaming SLM into local and national development plans and programs. The campaign introduced and promoted improved land management technologies and demonstrated soil and land degradation control measures that are easily adaptable by the farmers.

Following the LMC in 2005 and 2006, which later got mainstreamed into the local development plans and programs, the first ever Sustainable Land Management Project (SLMP), funded by the Global Environment Facility (GEF) through the World Bank, was introduced and implemented from 2006-2012. This six-year project with a total project grant of USD 7.66 million successfully piloted various SLM approaches and technologies in Bhutan's mountainous landscape. In fact, the project laid a strong foundation in terms of proven SLM approaches and technologies and key learning experiences which were later scaled out to other parts of the country through projects financed by GEF-LDCF, Bhutan Trust Fund for Environmental Conservation (BTFEC), UNDP-SGP, IFAD, Green Climate Fund (GCF) and Adaptation Fund (AF).

Photos: Awareness raising on SLM (L) and participants carrying napier slips to the campaign site (R).

3 SLM Achievements, Impacts and Key Learning Experiences

As noted above, the formal SLM initiatives in Bhutan took off in 2005 with the start of the national level LMC and the introduction of the first ever six-year dedicated SLM project from 2006-2012.

Since the start of the national level LMC in 2005 and with the introduction of the first SLM project in 2006, followed by the implementation of different area development projects, a range of SLM practices have been piloted and scaled out in other geographical areas. The types of SLM technologies promoted and achievements made between the period 2005 and 2024 are presented in Table 1 below.

Table 1: SLM Achievements between 2005-2024.

No.	Type of SLM Interventions	Achievement (2005-2024) in Acres
1	Terracing (bench/dryland)	4,473.21
2	Terrace consolidation	1,731.16
3	Orchard terracing	22.35
4	Surface stone removal	1,423.13
5	Contour hedgerows	5,885.68
6	Contour stone bund	1,314.05
7	Orchard basin making	203.55
8	Check dams	481.35
9	Orchard establishment	2,574.9
10	Landslide stabilization (plantation)	8,277.19
11	Integrated plant nutrient management	986.45
12	Water source protection	112.3
13	Improving ground cover & soil ferility through legume promotion	206.11
14	Fallowland reversion	2,006.21
Total (in Acres)		**29,697.64**

Impacts of past SLM Interventions

While no formal impact assessment of SLM projects was carried out, the preliminary assessment done in 2017 by the NSSC indicated that farmers from the past SLM project sites are fully aware of the importance and benefits of SLM in mitigating land degradation, increasing crop production and enhancing ecosystem services. The majority of the SLM project beneficiaries have reported that SLM has been highly effective in combating land degradation, improving soil fertility and soil quality, increasing crop yield, increasing resilience to climate change, easing workability, and enhancing ecosystem services.

The annual soil erosion rate measurement carried out by the NSSC also demonstrated that the SLM interventions, especially napier grass hedgerows, reduced soil erosion by about 44% (3.8 t/ha/year) as compared to traditional farming practices with no SLM intervention (8.6 t/ha/year).

Napier grass hedgerows have also provided other added benefits such as fodder grass for cattle, given that livestock owners do not have to collect fodder from the forest or take their cattle to the forest for grazing.

Similarly, the dryland terracing, which has been a major SLM intervention in the recent donor-funded projects, resulted in improvement of crop productivity through the conservation of soil fertility and soil moisture. That said, however, there is a decline in crop yield in the initial year due to soil disturbance although efforts are made to save top soil to the extent possible. Another impact of terracing is the ease of farm mechanization through use of power tillers, which saves farm labour.

Photos: Napier grass hedgerows (L) and dryland terracing (R).

Other long-term Benefits

Reduced risk to climate change

In the face of climate change, farmers have to adapt to the environmental changes by changing the cropping system practices. Land development will allow farmers to go for adaptive farming. In doing so, this will reduce climate change induced risks and vulnerabilities. A well developed land could also contribute to the carbon sequestration capacity of the soil, which has been declared to be an important aspect to combat climate change during the Paris Declaration in 2015.

Reduction in sediment load

The rate of surface soil erosion can be significantly reduced through physical land terracing and by the implementation of other SLM technologies. The main objectives of land development technologies are to reduce the velocity of the surface runoff, which in turn reduces the rate of surface soil erosion and thus reduces sediment load downstream.

KEY LESSONS LEARNED

Strengthening Community Participation for SLM

In the past, especially in the 1980s, the promotion of SLM technologies and other agriculture technologies, in general, were done following more of a top-down approach with a blanket recommendation to all the farmers across the landscape. The farmers were rarely consulted to understand the nature of the problem and to co-develop interventions to address land degradation and livelihood issues. This has led to the failure of most of the projects. Recognizing this, the SLM projects in Bhutan have put people at the heart of land restoration. This was done by adopting participatory natural resources mapping and SLM Action Planning. This participatory approach has served as a platform to sensitize beneficiaries on the importance of SLM, to co-develop SLM interventions by incorporating local knowledge and, most importantly, confirming their commitments, i.e. the sense of ownership. This has proven to be the key to the successful implementation of the SLM projects.

Stakeholder engagement

The Ministry of Agriculture and Livestock strongly believed that everyone is responsible and has a role to play in addressing land degradation. Therefore, strong emphasis was placed in the engagement of all the relevant stakeholders, although it was not always easy. But their engagement has undoubtedly contributed to the successful implementation of the SLM projects and programs. Building partnerships and cooperation is thus very critical for any project's success as it ensures coordination, collaboration, harnesses synergy and avoids duplication of efforts.

Incentives and livelihood improvement

Since many SLM practices are investment or labour-intensive (especially terracing, stone bunds, napier grass hedgerows), informal labour sharing, group/community mobilization helps to address the labour shortage problem.

Integration of short-term and long-term interventions is critical as the economic returns are not always achieved immediately, but in the medium-/long-term. Vulnerable or resource-poor farmers, in particular, have no patience to wait for long-term benefits as they are more concerned about their immediate or short-term needs first. From that perspective, smallholder farmers respond positively to incentives, and there is no better incentives than providing a wide range of seeds and seedlings and other cash generating interventions.

Adoption of SLM Practices

Lack of land ownership, small landholding size, farm labour shortage, absentee land owners, increasing fallow land or land abandonment and limited funding support are some of the factors affecting wider promotion and adoption of SLM interventions and land restoration initiatives.

Land is where three Rio Conventions can converge

It is now well recognized that the implementation of SLM in the farmer's field can bring together the three Rio Conventions UNCCD, CBD and UNFCCC and contribute to their goals. Land is thus a common platform where the three sister conventions can effectively converge.

Photos: Sediments halted by checkdam (L) and partial terrace formed through hedgerows (R).

4 About BHUCAT and WOCAT

BHUCAT – Bhutan Conservation Approaches and Technologies

Bhutan first embarked on SLM documentation using WOCAT tools and methodologies in 2012 and produced Bhutan Conservation Approaches and Technologies (BHUCAT). BHUCAT (2012) documented selected, most important SLM approaches and technologies that were tried and proven on steep to very steep slopes of Bhutanese agricultural landscapes. In total, 25 SLM best practices (12 approaches and 13 technologies) were compiled and published as a booklet. The pdf version is available on the WOCAT Website (https://wocat.net/en/wocat-media-library/bhutan-catalogue-of-soil-and-water-conservation-approaches-and-technologies/). However, except for few practices, not all the SLM approaches and technologies documented in BHUCAT (2012) were entered and made available publicly online on the WOCAT Global SLM Database (https://wocat.net/en/global-slm-database/). As a result, our SLM practices were not readily available and accessible for our own use and also not for online access by other countries. Therefore, it was decided in 2023 to update BHUCAT (2012) by documenting and sharing newly promoted SLM approaches and technologies using latest WOCAT tools and methods.

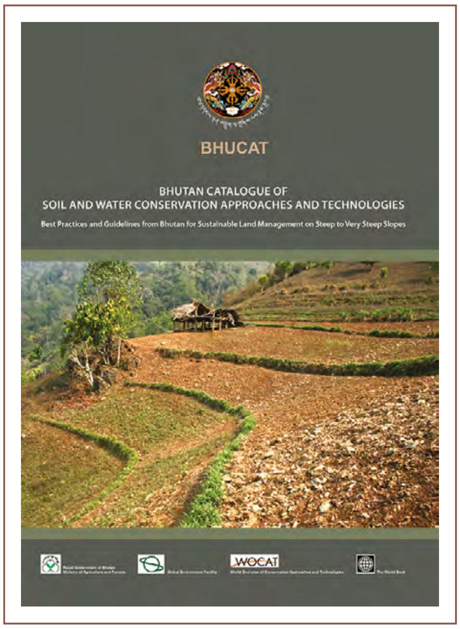

Figure 1: The cover of the 2012 Bhutan Conservation Approaches and Technologies (BHUCAT) publication.

The main objective of BHUCAT is to document and share valuable knowledge in land management, support evidence-based decision-making, and scale out identified good practices to wider communities, thereby contributing to Bhutan's commitment to land degradation neutrality, climate resilience and biodiversity conservation.

WOCAT – World Overview of Conservation Approaches and Technologies

Launched in 1992, the World Overview of Conservation Approaches and Technologies (WOCAT - www.wocat.net) is a global Network that promotes the documentation, sharing and use of knowledge to support adaptation, innovation and decision-making in SLM. Pioneer in transformative action for SLM, the Network establishes an innovative space for sharing and scaling good practices to address land degradation, climate change, and biodiversity loss. This facilitates local, national, regional and global knowledge sharing and analysis of which good practices work where, how and why, and what are their costs and benefits. It helps countries to understand local adaptations and innovations as well as assess different SLM impacts depending on the local conditions. WOCAT provides standard tools to document and disseminate best practices from experiences in addressing land degradation through SLM.

Photos: Consultation with the communities prior to implementation of SLM interventions.

Furthermore, WOCAT is supporting countries in participatory processes for mapping land degradation and estimating SDG 15.3.1, including the three land degradation neutrality (LDN) sub-indicators, through the development of LDN Decision Support Systems (LDN DSS). Its methodologies on knowledge management, database, and decision support tools for SLM and LDN are used by stakeholders worldwide.

Due to its long-term presence and wealth of SLM knowledge, the WOCAT Global SLM Database has been officially recognized by the UNCCD in 2014 as the primary recommended Global Database for SLM best practices. Today, the Global SLM Database contains over 2400 SLM Practices published from more than 130 countries, including Bhutan.

The UNCCD COP recognition gives WOCAT the mandate to support Country Parties to the UNCCD in documenting their own SLM best practices, using the UNCCD recommended Global WOCAT Database, and applying the SLM knowledge worldwide, i.e. from land users to decision-makers – to improve local land management.

Figure 2: The WOCAT Global SLM Database.

Photos: Typical dryland with maize crop in the east (L) and participants during training on SLM (R).

5 Documentation and Publication Processes

WOCAT provides standardized, user-driven, open-access, globally used tools and methods for the documentation and assessment of SLM practices. The SLM practices documentation and publication processes in Bhutan followed the established standard protocols of WOCAT (see Figure 3).

SLM in the context of WOCAT is defined as the *sustainable use of land resources – including soils, water, vegetation, and animals*. WOCAT focuses on **efforts to prevent and reduce land degradation and restore degraded land through improved land management technologies and approaches to implement these**.

All practices were considered, whether they are indigenous, newly introduced through projects, or recent innovations by land users. All information documented using the WOCAT SLM technologies and approaches questionnaires (https://wocat.net/en/global-slm-database/slm-practices-technologies-and-approaches/) is made available publicly in the Global SLM Database and is used to disseminate SLM knowledge and improve decision-making for further implementation and spreading of SLM practices locally, nationally and globally.

The WOCAT documentation process was carried out in **five main stages**, which are briefly highlighted in the following sections.

Stage 1: Selection of best practices for documentation

As a first step, a two-day consultation workshop was held from 8-9 May 2023 at hotel Punakha Residency in Khuruthang, Punakha, to select the best SLM approaches and technologies. The workshop was attended by technical experts from the Department of Agriculture, Department of Forest and Park Services, Department of Livestock,

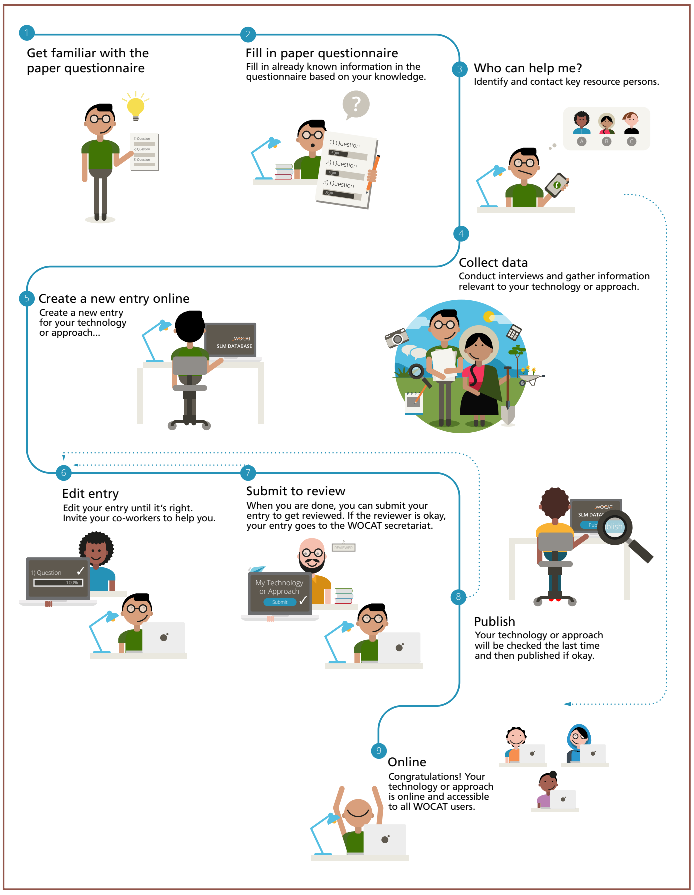

Figure 3: Documentation, Review and Publication Process of WOCAT.

Dzongkhag (District) administration and Agriculture Research and Development Centre. The main objective of the workshop was to discuss and agree on a **list of criteria** and select SLM approaches and technologies for documentation based on the agreed set of criteria.

Photos: River bank erosion coupled with flash floods is common land degradation in Bhutan (L). Traditional paddy field ready for harvest (R).

The following key criteria were proposed and agreed by the participants:

- Widely adopted
- Impact (positive)
- Investment cost
- Replicability/Scalability
- Resilience
- Sustainability
- Gender sensitivity
- Potential

Using the above set of criteria, the workshop participants selected 45 SLM practices consisting of 19 approaches and 26 technologies. The selection was done from a long list of practices that covered Agriculture and Water, Livestock, Forests and Traditional or Indigenous. The following list presents the selected SLM approaches and technologies:

Table 2: SLM approaches and technologies selected for documentation.

APPROACHES	TECHNOLOGIES
1. Agriculture and Water	**1. Agriculture and Water**
i. Traditional Labour Sharing for Farming	i. Traditional Soil Fertility Management through FYM application
ii. Participatory SLM Action Planning	ii. Rehabilitation of Fallow Land through Agroforestry
iii. Community Mobilization for SLM Interventions	iii. Vegetable Intercropping in Apple Orchards
iv. Climate-Smart Village Approach	iv. Mechanical Bench Terracing
v. Integrated Model Farm to Demonstrate Organic Technologies	v. Terrace Consolidation by Machine
vi. Agriculture Landscape Approach for SLM implementation	vi. Contour Grass Hedgerows on Steep Slopes
vii. Model Village Approach to Scale out Organic Agriculture	vii. Contour Stone Bunds
viii. Land Use Certificate to Engage Youth in Agriculture	viii. Low Cost Plastic-Lined Water Harvesting Pond
ix. Enhancing Agriculture Production through Fallow Land Reversion	ix. Plastic Mulching for Cash Crops
x. Public-Private-Community Partnership (PPCP) for Land Degradation Neutrality	x. Protected Agriculture for High Value Crops
2. Livestock	xi. Climate Resilient Irrigation Scheme
i. Improved Livestock Farming System	xii. Vermicomposting
ii. Improved Pasture Development	xiii. Citrus Canopy Management and Rehabilitation Program
iii. Darla Dairy Cooperatives	xiv. Securing Food through Electric Fencing
iv. Dairy Cooperatives and KOUFUKU Linkage for Milk Marketing	xv. Leaf Litter Collection for FYM production
3. Forest	xvi. Geocoding of Million Fruit Trees Plantation for Monitoring and Tracking
i. Zhasela Community Forest Management Group (CFMG)	xvii. Use of Dummy Tigers to Repel Wild Animals
ii. Community Forest Management Group	**2. Livestock**
iii. Sustaining Drinking Water through Payment for Environmental Services	i. Improved Dairy Shed
iv. Sacred Groves as Informal Protected Areas	ii. Biogas Plant
v. Nature-based Solution for Springshed Revival	iii. Stall Feeding of Dairy Cows
	iv. Managed Burning of Rangeland
	v. Sexed Semen Technology
	3. Forests
	i. Water Source Protection
	ii. Springshed Revival through Trenches and Checkdams
	iii. Cane and Bamboo Plantation to Sustain Raw Materials
	vi. Lake Revival: Towards Environmental Conservation

Stage 2:
Training on the Questionnaires for SLM Documentation

A hands-on training was conducted in a hybrid mode with the technical input from WOCAT, targeting the graduates and the lecturers of the College of Natural Resources (CNR) under the Royal University of Bhutan. The field documentation of SLM approaches and technologies, including their review, was mandated to the CNR as per the Tripartite Service Contract Agreement signed between the National Soil Services Centre, the CNR and WOCAT. There were 25 participants in total. The training was co-facilitated by Ms. Nicole Harari, Research Scientist and WOCAT Management Team member (online) and experts from the National Soil Services Centre (in-person).

The main objective of the training was to familiarize the CNR team with WOCAT tools and methods, especially in applying the SLM questionnaires. Besides familiarizing and understanding the questionnaires, the participants were also introduced to commonly used terminologies in the documentation process. The key terminologies and their definitions as used for WOCAT are:

SLM – The use of land resources – including soils, water, vegetation, and animals – to produce goods and provide services to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.

SLM approach – An SLM approach defines the ways and means used to implement one or several SLM technologies. It includes technical and material support, as well as involvement and roles of different stakeholders, etc. An approach can refer to a project/programme or to activities initiated by land users themselves.

SLM technology – An SLM technology is a practice applied in the field that controls land degradation and/or enhances productivity. It consists of one or several measures, such as agronomic, vegetative, structural, and management measures.

Roles of:

Compiler – The compiler is responsible for this data entry and can invite editors (WOCAT users) to help create it. Once the data entry is complete the compiler can submit it for review.

Editor – Editors can edit the SLM technology/approach, but they cannot submit it for review or invite other editors.

Reviewer – The reviewer can approve or reject the SLM technology/approach and can edit it.

Publisher – The publisher can approve or reject the SLM technology/approach and can edit it.

WOCAT Secretariat – The WOCAT Secretariat can review and publish the SLM technology/approach. The secretariat can also assign reviewers and publishers.

Stage 3:
Field Documentation of SLM Practices

Following the hands-on training, the CNR team began their field documentation from 6-31 July 2024. Six teams were formed with each team having a team leader or supervisor and designated specific geographical areas with a given number of SLM approaches and technologies to document. Prior to moving to the field, the teams already started filling in the questionnaires based on their knowledge and existing documents. The teams, in collaboration with the NSSC, also identified land users and other key resource persons, like local Agriculture Extension Supervisors, researchers, and others who have in-depth knowledge of the SLM technology/approach. A formal communication was also sent to the Dzongkhag (District) administrations, informing them about the documentation and its purpose. The communication also sought support from the local governments for the successful completion of the documentation. Further, a short refresher course was also convened among the team members to revisit questionnaires and to ensure everything was in order prior to moving to the field.

Photos: Participants familiarizing themselves with the WOCAT SLM questionnaires in the field.

While in the field, the team gathered information through interviews with land users and key resource persons. The team also took measurements, photographs, and produced technical drawings. All the compiled data, including photographs and technical drawings, were then entered into the Global SLM Database by creating a new SLM technology/approach data entry form.

Stage 4:
Validation of SLM approaches and technologies

With the completion of field documentation of SLM approaches and technologies, followed by additional review and edition by the team leaders, a five-day write-shop was held from 6-10 November 2024. The writeshop was attended by the national experts from relevant agencies and institutions, including the Departments of Agriculture, Livestock, Forests, Dzongkhag (District) Administrations, the College of Natural Resources (CNR) and the National Soil Services Centre (NSSC). The main objective of the writeshop was to further review and validate the SLM approaches and technologies documented by the CNR team prior to submission to the WOCAT Secretariat for final technical review and quality assurance. This process was followed to ensure high quality and agreed standards of the data.

Stage 5:
Reviewing and publishing SLM approaches and technologies

Technical editors, compilers, and the WOCAT Secretariat conducted the final review for data completeness and quality assurance. After approval, the SLM approaches and technologies were published on the WOCAT Global SLM Database. All SLM practices from Bhutan can be freely accessed under the following link: https://wocat.net/en/database/list/?country=bt.

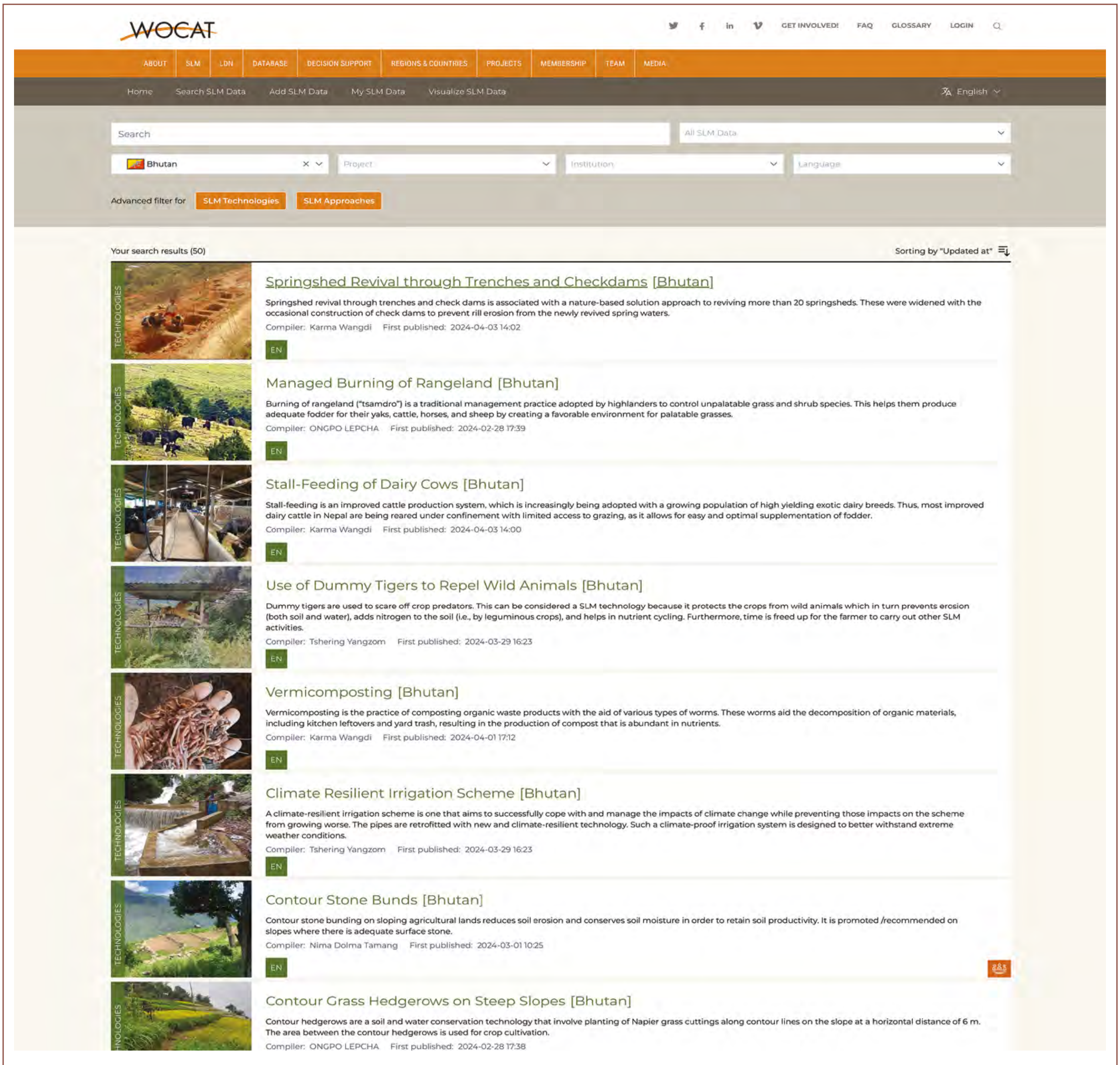

Figure 4: Screenshot from the WOCAT Database, showing a selected number of SLM practices from Bhutan.

6 Conclusion

Bhutan's unique mountain landscapes are highly fragile and vulnerable to land degradation, driven by steep slopes, fragile soils, erratic and intense rainfall, and increasing pressures from modernization and climate change. Sustainable Land Management (SLM), especially through soil and water conservation, is therefore central to safeguarding the limited land resources and to enhance the resilience of our agri-food systems. The Royal Government of Bhutan has consistently recognized the importance of SLM in addressing these challenges. Our national policies and strategies reaffirm our commitment to conserve soils, protect watersheds, and ensure that agriculture remains productive, resilient, and environmentally sustainable. These efforts are aligned with Bhutan's development philosophy of Gross National Happiness and our global pledge to achieve land degradation neutrality.

This publication (BHUCAT) is the NSSC's second attempt to compile the SLM best practices that are proven and widely promoted in the country. However, it is certainly not comprehensive. There are still many approaches and technologies that need documentation. It is therefore important that this document remains dynamic, by updating and improving it periodically, but most importantly compiling those approaches and technologies that are missed out in the current documentation.

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WOCAT. Glossary – Definitions of terms that are relevant to WOCAT's activities. Available at: https://wocat.net/en/glossary/.

Photos: Participants planting Napier Grass slips during World Desertification Day (17 June 2025) (L) and farmers carrying planting materials (Napier Grass slips) to the soil conservation site (R).

SLM Approaches and Technologies Summaries

In the following section of this publication, all documented SLM approaches and technologies are presented in the summary format that is automatically generated from the WOCAT Global SLM Database.

Approaches

Technologies

Approaches
Agriculture and Water

Labour-sharing group involved in weeding paddy in Bumdeling, Trashi Yangtse: Bhutan. (Tshering Yangzom)

Traditional labour sharing for farming (Bhutan)

Sanam Zhing La Gi Dhoen Lu Latshab (སོ་ནམ་ཞིང་ལཱ་གི་དོན་ལུ་ལཱ་ཚབ།)

DESCRIPTION

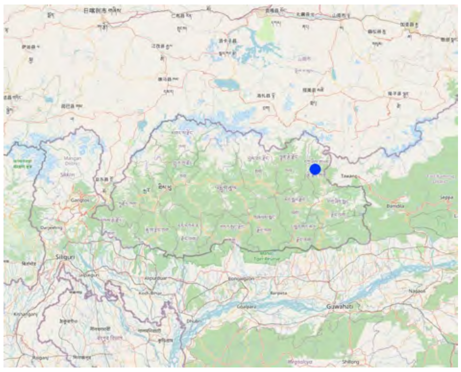
In the past, it was difficult for households to complete seasonal farming activities like ploughing, sowing, and transplanting in time. So, land users came together by adopting 'latsab' or labour sharing. This involves pooling land users, who work on a rotational basis on the plots of the different group members. Labour sharing is a very old approach but is still being practiced throughout the country.

In the past, it was difficult for households to complete seasonal farming activities like ploughing, sowing, and transplanting in time. So, land users came together by adopting 'latsab' or labour sharing. This involves pooling land users, who work on a rotational basis on the plots of the different group members. Labour sharing is a very old approach but is still being practiced throughout the country. In addition, land users also come together for any construction work or other activities related to land management. Labour sharing aims to complete seasonal farming activities more efficiently and on time. The approach also helps economically disadvantaged land users who cannot pay wages to employ. Other co-benefits reported are the improved sense of community and enhanced social cohesion because the exchange of experiences and collaboration builds mutual trust. Working in a group eases hard physical work, such as carrying and breaking large boulders, and is perceived to be much more enjoyable than working alone or in a household setting.

Groups are formed at the village and sub-village levels to enable households to take up labour-intensive SLM activities, such as stone bunding, bench terracing, stone check dam construction, water source protection works, or grass hedgerow development. Labour-sharing involves land users coming together to discuss important agricultural activities to be implemented. They also select the land users where the work should start. When it comes to activities related to SLM intervention, the land users are given initial practical training on the SLM intervention, which starts with hands-on work on the land of a group member, preferably that of a vulnerable household. Labour-sharing groups, therefore, facilitate the inclusion of vulnerable households, especially female-headed and small families, in the implementation of labour-intensive SLM interventions. In addition to technical guidance provided by extension staff, support is given to the group formation process, such as drafting informal by-laws and group management.

Any activities through a labour-sharing approach have to undergo specific stages. Initially, the land users will come together to discuss important agricultural or SLM activities to be carried out in a season. Secondly, they identify a 'Blenpa' who is a land user who requests help on his/ her land. Once in the field before they start any activities a supervisor or 'la pon' is appointed. If work involves heavy digging, a 'Nyempa' (preferably a strong man) is appointed, and he will be assisted by four or five women. The labour-sharing group is formed through common interests among different land users in the community. The group members come together and plan and prepare by-laws. They appoint a chairman or 'Trizin', who is the overall manager of the group. The accountant/treasurer or 'Tsezin' is appointed to take care of the finances. Any conflict between land users is solved within the group.

LOCATION



Location: Namthrang wog (sub village), Betsamaang(village), Bumdeling(region), Trashi Yangtse(Provience), Bhutan

Geo-reference of selected sites
- 91.45153, 27.65869

Initiation date: n.a.

Year of termination: n.a.

Type of Approach
- [x] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [ ] project/ programme based

Labour-sharing group member interacting with official from the College of Natural Resources (Ongpo Lepcha)

Labour-sharing group weeding paddy (Tshering Yangzom)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main aims/objectives of the approach are 1) Labour-sharing to complete seasonal activities faster and on time, 2) To support economically disabled land users who cannot pay for hired workers, and 3) To share resources like water which is important for carrying out farming activities.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: All land users involved are from same ethnic group. They shared common social, cultural, and religious, norms and values. Implementation of any SLM activities was seen as enabling.
- **Availability/ access to financial resources and services**: Land users were accessible to financial resources and services as most of them are either members of a vegetable group or a Chilli group. As a member, they are privileged to avail loans.
- **Collaboration/ coordination of actors**: The group formation is democratic and the leader selected to regulate the group was selected by land users themselves. Therefore, strong collaboration is observed.
- **Knowledge about SLM, access to technical support**: Land users are aware of SLM interventions like terracing, bunding, stone bunding, growing Napier grass, etc. These indicated that they have good knowledge and are accessible to technical support from SLM specialists.
- **Markets (to purchase inputs, sell products) and prices**: Land users indicated that they have a good market for their produce like chilli and potatoes. They have a group that deals with marketing.
- **Workload, availability of manpower**: Land users are happy that the current approach of labour-sharing helped them a lot when it comes to workload and labour shortage. Although if there are fewer household members, the approach helps them to carry out important agricultural activities in time.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

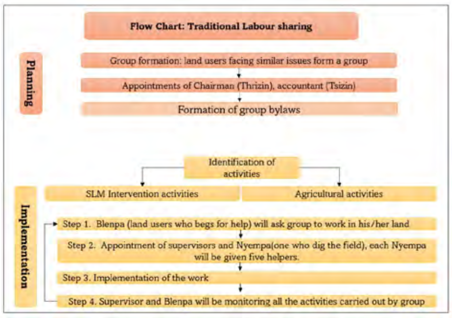
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	10 households were involved out of which 6 are females and 4 are male. They are mostly from the age group between 40-60 years old, All of them are married and are economically disabled. All of them belong to the same ethnic group known as	Land users are involved in the planning of by-laws, and implementation of activities, Elected chairman is responsible for the smooth functioning of the group. The accountant takes care of the finances. Any conflict between land users is solved within the group.
SLM specialists/ agricultural advisers	Extension agent	He/she is not part of the group but is involved whenever he/she needs assistance from the group. He/she acts as an SLM specialist at the village level.

Involvement of local land users/ local communities in the different phases of the Approach

Phase	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	The labour-sharing approach was initiated by the ancestors of current land users. Current land users found this approach as an effective way to mitigate labour shortage and resource management and they continue to preserve and practice it.
planning					✓	Land users are the ones who come together, prepare their by-laws and plan all the activities related to farming or SLM intervention.
implementation					✓	The approach has an elected chairman and accountant who are responsible for the smooth running of the group and finances. Any conflicts that arise between land users are solved within the group.
monitoring/ evaluation					✓	The group is monitored by the chairman. During the time of any activities, they also appoint a supervisor who will monitor the quality of the work performed by the members.

Flow chart

Flow chart created following conversation with the group. There are two important phases, initially planning which includes group formation, and by-law, and the second phase is the implementation phase.



Author: Ongpo Lepcha

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [x] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [ ] field staff/ advisers

Form of training
- [ ] on-the-job
- [ ] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [ ] courses

Subjects covered

Improved ways to dry Chilli, Nursery bed preparation, electric fencing, Growing Napier grass, Chainlink fencing, Greenhouse construction, etc.,

Advisory service

Advisory service was provided
- [ ] on land users' fields
- [ ] at permanent centres

Whenever there is an outbreak of crops or livestock diseases, advisory services are provided by agricultural and livestock officers on do and don't of the issues.

Institution strengthening

Institutions have been strengthened / established
- ☐ no
- ☐ yes, a little
- ☐ yes, moderately
- ☑ yes, greatly

at the following level
- ☑ local
- ☐ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.
Within the labour-sharing group, land users also have formed other groups like the Chilli group (focusing on cultivating and marketing chilli), Vegetable group (involved in growing and marketing vegetables other than chilli)

Type of support
- ☑ financial
- ☑ capacity building/ training
- ☑ equipment

Further details
The financial institution provides loans to those land users who are members of the group. Support from the government and external projects targeted to the groups. As a result, members of the group have received training in Chilli drying through the Tarayana Foundation. Members also shared that when they work in groups they also share tools, equipments, machinary, etc., which indirectly reduces the cost.

Monitoring and evaluation
Labour sharing involves working on a rotation basis. The group has a chairman who monitors the overall activities of the group. When it comes to agricultural or SLM intervention activities carried out at individual land user's fields. The supervisor is appointed who monitors and supervises the work.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

The group is mainly formed by those land users who are economically disabled. They work on a rotation basis so that they don't have to pay for human resources involved in carrying out any agricultural or SLM intervention activities.

The following services or incentives have been provided to land users
- ☑ Financial/ material support provided to land users
- ☑ Subsidies for specific inputs
- ☐ Credit
- ☑ Other incentives or instruments

Financial/ material support provided to land users
Electric fencing: The materials were supported by the government. Chilli dryer:

	partly financed	fully financed
Chilli Dryer They received one dryer from the Women's Division under the National Commission for Women and Children (NCWC).	☐	☑
Electric fencing All the materials required for electric fencing were provided by the Bhutan government.	☐	☑
Green house The total cost for greenhouse materials was shared between individual land user and the government. 30% of the total cost is borne by land users and 70% by the government.	☑	☐

Labour by land users was
- ☐ voluntary
- ☐ food-for-work
- ☐ paid in cash
- ☑ rewarded with other material support

Other incentives or instruments
The group also received a cake-making machine. However, this was shared among different groups from other places.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

Question	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation?			✓	
Did the Approach help land users to implement and maintain SLM Technologies?			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM?				✓
Did the Approach mitigate conflicts?				✓
Did the Approach empower socially and economically disadvantaged groups?				✓
Did the Approach improve access to markets?				✓

Did the Approach empower local land users, improve stakeholder participation?
Yes, the approach has empowered local land users. Gender equality is maintained and Chairmanship is done on a rotation basis. The work done by the group is supported by government and other external projects.

Did the Approach help land users to implement and maintain SLM Technologies?
The group is basically focused on agricultural activities and to protect their crop from wildlife they have installed electric fencing. They also rear dairy as a source of manure to improve the fertility of the soil.

Did the Approach improve knowledge and capacities of land users to implement SLM?
Government and external support is directed to the group because it is quite cheaper than providing to individual land users. Any kind of capacity development related to agricultural activities or SLM intervention is given to the group. Group members also shared that they received training in various fields of SLM like stone bunding, Terracing, Electric fencing, greenhouse construction, and improved dairy shed construction.

Did the Approach mitigate conflicts?
Establishment of the electric fencing solved human-wildlife conflicts. Irrigation water used to be an important issue for conflict in the past. However, group formation has helped the community improve their irrigation by improving source and also scheduling irrigation timing among the members.

Did the Approach empower socially and economically disadvantaged groups?
The group consists of members who are economically disabled. The group has helped them to sustain their livelihood as any agricultural activities are carried out in time. The members also don't have to pay for labours which otherwise is very expensive. Working together also builds a sense of belongingness and closeness among the members.

Did the Approach improve access to markets?
The members of the Labour-sharing group are also members of other groups like the Chilli and Vegetable group. This has helped them to market their produce.

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [x] reduced risk of disasters
- [x] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [ ] yes
- [x] uncertain

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The approach allows members to enhance social cohesion and community sense. They come together for any kind of work, thus tackling the main issue of labour shortage and easing hard physical work.
- Agricultural activities like ploughing, tilling, sowing, transplanting, weeding, watering, and harvesting, have to be completed on time. The approach allows every member to complete these activities on time avoiding crop failure and enhancing crop production.
- The approach includes all vulnerable groups giving them opportunities to share their problems and supporting them through labour-sharing to carry out important agricultural activities for crop production.

Strengths: compiler's or other key resource person's view

- The approach demands equal participation from all household members. Thus giving training on any SLM intervention activities by SLM experts becomes very easy. It is also easy to communicate to the group for dissemination of any information.
- The approach helps the economically disabled members to sustain their livelihood. This is because labour-sharing cut many of the costs involved in crop production or SLM intervention activities increasing the cost-benefit ratio.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Marketing of agricultural produce: There are many other groups at the village and sub-district level. They compete to capture the local market which is always saturated with supply. Exploring the market at the domestic and international levels is very expensive for the majority of the group. The government takes some initiative to explore the market for these groups or give them some incentives to do marketing like marketing van.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- The sustainability of the group: Most of the members are between the age group of 40-70. The young generation is not interested in agriculture and in the future, there are chances that this kind of group may die. The government must take some initiative to make our young generation like Agriculture by bringing new technologies that will ease hard human labour.

REFERENCES

Compiler
ONGPO LEPCHA

Editors
Tashi Wangdi

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Geduula - land user
Karma Dema - land user
Tshering Pelden - land user
Gonpo Tshering - land user
Ugyen Wangmo - land user
Karma - land user
Gurula - land user
Karma Choden - land user
Sither Chozom - land user
Tshewang Gonpo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6894/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
- BHUCAT (Bhutan catalogue of soil and water conservation approaches and technologies):Best practices and guidelines from Bhutan for sustainable land managements on steep to very steep slopes, National Soil Service Center, Department of Agriculture, Ministry of Agriculture and Forest 2012,: A copy of a book was provided by National Soil Service Center, Simtokha: Bhutan for Free.
- 2021 Labour force survey report Bhutan, National statistics Bureau, 2021, ISBN 978-99936-28-93-4: available online for free. https://www.nsb.gov.bt/wp-content/uploads/dlm_uploads/2022/04/LFS-2021-web.pdf

Links to relevant information which is available online
- SLM Labour-sharing group Bhutan: https://qcat.wocat.net/wocat/approaches/view/approaches_2491/
- Sharing labour to implement contour bunding in Nepal: https://qcat.wocat.net/wocat/approaches/view/approaches_2604/
- Organic agriculture, Labour exchange, and social networks: a case study of smallholder farming in Bhutan: https://link.springer.com/article/10.1007/s13165-022-00416-z

Land users listing and prioritizing the SLM interventions at Napchey chiwog, Punakha Dzongkhag. (Haka Drukpa)

Participatory SLM Action Planning (Bhutan)

Yuenten Sazhi Zinchong Gi Chharzhi Tsamni Na Chamar Tokni (ཡུན་བརྟན་ས་གཞི་འཛིན་སྐྱོང་གི་འཆར་གཞི་བཙམ་ནི་ནང་བཅའ་མར་གཏོགས་ནི།)

DESCRIPTION

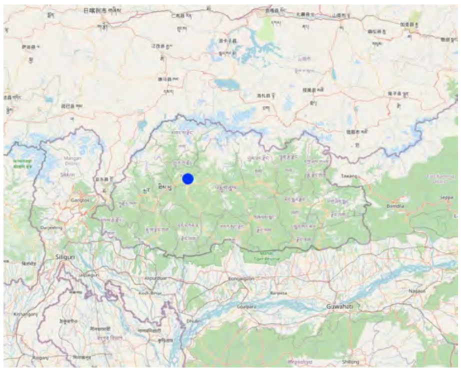
Participatory SLM action planning is an approach that identifies community-based and land-based issues and challenges, establishes the root causes, and finds out mitigation measures to address the issues for enhancing rural livelihoods.

Participatory SLM Action Planning (SLM AP) is a methodology intended to assess potential SLM interventions in order to address the most severe problems of land degradation. Priorities are determined by identifying the main local issues and their root causes, as well as land-based livelihoods and resources. All community households are included in SLM AP, which is conducted at the chiwog (village) levels. It incorporates Participatory Rural Appraisal (PRA) & Participatory Learning Action (PLA) tools such as natural resource mapping, problem censuses, cropping calendars, history lines, prioritization, ranking and ultimately drawing up a realistic SLM action plan. An external resource person facilitates the discussion while the community decides the final action plan. The process is very interactive and focus group discussions are organized specially for facilitating women's active participation.

Prior to the SLM action planning exercise, sensitization to available SLM technologies is a must. The sensitization program includes pictorial presentations, relevant SLM audio visuals and displaying of SLM posters. After community sensitization on the first day, the actual SLM action planning exercise is conducted the next day. The participants can discuss with their family members and identify which interventions to incorporate in the plan. The stakeholders involved in the planning exercise consists of community members, local leaders, community civil servants and resource persons. The role of the local leader is to identify interventions that benefits the whole community such as community plantations, landslide stabilization along farm roads, community water source protection and a capacity building program for rural livelihood improvements.

Though this is a holistic bottom-up approach, some of the activities may not qualify for endorsement in the final action plan due to a limited budget and high-cost investments with few beneficiaries. The other drawback is that for every action plan, travel of 3 to 4 days is needed in in every chiwog. In general, the SLM action plan consists of individual household plans and a community SLM plan. Therefore, since every household is included and action plans drawn, land users are satisfied with the approach.

LOCATION



Location: Punakha, Nabchey, Lingmukha, Bhutan, Bhutan

Geo-reference of selected sites

- 89.91118, 27.55821

Initiation date: 2020

Year of termination: n.a.

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

Natural Resource Mapping of the chiwog by the land users using a google earth image (Kuenzang Nima)

Land users endorsing the identified SLM interventions for incorporation in the final chiwog SLM action plan (Haka Drukpa)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

To assess potential SLM interventions in order to address the most severe problems with land degradation. Priorities are determined by identifying the main local issues and their root causes, as well as land-based livelihoods and resources.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Team building, Cooperation
- **Availability/ access to financial resources and services**: Project support
- **Collaboration/ coordination of actors**: All the stakeholders including from chiwog levels to Dzongkhag levels are involved in this approach
- **Knowledge about SLM, access to technical support**: They are aware of importance of SLM approaches and any related issues regarding the SLM are reported to gewog extension for further technical assistance.
- **Workload, availability of manpower**: Households helping each other during their work.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Workload, availability of manpower**: Labor shortages from few households

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	land users	Land users participation in SLM action plan and in program implementation
SLM specialists/ agricultural advisers	Department of Agriculture, National Soil Services Center	Provide technical services, facilitation roles, conducting periodic monitoring and progress reporting
local government	RNR extension staffs , Gewog administration staffs & Dzongkhag Agriculture staff	Program coordination, technical services and timely reporting
national government (planners, decision-makers)	Project management team	Providing funding support and field monitoring and reporting of project progress
international organization	Green climate fund	Provide financial support and impact assessment

Lead agency

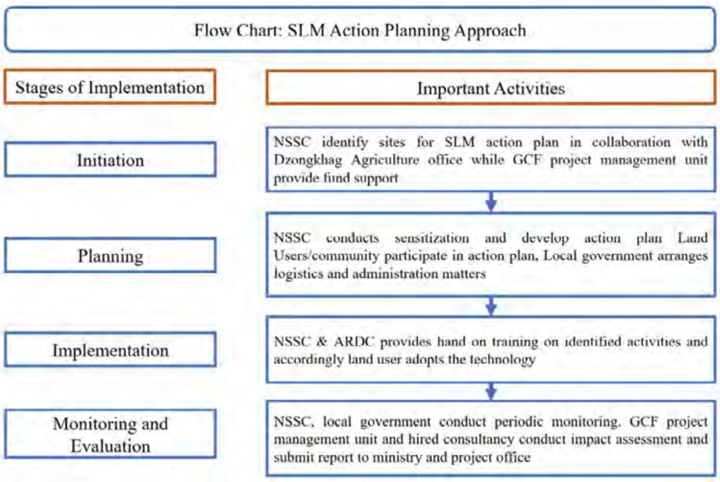
Green climate fund

Involvement of local land users/ local communities in the different phases of the Approach

Phase	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		Land users for participation and NSSC for technical support,
planning				✓		Land users, Green climate fund, NSSC, local government
implementation				✓		Land users, Green climate fund, NSSC, local government
monitoring/ evaluation				✓		Local government, NSSC, Project Management Unit

Flow chart

Overview of network of stakeholders engaged in SLM action planning.



Author: Haka Drukpa

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on

- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [x] field staff/ advisers

Form of training

- [ ] on-the-job
- [ ] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [ ] courses

Subjects covered

The training consists of in house sensitization and practical demonstration in field. The training topics covers wide range including SLM technologies, Climate resilient practices, group formation for water user association and improved livestock management techniques

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres
- [x] Extension office

Technical services were provided in the field as well as in meetings.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [x] yes, a little
- [ ] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
Informal labor sharing group were instituted facilitated by gewog extension officers to speed up the implementation of activities especially benefitting whole community such as water user group.

Type of support
- [x] financial
- [x] capacity building/ training
- [x] equipment

Further details
Funds were provided by the project office on annual workplan basis. Technical assistance provided by NSSC/ARDC/Dzongkhag

Monitoring and evaluation

Periodic monitoring was conducted by Project management Unit, NSSC, Dzongkhag while evaluation were carried out by private consultancy firms deputed by GCF project head office

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [x] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

This budget is for Punakha, Nabchey, Lingmukha funded by Green climate fund

The following services or incentives have been provided to land users
- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

Financial support by Green climate fund on SLM technologies 1) Contour stone bunds construction : USD 61.00/per acre 2) Hedgerows: USD 85/acre, 3) Machine terracing: USD 854/acre, 4) Small (1-2 meter wide and depth) Check-dams construction: USD 18/dam .

	partly financed	fully financed
equipment: machinery Machines for bench terracing		✓
equipment: machinery: tools Cost sharing (80% by Project, 20% by land user) Green house,	✓	
fuel fueling of government machines for terracing		✓
agricultural: seeds Horticulture seeds and seedlings		✓
agricultural: seeds: fertilizers		✓
construction: stone stone check-dams (45% by project and 55% by land users	✓	
working lunch for labor	✓	

Labour by land users was
- [ ] voluntary
- [x] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The decisions were made by the land users and the approach was well received.				✓
Did the Approach enable evidence-based decision-making? Land users were taken for short study visits to successful SLM sites where by decision made was supported by evidence based observation.			✓	

Did the Approach help land users to implement and maintain SLM Technologies? Yes, they still practice and maintain the SLM technologies implemented in their field, however, since SLM interventions were of long term return investment requiring high labor, the adoption rate still remains moderate.	✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Land users were trained on various technologies and advantages and some progressive farmers were scaling up at larger scale.	✓
Did the Approach empower socially and economically disadvantaged groups? As all the financial needs were fulfilled by GCF,	✓
Did the Approach improve gender equality and empower women and girls? Women were equally given opportunity to participate in planning and training program.	✓
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Younger generations were facilitated to take up high tech technologies such as hydroponic, mega green house, drip irrigation and even supported with farm machineries power tillers on cost sharing basis.	✓
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? Vulnerable agriculture farm lands were brought under SLM	✓
Did the Approach lead to improved food security/ improved nutrition? Since vulnerable farm lands were brought under SLM, farmers were able to use farm machines, adopt new techniques which facilitated in improving food security and better nutritional up take.	✓
Did the Approach lead to improved access to water and sanitation? Improved irrigation water supplies to the farm land	✓
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? Since land degradation and Climate change were two side of same coin, the approach had educated the land users on impacts of climate change and accordingly adapt and build resilience.	✓
Did the Approach lead to employment, income opportunities? Few school drop outs were able to start a farm enterprise and were able to generate cash income and employment (vegetable production)	✓

Main motivation of land users to implement SLM

- ✓ increased production
- ✓ increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- ✓ reduced risk of disasters
- ✓ reduced workload
- ✓ payments/ subsidies
- ☐ rules and regulations (fines)/ enforcement
- ☐ prestige, social pressure/ social cohesion
- ✓ affiliation to movement/ project/ group/ networks
- ✓ environmental consciousness
- ☐ customs and beliefs, morals
- ✓ enhanced SLM knowledge and skills
- ✓ aesthetic improvement
- ☐ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- ☐ no
- ✓ yes
- ☐ uncertain

Most of the SLM interventions were of one time investment and maintenance cost were very minimum. The land users will be able to take care and incase of major issues, the funds will be supported by the local government for maintenance such as irrigation channel renovation.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The Participatory SLM planning approach is basically putting the farmers first and farmers last. Since the plan is developed by land users, they take full ownership which ensures sustainability of the program.
- Improved social interaction and cohesion
- Opportunity for mass sensitization on SLM and climate change to the land users

Strengths: compiler's or other key resource person's view

- Best approach in empowering rural land users.
- Experts needed to facilitate only
- Ensures sustainability and successful program implementation

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Expertise and knowledge gap consult SLM specialist
- Elite land users dominating the decision making power Give equal opportunity to all actors in decision making.
- Poor participation or un-responsive participants during meetings Meeting to be attended by head of the household or one who can decide and have decision making power.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Difficult to fulfill all demands enlisted in the action plan (ambitious plan). Some interventions are outside project scope while its of utmost importance to the community such as farm road construction, human wildlife conflicts and new irrigation channel construction requiring high investment. Sensitization on Project scope, its intended supports and forward the outside project activities to the local government for sourcing funds.
- Taking program at chiwog level is time consuming and its resource intensive. Systematic planning and proper budget from initial phase
- Some land users takes opportunity of the project support though its not much important to them (free inputs). Periodic monitoring to ensure the proper utilization.

REFERENCES

Compiler
Karma Wangdi

Editors
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Reviewer
William Critchley
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Date of documentation: July 5, 2023

Last update: June 4, 2024

Resource persons
Tashi Dorji Drukpa - land user
Sonam Jigme - land user
Sonam Dendrup - land user
Namgay Wangmo - land user
Kinga Zangmo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6819/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
- NSSC Bhutan catalogue of soil and water conservation approaches and technologies, 2012: National Soil Service Center, Department of Agriculture, Ministry of Agriculture and Livestock, RGOB.
- Agriculture land development guidelines (17th June 2017): National Soil Service Center, Department of Agriculture, Ministry of Agriculture and Livestock, RGOB.

Links to relevant information which is available online
- Agriculture Land Development Guideline: www.nssc.gov.bt

Community members engaged in SLM implementation (Sonam Wangchuk)

Community Mobilization for SLM Interventions (Bhutan)

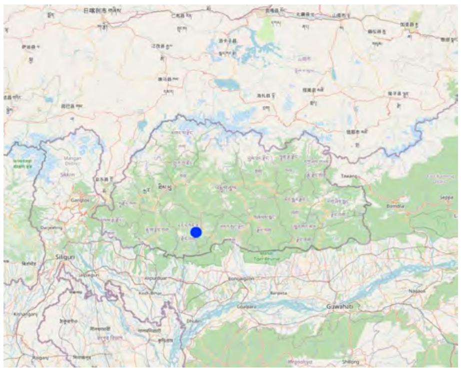
Yuenten Sazhi Zinchong Laglen Thab Niyi Dhoen lu Midhey Dreltog (ཡུན་བརྟན་ས་གཞི་འཛིན་སྐྱོང་ལག་ལེན་འཐབ་ནིའི་དོན་ལུ་མི་སྡེ་འབྲེལ་གཏོགས།)

DESCRIPTION

Community mobilization in implementing sustainable land management technologies is indispensable in engaging the community to identify their priorities, resources, needs and solutions. It ultimately promotes bottom-up participation and fosters accountability.

Community mobilization in implementing sustainable land management technologies involves active engagement of local communities in the planning, decision-making, implementation, and monitoring of land management. This approach recognizes the vital role of local communities in managing and conserving natural resources. By actively involving community members, SLM initiatives can be more effective and sustainable in the long-run.
With the objective of promoting a sense of unity and shared responsibility, SLM implementation in Pangserpo Chiwog of Drujeygang Gewog under Dagana Dzongkhag, has been executed through mobilization of a community group called 'Thuenpa Puenzhi Sonam Detshen'. This group, consisting of 13 members, was initially instituted as a vegetable progressive group in 2018.
The need for SLM came to light when one of the members adopted stone bunds, inspiring the rest of the members. Subsequently, the community group members collectively initiated an SLM programme to address land degradation issues and enhance agriculture productivity. The proven SLM technologies implemented includes stone bunds, terracing, and hedgerows.
The community mobilization approach has built capacity within the community for effective land use and conservation, fostering ownership and securing the longevity of the SLM programme. The bylaws - for instance mandatory active participation of every member in community work - have been successful in upholding the integrity of the initiative, thereby ensuring effective implementation of SLM related activities.
This group mainly consists of women headed households who support each other through a self-help approach. When labour shortage is the major challenge, the self-mobilized group plays a vital role in scaling up SLM interventions and improving their own livelihoods. In most cases of SLM grouping, the groups remain intact until project support is withdrawn, but for the Thuenpa Puenzhi Sonam Detshen, the group is still functional.

LOCATION



Location: Pangserpo Chiwog, Drujeygang Gewog, Dagana Dzongkhag, Bhutan

Geo-reference of selected sites
- 90.01408, 26.97879

Initiation date: 2019

Year of termination: n.a.

Type of Approach
- ☐ traditional/ indigenous
- ☑ recent local initiative/ innovative
- ☐ project/ programme based


Hedge establishment by the land users (Haka Drukpa)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The central goal of this approach is to foster community interaction and collaboration towards better outreach and implementation of SLM practices

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: The socio-cultural norms enable the implementation of SLM activities in the community, due to its effectiveness in mitigating land degradation issues, with no negative side impact.
- **Availability/ access to financial resources and services**: Initially the the government funded Nu. 200,000/- to execute the SLM technologies (stone bunds), later the group became financially stable by collecting fees (Nu.500 per member) from the group members and selling their agricultural products.
- **Institutional setting**: The community have better access to gewog Renewable Natural Resources, Agriculture Research and Development Centre, and National Soil Services Centre for any kind of technical supports related to SLM
- **Collaboration/ coordination of actors**: The land users collaborated with the Royal Government of Bhutan and Green Climate Fund project members for the execution of the community SLM interventions.
- **Legal framework (land tenure, land and water use rights)**: The land ownerships for instance are either family or individual, posing no hindrances to adopt any kind of SLM technologies.
- **Policies**: There is no policies that hinders the SLM intervention in the community
- **Land governance (decision-making, implementation and enforcement)**: The community holds meetings every month to discuss their issues and plans. By-laws were formulated during the initiation of the approach to enable efficient decision-making and implementation of the activities. Additionally, regardless of gender, land users actively participate in the activities that were done as part of the approach.
- **Knowledge about SLM, access to technical support** The members were well sensitized and trained on SLM and its best technologies by the National Soil Services Centre
- **Markets (to purchase inputs, sell products) and prices**: The market for the community is assured through school feeding program linkage (Drujeygang Central School and Pangna Primary Schools).
- **Workload, availability of manpower**: The SLM practices such as the construction of stone bunds are laborious. However, the involvement of the community and their labour contribution aids in achieving the implementation of the SLM practices.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Chairman and community members (land users)	The chairman was involved in initial group formulation by gathering like-minded members, and exploring for input subsidies. Land users are involved in forming a group and cooperating to address the issues, vegetable cultivation, and marketing.
SLM specialists/ agricultural advisers	Gewog/Block and Dzongkhag agriculture offices	In accepting and reviewing the group formation proposal, developing by-laws , sourcing funds, exploring markets, and monitoring.
teachers/ school children/ students	School Administrations	For community group and school feeding program linkages

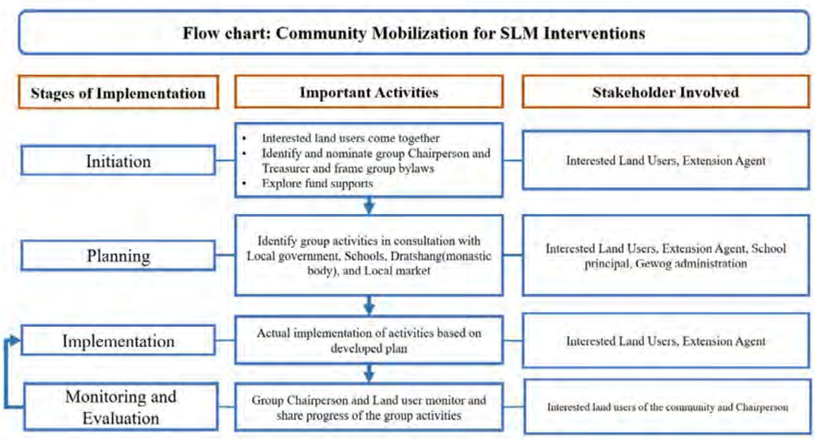
local government	Gewog/Block Administration	In accepting and reviewing the group formation proposal, developing by-laws , sourcing funds, exploring markets, taking the concerns of land degradation to the higher authorities
national government (planners, decision-makers)	Dzongkhag Adminstration	Final approval of the group formation and fund sourcing
international organization	Green Climate Fund (GCF) project	Provision of funds

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	One of the community members who is currently the chairperson adopted a SLM technology, and inspired other members. Subsequently, they further explored to implement SLM technologies in larger scales in the community.
planning				✓		Both the government and the land users were involved during the planning process. The government provided technical inputs whereas the land users contributed traditional knowledge.
implementation				✓		Both the government and the land users were involved during the implementation of the technologies. Where the government provided technical and financial support along with machineries. The land users contributed labour and farm tools.
monitoring/ evaluation				✓		The community meets every month to engage in self-monitoring and evaluation of the technologies. It is followed by addressing the issues and concerns raised. The Gewog, Dzongkhag, and NSSC also conducts periodic monitoring and evaluation.

Flow chart

Flow chart of how any SLM activities are carried out based on the approach.



Author: Ongpo Lepcha

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [x] field staff/ advisers

Form of training
- [ ] on-the-job
- [ ] farmer-to-farmer
- [x] demonstration areas
- [x] public meetings
- [ ] courses

Subjects covered

What actually SLM is, why SLM is important and required, and the best proven SLM technologies that are being implemented in Bhutan.

Advisory service

Advisory service was provided
- [x] on land users' fields
- [ ] at permanent centres

The advisory services on the technology and management were provided to farmers on land users' fields by Agriculture Extension Officers.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.

The institution is known by the name "Thuenpa Puenzhi Sanam Detshen" in the surrounding community. There are 13 members including the chairperson of the group. The chairperson's responsibility is to coordinate and address all community-related activities and concerns. He also oversees the institution's financial planning. The member's job is to cooperate with the chairperson and encourage one another in difficult times.

Type of support
- [x] financial
- [x] capacity building/ training
- [x] equipment
- [x] labour-sharing (Local name: Lagtshab)

Further details

The institution provides financial aid. Additionally, they engage in labour-sharing (lagtshab) where the land users rotate working on each other's fields to complete the work faster.

Monitoring and evaluation

The monitoring and evaluation are part of the approach. The land users get together once a month to review the activities conducted and plan future activities preventing recurring issues to strengthen the effectiveness of the approach.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [x] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

The government funded one time during the initial implementation of the technology. However, there is no annual budget allocated for the group now.

The following services or incentives have been provided to land users
- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [x] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

They were provided with Nu. 200,000/- to implement the technology through GCF project.

	partly financed	fully financed
equipment: machinery Power tiller was partly financed by the government. (Farmers and the government split the cost by 50%)	✓	
agricultural: seeds Initially all the seeds were provided by the government later it was stopped as the land users became financially stable to afford the seeds.		✓
Greenhouse The government paid 80% of the greenhouse's cost, and farmers paid 20%.	✓	

Labour by land users was
- [x] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

Credit

Conditions: The credit was provided to the community members from the group fund of the group without any interest.
Credit providers: Chairperson and assistant
Credit receivers: Group members including the chairperson.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The land users are now empowered and are able to implement SLM technologies on their own, because of capacity built through SLM sensitization and hand-on-training.				✓
Did the Approach enable evidence-based decision-making? The approach enabled land users to make evidence-based decisions. For example, the land users grew certain crops to be sold to the local market. However, the members of other communities started growing the same types of crops. Therefore, to reduce market competition the land users opted for different crops that are not grown by other groups. Also, linking with school feeding program was also a best evident decision.				✓
Did the Approach help land users to implement and maintain SLM Technologies? The group members collectively could source funds for SLM. The technology implementation through labour sharing was possible only due to the group members cohesiveness.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? The labour sharing strategy proved best in effective cost management (cost sharing).				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? The group sourced Nu. 200,000/- for the implementation of SLM technologies. Currently, the group makes Nu. 30,00,000/- a year, which they divide among themselves and save a certain amount to be used to maintain the technologies and as an emergency fund.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Capacity built through SLM sensitization, hand-on-training, and implementation.				✓
Did the Approach improve knowledge and capacities of other stakeholders? The capacities of local government officials were developed, while making their presence during the program.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Based on the community's interest and motivation to improve agricultural productivity, other stakeholders are convinced to support and collaborate with them.				✓
Did the Approach mitigate conflicts? The labour sharing mechanism through this approach has mitigated social conflicts especially due to labour shortage.				✓
Did the Approach empower socially and economically disadvantaged groups? The group members mainly consists of women headed households.				✓
Did the Approach improve gender equality and empower women and girls? Both male and female have equal rights to be part of the group. Initially, the group started with an equal number of male and female.				✓
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Majority of the children are in schools/colleges. But, they somehow get to engage in SLM program during their vacations representing their parents and relatives. Few youth living in the community are also engaged. Hence, the next generation land users are encouraged.			✓	
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? The land ownerships are either family or individual. So, there was no prior issues in land tenure or user rights.	✓			
Did the Approach lead to improved food security/ improved nutrition? Before the community mobilization approach, agricultural activity was mainly for self-consumption. The implementation of SLM with this approach has seen increased agricultural productivity even at this initial stage, leading to market-oriented farming, improved household income, improved food and nutrition security.				✓
Did the Approach improve access to markets? The approach improved land users' access to the market through school feeding program linkage.				✓
Did the Approach lead to improved access to water and sanitation? The water harvesting technology implemented through the approach provides irrigation water to the land users'fields.				✓
Did the Approach lead to more sustainable use/ sources of energy? The SLM technologies implemented by the land users in this community is not very related to the sustainable energy uses.	✓			
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? Adverse effects of climate change such as erratic rainfall reduced through SLM, especially due to sloping of agricultural lands.				✓

Did the Approach lead to employment, income opportunities?
The approach has significantly improved the land users' income as the technologies increased cultivable area, improved irrigation and eased farming. All these lead to an increase in agricultural productivity and household income.

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [x] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [x] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

The group is financially stable and has strong cooperation and interaction among the members

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The land users are self-sufficient in vegetables, and improved health and well-being of their families.
- The cooperation and interaction among the group members have been enhanced as the approach involves working in a group where they help each other to achieve a common goal.
- The approach has made the land users financially stable due to the income generated from selling vegetables.
- Due to bulk production in a community, the land users are able to access markets having demand for more quantities of vegetables such as school feeding programmes.

Strengths: compiler's or other key resource person's view

- The community has a capable leader, which is important to guide the group in terms of difficulties and prevent failure of the approach.
- The agricultural production has drastically increased, especially winter crops leading to reduced import.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The potato production is higher than the market demand Exploring markets beyond the community and local markets

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Limited market (Only two schools and few local markets) Explore markets beyond local markets

REFERENCES

Compiler
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William Critchley
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Resource persons

Tshering Tashi - land user
Tshering Pem (B) - land user
Lungten Mo - land user
Karchang Mo - land user
Tshering Pem (A) - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/approaches/view/approaches_6835/

Linked SLM data

Technologies: Contour Stone Bunds https://qcat.wocat.net/en/wocat/technologies/view/technologies_6891/
Technologies: Contour Stone Bunds https://qcat.wocat.net/en/wocat/technologies/view/technologies_6891/

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Wangdi, K. (2022). Promoting local farm produce in schools. BBS. Retrieved from http://www.bbs.bt/news/?p=165872: http://www.bbs.bt/news/?p=165872
- National Soil Service Center. (2011). Bhutan Catalogue of Soil and Water Conservation Approaches and Technologies: Best Practices and Guidelines from Bhutan for Sustainable Land Management on Steep to Very Steep Slopes. National Soil Services Centre (NSSC), Department of Agriculture, Ministry of Agriculture and Forests, Royal Government of Bhutan, Thimphu.: https://www.wocat.net/documents/140/Bhutan_catalogue_of_SLM_Technologies_and_Approaches.pdf

Links to relevant information which is available online

- Sustainable Land Managements in Bhutan: https://www.cif.org/sites/cif_enc/files/knowledge-documents/summary_brief_land_management_bhutan.pdf
- Community Participatory Sustainable Land Management Byelaw Formulation in the highland of central Ethiopia: https://www.ajol.info/index.php/acsj/article/view/101368/90558

The field of one of the community members where the Climate Smart Agriculture was implemented. (Tshering Zangmo)

Climate-Smart Village Approach (Bhutan)

Namshi Thuendrel Gi Yue (གནམ་གཞིས་མཐུན་འབྲེལ་གྱི་གཡུས།)

DESCRIPTION

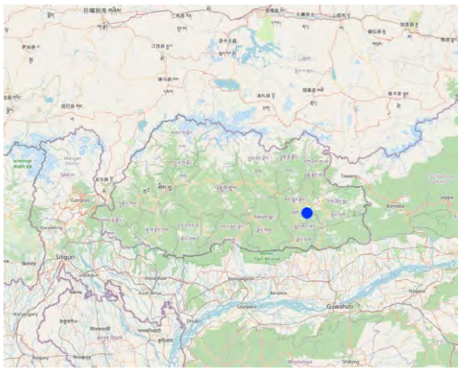
Climate change has become inevitable, and there is a need to address this impending danger. In the Climate-Smart Village (CSV) approach, land users in Ngaru-Pongtang have implemented several technologies and innovations to address climate change impacts, and the programme has worked with 50 households on a total area of 137 acres (55 ha).

This approach focused on transforming Ngaru-Pontang into a Climate-Smart Village (CSV) with actions that also contribute to mitigating climate change. The programme has worked with 50 households on a total area of 137 acres (55 ha). The approach included a participatory vulnerability assessment, and extensive training and education for the land users. They were equipped with skills, technologies, and innovative practices related to climate-smart agriculture (CSA). Additionally, the approach emphasized collaborative efforts, working closely with community members to foster better engagement and cooperation.

The primary objectives of the approach were to transform Ngaru-Pontang village into a CSV and thus effectively address the challenges posed by climate change. To achieve these goals, the approach employed various methods. It involved meetings with the community members, vulnerability assessment, fostering collaboration between the community, Agriculture Research and Development Centre (ARDC) Wengkhar, and Commercial Agriculture and the Resilient Livelihood Enhancement Programme (CARLEP). The community members received comprehensive training and attended workshops on climate-smart agriculture practices.
The implementation of the approach adopted the following stages:
1. Resource and livelihood analysis carried out through a Participatory Vulnerability Assessment.
2. Based on the findings from the above assessment, a project proposal was submitted to secure funding.
3. Subsequently, discussions were held with the community members, the extension agent, and the local government to ensure collective agreement and support.
4. A detailed plan with a timeline was developed to guide project implementation and monitoring.
5. Training and workshops on CSA practices were conducted by the ARDC and the extension agent, empowering the community members to take charge of project implementation and ensure sustainability.

Key stakeholders involved in the approach included:
1. ARDC Wenkhar, which led the implementation of the project, facilitated the training and workshops, provided technical assistance, and monitored the programme's progress.
2. The Gewog administration and the extension agent played crucial roles by offering support and assistance in implementing climate-smart agriculture practices in the field.
3. The community members actively participated in various program activities, playing a pivotal role in driving the project forward.

LOCATION



Location: Ngaru-Pongtang village, Thangrong gewog, Mongar Dzongkhag, Bhutan

Geo-reference of selected sites
- 91.35503, 27.19169

Initiation date: 2016

Year of termination: 2021

Type of Approach
- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

4. The Commercial Agriculture and Resilient Livelihood Enhancement Programme (CARLEP) acted as the funding agency.

The key CSA practices implemented through this approach are soil fertility improvement technologies (composting through use of FYM and bio-slurry, vermicomposting; liquid manure, biochar, Bhutan Agri-Microbial Solution (BAMS) and hedgerow plantations), community solar-electric fencing, heat and drought tolerant crops (spring paddy, soybean, avocados, mangoes and pineapples), biogas installations and establishment of weather station.
The implementation of CSA interventions has resulted in a wide range of impacts on livelihoods, income, and enhanced climate resilience. The diversification of crops, electric fencing, and improvement in irrigation have enabled farmers to expand their cultivation area thereby directly enhancing crop production and cash income. Similarly, the integration of improved livestock farming systems along with crops and the installation of biogas plants have reduced impacts on natural resources. Farmers have gained knowledge and exposure to different climate-smart agriculture practices. The only negative impact of the measures has been extra damage to crops by wild animals.

Ngaru-Pongtong community members (Lhap Dorji)

Enumerators and community members in one of the fields were CSA was implemented (Tshering Zangmo)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach
The main objective of the approach was to establish Ngaru-Pongtang as a CSV and showcase different CSA practices geared towards combating, mitigating and addressing climate change impacts, which can be replicated to other gewogs and Dzongkhags.

Conditions enabling the implementation of the Technology/ ies applied under the Approach
- **Availability/ access to financial resources and services**: Community members were provided with equipment and planting materials through project's support.
- **Institutional setting**: Local government and gewog agriculture extension agent were involved during the training, seminars and the implementation of the project activities to ensure ownership and sustainability of the project.
- **Collaboration/ coordination of actors**: Stakeholders (ARDC Wengkhar, local government and community members) participated and cooperated together during the entire project period.
- **Knowledge about SLM, access to technical support**: ARDC Wengkhar provided regular training and workshops with regard to climate-smart agriculture, good agricultural practices and sustainable land management for the successful implementation of the project.
- **Markets (to purchase inputs, sell products) and prices**: ARDC Wengkhar has facilitated agricultural marketing by linking up the community with Bhutan Agro-Industry located at Lingmethang, Mongar.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

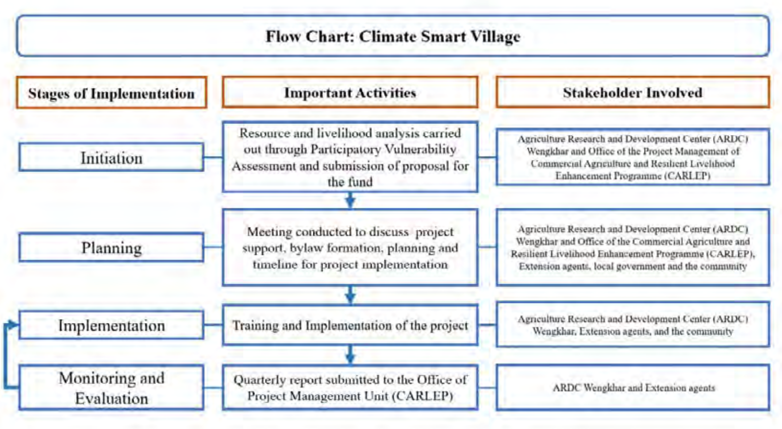
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Ngaru-Pongtang community	As a beneficiary, participated actively in the planning and implementation of the project activities, ensuring the project was successful and beneficial to them.
researchers	ARDC Wenkhar	Led the implementation of the project; facilitated the training and the workshops; provided technical assistance to the program; and monitored the progress of the program.
local government	Gewog administration and gewog agriculture office	They provided administrative support and collaborated with other stakeholders in successful designing and implementation of the project activities.
international organization	International Fund for Agricultural Development (IFAD)	IFAD provided financial assistance through its Commercial Agriculture and Resilient Livelihood Enhancement Programme (CARLEP)

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation		✓				The local community members were informed verbally and through community meeting about the project.
planning				✓		ARDC Wengkhar, Thangrong gewog administration, gewog agriculture extension agent and the community members came together and discussed the way forward for the project.
implementation				✓		Community members were provided with training and workshops on climate-smart agriculture and related agricultural skills. After the training and demonstrations, land users were divided into groups and made to apply these skills in their field.
monitoring/ evaluation				✓		Monitoring is being sporadically conducted by ARDC Wengkhar and the gewog agriculture extension agent, but it is left to the land users to monitor their own fields.

Flow chart

The flowchart was created based on the information provided by the community members



Author: Ongpo Lepcha

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☑ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☑ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☐ personal experience and opinions (undocumented)
- ☑ Consultation with the community members

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [x] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers

Form of training

- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [x] public meetings
- [ ] courses

Subjects covered

The topics covered included climate-smart agriculture, sustainable land management, and good agricultural practices.

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

ARDC Wengkhar and the agricultural extension agent provided all the technical advice and assistance required by the community members.

Institution strengthening

Institutions have been strengthened / established

- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level

- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.

The local government was involved in the project from start till end, which enhanced their understanding and capacity to initiate and replicate similar projects in other villages.

Type of support

- [ ] financial
- [x] capacity building/ training
- [ ] equipment
- [x] Technical assistance

Further details

Local government officials were engaged in the capacity building programs implemented for the community and also provided technical assistance as and when required.

Monitoring and evaluation

ARDC Wenkhar and the agriculture extension agent sporadically conducted monitoring and evaluation. However, the local land users are given the full responsibility to monitor their own fields and seek assistance when required.

Research

Research treated the following topics

- [ ] sociology
- [ ] economics / marketing
- [ ] ecology
- [ ] technology
- [x] Vulnerability Assessment

ARDC Wengkhar conducted a resource and livelihoods analysis through vulnerability assessment before designing and implementng the project in the community.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [ ] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: 55920.82

The funding was through Commercial Agriculture and Resilient Livelihoods Enhancement Programme (CARLEP) funded by International Fund for Agricultural Development (IFAD).

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

Material inputs such as seeds and seedlings, organic fertilizers, sprinkler pipes, and green shade net were provided through the project.

	partly financed	fully financed
equipment: machinery Sprinkler pipes and green shade nets	✓	
agricultural: seeds Seeds and saplings		✓
agricultural: seeds: fertilizers Organic fertilizers		✓

Labour by land users was

- [x] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The project built capacity of the land users and are able to implement and monitor project activities in their own fields.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? Conducting training and workshops were part of the approach and therefore this made implementing and maintaining the sustainability of the project possible.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? The training and workshop helped provide knowledge and skills regarding sustainable land management and climate smart agriculture practices.				✓
Did the Approach improve knowledge and capacities of other stakeholders? The project enabled local government to enhance their knowledge and capacity through direct engagement in the training program and in the implementation of the project activities in the field.			✓	
Did the Approach empower socially and economically disadvantaged groups? The project benefited all the community members equally disregarding of their background.		✓		
Did the Approach lead to improved food security/ improved nutrition? The climate-smart agriculture practices have improved the agricultural production through crop diversification, electric fencing and irrigation water improvement.				✓
Did the Approach improve access to markets? ARDC Wengkhar and the local government have facilitated the market by linking the community with Bhutan Agro-industry for processing.			✓	
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? Land users were trained on climate-smart agriculture and most importantly the land users have implemented climate smart agriculture practices in their fields which will definitely help build their capacity to adapt to the climate change.				✓

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation
- [x] Adapt and mitigate climate change

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

The land users have built their capacity, improved their production and cash income which should enable them to sustain the project activities.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Capacity building and technical assistance on CSA and SLM were provided.
- Gained knowledge and skills on CSA practices
- Were able to increase crop production through CSA interventions
- Were provided with an assured market for their produce

Strengths: compiler's or other key resource person's view

- Built human and natural capital through capacity building and implementation of CSA practices.
- Enhanced community resilience to climate change impacts

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The approach didn't address the pest problem, specifically the vertebrate pest adequately. Explore additional funding to support electric fencing and if possible chain link fencing.
- Farmers' hesitance to adopt technology. Create adequate awareness prior to actual design an implementation of the project.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
ONGPO LEPCHA

Editors

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 13, 2023

Last update: May 30, 2024

Resource persons
Karma Yangki - land user
Sanga Lhaden - land user
Lhendup - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6852/

Linked SLM data
Technologies: Low-Cost Plastic-Lined Water Harvesting Pond https://qcat.wocat.net/en/wocat/technologies/view/technologies_6821/
Technologies: Low-Cost Plastic-Lined Water Harvesting Pond https://qcat.wocat.net/en/wocat/technologies/view/technologies_6821/

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Saanogo, D, Sail, M., & Camara, B. A.. (2020). The climate-smart village approach: putting communities at the heart of restoration. Tropenbos International, Wageningen.: https://www.tropenbos.org/file.php/2385/etfrn-news-60-sanogo-the-climate-smart-village-approach.pdf
- Aggarwal, P. K., Jarvis, A., Campbell, B. M., & Zougmore, R. (2018). The climate-smart village approach: Framework of an integrative strategy for scaling up adaptation options in agriculture. Ecology and Society, 23(1).: https://www.researchgate.net/publication/322765373_The_climate-smart_village_approach_Framework_of_an_integrative_strategy_for_scaling_up_adaptation_options_in_agriculture

Links to relevant information which is available online
- The climate smart villages approach: https://www.grida.no/resources/4928
- THE CLIMATE-SMART VILLAGE APPROACH: FRAMEWORK OF AN INTEGRATIVE STRATEGY FOR SCALING UP ADAPTATION OPTIONS IN AGRICULTURE: https://ccafs.cgiar.org/resources/publications/climate-smart-village-approach-framework-integrative-strategy-scaling

Integrated Model Farm to Demonstrate Organic Technologies (Kezang Norbu)

Integrated Model Farm to Demonstrate Organic Technologies (Bhutan)

Petoen Gi Zhing Ngoezin Baedhi Rangzhin Sanam Thabrig Dremtoen (དཔེ་སྟོན་གྱི་ཞིང་ངོས་འཛིན་འབད་འདི་རང་བཞིན་སོ་ནམ་ཐབས་རིག་འགྲེམས་སྟོན།)

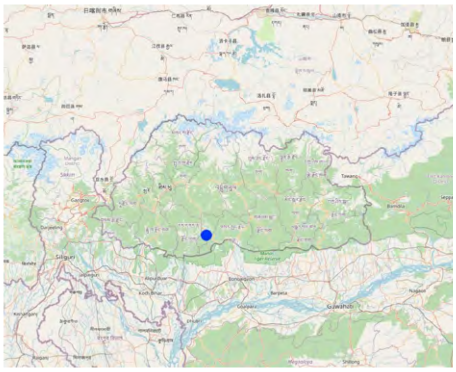
DESCRIPTION

The integrated model farm approach to organic farming incorporates various agricultural practices and technologies to optimize productivity and maximize sustainability while reducing negative environmental impacts.

This integrated model farm incorporates and demonstrates various principles and practices of organic farming. Such a farm utilizes diverse cropping systems, including crop rotation and intercropping, to promote diversity and reduce monoculture. These cropping systems contribute to improved soil health, reduced pests and diseases, and enhanced overall ecosystem resilience. Organic farming places significant emphasis on soil health, with integrated model farms using compost, vermicompost, and farmyard manure (FYM), as well as practices such as green manuring, mulching, and cover cropping. Livestock are also an integral part of these farms, contributing to nutrient cycling, weed control, and soil improvement. Overall, organic integrated model farms aim to reduce negative environmental impacts and promote sustainability.

The Organic Agriculture Hub in Mendrelgang Gewog, located in Tsirang Dzongkhag, has been established to support Bhutan's vision of becoming 100% organic. This hub is situated on private farmland spanning 8 acres (3.2 ha) and features various facilities, including a biodigester, azolla (an aquatic fern) and water harvesting tank, greenhouse, zero-energy cooling chamber, compost shed, and a vermiculture production house. Two types of worms, red wigglers and African night crawlers, are used for vermicompost production. Additionally, the hub serves as an educational center for researchers, farmers, and students. It is managed by the landowner, Phurba Moktan.
The establishment of the hub involved multiple stakeholders, including local organizations, the National Organic Flagship Programme, the United Nations Development Programme (UNDP) - and land users. The National Organic Flagship Programme, Green Climate Fund, and Rapid Financing Facility under UNDP provided support for the project, which cost more than US$ 3500. The local administration secured funds, and agriculture and livestock officials offered technical assistance to the land users, who conducted fieldwork related to organic production.
The establishment of the hub followed a systematic approach, starting with the development of a clear vision and objectives centered on sustainability, biodiversity conservation, and the promotion of organic farming principles. Site selection and analysis took into account factors like soil quality, water availability, and proximity to markets. The farm layout was designed to optimize space utilization and support biodiversity, with the inclusion of a biodigester, water harvesting tank, vermiculture facilities, compost pit and a greenhouse.
The benefits of this approach include raising awareness about transitioning to organic farming through the model farm - and learning the associated practices. However, one disadvantage of organic farming is that it can be more labour-intensive than conventional practices.

LOCATION



Location: Mendrelgang, Tsirang, Bhutan

Geo-reference of selected sites
- 90.13457, 26.95298

Initiation date: 2019

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

Bio-digester (cow urine collection tank) (Kezang Norbu)


Vermi-Composting Chamber (Kezang Norbu)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

-Promote organic farming through the use of organic technologies and practices.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Collaboration/ coordination of actors**: The land users collectively carry out the fieldwork.
- **Knowledge about SLM, access to technical support**: The ADAO, Gewog Livestock Extension Officer, and Agriculture Extension officer assist land users in soil management practices, preparation of organic manure and livestock rearing and management. The land users engage in crop-livestock integrated farming, with ongoing support and advice from the extension agents.
- **Markets (to purchase inputs, sell products) and prices**: The land users have improved access to the market as the farm produce is organic and in demand by different consumers.
- **Workload, availability of manpower**: The land users work collectively so the workload is shared and workload per person is minimized.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

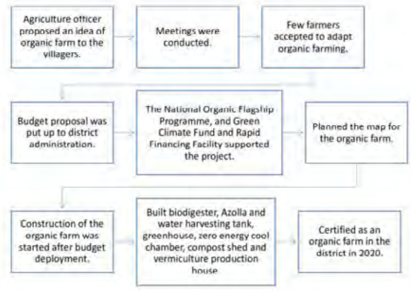
Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Dzongkhag Administration, Tsirang, BFDA, Dzongkhag Agriculture Officer, Dzongkhag Livestock Officer, Gewog Agriculture Extension Officer, Gewog Livestock Extension Officer, National Organic Flagship Programme, UNDP, and the land users.	The National Organic Flagship Programme, and Green Climate Fund and Rapid Financing Facility under UNDP supported the project financially. The hub was built at the cost of more than Nu 3 Lakhs. The Dzongkhag Administration sought funds. The Dzongkhag agriculture and livestock officials render technical services to the land users. The land users carry out fieldwork such as growing crops, rearing animals, and producing organic manures.
SLM specialists/ agricultural advisers	ADAO, Agriculture Extension Officer	The ADAO and Agriculture Extension Officer provides technical support to the land users.
national government (planners, decision-makers)	National Organic Flagship Programme	The National Organic Flagship Programme supported the project financially.
international organization	UNDP	The Green Climate Fund and Rapid Financing Facility under UNDP supported the project financially.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation			✓			The idea of establishing the Organic Agriculture Hub was proposed by the Assistant Dzongkhag Agriculture Officer. Subsequently, the ADAO and Extension teams incorporated their suggestions into his farm.
planning				✓		The Organic Agriculture Hub's complete establishment was a collaborative effort involving the land users, the Dzongkhag administration, Dzongkhag and Gewog agriculture officials.
implementation				✓		The land users, Dzongkhag administration, Dzongkhag and Gewog agriculture officials implemented the entire Organic Agriculture Hub establishment.
monitoring/ evaluation				✓		Land users, ADAO, NCOA and BFDA officials, as well as the Agriculture Extension Officer, are jointly monitoring the hub.

Flow chart



Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders
- [x] The idea for establishing the Organic Agriculture Hub and the identification of organic technologies and practices to be adopted by the land users were initiated by the Assistant Dzongkhag Agriculture Officer and the Gewog Agriculture Extension Officer.

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- ☑ land users
- ☐ field staff/ advisers

Form of training
- ☐ on-the-job
- ☐ farmer-to-farmer
- ☑ demonstration areas
- ☐ public meetings
- ☐ courses

Subjects covered

Preparation of biochar, rain water harvesting, composting and azolla production.

Advisory service

Advisory service was provided
- ☑ on land users' fields
- ☐ at permanent centres

The advisory service and assistance is provided by ADAO, officials from Agriculture Research and Development Center (ARDC) in Bajo and Gewog Agriculture Extension Officer.

Institution strengthening

Institutions have been strengthened / established
- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level
- ☑ local
- ☐ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.

The approach has promoted collaboration between research center and the local government.

Type of support
- ☐ financial
- ☑ capacity building/ training
- ☐ equipment

Further details

Research center provides technical assistance to the land users on various agricultural technologies and practices. The farm serves as an educational or organic training centre for interested farmers, researchers, and students.

Monitoring and evaluation

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: 2914.63

1. 70% of the cost by RGoB/NOFP: 281220.00 2. 30% of the cost sharing by farmers: 84,367.00 3. GCF: Compost shed and biochar materials

The following services or incentives have been provided to land users
- ☑ Financial/ material support provided to land users
- ☑ Subsidies for specific inputs
- ☐ Credit
- ☑ Other incentives or instruments

Financial/ material support provided to land users

Financial support with construction materials (cement, CGI sheet, iron rods, water pump, pipes and syntax) were provided.

	partly financed	fully financed
equipment: machinery	☑	☐
agricultural: seeds	☐	☑
construction: stone	☑	☐
cement	☐	☑
greenhouse Pre-fabricated green house were provided via cost sharing of 80:20	☑	☐

Labour by land users was
- ☐ voluntary
- ☐ food-for-work
- ☑ paid in cash
- ☐ rewarded with other material support

Other incentives or instruments

Plastic mulch was provided to the land users based on their proactiveness in farming.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? Both local communities and those from outside have benefited from the Organic Hub through participation in planning and implementation				✓
Did the Approach help land users to implement and maintain SLM Technologies? The land users have implemented a range of organic farming practices, including crop rotation, companion planting, intercropping, composting (including vermicomposting), biochar and bokashi preparations, and mulching. These practices collectively contribute to enhancing soil fertility. Additionally, the land users are involved in protected agriculture through the use of greenhouses.			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM? The implementation of Sustainable Land Management (SLM) has led land user to enhance his knowledge in both crop diversification and fertility aspects, thereby making a significant contribution to sustainable livelihoods in farming.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The existence of technology within the organic hub promotes collaboration among universities, research centers, and local government. Furthermore, the farm also functions as a technology demonstration center for visitors.				✓
Did the Approach improve access to markets? The market opportunities have improved as the farm produces organic produce which is preferred by consumers.			✓	

Main motivation of land users to implement SLM

- [x] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Land users will achieve self-sustainability without the need for external support, as their existing farming practices have been diversified and integrated.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Creating awareness about going organic through model farm.
- The soil is safeguarded and maintains its health by refraining from using chemicals like pesticides, herbicides, and fertilisers in the farming process. This practice ensures the long-term preservation of soil fertility.

Strengths: compiler's or other key resource person's view

- Organic technologies promote farm sustainability.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Reluctance to adopt the latest technology Raising awareness and showcasing technology to the users
- Sustainability of technology Enhancing skills and extending knowledge with appropriate support

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
Tshering Yangzom

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Kuenzang Nima

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 19, 2023

Last update: May 30, 2024

Resource persons
Meena Ghising - land user
Bishnu Maya Tamang - land user
Lhasang Dolma Ghising - land user
Krishna Bahadur Moktan - land user
Phurba Moktan - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6867/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Organic hub for an organic Bhutan: https://kuenselonline.com/organic-hub-for-an-organic-bhutan/
- Agriculture organic hub to help achieve country's 100 percent organic goal: http://www.bbs.bt/news/?p=179098

Physical land terracing at Namlaythang (Tashi Wangdi)

Agricultural Landscape Approach for SLM Implementation (Bhutan)

Yuenten Sazhi Zinchong Gi Dhoen Lu Sanam Sazhing Ngoe Zin Bae Thang (ཡུན་བརྟན་ས་གཞི་འཛིན་སྐྱོང་གི་དོན་ལུ་སོ་ནམ་ས་ཞིང་ངོས་འཛིན་འབད་ཐངས།)

DESCRIPTION

The Agricultural Landscape Approach in Sustainable Land Management is a holistic and integrated strategy that focuses on managing agricultural landscapes in a sustainable manner. The approach was successfully initiated in Namlaythang village and transformed the whole agricultural landscape covering 107 acres (43 ha) while benefitting 55 resettled households.

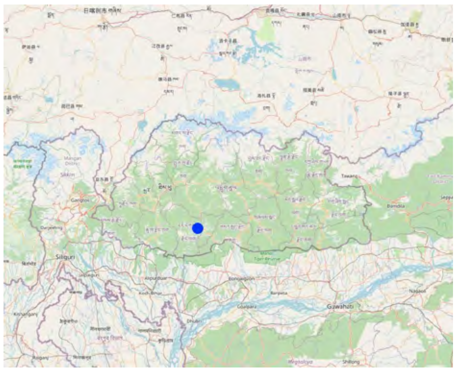
The Agriculture Landscape Approach in Sustainable Land Management (SLM) is a holistic and integrated strategy that focuses on managing agricultural landscapes in a sustainable manner. This approach recognizes the interrelation of various elements within a landscape, including soil, water, biodiversity, and human activities, ultimately aiming to optimize the benefits derived from these interactions while minimizing negative environmental impacts. This approach was initiated in Namlaythang village under Tsangkha gewog (block), Dagana Dzongkhag (district). Namlaythang was chosen for this approach because it is a new settlement with 55 resettled households who were granted land ranging from 1.75 to 3 acres (0.7 to 1.2 hectares) per family by His Majesty the King as per the National Rehabilitation Program. Since the area was recently cleared and converted to settlement and farming, there was a huge risk of land degradation due to direct exposure to rain and unsustainable agriculture practices. Therefore, it was not only timely to implement SLM to prevent land degradation but also appropriate to have adopted the Agricultural Landscape Approach by engaging the whole community.

The main aim of adopting the agricultural landscape approach was to bring transformational change at a scale. Too often, we plan and implement SLM interventions supported by different projects in small, localized areas and in a scattered manner. This limits the ability to scale out success (both spatially and temporally) despite being positive initiatives. The approach was also intended to facilitate a multi-stakeholder platform by bringing relevant stakeholders together to discuss common objectives and draw synergies across different agencies.

The process started by discussing the idea with the Dzongkhag and gewog agriculture offices followed by sensitization of land users on the importance of SLM and its technologies. This was followed by Participatory SLM Action planning wherein detailed action plans were prepared based on landowners' interest, feasibility of their land and the available technologies. The next mandatory activity carried out before implementation of SLM in the field was the conduct of field based hands-on training of the land users. The main SLM technologies planned and implemented included terracing, stone bunds, hedgerows, check dams/ gully plugs and plantations. In addition, climate resilient agriculture practices were also promoted such as greenhouses, low-cost water harvesting ponds, drip irrigation sets and fruit tree plantations.

In promoting this approach and other technologies, several stakeholders were involved including the Dzongkhag and gewog agriculture offices, National Soil Services Center (NSSC),

LOCATION



Location: Goongpa-Soomchu Chiwog, Tsangkha Gewog, Dagana Dzongkhag, Bhutan

Geo-reference of selected sites
- 90.03111, 27.02559

Initiation date: 2020

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

Agriculture Research and Development Center, Bajo (ARDC-Bajo), the landowners and a Green Climate Fund (GCF) Project. The agricultural offices provided the overall coordination and the facilitation role in implementing the approach and its associated technologies. The NSSC provided sensitization and training on SLM technologies and also facilitated participatory SLM Action Planning with the landowners and other stakeholders. Similarly, the ARDC-Bajo arranged material inputs for climate resilient agriculture practices and provided technical assistance to the landowners and the gewog agriculture extension officer. The GCF Project provided financial support based on the action plan.

The implementation of SLM and climate resilient agriculture practices following agricultural landscape approach in Namlaythang have been a great success. The approach has brought a transformational change at the landscape level through various SLM interventions which collectively contributed towards reduction of soil erosion and nutrient loss, conservation of soil moisture and the improvement of overall soil health and food security. The land users also feel empowered through sensitization, capacity building and their engagement in the whole process. In brief, the land users expressed their satisfaction with the approach and the impacts it has created in the agricultural landscape which is the basis of their livelihoods.

A major weakness of the approach is that there is no institution/group/cooperative formed for efficient coordination among the land users and other stakeholders which questions its sustainability.

Hands-on Training on SLM Technologies (Tashi Wangdi)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

To bring about transformational change through project intervention at the landscape level.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: The strong community cooperation
- **Availability/ access to financial resources and services**: The SLM and climate resilient agriculture technologies were implemented with financial support provided by the government through a Green Climate Fund (GCF) project
- **Institutional setting**: The land users implement a labour-sharing system where all the land users come together to work in the field and go to the next after completion of that field. They take turns to work in the field of all the land users.
- **Collaboration/ coordination of actors**: All the relevant stakeholders (Dzongkhag, Gewog, Research, NSSC, Land owners) came together in implementing SLM and climate resilient agriculture practices
- **Legal framework (land tenure, land and water use rights)**: The land is granted by His Majesty the King to the landless families under Land Use Certificate (LUC), where the land users have the right to settle, cultivate and make a living from the land, but do not have right to sell their land.
- **Policies**: National Food and Nutrition Security 2022 Bhutan Water Policy 2007
- **Land governance (decision-making, implementation and enforcement)**: The land users with land use right only. The land users can cultivate different crops on the land by implementing SLM technologies.
- **Knowledge about SLM, access to technical support**: Technical support was provided by the Gewog Agriculture Extension Officer, Agriculture Research Development Centre (ARDC) and NSSC. Moreover, there is a willingness of the farmers to gain more knowledge and experience.
- **Markets (to purchase inputs, sell products) and prices**: The village is well connected by the newly constructed farm road. All the farm produces can be marketed locally or can be taken to other markets

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Workload, availability of manpower**: Since most of the children were enrolled in schools, farm labour shortage is of major concern.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

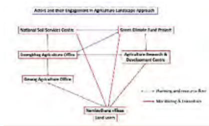
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Land owners	Attend sensitization and training program on SLM technologies and implement in the field.
SLM specialists/ agricultural advisers	National Soil Services Center (NSSC)	NSSC provided training, sensitization and demonstration on SLM technologies to the land owners
researchers	Agriculture Research and Development Centre (ARDC)	ARDC provided material inputs and technical assistance in implementing Climate Resilient Agriculture Practices in the field.
local government	Dzongkhag and gewog agriculture offices	The Dzongkhag and gewog agriculture offices arranged financial and technical assistance in implementing SLM and Climate Resilient Agriculture Practices in the field while also coordinating and facilitating the whole implementation process.
international organization	United Nations Development Programme (UNDP)	Provided financial support through a Green Climate Fund (GCF) Project

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		The land owners actively participate in the initial discussion on the SLM implementation following landscape approach. The process was facilitaed by the local government officials.
planning				✓		The land onwers and the local elected leaders were involved in the participatory SLM action planning that was facilitated jointly by the Dzongkhag and the NSSC.
implementation					✓	Land owners organized themselves into informal groups to implement SLM interventions with technical assistance from the Dzongkhag, gewog and ARDC.
monitoring/ evaluation				✓		Land owners were involved in the periodic monitoring and evaluation carried out jointly by the Dzongkhag, gewog, NSSC, ARDC and the GCF project.

Flow chart

This Flow chart shows the actors and their involvement in implementing Agricultural Landscape Approach in Namlaythang. It clearly shows that for planning and resource mobilization, other actors including the National Soil Services Centre, Green Climate Fund Project and the Agriculture Research and Development Centre worked through the Dzongkhag and Gewog Agriculture Offices. But for monitoring and evaluation, those actors can come directly to the field and carry out monitoring and evaluation without necessarily engaging the Dzongkhag and Gewog Agriculture Offices. However, if there is a need, they can inform and invite Dzongkhag and Gewog Agriculture Officials.



Author: Tashi Wangdi

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)
- [x] The decision was made based on the sensitization and the feasibility of the farming landscape.

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers

Form of training

- [ ] on-the-job
- [ ] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [ ] courses

Subjects covered

SLM Technologies (Terracing, hedgerows, stone bunds, plantations and check dams)

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

Advisory services were provided by the agriculture advisers from the Dzongkhag and Gewog Agriculture offices.

Institution strengthening

Institutions have been strengthened / established

- [ ] no
- [ ] yes, a little
- [ ] yes, moderately
- [x] yes, greatly

at the following level

- [x] local
- [x] regional
- [x] national

Describe institution, roles and responsibilities, members, etc.

There is no new institution established within the approach. However, various institutions were involved in promoting the technologies under the approach. At the local level, Dzongkhag and Gewog agriculture offices were involved in overall coordination and provided technical guidance. The Dzongkhag agriculture offices were also involved in sourcing funds for the implementation of the approach. Regional Agriculture Research and Development Center, Bajo (ARDC-Bajo) arranged material inputs for climate-resilient agriculture practices and provided technical assistance to the gewog agriculture extension officer and land owners. National Soil Service Center (NSSC) provided sensitization and training on SLM technologies and also facilitated participatory SLM Action Planning with the land owners and other stakeholders. The Green Climate Fund (GCF) Project was the main funding agency providing financial support based on the action plan.

Type of support

- [x] financial
- [x] capacity building/ training
- [x] equipment

Further details

The major financial support was provided by the GCF project and minor fund support was provided by the government for the implementation of the approach. Various stakeholders including NSSC, ARDC-Bajo, Dzongkhag and gewog offices were involved in the capacity building of the land owners. However, gewog offices were involved constantly due to the proximity and direct contact with the land owners. Equipment for the construction of greenhouses, low-cost water harvesting ponds, drip irrigation, terracing, stone bunds, hedgerows and check dams were provided during the implementation of technologies under the approach.

Monitoring and evaluation

The monitoring and evaluation are periodically done by the Dzongkhag Agriculture Office, NSSC and the Project Management Unit of the GCF Project.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [ ] < 2,000
- [ ] 2,000-10,000
- [x] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

The main funding source is GCF project

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [x] Other incentives or instruments

Financial/ material support provided to land users

The implementation of all the SLM technologies was funded by the GCF project. Besides, land owners also received material supports such as greenhouses, low cost water harvesting ponds, drip irrigation sets, seeds and seedlings with financial support from the project and government.

	partly financed	fully financed
agricultural: seeds Vegetable seeds		✓
construction: stone For stone check dam construction in the gullies		✓
construction: stone: wood For log check dam construction in the gullies		✓

Greenhouse Prefabricated Greenhouse sets	✓

Labour by land users was
- ✓ voluntary
- food-for-work
- paid in cash
- rewarded with other material support

Other incentives or instruments

The SLM Technologies and Climate Resilient Agriculture practices were provided in line with the SLM Guidelines and Best Practices 2021 and the Cost Sharing Mechanisms of the Ministry of Agriculture and Livestock.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The approach empowered local land users through capacity building and self-mobilization in implementing SLM technologies in the field.				✓
Did the Approach help land users to implement and maintain SLM Technologies? The landscape approach encouraged all the land owners to participate and implement SLM Technologies.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? The landscape approach enabled stakeholders to converge and coordinate better planning and implementation by avoiding duplication and harnessing synergy and complimentary effects.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? The training and technical support were provided to the land users improving their knowledge and skills to implement SLM technologies.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The landscape approach greatly enhanced collaboration between the existing stakeholders as it brought all the relevant stakeholders together to improve the land on which people depend for their livelihoods. For example, the gewog extension officers were trained by NSSC and ARDC-Bajo to disseminate technical information to the land users. However, there is no institution/group formed as part of the approach through which land users communicate within themselves or with other stakeholders to maintain or improve the technologies under the approach.			✓	
Did the Approach lead to improved food security/ improved nutrition? Through this approach different SLM and Climate Resilient Agriculture practices were implemented which ensures better soil health, better soil productivity and improved food security.				✓
Did the Approach lead to improved access to water and sanitation? Through this approach, certain supports were given to improve access and better utilization of water resource.			✓	
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? The landscape approach did improve the capacity of the land users through training and their active participation in the implementation of SLM technologies in the field.				✓
Did the Approach lead to employment, income opportunities? The landscape approach did contribute moderately to employment and income opportunities as some of the SLM technologies encouraged land owners to work their land and produce more for cash income.			✓	

Main motivation of land users to implement SLM
- ✓ increased production
- ✓ increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- ✓ reduced risk of disasters
- reduced workload
- payments/ subsidies
- rules and regulations (fines)/ enforcement
- prestige, social pressure/ social cohesion
- affiliation to movement/ project/ group/ networks
- environmental consciousness
- customs and beliefs, morals
- ✓ enhanced SLM knowledge and skills
- ✓ aesthetic improvement
- conflict mitigation

Sustainability of Approach activities
Can the land users sustain what hat been implemented through the Approach (without external support)?
- no
- ✓ yes
- uncertain

Based on the experience that land users have gained over the past 5 years, the land owners can sustain the technology implemented through this approach without external support as the maintenance cost is very minimal. The land owners feel that they can carry out maintenance on their own.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The community has not experienced any reported problems related to landslides, indicating the positive impact of terracing and check dams that have ensured the overall stability and sustainability of the area.
- The land users can make a living from increased agricultural production and cash income.
- Since the land was granted by His Majesty the King, the community receives so much of attention and technical support from different agencies. This has enabled the land users to avail much needed SLM interventions through the landscape approach.

Strengths: compiler's or other key resource person's view

- The land users are exposed to new knowledge and skills to implement SLM technologies, which could serve as a model for further replication in other areas.
- There is a transformational change at the landscape level, which otherwise becomes difficult if landscape approach was not adopted.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- No institution/group/cooperative has been formed for efficient coordination among the land users. By forming a permanent or formal group to continue the implementation and management of the SLM technologies.
- Limited integration of livestock and forest related technologies due to limited fund. Explore additional funding source from other sources such as Bhutan Trust Fund for Environmental Conservation (BTFEC) and UNDP Small Grant Project (SGP) to support implementation of livestock and forestry activities.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- No lead agency or personnel to initiate group formation. The Gewog Agriculture Extension Officer could lead the group formation if they feel the need.
- Lack of frequent monitoring of the implemented SLM technologies leading to reduced performance in terms of agriculture production and maintenance of the SLM technologies. Ensure timely monotiring from the Gewog and Dzongkhag Agriculture offices

REFERENCES

Compiler
Nima Dolma Tamang

Editors
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Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Damchoe Dorji - land user
Tsagay - land user
Jigme Dema - land user
Yeshi Wangda - land user
Nyagay Norbu - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6848/

Linked SLM data
Technologies: Staircase Technology https://qcat.wocat.net/en/wocat/technologies/view/technologies_7391/

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Sustainable Land Management (SLM) Guidelines and Best Practices 2021, The National Soil Services Center, Department of Agriculture, Ministry of Agricultue and Livestock: The National Soil Services Center, Semtokha, Thimphu, Bhutan

Links to relevant information which is available online

- Zhesar namleythang: https://www.facebook.com/people/Zhesar-namleythang/100063962648613/?paipv=0&eav=AfZtqSeoJRJKQqV2pCQNI-Il9HsLY_XP-7nuLPGmeGHxTe7zq2FNEBbJReJwVuGjErk&_rdr

Farmers of Organic Model village Lull, Lengbi Chiwog (Niki Rai)

Model Village Approach to Scale out Organic Agriculture (Bhutan)

Petoen Gi Yue Ngoe Zin Baedhi Rangzhin Sanam Dharchhab Tangthab (དཔེ་སྟོན་གྱི་གཡུས་ངོས་འཛིན་འབད་འདི་རང་བཞིན་སོ་ནམ་དར་ཁྱབ་བཏང་ཐབས།)

DESCRIPTION

Organic agriculture includes a variety of farming systems that advance the sustainable production of food and fibres, prioritizing human health, and environmental, social, and economic aspects. The main objective of the model village approach is to promote the commercialization of organic farm produce.

Organic farming is a system of agricultural production based on the use of natural processes and resources. Organic farming is on the rise worldwide. Until 1961, when chemicals were introduced to Bhutanese farmers, Bhutan was 100% organic. There were no chemicals to buy and no chemicals to use. There were no genetically modified seeds to buy and no genetically modified seeds to use. Farmers were required to weed their field by hands instead of spraying butachlor, a powerful pesticide used in paddy fields. According to Dzongkhag agriculture officer (DAO), a farmer in Wangdue, said that organic agriculture is "what we used to do." Traditional farming methods in Bhutan are organic and the departure from that has been a recent movement. But young farmers who started after the introduction of chemicals cannot remember a time when chemicals were not a part of their farming practices. The increase in chemicals is a recent trend, and depending on which chemical is under consideration the trend has either stagnated or grown. According to the national organic program, the use of fertilizer has remained constant over the last thirty years. On the other hand, the use of synthetic herbicides has grown each year. The primary example of herbicides used are butachlor in rice paddy fields and metribeuzin in potatoes (Hokenson, 2014).

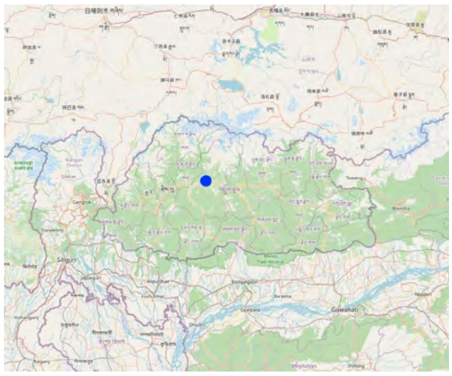
The Department of Agriculture in collaboration with Dzongkhag Agriculture Office and Gewog Administration identified Lull village, Lengbi Chiwog of Kazhi gewog as a "Model Organic Village" to improve the livelihoods of people through crop diversification and income generation. Lull village was identified as an organic village in 2018. The main objective of this approach is to promote the commercialization of organic farm produce through post-production and value addition (Dorji, 2022).

In 2013, 51-year-old Tashi Bidha was the only farmer in Lull, a village situated in the Kazhi gewog region, approximately 40 kilometers from Bajo, Wangdue. The village, comprising a mere eight households, was classified as one of the most isolated in the Wangdue region. Lull is presently the first prosperous organic village in Wangdue. This began in 2013 with the initiative of one individual to establish road connectivity. Phub Dorji, a native of Lull, remarked that the village lacked roads and electricity at the time.

The village's application for road connectivity was rejected in 2013 due to its failure to satisfy the minimum threshold of 20 households. Many were apprehensive when Phub Dorji suggested that they make their own road. Following some deliberation, however, six households reached a consensus. Six households contributed more than Nu.500,000 towards the repair of the 8.8 kilometers of road in Lull. Electricity arrived in the village months after the road was constructed. The community consented to transition to organic practices in 2017.

Wangdue's agriculture extension stated the village received potato seeds, asparagus seedlings, bio-fertiliser, bio-pesticide and vermicomposting among others. The village has five polyhouses, and they have first-hand training in bio-pesticide preparation. They are now technically equipped. Lull previously cultivated wheat, barley, and chili. The village currently produces more than eleven different types of commodities and distributes its goods in Phuentsholing, Thimphu, Punakha, and Wangdue. Potatoes, garlic, and chili peppers are among the principal cash commodities of Lull. Presently, income generation has increased to Nu 770,000 since the transition to organic practices.

LOCATION



Location: Kazhi, Lull village, Wangdue phodrang, Bhutan

Geo-reference of selected sites
- 90.09301, 27.55582

Initiation date: n.a.

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

Organic farm of Lull Village, Lengbi Chiwog. (Niki Rai)

Hands on training on Low Cost Plastic House Construction to the Land Users. (Mr. Sangay Wangdi, Senior Extension Supervisor, (Dzongkhag Organic Focal))

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

To improve the livelihoods of people by through crop diversification and income generation while promoting the commercialization of organic farming through post-production and value-addition for independency and self sufficiency.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Able to conserve biodiversity and nature resources on farm and in the surrounding environment.
- **Availability/ access to financial resources and services**: Increasing income and reducing production cost
- **Collaboration/ coordination of actors**: Integration of traditional knowledge, joint problem solving and farmer to farmer exchange can improve a community relations and lead to greater involvement and commitment of producers.
- **Policies**: Organic farming policy will help to protect farming communities in the present global situations.
- **Knowledge about SLM, access to technical support**: Sustainable use of resources ultimately protecting lands and use of organic fertilizers improving soil fertility
- **Other**: Environment- Reduces environmental contamination risks and minimises the public health costs of pesticide poisonings, etc.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Knowledge about SLM, access to technical support**: Less aware to the organic technical knowledge
- **Markets (to purchase inputs, sell products) and prices**: Higher prices for the organic products leading to low consumer demands and no specific market outlet for organic production.
- **Workload, availability of manpower**: Extensive labor as organic farm management requires intensive care and monitoring.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Land users	To practice various methods of organic farming
national government (planners, decision-makers)	National Centre for Organic Agriculture (NCOA)	Provide training on Organic farming practices, Local Organic Assurance Standard, facilitate farm input support, field inspections and certification.

Lead agency

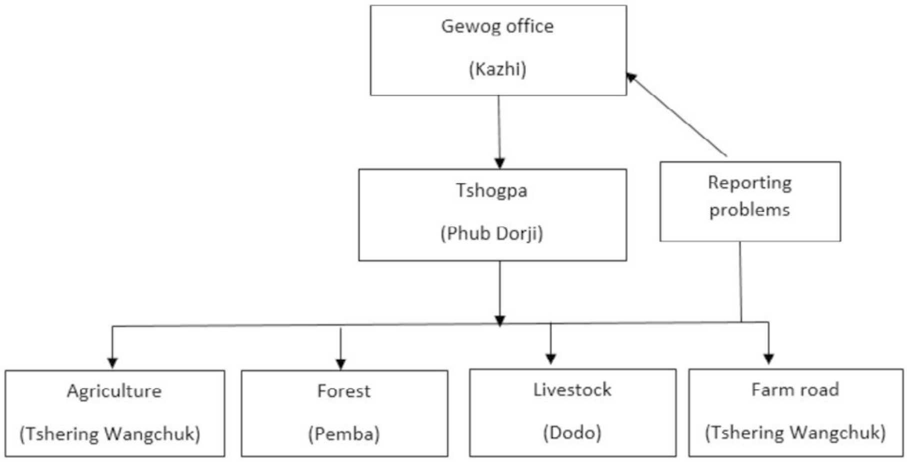
Dzongkhag Organic Focal Person, Extension Supervisor and Tshogpa.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	Lull, an abandoned village before 2013 due to its remote location, has witnessed a revival. Mr. Phub Dorji, the current Tshogpa of Lenbee chiwog from Lull village, has taken the initiative to construct the Lull farm road. He collected contributions for fuel and basic maintenance from beneficiaries, and the Dzongkhag Agriculture Office facilitated the deployment of a CMU Excavator. The construction of a 9.00 km farm road to Lull village was a collaborative effort, gradually connecting with the Dzongkhag and extending further to the National Centre for Organic Agriculture (NCOA). Thereafter, Lull village has been adopted as a "Model Organic Village".
planning			✓			The Dzongkhag, Gewog, and NCOA have collectively formulated a plan in consultation with land users and submitted a funding request to GEF-LDCF.
implementation					✓	NCOA, Dzongkhag Agriculture Office, Gewog Agriculture Office and Land Users.
monitoring/ evaluation		✓				The monitoring and evaluation as sited above were in team comprising of representative from NCOA, Dzongkhag and Gewog. Compilation of progress report and submission annually to NCOA, Dzongkhag and Gewog Administration.

Flow chart

Organic model village/ group and its linkage with the gewog center



Author: Niki Rai

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [ ] field staff/ advisers

Form of training
- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [x] public meetings
- [ ] courses

Subjects covered

Land users were provided with wide range of training targeting towards organic farming practices. The training was provided on Low Cost Plastic House Construction, Soil fertility Management (Composting & Vermi Composting), Nursery raising & transplanting, Bio Pesticide preparation and application and Post Harvest Management practices focusing on target crops. Further they were also provided with study tour to ARDC Bajo to update on the latest technology targeting on Soil fertility and Bio Pesticide management besides Bio Char preparation.

Advisory service

Advisory service was provided
- [x] on land users' fields
- [x] at permanent centres

Advisory services are provided from Gewog Agriculture Extension Supervisor/ Dzongkhag Organic Focal, ARDC Bajo, National Center for Organic Agriculture (NCOA).

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [x] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
They are able to produce organic products for their self consumption and also able to supply to other institutions like schools and to the common vegetable markets.

Type of support
- [ ] financial
- [x] capacity building/ training
- [x] equipment
- [x] Seeds, Bio Fertilizers, Bio Pesticides/Fungicide, Low Cost & Prefabricated Plastic House, Electric Fencing Materials & Grass cutter.

Further details
Land users were provided with inputs (Improved Seeds, Bio-Fertilizers, Bio-Pesticide and Fungicide) at the initial stage prior to the capacity building. After the training, the inputs that land users can afford were gradually lifted through timely consultation meetings. The crucial inputs that the land users can't afford were included in the plan - and they were supplied with electric fencing materials to mitigate crop depredation from wild pests followed by a grass cutter for timely weed management within and around the field.

Monitoring and evaluation

Monitoring and evaluation were done during the field visit to assess the physical progress by Extension Supervisor, Dzongkhag Agriculture Office & NCOA followed by consultation meetings where progress are reviewed and new plan were proposed. This progress and plan were finally submitted to NCOA, Dzongkhag Agriculture Office and Gewog Administration annually.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [x] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: 4000.0

GEF-LCDF

The following services or incentives have been provided to land users
- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

Funding in the initial set up was provided by GCF-LCDF- which stands for Global Environment Facility-Least Developed Countries Fund

	partly financed	fully financed
equipment: machinery Rice milling machine and other processing machine		✓
equipment: machinery: tools Green house	✓	
Electric fencing materials, Grass cutter		✓

Labour by land users was

- [x] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? Improved community relationship and led to greater involvement of the stakeholders and commitment of the producer			✓	
Did the Approach enable evidence-based decision-making? Land users proposal while planning has been improved from the initial. They can prioritize their needs towards strengthening organic farming.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? Organic farming practices improves sustainable use of resources ultimately resulting in conserving natural resources and increasing soil fertility			✓	
Did the Approach improve coordination and cost-effective implementation of SLM? Improved livelihoods through higher income generation and reduced production cost				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? There is an exchange and learning platform among the stakeholders			✓	
Did the Approach improve knowledge and capacities of other stakeholders? The approach involves a participatory decision making process.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The group is encouraging and influencing other local communities and has been learning site disseminated through television.			✓	
Did the Approach mitigate conflicts? Enhance team work, collaboration and cooperation among community and stake holders			✓	
Did the Approach empower socially and economically disadvantaged groups? This approach helped financially unstable farmers to improve their livelihood			✓	
Did the Approach improve gender equality and empower women and girls? No gender bias				✓
Did the Approach encourage young people/ the next generation of land users to engage in SLM? The evidence based learning through hands on training and study tour to ARDC Bajo has encouraged the young people currently in the community while those young students attending during the break and social influence are encouraging the young generations to take up the organic farming in the future.			✓	
Did the Approach lead to improved food security/ improved nutrition? The approach of organic farming provided healthy production leading to improved food security and nutrition.			✓	
Did the Approach improve access to markets? No specific market outlet for un processed organic product especially fresh vegetables though follow up are being done by Dzongkhag with opening of Organic Market Outlet at Bajo Town.	✓			
Did the Approach lead to improved access to water and sanitation? There is no usage of chemical fertilizers resulting in the reduction in pollution.			✓	
Did the Approach lead to more sustainable use/ sources of energy? This approach is an integrated human, environment and sustainable agriculture production system while reducing external inputs like use of synthetic fertilizers and other harmful chemical pesticide.				✓
Did the Approach lead to employment, income opportunities? Young generations are being encouraged to adopt organic production systems			✓	

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [x] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [x] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [x] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Organic production encourage long term commitment to maintain soil fertility, particularly addressing soil erosion, degradation and desertification and also reduce external energy consumption and reduce water use

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Low cost of investment and low external input use
- Higher prices for organic products provide higher earning for producer involved in production, processing and trade hereby benefiting the small farmers

Strengths: compiler's or other key resource person's view
- Provide awareness and knowledge among the producers about organic farming techniques
- Increase international organic market and provide niche export market for Bhutanese farmers that can comply with organic standards
- Provide a platform for business development in producing organic products and processing high value organic products(manufacturing)

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- Labor intensive Mechanization
- Lack of knowledge on organic production Hands on training on organic production
- Lack of specific market for organic production Need support policies from high levels

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- Certification is costly for small farmers and could be a serious barrier to access a market that will require certification in future. Proper legal framework and policies for farmers with affordable price in future.
- Limited awareness in the domestic market about nutritional, safety and quality of organic farm produce More awareness in the market as well as consumers

REFERENCES

Compiler
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Resource persons
Pemba - land user
Phub Dorji - land user
Dodo - land user
Tshering Wangchuk - land user
Tshering Wangchuk - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6838/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
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- Model organic village prospering, Chenga Dorji, 2022: website, BBS

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Glimpse of approach 'Land Use Certificate to engage youth in Agriculture' (Tshering Yangzom)

Land Use Certificate to engage youth in Agriculture (Bhutan)

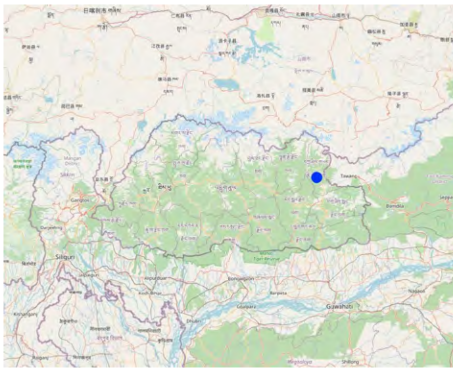
Nazhoen Sanam Na Dreltog Baeni Dhoen Lu Sa Chha Koelched Lagkher (ན་གཞོན་སོ་ནམ་ནང་འབྲེལ་གཏོགས་འབད་ནིའི་དོན་ལུ་ས་ཆ་བཀོལ་སྤྱོད་ལག་ཁྱེར།)

DESCRIPTION

The Land Use Certification (LUC) commenced in 2015 as the new allocation system for land and provided a new title of land tenure. Initially, LUC focused on allotting land to Government institutions and Gerab Dratshang (monastic bodies). However, LUC later focused on the unemployed youth who were interested in commercial farming.

The Land Use Certification (LUC) commenced in 2015 as the new system for the allocation of land and a new title of land tenure. Initially, LUC focused on allotting land to Government institutions and Gerab Dratshang (monastic bodies). However, LUC later focused on the unemployed youth who were interested in commercial farming. This documentation is based on the LUC group 'Tshendung LUC Integrated Farming Association'.
The main aims of the LUC approach are 1) to help sustainably manage and enhance productive use of land, 2) to encourage next-generation farming through farm mechanization and large-scale enterprising farming, and 3) to enhance the rural economy.
The approach started as an initiative towards the realization of the noble vision of strengthening sovereignty and security and enhancing social policy of equity and the national objective of self-reliance. Unemployed youth groups are expected to help sustainably manage and enhance the productive use of land - and the approach was to encourage next-generation farming through farm mechanization and large-scale production to promote enterprise-based farming and enhance the rural economy. Initially, it started with a meeting between district officials and unemployed youth. Later, bylaws were created, and agreements were signed. This was followed by sending youth for capacity development within and outside the country. They were trained on how to operate power tillers, use grass cutters and chain saws, and on the installation of electric fencing and greenhouses. In addition, they were trained in how to grow vegetables, fruit crops, and livestock production. In parallel infrastructure development activities were taking place in the current project sites.
The Tshendung LUC Integrated Farming Association enables land users to carry out agricultural activities more effectively. In addition, the association was able to transport and market their produce more efficiently than individual households. Other co-benefits reported are the improved community sense and enhanced social cohesion because the exchange of experiences and collaboration builds mutual trust. Working in a group eases hard physical work on the 9 acres (3.6 ha) of land.
The District Office initiated the group formation upon command from higher authority. They were also involved in planning, forming groups, bylaws, and monitoring the activities of the group. The District agricultural and livestock officers provided technical guidance on crop and livestock production. They also provided them with agricultural inputs. Lichen Primary School are consumers of the agricultural and livestock goods produced by the group. Land users are involved in planning the production and marketing of agricultural and animal products.
Initially, there were 11 youths in the group. They were provided with wide-ranging training and support including the preparation of land for growing crops and the construction of their

LOCATION



Location: Tshendung, Lichen chiwog (village), Yangtse gewog (sub district): Trashi Yangtse Dzongkhag (District), Lichen, Trashi Yangtse: Bhutan, Bhutan

Geo-reference of selected sites
- 91.47225, 27.57153

Initiation date: 2015

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

residence. In addition to agricultural inputs like seeds, and saplings, the group was also provided farm machinery and farm tools for easy implementation of farm works. The group is happy with all the initiatives the government has done, however, one thing that discouraged the group from continuing with farming activities was the location of the site. They didn't like the location - which is in the middle of the forest around 15-20km away from the town. This makes transportation of agricultural inputs like seeds and feeds and marketing of agricultural and livestock products very difficult. The government initially supported the group with everything but later this support was withdrawn, which made it very difficult for the group to survive on their own.

LUC project site, Lichen: Trashi Yangtse (Tshering Yangzom)


Poultry shed of the group (Ongpo Lepcha)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main aims/objectives of the approach are to 1) foster youth entrepreneurship in the country, 2) promote, foster, encourage, and assist the efficient, convenient marketing and distribution of agricultural products, livestock, and associated by-products with the growing market within Trashi Yangtse and other districts in the country.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Land users are generally from the same local ethnic groups called Yangtsepa. They shared the same social, cultural, religious, norms and values. Gender equality is considered and importance and priority is given equally.
- **Knowledge about SLM, access to technical support**: Technical support related to agriculture and livestock is provided by the District Agriculture officer and livestock officers. Inputs like seeds are also freely provided by the district. The activities are also monitored by the officers and advices are given if land users are doing thing wrongly.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services**: Initially, land users were provided all required support by the project including financial support, however, when the land users started implementing and working on the approach own their own. Gettingfinancial support was difficult.
- **Institutional setting**: Initially, there were 11 land users involved, however, today only two of the land users are active. Shortage of human resources hinders production and this result in low profit.
- **Collaboration/ coordination of actors**: Although the land users are able to produce a certain quantity of vegetables there are not many collaborators willing to buy their produce. They also lack a farm manager who can dedicate 100% of his time in marketing andfinding collaborators.
- **Markets (to purchase inputs, sell products) and prices**: The site of the approach is located very far from the market. The size of the market is very small with lots of other competitors like farmers groups i.e., Vegetable group, milk group, etc. And due to this competition, the prices the land users get are very low.
- **Workload, availability of manpower**: Totally, there are about 9 acres of land and there are only two land users who are active and working in the land. The workload is too much and this affects their production.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Youth from local communities	They are the land users on the project site.
SLM specialists/ agricultural advisers	District Agriculture and Livestock officers	Advisors: All technical supports related to the production of crops and livestock are provided by these officers.

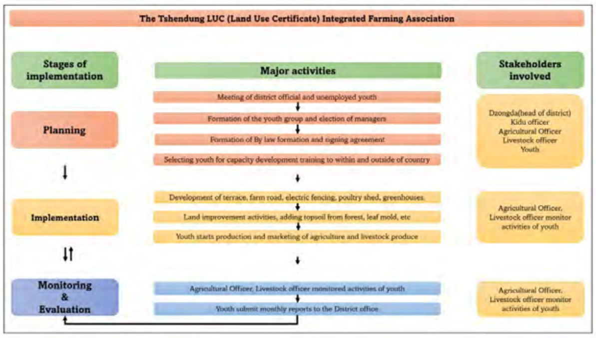
teachers/ school children/ students	Lichen Primary School	Consumers: Vegetables produced by the land users are sold to the school.
national government (planners, decision-makers)	District head office	Decision makers: provide technical support and financial support. involved in the planning and implementation of the activities under the approach.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation			✓			District officer, Kidu officer directed the youths on the opportunity through this approach.
planning				✓		The district officer, engineer, agricultural and livestock extension officer, head of the gewog/block, and land users identified the place and started the planning.
implementation				✓		The district engineer started the land development activities by creating a terrace and farm road. This was later followed by agricultural and livestock activities.
monitoring/ evaluation				✓		Focal person for LUC Agriculture extension officer Livestock extension officer District legal officer

Flow chart

Flow chart of the major events that took place before youth started taking care of the land. Also indicates different phase of approach and stakeholders involved.



Author: Ongpo Lepcha

Decision-making on the selection of SLM Technology

Decisions were taken by
- ✓ land users alone (self-initiative)
- mainly land users, supported by SLM specialists
- all relevant actors, as part of a participatory approach
- mainly SLM specialists, following consultation with land users
- SLM specialists alone
- politicians/ leaders

Decisions were made based on
- evaluation of well-documented SLM knowledge (evidence-based decision-making)
- research findings
- ✓ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- ✓ Capacity building/ training
- ✓ Advisory service
- ✓ Institution strengthening (organizational development)
- ✓ Monitoring and evaluation
- ✓ Research

Capacity building/ training

Training was provided to the following stakeholders
- ✓ land users
- field staff/ advisers

Form of training
- on-the-job
- ✓ farmer-to-farmer
- ✓ demonstration areas
- public meetings
- courses

Subjects covered

Production of fruits and vegetables, Poultry and dairy production, Power tiller operation, and record keeping.

Advisory service

Advisory service was provided
- ✓ on land users' fields
- ✓ at permanent centres

The agricultural extension officer and livestock officer provided advice on what crop to grow, and what livestock to rear.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
Institutional strengthening between the group and the Lichen Primary School was strengthened. Here the group is a producer of vegetables, butter, and cheese and the school is the buyer.

Type of support
- [ ] financial
- [ ] capacity building/ training
- [ ] equipment

Further details

Monitoring and evaluation
Crop and livestock production were monitored through observation by the agricultural officer and livestock officer.

Research
Research treated the following topics
- [ ] sociology
- [x] economics / marketing
- [ ] ecology
- [x] technology

The research was conducted to study the feasibility of different vegetables in different seasons. Trials were conducted and land users found out that most vegetables don't do well except vegetables like cabbage, beans, and chilli.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

There is no budget allocated for any SLM technologies in this approach. All financial needs were met by the project.

The following services or incentives have been provided to land users
- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [x] Other incentives or instruments

Financial/ material support provided to land users
Construction support: Road constructed by project, land development done by project Constructional material support: Electric fencing, housing, Irrigation, greenhouse, power tillers, power chain, grass cutter, wheelbarrow, secateurs, spades, shovels, etc.

	partly financed	fully financed
equipment: machinery The cost for 3 power tillers, 3 power tillers, 3 grass cutters, and 1 chaffer is all provided by the project for free.		✓
equipment: machinery: tools Tools like spades, secateurs, shovels, spade, sickle, rake, pruning saw, wheelbarrow, knife,		✓
agricultural: seeds Vegetable seeds were provided free by the project		✓
agricultural: seeds: fertilizers Suphala were initially provided for free.		✓
infrastructure: roads The cost involved in road and land development was paid by the project.		✓
House All materials used for making house and stores were provided by the project.		✓

Labour by land users was
- [ ] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [x] rewarded with other material support

Other incentives or instruments

Land development was carried out under the supervision of the District Agricultural and livestock officers, who are SLM experts at the district level. Greenhouses with simi automated irrigation, terraces with bunds, and electric fencing were promoted as incentives through the project.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? Land users received various training which helped them equip with knowledge and skills related to the use of agricultural machinery like power tillers, grass cutters, and chaffer machines. In addition, they also learned how to grow vegetables and fruits scientifically.			✓	
Did the Approach enable evidence-based decision-making? Land users initially practiced growing crops based on the local communities, however, later they learned to do off-season vegetables using a greenhouse, and the vegetables they grew were all based on the evidence that some vegetables are not doing good in the location.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? The site of the approach is located away from local communities. Using technologies like electric fencing became very important. The land user also shared their view on aspects and slopes of the land and their activities like maintaining the slope and fertility of the land. Land user also added that they were taught how to grow Napier grass to reduce land degradation.			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM? Land users received various training which helped them equip with knowledge and skills related to the use of agricultural machinery like power tillers, grass cutters, and chaffer machines. In addition, they also learned how to grow vegetables and fruits scientifically. This knowledge and skills indirectly helped them to maintain soil fertility and increase production.			✓	
Did the Approach empower socially and economically disadvantaged groups? Land users were mostly unemployed youths from nearby villages. They were sons and daughters of socially and economically disadvantaged groups. Some of them had an educational background and some never went to school. The approach have empower this youth very much in term of knowledge and skills.			✓	
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Land users were mostly youth between the age group of 20 to 30. This indicates that the approach has encouraged young people to engage in SLM.			✓	
Did the Approach lead to employment, income opportunities? It was learned that initially when this approach first started there were around 20 youths involved. Many youths have left the group after they have improved their skills and knowledge through the approach. Today many of them have their own farm and business.			✓	

Main motivation of land users to implement SLM

- [x] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [x] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [x] no
- [ ] yes
- [ ] uncertain

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Employment: The approach provided employment opportunities to more than 20 youth who were from socially and economically disabled groups.
- Income: The approach also became the source of income for 20 youths who were involved in the approach.
- Diversified source of income: With support from the project many technologies were incorporated into the site, like a poultry farm, fruit trees, vegetables, and a greenhouse. These technologies acted as a source of income for the land users.

Strengths: compiler's or other key resource person's view

- Capacity building and opportunities: Through the approach, land users were trained in different aspects like how to use power tillers, power chains, and grass cutters. livestock rearing, vegetables, and fruit cultivation. Through this training, their knowledge and skills were developed which was plus point as it provided an opportunity to look for better options.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Labor shortage: Initially 20 land users were involved however as time passed by, many left the group and this created a labor shortage. If the government can penalize those who leave the group.
- Crop failure: Since the site is located in a high altitude area (2300 masl) many crops do not grow well. This discourages land users and many left the group. Greenhouses are provided with drip irrigation facilities only. If Automation is added in the greenhouse it could solve the problem.
- Marketing: Local markets are captured by local producers. Land users shared their views on exploring market opportunities in another district. They also added that even if they find a good market it will be difficult since they don't have their own marketing van. Providing marketing van.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- A penalty for breach of contract: The land users were free to leave the group even after receiving capacity development training. If this was the case a time will come when everyone will leave. Therefore, we felt the government should make strict rules on those who leave the group after getting training.
- Wrong site selection: The current site is located 15-20Km away from the main town. The site is also located in the middle of the forest. When sites are very far from the market, it will be difficult for transporting agricultural inputs/products to and from the market. Providing a marketing van or changing the site.
- Loan: Government should arrange loan facilities for land users. This is because initially they were huge in number and the government supported them with everything. Now there are very less number of active land users and they require financial support to hire laborers and to buy agricultural inputs like seeds and feed for animals. If loan facilities are arranged for active land users it would solve the problem.

REFERENCES

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Reviewer
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Resource persons
Kuenzang Tenzin - land user
Sither Wangmo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6886/

Linked SLM data
n.a.

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

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Land users in the Chudawoong Commercial Vegetable Group and Agriculture Extension officer (first person from right) (Ongpo Lepcha)

Enhancing Agricultural Production Through Fallow Land Reversion (Bhutan)

Zhingtong Zhachoed Baedhi Sanam Thoenshug Yarseng Tangni (ཞིང་སྟོང་ཟ་སྤྱོད་འབད་འདི་སོ་ནམ་ཐོན་ཤུགས་ཡར་སེང་བཏང་ནི།)

DESCRIPTION

The approach is to enhance production of local vegetables and fruits through fallow land restoration - under a group established for the purpose.

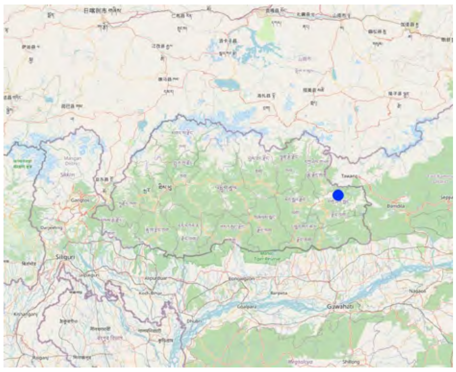
This approach of reverting fallowed land to productivity encompasses leasing land, working in groups, promoting SLM technologies, and forging market linkages. In this example, the land belongs to the community Lhakang (temple) where the community used to grow maize and pulses to be offered to the Lhakang. However, with increased wild animal depredation, and shortages of irrigation water the land was left fallow. In 2019, with support from the government and the Commercial Agriculture and Resilient Livelihoods Enhancement Program (CARLEP), International Fund for Agriculture Development (IFAD) Project, interested farmers from the community came together, leased the land, and started cultivating vegetables. The reverted fallow land is thus cultivated by the Chuthawoong Commercial Vegetable Farming group which is divided into three subgroups – one of women only - to increase efficiency. The group consist of seven and nine men in two male groups and seven women in one female group. There are no youths involved. The initial development involved the implementation of various SLM technologies such as stone bunding and napier grass strips to reduce soil erosion. Developing market linkages is another characteristic of the approach. The Regional Agricultural Marketing and Cooperatives (RAMCO) linked the land users with three schools to sell vegetables. Furthermore, the group signed a contract with Bhutan Agro Industries Limited (BAIL), Lingmithang (state-owned company) to supply dragon fruit and pineapple for processing.

The main aims and objectives of the approach are to become self-sufficient in vegetables and reduce imports, improve the livelihood and income of the land users and retain youth in agriculture through agricultural mechanization. The methods involved in implementing the approach were consultation among the community leaders and land users, and higher-level consultation with the Gewog Leaders and Dzongkhag Officials, consultation with the Agriculture Research and Development Center (ARDC) Wengkhar and with CARLEP project members.

Stages of implementation included conducting a feasibility study, followed by consultation meetings with the land users. Land development was carried out along with the installation of facilities including fencing, greenhouses, irrigation, and irrigation water storage tanks. After that, the group was formed and bylaws established. Seeds and seedlings were provided by the government.

Stakeholders involved include Gewog officials to develop land lease agreements. The Gewog Extension officer was involved throughout the process in providing guidance and support concerning irrigation, land development, vegetable and fruit cultivation and others. Dzongkhag officials were involved in the feasibility study and planning, and as one of the funding source. CARLEP act as the biggest funding agency to facilitate infrastructure support along with carrying out monitoring activities. ARDC-Wengkhar provided technical support and RAMCO established market linkages.

LOCATION



Location: Pakaling Chiwog, Radhi Gewog,, Trashigang Dzongkhag, Bhutan

Geo-reference of selected sites

- 91.72469, 27.38236

Initiation date: 2017

Year of termination: n.a.

Type of Approach

- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

Land users benefit from increased household income and being self-sufficient in vegetables. The major challenges faced by the land users are distance, as the land is located far away from their houses, and marketing issues, as total production remains above market demand.

Pineapple cultivation in the reverted fallow land (Ongpo Lepcha)

Image showing relevant information of the approach. (Ongpo Lepcha)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main aim of the approach is to reduce imports by increasing vegetable production, Improve the livelihood and living standard of the land users and retain youth in agriculture through agriculture mechanization.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services**: The approach received financial support from various organizations. Dzongkhag Administration (Royal Government of Bhutan) provided Nu. 500,000/-, followed by Nu. 850,000/- from CARLEP-IFAD project and Nu. 90,000 from BAIL.
- **Institutional setting**: There is a very good collaboration between the institutions such as Schools and with the BAIL.
- **Collaboration/ coordination of actors**: Although financial support was provided, the community came together to contribute labour for 300 days per household. The farm is Local Organic Assurance System (LOAS) certified and there is a common understanding to follow the organic guidelines.
- **Legal framework (land tenure, land and water use rights)**: The land belongs to the community Lhakang of Pakaling Chiwog. Out of 100 households, only 27 households were interested and engaged in renting the land for crop production. The Local government had facilitated and the lease agreement was drawn between the Lhakhang and community. The land users have to pay a sum of Nu.7500/- to the Lhakang. The group members can cultivate the land for all time while non group members have no right to object or raise any issues. In case, If the group disintegrates in future, any outsider or member of the community can take up the farming activity with no objections from the others.
- **Knowledge about SLM, access to technical support**: The land users had access to technical support Gewog Extension Officer, the Dzongkhag Agriculture officer and Researchers from the ARDC-Wengkhar.
- **Markets (to purchase inputs, sell products) and prices**: The groups have a linkage to supply vegetables to the schools and signed the contract with the BAIL, Lingmithang

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Workload, availability of manpower**: The land users are engaged in rice cultivation in their own fields and weaving. Therefore, the availability of manpower in the revived land is minimal.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

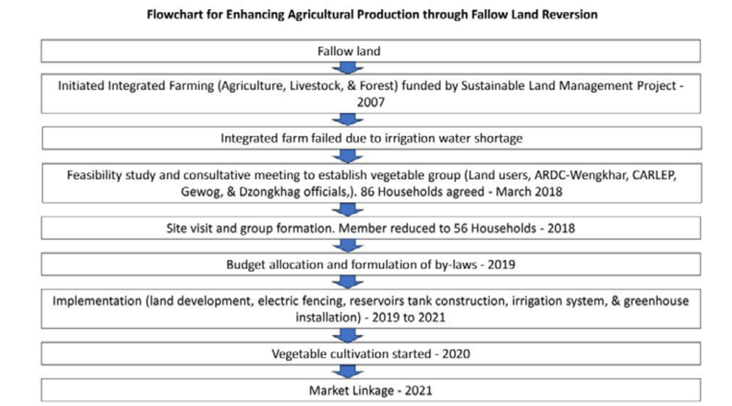
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Land users	Contributed labour during the establishment of the farm and involved in the cultivation of the vegetables. They are the main actors in the approach.
SLM specialists/ agricultural advisers	Gewog Extension officer, Dzongkhag Agriculture officer, Researchers from ARDC-Wengkhar.	Provides technical support such as training in vegetable cultivation, and setting up irrigation systems.
teachers/ school children/ students	Teachers engaged in School Feeding Programme	Purchase farm produce from the group.
private sector	BAIL	Provides fund support and purchase farm produce for processing
local government	Gup, Tshokpa	Involved in developing the land lease agreement.
national government (planners, decision-makers)	Royal Government of Bhutan	Conduct a feasibility study, and provide financial support.
international organization	CARLEP-IFAD	Provide fund sources for the establishment of the farm and conduct monitoring.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	The land was fallow for 27 years and in 2007 the land users tried to restore the land by initiating Integrated Agriculture Farm where they cultivated forest trees, crops and livestock. However, with the unavailability of water, the integrated farm was not successful. People informed the government about the need for a water pump and the Gewog Gup shared it in a higher meeting. This was the initiation of the Land restoration approach.
planning				✓		There were numerous meetings involving the land users, Gewog officials, Gewog Extension Officer, Dzongkhag officials, officials from ARDC-Wengkher and CARLEP.
implementation				✓		Land users and all the stakeholders were involved in the implementation of the approach.
monitoring/ evaluation				✓		External monitoring is done by Audit officers from the stakeholders involved, Audit officers from Bumthang for CARLEP, and Audit officers from Samdrup Jongkhar for RGoB. Internal monitoring is done by the Treasurer of the group.

Flow chart

The flowchart has been developed in consultation with the land users and Gewog Agriculture Extension Officer.



Author: Nima Dolma Tamang

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☑ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☑ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☑ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- ☑ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organizational development)
- ☑ Monitoring and evaluation
- ☐ Research

Capacity building/ training

Training was provided to the following stakeholders

- ☑ land users
- ☐ field staff/ advisers

Form of training

- ☐ on-the-job
- ☐ farmer-to-farmer
- ☑ demonstration areas
- ☑ public meetings
- ☐ courses

Subjects covered

Soil nutrient management, vegetable production technique, compost making and others.

Advisory service

Advisory service was provided

- ☑ on land users' fields
- ☑ at permanent centres
- ☑ On social media (WeChat)

Advisory service in the form of hands on training at site, at gewog centers and online social media forums such as WeChat.

Institution strengthening

Institutions have been strengthened / established

- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level

- ☑ local
- ☑ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.

The role of the group is to meet their objectives through vegetable production and motivate one another.

Type of support

- ☑ financial
- ☑ capacity building/ training
- ☑ equipment

Further details

The land users benefit from the approach as the income generated is useful in sustaining their livelihoods. Land users' capacity was built as they were engaged in the training and implementation of various SLM technologies. The group received equipment such as an irrigation system, electric fencing, greenhouse and others.

Monitoring and evaluation

The monitoring and evaluation are done by the donors to evaluate the success of the approach. The monitoring includes site visits and verifying the documents on the purchase and sale of the inputs of the produce and its economic benefits to the land users.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☑ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

CARLEP project and Royal Government of Bhutan

The following services or incentives have been provided to land users

- ☑ Financial/ material support provided to land users
- ☑ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users

Following are the financial support received by the group. 16 numbers of fabricated greenhouses where the land user paid 20% of the amount and 80% was funded by the donor. 100% funding was provided by the donor for the water pump, electric fencing, internal networking of irrigation, cement, grass-cutting machine, seeds and seedlings, water tank and curing shed construction. Labour input was contributed by the land users. The total of Nu. 90,00,000/- (Ninety hundred thousand) was supported for the project.

	partly financed	fully financed
Water pump, grass cutting machine Water pump and grass cutting machine 100% funded by the doner.		✓
agricultural: seeds By RGoB.		✓
Land development 100% machine contribution was done by the government with labour contribution from land users.		✓
infrastructure: roads By government.		✓
Greenhouse, electric fencing, internal networking irrigation system, curing shed For greenhouses, 80% was funded by the doner, 20% by land users. For electric fencing, internal networking irrigation system, cement, pipes, curing shed and water storage tank materials were funded 100% by the doner with labour contribution made by land users	✓	

Labour by land users was

- [x] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The approach improved farm income and their livelihood. It improved stakeholders participation such as schools, Extension officials, and BAIL.				✓
Did the Approach enable evidence-based decision-making? The approach enabled land users and the stakeholders involved to make decisions based on the findings. For example, the land users learned that potato cultivation was not profitable due to insect infestation, so they opted for chili cultivation in the next season.				✓
Did the Approach help land users to implement and maintain SLM Technologies? Land users implemented stone bunding and napier grass plantation to reduce soil erosion which they have maintained very well as it was very efficient in controlling soil erosion. The Napier grass was also sold creating income opportunities.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? The land users were involved in the SLM technologies establishment under the supervision of the SLM specialist leading to improved knowledge.				✓
Did the Approach improve knowledge and capacities of other stakeholders? The stakeholders' knowledge was improved greatly as the challenges faced by the land users were forwarded to the stakeholders (SLM specialist/RAMCO). The stakeholders were to address the challenge and in the process, the stakeholder had to develop new techniques and test them on the field which led to improved knowledge of both the parties.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? All the stakeholders and land users worked together to achieve a common goal i.e. increased income for land users and use of fallow land for agriculture production, reduce import.				✓
Did the Approach empower socially and economically disadvantaged groups? If the land users are interested, irrespective of their wealth and status, all the land users in the community are allowed to participate in the approach. Therefore, economically disadvantaged groups involved in farming activity have improved livelihood and increased household income.				✓
Did the Approach improve gender equality and empower women and girls? The approach has two subgroups with heterogenous members (male and female) and one subgroup has only female members encouraging women's participation in decision-making.				✓
Did the Approach encourage young people/ the next generation of land users to engage in SLM? The approach was initiated to encourage youths to participate in agricultural activities. However, there is no interest shown by the youths. This could be due to low-income generation, poor market access and less or no recreation facility in the approach site.	✓			

Did the Approach lead to improved food security/ improved nutrition?
The approach enabled land users to be self-sufficient in vegetables during winter and also generate income by selling the produce. Thus, making the community self-sufficient in vegetables and certain fruits.

Did the Approach improve access to markets?
The approach linked the land users to the market such as schools and processing units (BAIL).

Did the Approach lead to employment, income opportunities?
The approach improved the income of the land users as they were able to buy school necessities for their children from the income generated by selling vegetables from the approach site.

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

The approach is sustainable. Even though the market for large quantities of produce is not available. There is a market linkage created with local consumers. Further, the land users can link with the relevant stakeholders to export the produce. Moreover, the land users were well trained in vegetable production to sustain without external support.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Improved production and increased cultivable land is major strength of the approach. With the fallow land reversion and sufficient irrigation water, the land is is able to produce large amount of crop.
- The approach contributed to improved household income. By selling the crops grown in the revived area, the land users get additional income to support their livelihood.

Strengths: compiler’s or other key resource person’s view

- Improved nutrition to the school children as the quality of organic vegetables supplied by the group is better than the imported produce grown in a conventional system with the use of pesticides especially from India.
- Reduces import as the group sell their produce to the schools and nearby community. The demand for vegetable is met by domestic production, therefore there are fewer commodities imported.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The land is far from the houses of the land users making it difficult for the land users to give constant management and care.
- Radhi is known as the "Rice bowl of eastern Bhutan" and it is also famous for the Bhuray (type of fabric) gho and kira (National dress). Therefore the reverted land is neglected during peak rice production season and labour demanded by the weaving of the Buray gho and kira high.

- Due to less market and surplus production. Land users are challenged with marketing of their crops. Encourage middlemen to purchase their produce and sell it to other parts of the country.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

REFERENCES

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Tshering Pelden - land user
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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6890/

Linked SLM data
Technologies: Protected Agriculture for High Value Crops https://qcat.wocat.net/en/wocat/technologies/view/technologies_6846/
Technologies: Protected Agriculture for High Value Crops https://qcat.wocat.net/en/wocat/technologies/view/technologies_6846/

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Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Lhamo C. (2021). Agricultural production through fallow land reversion with numerous interventions. CARLEP. Retrieved from https://carlep.gov.bt/agricultural-production-through-fallow-land-reversion-with-numerous-interventions/: https://carlep.gov.bt/agricultural-production-through-fallow-land-reversion-with-numerous-interventions/

Typical Mountain Hazelnut Orchards established through the approach (Tashi Wangdi)

Public-Private-Community Partnership for Land Degradation Neutrality (Bhutan)

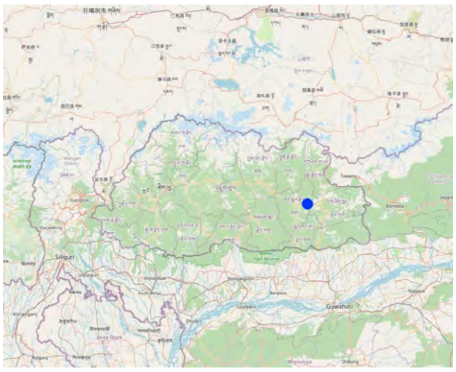
Zhung Ger dang Midhey Thuendrel Thok Sazhi Dhakzin Thabthang (གཞུང་ སྒེར་དང་མི་སྡེ་མཐུན་འབྲེལ་ཐོག་ས་གཞི་བདག་འཛིན་འཐབ་ཐངས།)

DESCRIPTION

The public-private-community partnerships (PPCP) approach is a synergistically operational model that is used to achieve sustainable development in which the three parties jointly develop a business unit/service of mutual benefit and provide maximum benefit to the wider community. This approach is designed to enable economically disabled households and community organizations to generate long-term benefits through sustainable agriculture - in this case hazelnut production.

The Mountain Hazelnut Venture (MHV) is a social enterprise established as a Public-Private-Community Partnership (PPCP) between the people and the Royal Government of Bhutan and a private company. The PPCP approach involves private entity funding of a project, and it has become common countrywide, The MHV has enabled a large-scale Foreign Direct Investment (FDI) project. The MHV provides hazelnut trees, agricultural inputs, and technical assistance to smallholder farmers. At harvest, the company purchases hazelnuts from partner growers, which are then processed for international export. The primary objective of this approach is to foster collaboration between the private company and the community to generate long-term income and revitalize vulnerable communities through sustainable agriculture. Hazelnut orchards stabilize mountain slopes, reduce soil erosion, improve water retention, and help adapt to, and mitigate, climate change by improving ground cover, retaining soil moisture and sequestering carbon.
The private company looks for interested farmers who are then registered. The company propagates good quality hazelnut seedlings and distributes them. This is followed up by constant monitoring by technical staff until fruits are harvested and processed. The implementation stage includes planning, providing them with necessary agricultural inputs, and technical support through extension and monitoring. Once the fruits are harvested, payment is made to the farmers. Implementation involves the MHV engaging with community members alongside agricultural extension agents to present and convince them about the benefits of the project. Additionally, the MHV provides training, workshops, and ongoing support. They finance the project while also taking on the role of monitoring and evaluating its outcomes.
There are three key stakeholders involved in this approach. They are the community members (landowners), the Royal Government of Bhutan, and the Mountain Hazelnut company. It is reported that there are more than 8,000 smallholder land users registered with MHV from 19 of 20 districts in Bhutan. The roles of the land users are to grow hazelnuts through nurturing the seedlings, harvesting the nuts, and selling them to the Hazelnut company as per the mutual agreement. Land users are provided free seedlings, consistent technical and field support, and the guaranteed buyback of nuts by the company. They also received training and assistance. The second key stakeholder is the Royal Government, who provides clearance and facilitates the establishment of business in line with the national Foreign Direct Investment (FDI) Policy. In the field, agriculture extension agents represent the government by facilitating communication between the hazelnut company and the

LOCATION



Location: Domlung village, Ngatshang gewog, Mongar Dzongkhag, Bhutan

Geo-reference of selected sites
- 91.36327, 27.28914

Initiation date: 2011

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

communities. Lastly, the MHV as a private company is committed to fostering the development of entrepreneurs in the agribusiness sector across Bhutan.
The advantages of the approach to the land users are the financial, technical and material support provided by the private company. The land users can also develop their skills and knowledge through training on hazelnut cultivation and good agricultural practices (GAP). Hazelnut is a new crop in the locality.
Finally, the company is committed to generating income and improving the livelihood of rural communities in Bhutan. However, despite the noble objectives, the company has failed to realize its intended target, and this is an increasing cause of concern. Furthermore, there are complaints that the harvests have been poor – or even zero in some cases. It is clear that there had been inadequate investigation into the viability of hazelnuts in Bhutan. While failing on the economic front so far, from the land degradation neutrality (LDN) point of view, the hazelnut plantations have improved ground cover immensely thereby generating environmental benefits through stabilization of vulnerable agricultural land, reduction in land degradation and carbon sequestration.

Hazelnut trees planted in Domlung village through the approach (Tshewang Phuntsho)

MHV Field Coordinator with one land user family (Mountain Hazelnut Venture (MHV))

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The primary objective of this approach is to persuade the community to embrace the Mountain Hazelnut Venture and foster collaboration between the private company and the community to advance the project, generate long-term income, revitalise vulnerable communities through sustainable agriculture, stabilising mountain slopes, reducing erosion, improving water retention, and mitigating climate change by improving soil fertility and carbon sequestration.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Because land users are from same ethnic group, they shared similar culture and traditional. There were no objection from other land users on implementing the technology.
- **Availability/ access to financial resources and services**: The project is fully funded by a private company, meaning the company provides all the planting materials and inputs with regard to it; very minimal cost goes into the project by the land users.
- **Collaboration/ coordination of actors**: Officials from the private company often visit the community to monitor and evaluate the progress of the project, and has played a significant role in providing the community members with all the skills and knowledge with regard to hazelnut cultivation.
- **Knowledge about SLM, access to technical support**: The land users were trained on good agricultural practices (GAP) for hazelnut cultivation and proper land management practices before implementing the project.
- **Workload, availability of manpower**: Hazelnuts are fairly easy to grow and not much care is required. Hence not much of labour is required.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Markets (to purchase inputs, sell products) and prices**: Despite the guaranteed buyback by the company, the land users could not harvets any hazelnuts as there is no fruiting yet.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

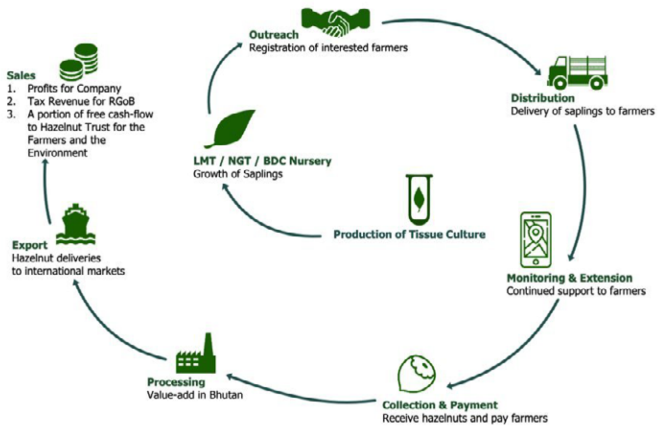
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Domlung community members (land users)	The roles of the Interested land users are to grow hazelnut saplings on their land, nurture these seedlings, harvest the nuts, and sell them to the Hazelnut company.
private sector	Mountain Hazelnut Venture	It is committed to fostering the development of entrepreneurs in the agribusiness sector across Bhutan. It provides farmers with seedlings, and agricultural inputs such as fertilizers and extension services, and also buys the nuts from the land users. Apart from this Mountain Hazelnuts is committed to fostering the development of entrepreneurs in the agribusiness sector across Bhutan.
national government (planners, decision-makers)	Ministry of Agriculture and Livestock of the Royal Government of Bhutan	Provided clearance and facilitaed business establishment as per the Foreign Direct Investment (FDI) Policy.
Extension agent	Ngatshang gewog (block) Agriculture Extension Agent	Facilitated communication between the private company and the communities.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		The land users were sensitized on the Mountain Hazelnut Venture, in particular the long term benefits of improving income and livelihoods. Mutual agreements were signed between the company and the land users.
planning		✓				The private company (MHV) decide on the timeline of the project and how to implement it. However, the community members and the extension agents are informed about the plan.
implementation					✓	For the implementation, land users were equipped with all the skills and materials required for the projects success. They plant and cultivate the hazelnut in their fields on their own, with some assistance from the company's field coordinator.
monitoring/ evaluation				✓		Officials from the company (MHV) visits the land users field together with the land users, where the hazelnuts were cultivated and checks the progress of the project.

Flow chart

The flow chart of the approach was adopted from Mountain Hazelnut Venture (MHV) website



Author: Mountain Hazelnut Venture website (https://www.mountainhazelnuts.com/)

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders
- [x] Private sector (MHV)

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [ ] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [ ] field staff/ advisers

Form of training
- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [x] public meetings
- [ ] courses

Subjects covered

The subjects covered included the cultivation of hazelnuts, good agricultural practices, proper land and agronomic management of hazelnuts, grafting, weed control, and sustainable land management.

Advisory service

Advisory service was provided
- [x] on land users' fields
- [ ] at permanent centres
- [x] Private company

Advisory services were provided by the field coordinator and other officials from the private company (MHV).

Monitoring and evaluation
In accordance with the land users of Domlung, officials from the private company visits the village sporadically to check the progress of the project.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: 30000000.0

Mountain Hazelnut Venture (The annual budget is the total investment of the company for the entire project)

The following services or incentives have been provided to land users
- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users
The financial support was received in the form of planting materials and other materials such as fencing.

	partly financed	fully financed
Nets Green nets		✓
agricultural: seeds Hazelnut saplings were provided to the land users for free of cost.		✓
agricultural: seeds: fertilizers Fertilizers are bought at 50% of its original price by the land users.	✓	

Labour by land users was
- [ ] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [x] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach help land users to implement and maintain SLM Technologies? Almost all the farming households in Domlung have cultivated hazelnuts. They were trained on how to manage land and they also reported the benefits of growing trees besides harvesting the nuts.				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? There was no improvement in access to financial resources, but the land users have been supported financially for the project through provisin of inputs either free or on cost sharing basis.	✓			
Did the Approach improve knowledge and capacities of land users to implement SLM? All the land users in Domlung village have attended several trainings and workshops before the project implementation. Some of this training included SLM intervention topics like Terrace making, stone bund walls, and growing hazelnuts in erosion-prone areas.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The approach involves three main stakeholders i.e., land users, extension officers of the Royal Government and the private company. The approach has strengthened collaboration between stakeholders, i.e., land users and extension, extension and private company, etc.				✓
Did the Approach empower socially and economically disadvantaged groups? All the land users were engaged as stakeholders and were equally benefited.		✓		
Did the Approach improve gender equality and empower women and girls? The approach allowed both men and women to participate. Thus gender equality was well taken care. It is also one of the company's objectives to ensure that women comprise approximately half of MH staff at all levels, from community lead growers through the executive team.				✓
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Young land users of the community were the ones who showed more interest to the project.				✓
Did the Approach lead to improved food security/ improved nutrition? Although the land was cleared for planting hazelnuts, there were problems with pollination and variety resulting no fruiting. As a result land users turned hopeless without any income.	✓			
Did the Approach improve access to markets? Access to the market was assured through the project. However, there was no nut production.	✓			
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? Hazelnut plantation improved ground cover thereby enabling carbon sequestration and soil organic matter.			✓	
Did the Approach lead to employment, income opportunities? Individuals from outside the community were able to work for the private company in the last few years.			✓	
Contribution ot Land Degradation Neutrality (LDN) Although the MHV project failed to fully realize its main economic objective of income generation, the hazelnut plantation did improve ground cover and helped avoid, reduce and restore degraded land. It thus contributed towards achieveing voluntary Land Degradation Target (LDN) target set by the Royal Government of Bhutan.			✓	

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [x] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [x] no
- [ ] yes
- [ ] uncertain

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Support from the company: Easy for the land users to implement the project due to material and technical supports from the approach. Land users received inputs like hazelnut seedlings at the beginning, which was for free. They also received support for growing the seedlings, Taking care of the seedlings, etc.,
- Assured market: Land users also mentioned that the main motivation to get involved in such an approach was the market and the possibility of generating income. The company was willing to buy whatever quantity of hazelnuts they could produce from their land.
- Capacity development: In addition to the support (agricultural inputs), the land users also received various training through which they were exposed to other technologies which some of them were totally unaware. They could enhance their skills and knowledge on hazelnut production like orchard cultivation, hazelnut value-chain, including processing and the provision of goods and services.

Strengths: compiler's or other key resource person's view

- Opportunities to economically disabled land users: One of the primary objectives of Mountain Hazelnut Venture is to enable smallholder farming households to generate long-term income, revitalize vulnerable communities through sustainable agriculture. Through this approach many youths were given employment as a worker in the project sites.
- Focus on sustainable land management: The approach made land uesres to grow hazelnuts sapling in their marginal or unproductive land. When hazelnuts is fully grown, hazelnut plantations stabilize mountain slopes, reduce soil erosion, improve water retention, and mitigate climate change by improving soil fertility and carbon sequestration. In brief, hazelnut plantation as a SLM intervention, contributes to the realization of the land degradation neutrality (LDN) target and adapt to and mitigate climate change.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- No transparency of the information: Land users shared that they were lured by some officals saying the approach to be very profitable. They didn't explained them very well on positive and negative long term impact of the project. They didnt know about the plant (hazelnuts), Its problem in fruiting, etc., This type of project is maily implemented for the welfare of the community. It should never be implemented for sole benefit of the company.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- No proper planning and research: The main reason why this hazelnut planations failed in many places in Bhutan could be due to lack of proper planning and research. Given the wide range of elevation and climatic conditions in Bhutan, more adaptability or suitability trials at different elevations could have been conducted. Suitability trials of different varieties of hazelnuts could have been done so that the best performing varieties and management practices could have been promoted to the land users on large scale.
- No risk management: It appears like the MHV initiated its business with full confidnce that the project will do well in Bhutan and as such no risk management plans were in place. For instance, land users sacrificed most of their land with the hope of generating good income, but this didn't happen in reality. Many land users were left devasted and hopeless without any compensation from the company. Any project should account the risk and accordingly provision risk management plan in the proposal and agreement. Such provisions should also be made transparent to all the parties so that it becomes very clear about the compensation should the project fail.

REFERENCES

Compiler
ONGPO LEPCHA

Editors
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Reviewer
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Resource persons
Karma Tenzin - land user
Tshewang Penjor - land user
Yeshey Wangmo - land user
Ngawang Lhamo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6843/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Asian Development Bank. (n.d.). Public-Private Partnership Handbook. ADB.: https://www.adb.org/sites/default/files/institutional-document/31484/public-private-partnership.pdf
- Perez, M. C. (2015). Public-Private-Community-Partnerships for Renewable Energy Cooperatives. Wegeningen UR.: https://edepot.wur.nl/337095

Links to relevant information which is available online
- Mountain Hazelnut Venture: https://www.mountainhazelnuts.com/
- Public–Private–Community Partnership: https://penabulufoundation.org/en/public-private-community-partnership/

Approaches
Livestock

Land Users of Rikhey-Domphu Milk Group (Tshering Yangzom)

Improved Livestock Farming System (Bhutan)

Rigsar Gi Thokley Gonor Sochong Baethang (རིགས་གསར་གྱི་ཐོག་ལས་སྒོ་ནོར་གསོ་སྐྱོང་འབད་ཐངས་།)

DESCRIPTION

The approach involves a group of farmers implementing an improved dairy system. The system incorporates practices and technologies that enhance animal welfare, reduce environmental impact, and increase production.

This case describes how a group approach can facilitate and encourage improved dairy production with better sheds, more productive breeds, environmental sustainability and marketing. Upgraded dairy production is described in detail under the technology "Improved dairy sheds" (T6898).

Initially, the land users were a part of a bigger milk group established in 1993. In 2017, some detached themselves and formed "Om Nyamdel Tshogde" which is a group composed of 67 members from Rikhey and Domphu chiwogs, led by a Chairperson, Mrs. Yangzom. The group also has a treasurer, Drungchen, and a driver. The main objective of forming the milk group was to improve the livelihoods of land users through higher yields via better livestock farming. The group formation process was assisted by the livestock extension officer. The funding was mobilized from the community itself.

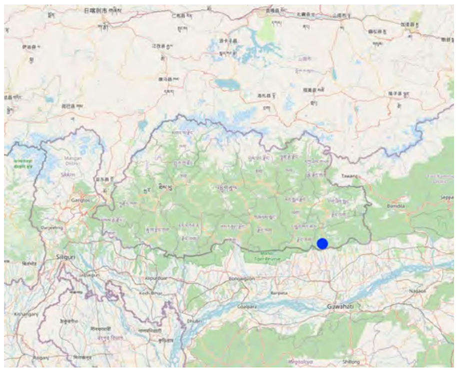
The group members, with some support from the government, constructed improved dairy sheds, and biogas plants, and received training on fodder plantations. The stakeholders involved were land users, livestock extension officers, and the private cooperative B-COOP. The land users' role is to coordinate and conduct activities related to livestock farming. The extension officer's role is to provide veterinary and technical services. B-COOP's role is to buy dairy products from the group, especially milk.

The group members have installed improved dairy sheds with cemented floors, feeding troughs, corrugated galvanised iron (CGI) roofing, and a continuous water supply. Also, cattle have access to timely veterinary services. Cow dung and urine are used as fertilizers and also in biogas plants. Biogas plants generate renewable energy (methane), thereby cutting down the use of liquefied petroleum gas (LPG) gas which is derived from fossil fuel.

Under improved dairy sheds, stall-feeding is practised which bars the cattle from going to forests to feed. This prevents the degradation of land by cattle movement through trampling. For better nutrition and feeding, grass fodder species including Super Napier (pakchung), Napier, and Guatemala are grown, cut and and fed to cattle. In addition, other feeds provided included banana stems, maize stems, maize powder, mustard cake, and processed feeds. The group delivers at least 300 litres of milk per day to B-COOP, and some milk goes to India.

Improved breeds have replaced numerous low-yielding local cattle thereby making more efficient use of cattle feed. Also, fewer, more productive animals help reduce environmental degradation and methane losses to the atmosphere. The majority of cattle reared have been bred through artificial insemination. Most cattle are 50:50 hybrids between local breeds and improved breeds such as Jersey. Improving the breeds helps to increase milk production (e.g Holstein Friesian) and or percentage butter fat (e.g. Jersey). To feed and sustain productive, improved breeds, various fodder species are cultivated in large areas. This helps in carbon sequestration and preventing soil erosion.

LOCATION



Location: Kheripam village, Domphu chiwog, Dewathang gewog, Samdrup Jongkhar Dzongkhag, Bhutan

Geo-reference of selected sites
- 91.53619, 26.86058

Initiation date: 2017

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

What the land users like about the approach is that improved livestock farming results in a continuous source of income, as milk production is not seasonal like vegetable production, it provides organic fertilizers for fields, improves livelihoods, makes use of waste such as cow dung in biogas plants which means reduced dependency on LPG gas which is quite expensive. Also access to credit is increased. Government support has increased after the milk group formation. Furthermore, the workload is shared among the land users, especially during the making of biogas plants, thus easing the workload per person.

Land users of Rikhey-Domphu milk group (Tshering Yangzom)


Improved dairy shed of land user Tshewang Zangmo (Tshering Yangzom)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main aims of the approach are to enhance the overall well-being of animals, optimize animal production, minimize forest grazing and promote continuous stall feeding, increase the availability of FYM and urine for application to fields, develop pasture with fodder grasses, foster efficient waste utilization, provide a comfortable working environment for land users, and improve the livelihoods of land users through higher yields and better household income.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services**: There is assured monthly income for the land users due to the supply of milk to B-COOP and India.
- **Institutional setting**: There is assured monthly income for the land users due to the supply of milk and other dairy products to B-COOP and India. This has helped improve the livelihoods of land users through higher yields and better household income.
- **Collaboration/ coordination of actors**: There is labour sharing in the group (for example in the construction of biogas plants) thereby easing the workload in the group. The milk group is collectively run by the land users. Every land user is equally involved in meetings related to the group. The land users also share experiences and ideas, resulting in continuous improvement. All these enhance collaboration/coordination among the land users.
- **Policies**: The government has supported the land users by providing deep freezers and other livestock farming construction materials free of cost.
- **Knowledge about SLM, access to technical support**: The land users realize the importance of improved livestock farming systems and biogas plants. They also have access to advisory services from the livestock extension officer.
- **Markets (to purchase inputs, sell products) and prices**: The group sells dairy products to Bhutan (B-COOP) and India, especially milk and generates income. The group has access to different markets which might have been difficult for individual farmers to have access to.
- **Workload, availability of manpower**: There is labour-sharing in the group (for example in the construction of biogas plants) thereby easing the workload in the group.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	The land users of Rikhey-Domphu chiwogs.	Collectively produce milk (at least 300 L/day).
SLM specialists/ agricultural advisers	Livestock extension officer.	Provide technical support to land users.
private sector	Bhutan Cooperative (B-COOP)	Buy milk from the group.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation			✓			The livestock extension officer proposed the formation of the milk group.
planning				✓		The livestock officer and land users planned the group management plan.
implementation					✓	The land users carried out the fieldwork of producing milk and constructing improved dairy sheds and biogas plants.
monitoring/ evaluation					✓	The land users monitor their group activities.

Flow chart

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [x] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on

- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers

Form of training

- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [x] public meetings
- [ ] courses

Subjects covered

-Biogas plant construction

-Fodder grass plantation

Advisory service

Advisory service was provided

- ☑ on land users' fields
- ☑ at permanent centres

The land users have access to advisory services from the livestock extension agent.

Institution strengthening

Institutions have been strengthened / established

- ☐ no
- ☐ yes, a little
- ☐ yes, moderately
- ☑ yes, greatly

at the following level

- ☑ local
- ☐ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.
There is assured monthly income for the land users due to the sell of milk and other dairy products such as cheese and butter.

Type of support

- ☑ financial
- ☐ capacity building/ training
- ☐ equipment

Further details

Monitoring and evaluation

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☑ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

There is no annual budget allocated for the construction of improved dairy sheds and biogas plants. For biogas plant construction, pipes, metals, and 15 bags of cement were provided to land users by the government. For dairy shed construction, roofing material (18 CGI sheets) and 18 bags of cement were provided. These materials were provided by the government only once. There is no annual providing of materials or money to the land users.

The following services or incentives have been provided to land users

- ☑ Financial/ material support provided to land users
- ☑ Subsidies for specific inputs
- ☑ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users
For biogas plant construction, pipes, metals, and 15 bags of cement were provided to land users by the government. For dairy shed construction, roofing material (18 CGI sheets) and 18 bags of cement were provided. Also, deep freezers were provided to the land users.

	partly financed	fully financed
Deep freezers	☐	☑
Cement bags CGI sheets Pipes Metals A part of these materials was financed by the government.	☑	☐

Labour by land users was

- ☑ voluntary
- ☐ food-for-work
- ☐ paid in cash
- ☐ rewarded with other material support

Credit
Conditions: Nu 20,000 credit
Credit providers: BDBL
Credit receivers: Land users

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach help land users to implement and maintain SLM Technologies? Improved livestock farming system has promoted technologies such as improved dairy sheds and biogas plants.	☐	☐	☐	☑

Did the Approach improve knowledge and capacities of land users to implement SLM?
The land users have adopted technologies such as improved dairy sheds and biogas plants.

Did the Approach build/ strengthen institutions, collaboration between stakeholders?
The land users have been able to sell milk and other dairy products to B-COOP and India and this has helped the land users generate income. Also, B-COOP and India have benefitted from the continuous milk supply from the milk group. The milk group has helped in forming a partnership between the land users and the buyers.

Did the Approach mitigate conflicts?
The land users have developed pasture land of Super Napier, Napier, and Guatemala grasses for stall feeding of cattle. This has minimized the issue of cattle entering other land users' fields and foraging on the crops.

Did the Approach empower socially and economically disadvantaged groups?
Land users from different backgrounds are now part of the milk group.

Did the Approach improve gender equality and empower women and girls?
Land users in the milk group are a mix of males and females. There is no gender discrimination.

Did the Approach lead to improved food security/ improved nutrition?
Land users have assured monthly income due to the sale of milk and other dairy products. This has led to better household income. Also, stall feeding under an improved dairy shed has promoted the cultivation of fodder of good quality and variety leading to increased and quality milk production.

Did the Approach improve access to markets?
Land users now sell milk and other dairy products to B-COOP and India.

Did the Approach lead to more sustainable use/ sources of energy?
Biogas plants have reduced the use of LPG in some households.

Did the Approach lead to employment, income opportunities?
Group marketing has helped land users earn better.

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [x] no
- [ ] yes
- [ ] uncertain

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Government support especially to groups.
- Easy access to market because of group formation.
- Improved livelihood of farmers through higher farm yields and better household income.
- Use of a renewable of energy like biogas instead of LPG.
- Improved health and animal welfare.

Strengths: compiler's or other key resource person's view

- Knowledge sharing (land users can share their ideas and experiences while working in a group).
- Improved dairy shed made of cement, gravel, and stones is more durable than the old dairy shed made from wood.
- Availability of good quality fodder and a diverse range of forage options.
- Increase in organic matter due to FYM application and better soil moisture retention by increased soil organic matter.
- Reduced labour due to reduced fodder collection and herding in the forest.
- Efficient waste utilization.
- Reduced land degradation due to reduction in forest grazing.
- Increased vegetation cover due to improved pasture development and reduction in forest grazing.
- Less soil compaction through decreased trampling by animals.
- Comfortable working environment for land users.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Sometimes working in a group can be difficult. Internal conflicts and misunderstanding are common in group ventures. Regular group meetings and guidance by extension staff.

REFERENCES

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Last update: May 30, 2024

Resource persons
Yangzom - land user
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Wangdi - land user
Jampel - land user
Tendel Zangmo - land user
Cheki Wangmo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6895/

Linked SLM data
Technologies: Improved Dairy Shed https://qcat.wocat.net/en/wocat/technologies/view/technologies_6898/
Technologies: Improved Dairy Shed https://qcat.wocat.net/en/wocat/technologies/view/technologies_6898/

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
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Improved Temperate Pasture (Wangchuk, National Centre for Animal Nutrition, Bumthang)

Improved Pasture Development (Bhutan)

Tsamdro Yardrak Tangthang (རྩྭ་འབྲོག་ཡར་དྲག་བཏང་ཐངས་།)

DESCRIPTION

The improved pasture development approach focuses on enhancing pasture productivity, which is managed sustainably for grazing. Livestock productivity depends greatly on improved pastures. It is very important to manage pastures to support the livelihoods of rural communities in Bhutan.

The improved pasture development approach in Bhutan started at the beginning of the 5th Five Year Plan (1982-1987). Thangbi village, Bumthang, focuses on enhancing pastureland productivity and sustainability through the cultivation of improved varieties of grasses provided by the project. This initiative not only prevents land degradation and erosion but also enhances fertility by introducing leguminous species like clover. In temperate areas, improved pasture consists of a mixture of white clover, tall fescue, cocksfoot, and Italian ryegrass while in the subtropical areas, green leaf desmodium, molasses grass (Melinis sp.), ruzi grass (Brachiaria sp.), and stylo are grown.

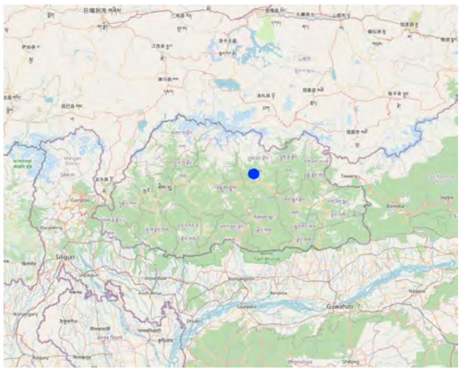
Given the significant role livestock plays in the livelihood of Bhutanese communities, where productivity is strongly influenced by seasonal variations in fodder availability, improved pasture development addresses crucial objectives. These are: 1) Enhancing the resilience of pasture ecosystems to ensure continuous, high-quality fodder production; 2) Increasing forage availability and quality by promoting the cultivation of improved fodder species; and 3) Improving livestock productivity, directly impacting income generation through increased yields of animal products - especially of milk, cheese, and butter.

Implementation involves four stages: 1) Initial assessments of pasture conditions and land suitability, conducted by livestock extension officials; 2) Planning sessions involving officials from the Department of Livestock and land users; 3) Establishment of the identified areas for growing improved fodder species; and 4) Management of improved pasture plots by land users, accompanied by regular monitoring and evaluation to ensure effectiveness.

Key stakeholders in this approach include livestock extension agents and community members. Livestock extension agents act as a liaison between the community and the government. They also procure and distribute fodder grass seeds. Community members establish pastures in their farms, taking on responsibilities such as monitoring the water supply and caring for the grasses throughout their growing seasons.

Land users appreciate the approach because it ensures abundant fodder availability year-round, improving milk production through the cultivation of superior grass species, and reducing the workload associated with foraging in forests or tending grazing cows. However, concerns raised by land users include a reduction in cultivable land due to fodder grass cultivation and a lack of training regarding fodder management for those involved in the approach.

LOCATION



Location: Thangbi Village, Choekhor Gewog (Block), Bumthang Dzongkhag (District), Bhutan

Geo-reference of selected sites

- 90.71134, 27.61037

Initiation date: 1980

Year of termination: n.a.

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

Pasture land established in Thangbi village (Tshewang Phuntsho)

Improved Pasture land (Wangchuk, National Centre for Animal Health, Bumthang)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

1) Enhance the resilience of pasture ecosystems: For countries like Bhutan, fodder production is largely affected by season and during off season, the productivity goes down drastically, leaving many land users in distress. Therefore, improved pasture development enables land users to continuously harvest quality fodder for their cows.
2) Increase forage availability and quality: The improved pasture development approach not only focuses on the production of fodder in quantity but also the quality by encouraging land users to grow improved varieties of fodder species.
3) Improve livestock productivity: Improving productivity is the primary objective as it directly connects to the quantity of animal produce like milk, cheese, butter, etc., that affects the income generated.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Community members/land users shared the same social, cultural, and religious norms and values. Implementation of any project didn't have any issues.
- **Availability/ access to financial resources and services**: Community members/land users are provided with improved varieties of fodder grass for free based on the area of the land.
- **Institutional setting**: The improved pasture development has helped improve the livelihood of the community members.
- **Workload, availability of manpower**: The workload has relatively decreased: In the past, community members had to go to the forest to either collect fodder or look after cow that graze on the grasses, but now pasture grass is readily available.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Knowledge about SLM, access to technical support**: The land users know that pasture development is directly related to SLM, however land users didn't receive any trainings on the improved pasture development through the approach.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

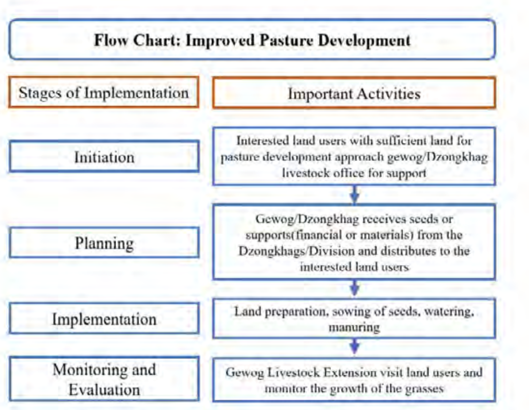
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Community members	Receive the fodder grass seeds and establish pasture lands in their registered lands. He/she also monitors the water requirement and takes care of the grasses throughout its growing seasons.
Department of Livestock, Ministry of Agriculture and Livestock	Livestock extension agent	The livestock extension agent act as a bridge between the community and the governments. He/she handles the project at the grassroots level by meeting and discussing improved pasture development personally with the interested land users. He/she is responsible for procuring the seeds of fodder grasses and distributing them to the community members.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation		✓				Livestock extension agent upon consultation with research centers will carry out initial assessments of pasture conditions (which species of pasture grass species to be grown) and land suitability study.
planning				✓		The livestock extension agent and the community members decided on how to establish and implement the project.
implementation					✓	In the initiation phase grass species are already identified and once planning is done. Land users will be provided seeds and they have to establish the pasture on their own.
monitoring/ evaluation					✓	Monitoring of pasture field is normally done by the community members, and ocasionally it is monitored by the extension for scheduled reporting purpose.

Flow chart

The flow chart was created based on the information provided by the community members.



Author: Ongpo Lepcha

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders
- [x] Livestock extension agent

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)
- [x] Consultation with research centers

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [ ] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

Whenever community members require any sort of technical assistance or advisory services, Livestock Extension agent at their capacity provides the support. however, if higher intervention is required EA solicit supports from the dzongkhag, Central programs and the department of livestockand accordingly provide assistance.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [x] yes, a little
- [ ] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
The livelihood of the community has been relatively better with the improved pasture development.

Type of support
- [ ] financial
- [ ] capacity building/ training
- [ ] equipment
- [x] Planting materials

Further details
The extension agent would provide improved pasture grass seeds based on the availability of budget for seeds procurement.

Monitoring and evaluation
Monitoring is mostly done by the community members.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [x] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

The funding is mostly in terms of cost of the improved pasture grass varieties.

The following services or incentives have been provided to land users
- [ ] Financial/ material support provided to land users
- [ ] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach help land users to implement and maintain SLM Technologies? No workshop or tainings were provided to the community members, however, they relied on their traditional knowledge on pasture land management.		✓		
Did the Approach improve knowledge and capacities of land users to implement SLM? Community members relied on their traditional knowledge about pasture grass management		✓		
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The livelihood of the community has relatively improved compared to the past.		✓		
Did the Approach empower socially and economically disadvantaged groups? All the households in the community irrespective of their background were provided with the pasture grass seeds.			✓	
Did the Approach improve gender equality and empower women and girls? All genders were equally encouraged to participate			✓	
Did the Approach lead to improved food security/ improved nutrition? The cultivated land has decreased due to the improved pasture land	✓			

Main motivation of land users to implement SLM
- [x] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [x] reduced risk of disasters
- [x] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities
Can the land users sustain what hat been implemented through the Approach (without external support)?
- [ ] no
- [ ] yes
- [x] uncertain

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Reduced workload
- Fodder available in large amount
- Higher milk production

Strengths: compiler's or other key resource person's view
- Reduction of surface runoff
- Increase fertility of the soil

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- Reduction in cultivated land
- Land users have to depend on livestock officers for seeds Training on seed production can be given to enhance their skills

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
ONGPO LEPCHA

Editors
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Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: June 4, 2024

Resource persons
Baleymo - land user
Sonam Choden - land user
Phurpa Wangmo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6858/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Marzban, S. & Valizadeh, N. (2020). Pasture Development: Fundamentals and Managerial Perspectives.: https://www.researchgate.net/publication/339074876_Pasture_Development_Fundamentals_and_Managerial_Perspectives

Links to relevant information which is available online
- Improving the quality of pastures: https://business.qld.gov.au/industries/farms-fishing-forestry/agriculture/sustainable/graze/pasture/improve
- Pasture Development on Small Farms: https://farmstyle.com.au/news/pasture-development-small-farms
- Strategies for improving run down pastures: https://www.incitecpivotfertilisers.com.au/news-and-insights/agronomic-insights/pasture/strategies-for-improving-run-down-pastures
- Pasture Management: Effective Planning & Implementation: https://eos.com/blog/pasture-management/

Core members of the dairy cooperatives in front of the processing unit (Niki Rai)

Darla Dairy Cooperatives (Bhutan)

Darla Gonor Nyamley Tshogdey (དར་ལ་སྒོ་ནོར་མཉམ་ལས་ཚོགས་སྡེ།)

DESCRIPTION

The Darla dairy cooperative is an example of where farmers come together to form collective organizations for production, collection, transportation, processing, and marketing of milk and dairy products. These are business models operated as member-owned and member-controlled organizations.

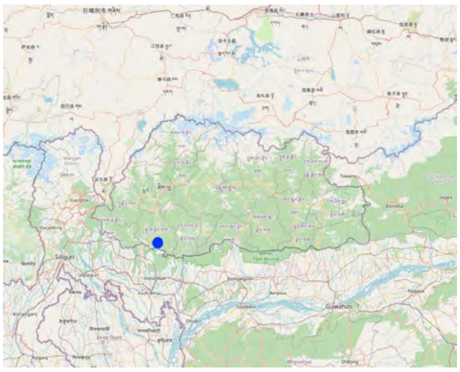
Livestock in Bhutan are reared for a multitude of purposes, encompassing the production of milk, food, and dung, as well as serving as a means of generating draught power, generating revenue, and accumulating assets. Dairy products, particularly butter and cheese, occupy significant significance within the Bhutanese nutritional framework and have emerged as a noteworthy economic resource for certain households in recent times. Knowing its importance many Bhutanese farmers are forming the cooperative groups. One thing that has been constantly growing over the years in Darla Gewog under Chhukha Dzongkhag is a Farmer’s Cooperative.

Darla dairy cooperatives are business owned and operated by dairy farmers, designed to collectively manage market milk and dairy products (Singh & Gupta, 2015). One of their main features is the collective ownership structure, where farmers become members and actively participate in decision-making processes. By pooling resources, dairy cooperatives enable farmers to access shared facilities, such as milk processing plants and storage, reducing individual cost and enhancing efficiency. Additionally, they offer fair and transparent pricing mechanisms, ensuring farmers receive a competitive price for their milk. Dairy cooperatives also provide valuable technical assistant, training, and access to markets, supporting farmer's growth and sustainability in the dairy industry (USDA, 2015).

The aims and objectives of dairy cooperatives revolve around empowering dairy farmers and promoting their collective welfare. One of the primary objectives is to facilitate shared ownership and democratic decision-making, allowing farmers to collectively manage their dairy operation. Another key aim is to ensure fair and equitable distribution of profits among members, promoting economic sustainability and social development within the dairy community. Dairy cooperatives also strive to provide access to modern technologies empowering farmers with the knowledge and skill needed for sustainable dairy farming practices (FAO, 2019).

The formation of a dairy cooperative typically involves several methods and steps to ensure successful establishment. Firstly, a core group of dairy farmers with common goals come together to initiate the cooperative. They conduct meetings, gauge interest, and identify potential members. Once the core group is established, they create formal bylaws that outline the cooperative's objectives, membership criteria, decision-making processes and profit-sharing mechanisms. To attract more members, awareness campaigns and informational sessions organized by gewog livestock extension agents showcase the benefits of joining the cooperatives. Financial planning and livestock management efforts are also undertaken to raise the necessary capital for initial investments, such as setting up milk processing facilities and infrastructures. There are 101 registered dairy farmers who

LOCATION



Location: Darla, Chukha, Bhutan

Geo-reference of selected sites

- 89.55445, 26.86972

Initiation date: 2014

Year of termination: n.a.

Type of Approach

- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

contribute milk through the cooperative. The dairy cooperative is operated by 6 core members who manage the daily activities.

Dairy cooperatives play a crucial role in the dairy industry by bringing together various stakeholders and facilitating their collaboration. The primary stakeholders involved in dairy cooperative includes dairy farmers who are the core members and owner of the cooperative. They actively participate in decision-making and contribute their milk to the cooperative for processing and marketing. Additionally, consumers are significant stakeholders as they rely on dairy cooperatives to provide them with high quality milk and dairy product. Other stakeholders like the gewog livestock extension agent, the District livestock officer and other officials are involved in a meeting which is conducted twice a year. Marketing opportunities are the main driving forces for producers to produce more of any type of product. Identification of market opportunities and the development of proper marketing strategies for milk and milk products for selected groups of villages would be a useful approach to support dairy cooperatives.

Filling milk cans in front of the Dairy Cooperative unit (Tshering Zangmo)

Members of the cooperative arranging milk filled cans to transport it to Thimphu (Tshering Zangmo)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The dairy cooperative aims to increase income through marketing of surplus milk, by engaging unemployed youths. Such intervention is expected to address problem srelated to rural urban migration.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services**: Priority support is given to the group and cooperatives in terms of investment and financial support by the government.
- **Collaboration/ coordination of actors**: Dairy cooperative enables farmers' to access and shared facilities, by pooling resources
- **Markets (to purchase inputs, sell products) and prices**: Increasing demand for milk and dairy products motivate farmers' to raise more dairy cattle and increase production
- **Workload, availability of manpower**: Enabled sharing of workload equitably

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

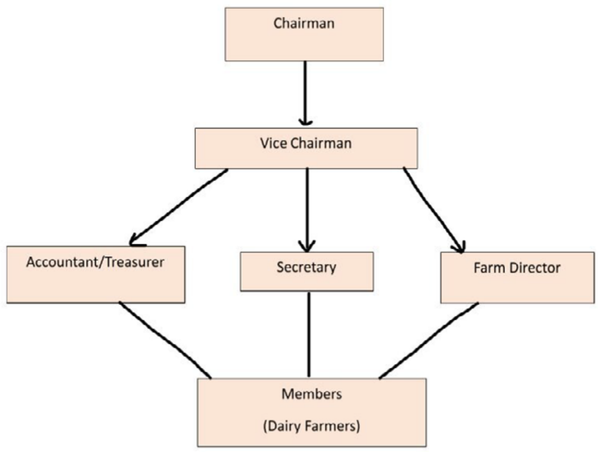
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Dairy farmers	Actively participate in decision-making and, produce and supply milk to the cooperative for processing and marketing as specified in the bylaw
local government	Livestock Extension Agent	Provide technical supports (health, feed and fodder, breeding and management) and monitor the progress of cooperative
national government (planners, decision-makers)	District Livestock Officer Royal audit authority	Assist in prioritization of issues and planning Mobilize human and financial resources Monitor and ensure adequate financial supports

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		The core dairy farmers with guidance from the Gewog Livestock Extension Agent came up with ideas to establish a dairy cooperative/group.
planning				✓		Core members along with intellectual people from the village assisted by gewog livestock extension agent planned and proposed.
implementation				✓		Interested dairy farmers supported by the gewog livestock agent and dzongkhag implemented the activity following the workplan and bylaws agreed upon.
monitoring/ evaluation			✓			The activities of the dairy cooperatives are monitored periodically through field visit, monthly report, Bi-annual general assembly meeting and annual audit.

Flow chart

Presented flow chart of Darla Dairy cooperatives with engagement of all the members



Author: Terms of Reference of Darla Dairy Cooperatives

Decision-making on the selection of SLM Technology

Decisions were taken by

- [x] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers

Form of training

- [x] on-the-job
- [ ] farmer-to-farmer
- [ ] demonstration areas
- [ ] public meetings
- [ ] courses

Subjects covered

Group mobilization, bookkeeping , planning
Hygienic and clean milk production, collection, transportation, and processing.
Breeding and management (AI, Housing, feeding system)

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

Officials from NCOA Yusipang monitored their work, and livestock officials organized awareness program on the management, care, prevention and control of common cattle diseases

Institution strengthening

Institutions have been strengthened / established

- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level

- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
The number of dairy cooperative members have increased by 15 households.

Type of support

- [ ] financial
- [ ] capacity building/ training
- [x] equipment

Further details
All members of the cooperative were supplied with milk cans to collect, store and transport milk

Monitoring and evaluation

Physical on site monitoring and evaluating the quality, standard, cleanliness of the work and products

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [ ] < 2,000
- [ ] 2,000-10,000
- [x] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

The approach was implemented with the seed money collected from the members.

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

They were provided with the milk processing equipment

	partly financed	fully financed
Machines -Chunning machine -Office furnitures - cream separator -analyzer -yogurt incubator -deep freezer and fridge		✓

Labour by land users was

- [ ] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? They got more recognition and support			✓	
Did the Approach enable evidence-based decision-making? future plans are drawn based on the needs, issues and challages faced during the operation of dairy cooperative			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Physical and financial support received have enhanced, improved social cohesion			✓	
Did the Approach improve gender equality and empower women and girls? Every men and women is given equal right.		✓		
Did the Approach lead to improved food security/ improved nutrition? Increased milk and dairy products and excess dairy products are processed and supplied to schools, hospitals and other markets.			✓	
Did the Approach improve access to markets? Formalized group marketing, and the quality of milk products have improved			✓	
Did the Approach lead to employment, income opportunities? Some school drop-outs and laid-off youths are employed in collecting and transportation of milk.			✓	

Main motivation of land users to implement SLM

- [ ] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [x] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [x] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

The initial investment has been recovered, and current income meets the operation cost.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Source of cash income
- Increased cooperation and network
- improve household livelihood

Strengths: compiler's or other key resource person's view

- Creates employment opportunities to the school drop-outs and rural youths
- Contributes to food security and better nutrition

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Scattered settlement and production Increase the number of transportation vehicles, improve road connectivity
- Short shelf life of milk Try marketing in nearby places if possible, install cold chain facilities
- Delay in payment Create a terms of agreement with the retailers to ensure payment on time

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- No proper market outlet for wholesale marketing explore market outside gewog

REFERENCES

Compiler
Karma Wangdi

Editors
chenga Tshering

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 21, 2023

Last update: June 4, 2024

Resource persons

Bal Kumar Samal - land user
Pancha Maya Gurung - land user
Datta Singh Chettri - land user
Chandra Kumar Basnet - land user
Ram Kharki - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/approaches/view/approaches_6868/

Linked SLM data

n.a.

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online

- Cooperatives in the Dairy Industry: https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.rd.usda.gov/files/cir1-16.pdf&ved=2ahUKEwi9z4b8-Z6AAxV7umMGHQsgBZUQFnoECBMQAQ&usg=AOvVaw0jmrAUETNEh8crEba04qjj
- Dairy development through cooperative structure: https://www.fao.org/3/T3080T/t3080T0a.htm
- Analysis of knowledge and adoption level of the dairy farmers regarding clean milk production (CMP) practices: https://www.indianjournals.com/ijor.aspx?target=ijor:jdfhs&volume=34&issue=3&article=002

Image showing improved diary shed and land users involved in the documentation. (Tshering Yangzom)

Dairy Cooperatives and KOUFUKU linkage for milk marketing (Bhutan)

Gonor Nyamley Tshogdey dang KOUFUKU Thuedrel Gi Thogley Om Tshongjur (སྒོ་ནོར་མཉམ་ལས་ཚོགས་སྡེ་དང་ཀོའུ་ཕུ་ཀུ་མཐུན་འབྲེལ་ཐོག་ཨོམ་ཚོང་སྦྱུར་འཐབ་ཐངས།)

DESCRIPTION

This approach links dairy cooperatives with a dairy plant, KOUFUKU International Limited (KIL), for milk marketing. It is an established dairy value chain that addresses milk and dairy product marketing issues and improves the livelihoods of many small dairy farmers in eastern Bhutan.

This approach links dairy cooperatives with a dairy plant, KOUFUKU International Limited (KIL), for milk marketing. It is an established dairy value chain that addresses milk and dairy product marketing issues and improves the livelihoods of many small dairy farmers in eastern Bhutan. The approach encompasses milk cooperatives, collection centres, milk transport vans, and the processing unit operated by KIL. Currently, milk is supplied to the company by approximately 22 milk cooperatives, each consisting of land users engaged in dairy farming. This documentation focuses on the linkage between KIL and one such cooperative named Samphel Chirphen Jersey Detshen of Udzorong Gewog in Trashigang Dzongkhag.

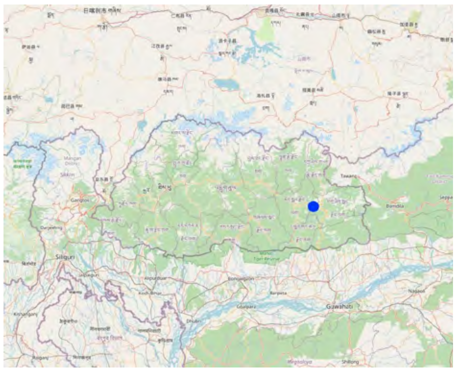
At the heart of the system are collection centres, strategically placed at each dairy cooperative and equipped with chilling machines. Managed by the dairy cooperatives, these centres serve as crucial points for milk collection. A dedicated milk transport van and driver is arranged to facilitate the transportation of milk from individual land users to the collection point, and onward to the processing unit. Designed with insulation, the van ensures the quality of the milk is maintained, preventing deterioration during transit. The pricing structure for land users is influenced by their choice in milk collection and transport: those opting for the company's services receive a lower price per litre.

The KIL processing unit, situated in Chenary, Trashigang Dzongkhag, is a subsidiary of Druk Holding and Investments Limited (DHI). This unit produces a variety of processed milk products, including "Druk Zambala Cheese," salted and non-salted butter, stirred yogurt, gouda cheese, and cottage cheese. This approach improves the livelihoods of land users, encouraging cooperative members to increase milk production which ultimately increases cash income.

For KIL, the company's involvement aims to augment processing capacity. Despite having the potential to process 4000 litres of milk daily, only 44% of this capacity was utilized as of 2021. The approach embraces an inclusive model, involving smallholder land users in cooperative formation and connecting them to the market, making it a successful value chain intervention.

The implementation method of Samphel Chirphen Jersey Detshen employs a consultative approach, engaging various stakeholders such as the Gewog Livestock Extension Officer, Dzongkhag Livestock Officer, CARLEP officials, and a representative from KIL. This collaborative method enables land users to voice their needs, ensuring decisions that benefit the community.

LOCATION



Location: Tshedung Village, Rizor Chiwog, Udzorong Gewog, Trashigang Dzongkhag, Bhutan

Geo-reference of selected sites

- 91.43788, 27.26093

Initiation date: 2021

Year of termination: n.a.

Type of Approach

- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

The stages of implementation involve the initiation of cooperative formation driven by awareness created by the Livestock Extension Officer. Group formation facilitates resource-sharing and reduces workload of land user. Further, subsidies and incentives support from the government are directed towards the cooperative rather than individual land users, emphasizing the importance of forming cooperatives to maximize benefits. The dairy cooperative members were supported to construct improved cattle sheds and biogas plants to improved livestock rearing.
Initially, the Samphel Chirphen Jersey Detshen faced marketing challenges, prompting government intervention to connect them with KIL. Consultations resulted in an agreement where land users committed to supplying a minimum of 100 litres per day at a negotiated rate of Nu. 35 per litre, establishing KIL as their end market. Subsequently, improved cattle breeds were acquired, and the cooperatives increased their daily milk supply from 71 to 280-300 litres. Stakeholders, including Gewog Livestock Extension Officer, Dzongkhag Livestock Officer, Gewog Officials, and CARLEP-IFAD, play pivotal roles in providing technical guidance, subsidies, and funding. Regular monitoring ensures the success of the activity.
In summary, this approach benefits land users by enhancing marketing services and providing sustainable sources of household income – and indirectly improves SLM through encouraging better husbandry of dairy cattle and associated biogas plants.

Marketing van that collect milk from farmers milk collection unit. (KOFUKU International Ltd.)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The approach aims to establish an efficient marketing system of the milk by creating a linkage between the land user and the milk processing unit. it will also contriutes to increased in income and improvement of land users' livelihoods.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Technologies under the approach such as biogas and improved diary sheds are environment friendly which complements the religious belief of Buddhism through being socially just.
- **Availability/ access to financial resources and services**: During the construction of a biogas plant, land users were accessible to the loan from Bhutan Development Bank Limited (BDBL). BDBL focuses on rural prosperity and provides funds for agricultural purposes. Subsidy support is provided by the government.
- **Institutional setting**: The institutional setting enabled the implementation of technology as there were only a few land users trained for the construction of biogas. The trained land user from the group shared the skills and knowledge with other land users during the installation of the biogas plant.
- **Collaboration/ coordination of actors**: Land users shared ideas, and workloads, and made collective decisions in the meeting to resolve the issues.
- **Knowledge about SLM, access to technical support**: Implementation of improved cattle sheds and biogas enriched the land user with the knowledge of soil nutrient management. For example, in the past, the land users never collected cow urine due to poor cattle shed design, now they can collect cattle urine and use it as a nitrogen source in vegetable fields.
- **Markets (to purchase inputs, sell products) and prices**: The linkage reduced the workload of the land users to market the produce as the milk collection was done from the land users' house.
- **Workload, availability of manpower**: The approach led to reduced workload as each land user need not reach the milk at the collection centre. Further with the cemented cattle shed, maintaining sanitation and cleaning the shed requires less time.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

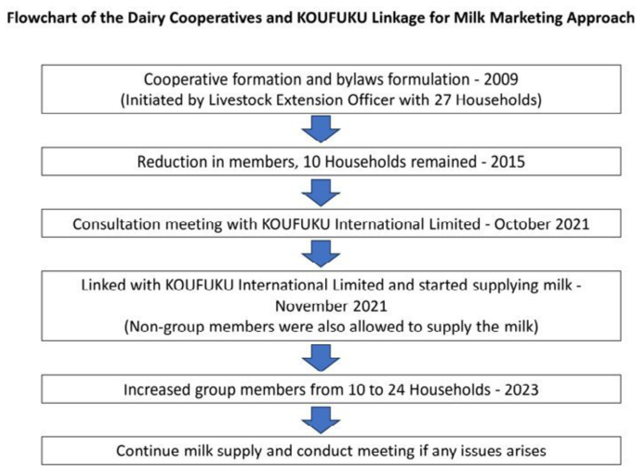
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	A total of 34 members (25 male and 9 female), aged between 35 to 50 years old from Samphel Chirphen Jersey Detshen were involved in the approach.	Produce and supply fresh milk to milk processing unit. Elected members such as Chairman, Secretary and Treasures to function as per bylaws.
SLM specialists/ agricultural advisers	Gewog Livestock Officer and Dzongkhag Livestock Officer	Provide technical inputs, monitor the activities and progress of the group and take issues that are not resolved within the cooperative to higher forums such as Gewog and Dzongkhag meetings.
private sector	KOUFUKO International Limited	Purchase milk from the land users and provide support in transportation and marketing.
local government	Gup, Tshokpa, Mangmi	Monitor group activities and allocate gewog funds if required for the group. For example, the Gewog fund of Nu. 10,00,000/- (Ten hundred thousand) was allocated to purchase improved cattle breeds (jersey) for the land users where a 70% subsidy was provided and only 30% of the total cost was borne by land users.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation			✓			Gewog Livestock Extension Officer motivated the land users to form cooperatives by creating awareness of the benefits involved in working in a group rather than individually.
planning				✓		All the stakeholders (Gewog Livestock Extension Officer, Dzongkhag Livestock officer, representatives of the KOFUKU International Limited and CARLEP-IFAD officials) were involved in the planning process.
implementation				✓		All the stakeholders with related expertise were involved in the implementation process. For example, the Dzongkhag engineer, Gewog Livestock Extension Officer, Dzongkhag Livestock officer, Gup, CARLEP-IFAD officials and land users were involved in the construction of the milk collection shed,
monitoring/ evaluation				✓		External monitoring is done by CARLEP-IFAD officials, the Gewog Livestock Extension Officer, Dzongkhag Livestock Officer. Internal monitoring is done by Thrizin to ensure the minimum milk capacity (100 litres) is met.

Flow chart

The flowchart is developed in consultation with the land users.



Author: Nima Dolma Tamang

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [x] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [ ] field staff/ advisers

Form of training
- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [x] courses

Subjects covered

Cattle shed and biogas plant construction and their benefits. Fodder grass plantations such as napier, super napier (Pakchong), and others.

Advisory service

Advisory service was provided
- [x] on land users' fields
- [x] at permanent centres

The Gewog Extension Officer is involved in providing advisory services based on the need.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.

The institution is strengthened through the approach as there were only 10 members in the cooperative in 2022 which increased to 24 as of 2023.

Type of support
- [ ] financial
- [x] capacity building/ training
- [ ] equipment

Further details

Training provided by DLO for biogas construction

Monitoring and evaluation

External monitoring is done by CARLEP-IFAD officials, the Gewog Livestock Extension Officer, the Dzongkhag Livestock Officer and Gewog Officials. The monitoring officials conduct the site visits to see the implementation of an improved dairy shed, improved cattle breeds, fodder grass plantation and biogas plant. The monitoring is mainly done to meet the objective of the funding agency and service providers i.e. to increase milk productivity and improve the livelihood of the land users.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

There is no annual budget allocated for the approach as the linkage is well established. The land users are equipped to sustain themselves. However, if new challenges arise, the budget is sought from various stakeholders.

The following services or incentives have been provided to land users
- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [x] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

1. Financial support Nu. 11,700/- (USD 140.54) provided for biogas construction for individual households 70% subsidy for procurement of improved cattle breeds 2. Equipment 70% subsidy was provided for the deep fridge for individual household and 3 large for the collection point (30-40 litres) 30% of the amount was paid by land users. Doner funded 100% for the milk collection can, butter churner, and chiller machine. 3. Construction materials per household Donor funded 100% for the biogas construction materials 8 bags of cement, metal, pipe, stove Donor funded 100% for the improved cattle shed construction materials 18 bags of cement, 18 number of CGI sheets, half truck sand.

	partly financed	fully financed
equipment: machinery Donor funded 100% for the milk collection can, butter churner, and chiller machine.		✓
Deep fridge 70% by the donor CARLEP and 30% by the land user	✓	
agricultural: seeds Fodder seeds were fully financed		✓
Cement, matal, pipe 100% financed for the construction of biogas and cattle shed		✓
Cattle shed 18 bags of cement, 18 CGI sheet, half truck sand.		✓

Labour by land users was

- [x] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

Credit

Conditions: Land users in the group can avail loans of up to Nu. 20,000 (USD 240.25) loan payable on quarterly basis for 3 years.
Credit providers: Bhutan Development Bank Limited - A bank focusing on rural development.
Credit receivers: Land users

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The approach improved farm income, knowledge and skills empowering land users to deal with difficult situations efficiently.				✓
Did the Approach enable evidence-based decision-making? Yes, to cite an example, the land users learned that super napier (Napier Pakchong 1 which is a hybrid between Pennisetum purpureum and Pennisetum americanum cv. Pakchong 1) gives more milk than the guatemala. Therefore, they opted for plantation of super napier than guatemala.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? Yes, the approach improves market linkage and indirectly encourages land users to increase milk production due to an assured market. The byproduct of the approach (cow dung) can be used to develop farm yard manure (FYM) and biogas plants ultimately improving soil quality, production of alternative energy source for cooking and heating.				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? The approach enabled stakeholders to mobilize funds and provide subsidies and financial resources to implement SLM. The land users got Nu. 20000/- loan from BDBL to construct improved diary shed.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Through the approach, the land users were trained on SLM implementation increasing their knowledge and skills.				✓
Did the Approach improve knowledge and capacities of other stakeholders? The cooperative is supported by various stakeholders in terms of technical and advisory services. When there is any issues faced by the land users, they turn to the stakeholders for support, where the stakeholders need to develop a method to solve their issues leading to improved knowledge of the stakeholders.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The approach improved collaboration between stakeholders including CARLEP-IFAD, Gewog and Dzongkhag officials and KOUFUKU International Limited company.				✓

Did the Approach mitigate conflicts?
In the past, there were social conflicts in the group as there were a few individuals who failed to do their duty of collecting milk and turning up for other group activities leading to social conflict and misunderstanding. With the establishment of linkage with the processing unit, marketing is facilitated by the company leading to a significant reduction in the social conflict.

Did the Approach improve gender equality and empower women and girls?
Any interested land users irrespective of their gender can be part of the cooperative. The greater number of males in the group member list is due to the majority of the men being head of the household. While implementing, both the parties are given equal opportunity.

Did the Approach encourage young people/ the next generation of land users to engage in SLM?
Although there are opportunities for the youths to open a large-scale dairy farm with a secured market. There were no interested youth from the community to take up dairy farming. This could be due to better opportunities and facilities available in the town than village setting. However, there were few youth entrepreneurs from the Dzongkhag involved in large-scale dairy farming.

Did the Approach lead to improved food security/ improved nutrition?
The approach provided a sustainable income source increasing the land users' buying capacity for nutritious foods.

Did the Approach improve access to markets?
There is a significant improvement in the milk market as the buyer comes to the land users' doorstep to collect milk.

Did the Approach lead to more sustainable use/ sources of energy?
Yes, the approach led to the implementation of biogas technology which is one of the sustainable sources of energy.

Did the Approach lead to employment, income opportunities?
On average individual household generates Nu. 12000/- by selling milk. Thereby, improving farm income and motivating land users to engage in livestock farming ultimately generating employment.

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Support needed for the establishment of the linkage is completed. Hereafter, the land users can sustain themselves without external support.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The major strength of the approach is milk marketing where land users get access to the market without having to worry about transportation. On the other hand, KOUFUKU International Limited can increase its production capacity of milk products.
- Forming a cooperative and working together enabled land users to avail various support from the government as majority of the support is provided to the group than individual households.
- The approach improved household income leading to improved livelihoods of the land users.

Strengths: compiler's or other key resource person's view

- Encourages other land users to form milk cooperatives. Udzorong Gewog is one of the remote areas of Trashigang Dzongkhag and the ability to establish linkage and generate income from livestock farming would encourage other land users from different chiwog and gewogs to form milk cooperatives. This would ultimately improve the living standard of the community and country.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The land users feel the price for one litre of milk is less (Nu. 35/-) which is barely enough to buy karma feed (formulated cattle feed costing Nu. 1850/- per bag) and mustard cake (Nu. 1900 per bag). The use of fodder grass (pakchong, napier, and guatemala) gives low milk production compared to processed feed. Sensitize and institute quality based payment for milk, encourage formulation of local feed, and adopt TMR
- Need for more members in the cooperative to increase the overall productivity. Sensitize and encourage other farmers to join the cooperative.
- The spread of cattle diseases such as lumpy skin disease (LSD) leads to the loss of cattle and reduced milk production. Need for immediate and improved veterinary service in the country. Encourage to put in place biosecurity measures.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- The land users are provided with lots of subsidies and inputs making them highly dependent. Which could reduce their capacity to innovate and search for solutions on their own. Subsidies should be given with conditions.

REFERENCES

Compiler
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Last update: May 30, 2024

Resource persons
Kelzang - land user
Yeshey Tenzin - land user
Karma - land user
Tshering Zangmo - land user
Jigme Choden - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6889/

Linked SLM data
Technologies: Improved Dairy Shed https://qcat.wocat.net/en/wocat/technologies/view/technologies_6898/
Technologies: Improved Dairy Shed https://qcat.wocat.net/en/wocat/technologies/view/technologies_6898/

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Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

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Links to relevant information which is available online
- Koufuku International Limited: https://kil.bt/
- Koufuku International Limited: https://www.instagram.com/koufukudairy/?hl=en

Approaches
Forests

Zhasela Community Forest (Tshering Yangzom)

Zhasela Community Forest Management Group (CFMG) (Bhutan)

Zhasela Drongdhey Nagtshel Zinchong Detshen (ཞ་འཆི་ལ་གྲོང་སྡེ་ནགས་ཚལ་འཛིན་སྐྱོང་སྡེ་ཚན།)

DESCRIPTION

The Zhasela Community Forest (CF) in Lhuentse covers an area of approximately 208 acres (83 ha). The Zhasela CF Management Group (CFMG), consisting of members of 15 households, has been formed for sustainable utilization and management of forest resources, protection of water sources, and income generation through the sale of sustainable forest products to reduce poverty.

Zhasela Community Forest (CF) covers an area of approximately 208 acres (83 ha). The community forest name "Zhasela" is derived from the local deity of the forest, Zhasela. The CF is a cool broadleaf forest. The dominant tree species found are the species of the genera Michelia, Persia, Symplocos, Betula, and Cinnamomum. The CF is looked after by the Community Forest Management Group (CFMG) consisting of members of 15 households. The operation of the CFMG is guided by the Community Forest Management Plan (CFMP). The first period of Zhasela CF management was between 2004 and 2014. The CF coverage was around 84 acres (33 ha) with 13 CFMG households. At the end of the first planning period, the CF management was retained and the CFMP revised for the next 10 years. The revised plan period was completed in 2017 with the addition of almost 124 acres (50 ha) resulting in a total 208 acres (83 ha). The CFMG members increased from 13 to 15 households. The CFMG carries out the activities highlighted in the CFMP.

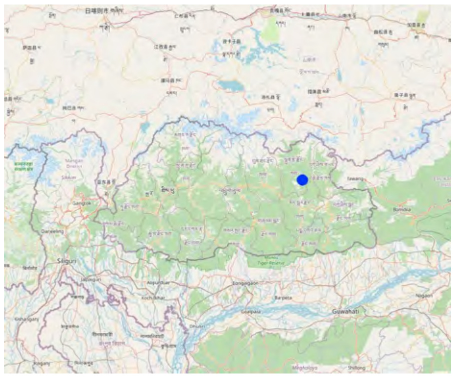
The main objectives of the approach are sustainable utilization and management of forest resources, protection of water sources, and income generation through the sale of sustainable forest products to reduce poverty.

Apart from the CFMG members, the stakeholders involved in the approach are the territorial division office, Gewog Forestry Extension Officer (GFEO), and CFMG members. The territorial division office's roles include training CFMG on a need's basis; providing technical inputs while implementing the CFMP; monitoring and providing feedback on CFMP implementation; providing market information and supporting marketing; providing support for amendment and revision of CFMP; verifying CFMG's records annually; translating CFMP to a Dzongkha version; coordinating study tours; and disseminating or advertising information related to CF or CFMG.

What the CFMG members like about this approach is that it protects water sources, provides access to forest resources such as timber, fuel wood, and non-timber forest products (NTFPs) such as fodder, fencing/flag poles, and leaf litter. The approach also helps to resolve conflicts regarding access to forest resources, conserves the local forest, reduces erosion and landslides, and thus aids in habitat protection and biodiversity conservation.

In terms of the community, the approach also helps provide loans to members from the CF fund lending scheme with minimal interest. The other advantages of this approach include diversifying income sources by reducing dependency on a single source of income like livestock farming or crop production, strengthening social cohesion by empowering local communities to manage their resources collectively, facilitating collaboration among different stakeholders, sustainably utilizing and managing forest resources, and improving living standards and reducing poverty in rural communities.

LOCATION



Location: Bragong village, Jalang chiwog, Minjey gewog, Lhuentse Dzongkhag, Bhutan

Geo-reference of selected sites
- 91.23899, 27.5791

Initiation date: 2004

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

Zhasela Community Forest Management Group (Tshering Yangzom)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main objectives of the approach are sustainable utilization and management of forest resources, protection of water sources, and income generation through the sale of excess forest products to reduce poverty.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services**: The CFMG has a 'CF fund lending scheme' where the money generated from selling CF resources such as surplus timber and wood products is lent to CFMG members at a minimal interest. Sometimes interest-free loans are provided to bereaved families and families bearing medical expenses due to sickness. The scheme provides relatively easy and cheap local access to cash for group members. During the first plan period of Zhasela CF management, CFMG generated more than Nu 320,000 from the sale of surplus timber and finished products. Nu 299, 600 was divided among the group members and each member received Nu 23,000.
- **Institutional setting**: The CFMG has helped the members improve their livelihoods and reduce poverty. The CFMG generate income through the sale of forest resources to contractors, government agencies, and private individuals.
- **Collaboration/ coordination of actors**: There is labour-sharing in the group for activities such as the plantation of seedlings, fire line creations, and overall forest management thereby easing workload in the group and improving collaboration and coordination. The CFMG members also help each other out in times of need. For example, Mr. Tshering Dorji's house was damaged by an earthquake in September 2009. In spring 2010, the CFMG allotted four drashing (trees of at least 50 cm diameter at breast height) from the CF free of cost to him for the reconstruction of his house.
- **Knowledge about SLM, access to technical support**: Members realize the importance of the CF. They realize that the forest helps protect water sources, avoid erosions and land slides through land coverage, and increase wood production.
- **Markets (to purchase inputs, sell products) and prices**: There is a good market for the sale of surplus timber from the CF. Timber is sold in the form of logs, planks, and finished products like altar. The CFMG has been able to earn a substantial amount from the sale of timber to contractors, government agencies, and private individuals.
- **Workload, availability of manpower**: There is labour-sharing in the group thereby easing workload in the group.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	15 CFMG members from 15 households.	The CFMG members carry out the activities highlighted in the CFMP.
SLM specialists/ agricultural advisers	GFEO	The GFEO monitors the activities implemented by the CFMG and provides necessary assistance in any field that the CF members require.
national government (planners, decision-makers)	Territorial division office	The territorial division office's roles include training CFMG on a need base, providing technical inputs while implementing the Community Forest Management Plan (CFMP), monitoring and providing feedback on CFMP implementation, providing market information and supporting marketing, providing support for amendment and revision of CFMP, verifying CFMG's records annually, translating CFMP to Dzongkha version, coordinating study tours, and disseminating or advertising information related to CF or CFMG.

Involvement of local land users/ local communities in the different phases of the Approach

Phase	none	passive	external support	interactive	self-mobilization	Description
initiation/ motivation				✓		The people of Bragong village had observed a gradual depletion of forest resources near their village. Forest resources such as timber, firewood, fencing/flag poles, fodder, and other forest products had become scarce. So, the community came forward with the proposal to establish a CF. Furthermore, the GFEO had been emphasizing CF's importance to the villagers multiple times. This eventually led to the formation of the CF.
planning				✓		Forest territorial division office, GFEO, and CFMG members were involved. Through multiple discussions, they came up with the CFMP.
implementation				✓		The territorial division office, GFEO, and CFMG were involved. They formulated and finalized the CFMP. The CFMG members then carried out the activities highlighted in the CFMP under the guidance of GFEO and territorial division office.
monitoring/ evaluation				✓		The GFEO and CFMG members are involved. The monitoring of CF activities is done by all CF members. The necessary records are maintained by the nominated executive committee members (chairperson, secretary, treasurer) of CFMG. The executive members are mandated to submit annual progress reports to the GFEO. The GFEO monitor the activities implemented by CFMG.

Flow chart

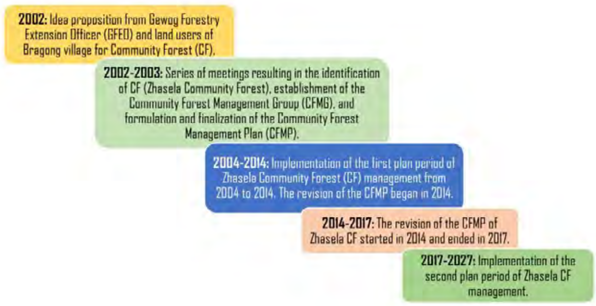


Figure 1. Flow chart showing the conception of Zhasela CF

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders
- [x] Land users (CFMG members) and GFEO

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)
- [x] The people of Bragong village had observed a gradual depletion of forest resources near their village. Forest resources such as timber, firewood, fencing/flag poles, fodder, and other forest products had become scarce. So, the community came forward with the proposal to establish a CF. Furthermore, the GFEO had been emphasizing CF's importance to the villagers multiple times. This eventually led to the formation of the CF.

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers

Form of training

- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [x] courses

Subjects covered

Accounting and record keeping
Forest management
Nursey management
Leadership skills
Power chain operation

Advisory service

Advisory service was provided

- ☑ on land users' fields
- ☑ at permanent centres

Land users have access to advisory services from the GFEO. The GFEO provides necessary assistance in any field that the CF members require and also advises the CFMG on the implementation of CFMP, the latest policies and amendments of the rule.

Institution strengthening

Institutions have been strengthened / established

- ☐ no
- ☐ yes, a little
- ☐ yes, moderately
- ☑ yes, greatly

at the following level

- ☑ local
- ☐ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.

Land users have benefitted a lot from the CF, the water sources are protected, erosions and landslides are prevented, and there is sustainable utilization and management of forest resources. Also, land users are able to generate income through the sale of surplus forest products especially timber. During the first plan period of Zhasela CF management, CFMG generated more than Nu 320,000 from the sale of surplus timber and finished products. Nu 299, 600 was divided among the group members and each member received Nu 23,000.

Type of support

- ☑ financial
- ☑ capacity building/ training
- ☐ equipment

Further details

Monitoring and evaluation

The Chief Forestry Officer, Gewog Ranger, and land users are involved in monitoring and evaluation. The monitoring of CF activities is done by all CF members (land users). The necessary records are maintained by the nominated executive committee members (chairperson, secretary, treasurer) of CFMG. The executive members are mandated to submit annual progress reports to Gewog Ranger. The Chief Forestry Officer and Gewog Ranger monitor the activities implemented by CFMG.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☑ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

There is no set annual budget for the SLM component of the approach but wherever necessary the land users use the CFMG fund and sometimes get financial and material support from the government.

The following services or incentives have been provided to land users

- ☑ Financial/ material support provided to land users
- ☑ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users

The CFMG received Nu.100,000 to carry out some of the activities reflected in the CFMP, four rolls of barbed wire, and some tree seedlings.

	partly financed	fully financed
The CFMG received Nu.100,000 from the government to carry out some of the activities reflected in the CFMP, four rolls of barbed wire, and some tree seedlings.		☑

Labour by land users was

- ☑ voluntary
- ☐ food-for-work
- ☐ paid in cash
- ☐ rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? CF management has improved participation among the member households. The CFMG members work together and carry out the activities highlighted in the CFMP. There is labour-sharing in the group for activities such as the plantation of seedlings, fire line creations, and overall forest management thereby easing workload in the group and improving collaboration and coordination. The CF has helped empower local communities to manage their resources collectively. The CFMG members also help each other out in times of need. For example, Mr. Tshering Dorji's house was damaged by an earthquake in September 2009. In spring 2010, the CFMG allotted four drashing (trees of at least 50 cm diameter at breast height) from the CF free of cost to him for the reconstruction of his house. CFMG has improved stakeholder participation between members and the government. Both land users and government officials like GFEO have benefitted through the CF. As for the members, due to CF, they have access to forest resources such as timber, fuel wood, fencing/flag poles, NWFPs, and free grazing. Their water sources are also protected and risks of erosions and landslides have been minimized. All of these motivate them to manage the forest. As for the GFEO, the forest is sustainably being managed by the members guided by CFMP thereby making their work easier. The members and the GFEO are working together with the officials giving technical advice and conducting periodic monitoring and the members carrying out various sustainable forest management field work. The CF has facilitated collaboration between different stakeholders.				☑
Did the Approach enable evidence-based decision-making? During the first plan period of Zhasela CF management, CFMG utilized 147 drashing (trees of at least 50 cm dbh which is used for sawn timber), 20 numbers of cham (trees of 30-50 cm dbh which are used for beams), 3 numbers of tsim (trees of 20-30 cm dbh which are used for large poles), and 4 numbers of dangchung (trees of 10-20 cm dbh which are used for small poles). The group also generated income through the sale of surplus timber and finished products (altars). The group generated more than Nu 320,000 from the sale of surplus timber and finished products. Nu 299, 600 was divided among the group members and each member received Nu 23,000. Some of the activities carried out in the first plan period were 2 acres of barren land were planted and maintained, a tree nursery was established, and approximately 5 acres of unwanted bushes were cleared for enhancement of regeneration and growth of retained trees. The water sources were protected and risks of erosions and landslides were minimized. The members got access to many forest resources. The members reaped a lot of benefits from the CF and this made them revise and continue CFMP for another 10 years (2017-2027). All the positive aspects of the CF enable evidence-based decision-making.				☑
Did the Approach help land users to implement and maintain SLM Technologies? The management of CF by the CFMG has helped land users protect water sources, minimize erosion and landslides, and sustainably use forest resources.				☑

Did the Approach improve knowledge and capacities of land users to implement SLM?
CF has helped land users protect water sources and sustainably use forest resources.

Did the Approach empower socially and economically disadvantaged groups?
The CF has helped land users have access to forest resources such as timber, fuel wood, fencing/flag poles, and NWFPs and provided an opportunity to generate income.

Did the Approach improve gender equality and empower women and girls?
CFMG comprises both male and female land users. There is no gender discrimination.

Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?
CF has resolved conflicts regarding access to forest resources.

Did the Approach lead to improved food security/ improved nutrition?
The CF has helped land users have access to forest resources such as timber, fuel wood, fencing/flag poles, and NWFPs and provided an opportunity to generate income. Also, CFMG provides loans to its members.

Did the Approach lead to improved access to water and sanitation?
The CF has helped protect the water sources.

Did the Approach lead to employment, income opportunities?
The land users generate income by selling forest products as they have access to forest resources.

Main motivation of land users to implement SLM

- [ ] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Sustainable use of resources in CF ensures regeneration and replenishment of harvested resources.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Protection of water sources.
- Access to forest resources such as timber, fuel wood, fencing/flag poles, fodder, leaf litter, and NWFPs.
- Conflict mitigation due to clarity on access to forest resources.
- Access to loans from the CF fund lending scheme with minimal interest.
- Conservation of local forest.
- Reduce erosion and landslides in the area.
- Habitat protection and biodiversity conservation.

Strengths: compiler’s or other key resource person’s view

- Diversify income sources by reducing dependency on a single source of income like livestock farming or crop production.
- Improve living standards and reduce poverty in rural communities.
- Sustainable utilization and management of forest resources.
- Strengthen social cohesion by empowering local communities to manage their resources collectively.
- Facilitate collaboration among different stakeholders.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- Farmers are not able to sell NWFPs due to a lack of markets in the vicinity. Since one of the roles and responsibilities of the territorial division office is to provide market information and support marketing (as highlighted in CFMP), it should come up with ways to link land users and markets in Lhuentse.

REFERENCES

Compiler
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Last update: May 30, 2024

Resource persons

Palden Dorji - land user
Tshewang Rinzin - land user
Yangchenmo - land user
Sonam Norbu - land user
Kinga Yonten - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/approaches/view/approaches_6892/

Linked SLM data

n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting– GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Phuntsho, S., Schmidt, K., Kuyakanon, R., & Temphel, K. J. (n.d.). Community Forestry in Bhutan: Putting People at the Heart of Poverty Reduction.: http://uwice.gov.bt/admin_uwice/publications/publication_files/Reports/2011/UWICER-CFIB.pdf#page=27
- Wangchuk, S. (2014). Equity in Community Forestry Management: A Case of Lhuentse and Mongar Dzongkhags, Eastern Bhutan. Journal of the Bhutan Ecological Society, 48-59.: https://www.researchgate.net/profile/Sonam-Wangchuk-5/publication/313663481_Equity_in_Community_Forestry_Management_A_Case_of_Lhuentse_and_Mongar_Dzongkhags_Eastern_Bhutan/links/58a2047f45851598babae778/Equity-in-Community-Forestry-Management-A-Case-of-Lhuentse-and-Mongar-Dzongkhags-Eastern-Bhutan.pdf

Links to relevant information which is available online

- Phuntsho, S., Schmidt, K., Kuyakanon, R., & Temphel, K. J. (n.d.). Community Forestry in Bhutan: Putting People at the Heart of Poverty Reduction.: http://uwice.gov.bt/admin_uwice/publications/publication_files/Reports/2011/UWICER-CFIB.pdf#page=27

Bamboo plantation (Kuenzang Nima)

Community Forest Management Group (Bhutan)

Drongdhey Nagtshel Zinchong Dhetshen (གྲོང་སྡེ་ནགས་ཚལ་འཛིན་སྐྱོང་སྡེ་ཚན།)

DESCRIPTION

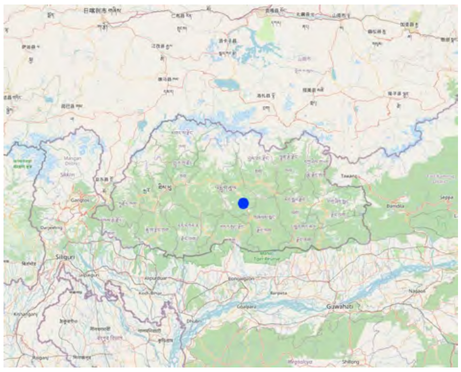
The Community Forest Management Group (CFMG) functions with an aim to sustainably manage and utilize potential Non-Wood Forest Products (NWFP) such as cane and bamboo to diversify income sources. The Jangbi CFMG comprises three Monpa (indigenous) communities viz. Jangbi, Wangling and Phrumzur. The group's main mandates are to maintain raw material (bamboo and cane) germplasm, uphold the ancestral arts and crafts skills, and ensure the sustainable harvest of natural raw materials.

Tsharzo (bamboo craft) is popular in the eastern and southern parts of Bhutan where raw materials such as bamboo and cane are abundant. Tsharzo makes use of cane and bamboo to weave products such as orongbhazib (backpack), lapchu (hand basket), chungchu (basket), bechab (winnow), tsew (basket to carry fodder, fruits, shoots etc.) and pari (mats), among others. The Community Forest Management Group (CFMG) under Jangbi chiwog, Trongsa Dzongkhag is called Monpa Selwai Yoezer Tshogpa. The Jangbi CFMG is one of the successful groups that promote bamboo and cane products in the country. The group consists of 59 households (HH) from three villages, Jangbi (23 HH), Wangling (22 HH), and Phrumzur (14 HH). The group was formed under the United Nations Development Programme (UNDP) on 14 April 2000, and officially came into play in 2007, upon drafting the bylaws. The bylaws were revised upon the need for further improvement in the year 2018. The group was formed to promote and enhance bamboo and cane products, thereby sustaining the existing trend and culture of the community. The group's main mandates are to maintain raw material germplasm (namely bamboo and cane), uphold ancestral arts and crafts skills, and ensure the sustainable harvest of natural raw materials.

The group received initial fund support of Nu. 1,400,000 from UNDP and Nu. 800,000 from Bhutan Orchids, a non-governmental organization (NGO). The government has given a total of 45 acres of land to the land users of Jangbi CFMG to plant bamboo and cane. Out of the 45 acres, 15 acres of land are collectively managed by all the land users of Jangbi CFMG for nursery raising. And 10 acres each is managed by each village under Jangbi chiwog for plantation activities. The land users plant different varieties of bamboo on the land. Some major activities carried out by the group involve documentation of the existing stock of cane and bamboo and new plantations. Cane and bamboo plantations are fenced to protect against wild and domestic animals.

Initially, Tsharzo in Jangbi CFMG was taken up on a contract basis. However, the proposal to establish a community Tsharzo group named Monpa Selwai Yoezer Tshogpa was approved by the Dzongkhag administration and was funded by the UNDP. Upon approval of the proposal, the Dzongkhag Forestry Department assisted the land users in land development (nursery development) for the cultivation of bamboo and cane in the allocated areas on 45 acres of state-owned land. The stakeholders involved in the formation of CFMG were the community

LOCATION



Location: Jangbi Chiwog, Langthel Gewog, Trongsa Dzongkhag, Bhutan

Geo-reference of selected sites

- -269.4142, 27.29307

Initiation date: 2000

Year of termination: n.a.

Type of Approach

- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

members of Jangbi, Wangling, and Phumzur villages, of Jangbi chiwog, an NGO (Bhutan Orchids), the gewog administration, the forestry department, and UNDP. The community members' roles included carrying out fieldwork (plantation of bamboo and cane, their maintenance) and engaging in decision-making processes under CFMG. The gewog administration supported the group with technical, financial, and advisory services. The NGO provided fund support of Nu. 800,000 and UNDP provided initial fund support of Nu. 1,400,000. The forestry department sourced the initial funds from UNDP, formulated bylaws, and facilitated hands-on training on bamboo and cane plantations.

The benefits of the approach include the establishment of dedicated germplasm, sustainable harvest of natural raw materials, conservation and promotion of ancestral arts and crafts skills, social cohesion through group formation, and employment opportunities. Bamboo and cane plantations play a great role in preventing soil degradation. Bamboo and cane have extensive root systems that help prevent erosion, stabilize soil, and reduce landslide risks. They are excellent for revegetation as they quickly establish themselves. Bamboo is also an efficient carbon sink, absorbing significant amounts of carbon dioxide from the atmosphere. This helps mitigate climate change by reducing greenhouse gas concentrations. Bamboo and cane provide habitats for some organisms thereby increasing biodiversity. Products made from bamboo and cane are biodegradable, reducing the environmental impact.

Bamboo plantation (Kuenzang Nima)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The group's main aims are:

i. To maintain raw material germplasm (bamboo and cane).

ii. Uphold the ancestral arts and crafts skills.

iii. To ensure sustainable harvest of natural raw materials.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: The bamboo and cane plantation for their products is enabled under the CFMG. The bamboo and cane products are one the major identities, sources of income, and an ancestral legacy. The socio-cultural norms enable the technology implemented under this approach.
- **Availability/ access to financial resources and services**: The plantation and production of bamboo and cane products are not very financially intensive. Also, the products fetch good market prices.
- **Institutional setting**: The sale of bamboo and cane products has helped diversify the income sources of the group members and improve their living standards.
- **Collaboration/ coordination of actors**: The group is being spearheaded by a chairman, a secretary, and a treasurer. These key actors have been vibrant in supervising the functions of the group. Hence, the group's coordination has been beneficial in implementing the technology under this approach.
- **Legal framework (land tenure, land and water use rights)**: The legal guidelines of the group are clear and convenient with respect to user rights. For instance, the members are provided with 45 acres of state land to use as germplasm (bamboo and cane).
- **Policies**: The policies framed under this approach are aimed mainly at ensuring the sustainability of the raw materials. For instance, each household is allocated 2 acres of natural forest to collect 2 man loads of bamboo, 2 man loads of cane, and 2 man loads of Bji in a year. They are not allowed to collect any raw materials from the 45-acre germplasm. The respondents think that it is an effective approach to sustaining the raw materials.
- **Land governance (decision-making, implementation and enforcement)**: The overall land governance is as per the state's land rules and regulations, which is not a hindering factor.

- **Knowledge about SLM, access to technical support**: With the awareness of SLM, the group was instituted. The implementation of the technology has not been hindered.
- **Markets (to purchase inputs, sell products) and prices**: As per the respondents, the market has not been a problem. They are also given opportunities to display and advocate their products in various functions nationwide.
- **Workload, availability of manpower**: The bamboo and cane product making is not very labour-intensive. Rather it is skill oriented. Hence, manpower/workload is not an issue. The by-laws of the groups clearly mention the roles and responsibilities of the members and their involvement in any activities related to cane and bamboo management is mandatory.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

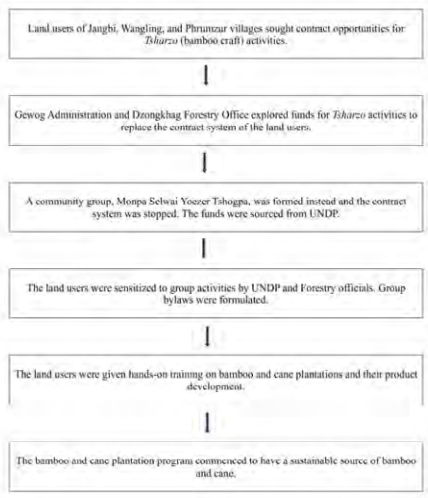
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	The community members of Jangbi, Wangling, and Phrumzur villages.	Their roles include carrying out fieldwork (plantation of bamboo and cane, their maintenance) and engaging in decision-making processes under CFMG.
NGO	Bhutan Orchids	Provided additional fund support of Nu. 800,000.
local government	The Gewog Administration	It supports the group with technical, financial, and advisory services.
national government (planners, decision-makers)	Department of Forests and Park Services (DoFPS)	The initial fund was sourced from UNDP. The Department of Forests and Park Services technically supported the formulation of a management plan and by-laws for the group and facilitated hands-on training on bamboo and cane plantations.
international organization	UNDP	UNDP provided initial fund support of Nu. 1,400,000.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		In the year 2000, a few community representatives approached the Forestry officials to explore the market and sale plans for bamboo and cane products. The representatives expressed an interest in acting as vendors. In return, the forestry officials suggested instituting a group. Hence, the idea of Community Forest Management Group (CFMG) was conceived for managing cane and bamboo species (non-wood forest produce).
planning		✓				The fund securing was supported by Gewog Administration whereas formulation of a management plan and by-laws was technically supported by forestry officials, Department of Forests and Park Services.
implementation				✓		Following the sensitization program from UNDP and the Gewog Administration, a hands-on training program was conducted by forestry officials on bamboo and cane plantations.
monitoring/ evaluation					✓	The monitoring activities are carried out by the group members themselves on an annual basis. As such, the scale-up programs are limited due to budget constraints.

Flow chart

This is a flow chart of Monpa Selwai Yoezer tshokpa (Jangbi Tsharzo)



Author: Tenzin chophel

Decision-making on the selection of SLM Technology

Decisions were taken by

- [x] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers

Form of training

- [ ] on-the-job
- [ ] farmer-to-farmer
- [x] demonstration areas
- [x] public meetings
- [ ] courses

Subjects covered

The members were trained on the plantation and management of bamboo and cane and about their germplasm.

Advisory service

Advisory service was provided

- [x] on land users' fields
- [x] at permanent centres

The CFMG is under the jurisdiction of the Jigme Singye Wangchuck National Park under the Department of Forests and Park Services. The advisory services are provided by the Langthel Park Range Office.

Institution strengthening

Institutions have been strengthened / established

- [ ] no
- [ ] yes, a little
- [ ] yes, moderately
- [x] yes, greatly

at the following level

- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.

The sale of bamboo and cane products has helped diversify the income sources of the group members and improve their living standards.

Type of support

- [x] financial
- [ ] capacity building/ training
- [ ] equipment

Further details

Monitoring and evaluation

The monitoring and evaluation of the management plan is conducted by group members and Department of Forests and Park Services. In order to ensure the proper implementation of activities, annual monitoring is conducted by the executive committee members (Chairman, Secretary and Treasurer) based on the management plan prescriptions and by-laws framed for a period of 10 years. Similarly, the respective field office conducts annual monitoring of the group and submits the report to the Department for review and accordingly advice the field offices to carry out the corrective measures. Based on the Forest and Nature Conservation Act and Rules, a midterm evaluation on the 5th year and final evaluation on the 10th year of the plan period is conducted by the Department of Forests and Park Services for monitoring of the activities planned for 10 years. The monitoring and evaluation report for the group shall determine the revision and implementation of the plan for next 10 years.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☑ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

The total fund supported by UNDP and Bhutan Orchids was Nu. 1,400,000 and Nu. 800,000 respectively. These budgets were granted for both the institution of the group and the initiation of technology implementation. The fund support was for the commencement of bamboo and cane plantations in the initial year. There is no funding now and the land users now manage the plantation activities themselves.

The following services or incentives have been provided to land users

- ☑ Financial/ material support provided to land users
- ☐ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users

The total fund of Nu. 2,200,000 was supported by UNDP and Bhutan Orchids to institute the group, and to initiate the technology implementation.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The multiple sensitization and training programs initiated by the benefactors have empowered the land users, especially in sustaining raw materials for the bamboo and cane product developments.			✓	
Did the Approach enable evidence-based decision-making? The 45 acres of germplasm successfully maintained by 59 household members is a main indicator.				✓
Did the Approach help land users to implement and maintain SLM Technologies? The approach has encouraged land users to go for bamboo and cane plantations.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? The land users are collectively working towards maintaining raw material germplasm (bamboo and cane), upholding ancestral arts and crafts skills, and ensuring sustainable harvest of natural raw materials. This promotes collaboration and coordination among the land users. The land users collect the seedlings from the nearby forest within the community without having to buy from external sources for the germplasm. This is the cost-effective implementation of SLM.			✓	
Did the Approach mobilize/ improve access to financial resources for SLM implementation? The group has initiated a micro-financing scheme. A household can avail a loan up to Nu. 50,000 with 5% interest per month for CFMG members, and at the existing bank interest rate for non-members.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? The product development skills are further strengthened through training and exposure visits. Likewise, the knowledge of SLM has enhanced, where for instance, the farmers have started planting bamboo in degraded lands especially triggered by newly constructed roads.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The approach could bring different stakeholders such as UNDP, Bhutan Orchids, Dzongkhag Administration and Forest Offices, Department of Forests and Park Services and the local community together onboard to achieve goals of sustaining raw materials and improving rural livelihood.				✓
Did the Approach mitigate conflicts? Though no major conflicts in the community existed earlier, the institution of the approach further enhanced the community coordination in utilizing natural raw materials. For instance, every household is allotted 2 acres each to collect the raw materials, which ensures equity amongst the community members.				✓

Did the Approach empower socially and economically disadvantaged groups?
advantaged and disadvantaged households. Moreover, the 20% remittance compulsorily levied on every sale has improved the group's fund.

Did the Approach improve gender equality and empower women and girls?
Participation in the program/group activities has no gender discrimination.

Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?
The permits have been passed to establish 45 acres of germplasm in state land, without having to use cultivatable individual lands.

Did the Approach lead to improved food security/ improved nutrition?
The income earned through the implementation of technology under this approach has enhanced family income, leading to enhanced food security and improved nutrition.

Did the Approach improve access to markets?
The arts and crafts expo opportunities provided by various institutions have led to market enhancements. Thereby, people have started selling fewer products with higher market prices, unlike in earlier years when people used to earn very little even by selling a large number of products.

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?
The establishment of germplasm under the approach has led to higher vegetation coverage, which ultimately addresses climate-related disasters in the long run.

Did the Approach lead to employment, income opportunities?
The people back in the community are able to engage in making bamboo and cane products besides their usual farm activities. And the income earned by selling these products has enhanced the family income.

Main motivation of land users to implement SLM

- [ ] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [x] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [x] no
- [ ] yes
- [ ] uncertain

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Preserve and promote ancestral arts and crafts skills.
- Dedicated germplasm (bamboo and cane) established.
- Income generation through the sale of bamboo and cane products.
- Sustainable harvest of natural raw materials.

Strengths: compiler’s or other key resource person’s view

- Social cohesion through collaboration and coordination among the land users in the group.
- Bamboo and cane have extensive root systems that help prevent erosion, stabilize soil, and reduce landslide risks.
- Employment opportunities.
- Products made from bamboo and cane are biodegradable, reducing the environmental impact.
- Higher vegetation cover.
- Sustainable utilization of forest resources (bamboo and cane).
- Diversify income sources of the land users.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The identified germplasm area lacks suitable places for convenient plantations. The majority of the area is rugged terrain and steep. Exclude the steep and rugged terrains. Explore and identify suitable and convenient areas for plantation.
- The wooden fencing poles surrounding the germplasm area are not durable (cannot withstand barbed wires for longer periods). Replace the wooden fencing poles with steel posts or other durable materials.
- No funds to scale up. For instance, the canes lost in the 2017 forest fire have not been re-generated like bamboo. Additional funds are to be sought to scale up the plantation programs.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

REFERENCES

Compiler
Tshering Yangzom

Editors
Haka Drukpa

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Sonam - land user
Nagari - land user
Chencho - land user
Lethro - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6861/

Linked SLM data
Technologies: Cane and Bamboo Plantation to Sustain Raw Materials https://qcat.wocat.net/en/wocat/technologies/view/technologies_6859/
Technologies: Cane and Bamboo Plantation to Sustain Raw Materials https://qcat.wocat.net/en/wocat/technologies/view/technologies_6859/

Documentation was faciliated by

Institution
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Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Bamboo/cane plantation to sustain Monpa livelihood: https://kuenselonline.com/bamboocane-plantation-to-sustain-monpa-livelihood/
- Monpa, the early settlers of Bhutan in Jigme Singye Wangchuck National Park and conservation strategy: https://researchoutput.csu.edu.au/en/publications/monpa-the-early-settlers-of-bhutan-in-jigme-singye-wangchuck-nati
- Monpas of Bhutan: A Study of Tribal Survival and Development Responses: https://architales.org/wp-content/uploads/2020/06/03-Raghubir-CHANDp25-37.pdf

Water source of Patshaling, Tsirang Dzongkhag (Gem Tshering)

Sustaining Drinking Water through Payment for Environment Services (PES) (Bhutan)

Rangzhhin Thakor Zhabtog Lachha Troedhey Thungchhu Yuenten Zhagthab (རང་བཞིན་མཐའ་སྐོར་ཞབས་ཏོག་གླ་ཆ་སྤྲོད་འདི་འཐུང་ཆུ་ཡུན་བརྟན་བཞག་ཐབས།)

DESCRIPTION

This approach compensates land users annually for taking care of a water source and its surroundings. The source is being looked after by two groups of environmental service providers and water is supplied to seven gewogs and Damphu Municipality in the Tsirang Dzongkhag.

Due to shortages of good quality water, and the need for protection of the watershed to improve quality and quantity, a "Payment for Ecosystem Services" (PES) contractual agreement has been put into place between providers of the services and users. This strategy's primary goal is to maintain the availability of drinking water for places experiencing shortages. The agreement is between the Thakhorling Community Forest Management Group (CFMG) referred to as the "Primary Provider" and Khuchi-Darachhu CFMG as the "Secondary Provider" of environmental services (ES), and the Drinking Water users of Damphu referred to as "Users" of the drinking water source. Official government intermediaries administer the payment for environmental services (PES) mechanism to ensure that it is implemented successfully between the providers and the user.

Under the agreement,

•The ES Providers pledge that a buffer strip of 100 meters shall be maintained on both sides of the stream, where no vegetation or trees can be removed or harvested, and no grazing is permitted. This helps ensure proper recharging of spring sources as well as improving water quality.

•The ES Providers agree to plant native species annually to rehabilitate degraded watersheds.

•The ES Primary Provider commits to guarding the entire watershed from illegal extraction and overgrazing to improve vegetation cover and to ensure the continuous flow of springs.

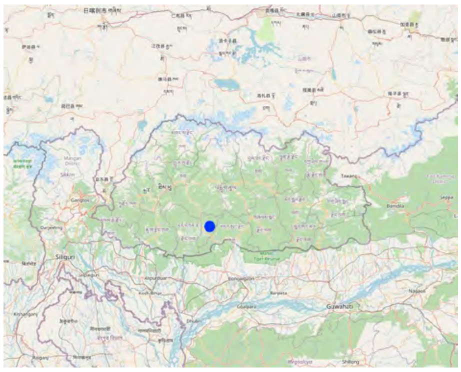
•The ES Primary Provider promises to clear stream channels every four months to facilitate continuous flow of water.

•The ES Users take responsibility to pay for all the activities undertaken by ES Providers for the protection of the watershed.

•The ES Providers (both primary and secondary) will receive (approx.) US $2700 per year from the Users. The payment is included in the monthly water bill, collected by the Municipal Authority of Damphu, and released to the ES Providers annually. However, in case of increase in water users from current numbers (6000), an additional fee collected will also be released to ES Providers as an additional incentive.

•In the event the ES Provider fails to carry out the activities as agreed, the Dzongkhag Administration has the authority to retain the PES fee of the failed activity and release the fees for other activities.

LOCATION



Location: Thakorling village, Tsirang, Bhutan

Geo-reference of selected sites

- 90.17988, 27.0451

Initiation date: 2019

Year of termination: 2029

Type of Approach

- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

This agreement is valid for a period of ten years from July 2019 until June 2029 and may be renewed or extended based on the consensus of the parties. To execute the agreement, two water user groups were formed with a chair and committee, and these created tight by-laws. Once every three months, the chairman inspects the water source's cleaning process – for which the workers receive compensation. The land users work in groups to preserve the water source and the surroundings, and they are paid annually. Each year, the groups must plant trees on an acre of land (0.4 ha) close to the water supply.
Monitoring and evaluation of the PES are conducted twice a year - in June and in December- by the officials from Dzongkhag, Municipal, Thromde and Forest Division. After a successful evaluation, they sign a form which is essential to ensure the annual budget for the PES.
Since the water source is in Thakorling, the land users' permission was crucial to supply water to other locations. Many initially opposed the notion of sharing the water source because they believed it would one day result in a water shortage in their own region. But consultations helped them change their minds. Officials gave them assurances that should a water crisis emerge in the Thakorling area, the municipality and Thromde vowed to provide them with water at any cost. Almost everyone accepted the agreement though there are still a small number of people who disagree.

Consultation meeting with the Gewog leaders regarding the PES (Gem Tshering)

Water source (Gem Tshering)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

To protect the water source and maintain continuous supply of clean water to 7 geogs, Damphu Municipality and other institutions.

To protect the water source and distribute water to areas where there is a scarcity.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: The land users were willing to share the water source with the other users.
- **Availability/ access to financial resources and services**: The funds required to implement this plan were all provided by the government.
- **Institutional setting**: Groups were formed to protect water source.
- **Collaboration/ coordination of actors**: The land users worked collectively when they had to clean and carry out maintenance works.
- **Legal framework (land tenure, land and water use rights)**: PES group formed for ten years with agreement signed between Parties (Service Providers and Service Users).
- **Policies**: Section 47 of Forest Act 2023 provides support for the establishment of PES.
- **Markets (to purchase inputs, sell products) and prices**: Market and price is determined by the agreement signed between Service Providers and Service Users.
- **Workload, availability of manpower**: Workload is eased by the presence of other land users (availability of manpower).

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Some land users were against this idea as they thought they might face water scarcity in the community in the future.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Land users	Land users formed groups to protect, manage and conserve forests under the ecosystem services.
Thromde, Municipal and Divisional Forest Office.	Thromde, Municipal and Divisional Forest Office.	Conduct PES meetings, allocate budget and monitor and evaluate the activities carried out by the land users.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation	✓					Considering the water crisis in Tsirang and recognising the importance of forests in providing goods and services the Divisional Forest Office (DFO) introduced Payment for Ecosystem Services (PES) scheme in August 2017.
planning				✓		Both land users and government officials were involved while establishing the approach.
implementation				✓		ES providers, Thakorling Community Forest Management Group (CFMG) and Khuchi-Darachhu CFMG protect, manage and conserve forests under the ecosystem services. ES users pay for all the activities undertaken by ES providers. Divisional Forest Office looks after the overall conduct of activities in the PES scheme.
monitoring/ evaluation				✓		Divisional Forest Office and land users were involved.

Flow chart

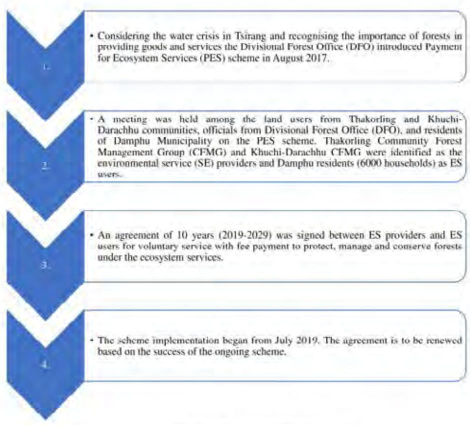


Fig.1. Inception of PES scheme

Author: Tshering Yangzom

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders
- [x] Divisional Forest Office and Damphu Municipality in consultation with the land users.

Decisions were made based on

- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [ ] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

The ES providers have to carry out certain regular activities like cleaning the stream, afforestation, guarding community forest against illegal extraction of forest resources, limiting the number of cattle members, and maintaining sanitation and hygiene, among others. The land users have access to advisory services mostly from the Divisional Forest Office.

Institution strengthening

Institutions have been strengthened / established

- [ ] no
- [ ] yes, a little
- [ ] yes, moderately
- [x] yes, greatly

at the following level

- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.

The two community forest management groups identified as the ES providers have a chairperson, a secretary, and an accountant each (appointed from among the land users). The land users jointly carry out activities like cleaning the stream, afforestation, guarding community forest against illegal extraction of forest resources, limiting the number of cattle members, and maintaining sanitation and hygiene, among others.

Type of support

- [x] financial
- [ ] capacity building/ training
- [ ] equipment

Further details

The finances come from the water users annually thereby resulting in the generation of income for the land users/ ES providers.

Monitoring and evaluation

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [x] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

Environmental services users.

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [ ] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

Finacial support from the environmental services users.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? All the land users works collectively in groups to protect, manage and conserve forests				✓
Did the Approach help land users to implement and maintain SLM Technologies? The land users carry out SLM activities such as afforestation, guarding community forest against illegal extraction of forest resources, limiting the number of cattle members, and maintaining sanitation and hygiene, among others.			✓	
Did the Approach improve coordination and cost-effective implementation of SLM? The land users work collectively towards the shared goal of forest protection via funds from the ES users.				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? The approach has improved access to financial resources via funds from the ES users.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? The land users are mostly engaged in small but important SLM activities such as afforestation, guarding community forest against illegal extraction of forest resources, limiting the number of cattle members, and so on.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? All the land users work collectectively in groups to manage and conserve forests.				✓
Did the Approach mitigate conflicts? Water crisis has been solved.				✓

Did the Approach empower socially and economically disadvantaged groups?
The land users from various backgrounds are part of ES providers.

Did the Approach improve gender equality and empower women and girls?
Both men and women are in the groups of ES providers.

Did the Approach encourage young people/ the next generation of land users to engage in SLM?
The approach is focused on forest management and conservation and it positively showcases the benefits of managing and protecting the forests.

Did the Approach lead to improved food security/ improved nutrition?
ES providers get some amount from the ES users and this amount increases the access to financial resources. Improved access to financial resources in turn increases the access to improved food or nutrition.

Did the Approach lead to improved access to water and sanitation?
ES users have access to clean and continuous water.

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?
This approach encourages afforestation, reduced overgrazing or clearing of vegetation which can indirectly be related to fighting climate change in small ways.

Did the Approach lead to employment, income opportunities?
The land users are able to generate income through their environmental services to the ES users.

Main motivation of land users to implement SLM

- [ ] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [x] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [ ] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

PES scheme is sustainable without external support as long as the ES providers keep on providing environmental services and the ES users pay for the services. Also, this scheme promotes the different practices of protecting, managing and conserving forests such as afforestation, guarding against illegal extraction of forest resources, and limiting the number of cattle which are all sustainable practices.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Improved access to financial resources.
- Deeping of SLM knowledge of the land users because of different sustainable forest management practices carried out.
- Sustainable PES scheme as the fund is generated by the ES users with no reliance on external funding.

Strengths: compiler's or other key resource person's view

- Since the land users plant trees each year and have strict rules and regulations to protect the environment, it helps in environmental conservation.
- Help preserve natural resources and educate the local people on how to protect the continuous flow of water from the sources.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Water shortage during winter season. The land users have constructed water harvesting ponds.
- Disagreements in the implementation of plans during the initial period. Held meetings to clear the confusion and solve the disagreements.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Dispute among the members. Through discussions
- Water crisis in the near future as the land users share water from a single source. Protect the water source and use water wisely.

REFERENCES

Compiler
Tshering Yangzom

Editors
Haka Drukpa

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 19, 2023

Last update: May 30, 2024

Resource persons
Lhasang Tamang - land user
Dawa Tamang - land user
Ganesh Sunwar - land user
Basant Kumar Ghalley - land user
Bal Bir Rai - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6862/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Protecting the water source of Damphu town through PES scheme: https://www.bbs.bt/news/?p=118173#:~:text=Beginning%20this%20month%2C%20the%20residents,forest%20of%20the%20two%20chiwogs.
- Payment for Environmental Services scheme established in Tsirang: https://www.facebook.com/search/top/?q=payment%20for%20environmental%20service%20established%20in%20Tsirang%202019

Sacred groves surrounding the 300 year old worship tree. (Tshering Gyeltshen)

Sacred Groves as Informal Protected Areas (Bhutan)

Ney dang Draktsen Tshu Sungchop Sakhong Khey Chhoe Yoep (གནས་ས་དང་བྲག་བཙན་ཚུ་སྲུང་སྐྱོབ་ས་ཁོངས་ཁྱད་ཆོད་ཡོདཔ།)

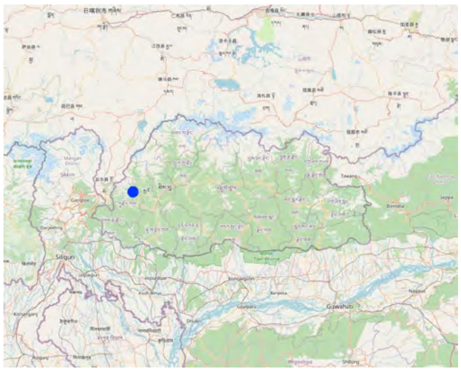
DESCRIPTION

A sacred grove is considered to be the home of the Local Deity of a region and is revered and protected by the people with respect and dedication. Here, a sacred grove of trees and undisturbed ground surround a majestic blue pine that is believed to be more than 350 years old.

A sacred grove is considered to be the home of the Local Deity of a region and is revered and protected by the people with respect and dedication. Here, a sacred grove of trees and undisturbed ground surround a majestic blue pine that is believed to be more than 350 years old.
The distinct feature of the approach is that it is undertaken by an informal group borne out of pure faith and dedication to their local hero and legend. In this case, people protect and conserve a particular sanctuary the size of two football pitches. Trees surround it with important signs and symptoms considered to serve the purpose of sacred offerings to the deity that saved the people of that locality in the 17th century AD.
In the middle is a tall blue pine tree that holds a prayer flag on its crown which is renewed once a year. It is believed to have been planted some 350 years ago to mark the victory of the people of Haa against Tibetan invaders. The victory of the Haaps was guaranteed by the magic and Herculaneum feat of Ap Chhundue who is said to have defeated every Tibetan soldier with a single slash in that very ground.
To revere him for his extraordinary deeds, people celebrate two types of occasions, decorating the surrounding trees and encircling the middle tree singing and citing words of praise to Ap Chhundue while holding a sword in one hand and a circular shield in another. The village's Pawo (oracle) performs his rituals, foretells the general predictions and warnings (if any) for the coming year, and suggests remedies and tips for a fruitful year ahead.
During the occasion, the trees that grow around are tied with colourful prayer flags and scarves. Different shapes and sizes of ritual cakes are made and kept in front of the sacred tree and a set of prayers is conducted by the monks led by the head lama of Haa Rabdey (monastic school). The sacred tree in the middle and other trees are included among the ritual cakes and have to be equally mentioned in the prayers that the monks recite. That is why these trees are left untouched.
As per the grandson of their former Ap Pawo (Astrologer/ Oracle) who never missed the events happening in that haven, he saw a connection and coexistence of three different backgrounds with one goal in mind, which was to preserve that sacred place and continue to pass it on to future generations.

In conclusion, the people of Haa not only preserve their culture and identity, but also preserve and promote the natural environment. No wonder Haa Dzongkhag (State) is still under 80% forest cover - contributing to a carbon-negative nation.

LOCATION



Location: Jangkakha, Bji Geog, Haa, Bhutan

Geo-reference of selected sites
- 89.24654, 27.41483

Initiation date: n.a.

Year of termination: n.a.

Type of Approach
- ☑ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☐ project/ programme based

5 representatives from 3 Chiwogs interacting and talking about the history and significance of the place. (Singye Dorji.)

Appeasing of Ap Chhundu at the sacred grove (Sonam Wangdi, Range Officer, Haa)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main aims/objectives of the approach are:
1) Maintaining the sanctity and sacredness of the place.
2) Protect sacred trees believed to hold important historical imprints.
3) Promote and preserve cultural and historical significance of the place through worship of the sacred trees and rocks in the place.
4) Strengthen and improve coordination and cooperation among different villages of the region.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Preserves the social cohesion and traditional values of Haa valley.
- **Availability/ access to financial resources and services**: The local people celebrate two significant religions ceremonies in that place.
- **Collaboration/ coordination of actors**: During religious ceremonies and offerings, people of different villages of the region come together to celebrate and worship the same hero (Guardian Deity)

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Difficult to organize due to the dwindling rural population.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Indeed every people of the locality are involved especially the village representatives called Gup(Sub-district head) and other local leaders of different communities.	Their role is to protect the place from external destruction by foreign investors and wood industries.
community-based organizations	Lead by the community representatives, they honor and even celebrate and worship the trees in and around the celebration ground.	
teachers/ school children/ students	Teachers lead students in bush cleaning and mass paper picking every 3 months and after big celebrations.	
local government	Local government plays crucial role in organizing two important occasions where people of the community come together to celebrate and worship these sacred groves of trees.	

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization
initiation/ motivation					✓
planning					✓
monitoring/ evaluation	✓				
None	✓				

It all started in the 17th Century after local people decided to make offer and worship the sacred battle ground.
No other people or policy makers were involved in planning.

Flow chart

General history/ flow chart of the informal group Approach.

Author: Tshering Gyeltshen.

Decision-making on the selection of SLM Technology

Decisions were taken by
- [x] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [ ] Capacity building/ training
- [ ] Advisory service
- [x] Institution strengthening (organizational development)
- [ ] Monitoring and evaluation
- [ ] Research

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [x] yes, a little
- [ ] yes, moderately
- [ ] yes, greatly

at the following level
- [ ] local
- [x] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
This approach brings together different sectors of Haa Dzongkhag to celebrate amd honour the local deity of Haa on the ground where sacred groves of forest is protected.

Type of support
- [ ] financial
- [ ] capacity building/ training
- [ ] equipment

Further details

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☑ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

The main donor for the preservation of culture to conserve the Nature through protecting the area is Culture sector of the Dzongkhag Administration.

The following services or incentives have been provided to land users

- ☐ Financial/ material support provided to land users
- ☐ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach enable evidence-based decision-making? Yes, there are incidences of people going against the belief and rule of the approach that they faced consequences in the form of mishaps and trouble.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? This approach directly leads to natural preservation and promotion of Sustainable Land Management.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? This approach leads to strengthening of the collaboration and cooperation among communities especially during one of the celebrations of their local deity where trees are also worshiped and appreciated.				✓
Did the Approach mitigate conflicts? There's no direct climate mitigation but in a way fights global warming through prevention of deforestation.		✓		
Did the Approach lead to more sustainable use/ sources of energy? The idea of the approach is that people can collect dead and dry branches of wood from the sacred groves. The land users could also collect dry pine leaves but should not cut down the trees or surrounding young pants. So definitely the approach encourages sustainable use of resources.				✓
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?		✓		
Did the Approach lead to employment, income opportunities? It is an informal group/ approach where no one is recruited.	✓			

Main motivation of land users to implement SLM

- ☑ increased production
- ☐ increased profit(ability), improved cost-benefit-ratio
- ☑ reduced land degradation
- ☑ reduced risk of disasters
- ☐ reduced workload
- ☐ payments/ subsidies
- ☐ rules and regulations (fines)/ enforcement
- ☑ prestige, social pressure/ social cohesion
- ☐ affiliation to movement/ project/ group/ networks
- ☐ environmental consciousness
- ☑ customs and beliefs, morals
- ☐ enhanced SLM knowledge and skills
- ☐ aesthetic improvement
- ☐ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- ☐ no
- ☑ yes
- ☐ uncertain

This approach of protected area has been passed down for generations dating back to 17th century and with strong and undying belief, it will sustain without external support.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Preservation and promotion of culture and traditions
- Paying tribute and respects, which ultimately leads to blessings and protection ensured by their local deity.
- Prevention of uncontrollable calamities and disasters.

Strengths: compiler's or other key resource person's view

- Improvement of unity and cooperation among and within local communities.
- Unique culture and custom which provides unique identity to the local people.
- Intense respect, connection and harmony with nature and unseen forces.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Lack of belief and interest in such beliefs by younger generation. Parents must retell the legendary history and restore faith in young minds.
- Diminishing of the faith and customs passed down from forefathers. Spark faith and interest through stories and proofs.
- Lack of cooperation among and within local communities. Must make it a formal group in future.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Lack of written accounts and documents. Must start drafting general charter of the informal group.
- Lack of proper hierarchy and coordination of events related to the approach. Must have a formal association.
- Lack of funds and budget for general coordination and celebrations during the workshop of the sacred grooves. Provide funds for continued preservation of the natural habitat of the place.

REFERENCES

Compiler
Karma Wangdi

Editors
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Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: June 4, 2024

Resource persons

Tashi Penjor (penjortashi73@gmail.com) - land user
Kachey Kachey - land user
Passang Passang - land user
Kezang Norbu - land user
Tshentse Tshentse - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/approaches/view/approaches_6856/

Linked SLM data

n.a.

Documentation was faciliated by

Institution

- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- n/a: n/a

Links to relevant information which is available online

- n/a: n/a

Photo of harvesting pond for the water coming from springsheds revived above (Tshering Gyeltshen)

Nature-based Solutions for Springshed Revival (Bhutan)

Rangzhin Thablam Thok Chhuka Sakhong Nyamsuung (རང་བཞིན་ཐབས་ལམ་ཐོག་ཆུ་ཀ་ས་ཁོངས་ཉམས་སྲུང་།)

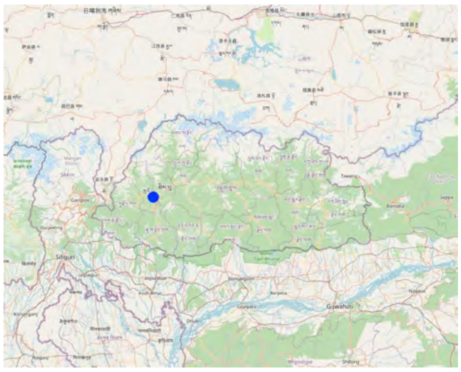
DESCRIPTION

Springshed revival can be achieved through Nature-based Solutions (NbS) with a hydrogeological approach, complemented by socio-ecological inputs, and engineering surveys.

Springs are natural occurrences where fresh water emerges from the ground through openings known as spring vents. They are outlets from aquifers, water-bearing layers underground, to the surface. The water in springs originates from rainfall during specific seasons, which falls on the springshed, infiltrates the ground and is collected as groundwater. When the groundwater is pressurized and rises, it creates springs, which then contribute to the flow of water into rivers or other water bodies. In mountainous regions like Bhutan, springs serve as the primary water source for rural households (ICIMOD, 2021).
Spring revival through "nature-based solutions" (NbS) in springsheds refers to a comprehensive effort aimed at reviving and restoring the functionality of springs. The primary objectives of spring revival initiatives include ensuring sustainable water supply, mitigating the threat of springs drying, conserving biodiversity, and improving the livelihoods of communities dependent on spring water. To achieve these goals, diverse methods are employed, involving various stakeholders. While spring revival offers numerous advantages, it also presents certain disadvantages that should be considered (Konek & Samanta, 2022).

The methods used under NbS to revive springs are multifaceted and typically involve a combination of hydrogeological, ecological, hydrological, and community-based approaches. Hydrogeology can lead to a better understanding of aquifers and the nature of springs and springsheds, thus providing ways for better management. Ecological methods focus on restoring the natural catchment area (the springshed itself) and improving vegetation cover to enhance water infiltration and recharge. Measures such as reforestation, contour trenching, and check dams are implemented to reduce erosion, promote groundwater recharge, and maintain spring flow. Hydrological interventions include the construction of recharge structures, groundwater recharge pits, and percolation tanks to replenish the aquifer and ensure sustained spring flow. Community-based approaches encompass raising awareness, capacity building, and participation in springshed conservation and management activities. These efforts often include the establishment of user groups, water committees, and the adoption of sustainable water use practices (Shrestha et al., 2017).
Stakeholders play vital roles in spring revival initiatives. Local communities living in Lholing areas are key stakeholders as they are directly affected by water availability and are actively involved in the preservation and management of springs. Government agencies such as the Department of Water, Department of Forests and Park Services and Gewog Administration provide technical expertise, funding, and policy support. Academic institutions and research organizations contribute scientific knowledge, monitoring, and evaluation, while international agencies and donor organizations may provide financial assistance and expertise.

LOCATION



Location: Lholing Chiwog, Shaba Geog, Paro Dzongkhag, Shaba, Paro, Bhutan

Geo-reference of selected sites
- 89.49825, 27.3625

Initiation date: 2018

Year of termination: n.a.

Type of Approach
- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

According to Tamba et al. (2012) the advantages of spring revival are significant and far-reaching. By restoring spring flow, communities get access to a reliable and sustainable water source, which is crucial for their domestic, agricultural, and livestock needs. Spring revival through NbS also contributes to biodiversity conservation, as the presence of flowing water supports diverse aquatic and terrestrial ecosystems, including endemic species. Moreover, the revival of springs enhances groundwater recharge, which can benefit other water sources in the area. The community involvement and capacity-building aspects of NbS initiatives foster social cohesion, empowerment, and the development of local governance structures. Revived springs have the potential to enhance community resilience to climate change by providing water during periods of drought or erratic rainfall.

However, NbS also come with certain challenges and disadvantages. Adequate financial resources and long-term funding commitments are often required, which can pose a challenge in resource-constrained settings. Technical expertise and knowledge gaps may hinder the effectiveness of revival methods, emphasizing the need for capacity building and technical support. The involvement of multiple stakeholders can lead to coordination issues and conflicts of interest. Furthermore, the success of spring revival initiatives relies heavily on community participation. Thus, lack of community engagement or ownership can hinder sustainability. Environmental and social impacts need to be carefully considered, as inappropriate interventions or changes in hydrological patterns can have unintended consequences on ecosystems and communities (Khadka et al., 2019).

Weather stations were installed to monitor temperature and rainfall pattern (Thinley Tshering)

Water recharge trenches (Thinley Tshering)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

Nature-based solution to reviving springs as a source of water for:

1. Drinking
2. For animal use
3. Agriculture

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Water became the source of whole existence.
- **Availability/ access to financial resources and services**: This type of project can be brought into action with the help of continued implementation of activities and grants
- **Institutional setting**: More stakeholders
- **Legal framework (land tenure, land and water use rights)**: Water Act of Bhutan 2010
- **Policies**: Drinking water has been a priority over other usage as per our Act and policies.
- **Land governance (decision-making, implementation and enforcement)**: The Department of Water and Department of Forests and Park Services have been promoting conservation and management of water resources.
- **Markets (to purchase inputs, sell products) and prices**: The communities have access to local markets to sell their agricultural products.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Knowledge about SLM, access to technical support**: Our farmers usually lacks the knowledge on SLM principle left without assisting in this type of field.
- **Workload, availability of manpower**: Required huge labour contributions. Labour shortage is a problem

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	A total of 8 stakeholders were involved, only two of them are directly assisting in spring revival	Helped as a labor who have contributed in making trenches and fencing around the shed.
SLM specialists/ agricultural advisers	8 Foresters from the Divisional Forest Office, Paro were involved	Planning, coordinating and providing technical assistance for the spring revival
local government	Gup (Local Chief) and Tshogpa of Shaba Gewog Administration.	Administrative support
national government (planners, decision-makers)	Department of Forests and Park Services	Provide technical support
international organization	Green Climate Fund, ICIMOD	Provide funding support and tecnical expertise

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		A person from each household was involved in the initial planning and meeting with the specialists to agree to.
planning		✓				The plannings were mostly done by specialists from the forest department.
implementation			✓			Land users/local community were engaged as paid labours.
monitoring/ evaluation				✓		Twice a year monitoring is done by the specialists and other minor monitoring is dine by the community around the springsheds.
None	✓					No research was carried out.

Flow chart

1. Comprehensive mapping of springs and springsheds.
2. Setting up of a data monitoring system.
3. Understanding socio-economic and governance systems of springs.
4. Hydrogeological mapping.
5. Creating a conceptual hydrogeological layout of the springshed.
6. Classification of spring type, identifying mountain aquifer and demarcating recharge area.
7. Developing springshed management and governance protocols and
8. Impact assessment.

Author: Singye Dorji & Tshering Gyeltshen

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [x] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach

- [ ] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

Institution strengthening

Institutions have been strengthened / established

- [ ] no
- [x] yes, a little
- [ ] yes, moderately
- [ ] yes, greatly

at the following level

- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.

Type of support

- [ ] financial
- [ ] capacity building/ training
- [ ] equipment

Further details

Monitoring and evaluation

Physical on site monitoring and evaluating the springshed

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [x] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

Royal Government of Bhutan funding was released under Ministry of Energy and Natural Resources (erstwhile Ministry of Agriculture and Forests).

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

Financial/ material support provided to land users

The government fully funded the initiative of springshed revival where they even paid N. 700 to the labour helpers that from the community engaged.

	partly financed	fully financed
labour Paid for the local labourers and also 4 technicals staffs from Department of Forest and Park Services.		✓
equipment: machinery One Excavator untill the completion of the project.		✓
equipment: machinery: tools Basic tools such as spades, crowbars and shovel.		✓
Lunch and refreshments for all the labourers.		✓
Barbed Wire Fence. For a few bigger springsheds.		✓

Labour by land users was

- [ ] voluntary
- [ ] food-for-work
- [x] paid in cash
- [ ] rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? The approach helped local land users understand about some basic Knowledges in springshed management and maintenance.			✓	
Did the Approach enable evidence-based decision-making? Yes the decisions made were always discussed and consulted together.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? The approach lead to the implementation of important SLM Technologies which involved water storage, check dams and benchmark preparations				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Yes in this springshed revival (nature-based solution)				✓
Did the Approach improve knowledge and capacities of other stakeholders? Yes this approach lead to the improvement of knowledge about ground water and springs.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Yes, it helped/enhanced the cooperation and systematic use of the spring water for various uses for washing and cattle feeding.			✓	
Did the Approach mitigate conflicts? In the past people had recurring conflicts with regard to use and division of the small water source. After this approach with the implementation of systematic use of water from the springshed conflicts among land users are greatly reduced.				✓
Did the Approach encourage young people/ the next generation of land users to engage in SLM? The springshed revival of Lholing encouraged few young people to stay back at home with their parents to work in the farms, now that they are able to get some amount of irrigation water from the springsheds that are revived.		✓		
Did the Approach lead to improved food security/ improved nutrition? The approach of springshed revival helped improve food security to some extent as the approach encouraged the land users to establish kitchen gardens where irrigation was done from the spring water that were revived and created.		✓		
Did the Approach lead to improved access to water and sanitation? It definitely improved sanitation as they used spring water for bathing and laundry purposes.			✓	
Did the Approach lead to employment, income opportunities? Yes a little through farming activities.		✓		

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Now that the springsheds are revived, the local land users with some basic knowledge could do necessary maintenance and protection of these vital area.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Provides a source of drinking water for wild animals.
- Provides drinking water source for the domestic animals
- Improved sanitation through constant supply of spring water.

Strengths: compiler's or other key resource person's view

- Increased source of irrigation water from different spring-shed.
- Balanced ecological management of water resources.
- Catchment area created as springshed could prevent splash and rill erosions.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Attracts wild animals to the nearby field which come to drink water from the springsheds. Improved fencing of the fields

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Artificial creating of some of springshed lead to loss of pasture lands
- Risk of cattle/ children drowning in the bigger spring-sheds Fencing around the springshed.

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Reviewer
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William Critchley

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Resource persons
Gem Dorji - land user
Chencho Chencho - land user
Chencho Dorji - land user
Wangmo Nidup - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6850/

Linked SLM data
n.a.

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Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

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- Reviving traditional water sources for resilient water future: case of Darjeeling City, India.: https://link.springer.com/article/10.1007/s10708-021-10444-z

Technologies
Agriculture and Water

Traditional Soil Fertility Management (College of Natural Resources)

Traditional Soil Fertility Management through FYM Application (Bhutan)

Nor Lue Luktey Sa Chue Zinchong (ནོར་ལུད་བླུགས་ཏེ་ས་བཅུད་འཛིན་སྐྱོང་།)

DESCRIPTION

Traditional soil fertility management refers to the practice of improving and maintaining soil fertility using organic amendments, specifically farmyard manure (FYM). Other organic materials and crop residues can be effectively utilized through process of decomposition, fermentation and pyrolysis to produce compost, bokashi and biochar respectively.

Traditional soil fertility management refers to the practice of improving and maintaining soil fertility using organic amendments, specifically farmyard manure (FYM). Farmyard manure is a mixture of livestock excreta, bedding materials, and other organic wastes accumulated in the farmyard. It is typically left to decompose, or it is composted, before being applied to agricultural fields.

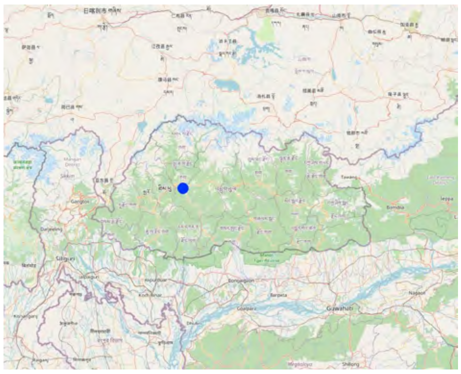
FYM application enhances soil fertility by replenishing essential plant nutrients, improving soil structure and moisture retention, increasing microbial activity, and promoting overall soil health. The organic matter in FYM serves as a nutrient source for plants, while also enhancing the soil's ability to retain water and nutrients, reducing erosion, and promoting beneficial microbial activity (Hossain et al., 2021).

Bhutan, a landlocked country nestled in the eastern Himalayas, has a predominantly agrarian economy. Farming practices in Bhutan often involve smallholder farmers who rely on traditional methods of soil fertility management, including the application of farmyard manure. According to Dorji et al., (2018) traditional soil fertility management through FYM application is very common in Bhutan. The use of FYM helps support sustainable agricultural production in the country.

Soil fertility management through FYM application in Bhutan, is conducted as follows. First and foremost, the collection of farmyard manure is essential, which involves the accumulation of livestock excreta, bedding materials, and organic waste in the farmyard. Then the collected material needs to be properly managed and decomposed through composting to ensure the production of high-quality farmyard manure. Adequate storage facilities for the composted manure should be established to prevent nutrient loss and maintain its quality. Additionally, farmers need to be trained and educated on the proper techniques of FYM application, including the optimal timing, rate, and method of application to maximize its effectiveness. Regular monitoring and assessment of soil fertility parameters are crucial to evaluate the impact of FYM application and make necessary adjustments to the management practices (Wangmo, 2020).

Traditional soil fertility management through FYM application in Bhutan offers numerous benefits and positive impacts as already noted. Furthermore, the use of FYM helps to reduce the dependency on synthetic fertilizers, thereby contributing to sustainable agriculture and minimizing the risk of environmental pollution. Overall, traditional soil fertility management through FYM application supports long-term soil health, sustainable agricultural production, and environmental conservation in Bhutan (Gyeltshen, 2020).

LOCATION



Location: Nahi, Wangdue Phodrang, Bhutan, Bhutan, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.85244, 27.46879

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: more than 50 years ago (traditional)

Type of introduction
- [ ] through land users' innovation
- [x] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

Cattleshed where the FYM is produced (Niki Rai)

Field where the FYM is applied (Niki Rai)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - rice (upland). Cropping system: Maize or similar rotation with hay/pasture

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply

- rainfed
- ✓ mixed rainfed-irrigated
- full irrigation

Purpose related to land degradation

- ✓ prevent land degradation
- ✓ reduce land degradation
- restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Degradation addressed

chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

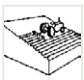
physical soil deterioration - Pc: compaction

biological degradation - Bh: loss of habitats, Bl: loss of soil life

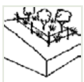
SLM group

- rotational systems (crop rotation, fallows, shifting cultivation)
- integrated crop-livestock management
- integrated soil fertility management

SLM measures



agronomic measures - A2: Organic matter/ soil fertility

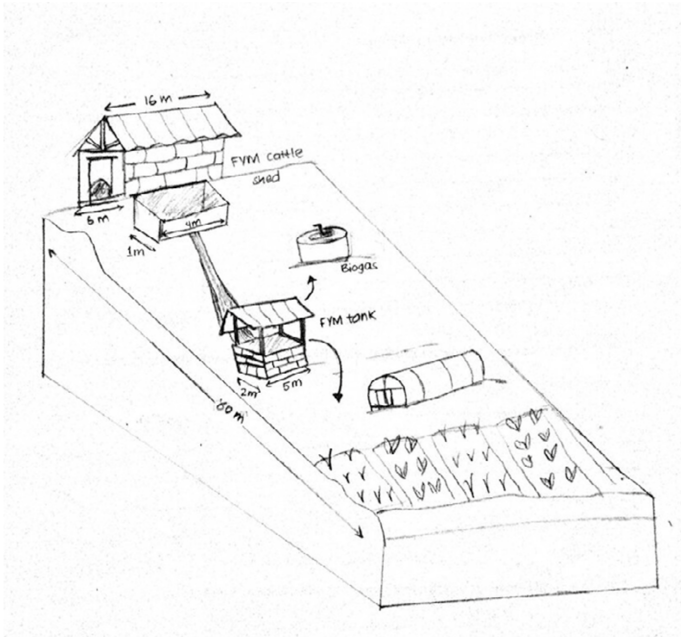


management measures - M3: Layout according to natural and human environment

TECHNICAL DRAWING

Technical specifications

Technical specifications as in the diagram above



Author: Niki Rai

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 82.0 Ngultrum
- Average wage cost of hired labour per day: 800

Most important factors affecting the costs

Financial and labor charge including working lunch

Establishment activities

1. Site selection (Timing/ frequency: Winter)
2. Construction of cow shed (Timing/ frequency: After site selection)
3. Collection of FYM near the cow shed (Timing/ frequency: regular basis)
4. Washing off the by products into the pit (Timing/ frequency: Every morning)
5. Placement of FYM in the field (Timing/ frequency: Before cultivation)
6. Application of FYM in the field during cultivation (Timing/ frequency: Before cultivation)

Maintenance activities

1. Wood change (Timing/ frequency: Where there is damage due to heat and rain)
2. CGI sheet change (Timing/ frequency: Where there is damage due to heat and rain)
3. Cement (Timing/ frequency: For maintainance)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
labor	per head	6.0	500.0	3000.0	100.0
Equipment					
spade	nos.	2.0			100.0
pickaxe	nos.	2.0			100.0
Crowbar	nos.	2.0			100.0
					100.0
					100.0
Construction material					
Wood	nos	5.0	350.0	1750.0	100.0
CGI sheet	nos.	22.0			
cement	kg	250.0			
Total costs for maintenance of the Technology				**4'750.0**	
Total costs for maintenance of the Technology in USD				*57.93*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [x] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 3733.0
In July precipitation reaches at peak, with an average of 713 mm
Name of the meteorological station: NCHM
Warm temperate zone, One of the Bhutans agro climatic zone

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [x] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [x] elderly

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual
- [x] Family

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	good
education	poor	good
technical assistance	poor	good
employment (e.g. off-farm)	poor	good
markets	poor	good
energy	poor	good
roads and transport	poor	good
drinking water and sanitation	poor	good
financial services	poor	good

IMPACTS

Socio-economic impacts

Crop production

Crop production	decreased	increased	Quantity before SLM: less Quantity after SLM: production doubled
crop quality	decreased	increased	
land management	hindered	simplified	The application of FYM simplifies land management by improving soil structure, fertility, and health, which in turn promotes better crop growth and reduces the need for external inputs and interventions. Incorporating FYM into agricultural practices contributes to sustainable land management and long-term soil productivity
expenses on agricultural inputs	increased	decreased	
farm income	decreased	increased	

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved
SLM/ land degradation knowledge	reduced	improved

Ecological impacts

soil moisture	decreased	increased
soil loss	increased	decreased
nutrient cycling/ recharge	decreased	increased
biomass/ above ground C	decreased	increased
beneficial species (predators, earthworms, pollinators)	decreased	increased

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Manure is used only if it is available near the farm

CLIMATE CHANGE

Gradual climate change

annual rainfall decrease	not well at all	very well	Answer: not known

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- 11-50%
- ✓ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- 0-10%
- 11-50%
- ✓ 51-90%
- 91-100%

Number of households and/ or area covered

Almost all the farmer use or adopted this technology

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Improve soil structure
- Increases soil organic content
- Helps manage soil fertility

Strengths: compiler's or other key resource person's view

- Improve soil health and microbial activity
- Method to improve soil fertlity

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Labor intensive Labor sharing

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Labor intensive and heavy field work causing compaction Field applications should depend on soil moisture conditions

REFERENCES

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Resource persons
Sonam Zam - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6822/

Linked SLM data
n.a.

Documentation was faciliated by

Institution

- National Soil Services Centre (National Soil Services Centre) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

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Banana plantation in the rehabilitated area (Kuenzang Nima)

Rehabilitation of Fallow Land Through Agroforestry (Bhutan)

Shing Tho Tsug Tey Zhing Tong Leg Choe (ཤིང་ཐོག་བཙུགས་ཏེ་ཞིང་སྟོང་ལེགས་བཅོས།)

DESCRIPTION

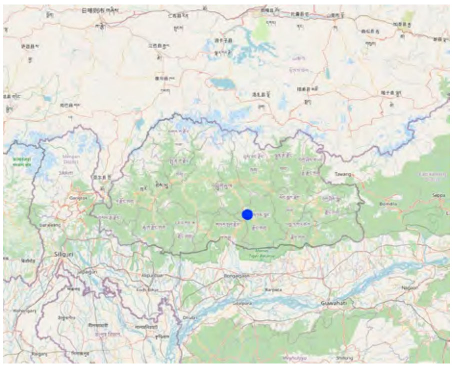
Fallow is arable land deliberately set aside due to challenges faced in cultivation. The rehabilitation of lands left fallow for decades through the adoption of agroforestry has been one success story of the Khengrig Namsum Cooperative in the central region of Bhutan. The integration of perennial trees (fruit and high-value trees) and seasonal crops creates environmental, economic, and social benefits.

Fallow land is the term for arable fields either partially or completely left unused and unproductive, owing to reasons such as labour shortages, lack of irrigation, human-wildlife conflict and/or the plots being far away from the settlements. Land rehabilitation is a promising approach towards mitigating the fallow land issue. Thus, the Khengrig Namsum Cooperative (KNC), a registered firm under the Department of Agriculture Marketing and Cooperatives, Ministry of Agriculture and Livestock (MoAL), Bhutan has ventured into rehabilitating 235 acres (94 ha) of fallow lands since 2016, through the adoption of agroforestry. The KNC was founded by Mr. Thinley Wangdi (the current chairman), with the motive of improving the livelihoods of the people of Zhemgang Dzongkhag through locally grown farm produce.

The KNC with funds from the Global Environment Facility - Small Grant Program (GEF-SGP) through the United Nations Development Program (UNDP), Bhutan, revived the fallow through agroforestry (intercropping of banana and bamboo plants). The KNC intervened in three strategic locations, benefitting 36 households. This particular agroforestry approach was not only aimed towards enhancing livelihoods but also to diversify production: through banana chips production and bamboo product development.

Upon securing the funds, implementation started with the procurement of planting and fencing materials, hands-on training, and then planting and fencing activities. Installation of electric fencing was done to reduce human-wildlife conflict. There was specific training on product development. Moreover, the KNC was able to link up with nearby schools for the school feeding programme, to supply fruits and vegetables. The cooperative demonstrates skills in processing its own products and enabling better access to renewable natural resources in the locality. On the contrary, not having proper cold storage facilities has negative impacts on processing units and has resulted in unreliable market coupling.

LOCATION



Location: Rebati Chiwog under Ngangla Gewog, Brumbi and Jiwongolia Chiwog under Trong Gewog, Zhemgang Dzongkhag, Bhutan

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- -269.31295, 27.14889

Spread of the Technology: evenly spread over an area (0.95 km²)

In a permanently protected area?: No

Date of implementation: 2015

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use
Land use mixed within the same land unit: Yes - Agroforestry

Cropland
- Annual cropping: cereals - maize, root/tuber crops - potatoes, vegetables - melon, pumpkin, squash or gourd, Ginger, turmeric
- Perennial (non-woody) cropping: banana/plantain/abaca
- Tree and shrub cropping: avocado, citrus, tree nuts (brazil nuts, pistachio, walnuts, almonds, etc.)

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Forest/ woodlands
- (Semi-)natural forests/ woodlands: subtropical humid forest natural vegetation. Management: Selective felling, Non-wood forest use

Tree types (mixed deciduous/ evergreen): n.a.
Products and services: Timber, Other forest products

Water supply
- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation
- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

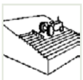
soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

soil erosion by wind - Et: loss of topsoil

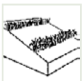
biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats

SLM group
- agroforestry

SLM measures



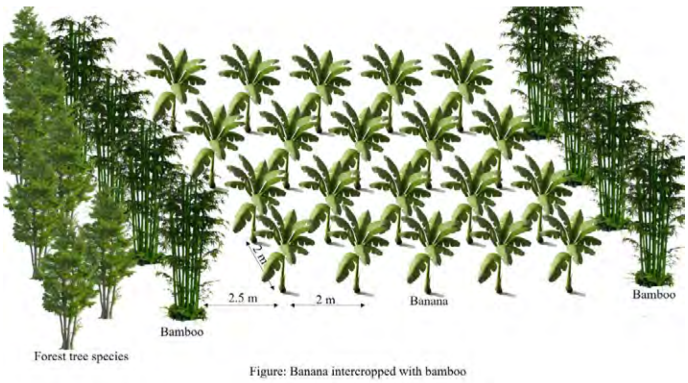
agronomic measures - A1: Vegetation/ soil cover



vegetative measures - V1: Tree and shrub cover

TECHNICAL DRAWING

Technical specifications
The technical drawing shows the banana plant and bamboo intercropped.



Author: Ongpo Lepcha

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **235 acres**)
- Currency used for cost calculation: **Ngultrum (Nu.)**
- Exchange rate (to USD): 1 USD = 80.0 Ngultrum (Nu.)
- Average wage cost of hired labour per day: Nu. 450

Most important factors affecting the costs

The most important factors affecting the costs while implementing this technology is land preparation and plantation of seedlings.

Establishment activities

1. Explored funds from UNDP through development of project proposal, led by the chairman (Timing/ frequency: 2016)
2. Forest clearing and development using tractor at Brumbi and Rebati (Timing/ frequency: December 2016 - November 2018)
3. Electric fencing (Timing/ frequency: February 2017 - May 2017)
4. Procurement of fruit seedlings (local banana and bamboo) from Bhur nursery, Sarpang Dzongkhag (Timing/ frequency: May 2017 - July 2018)
5. Hands-on-training on fruit tree plantations (KNC members and other farmers) and product development from bamboo (Timing/ frequency: May 2017 - November 2018)
6. Plantation of banana seedlings and bamboo (Timing/ frequency: June 2018)

Establishment inputs and costs (per 235 acres)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Labor	person days	1440.0	451.0	649440.0	100.0
Equipment					
Land preparation	Lumpsum	1.0	725432.0	725432.0	
Plant material					
Cost of seedlings (local banana and bamboo)	Lumpsum	1.0	979170.0	979170.0	
Construction material					
Electric fencing	Lumpsum	1.0	267410.0	267410.0	
Plantation of bamboo and banana	Lumpsum	1.0	231594.0	231594.0	
Other					
Project administration and participation	Lumpsum	1.0	182042.0	182042.0	
Project signboard and installation	Lumpsum	1.0	19500.0	19500.0	
Formulation of by-laws and agreements	Lumpsum	1.0	72301.0	72301.0	
Hands-on-training on plantations and product development	Lumpsum	1.0	100781.0	100781.0	
Total costs for establishment of the Technology				**3'227'670.0**	
Total costs for establishment of the Technology in USD				*40'345.88*	

Maintenance activities

1. Replacement of electric fence poles (Timing/ frequency: Every after three years (winter))
2. Replacement of solar batteries (Timing/ frequency: replaced once (1 battery))
3. Replacement of fruit plants (Timing/ frequency: Every season)

NATURAL ENVIRONMENT

Average annual rainfall

- [x] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

The rainfall data of 2017 was used
Name of the meteorological station: Station: Bhur, Type: Class A, Station ID: 23310046
The area falls under the warm and humid Subtropical zone among the six Agroecological zones of Bhutan.

Slope

- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [x] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms

- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude

- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in

- [ ] convex situations
- [x] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [ ] groups/ community
- [x] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [x] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family land ownership

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [x] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor				good
health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

crop production	decreased → increased (rated: increased, highest)	Crop production increased exponentially in Rebati, where crop production prevailed before the introduction of the agroforestry system. For the reverted fallow land in Brumbi and Jiwongolia, crop production increased by 100%. The abundant availability of bananas from the rehabilitated areas has greatly facilitated the cooperative employees in procuring a sufficient quantity of bananas for banana chip production. Previously, they had to embark on time-consuming journeys to various locations to source bananas, which not only proved laborious but also led to an increase in production costs.
crop quality	decreased → increased (rated: increased, highest)	Quantity before SLM: Local varieties Quantity after SLM: Improved varieties The cultivation of enhanced banana varieties, including G9, Jaji, and Dosari, has resulted in a noticeable enhancement in quality
fodder production	decreased → increased (rated: increased, highest)	Following the harvest of banana fruit, the stems and leaves are utilized as fodder for livestock
risk of production failure	increased → decreased (rated: decreased, highest)	The risk of production failure is minimized as the land users engage in agroforestry, diversifying their income sources. Their earnings do not rely solely on one crop; instead, they come from a variety of sources, including bamboo products, bananas, vegetables, and spices. Consequently, if one crop encounters difficulties or fails, the other crops can continue to generate income for the cooperative
product diversity	decreased → increased (rated: increased, second highest)	Agroforestry promotes the diverse cultivation of both forest and agricultural plants, resulting in a wide range of products. As an example, the land users are able to produce bamboo products, spices, and banana chips due to the diversity of their cultivation practices
production area (new land under cultivation/ use)	decreased → increased (rated: increased, highest)	The technology is implemented in the previously uncultivated land (fallow) leading to the increased production area.
land management	hindered → simplified (rated: simplified, highest)	The conversion of fallow land into cultivated land has enhanced land management and stewardship. This transformation involves the addition of manure and timely interventions, effectively reducing soil erosion and improving the overall care of the land
expenses on agricultural inputs	increased → decreased (rated: increased, slightly)	There are increased expenses on agricultural inputs. However, the increased expenses are compensated by the income generated from the farm.
farm income	decreased → increased (rated: increased, highest)	Quantity before SLM: Nu. 23,00,000/- annual income Quantity after SLM: Nu. 55,00,000/- annual income The ready availability of bananas as a raw material has significantly boosted the production of banana chips and led to a substantial increase in the annual revenue of the cooperative. Furthermore, land users supplying bananas to the cooperatives have also experienced a rise in their annual income
diversity of income sources	decreased → increased (rated: increased, highest)	The KNC has diverse value-added products and natural products such as watermelon, bamboo products, and homemade pickles diversifying their income sources.
workload	increased → decreased (rated: decreased, highest)	Reduced workload due to increased availability of raw materials for banana chip processing.

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved	The staff of the KNC is food secure due to increased income generated from the cooperative. Likewise, the land users supplying raw materials are also meeting the food security from the income generated by supplying raw materials to the KNC. The land users are self-sufficient in bananas, bamboo and some spices.
health situation	worsened	improved	The land users shared that the improved annual income is directly related to improved health and well-being of the family/community.
cultural opportunities (eg spiritual, aesthetic, others)	reduced	improved	Their venture into such activity has added value to the community, where the community has been recognized as one of the successful pilot sites for rehabilitating fallow lands. Moreover, external visitors are attracted to witness the success of the community. Also, the community bond has been strengthened, through an approach like labour sharing practised during the implementation of the technology.
SLM/ land degradation knowledge	reduced	improved	Before, the land users' knowledge about SLM technologies was confined to a few technologies. Now they have realized that SLM is a holistic approach involving different technologies. Therefore, the understanding and knowledge of agroforestry as one of the SLM measures has been enhanced.
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened	improved	Disadvantaged families constrained by poor market access benefited from this technology.

Ecological impacts

vegetation cover	decreased	increased	The plantation of banana plants and bamboo has covered a wide range of land, leading to better vegetation cover.
biomass/ above ground C	decreased	increased	The increased vegetation cover by different fruit, bamboo, and vegetables leads to increased above-ground biomass.
beneficial species (predators, earthworms, pollinators)	decreased	increased	Agroforestry harbours various plant species attracting diverse beneficial insects that feed on these plants.
habitat diversity	decreased	increased	The destruction of natural habitats has been decreased due reduced dependency of land users on wild bamboo products.
landslides/ debris flows	increased	decreased	The risk of surface erosion has been mitigated due to improved ground cover.
wind velocity	increased	decreased	Cultivation of bamboo species reduces wind velocity reducing surface erosion.

Off-site impacts

Biological diversity conservation	Decreased	Increased	Biological diversity increased due to the cultivation of different plant species which also act as a habitat for different insects and birds.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative ... very positive	✓ very positive
Long-term returns	very negative ... very positive	✓ very positive

Benefits compared with maintenance costs

Short-term returns	very negative ... very positive	✓ very positive
Long-term returns	very negative ... very positive	✓ very positive

The agroforestry with banana and bamboo plantations has been advantageous with both short-term and long-term benefits. For instance, banana gives fruiting in less than a year (9 months) after plantation.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all ... very well	✓ very well
annual rainfall decrease	not well at all ... very well	✓ very well

Climate-related extremes (disasters)

local rainstorm	not well at all ... very well	✓ very well
local thunderstorm	not well at all ... very well	✓ very well
heatwave	not well at all ... very well	✓ very well
extreme winter conditions	not well at all ... very well	✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Number of households and/ or area covered

36 households and one cooperative (KNC)

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Increased production area. The reversion of fallow land through agroforestry significantly increased the production area for the land users.
- Increased income. The easy access to the raw materials for KNC and easy market access for the land users leads to improved income for the KNC staff and land users supplying bananas to the cooperative.
- The technology is easy to implement as bananas and bamboo are perennial providing continuous income to the land users with little maintenance required. The land users need not be involved in agronomic practices such as land preparation and sowing every year.

Strengths: compiler’s or other key resource person’s view

- Restoration of cultivable land lost to forest encroachment.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Loss of cooperative members due to better opportunities, which ultimately would affect sustainability. Provide timely incentives and adequate facilities.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- Youths do not prefer to work in agriculture as it is viewed as laborious. Introduce fully mechanized and smart farming systems to attract youth.

REFERENCES

Compiler
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Editors
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Reviewer
William Critchley
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Joana Eichenberger

Date of documentation: July 10, 2023

Last update: May 30, 2024

Resource persons
Dawa Zangpo - land user
Tashi Wangmo - land user
Pema Wangmo - land user
Tshering Dolkar - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6839/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Rehabilitation of fallow land through agroforestry, UNDP, 2020: https://www.undp.org/bhutan/stories/rehabilitation-fallow-land-through-agroforestry
- Background on Fallow Land Bank, NLCS, n.d.: https://flb.nlcs.gov.bt/index.php/background-on-fallow-land-bank/
- Khenrig Namsum Cooperative, HELVETAS Bhutan, 2019: http://csogrant.bt/khenrig-namsum-cooperative/
- WFP Bhutan Country Brief, OCHA services, 2023: https://reliefweb.int/report/bhutan/wfp-bhutan-country-brief-february-2023
- KNC-Zhemgang, Bhutan, n.d.: https://www.bhutan-network.org/portfolio/knc-zhemgang-bhutan/

Vegetables intercropped in orchards at Yusipang Chiwog. (Tshering Gyeltshen)

Vegetable Intercropping in Apple Orchards (Bhutan)

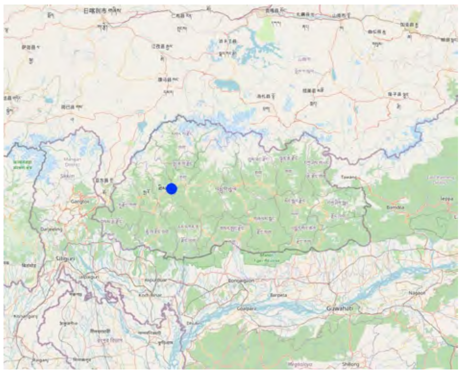
Apple Dhum Ra Nang Tshoe Sey La Sey Tsug Ni (ཨེ་པྣལ་ལྷུམ་ར་ནང་ཚོད་བསྲེ་སླ་བསྲེ་བཙུགས་ནི་།)

DESCRIPTION

Vegetables are intercropped between fruit-bearing trees in orchards. This maximizes land utilization, increases agrobiodiversity, and optimizes agricultural productivity.

Intercropping of vegetables with fruit-bearing trees in orchards can be an effective system in terms of production and agroecology. It is a sustainable farming technique that optimizes land use, increases agrobiodiversity, diversifies production, and enhances overall yields. Land users in Yusipang grow peas, beans, and cole crops (cabbages, kale, etc.) in their apple orchards.
Intercropping vegetables in orchard land optimizes the use of space, sunlight, water and nutrients. Intercropping also increases biodiversity within the orchard ecosystem. This coexistence of species reduces the vulnerability of the orchard to crop failure and pest infestation: it improves the residence of the overall system.
Trees in the system absorb nutrients from the soil and return them through fallen leaves, thereby improving soil fertility and reducing reliance on external fertilizers. This nutrient recycling improves the overall health of the orchard ecosystem. Intercropping can also help in natural pest management through various mechanisms – including the attraction of beneficial insects - thus reducing the need for chemical pesticides. It also fosters a beneficial microclimate.
To establish intercropping of vegetables in orchards, careful planning and design is required with respect to crop selection, spacing of trees and intercrops, irrigation, and nutrient management. Regular weeding and mulching are required alongside adequate irrigation, integrated pest management, and pruning of fruit trees to prevent competition for light and space.
Intercropping of vegetables in orchards thus offers multiple benefits to farmers and the overall agricultural system, including increased farm productivity. It increases climate resilience and improves the health of the agroecosystem. However, it is important to be aware of potential drawbacks. These include competition between crops for resources - and labour. Sound management practices can overcome these challenges and maximize the effectiveness of intercropping.

LOCATION



Location: Yusipang, Chang Gewog, Thimphu Dzongkhag, Thimphu, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.71344, 27.46436

Spread of the Technology: evenly spread over an area (0.4 km²)

In a permanently protected area?: No

Date of implementation: 10-50 years ago

Type of introduction
- ☐ through land users' innovation
- ☑ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☐ through projects/ external interventions

Far view of the northern part of the orchard. Here the land user has planted many vegetables such as cauliflower, beetroot, chilli, and maize within the orchard. (Tshering Gyeltshen)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: vegetables - other, vegetables - root vegetables (carrots, onions, beet, other), Cole crops, chili, beans, peas
- Tree and shrub cropping

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

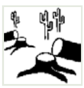
- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

soil erosion by wind - Et: loss of topsoil

physical soil deterioration - Pc: compaction, Ps: subsidence of organic soils, settling of soil

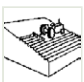


biological degradation - Bc: reduction of vegetation cover

SLM group

- agroforestry
- rotational systems (crop rotation, fallows, shifting cultivation)
- improved ground/ vegetation cover

SLM measures

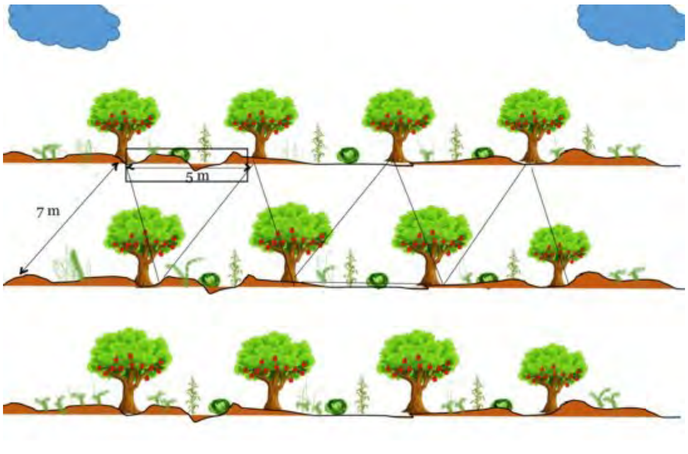


agronomic measures - A1: Vegetation/ soil cover

TECHNICAL DRAWING

Technical specifications

None



Author: Designed by Tshering Gyeltshen

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 acre**; conversion factor to one hectare: **1 ha = 1 acre**)
- Currency used for cost calculation: **BTN**
- Exchange rate (to USD): 1 USD = 81.0 BTN
- Average wage cost of hired labour per day: Nu. 800

Most important factors affecting the costs

n.a.

Establishment activities

1. Assess the orchard: Evaluate the orchard's existing conditions, including soil fertility, drainage, sunlight availability, and pest and disease history. This assessment will help determine the feasibility and suitability of intercropping vegetables in the orchard. (Timing/ frequency: Anytime)
2. Select compatible vegetable crops: Choose vegetable crops that are compatible with the existing fruit trees in terms of their growth requirements, sunlight tolerance, water needs, and harvesting periods. Consider crops that are less competitive and can thrive in the orchard's microclimate. (Timing/ frequency: Year-round)
3. Plan the intercropping layout: Develop a planting design that optimises space utilisation and resource distribution. Consider factors such as crop spacing, row orientation, and the arrangement of vegetable crops within the orchard. Ensure that the intercropped vegetables are positioned to minimise shading and competition with the fruit trees. (Timing/ frequency: Anytime)
4. Prepare the soil: Prior to planting, prepare the soil by clearing any existing vegetation and weeds. Conduct soil testing to assess nutrient levels and pH, and amend the soil if necessary to create optimal growing conditions for both the vegetables and fruit trees. (Timing/ frequency: Spring)
5. Implement irrigation systems: Install or adapt irrigation systems to accommodate the intercropped vegetables' water requirements. Consider the water needs of both the vegetables and fruit trees when determining irrigation frequency and duration. (Timing/ frequency: Anytime)
6. Manage nutrients: Determine the nutrient requirements of the intercropped vegetables and fruit trees. Based on soil test results, develop a fertilization plan that addresses the nutritional needs of both crops. Apply organic or synthetic fertilizers as appropriate, considering the specific nutrient requirements of each crop. (Timing/ frequency: Anytime)
7. Implement pest and disease management strategies: Develop an integrated pest management (IPM) plan to control pests and diseases effectively. Monitor the orchard regularly for signs of pests or diseases and take appropriate preventive or corrective actions, such as using natural predators, applying organic pesticides, or practising cultural methods like crop rotation. (Timing/ frequency: After plantation)
8. Weed management: Employ weed control measures to minimise competition between the vegetables and fruit trees. This can include mulching the soil around plants, practising regular manual weeding, or using targeted herbicides that are safe for both crops. (Timing/ frequency: After plantation)
9. Monitor and adjust: Continuously monitor the growth and performance of both the vegetables and fruit trees throughout the growing season. Make necessary adjustments to irrigation, fertilisation, pest control, and other management practices based on observations and the specific needs of each crop. (Timing/ frequency: Year-round)

Total establishment costs (estimation)

23000.0

Maintenance activities

n.a.

Total maintenance costs (estimation)

6000.0

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [x] 501-750 mm
- [x] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
The average rainfall ranges from 650-850 mm.
Name of the meteorological station: The rain estimate has been derived based on the agro-ecological zone (AEZ) the area falls under. Bhutan is divided into AEZs (source: https://www.fao.org/3/ad103e/AD103E02.htm).
The area falls under Cool Temperate Zone. Bhutan has six AEZs. The wet sub-tropical zone is from 150 to 600 m, followed by the humid sub-tropical zone from 600 to 1,200 m. The dry sub-tropical zone starts at 1,200 m and extends to 1,800 m, followed by the warm temperate zone, which reaches 2,600 m. The cool temperate zone lies between 2,600 and 3,600 m and, finally, the alpine zone between 3,600 m and 4,600 m.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [x] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household

- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale

- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership

- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [ ] individual, titled

Land use rights

- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights

- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production	decreased						✓		increased	Crop production has increased due to intercropping.
risk of production failure	increased						✓		decreased	The risk of production failure is decreased due to crop diversity. Even if one commodity fails, other surviving commodities make up for the loss.
product diversity	decreased						✓		increased	Crop diversity has increased.
production area (new land under cultivation/ use)	decreased						✓		increased	Intercropping has led to maximum utilization of the orchard area.
land management	hindered					✓			simplified	Land management has improved with better land utilization through intercropping.
demand for irrigation water	increased		✓						decreased	Increase in water requirement due to full, efficient utilization of the land and more number of diverse plants growing on the land.
farm income	decreased						✓		increased	Farm income has increased due to diverse sources of income.
diversity of income sources	decreased						✓		increased	The land user has two different sources of income, fruits and vegetables.
workload	increased			✓					decreased	Increased workload due to many different crops covering the land.

Socio-cultural impacts

food security/ self-sufficiency	reduced						✓		improved	Farm income has increased due to diverse sources of income from intercropping.
SLM/ land degradation knowledge	reduced					✓			improved	Intercropping reduces nutrient depletion associated with monoculture.

Ecological impacts

soil cover

reduced — improved

Soil cover has increased due to intercropping of different vegetables between apple trees.

soil loss

increased — decreased

Soil erosion has decreased due to increased soil cover.

nutrient cycling/ recharge

decreased — increased

Nutrient cycling has improved. Fruit trees absorb nutrients from the soil and release them back into the soil through decomposed fallen leaves, branches, or other parts.

vegetation cover

decreased — increased

Vegetation cover has increased due to the growing of a mix of vegetables between the trees in the orchard.

plant diversity

decreased — increased

Different vegetables are intercropped and rotated in the orchard.

habitat diversity

decreased — increased

Different crops provide habitats to a variety of living organisms.

micro-climate

worsened — improved

Micro-climate has increased as fruit trees provide shade and regulate temperature, act as windbreaks, and the soil cover through various vegetables helps retain moisture in the soil by preventing erosion.

Off-site impacts

impact of greenhouse gases

increased — reduced

Intercropping enhances carbon sequestration in the soil.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative — very positive

Long-term returns — very negative — very positive

Benefits compared with maintenance costs

Short-term returns — very negative — very positive

Long-term returns — very negative — very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all — very well

seasonal temperature increase — not well at all — very well — Season: summer

annual rainfall decrease — not well at all — very well

Climate-related extremes (disasters)

local snowstorm — not well at all — very well

cold wave — not well at all — very well

insect/ worm infestation — not well at all — very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [x] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- 1. Increased land productivity: Intercropping vegetables in orchards allows for more efficient use of land by utilizing the space between fruit trees. This increases overall productivity and maximizes the yield from the same area of land.
- 2. Diversified income streams: By intercropping vegetables, orchard owners can generate additional income from the sale of different crops. This helps to diversify their revenue streams and reduce dependence on a single crop, thereby minimizing financial risks.
- 3. Improved pest and disease management: Certain vegetable crops can act as natural pest repellents or trap crops, effectively reducing the population of pests that target fruit trees. By intercropping, orchard owners can create a more balanced ecosystem, leading to better pest and disease management without relying heavily on chemical interventions.

Strengths: compiler’s or other key resource person’s view

- 1. Enhanced soil fertility and nutrient cycling: Intercropping systems often involve the planting of leguminous vegetables, such as peas or beans, which are capable of fixing atmospheric nitrogen and improving soil fertility. These vegetables can replenish nitrogen levels in the soil, benefiting the overall health and growth of both the fruit trees and the intercropped vegetables.
- 2. Weed suppression: Intercropping vegetables can help suppress weed growth in orchards. The dense foliage of intercropped vegetables can shade out and outcompete weeds, reducing the need for manual weeding or herbicide application. This results in reduced labour and cost associated with weed control.
- 3. Microclimate regulation: Intercropping can modify the microclimate within the orchard. The intercrop plants provide shade and windbreak, which can help regulate temperature, humidity, and air movement. These microclimate modifications can protect fruit trees from extreme weather conditions and create more favorable growing conditions, promoting overall orchard health.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Competition for resources: Intercropped vegetables and fruit trees compete for essential resources such as water, nutrients, sunlight, and space. This competition can result in reduced growth and yield for both crops. Supply adequate nutrients.
- Increased management complexity: Intercropping adds complexity to the management of the orchard. Different crops may have different requirements in terms of irrigation, fertilization, pest control, and harvesting, requiring additional attention and labour. Proper planning and management taking into consideration differing requirements.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- Difficulty in weed control: Intercropping can make weed control more challenging. Different crops may have different susceptibilities to weeds, and managing weeds without harming the intercropped vegetables or fruit trees can be demanding. Weed management and different control measures should be taken.
- Reduced crop specialisation: Intercropping can limit the space available for each crop, leading to reduced specialisation. This may result in lower yields compared to cultivating a single crop in a dedicated area with optimised growing conditions. Must keep proper/required spaces between each of the plants.
- Harvesting difficulties: Harvesting intercropped vegetables in an orchard can be more time-consuming and labour-intensive compared to harvesting a single crop. The presence of fruit trees and the arrangement of different crops may hinder access and make harvesting more challenging. Mechanized harvesting may reduce time taken for harvest.

REFERENCES

Compiler
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Editors
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Reviewer
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Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Rai Sharman - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6844/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Mishra, U. & Wani, N. A. (2022). An integrated circular economic model with controllable carbon emission and deterioration from an apple orchard.: Google Scholar
- Hashemi, A. & Karamidehkordi, E. (2010). FARMERS'KNOWLEDGE OF INTEGRATED PEST MANAGEMENT: A CASE STUDY IN THE ZANJAN PROVINCE IN IRAN.: Free website
- Kumar, L. & Chhogyel, N. (2018). Climate change and potential impacts on agriculture in Bhutan: a discussion of pertinent issues.: Free source

Links to relevant information which is available online

- An integrated circular economic model with controllable carbon emission and deterioration from an apple orchard: https://doi.org/10.1016/j.jclepro.2022.133962
- FARMERS'KNOWLEDGE OF INTEGRATED PEST MANAGEMENT: A CASE STUDY IN THE ZANJAN PROVINCE IN IRAN.: https://hal.science/hal-00510402
- Climate change and potential impacts on agriculture in Bhutan: a discussion of pertinent issues: https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-018-0229-6

Bench Terraces (Tashi Wangdi)

Mechanical Bench Terracing (Bhutan)

Thruel Chhey Lag Len Thap Tey Aring Chey Ni (འཕྲུལ་ཆས་ཐོག་ལ་རིང་བཅད་ནི།)

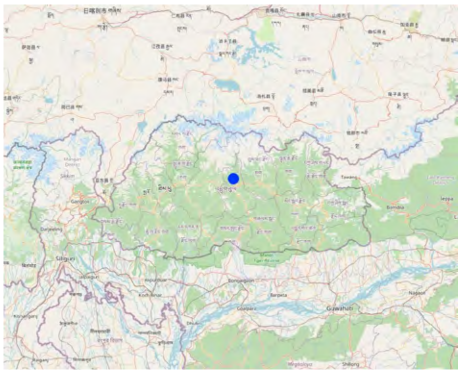
DESCRIPTION

Soil erosion by water is one of the major problems in hilly or mountainous countries like Bhutan. In such areas, effective erosion control measures are required to reduce the slope gradient and minimize surface runoff. Among many SLM interventions, mechanical bench terracing is one of the most widely promoted and popular technologies in Bhutan.

Bhutan is one of the most mountainous countries in the world and agricultural activities are carried out on slopes up to 35 degrees (70 percent). Erosion by water is one of the major causes of land degradation. In such areas, effective erosion control measures include reducing slope gradients to minimize runoff by creating a series of level platforms or "bench terraces" along the contour. Current bench terracing is made using small to medium-sized earthmoving machines called excavators, and thus the technology is called Mechanical Bench Terracing. This is one of the main SLM measures promoted widely and most preferred by landowners who claim that it reduces soil erosion, improves soil fertility, conserves soil moisture, and eases field operations. Bench terraces create impact by 1) helping minimize the risk of soil erosion caused by surface runoff, 2) effectively regulating water flow, and 3) preventing soil saturation by allowing better drainage. Additionally, bench terracing transforms previously unusable or less productive land into cultivable areas, maximizing the utilization of limited land resources. A typical bench terrace on a 20-25 degree slope has a terrace bed of 2-5 m meters and a riser of 0.75 to 1 metre high. The risers are made of earth and the terrace is made flat most of the time to prevent runoff of rainwater.
Establishing and maintaining bench terracing involves a feasibility study of the sites, participatory planning, hands-on training of the landowners, and surveying of contour lines using A-frames. There is also procurement of construction materials, arranging labour and machines and training machine operators. Once constructed, proper water management, soil fertility, and nutrient management practices are crucial for ensuring the long-term sustainability and productivity of the terraced land. Furthermore, knowledge and training on crop cultivation techniques, field management, and maintenance are vital to optimize the benefits.
In summary, bench terracing offers numerous benefits. These include:
1) Overall reduction in land degradation
2) Soil conservation by prevention of erosion by runoff
3) Conservation of soil fertility
3) Increase arable land available for cultivation
4) Ease of mechanized field operations with level terrace beds
5) Water conservation and drainage6) Improved crop production

Land users like the fact that bench terracing provides land that is easier to work. The land is better utilized for cultivation, resulting in improved productivity. Land users generally appreciate its numerous benefits in terms of land productivity, soil conservation, and water management. What they dislike are the expense and labour input if expenditure has to be borne by the land owners and neither machine operators nor small to medium-sized machines are readily available in the market for hire.

LOCATION



Location: Bemji Village, Nubi Gewog (block), Trongsa Dzongkhag (district), Trongsa Dzongkhag (district), Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.4616, 27.57184

Spread of the Technology: evenly spread over an area (1.0097 km²)

In a permanently protected area?: No

Date of implementation: 2019

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Mechanical bench terracing in progress at Bemji village, Nubi gewog (block). (Chenga Tshering)

Land user reaping the benefits of terracing with bountiful harvest and beautified landscape too (Chenga Tshering)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [x] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact
- [x] Improve farm mechanization

Land use

Land use mixed within the same land unit: No

Cropland

- Annual cropping: cereals - rice (wetland), cereals - wheat (spring), root/tuber crops - potatoes, vegetables - leafy vegetables (salads, cabbage, spinach, other)

Number of growing seasons per year: 2
Is intercropping practiced? No
Is crop rotation practiced? Yes

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

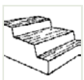
soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

soil erosion by wind - Et: loss of topsoil

SLM group

- cross-slope measure

SLM measures

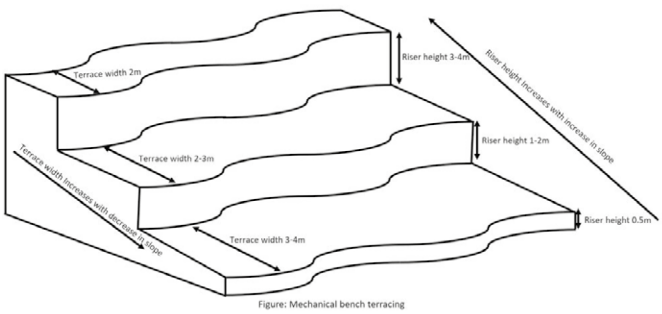


structural measures - S1: Terraces

TECHNICAL DRAWING

Technical specifications

Technical Drawing of bench which are made mechanically



Author: Ongpo Lepcha

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **2.4 acres**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 80.62 Ngultrum
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs
n.a.

Establishment activities
1. Feasibility study (Timing/ frequency: Based on land user and extension agents convenience)
2. Participatory SLM Action planning (Timing/ frequency: Based on land user and extension agent convenience)
3. Hands on training for land owners and machine operator (Timing/ frequency: Prior to actual implementation of the activity)
4. Bench terracing by machine (Timing/ frequency: When the land is fallow (Nov-Feb))
5. Leveling and removal of stones (Timing/ frequency: Based on land user convenience)

Establishment inputs and costs (per 2.4 acres)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
Labour	person-days	98.0	500.0	49000.0	100.0
Equipment					
Excavator	nos	1.0	40916.0	40916.0	
Total costs for establishment of the Technology				**89'916.0**	
Total costs for establishment of the Technology in USD				*1'115.31*	

Maintenance activities
1. Maintenance of terrace bunds (Timing/ frequency: When ever necessary)

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
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- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
The data used was from the nearest weather station of the National Center for Hydrology and Meteorology (NCHM).
Name of the meteorological station: https://www.nchm.gov.bt/home/pageMenu/906
Warm temperate zone

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
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- [ ] poor drinking water (treatment required)
- [x] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [x] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [x] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [x] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor		✓		good
markets	poor	✓			good
energy	poor			✓	good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor	✓			good

IMPACTS

Socio-economic impacts

Crop production

decreased | | | | | ✓ | | | increased

Quantity before SLM: Before 1,814 kgs/acre
Quantity after SLM: After bench terracing 1,971 kgs/acre
According to the land user, there has been increased crop production.

crop quality

decreased | | | | | | ✓ | | increased

According to the land user, the quality has relatively improved but is unable to describe the changes, however, he observed changes in the size of the grain and enhanced grain filling ability.

product diversity

decreased | | | | | ✓ | | | increased

Quantity before SLM: In the past, the land owner has been growing only wheat or barley
Quantity after SLM: Now the owner is growing paddy followed by wheat or barley in a year
The land user shared that the number of crops grown in the area has increased, and people also started commercial farming.

production area (new land under cultivation/ use)

decreased | | | | | ✓ | | | increased

Quantity before SLM: 23 acres of land
Quantity after SLM: 2.4 acres of land are currently being cultivated after bench terracing
This is probably due to the lack of labour and some of the farm lands located very far from the home/settlement.

land management

hindered | | | | | | ✓ | | simplified

The land users shared that after bench terracing, the management of land has greatly improved. This is evident from the quality of crops that they grow on the terrace. Working on the land is also easy unlike working on slopes.

expenses on agricultural inputs

increased ✓ decreased

Quantity before SLM: Before bench terracing the owner used oxen for ploughing
Quantity after SLM: Now they use power tillers and cost have reduced for agriculture farming
Other objective of promoting bench terracing is also to enable farm mechanization.

farm income

decreased ✓ increased

Before bench terracing the land owners use the field for growing only wheat or barley. After bench terracing they grow two crops in a year, paddy followed by wheat or barley

Socio-cultural impacts

Ecological impacts

surface runoff

increased ✓ decreased

Since the land is on a sloping area there is surface and rill erosion in the past, but after the bench terracing, the incidences of surface and rill erosions are minimal

excess water drainage

reduced ✓ improved

As the terraces field are used for paddy cultivation there is no excess water. Even if there is excess the land owner can easily drainage to water ways

landslides/ debris flows

increased ✓ decreased

Erosion was easily observable in the past due to the agricultural land being on mountain slopes. However, now, due to the series of levelled land, water erosion and landslides are no longer observed.

Off-site impacts

water availability (groundwater, springs)

decreased ✓ increased

Before terracing rainwater is lost due to surface runoff however with terracing surface runoff is prevented as a result the amount of irrigation water required has reduced. Thus increasing water availability.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns very negative ✓ very positive
Long-term returns very negative ✓ very positive

Benefits compared with maintenance costs

Short-term returns very negative ✓ very positive
Long-term returns very negative ✓ very positive

The land users were not able to explain very clearly the benefits of the technology. This is because land users were supported by the government for the establishment of the terrace. They didn't have any idea how much would it cost if they had to do everything by themselves.

CLIMATE CHANGE

Gradual climate change

annual temperature increase not well at all ✓ very well
annual rainfall increase not well at all ✓ very well

Climate-related extremes (disasters)

local rainstorm not well at all ✓ very well
local thunderstorm not well at all ✓ very well
local hailstorm not well at all ✓ very well
local snowstorm not well at all ✓ very well
landslide not well at all ✓ very well
epidemic diseases not well at all ✓ very well
insect/ worm infestation not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- 11-50%
- ✓ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ✓ 0-10%
- 11-50%
- 51-90%
- 91-100%

Number of households and/ or area covered
16 hhs covering 19.50 acres of vulnerable land were brought under bench terracing in Bemje village

Has the Technology been modified recently to adapt to changing conditions?
- [ ] Yes
- [x] No

To which changing conditions?
- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Agronomic management and working have become relatively easier: with bench terracing working with animals or machinery for tillage activities becomes very easy unlike in slopes.
- Land can be better utilized, despite decreased total cultivated land: Terrace provides land users the option to fully utilize the available land. If it was a slope, even if they have more land they cannot use them for farming.
- Prevents the degradation of the land by rain: The main purpose of terracing is to reduce and prevent land degradation caused by surface runoff.
- Irrigation water is better utilized and conserved: When the surface is properly leveled irrigation water is well distributed.

Strengths: compiler’s or other key resource person’s view
- Prevents landslide: Since the surveyed area was located on the mountain slopes, there are chances of slides if measures were not taken and bench terraces were not made.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- It is a very expensive affair: If machinery and laborers have to be managed by individual land users it would be very expensive. However, in Bhutan, the technology is mostly funded by the project and Government of Bhutan
- Land users could not convert all available land into the terrace. More support from the government so that they can convert all slopy areas into terraces.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome
- Since bench terracing required huge expenditure it is difficult for the owners to bear the full cost To implement the intervention through donars fund on cost sharing basis

REFERENCES

Compiler
ONGPO LEPCHA

Editors
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Reviewer
William Critchley
Rima Mekdaschi Studer
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Resource persons
Tenzin Penjor - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6836/

Linked SLM data
n.a.

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Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

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- Sustainable Land Management: Guidelines and Best Practices 2021: http://www.nssc.gov.bt

Links to relevant information which is available online
- Turning slopes, dry land into viable agricultural land in Trongsa: https://www.undp.org/bhutan/stories/turning-slopes-dry-land-viable-agricultural-land-trongsa
- Bench Terraces: Classification and Maintenance | Soil Management: https://www.soilmanagementindia.com/soil-erosion/terracing/bench-terraces-classification-and-maintenance-soil-management/15307

Consolidated Terraces (Irrigated Paddy Fields) (Sonam Wangchuk)

Terrace Consolidation by Machine (Bhutan)

Thruel Chhey Lag Len Thap Tey Aring Ja Kaed Tang Ni (ཁྲུལ་ཆས་ཐོག་ཨ་རིང་བརྒྱ་སྐྱེད་བཏང་ནི།)

DESCRIPTION

Terrace consolidation is the merging of existing narrow bench terraces into larger terraces to enable farm mechanization, commercial farming and crop intensification. This technology is promoted as the existing terraces are generally narrow and this limits efficient operation and utilization of land and other resources.

Terrace consolidation involves merging of small terraces into larger terraces using a machine to make more efficient use of land through farm mechanization, commercial farming and crop intensification. This technology is promoted as the existing terraces are generally narrow and this limits efficient operation and utilization of land and other resources.

The consolidation of narrow terraces is recommended if the general slope of the proposed site is less than 20° (36%) with good soil drainage and low risk of land degradation. While consolidating narrow terraces, it is strongly recommended to remove the topsoil from the terraces and put it back once the levelling is completed. The consolidated terrace should maintain a maximum riser height of 1.5 m and bed width of 3.5 m. For slopes below 12° (21%), the bench width should not exceed 5–6 m.

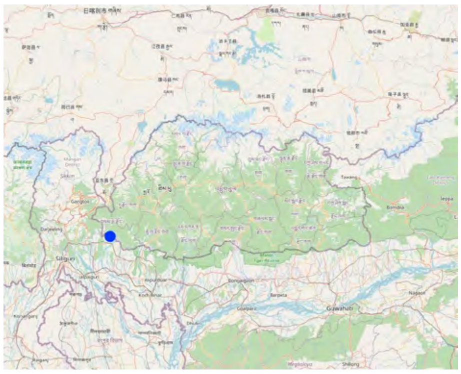
Farmers can expand the amount of arable land available, maximize agricultural operations, and encourage sustainable farming methods for higher crop output and enhanced ecological resilience by converting narrower and more steep bench terraces into bigger ones (NSSC, 2020). A large portion of hillside farmers around the world rely on terracing. For the purpose of facilitating the growth of field crops, horticultural crops, fodder, and other crops that require specific management practices (e.g., irrigation), alone or in agroforestry systems, hilly or mountainous terrains are divided into narrow but graduated steps, typically 2-3 m wide and 50-80 m long across the slopes (Chapagain & Raizada, 2017).

Enlargement of terraces begins with a thorough survey and analysis of the topography and terrain. In order to build larger terraces with the least amount of environmental damage, this phase is essential. The next step in the construction process is to reshape the present, small terraces into larger, more open ones. To make wider terraced levels, this may entail moving soil and cutting through slopes. Furthermore, filling up the gaps and levelling the land's surface is required in order to reduce the number of risers and produce a continuous, gently sloping terrace. The installation of suitable drainage systems is also crucial to guarantee adequate water management and stop soil erosion.

Larger terraces enhance water management capabilities. With a more extensive surface area, water runoff is minimized, and the distribution of irrigation water becomes more even, promoting better soil moisture retention and reducing erosion. This, in turn, contributes to soil health and fertility, supporting sustainable farming practices. Moreover, the consolidation of smaller terraces into larger ones reduces the overall number of risers, thereby enhancing accessibility for farmworkers and farm machinery. This ease of access further optimizes the use of resources and fosters better crop management. Additionally, larger terraces can enable the implementation of crop diversification strategies, such as intercropping and crop rotation, promoting biodiversity and mitigating the risk of crop failure due to pests or adverse weather conditions.

However, the process of enlarging terraces involves altering the terrain, which can lead to soil erosion, habitat destruction, and ecological imbalances. This environmental impact may negatively affect local flora and fauna, reducing biodiversity and disrupting the delicate ecological equilibrium (Deng et al., 2021). Planning for safe discharge of excess water out of the terrace system effectively helps preserve soil fertility and reduces runoff. It is essential also to pay close attention to the preservation of the local ecosystem and biodiversity throughout the process.

LOCATION



Location: Sang-Ngag-Chhoeling, Samtse, Bhutan

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 88.97161, 26.95436

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2021

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Terrace Consolidation in Progress using an excavator (Tashi Wangdi)

Consolidated Terraces (Sonam Wangchuk)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: No

CroplandNumber of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? No

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [x] adapt to land degradation
- [ ] not applicable

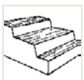
Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

SLM group

- cross-slope measure
- wetland protection/ management
- ecosystem-based disaster risk reduction

SLM measures

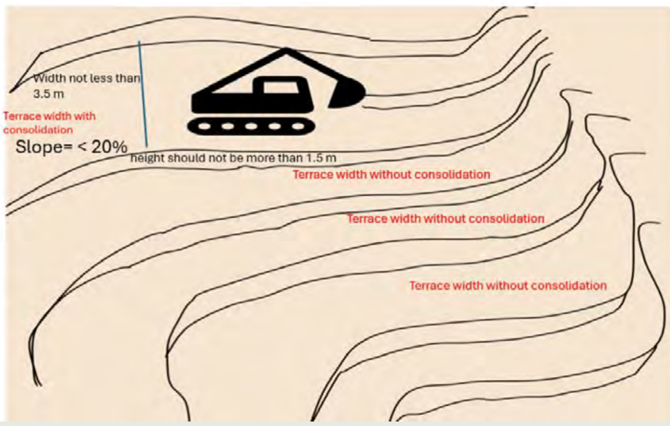


structural measures - S1: Terraces, S2: Bunds, banks

TECHNICAL DRAWING

Technical specifications

consolidation of old and small terraces with machines



Author: karma Wangdi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **2.5 acre**; conversion factor to one hectare: **1 ha = 1ha**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 80.0 Ngultrum
- Average wage cost of hired labour per day: 500

Most important factors affecting the costs

The major factor affecting the cost for implementing this technology is in hiring of excavator

Establishment activities

1. Secure funding support from GCF (Timing/ frequency: January (Before cropping))
2. Action planning in consultation with beneficiaries and the stakeholders (Timing/ frequency: February (Before cropping))
3. Arrangement of excavator machine (Timing/ frequency: First week of March (Before cropping))
4. Activity implementation (Timing/ frequency: Second week of March till April (Before cropping))

Establishment inputs and costs (per 2.5 acre)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
Assisting operator (reaching fuel)	no	60.0	500.0	30000.0	100.0
Labelling of terraces	no	60.0	500.0	30000.0	100.0
Equipment					
Hiring of Excavator	day	6.0	20000.0	120000.0	
Total costs for establishment of the Technology				**180'000.0**	
Total costs for establishment of the Technology in USD				*2'250.0*	

Maintenance activities

n.a.

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [x] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

Average annual rainfall in mm: 1500.0
The gewog experiences mostly heavy shower with annual rainfall ranging from 1500 mm to 4000 mm
Name of the meteorological station: National Center for Hydrology and Metrology (NCHM), Bhutan
Subtropical monsoon climatic zone

Slope

- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms

- [ ] plateau/plains
- [x] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude

- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in

- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth

- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)

- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)

- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content

- [ ] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table

- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water

- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)

- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?

- [ ] Yes
- [x] No

Occurrence of flooding

- [x] Yes
- [ ] No

Species diversity

- [ ] high
- [x] medium
- [ ] low

Habitat diversity

- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
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Off-farm income
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- [ ] > 50% of all income

Relative level of wealth
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- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [x] children
- [x] youth
- [x] middle-aged
- [x] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

	poor				good
health	poor		✓		good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

Crop production	decreased							✓	increased	Before the terrace consolidation they used to have minimum production but now they are producing for both self consumption and commercial purpose. these are expert estimates or data measured.
production area (new land under cultivation/ use)	decreased							✓	increased	The merging of small terraces has increased the cropping area. These are expert estimates or data measured.
land management	hindered							✓	simplified	Overall Land management has become easier for them as they can use more machines due to larger flat terraces
expenses on agricultural inputs	increased							✓	decreased	The deployment of number of labor has reduced with the intervention of farm machineries, thus reducing the cost of production with reduced time and man power. These are expert estimates or data measured.
farm income	decreased							✓	increased	Farm income has increased compared to past as they have larger area of cultivation.
diversity of income sources	decreased							✓	increased	The time and resources saved from this technology intervention has been beneficial in for other use. These are expert estimates or data measured.
workload	increased							✓	decreased	Due to mechanized farming favoured by terrace consolidation, the workload at an individual level has significantly reduced. These are expert estimates or data measured.

Socio-cultural impacts

food security/ self-sufficiency

reduced ✓ improved

The increased cropping area and contributed in increase in production, thus enhancing the food and nutrition security. These are expert estimates or data measured.

health situation

worsened ✓ improved

The better crop productivity is found to be contributing better health quality of the farm household. These are expert estimates or data measured.

SLM/ land degradation knowledge

reduced ✓ improved

Could have better understanding on SLM and its benefits through the sensitization programs. These are expert estimates or data measured.

Ecological impacts

soil loss

increased ✓ decreased

The flat terraces has been always been adventitious in controlling overall soil and nutrient loss. These are expert estimates or data measured.

soil accumulation

decreased ✓ increased

Because of very minimum soil loss, the soil accumulation rate in these terraces has been very high. These are expert estimates or data measured.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns very negative ✓ very positive

Long-term returns very negative ✓ very positive

Benefits compared with maintenance costs

Short-term returns very negative ✓ very positive

Long-term returns very negative ✓ very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase not well at all ✓ very well

annual rainfall decrease not well at all very well Answer: not known

Climate-related extremes (disasters)

local rainstorm not well at all ✓ very well

local thunderstorm not well at all ✓ very well

local windstorm not well at all ✓ very well

heatwave not well at all ✓ very well

cold wave not well at all ✓ very well

extreme winter conditions not well at all ✓ very well

drought not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [x] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

8 households

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Increased production
- Enhanced farm mechanization and workability

Strengths: compiler's or other key resource person's view
- Reduced surface runoff
- Optimal use of resources
- Increased production
- Enhanced farm mechanization and workability

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- cost for terrace consolidation help and support through government and projects

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- Heavy and large machineries (excavator) used to carry out terrace consolidation might pose soil compaction and sealing Use of smaller excavators specifically designed for terracing

REFERENCES

Compiler
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Resource persons
Ram Bahadur Limbu - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6871/

Linked SLM data
n.a.

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- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- BHUCAT, NSSC, 2011: Website

Links to relevant information which is available online
- Agronomic Challenges and Opportunities for Smallholder Terrace Agriculture in Developing/ Countries/: https://doi.org/10.3389/fpls.2017.00331
- Advantages and disadvantages of terracing/A comprehensive review. International Soil and Water Conservation Research: https://doi.org/10.1016/j.iswcr.2021.03.002
- PARTICIPATORY SLM ACTION PLAN 2020 /Supporting Climate Resilience and Transformational Change in the Agriculture Sector in Bhutan Funded by Green Climate Fund.: https://www.bhutangcf.gov.bt/wp-content/uploads/2021/12/SLM_Action-Plan_2020.pdf
- Soil and Water Conservation / Lesson 5 Terraces for Water Erosion Control: http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2098

Contour hedgerows in Boucholing village (Kuenzang Nima)

Contour Grass Hedgerows on Steep Slopes (Bhutan)

Tsayi Gaytshig (ཙྭའི་ཀད་ཚིག།)

DESCRIPTION

Contour hedgerows are a soil and water conservation technology that involve planting of Napier grass cuttings along contour lines on the slope at a horizontal distance of 6 m. The area between the contour hedgerows is used for crop cultivation.

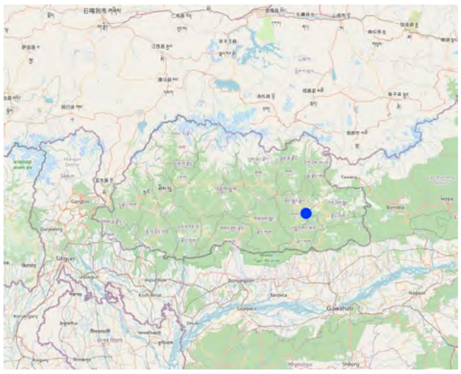
Contour hedgerows are a soil and water conservation technology that involves planting Napier stem cuttings along contour lines on slopes. They are planted at a horizontal distance of 6 meters between rows and 15-20 centimeters between cuttings within lines. On average it requires 3500-4000 Napier slips to cover one acre (0.4 ha). Hedgerows form living barriers that trap sediment and reduce surface runoff. With time, as the sediment builds up behind the hedges, the area between the hedgerows develops into flat alleys or "terrace beds". This technology is effective in reducing soil erosion and conserving water. The hedgerows also boost crop productivity. The contour hedgerow system is widely used in hilly terrain in Bhutan and elsewhere.

The main purposes of the technology are to 1) serve as a barrier to check the movement of soil and water down the slope, 2) effectively utilize sloping areas for agricultural purposes, and 3) increase crop and fodder production.

The major activities/ inputs needed to establish/ maintain contour hedgerows are: 1) surveying of the area by an SLM specialist (planning and site assessment), 2) selecting suitable hedgerow planting materials, 3) registration of interested farmers, 4) training of farmers, 5) layout of contour lines using A-frames, 6) distribution of planting materials and establishment of hedgerows in farmland, 7) monitoring and evaluation of hedgerows, and 8) maintenance of hedgerows. Maintenance includes replacement of cuttings in gaps - either damaged by cattle or natural mortality and trimming of grass back to 15 centimeters after reaching 1 meter. Inputs required include: 1) planting materials (Napier grass), 2) A-Frame for contour lines, 3) spades, pickaxes, shovels, crowbars, etc., and 4) human resource input by SLM specialists.

Contour hedgerows have many benefits/ impacts on the livelihood of the land users including 1) soil and water conservation, 2) use of the sloping areas for crop or fodder production, 3) effective conservation through using local materials with a 90% survival rate, 4) habitat for natural predators, pollinators, insect-eating birds, and rodent predators, 5) groundwater recharge, and 6) they beautify the overall agricultural landscape. Another important benefit of the hedgerows is the availability of fodder grass for livestock, which otherwise would have to be collected from the forest. The disadvantages include the need for regular maintenance and gapping up. At times, conflicts arise within the community due to grazing of hedges by neighbors' cattle.

LOCATION



Location: Boucholing village, Thangrong gewog (block), Mongar Dzongkhag (district), Mongar, Bhutan

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites
- 91.34359, 27.20293

Spread of the Technology: evenly spread over an area (approx. 10-100 km2)

In a permanently protected area?: No

Date of implementation: 2014

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

An overview of established hedgerows at Boucholing chiwog. (Tashi Wangdi & Chenga Tshering)

Well established hedges with maize crop in the alleys. (Tashi Wangdi)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: No

Cropland

- Annual cropping: cereals - maize, root/tuber crops - sweet potatoes, yams, taro/cocoyam, other, vegetables - leafy vegetables (salads, cabbage, spinach, other), chilli

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

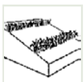
Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

SLM group

- cross-slope measure

SLM measures

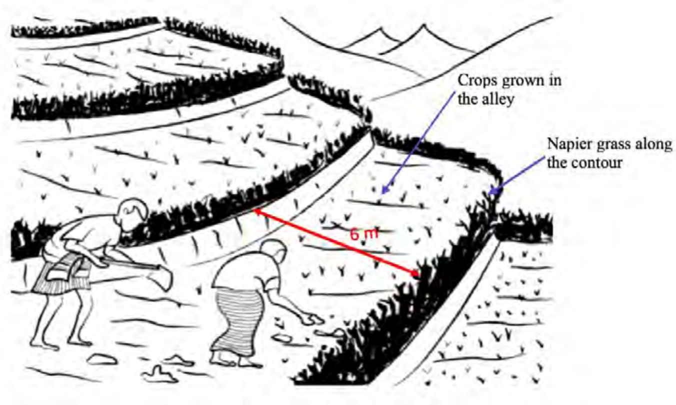


vegetative measures - V2: Grasses and perennial herbaceous plants

TECHNICAL DRAWING

Technical specifications

Technical drawing as per the specification given in the SLM Guidelines 2021. See steps for the establishment of hedgerows below:
a)Determine the hedgerow interval for each landform based on the gradient (but based on farmers feedback, the interval is generally set at 6 meters) and then lay out the contour lines. Along the contours, prepare a strip of land with a width of about 40-50cm wide to plant the grass slips or broadcast fodder grass seeds. Napier (Pennisetum spp.) and Pakchong grass spp. is recommended as hedgerow plants for areas that are below 1600 m. However, for areas above 1600 m, temperate grass mixture should be considered;
b)A row of fodder grass slips or seedlings should be planted with a spacing of 15-20 cm. If grass slips are used, at least two nodes should be inserted into the soil for proper establishment/rooting. On the other hand, if grass seeds are used, the seed rate should be 25g per square metre;
c)Mulching should be done right after the grass slip planting or grass seeding to reduce surface erosion, conserve soil moisture, and aid proper germination;
d)Gap filling and trimming of hedgerows should be done as and when required. The trimmed materials can either be used as fodder or mulching materials; and
e)If desired, improved fruit trees suitable at the proposed site can be planted along the hedges at 5 x 5 m spacing. Fruit trees in two adjacent hedgerows should be planted in staggered position to avoid competition for sunlight, water, and soil nutrients.



Author: NSSC

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **Ha**; conversion factor to one hectare: **1 ha = 0.4**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 82.08 Ngultrum
- Average wage cost of hired labour per day: 250

Most important factors affecting the costs

Labour cost and cost of the planting materials.

Establishment activities

1. Planning (Timing/ frequency: done between the stakeholders several times)
2. Community meeting and member agreement (Timing/ frequency: twice)
3. Training and workshop (Timing/ frequency: for almost a week)
4. Demonstration (Timing/ frequency: once)
5. Implementation (Planting of napier in the field in groups) (Timing/ frequency: based on the land users convenience and season of plantation)

Establishment inputs and costs (per Ha)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
Labours	person-days	4.0	250.0	1000.0	100.0
Plant material					
Napier	bundle	35.0	200.0	7000.0	
Other					
Payment for resource persons	No of days	5.0	1500.0	7500.0	
Total costs for establishment of the Technology				**15'500.0**	
Total costs for establishment of the Technology in USD				*188.84*	

Maintenance activities

1. Harvesting, cutting of napier and maintaining the height of the plant (Timing/ frequency: when the napier reaches a height of one meter)
2. Replacing of missing and damaged hills (Timing/ frequency: whenever possible)

Maintenance inputs and costs (per Ha)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
labour	person-days	2.0	250.0	500.0	100.0
Plant material					
Napier slips	Bundle	10.0	200.0	2000.0	
Total costs for maintenance of the Technology				**2'500.0**	
Total costs for maintenance of the Technology in USD				*30.46*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
The data used was from the nearest weather station of the National Center for Hydrology and Meteorology (NCHM).
Name of the meteorological station: https://www.nchm.gov.bt/home/pageMenu/906
Dry subtropical zone

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [ ] poor drinking water (treatment required)
- [x] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [x] Yes
- [ ] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household

- ✓ < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Scale

- ✓ small-scale
- medium-scale
- large-scale

Land ownership

- state
- company
- communal/ village
- group
- individual, not titled
- ✓ individual, titled

Land use rights

- open access (unorganized)
- communal (organized)
- leased
- ✓ individual

Water use rights

- ✓ open access (unorganized)
- communal (organized)
- leased
- individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor			✓	good
markets	poor		✓		good
energy	poor			✓	good
roads and transport	poor		✓		good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS

Socio-economic impacts

Crop production

Crop production	decreased						✓		increased	Crop production is higher than in the past since the contour hedgerows have helped control soil erosion and allowed for proper land utilization. The land user reported about a 25% increase compared to the past.
crop quality	decreased						✓		increased	The crop quality is also relatively better now compared to the past when the technology was not applied. The land users reported that crops near the hedgerows were found more greener.
fodder production	decreased							✓	increased	Quantity before SLM: No fodder was produced Quantity after SLM: After napier plantation, napier are harvested as fodder for cattle. Napier grass was not planted in the past. It was introduced by the National Soil Services Center as part of this technology. The Napier grass planted along the contour has helped not only with soil erosion control but also provided fodder grass for the cattle. The land user reported that there was a 100% increase in fodder because unlike in the past now they don't have to send their cow for grazing in the forest.
fodder quality	decreased							✓	increased	Compared to normal grass that the cattle would graze on, napier is nutrient-rich and of better quality than the normal grass.
risk of production failure	increased					✓			decreased	The napier plantation has helped prevent soil erosion that would normally occur in the farm lands thereby preventing crop failure due to soil fertility and moisture conservation.
product diversity	decreased						✓		increased	With the help of the project, the land users were able to utilise the sloping land. This enabled land users to grow crops other than maize.
production area (new land under cultivation/ use)	decreased							✓	increased	The contour hedgerows have allowed for the sloping and degraded lands to be revitalised into usable cultivable lands.
land management	hindered							✓	simplified	Quantity before SLM: Hard manual land management Quantity after SLM: mechanization of the agriculture in the community With the help of the project, farm lands in the community were made into terraces and made land management easier compared to the past.

expenses on agricultural inputs

increased — decreased

The expenses on agricultural inputs have stayed relatively the same, however, has made working on the farm land easier.

farm income

decreased — increased

With fodder availability, land users can now focus more on agriculture instead of herding cattle for grazing. The project has also allowed for land users to diversify their products.

workload

increased — decreased

Workload has decreased due to farm mechanization through use of power tillers, which was not possible prior to the SLM intervention.

Socio-cultural impacts

Ecological impacts

surface runoff

increased — decreased

Prior to hedgerow establishemt, there was serious surface erosion, which is not the case now.

plant diversity

decreased — increased

Quantity before SLM: primarily maize was cultivated
Quantity after SLM: maize, cole crops, tubers and chilies are cultivated
In the past, the community members would normally cultivate maize and small amounts of vegetables for self consumption, but now a diverse variety of crops are cultivated.

Off-site impacts

downstream flooding (undesired)

increased — reduced

Downstream flooding is relatively less, since the hedgerows has prevented or reduced surface eorsion which would otherwise impact the downstream settlements and water bodies.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative — very positive
Long-term returns — very negative — very positive

Benefits compared with maintenance costs

Short-term returns — very negative — very positive
Long-term returns — very negative — very positive

Since the project was fully funded and minimal cost went into its establishment by the land users, the benefits are higher.

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all — very well
annual rainfall decrease — not well at all — very well

Climate-related extremes (disasters)

local rainstorm — not well at all — very well
local thunderstorm — not well at all — very well
local hailstorm — not well at all — very well
local windstorm — not well at all — very well
drought — not well at all — very well
landslide — not well at all — very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

40 households

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Hedgerow requires less management
- Napier are also used as fodder for livestock
- Prevents the land from erosion due to heavy rain
- Helps in build up of terraces and facilitates in mechanization of farm

Strengths: compiler's or other key resource person's view

- Additional income opportunities through the production of marketable products from hedgerow vegetation.
- Improved livelihoods for communities through long-term agricultural productivity.
- Support for sustainable agricultural practices and resilient farming systems.
- Preservation of fertile land and protection of agricultural resources.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Grazing of hedges by free cattle in absence of fences in farm land Establish community byelaws not to let their cattle free in the fields or install fencing aroung the field.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Shading and potential competition with crops for soil nutrients by hedges Maintaining height and width of hedges
- The establishment and maintenance of contour hedgerows require time, effort, and financial resources The funding for the establishment of technology has already been provided and for maintenance, the expenditure is minimal.

REFERENCES

Compiler
ONGPO LEPCHA

Editors
Kuenzang Nima

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 15, 2023

Last update: June 4, 2024

Resource persons

Khemo Daza - land user
Ugyen Dorji - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/technologies/view/technologies_6854/

Linked SLM data

n.a.

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- ICIMOD. (1999). Manual on Contour Hedgerow Inter-cropping Technology. ICIMOD.: https://lib.icimod.org/record/31840/files/manual_on_contour_hedgerow_inter-cropping_technology.pdf
- Pellek, R. (1992). Contour hedgerows and other soil conservation interventions for hilly terrain. Agroforestry Systems, 17, 135-152.: https://link.springer.com/article/10.1007/BF00053118
- Kaushal, R., Mandal, D., Panwar, P., Rajkumar, Kumar, P., Tomar, J. M. S. & Mehta, H. (2021). Chapter 20 - Soil and water conservation benefits of agroforestry.: https://www.sciencedirect.com/science/article/abs/pii/B9780128229316000204

Links to relevant information which is available online

- Sustainable Land Management for improved land productivity and community livelihood in Thangrong, Mongar: https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=27647
- Soil erosion control with contour planting: https://apps.worldagroforestry.org/Units/Library/Books/Book%2082/imperata%20grassland/html/4.1_soil.htm?n=20
- Sustainable Land Management: Guidelines and Best Practices 2021: https://www.nssc.gov.bt

Contour Stone Bunds (Tshering Yangzom)

Contour Stone Bunds (Bhutan)

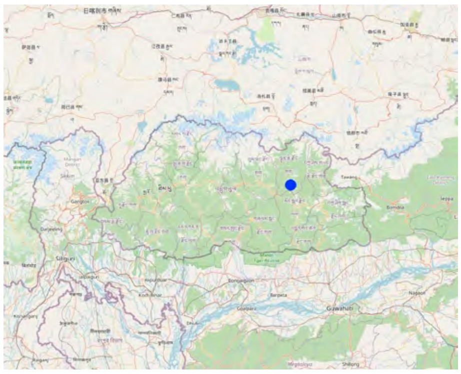
Dhoyi Gaytshig (རྡོའི་རྒྱད་ཚིག།)

DESCRIPTION

Contour stone bunding on sloping agricultural lands reduces soil erosion and conserves soil moisture in order to retain soil productivity. It is promoted /recommended on slopes where there is adequate surface stone.

Contour stone bunds are small walls of stone that are laid out along the contour line to help reduce soil erosion, conserve soil moisture, increase soil fertility, to ease workability, increase cropping area, and ultimately ensure sustainable use of lands for enhanced food and nutrition security. This practice is recommended in fields that have plenty of surface stones (> 20%). Construction of contour stone bunds not only helps to get rid of the excess surface stones and gravel but also reduces the slope gradient through formation of partial terraces over a few years.
The stone bund is not new to Bhutan, being a mountainous country, forefathers used the technique to remove stones from the field and stabilise the land for agricultural purposes. Therefore, there were some traditional stone lines constructed in the study area.
Constructing stone bund is labour intensive, therefore land users resort to a labour sharing approach where all the land users from the community come together and work on a rotational basis until every household in the community has established stone bunds.
The major activities and inputs required to establish the contour stone bund includes sensitization of beneficiaries, followed by SLM action planning, and hands-on-training. Field implementation follows this sequence: (a) determination of intervals between stone bunds, (b) demarcation of contour lines using an 'A' frame, (c) digging a trench of 0.1 - 0.2 m deep and 0.5 m wide to establish a foundation along the contour lines, and (d) constructing stone lines along the trenches with the larger stones at the base to set a sound foundation. A typical stone wall is 0.3 m high (1 ft) and 0.3 - 0.5 m wide, but this depends on the slope and availability of stones in the field. Contour stone bunds are commonly spaced 6 metres apart on slopes of 60%. In some cases, the fodder grass slips are also planted at the base of the stone bund for better stabilization of the bunds and fodder availability.
The major drawbacks of this SLM technology according to respondents are (a) labour demanding, (b) no immediate return, and (c) the space between piled stones harbours rodents leading to crop damage.

LOCATION



Location: Zangkhar Village, Yabi-Zangkhar Chiwog, Jaray Gewog, Lhuentse Dzongkhag, Bhutan

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 91.15742, 27.50286

Spread of the Technology: evenly spread over an area (approx. 0.1-1 km2)

In a permanently protected area?: Yes

Date of implementation: 2015

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Stone bunds constructed along the contour line in agriculture dryland. (Haka Drukpa)

Leaving no stones unturned. (Haka Drukpa)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

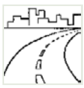
Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: root/tuber crops - potatoes, vegetables - leafy vegetables (salads, cabbage, spinach, other), Chili, cauliflower, cabbage, onion, brinjal and garlic.
- Perennial (non-woody) cropping

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes



Settlements, infrastructure - Settlements, buildings, Traffic: roads, railways, Energy: pipelines, power lines

Water supply

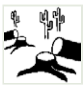
- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [x] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wo: offsite degradation effects



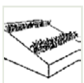
biological degradation - Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bp: increase of pests/ diseases, loss of predators

water degradation - Ha: aridification

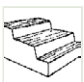
SLM group

- cross-slope measure

SLM measures



vegetative measures - V2: Grasses and perennial herbaceous plants

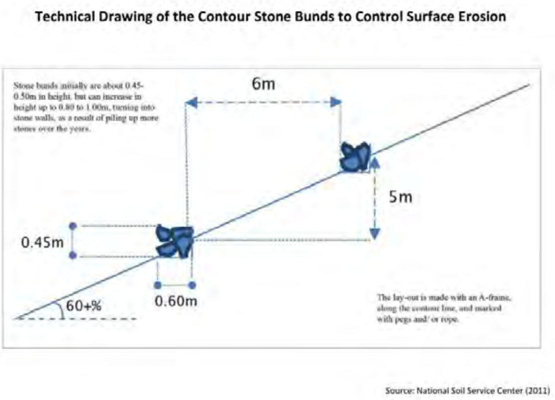


structural measures - S2: Bunds, banks

TECHNICAL DRAWING

Technical specifications

The specifications provided in the technical drawing (NSSC, 2011) may vary based on the field situation and slope of the land. Variations may be in the width of the terrace (3 m to 6 m), the height of the stone bund (0.45 m to 1m), and minimal variations are observed in the width of the stone bund (0.6 m).



Author: National Soil Service Centre

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **3 acres**)
- Currency used for cost calculation: **Nu**
- Exchange rate (to USD): 1 USD = 80.0 Nu
- Average wage cost of hired labour per day: 400

Most important factors affecting the costs

The most important factor affecting the cost is labor.

Establishment activities

1. Traditional stone bund construction (Timing/ frequency: 50 years earlier)
2. Sensitization, SLM action planning, and Hands-on-training (Timing/ frequency: 2015)
3. Field implementation of the activity (Timing/ frequency: 2015)
4. Provision of incentives (Nu. 3000 per acre) (Timing/ frequency: 2015)
5. Project phase-off (Timing/ frequency: 2017)
6. Scaling up of this technology through GEF-LDCF (Timing/ frequency: 2022)

Establishment inputs and costs (per 3 acres)

Specify input	Unit	Quantity	Costs per Unit (Nu)	Total costs per input (Nu)	% of costs borne by land users
Labour					
Labour	Person/day	49.0	400.0	19600.0	100.0
Other					
Project incentive	Per hectare	1.0	6420.0	6420.0	
Total costs for establishment of the Technology				**26'020.0**	
Total costs for establishment of the Technology in USD				*325.25*	

Maintenance activities

n.a.

NATURAL ENVIRONMENT

Average annual rainfall

- < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- ✓ 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone

- humid
- ✓ sub-humid
- semi-arid
- arid

Specifications on climate

Average annual rainfall in mm: 1250.0
The rainfall received in the region may vary from 1000 to 1500 mm. The rainfall data of the Gewog is not available. The area shares a border with the Medtsho Gewog and has similar agroecological zones. The data provided is for Medtsho Gewog.
Name of the meteorological station: Website, Lhuentse Dzongkhag Administration
The Gewog falls under dry sub-tropical to warm temperate region (1500 to 2400 meters above sea level) from the six agroecological zones of Bhutan. It is characterized by extreme cold in winter and moderate in summer, humid and foggy.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [x] steep (31-60%)
- [x] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [x] 1,501-2,000 m a.s.l.
- [x] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.

Technology is applied in
- [x] convex situations
- [ ] concave situations
- [ ] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: ground water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor		✓		good
energy	poor			✓	good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production	decreased – increased	The cultivation of potatoes increased due to an increase in the cultivable area as the stones are removed.
crop quality	decreased – increased	Crops appear greener and healthier due prevention of soil erosion as the topsoil is retained. Maize leaves were dark green and potatoes were bigger.
risk of production failure	increased – decreased	Due to the removal of stones from the soil, it is suitable for diverse crop growth (deep-rooted and shallow). Therefore, the land user can cultivate diverse crops throughout the year. Crop diversity and increased growing season will ensure land user with stable household income even if one crop fails.
product diversity	decreased – increased	The technology reduces workload (mechanization) and increases cultivable area leading to the cultivation of diverse crops for market purposes.
production area (new land under cultivation/ use)	decreased – increased	Increased due to the removal of stones from the land.
expenses on agricultural inputs	increased – decreased	Expenses on agriculture input are reduced. For example, with the use of a power tiller which costs Nu. 1500 per day, it takes 2 days to complete ploughing. If it is done by oxen then it takes 8 days and Nu. 400 is paid as a labour charge per day. The total amount required using the power tiller is Nu. 3000 and using oxen is Nu. 3200 with an additional cost of food for the labourers.
farm income	decreased – increased	Previously the land user was not able to meet the demand for maize as a feed for the cattle. With the introduction of stone bunding and increased production, the land user can meet her domestic demand for maize and additionally sell processed maize alcohol as a source of farm income.
diversity of income sources	decreased – increased	There is an increased diversity of income sources as the land user can grow different crops throughout the year and also sell some processed products.
workload	increased – decreased	Reduced work load due to farm mechanization. The removal of stone from field had eased workability, lesser wear and tear of farm tools.

Socio-cultural impacts

food security/ self-sufficiency	reduced – improved	With the increase in cultivable areas, technology has ensured food self-sufficiency and generated income to meet other household demands for food.
recreational opportunities	reduced – improved	Reduced workload is directly related to an increase in the available time for recreational opportunities.
national institutions	weakened – strengthened	Support provided by the NSSC and land users' active participation in the implementation of the technology enabled the national agency to have a better understanding of the land users. Labour sharing enabled the community to work together to achieve a common goal which improved collaboration among the community members.
SLM/ land degradation knowledge	reduced – improved	Awareness was created during the introduction of the technology by SLM specialists. Further, the field observation on the neighbours' fields who have already established stone bunds has led to 90% of the population knowing about the stone bunding in the locality.

conflict mitigation

worsened improved

Human-wildlife conflict was reduced as wild boars were not able to climb the stone bund. Although other wild animal such as procupine continued to cause harm to the crop.

situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)

worsened improved

The technology improved soil quality leading to improved production and increased household income.

Ecological impacts

soil moisture

decreased increased

The stone bund holds irrigation water preventing surface runoff. Further, the gradual labelling of the land increases soil moisture retention capacity.

soil cover

reduced improved

Increased due to crop diversification and year-round cultivation.

soil loss

increased decreased

Soil erosion and surface runoff is reduced leading to decreased soil loss.

soil accumulation

decreased increased

Eroded soil is accumulated at bunds.

soil organic matter/ below ground C

decreased increased

Soil organic matter is decreased at the upper part of the terrace and increased at the lower part of the terrace due to runoff from the slopes.

vegetation cover

decreased increased

Increased with the practice of year-round cultivation.

plant diversity

decreased increased

The technology increased suitability of the soil for diverse crops increasing plant diversity.

pest/ disease control

decreased increased

The better crop stand resists pest and diseases attacks on crops. To some extend, the stone bunds keep the wild boars away.

landslides/ debris flows

increased decreased

Reduced surface runoff leads to decreased landslides or debris flow.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns very negative very positive

Long-term returns very negative very positive

Benefits compared with maintenance costs

Short-term returns very negative very positive

Long-term returns very negative very positive

The benefits compared with the establishment costs for the short term are positive due to the subsidy provided.

CLIMATE CHANGE

Gradual climate change

annual rainfall increase

not well at all very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Number of households and/ or area covered

Total of 33 households adopted stone bunds technology.

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Sloping land is challenged by soil erosion and it has a poor ability to retain water. This challenge was alleviated by stone bunding as it significantly reduced soil degradation.
- The land user shared that there is an increased cultivable area after the implementation of the technology. Bigger stones were excavated and piled as stone bunds increasing the total area for cultivation.
- The technology eased farming, as agronomic practices such as tilling became efficient due to the use of power tillers. Soil depth was increased leading to ease in weeding, bed making and other management practices.
- Stone walls prevented wild boar from entering the field reducing crop loss. Therefore, the farmers need not guard the field from wild boar.
- Increased cultivable area and easy working conditions of the soil lead to increased production, and improved livelihood of the farm household.

Strengths: compiler's or other key resource person's view

- The technology contributed to reducing rural-urban migration and generated employment. Stone bunding indirectly helped the farming community to engage in agricultural activities and stay back in the village rather than going out to the city in search of employment.
- Prevent natural disasters. The Gewog is located in the steep slopes and there is a risk of landslides leading to loss of agricultural land, property, and life. Stone bunding prevents surface runoff which could aggravate and lead to land slides.
- Once the stone and boulders are removed and piled along contour line, it improves workability on the farm.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Construction of stone bunds is a laboursome and has no direct benefit to the land users. Practice labour sharing working modality.
- If stone bunds were not constructed properly, it could be easily damaged by cattle, washed or collapsed by heavy rainfall. Proper piling of stones during the stone bund construction.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Some sort of incentives is required to scale out the adoption of technology as its requires huge labour and time with no immediate benefits. Incentive of Nu 3000 tied with construction of 1 ac of stone bunds

REFERENCES

Compiler
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Editors
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Reviewer
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Date of documentation: Aug. 19, 2023

Last update: June 4, 2024

Resource persons
Pema Yangzom - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6891/

Linked SLM data
Approaches: Community Mobilization for SLM Interventions https://qcat.wocat.net/en/wocat/approaches/view/approaches_6835/

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- NSSC. (2011). Bhutan catalogue of soil and water conservation approaches and technologies. National Soil Service Center (NSSC), Department of Agriculture, Ministry of Agriculture and Forests, Royal Government of Bhutan, Thimphu: Book and soft copy from https://www.wocat.net/documents/140/Bhutan_catalogue_of_SLM_Technologies_and_Approaches.pdf

Links to relevant information which is available online
- Sustainable Land Management for improved land productivity & community livelihood in Thangrong: https://www.youtube.com/watch?v=-XS-qFv2dYQ

Low-cost plastic-lined water harvesting pond (Thinley Penjor Dorji)

Low-Cost Plastic-Lined Water Harvesting Pond (Bhutan)

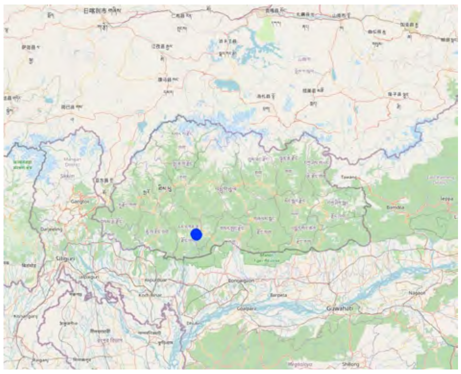
Chhusho Laglen Thabtey Zowai Chhu Sakni Zing (ཆུ་ཤོག་ལག་ལེན་འཐབ་སྟེ་བཟོ་བའི་ཆུ་བསག་ནིའི་རྫིང་།)

DESCRIPTION

Low-cost plastic-lined water harvesting ponds collect and store rain and overland flow water for agricultural and domestic purposes in the dry season. They are both economic and efficient.

Low-cost plastic-lined water harvesting pond are used to collect and store rain or overland flow water for agricultural purposes in the dry season. They are economic and efficient. These ponds are required in the context of irrigation water shortages. Although rainfall has been projected to be increasing (NCHM, 2017), irrigation water shortage was - and continues to be - one of the major constraints in crop production (IHPP, 2017).
Water from precipitation and surface water sources is lost due to inadequate collection and storage. Villages at the top of the hills, in particular, suffer from acute irrigation as well as drinking water shortages. To tap and collect wastewater, rainwater, and water from other perennial and non-perennial sources, low-cost plastic lined water harvesting ponds are proposed. This water can be used during the dry or "lean" season for agricultural as well as household purposes.
The proposed model pond (plastic sheet size; 9m * 7m) costs less than Nu. 25, 000 (USD 315) for construction but can hold more than 27, 000 litre of water. The same dimension of pond if constructed using concrete, would cost more than Nu. 1, 19, 000 (USD 1500). Furthermore a 10, 000 litre synthetic tank available on the market costs more than Nu.35, 000.
Irrigation water shortage results in fallow lands. It is reported that 6,400 acres (2,600 ha) of irrigable land was left fallow in 2016 and 26 % of the total households surveyed were affected by irrigation water shortages (DoA, 2016). By reducing fallow land and increasing crop production, this technology could be a stepping stone towards food self-sufficiency – as well as providing water for consumption by people and livestock.
Though a similar technology is said to have introduced in the country many years ago, the present form of the technology was introduced to Barshong gewog in Tsirang Dzongkhag by the 'Himalica' pilot project in 2014. However, the proposed technology has been modified and improved to suit to the topography and needs of farmers in Bhutan. The proposed pond design is a reverse truncated square pyramid shape unlike the cuboid shape ponds of ICIMOD's. The pond is designed in such way as to increase pond stability and ease of construction.
Concrete tanks require specific construction methods and faults can develop with ice freezing and expanding in cracks in tank walls during the winter (Slater, 2011). Plastic (silpaulin) sheet lined ponds are leak-proof and primarily depend on the longevity of the plastic sheet unlike concrete tanks. Concrete water tanks, (especially elevated tanks) are also prone to damage due seismic activities (Housner, 1963).
The low-cost plastic lined water harvesting pond adopted is cheap, environmentally friendly, and has positive social impacts. It reduces irrigation water constraints, addresses fallow land problems, and supplements water for domestic purposes. The technology is a tool for reducing poverty, expanding cultivated land and increasing food self-sufficiency resulting in a healthier and happier society.

LOCATION



Location: Pangserpo Chiwog, Drujeygang Gewog, Dagana Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.01645, 26.9723
- 90.01398, 26.97885

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2019

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Water harvesting pond (Thinley Penjor Dorji)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: legumes and pulses - beans, root/tuber crops - potatoes, vegetables - leafy vegetables (salads, cabbage, spinach, other), vegetables - other, vegetables - root vegetables (carrots, onions, beet, other), chilli, onion
- Tree and shrub cropping: citrus

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [x] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

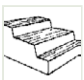
soil erosion by water - Wt: loss of topsoil/ surface erosion

water degradation - Hs: change in quantity of surface water

SLM group

- water harvesting
- irrigation management (incl. water supply, drainage)

SLM measures



structural measures - S5: Dams, pans, ponds, S7: Water harvesting/ supply/ irrigation equipment

TECHNICAL DRAWING

Technical specifications

Site selection for pond construction:
Choose a site for the pond at the top of the farm for easy flow/use of water to the agricultural fields. Select the site only at the stable soils to avoid collapse, and bursting of the pond. Water sources for the pond may be perennial water sources, rainwater gutter systems, water from tap stand, and waste water from farm house or a combination of the different sources.
Materials required: The materials required for making the pond are:
1.Plastic sheet of desired length and breadth
a.250-300 GSM (gram per square meter)]
b.UV stabilized
2.Measuring tape (30m)
3.Shovel, spade, and crowbar
4.Mosquito net or similar ones
5.HDPE pipes, gates valves
6.Fencing materials (bamboo poles, wooden poles, barbed wire, nails, wire mesh, binding wire)
Procedure to dig the pond:
1.Clear the vegetation and level the ground to construct the harvesting pond.
2.Measure the base length (l), and the base breadth (b) on the leveled ground. These length and breadth will be the length and breadth of the pond floor. Dig out the soil till 1.2 m height (h) to construct a cuboidal pond.
3.From the top edges of the cuboidal pond, measure distance 'g' in all four sides. Make slanting cuts from the top to the base on all four sides. Scrap off soils on all sides to obtain slope of 700. The gradient is made for slope stabilization and convenience to lay out plastic sheet.
4.Make the cut surfaces including the floor smooth by using mud and cow dung paste or mud paste in order to avoid damages to the plastic sheet while laying out and when filled with water. The pit ready to lay out plastic sheets should have the dimensions.
5.Carefully lay out the plastic sheet over the pit. Keep an anchor length (overlap) of 0.5m on all sides of the pit. Fix wooden or bamboo pegs or iron rod through the eyelets of the plastic sheet and or cover the overlapping plastic edges by at least 10cm of mud or soil to strongly anchor the plastic sheet.

Figure 1: Plastic lined water harvesting pond

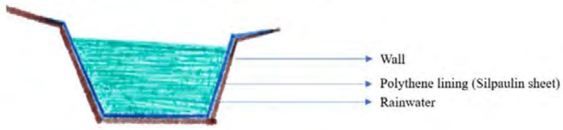


Figure 2 : Cross section Plastic lined water harvesting pond

Author: Ongpo Lepcha

6.Construct a drain with 30cm width and 30cm depth around the edges of the plastic sheet which was covered with soil or mud. The drainage should slope towards a suitable drain out area.
7.Fence the pond using wire mesh/bamboo/wooden poles/timber to prevent mishaps or accidents. Fill the pond with water only after fencing. Galvanized wire mesh is preferable.
Using water:
Water from the pond can be used in the following ways:
Directly siphoning off with a pipe
Pumping up with a small motor pump
Taking out with suitable containers
Inserting a drain out pipe at one of the base corners.
The insertion of the drain out pipe should be done during the construction of the pond.

Note: The stone wall may be required in specific situations if built in a slope like this one but not generally needed. Technical drawing of the water harvesting pond without the cement structure is available at http://rcbajo.gov.bt/leaflet/ also shared under section 7 of this document.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **water harvesting pond** volume, length: **41.6 cubic metre**)
- Currency used for cost calculation: **Ngultrum (Nu.)**
- Exchange rate (to USD): 1 USD = 80.0 Ngultrum (Nu.)
- Average wage cost of hired labour per day: Ngultrum 350

Most important factors affecting the costs

The most important factors that affect the cost are the construction materials and labour. In this particular situation, cement wall is also one of the major factors affecting the cost although it is not usually required.

Establishment activities

1. Surveying and site selection (Timing/ frequency: Anytime)
2. Procuring materials (Timing/ frequency: Anytime after surveying)
3. Construction of pond (Timing/ frequency: Dry season)
4. Fencing (Timing/ frequency: After completion of water harvesting pond)
5. Monitor (Timing/ frequency: Checking water level, infestation of mosquitoes and checking safety measures like fencing and leakages)

Establishment inputs and costs (per water harvesting pond)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Construction of pond	Person-days	8.0	500.0	4000.0	100.0
Construction material					
HDPE pipe	Metre	100.0	40.0	4000.0	100.0
Wire mesh	Pieces	2.0	3500.0	7000.0	
Silpaulin plastic sheet	Pieces	1.0	7500.0	7500.0	
Wooden post	Pieces	14.0	60.0	840.0	100.0
Total costs for establishment of the Technology				**23'340.0**	
Total costs for establishment of the Technology in USD				*291.75*	

Maintenance activities
1. Construction of concrete wall (Timing/ frequency: Dry season)
2. Monitor (Timing/ frequency: Throughout the year)
3. Maintenance of fence (Timing/ frequency: Annually)

Maintenance inputs and costs (per water harvesting pond)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Reconstruction of pond	Person-days	15.0	500.0	7500.0	
Construction material					
Cement (50 kg per bag)	Bag	10.0	400.0	4000.0	
Total costs for maintenance of the Technology				**11'500.0**	
Total costs for maintenance of the Technology in USD				*143.75*	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☑ 1,501-2,000 mm
- ☑ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone
- ☐ humid
- ☑ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate
Average annual rainfall in mm: 2000.0
It has an annual rainfall range of 1200-2500 mm
Name of the meteorological station: National Centre of Hydrology and Meteorology
Falls under humid subtropical and dry subtropical zones from the six Agro-ecological zones of Bhutan.

Slope
- ☐ flat (0-2%)
- ☐ gentle (3-5%)
- ☐ moderate (6-10%)
- ☐ rolling (11-15%)
- ☑ hilly (16-30%)
- ☑ steep (31-60%)
- ☐ very steep (>60%)

Landforms
- ☐ plateau/plains
- ☐ ridges
- ☑ mountain slopes
- ☑ hill slopes
- ☐ footslopes
- ☐ valley floors

Altitude
- ☐ 0-100 m a.s.l.
- ☐ 101-500 m a.s.l.
- ☑ 501-1,000 m a.s.l.
- ☑ 1,001-1,500 m a.s.l.
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- ☐ 3,001-4,000 m a.s.l.
- ☐ > 4,000 m a.s.l.

Technology is applied in
- ☑ convex situations
- ☐ concave situations
- ☐ not relevant

Soil depth
- ☐ very shallow (0-20 cm)
- ☐ shallow (21-50 cm)
- ☑ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☐ very deep (> 120 cm)

Soil texture (topsoil)
- ☐ coarse/ light (sandy)
- ☑ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- ☐ coarse/ light (sandy)
- ☑ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Topsoil organic matter content
- ☑ high (>3%)
- ☐ medium (1-3%)
- ☐ low (<1%)

Groundwater table
- ☐ on surface
- ☐ < 5 m
- ☐ 5-50 m
- ☐ > 50 m

Availability of surface water
- ☐ excess
- ☑ good
- ☐ medium
- ☐ poor/ none

Water quality (untreated)
- ☐ good drinking water
- ☐ poor drinking water (treatment required)
- ☑ for agricultural use only (irrigation)
- ☐ unusable

Water quality refers to: surface water

Is salinity a problem?
- ☐ Yes
- ☑ No

Occurrence of flooding
- ☐ Yes
- ☑ No

Species diversity
- ☐ high
- ☑ medium
- ☐ low

Habitat diversity
- ☐ high
- ☑ medium
- ☐ low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production	decreased							✓	increased	The land users mentioned that there has been an increase in production due to the availability of irrigation water during the dry season.
crop quality	decreased							✓	increased	Improved irrigation water leads to better quality of crops. For example, the leafy vegetables will be flaccid with a reduced total leaf area in the absence of irrigation.
risk of production failure	increased						✓		decreased	The availability of water during the critical periods of crop development in dry seasons reduces the risk of production failure.
water availability for livestock	decreased							✓	increased	The harvested and stored water from the tank is used to feed the livestock. It is also used to maintain the sanitation of the cattle shed.
irrigation water availability	decreased							✓	increased	The spring water dries in the winter. Therefore, the stored water in the water harvesting tank is available during dry seasons for irrigation.
demand for irrigation water	increased							✓	decreased	Trapping the rainwater prevents the utilization of scarce spring water. Therefore, reducing the demand for irrigation from the spring water source.
farm income	decreased						✓		increased	Irrigation plays a significant role in crop cultivation. Therefore, with adequate irrigation water crop production and productivity increase leading to increased farm income.

Socio-cultural impacts

food security/ self-sufficiency

reduced | improved

With sustainable sources of irrigation, land users produce enough food for self-consumption increasing food security. Further, the land users sell the produce and generate income with which they can purchase nutritious foods that are not available on the farm.

health situation

worsened | improved

Water is important to keep the surroundings clean. Therefore, the technology improves the health of the farm household and livestock.

conflict mitigation

worsened | improved

Using drinking water for irrigation leads to social conflict. However, the issue is resolved with the low-cost plastic-lined water harvesting technology.

Ecological impacts

water quantity

decreased | increased

The amount of water available for farm activities is increased as the technology traps overflow and rainwater preventing water wastage.

harvesting/ collection of water (runoff, dew, snow, etc)

reduced | improved

The rainwater and overflow water are harvested efficiently preventing runoff and surface erosion.

pest/ disease control

decreased | increased

Water harvesting pond acts as a suitable habitat for mosquitoes therefore increasing the risk of malaria.

drought impacts

increased | decreased

The impact of drought on agricultural activity is significantly reduced as the tank increases water availability.

Off-site impacts

water availability (groundwater, springs)

decreased | increased

Reduced spring water requirement in the field is diverted to water availability for other farming communities and wildlife.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative | very positive

Long-term returns — very negative | very positive

Benefits compared with maintenance costs

Short-term returns — very negative | very positive

Long-term returns — very negative | very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all | very well

annual rainfall decrease — not well at all | very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [x] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [x] Yes
- [ ] No

To which changing conditions?

- [x] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

The location of the water harvesting technology on slopes presents a risk of potential landslides caused due to climate change effects such as heavy rainfall. Therefore, the structure of the technology was modified to address this issue by providing support using the cemented wall. The modification is suitable for the steep slopes and is not required on the plain areas.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Increased crop production. The technology enables land users to cultivate crops during dry seasons.
- Increased water availability. The water harvesting pond provides adequate water for livestock rearing, household use and agricultural purposes.

Strengths: compiler's or other key resource person's view

- It is cost-effective compared to a cemented tank.
- The water harvesting tank constructed using high-quality plastic is durable providing economical benefits.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Risk of accidents leading to the drowning of small children and domestic animals such as dogs. Constructing a fence around the pond and creating awareness.
- The technology acts as a habitat for mosquitoes leading to increased malaria infection in the household. Regular cleaning and removal of sediments, vegetation, algal and plankton growth (serves as a food source for mosquitoes).

REFERENCES

Compiler
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Editors
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Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 6, 2023

Last update: May 30, 2024

Resource persons

Sangay - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/technologies/view/technologies_6821/

Linked SLM data

Approaches: Climate-Smart Village Approach https://qcat.wocat.net/en/wocat/approaches/view/approaches_6852/

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online

- Low cost plastic lined water harvesting pond: http://rcbajo.gov.bt/leaflet/

Adoption of technology in early chili production (Dhan Gallay)

Plastic mulching for cash crops (Bhutan)

Nyuel Thok Nang Chhu Sho Thing Ni (དངུལ་ཐོག་ནང་ཆུ་ཤོག་ཤིང་ནི།)

DESCRIPTION

Plastic mulching comprises thin plastic sheets laid out on raised soil surfaces around plants to help conserve soil moisture, prevent water and wind erosion, control weeds, and regulate soil temperature. It is used in agriculture to increase crop yields. However, there are environmental concerns about soil contamination and waste disposal.

Plastic mulching is a widely used agricultural practice in Bhutan, primarily employed in the cultivation of cash crops. Farmers have adopted plastic mulching to enhance crop production and address specific agricultural challenges. It allows farmers to optimize water usage by reducing evaporation and maintaining soil moisture levels, which is crucial in regions where water resources are limited. It also helps suppress weed growth, minimizing competition for nutrients and ensuring healthier crop growth. Additionally, the regulation of soil temperature through plastic mulching can extend the growing season and improve crop quality and yields. These benefits are particularly valuable in Bhutan's mountainous terrain and varied climatic conditions.
However, the application of plastic mulching can have both direct and indirect impacts on the natural environment. Improper disposal or management of plastic mulch can lead to environmental pollution, including soil contamination and plastic waste accumulation. Therefore, sustainable practices and appropriate waste management techniques are crucial to minimize the potential negative effects on the natural environment.
Plastic mulching serves several purposes and functions in agricultural practices. One of its primary functions is moisture conservation, as it helps prevent water evaporation from the soil surface by acting as a barrier. Additionally, plastic mulch controls weeds by blocking sunlight and inhibiting weed seed germination, reducing competition for nutrients. Another important function is soil temperature regulation, as plastic mulching traps heat from the sun, raising soil temperatures in cooler climates and promoting faster plant growth. Overall, plastic mulch contributes to enhanced crop performance.
Furthermore, it helps prevent soil erosion by protecting the soil surface from wind and water erosion, thus maintaining soil structure and fertility, and creating a barrier between plants and the soil, reducing the risk of soil-borne pests and diseases affecting the crops. It can also deter certain pests by disrupting their habitat and limiting access to plants.
Plastic mulching involves the use of thin sheets or films made of polyethylene or similar materials, which come in various colours and thicknesses. Manual tools are utilized to lay the sheets evenly over the prepared soil. Before laying the plastic mulch, the soil is typically ploughed, levelled, raised, and cleared of debris to create a smooth surface. To prevent displacement by wind or other factors, the plastic mulch needs to be securely anchored to the ground. Plastic mulching can be combined with drip irrigation systems to provide water and nutrients directly to the plant roots.
Some specific advantages pointed out by the land user include the opportunity to achieve higher returns on agricultural investments. It reduces the need for manual weeding or herbicide application, saving time, labour, and resources. Additionally, it reduces the frequency of irrigation. It also extends the growing season expanding options and potential profits. There are many advantages of mulching but there are some serious disadvantages of the technology. Plastic mulching poses environmental concerns related to soil contamination and waste accumulation. Plastic mulches are a significant source of microplastic pollution in agricultural soils and these microplastics negatively affect soil health. The disposal of plastic mulches is a challenge as recycling options are limited resulting in waste accumulation on farms. These accumulated wastes are eventually burned and release greenhouse gases, contributing to climate change and global warming. Additionally, the residues left behind after burning plastic mulches can persist in the soil for extended periods thereby contaminating the soil. Also, the cost of purchasing plastic mulch can prove to be too high for farmers if the land area is huge. Though mulching helps increase crop yields, it has negative effects on the natural environment - thus the use of mulching necessitates careful consideration.

LOCATION

Location: Sergithang, Tsirang, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.1267, 27.10645

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2018

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions
- [x] It was introduced by the gewog Agriculture Extension Officer and through exposure to social media.

Adoption of mulching technology by the land user in Sergithang (Dhan Gallay)

Plastic mulching used in early chilli production (Dhan Gallay)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: cereals - maize, cereals - rice (wetland), root/tuber crops - potatoes, vegetables - leafy vegetables (salads, cabbage, spinach, other), vegetables - melon, pumpkin, squash or gourd, vegetables - root vegetables (carrots, onions, beet, other)
- Tree and shrub cropping: avocado, fruits, other, mango, mangosteen, guava

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Forest/ woodlands

- (Semi-)natural forests/ woodlands

Tree types (mixed deciduous/ evergreen): n.a.
Products and services: Fuelwood

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

soil erosion by wind - Et: loss of topsoil

biological degradation - Bp: increase of pests/ diseases, loss of predators

water degradation - Ha: aridification, Hs: change in quantity of surface water

SLM group

- Weed management

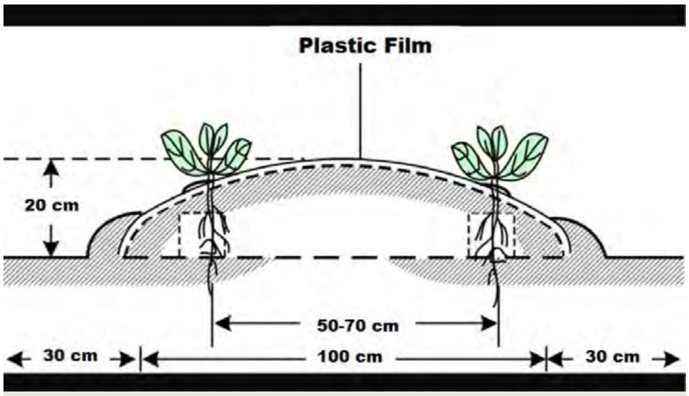
SLM measures

other measures - Plastic mulching may fall under structural measures.

TECHNICAL DRAWING

Technical specifications

This diagram shows a cross-section of a raised bed using plastic mulching. The plants grow through the punctured holes in the plastic. The length of the bed varies from farm to farm and is 1 m wide and spaced 30 cm apart (bed-bed spacing) for easy access/movement. The bed is usually raised to 20 cm in height. The planting distance shown in the diagram is for chilies, 50-70 cm. The distances will vary according to the crop/variety.



Author: Thinley Penjor Dorji

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 acre**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 82.1 Ngultrum
- Average wage cost of hired labour per day: Nu 400

Most important factors affecting the costs

Higher cost of plastic mulching and hiring a power tiller.

Establishment activities

1. Field preparation (tilling) (Timing/ frequency: Winter)
2. Field preparation (rotary tilling) (Timing/ frequency: Winter)
3. Manure application (Timing/ frequency: Winter)
4. Bed preparation (Timing/ frequency: Winter)
5. Laying of plastic mulch (Timing/ frequency: Winter)
6. Making holes in the plastic (Timing/ frequency: Winter)
7. Transplantation (Timing/ frequency: Winter)

Establishment inputs and costs (per 1 acre)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
Field preparation (tilling)	Person/day	5.0	400.0	2000.0	100.0
Manure application and rotary tilling	Person/day	8.0	400.0	3200.0	100.0
Bed preparation, laying of plastic mulch and making holes	Person/day	12.0	400.0	4800.0	100.0
Transplantation	Person/day	8.0	400.0	3200.0	100.0
Equipment					
Power tiller (tilling)	Per day	1.0	2500.0	2500.0	100.0
Power tiller (rotary tilling)	Per day	1.0	2500.0	2500.0	100.0
Plant material					
Seeds	Packet	5.0	15.0	75.0	100.0
Construction material					
Plastic mulch	Rolls	4.0	2800.0	11200.0	100.0
Other					
Food and Refreshment	per person	33.0	350.0	11550.0	100.0
Total costs for establishment of the Technology				**41'025.0**	
Total costs for establishment of the Technology in USD				*499.7*	

Maintenance activities

n.a.

Total maintenance costs (estimation)

29823.0

NATURAL ENVIRONMENT

Average annual rainfall
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Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Falls under Humid Sub-tropical Zone with an annual rainfall of 1200-2500 mm
Name of the meteorological station: The rain estimate has been derived based on the agro-ecological zone (AEZ) the area falls under. Bhutan is divided into AEZs (source: https://www.fao.org/3/ad103e/AD103E02.htm).
Bhutan has six AEZs. The wet sub-tropical zone is from 150 to 600 m, followed by the humid sub-tropical zone from 600 to 1,200 m. The dry sub-tropical zone starts at 1,200 m and extends to 1,800 m, followed by the warm temperate zone, which reaches 2,600 m. The cool temperate zone lies between 2,600 and 3,600 m and, finally, the alpine zone between 3,600 m and 4,600 m.

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
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- [x] No

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- [ ] Yes
- [x] No

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- [x] Sedentary
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- [ ] cooperative
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- [x] men

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- [ ] company
- [ ] communal/ village
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- [ ] individual, not titled
- [x] individual, titled

Land use rights

- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights

- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor	✓			good
markets	poor			✓	good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

decreased							✓	increased	The production of winter chili has increased to 700-800 kg following the use of mulching.

crop quality

decreased			✓					increased	Crop quality has increased due to reduced competition from weeds.

risk of production failure

increased						✓		decreased	The risk has decreased as mulching helps conserve moisture, prevent water and wind erosion, control weeds, and regulate soil temperature.

land management

hindered					✓			simplified	Mulching reduces soil erosion.

farm income

decreased							✓	increased	The farm income from chilli has increased resulting from mulching

workload

increased						✓		decreased	Workload has decreased due to a reduction in weeding requirements.

Socio-cultural impacts

food security/ self-sufficiency

reduced							✓	improved	The land user produces enough for self-consumption as well as for commercial purposes.

Ecological impacts

soil moisture

decreased							✓	increased	Soil moisture is retained and the need for frequent irrigation is reduced.

soil loss

increased							✓	decreased	Soil erosion has reduced due to mulching.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative					✓			very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative			✓					very positive

In the long run, the benefits will be negative, as the land user has to invest in additional costly plastic mulch. Furthermore, the existing mulching plastic is not durable.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all				✓		very well	
seasonal temperature increase	not well at all				✓		very well	Season: winter
annual rainfall increase	not well at all				✓		very well	
seasonal rainfall increase	not well at all				✓		very well	Season: summer

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- 11-50%
- ✓ > 50%

Number of households and/ or area covered

All the land users of Sergithang have implemented the technology.

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- 0-10%
- 11-50%
- 51-90%
- ✓ 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Yes
- ✓ No

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Plastic mulching technology increases crop production.
- The workload is reduced as there is reduction in the need of weeding.
- It isn't a very complex technology and can be adopted easily.
- Controls weeds.

Strengths: compiler's or other key resource person's view

- It aids off-season (winter) crop production.
- Conserves moisture.
- Reduces erosion (wind and water).

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Plastic mulching poses environmental concerns related to soil contamination and waste accumulation. Disposal of plastic mulch is a challenge as recycling options are limited resulting in waste accumulation on farms. But one thing that the land users can do is switch to biodegradable plastic mulches or even better organic mulches (straw and Artemisia myriantha). In Bhutan straw and Artemisia myriantha mulches are very common.
- Plastic mulching can prove to be very expensive if the land area is huge. Opt for other more environmentally friendly alternatives such as straw and Artemisia myriantha mulching.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
Tshering Yangzom

Editors
Kuenzang Nima

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Resource persons
Pratap Singh Rai - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6864/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Vegetable cultivation Theme 3 Mulching: http://rcbajo.gov.bt/wp-content/uploads/2020/05/Veg-Theme-03-Mulching-printing.pdf

Dragon fruit as an example of a high value crop in a greenhouse (Chimi Yangki)

Protected Agriculture for High Value Crops (Bhutan)

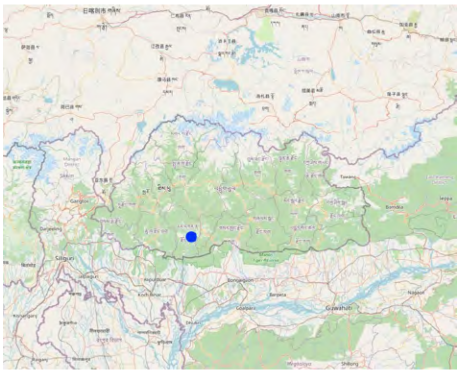
Ngotshel Shelkhim Nang Nyuel Thog Tsug Ni (སྔོ་ཚལ་ཤེལ་ཁྱིམ་ནང་དངུལ་ཐོག་བཙུགས་ནི།)

DESCRIPTION

Protected agriculture (controlled environment agriculture) is the use of technology to modify the growing environment for crops to extend the growing period and increase yields. It can include greenhouses, shade nets or polytunnels. This technology is moderately expensive therefore it is used only for the cultivation of high-value crops and raising seedlings in winter.

Protected agriculture, also known as controlled environment agriculture, refers to the practice of growing crops within an enclosed structure that provides controlled environmental conditions. There are various structures that can be employed, such as greenhouses, shade nets, polytunnels and glasshouses. This documentation focuses on greenhouses. These are commonly used for cultivating high-value crops that yield a higher economic return per unit area compared to traditional field crops. Technical specification for a 20 m x 5 m greenhouse set consists of a galvanized tubular frame, two doors, UV stabilized 120 GSM cross-laminated clear plastic sheet, channels and a nylon belt for holding the plastic sheet. Construction activities include clearing, levelling the ground and ensuring drainage. Installation of water lines, electrical connections, heating systems and ventilation systems is required.
Greenhouses are typically designed with a framework made of materials like metal, wood, or PVC. The structure must be sturdy enough to support covering materials and withstand environmental loads such as wind and snow. Coverings are transparent or translucent materials that allow sunlight to enter the structure. Common options include glass, polycarbonate panels, or plastic film. The choice of covering material depends on factors such as light transmission, insulation properties, durability, and cost. Greenhouses require adequate ventilation to control temperature, humidity, and air circulation. Vents, louvres, or roll-up side walls can be used to regulate airflow and prevent heat buildup. Exhaust fans or natural ventilation methods help remove excess heat, humidity, and carbon dioxide from the structure. Efficient irrigation systems, such as drip irrigation, and micro-sprinklers, are used to deliver water directly to plants' root zones. Raised beds of 1.2 m width and 30 cm height and planting distance of 60 cm are applied for (for example) watermelon.
Greenhouses allow for the cultivation of plants throughout the year, regardless of the external weather. By maintaining a stable and favourable climate inside, growers can start plants earlier in the spring, extend the growing season into the fall, or even grow plants year-round in certain regions. It shields plants from adverse weather conditions such as frost, heavy rain, wind, or hail, which can damage or destroy crops. Greenhouses provide a physical barrier that safeguards plants from external threats, minimizing the risk of disease, pests, and other environmental stresses.
Greenhouses provide a range of benefits and impacts, including increased food production by extending the growing season and improving food security. They produce higher crop yields by providing optimal growing conditions and conserving water through efficient irrigation systems. Greenhouses also contributes to reduced pesticide use, energy efficiency, local and seasonal produce, employment opportunities, research and innovation, and serves as an attractive space for recreation and education. Overall, greenhouses offer sustainable and efficient solutions for agriculture while enhancing environmental stewardship and community well-being.
Protected agriculture through the use of greenhouses offers land users the ability to control environmental factors, leading to optimal conditions for plant growth and higher crop yields compared to open-field cultivation. It protects from adverse weather conditions, reducing crop losses due to frost, rain, or wind. Additionally, the controlled environment minimizes the risk of pests and diseases, resulting in fewer losses and reduced reliance on pesticides. Overall, greenhouses enhance productivity, profitability, and sustainability for land users. On the other hand, setting up a greenhouse requires a significant initial investment, including the construction or purchase of the structure, equipment, and environmental control systems. Operating a greenhouse involves ongoing costs for utilities, maintenance, and replacement of equipment, which can impact profitability. The cost can be reduced by establishing a low cost greenhouse with locally available materials such as bamboo.

LOCATION



Location: Tsendagang Gewog, Dagana Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.96147, 26.94935

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2020

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions
- [x] Through other farmers

Watermelons grown inside the greenhouse (Chimi Yangki)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact
- [x] To improve livelihood

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: legumes and pulses - beans, vegetables - melon, pumpkin, squash or gourd, vegetables - other, Chilli
- Perennial (non-woody) cropping: banana/plantain/abaca, flower crops - perennial
- Tree and shrub cropping: tree nuts (brazil nuts, pistachio, walnuts, almonds, etc.)

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply

- [ ] rainfed
- [ ] mixed rainfed-irrigated
- [x] full irrigation

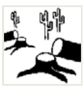
Purpose related to land degradation

- [x] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

soil erosion by wind - Et: loss of topsoil



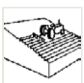
biological degradation - Bc: reduction of vegetation cover, Bp: increase of pests/ diseases, loss of predators

water degradation - Hs: change in quantity of surface water

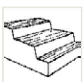
SLM group

- rotational systems (crop rotation, fallows, shifting cultivation)
- improved plant varieties/ animal breeds
- irrigation management (incl. water supply, drainage)

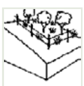
SLM measures



agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility



structural measures - S1: Terraces, S11: Others

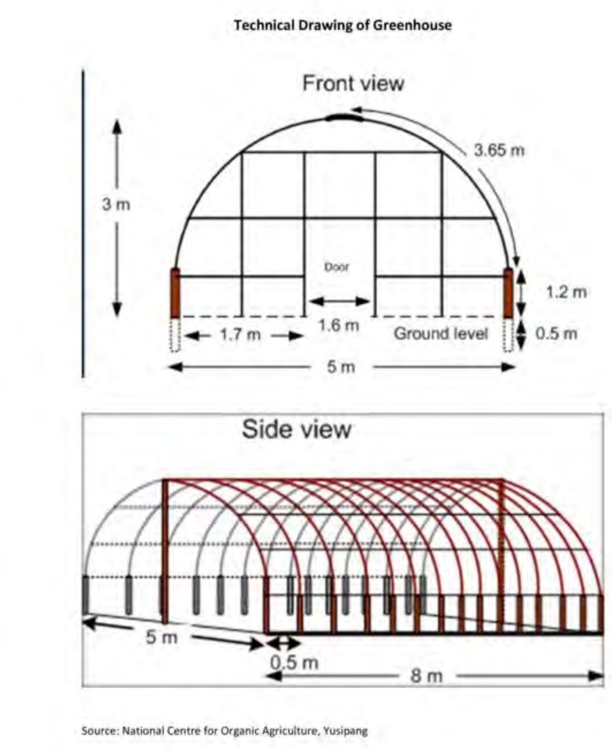


management measures - M1: Change of land use type

TECHNICAL DRAWING

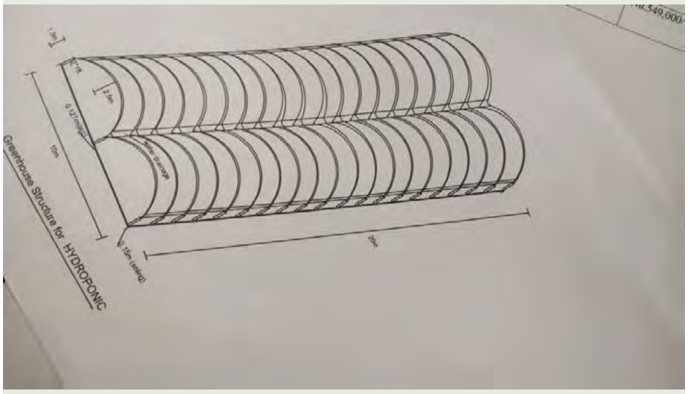
Technical specifications

The technical drawing provided is for the low-cost greenhouse (Made up of bamboo). Generally, the length of a commercial greenhouse is 10 or 20 m and the width of 5 m. The greenhouse can be modified based on the crop to be cultivated. Additional facilities such as drip irrigation set, blower, fan, cooling pad and exhaust fan, temperature sensors are added modify the environment.



Author: National Centre for Organic Agriculture, Yusipang

Technical details for setting up 5m by 20m double poly house protected structure



Author: ARDC Bajo

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **3.75 acres**)
- Currency used for cost calculation: **Ngultrum (Nu.)**
- Exchange rate (to USD): 1 USD = 79.0 Ngultrum (Nu.)
- Average wage cost of hired labour per day: 500

Most important factors affecting the costs

Infrastructure and machinery.

Establishment activities

1. Clearing of vegetations (Timing/ frequency: Winter)
2. Agriculture land development (Timing/ frequency: Winter)
3. Field preparation (Timing/ frequency: Winter)
4. Installation of greenhouse and other structure (Timing/ frequency: Winter)
5. Sowing and plantation of crops and fruits (especially late winter crops) (Timing/ frequency: Winter)

Establishment inputs and costs (per 3.75 acres)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Farm establishment	Number	30.0	500.0	15000.0	100.0
Installation of structure and plantation	Number	15.0	500.0	7500.0	100.0
Equipment					
Excavator (farm establishment)	Number of days	12.0	24000.0	288000.0	100.0
Power tiller	Per hour	16.0	250.0	4000.0	50.0
Plant material					
Dragon fruit	Per sapling	300.0	50.0	15000.0	
Watermelon seed	Per packet	1.0	2700.0	2700.0	
Construction material					
Greenhouse	Number	6.0	80000.0	480000.0	20.0
Dragon fruit staking	Number	39.0	700.0	27300.0	100.0
Total costs for establishment of the Technology				**839'500.0**	
Total costs for establishment of the Technology in USD				*10'626.58*	

Maintenance activities
n.a.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [x] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
The area falls under a humid subtropical and warm subtropical zone among the six agro-ecological zones of Bhutan.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [x] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [x] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

decreased ☐☐☐☐☐☐☑ increased

Compared to open fields, protected agriculture has shown an increase in production. This could be due to the extended growing period, reduced disease incidence and ease of performing cultural activities.

crop quality

decreased ☐☐☐☐☐☐☑ increased

The crop quality is improved in the protected agriculture as the optimum environmental conditions are provided.

risk of production failure

increased ☐☐☐☐☐☐☑ decreased

The risk of production failure is reduced as the crop is not exposed to abiotic stress.

land management

hindered ☐☐☐☐☑☐☐ simplified

Quantity before SLM: 10%
Quantity after SLM: 20%
Land management in the protected cultivation is easier compared to open field.

expenses on agricultural inputs

increased ☐☐☑☐☐☐☐ decreased

Quantity before SLM: 0%
Quantity after SLM: 10%
Initial investment for the establishment of the protected structure is high. However, the expenses on agricultural inputs were reduced after establishment. Further, the initial negative expenses are compensated by the return from selling the farm produce.

farm income

decreased ☐☐☐☐☐☑☐ increased

Quantity before SLM: 20%
Quantity after SLM: 70%
There is a significant increase in the farm income after the establishment of the protected structure as the quantity and the quality of the high-value crops increased fetching higher prices. This has led to an increase in farm income.

workload

increased decreased

The workload has reduced after the establishment of the greenhouse. For example, the greenhouse is equipped with a drip irrigation system in which the land users can regulate the irrigation frequency and need not water the plants manually.

Socio-cultural impacts

food security/ self-sufficiency

reduced improved

Quantity before SLM: 20%
Quantity after SLM: 80%
The increase in agricultural production has made the land user self-sufficient in certain fruits and vegetables. The technology has also contributed to the food security of the farm household as the income generated from the farm can be used to purchase nutritious foods that are not available on the farm.

Ecological impacts

Off-site impacts

water availability (groundwater, springs)

decreased increased

Unlike flooding irrigation in open fields which requires a large amount of water, a protected structure optimizes water usage. It is achieved by drip irrigation and manual irrigation leading to minimum water wastage. This increases water availability on other parts of the farm or for the community.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well	
annual rainfall increase	not well at all	very well	
seasonal rainfall increase	not well at all	very well	Season: summer

Climate-related extremes (disasters)

epidemic diseases	not well at all	very well
insect/ worm infestation	not well at all	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [x] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Improved market access. Protected structures enable off-season cultivation of certain high-value crops such as chilli and beans leading to higher market access and increased income.
- Reduced pest and disease incidence. This could be due to optimum growing conditions provided to the plant and ease of pest and disease management. For example, the land user can remove a part of the plant that is infested or remove the crop that is infested in the particular greenhouse and still obtain the yield from other greenhouses. This is not possible in the open field condition.
- Improved quality of the crops. The environmental conditions inside the greenhouse can be maintained at the optimum level required by plants leading to better quality produce.

Strengths: compiler's or other key resource person's view

- Reduced workload. After the establishment of the protected structure, there is less workforce required for the cultivation.
- Increased production. The land users can extend the growing period in the enclosed structure which leads to increased cropping season per year maximizing agricultural production.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The establishment of the technology has high initial investment. Getting loans from financial institutions and sourcing fund from the government.
- The farm is challenged with labour shortage. Increasing the daily wage of labour and providing necessary facilities such as clean drinking water, washing and toilet facilities and providing incentives to retain them.
- Difficult to manage the farm. Improving record keeping, developing farm calendar and scheduling activities.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
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Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Abi Narayan - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6846/

Linked SLM data
Approaches: Enhancing Agricultural Production Through Fallow Land Reversion
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6890/

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Institution
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Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- ARDC Wengkhar. (2017). Activity completion report for CARELP support to ARDC-Wengkhar.: https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.carlep.gov.bt/wp-content/uploads/2016/11/Activity-Completion-Report-2016_17_CARLEP-Support-to-ARDC-wengkhar_FINAL.pdf&ved=2ahUKEwi3wZSPj_CAAxUB3TgGHTh_A0cQFnoECBEQAQ&usg=AOvVaw3lsXjKzuaScR91V1MntyJZ

Links to relevant information which is available online
- Polyhouse Construction Basics in Bhutan (Dzongkha language): https://www.youtube.com/watch?app=desktop&v=i8izu3PmQRE

Climate Resilient Irrigation Scheme (sluice gate of the irrigation system) (Kuenzang Nima)

Climate Resilient Irrigation Scheme (Bhutan)

Nam Shi Thub Pai Zhing Chhu Yu Wa (གནམ་གཞིས་ཐུབ་པའི་ཞིང་ཆུ་གཡུར་བ།)

DESCRIPTION

A climate-resilient irrigation scheme is one that aims to successfully cope with and manage the impacts of climate change while preventing those impacts on the scheme from growing worse. The pipes are retrofitted with new and climate-resilient technology. Such a climate-proof irrigation system is designed to better withstand extreme weather conditions.

The climate-resilient irrigation scheme in Khomshar Chiwog under Bardho Gewog (Block), Zhemgang Dzongkhag (District), was funded by the Green Climate Fund (GCF), UNDP-Bhutan. The 3.9 km irrigation system was designed with a high-density polyethylene (HDPE) pipe system benefiting 150 households with a command area of 955 acres (approx. 386 ha). The total irrigation cost incurred was Nu. 18,055,180 (approx. USD 225,700) and was completed in 11 months (7 December 2020 - 7 November 2021). The irrigation scheme was officially handed over to the community on 27 August 2021, upon the formation of a water-user group (WUG).

The smart irrigation system consists of key components, viz. intake, sluice gate, silt-cum-inlet tank, flush-out valves, air release valve, water distribution points, and tail point. The intake collects and diverts the water from the source to the sluice gate. The land users were taught to maintain the intake by regularly clearing it from bushes and removing debris. The sluice gate controls the flow of the water into the tank based on the water requirement. The silt-cum-inlet tank holds the water to settle out sediments and debris before clean water flows through the pipe at a constant rate. Flush out valves clear the sediment and debris from the tank. The air release valve vents out the air trapped in the pipe and water distribution points. Water distribution points deliver water to the users, as required, up to the tail point where water is discharged.

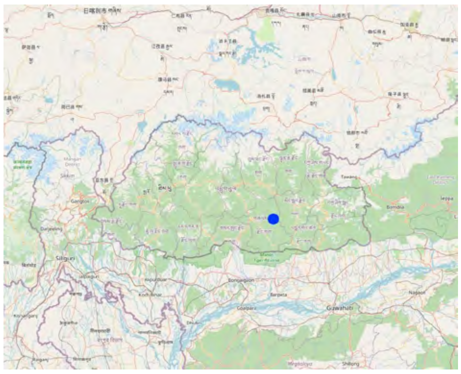
The irrigation scheme fulfils the need for a continuous water supply for both drinking and irrigation purposes. To ensure sustainability, a WUG headed by a chairman, a secretary, and a treasurer was instituted. The WUG ensures operations, maintenance, and harmonious distribution of water. The group is also responsible for the safety of the irrigation system.

The main reason for considering such irrigation scheme as being "climate resilient" is that unlike open earthen channels, this type of irrigation scheme results in zero loss of water through evaporation and leakage, as it is a closed channel. Furthermore, being closed, it is not prone to blockages caused by landslides triggered by rainfall. There is also complete end-to-end management, i.e., management at source including the watershed, and management at tail-end.

The irrigation scheme was constructed by a private company through a contract award: community members were not involved. The irrigation scheme was also accompanied by a land development programme (bench terracing) by a separate contractor, with the prospect of transitioning to irrigated paddy cultivation in the future after adequate soil stabilization. More than 90 acres (36 ha) of fallow lands were revived. This blended approach was applied to ensure the food self-security/sufficiency of the beneficiaries.

Though at a very initial stage, the construction and operation of the irrigation scheme have brought happiness to the beneficiaries. They expressed their hope and expectation of improved crop production, stable and reliable water availability, and major fallow land reversion.

LOCATION



Location: Khomshar Chiwog, Bardho Gewog, Zhemgang Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites

- 90.94878, 27.1353

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2021

Type of introduction

- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Climate Resilient Irrigation Scheme (sluice gate) (Kuenzang Nima)

High-density polyethylene (HDPE) pipe (Kuenzang Nima)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [x] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: cereals - maize, cereals - rice (wetland)
- Perennial (non-woody) cropping: banana/plantain/abaca, herbs, chili, capsicum
- Tree and shrub cropping: avocado

Number of growing seasons per year: 2
Is intercropping practiced? No
Is crop rotation practiced? No

Forest/ woodlands

- (Semi-)natural forests/ woodlands. Management: Selective felling, Non-wood forest use

Tree types (mixed deciduous/ evergreen): n.a.
Products and services: Timber, Fuelwood, Grazing/ browsing

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

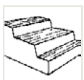
Degradation addressed

water degradation - Hs: change in quantity of surface water, Hp: decline of surface water quality

SLM group

- irrigation management (incl. water supply, drainage)

SLM measures



structural measures - S7: Water harvesting/ supply/ irrigation equipment

TECHNICAL DRAWING

Technical specifications

Source: https://www.bhutangcf.gov.bt/wp-content/uploads/2022/06/Khomshar-WUA_Training-Report.pdf

As-built plan of Climate Resilient Irrigation Scheme

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Irrigation line** volume, length: **Irrigation line: 3.9 km**)
- Currency used for cost calculation: **Nu.**
- Exchange rate (to USD): 1 USD = 80.0 Nu.
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs

n.a.

Establishment activities

n.a.

Total establishment costs (estimation)

18055180.0

Maintenance activities

1. Replacement of pipe (Timing/ frequency: One time (just after the completion))

Total maintenance costs (estimation)

48000.0

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [ ] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

Annual rainfall: 1200-1800 mm
The rain estimate has been derived based on the agro-ecological zone (AEZ) the area falls under. Bhutan is divided into six AEZs (source: https://www.fao.org/3/ad103e/AD103E02.htm).
Bhutan has six AEZs. The wet sub-tropical zone is from 150 to 600 m, followed by the humid sub-tropical zone from 600 to 1,200 m. The dry sub-tropical zone starts at 1,200 m and extends to 1,800 m, followed by the warm temperate zone, which reaches 2,600 m. The cool temperate zone lies between 2,600 and 3,600 m and, finally, the alpine zone between 3,600 m and 4,600 m.
Dry Sub-tropical Zone in Bhutan

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [x] rolling (11-15%)
- [x] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [x] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [x] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family land

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor	✓			good

IMPACTS

Socio-economic impacts

Crop production

crop production	decreased	increased	Quantity before SLM: 250-300 Drey from one acre paddy land Quantity after SLM: 600-700 Drey from one acre The old conventional irrigation channel used to suffer multiple breakdowns quite often. Due to this most of the paddy fields were left fallow (30%) because of insufficient irrigation water. Currently, all the wetlands (100%) are brought under cultivation. Hence, the production has been enhanced. Note: Drey is a traditional grain measuring container. One Drey is about 1.5 kg.
crop quality	decreased	increased	The paddy harvest appears to be of better quality when there is enough irrigation. Otherwise, the growths are hampered, resulting in higher vegetative growths only.
fodder production	decreased	increased	The higher hay production (by-product) has been beneficial for farmers to feed livestock.
animal production	decreased	increased	Safe and readily available water to feed the livestock, facilitated by the irrigation scheme has enhanced animal production. Earlier, the farmers used to depend on the far-flung streams/ponds.
land management	hindered	simplified	Better access to irrigation water has motivated farmers to adopt land development. Hence, about 90 acres of fallow lands in the community have been revived through new terrace constructions.
drinking water availability	decreased	increased	The irrigation water is being used for drinking purposes too. The drinking water quantity has been enhanced. Earlier, the drinking water source was not enough to meet the requirements due to higher households, especially in winter.
drinking water quality	decreased	increased	The drinking water tapped from this irrigation is clean and hygienic, unlike before.
water availability for livestock	decreased	increased	
water quality for livestock	decreased	increased	
irrigation water availability	decreased	increased	
irrigation water quality	decreased	increased	
demand for irrigation water	increased	decreased	Due to new terrace construction, the demand for irrigation water has increased.
expenses on agricultural inputs	increased	decreased	One acre of paddy cultivation used to take 4-5 days. Now, one acre takes 1 day. Mechanization is enhanced.
farm income	decreased	increased	Currently, the impact is at the initial stage (1 year). The income could quantified in the later years.

Socio-cultural impacts

cultural opportunities (eg spiritual, aesthetic, others)	reduced	improved	Irrigation and land development interventions have beautified the community (aesthetic). The external visitors are astonished.
SLM/ land degradation knowledge	reduced	improved	
conflict mitigation	worsened	improved	Community dispute over water demand and mid night water guarding during paddy cultivation due to water scarcity used to be rampant before.
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened	improved	

Ecological impacts

water quantity	decreased	✓ (increased)	increased
water quality	decreased	✓ (increased)	increased
soil moisture	decreased	✓ (increased)	increased
biomass/ above ground C	decreased	✓ (increased)	increased
flood impacts	increased	✓ (decreased)	decreased
landslides/ debris flows	increased	✓ (decreased)	decreased

The conventional irrigation channel used to result in water seepage and accumulation of groundwater, leading to flooding of underneath fields. Now, this pipe irrigation has been solved and flooding is not evident.

Due to improper irrigation source management before, the water outflow was used to wash away a huge portion of lands and roads below. Due to enhanced source protection, this issue is solved.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	✓ (very positive)	very positive
Long-term returns	very negative	✓ (very positive)	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓ (very positive)	very positive
Long-term returns	very negative	✓ (very positive)	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	✓ (very well)	very well
annual rainfall increase	not well at all	✓ (very well)	very well

Climate-related extremes (disasters)

local rainstorm	not well at all	✓ (very well)	very well
local thunderstorm	not well at all	✓ (very well)	very well
local windstorm	not well at all	✓ (very well)	very well
extreme winter conditions	not well at all	✓ (very well)	very well
landslide	not well at all	✓ (very well)	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 11-50%
- ☑ > 50%

Number of households and/ or area covered

150

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ☑ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- ☐ Yes
- ☑ No

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Enough irrigation and drinking water compared to earlier conventional system.
- Fallow land reversion is being enhanced.
- Cleanliness (social hygiene) due to better water availability.

Strengths: compiler's or other key resource person's view

- Fallow land reversion is being enhanced.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Risk of source destruction due to landslide. Shifting the current source tank to a different location.
- No proper filtration at the source. Currently, a locally fabricated filter is being used. Permanent filter is required.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- The road leading to source, constructed exclusively to monitor the irrigation line is not being maintained well. Timely road maintenance by the beneficiaries.
- The source tank premise needs proper fencing to avoid casualties. Fencing the irrigation source premises.

REFERENCES

Compiler
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Reviewer
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Resource persons
Sonam Dorji - land user
Tenzin Chedup - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6849/

Linked SLM data
n.a.

Documentation was faciliated by

Institution

- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online

- Formation and Training Report on Khomshar Water-User Group and the Bylaws for the Khomshar Irrigation Scheme in Bardo Gewog under Zhemgang Dzongkhag: https://www.bhutangcf.gov.bt/wp-content/uploads/2022/06/Khomshar-WUA_Training-Report.pdf

Earthworms used for vermicomposting (Karma Wangdi)

Vermicomposting (Bhutan)

Chong Boob Gi Lue Zhoni (ཀྱོང་འབུབ་ཀྱི་ལུད་བཟོ་ནི།)

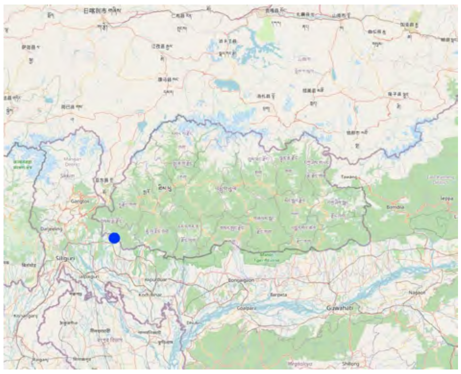
DESCRIPTION

Vermicomposting is the practice of composting organic waste products with the aid of various types of worms. These worms aid the decomposition of organic materials, including kitchen leftovers and yard trash, resulting in the production of compost that is abundant in nutrients.

Vermicomposting is where organic wastes are broken down by redworms (Eisenia fetida or Lumbricus rubellus) and other types of earthworms. The worms produce nutrient-rich castings, which are valuable natural fertilizers for plants and enhance soil health. Vermicomposting is an effective and environmentally acceptable approach to recycle organic waste and produces a valuable resource for farming and gardening (Grant, 2021).
The raw substrate is initially ground in the gizzard to create smaller particles, increasing the surface area during the vermicomposting process. Earthworm gut microorganisms and digestive enzymes continue to work on the material to create a fine granular product that is rich in healthy nutrients and microbiota (Sharma & Garg, 2017). Vermicomposting is popular in urban gardening and horticulture, where space and resource constraints are common.
It is a sustainable and effective method for managing organic waste because it combines a number of essential traits and components. Firstly, it involves the usage of particular types of earthworms, such Eisenia fetida (red wigglers), which are renowned for their capacity to ingest enormous quantities of organic material. Maintaining optimum moisture levels, typically between 60 and 80 percent, is necessary for efficient vermicomposting. Another crucial component is aeration, which encourages aerobic decomposition and reduces odour. Vermicompost bins or beds are made with sufficient drainage and ventilation systems to do this. The ideal temperature range is between 15 o to 30 o C (Adhikary, 2012).
Vermicomposting's goals and functions include waste reduction, improved soil fertility, soil restoration, sustainable agriculture, and easily accessible waste management. Vermiculture encourages eco-friendly gardening and supports sustainable agriculture methods by limiting the use of chemical fertilizers. The initial expense and time needed to set up a vermicomposting system are two significant drawbacks. Another difficulty is the requirement for constant monitoring and upkeep, including controlling moisture levels, ensuring adequate aeration, and controlling temperature conditions. Poor environmental care can result in bad smells or even the death of earthworms.

Samtse's first and only vermicomposting facility in Norbugang gewog is performing successfully. The project, which began on a couple's farm near Bhimtar in December 2013, employs earthworms to convert organic waste into high-quality compost. It is the end result of the decomposition of organic elements by earthworms. The dzongkhag's assistant agricultural officer (ADAO) spearheaded the idea of establishing the compost plant, with assistance from the national organic program. The main substrate used for vermicomposting is cow dung and banana stems. The mixture is spread out as a bed inside the compost house for the earthworms to feed. The worms break down the mixture to produce vermicompost. Initially, a kilogram of red earthworms (Eisenia foetida) were cultivated in a nursery. In a month, the nursery produced 10 kg, which was then employed in the project. According to Dibya Gurung, the worms needed 28 days to feed on the organic wastes in the existing compost house environment. Bhutanese farmers utilize vermicompost as a nutrient-rich organic fertilizer to enhance soil fertility and improve crop yields. This promote sustainable agriculture practices and reduce dependence on chemical fertilizers, aligning with Bhutan's goal of achieving food self-sufficiency.
There are currently 12 organic fertilizer producers in the Bhutan producing various types of compost, including vermi-compost, liquid fertilizer, bio-slurry compost, chicken manure, and EM solution. However, there is no record of a dedicated vermiculture enterprise in the nation, even though worms are required to make compost organic fertilizer, according to the National Soil Services Centre (NSSC), Department of Agriculture (DoA). For instance, the country generated 8130MT of organic fertilizers, according to the NSSC's annual report for 2021–2022 (Dorji, 2022).

LOCATION



Location: Norbugang, Samtse, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.02592, 26.93462

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: less than 10 years ago (recently)

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Vermicompost

Stocks of vermicompost ready to be sold (Tshering Zangmo)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ☑ improve production
- ☐ reduce, prevent, restore land degradation
- ☑ conserve ecosystem
- ☐ protect a watershed/ downstream areas – in combination with other Technologies
- ☑ preserve/ improve biodiversity
- ☐ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☑ create beneficial economic impact
- ☐ create beneficial social impact

Land use

CroplandIs intercropping practiced? Yes
Is crop rotation practiced? No

Water supply

- ☐ rainfed
- ☐ mixed rainfed-irrigated
- ☑ full irrigation

Purpose related to land degradation

- ☐ prevent land degradation
- ☑ reduce land degradation
- ☑ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

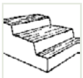
Degradation addressed

other - Specify: Improve soil fertility management

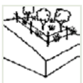
SLM group

- integrated soil fertility management
- waste management/ waste water management
- home gardens

SLM measures



structural measures - S8: Sanitation/ waste water structures

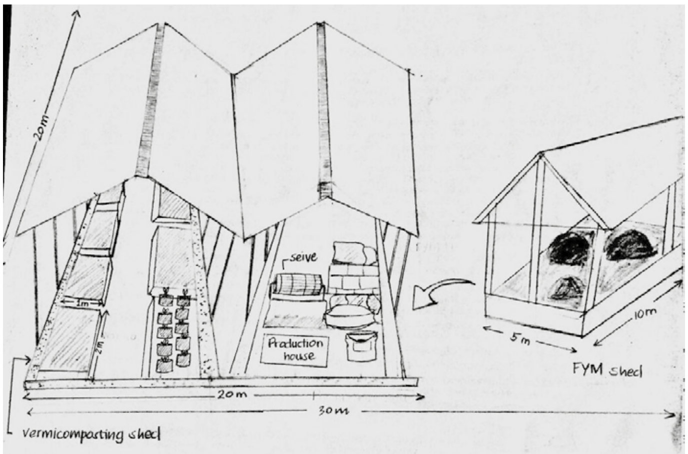


management measures - M6: Waste management (recycling, re-use or reduce)

TECHNICAL DRAWING

Technical specifications

The technology is located in five acres land



Author: Niki Rai

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology unit
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 250.0 Ngultrum
- Average wage cost of hired labour per day: 250

Most important factors affecting the costs
Financial and availability of earthworms

Establishment activities
1. Site selection (Timing/ frequency: winter)
2. Collection of raw materials (Timing/ frequency: winter)
3. construction of vermicomposting shed (Timing/ frequency: winter)
4. construction of bricks lined beds for rearing earth worms (Timing/ frequency: winter)
5. Construction of FYM shed (Timing/ frequency: winter)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
labor	per head	7.0	250.0	1750.0	50.0
Plant material					
Cow dung	Kg	5000.0	2.0	10000.0	
Construction material					
cement	bag	145.0	290.0	42050.0	
Bricks	piece	4000.0	7.0	28000.0	
Bamboo mat	roll	10.0	3500.0	35000.0	
Green net	roll	6.0	2200.0	13200.0	
Sand	truck	1.0	3500.0	3500.0	
stone	truck	2.0	3500.0	7000.0	
CGI sheet	piece	25.0	1190.0	29750.0	
Total costs for establishment of the Technology				**170'250.0**	
Total costs for establishment of the Technology in USD				*681.0*	

Maintenance activities
1. construction of production house (Timing/ frequency: winter)
2. Replacement of green net (Timing/ frequency: winter)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
labor	per head	4.0	500.0	2000.0	
Construction material					
cement	bags	8.0	290.0	2320.0	
sand	bolero	1.0	3000.0	3000.0	
pebbles	bolero	1.0	3200.0	3200.0	
Green net	roll	6.0	2200.0	13200.0	
Total costs for maintenance of the Technology				**23'720.0**	
Total costs for maintenance of the Technology in USD				*94.88*	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☑ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone
- ☐ humid
- ☐ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate
Average annual rainfall in mm: 1500.0
Annual rainfall ranges from 1500 mm to 4000 mm that occurs in monsoon month
Name of the meteorological station: National center for hydrology and meteorology
Wet subtropical zone

Slope
- [x] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [x] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [x] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [x] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor			good
health			✓	
education				✓
technical assistance			✓	
employment (e.g. off-farm)			✓	
markets			✓	
energy			✓	
roads and transport			✓	
drinking water and sanitation				✓
financial services				✓

IMPACTS

Socio-economic impacts

Crop production	decreased	increased	The use of vermicompost in crop production offers a sustainable approach to soil fertility management, plant nutrition, disease suppression, and pest control. By harnessing the benefits of vermicompost, farmers can improve agricultural productivity.
land management	hindered	simplified	They can maintain the soil fertility, improve soil structure, retain soil moisture and improve soil health with improved soil micro flora.
expenses on agricultural inputs	increased	decreased	
farm income	decreased	increased	Generate more income after the establishment of vermicomposting
diversity of income sources	decreased	increased	They can use in their own farm (floriculture) and sell to others in market.
workload	increased	decreased	They need more labor for as they have increased their farm size.

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved	Compared to before they are self -sufficient and improved status in the community
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened	improved	They are able to provide job opportunities for others.

Ecological impacts

soil moisture	decreased	increased	The soil they used in their flower potting made of vermicompost content soil moisture.
nutrient cycling/ recharge	decreased	increased	They can use their kitchen waste for recycling
soil organic matter/ below ground C	decreased	increased	The vermicomposting soil contains extra nutrients for gardening.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative / very positive

Long-term returns — very negative / very positive

Benefits compared with maintenance costs

Short-term returns — very negative / very positive

Long-term returns — very negative / very positive

Initial set-up cost is expensive and would be challenging if there is no external support.

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all / very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [x] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

Number of households and/ or area covered

1

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [x] Yes
- [ ] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [x] labour availability (e.g. due to migration)

They have increased the farm size to larger scale from small scale after they got financial support from the Nation Organic Program.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Soil fertility is enhanced and reduce in use of harmful chemicals
- Farm income generation
- Can do other business like floriculture

Strengths: compiler's or other key resource person's view

- Ecofriendliness
- Well recognized by other institutions

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- High installment cost External supports
- Maintenance requirements Proper management

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Long process and challenging to harvest Systematic process and skilled labor
- Intensive care Proper sanitation

REFERENCES

Compiler
Karma Wangdi

Editors
Kuenzang Nima

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 22, 2023

Last update: June 4, 2024

Resource persons
Divya Gurung - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6874/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- NSSC Bhutan catalogue of soil and water conservation approaches and technologies, 2012: Website
- Organic fertilizer production manual: http://dx.doi.org/10.13140/RG.2.2.15894.83521

Links to relevant information which is available online

- Vermicompost, the story of organic gold, explaining main features of vermicomposting: https://doi.org/10.4236/as.2012.37110
- Vermicomposting, Benefits and drawbacks of vermicomposting: https://doi.org/10.1016/j.sjbs.2021.02.072
- Earthworm Vermicompost , Common Vermicomposting Problems.: https://www.gardeningknowhow.com/composting/vermicomposting/problems-with-vermicomposting.htm
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- Vermicomposting , Purpose of vermicomposting: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/vermicomposting
- Vermicomposting, what is vermicomposting: https://composting.ces.ncsu.edu/vermicomposting-2/

Citrus canopy management and rehabilitation program (Thinley Penjor Dorji)

Citrus Canopy Management and Rehabilitation Program (Bhutan)

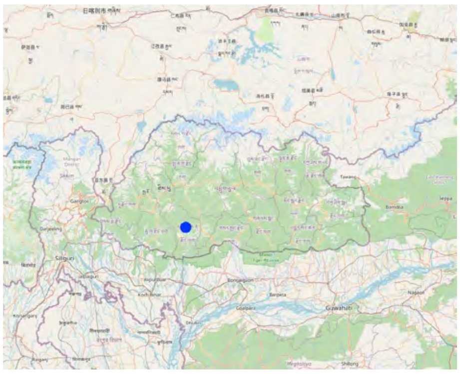
Tshel Shing Zin Chong Dang Nyam Sung Ley Rim (ཚལ་ཤིང་འཛིན་སྐྱོང་དང་ཉམས་སྲུང་ལས་རིམ།)

DESCRIPTION

Citrus canopy management refers to the set of practices and techniques employed to optimize the growth, health, and productivity of citrus trees by manipulating the structure and density of their canopy. Effective canopy management is crucial for achieving desirable outcomes in citrus cultivation, such as improved fruit quality, increased yields, efficient use of resources, and enhanced tree health.

Citrus canopy management practices remain basic in Bhutan. Thus, the Australian Centre for International Agricultural Research (ACIAR) project was initiated and demonstrated citrus canopy management practices in selected orchards in 2010. In the same year, the Japan International Cooperation Agency (JICA) project trained land users and extension officers in eastern Bhutan on citrus management practices such as planting methods, nutrient management, pruning and training including top working, fruit thinning and post-harvest management practices. Since then, citrus growers have been slowly adopting the practices in their orchards. However, the adoption rate is low - affecting the yield and quality.
Bhutan has suitable climatic conditions for citrus production, particularly in the southern parts of the country due to the subtropical climate. Citrus such as oranges, mandarins and lemons are grown in orchards and home gardens. In Bhutan, citrus canopy management practices focus on optimizing tree growth, fruit production, and overall tree health. The main elements include pruning, training systems, canopy density management, tree height and size control, and disease and pest management integrated with irrigation and nutrient management practices. Pruning involves selectively removing branches, shoots, or foliage to shape the tree and improve its health. The stump should always be cut as close to the collar region as possible. Training structures the tree in a specific manner to optimize growth and management. Canopy density management regulates foliage density for light penetration and airflow. Techniques such as hedging or topping control the height and size of trees. Disease and pest management practices include adequate air circulation and sunlight exposure. Integration with irrigation and soil nutrient management enhances tree health and productivity. The desirable shape and size of citrus are variable depending on the grower's choice, location, and - most importantly - operational health and safety concerns. In general, the desirable shape and size of the tree should be 2 to 5 m tall, 2 to 5 m width of canopy, and 4 to 6 primary (scaffold) branches that are at least 1 m above the ground level.
The purposes/functions of citrus canopy management technology are to optimize fruit production, improve tree health, and facilitate harvest and maintenance operations. It helps maximize fruit yield and quality. Pruning and maintenance practices enhance tree vigour, reduce the risk of diseases and pests, and improve overall plant health. Controlling tree size and shape makes harvesting easier and more efficient, and simplifies other maintenance activities such as irrigation, fertilization, and pest control.
To establish and maintain citrus canopy management technology, activities such as regular pruning and training, knowledge and skill development, use of proper tools and equipment, monitoring and assessment, irrigation, and nutrition management are required. Regular pruning and training of citrus trees according to the selected system and management objectives is essential. Monitoring tree growth, health, and productivity is important, along with proper irrigation scheduling, water management, and nutrient application.
The benefits/impacts of the technology are improved sunlight exposure, enhanced air circulation, reduced disease incidence, increased fruit size and quality, ease of harvest, consistent yield, optimized water use, better pest management, and others. A well-managed canopy makes it easier to access the fruit during harvest, and achieve higher yields and better-quality fruits, reduced need for pesticides, as well as directing nutrients toward fruit production rather than excessive vegetative growth. However, there are some drawbacks of the technology such as the requirement for time-consuming manual labour, lower initial yields, high initial investments for equipment, and concerns about over-pruning.

LOCATION



Location: Nindukha Village, Kana Gewog, Dagana Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.89701, 27.05156

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2019

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Overview of a citrus orchard (Thinley Penjor Dorji)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: No

Cropland

- Tree and shrub cropping: citrus

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? No

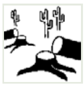
Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

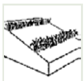


biological degradation - Bc: reduction of vegetation cover

SLM group

- integrated soil fertility management
- irrigation management (incl. water supply, drainage)
- Tree canopy management

SLM measures



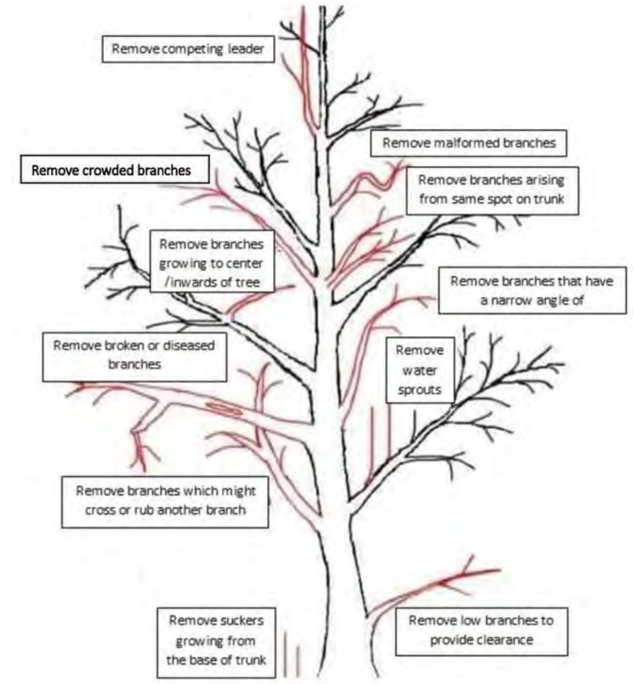
vegetative measures - V5: Others

other measures - Improve/optimize fruit production and quality by manipulating the growth and structure of trees.

TECHNICAL DRAWING

Technical specifications

The spacing between trees is 6 m. There are a total of 100 trees per acre. Diseased or damaged trees are removed.



Author: Thinley Penjor Dorji

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **2.47 acre**; conversion factor to one hectare: **1 ha = 1**)
- Currency used for cost calculation: **Ngultrum (Nu.)**
- Exchange rate (to USD): 1 USD = 80.0 Ngultrum (Nu.)
- Average wage cost of hired labour per day: 500

Most important factors affecting the costs

The land users mentioned that the equipment is the main factor affecting cost.

Establishment activities

1. Pruning (Timing/ frequency: Right after harvest)
2. Applying Bordeaux mixture (Timing/ frequency: Anytime)
3. Making basin (Timing/ frequency: Winter)
4. Applying manure (Timing/ frequency: Anytime)
5. Removal of dead woods or shoots (Timing/ frequency: Anytime)

Establishment inputs and costs (per 2.47 acre)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Pruning	Person/day	17.0	500.0	8500.0	100.0
Equipment					
Pruning saw	Number	1.0	2000.0	2000.0	100.0
Secateurs	Number	1.0	2500.0	2500.0	100.0
Plant material					
Sapling	Number	247.0	150.0	37050.0	
Fertilizers and biocides					
Bordeaux mixture	Litres	12.0	125.0	1500.0	
Total costs for establishment of the Technology				**51'550.0**	
Total costs for establishment of the Technology in USD				*644.38*	

Maintenance activities

1. Pruning of dead woods and water shoots (Timing/ frequency: Anytime)
2. Fertilizer application (Timing/ frequency: Anytime)
3. Shoot selection in the following years (Timing/ frequency: Every year when new shoots sprout)

Maintenance inputs and costs (per 2.47 acre)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Pruning	Person/day	7.0	500.0	3500.0	98.0
Total costs for maintenance of the Technology				**3'500.0**	
Total costs for maintenance of the Technology in USD				*43.75*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [x] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
The area falls under the humid Subtropical zone from the six Agro-ecological zones of Bhutan.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [x] steep (31-60%)
- [ ] very steep (>60%)

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- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
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- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [x] deep (81-120 cm)
- [ ] very deep (> 120 cm)

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- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
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Soil texture (> 20 cm below surface)
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- [ ] low (<1%)

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- [ ] on surface
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- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

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- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
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- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
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- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household	Scale	Land ownership	Land use rights
☐ < 0.5 ha	☑ small-scale	☐ state	☐ open access (unorganized)
☑ 0.5-1 ha	☐ medium-scale	☐ company	☐ communal (organized)
☐ 1-2 ha	☐ large-scale	☐ communal/ village	☐ leased
☐ 2-5 ha		☐ group	☑ individual
☐ 5-15 ha		☐ individual, not titled	**Water use rights**
☐ 15-50 ha		☑ individual, titled	☐ open access (unorganized)
☐ 50-100 ha			☑ communal (organized)
☐ 100-500 ha			☐ leased
☐ 500-1,000 ha			☐ individual
☐ 1,000-10,000 ha			
☐ > 10,000 ha			

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

decreased ☐ ☐ ☐ ☐ ☐ ☐ ☑ increased

Land users mentioned that there was a significant increase in crop yield after canopy management.

crop quality

decreased ☐ ☐ ☐ ☐ ☐ ☐ ☑ increased

Quantity before SLM: 50-60%
Quantity after SLM: 80%
The land users stated that the size of the fruit was bigger and of better quality after canopy management.

risk of production failure

increased ☐ ☐ ☐ ☐ ☐ ☐ ☑ decreased

The land users stated that the risk of producing lower quality fruits that are not acceptable in the market has greatly reduced.

expenses on agricultural inputs

increased ☐ ☐ ☑ ☐ ☐ ☐ ☐ decreased

The cost of equipment is moderately expensive. However, the land users feel the cost is compensated by the increase in income. The land users also take special care of the equipment.

farm income

decreased ☐ ☐ ☐ ☐ ☐ ☐ ☑ increased

Improved quality and quantity of citrus are directly related to increased farm income as there is a higher price provided for good quality produce.

workload

increased ☐ ☐ ☑ ☐ ☐ ☐ ☐ decreased

Quantity before SLM: 40%
Quantity after SLM: 50%
The management practices such as training, pruning, and application of Bordeaux mixture are laborious. Therefore, the workload of land users has increased by about 10 per cent.

Socio-cultural impacts

food security/ self-sufficiency

reduced ☐ ☐ ☐ ☐ ☐ ☑ ☐ improved

The land users are self-sufficient in terms of citrus. Further, the portion of their yield is shared with their relatives making the community self-sufficient. The income generated from selling the produce is used to procure nutritious foods from the market making them food secure.

health situation

worsened ☐ ☐ ☐ ☐ ☑ ☐ ☐ improved

Improved income if used efficiently increases the health situation of the family members.

SLM/ land degradation knowledge

reduced ☐ ☐ ☐ ☐ ☐ ☑ ☐ improved

The traditional practice did not include nutrient management of the orchard. The citrus canopy management technology includes proper manuring or nutrient management of the orchard leading to increased knowledge of SLM for the land users.

Ecological impacts

vegetation cover	decreased						✓		increased	The technology improved tree health reducing the risk of orchards converting to fallow land and increasing vegetation cover.
beneficial species (predators, earthworms, pollinators)	decreased					✓			increased	The improved soil and canopy management increased earthworm and bee populations on the farm.
pest/ disease control	decreased					✓			increased	After canopy management, the land users stated that they have experienced fewer pest and disease incidences. This could be due to better sunlight penetration and air movement in the tree canopy.

Off-site impacts

damage on neighbours' fields	increased					✓			reduced	The orchard harbouring pests and diseases can damage neighbouring fields as the diseases are transmitted from one field to another through vectors and other sources. Therefore, the technology improves the health of the orchard and prevents the risk of damaging neighbouring orchards.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative			✓					very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all				✓		very well
annual rainfall decrease	not well at all				✓		very well

Climate-related extremes (disasters)

local hailstorm	not well at all		✓				very well
epidemic diseases	not well at all		✓				very well
insect/ worm infestation	not well at all		✓				very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [x] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

7 households adopted the technology from the total of 50 households.

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Increased production. The canopy management technology increases production in the long run although there is a sudden reduction in the yield in the first year of implementation.
- Improved quality. The technology is a wholesome approach to improving the canopy, nutrient management and irrigation management leading to quality fruit production.
- Reduced pests and disease incidence. The technology reduces the favourable environment for the multiplication of diseases and pest. For example, by pruning the canopy which increases aeration ultimately reducing fungal growth.

Strengths: compiler's or other key resource person's view

- Increased income and improved livelihood. Canopy management increases yield in the long run leading to increased farm income and improved living standards of the land users.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Labour intensive. The technology includes pruning, thinning, irrigation and nutrient management activities which require a lot of labour. Implementing a labour-sharing mechanism as it is cost-effective and strengthens community collaboration.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Low initial crop yield. Due to excessive pruning in the first year of technology implementation, there is a marked reduction in the yield of the citrus. With better care and management, yields increase after 2 to 3 years.

REFERENCES

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Resource persons
Lethro - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6847/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online

- Canopy Management Guide for Citrus Mandarin in Bhutan: http://rcbajo.gov.bt/wp-content/uploads/2020/05/Canopy-management-guide-for-citrus-mandarin.pdf
- Pruning and Training - Evergreen Trees: http://rcbajo.gov.bt/wp-content/uploads/2020/06/Pruning-Training-evergreen.pdf

Rice field in the fenced area (Sangay Lhendup)

Securing Food Through Electric Fencing (Bhutan)

Logmey Raw Ley Ten Za Thung Sung Chop (གློག། མེ་རྫ་ལས་བརྟེན་ཟ་འཐུང་སྲུང་སྐྱོབ།)

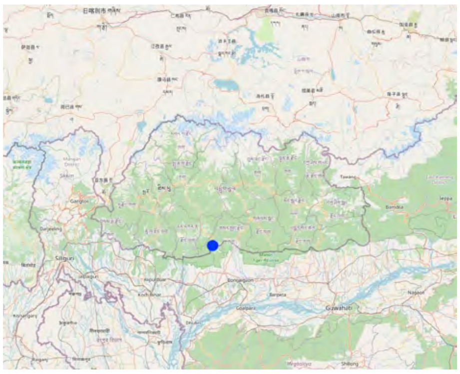
DESCRIPTION

The Electric Fencing System in Bhutan serves as a non-lethal approach to safeguarding crops from wild animals, aligning with the principles of Gross National Happiness (GNH). GNH emphasizes values such as compassion, non-killing, and harmonious coexistence with nature and its elements.

The Electric Fencing System in Bhutan serves as a non-lethal approach to safeguarding crops from wild animals, aligning with the principles of Gross National Happiness (GNH). GNH emphasizes values such as compassion, non-killing, and harmonious coexistence with nature. The National Plant Protection Centre (NPPC), Department of Agriculture (DoA), Ministry of Agriculture and Livestock (MoAL) has been facilitating the application and installation of electric fence systems nationwide. This is achieved through the provision of comprehensive guidelines to help the public comprehend the fundamental components and installation procedures.
In essence, the electric fence system consists of three major parts: Energizers, Insulators, and Earth return. The energizer is responsible for generating high-voltage pulse electricity (ranging from 9-12 KV), which is then delivered along the fence wires. The majority of energizers are directly connected to the electricity line, while in some isolated cases, solar panels and batteries are used as alternative power sources. Insulators are typically crafted from a non-conductive material and serve as a barrier between the electrified wire and the wooden post. In the Bhutanese market, these insulators are not readily available, thus as an alternative, high-density polyethylene (HDPE) pipe has been found to be effective and cheap. The electric fence earth return serves as an essential pathway in the electric circuit, collecting high voltage and current from the earth and returning it to the energizer.
The loss of crops to wild animals leads to increased production costs in Bhutan (time spent in crop guarding) and the expansion of fallow lands. Farmers often resort to illegal and fatal methods of electric fencing, tapping electricity directly from the main line. To address these issues, the implementation of electric fencing, utilizing imported IEC-certified energizers and locally fabricated fencing materials, has proven to be successful. This electric fencing system, introduced after five years of pre-testing across the country, covers various locations targeting different problem species of animals. Not only is this technology effective in controlling wild pests, but it also enjoys high social acceptance among Bhutanese farmers due to its cost-effectiveness and being non-lethal to wild pests.
A recent study on the impact of electric fencing on food security focused on the Laptsakha community in Senggye Gewog, Sarpang Dzongkhag. They faced threats to food security from elephants, boar and stray cattle from neighboring communities in India. Crop production in Laptsakha was negligible before the introduction of electric fencing: resettled households contemplated returning, fertile lands were left fallow, and incomes shrank. The turning point came in 2013 with the introduction of electric fencing. This intervention successfully mitigated wildlife attacks on crops, ensuring food security and contributing to a harmonious ecosystem and improved livelihoods for the people of Laptsakha.
The electric fence, covering a distance of 7 km, protects a total of 60 households in all, safeguarding about 60 (24 ha) acres of vulnerable lands. Electric fences have various benefits including:
•Harmonious Approach: they do not cause harm to animals beyond a repellent shock.
•Economical and Easy to Build: they are cost-effective and relatively easy to construct.
•Learning and Deterrence: animals quickly learn to respect electric fences.
•Durability: they have an extended service life.
•Versatility: they offer a variety of designs and can control a wide range of wild animals.

The installation of an electric fence involves a participatory approach and several key steps:
•Location and Length: determine the location and approximate length of the electric fence either by manual measurement, or remote technologies for larger expanses.

LOCATION



Location: Laptsakha Village, Senggye Gewog, Sarpang Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.22257, 26.85369

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: Yes

Date of implementation: 2013

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

•Material Estimation: estimate the required materials per kilometre based on the identified area, including wooden poles, HDPE pipe, and GI wire.
•Additional Materials: Consider other essential materials like energizers, solar panels, charge controllers, and batteries, depending on the specific requirements.
•Cost Estimation: Calculate the cost of installation, which varies regionally. For example, to instal one kilometre of an electric fence is estimated at about Nu. 7,450 (USD 95) excluding labour costs and cost of wooden poles which is sourced locally.

The implementation of electric fencing in the community has brought significant advantages, particularly in securing food. Prior to this intervention, the community faced severe challenges in harvesting crops, with approximately 70% of fertile lands being left fallow due to constant human-wildlife conflicts. Crop guarding became routine & risky.
With the introduction of electric fences, the community's agricultural landscape has undergone a positive transformation. Crop diversification has been enhanced, encompassing maize, ginger, paddy, mandarin fruit trees and areca nut. The frequency of wild elephant attacks has significantly decreased, leading to a notable increase in crop production. This has resulted in secured food sources and improved livelihoods. Additionally, the community has successfully revived previously fallow lands.
While the electric fencing has proven effective, there are challenges faced by the land users, notably the frequent damage to energizers, primarily attributed to thunderstorms. This has resulted in higher maintenance costs. In one specific instance, the community had to mobilize approximately Nu. 145,000 (USD 1800) independently to replace damaged energizers and other materials, supplementing the continued support from the government.

Rice field in the protected area (Sangay Lhendup)

Electric fencing in Laptsakha (Sangay Lhendup)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use
Land use mixed within the same land unit: Yes - Agroforestry

Cropland
- Annual cropping: cereals - maize, cereals - millet, cereals - rice (wetland)
- Perennial (non-woody) cropping: areca, pineapple, Banana, cardamom

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

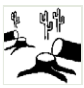
Forest/ woodlands
- (Semi-)natural forests/ woodlands: subtropical humid forest natural vegetation. Management: Selective felling, Non-wood forest use

Tree types (mixed deciduous/ evergreen): n.a.
Products and services: Timber, Fuelwood, Grazing/ browsing

Water supply
- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation
- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

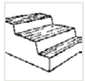


biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline

SLM group

- natural and semi-natural forest management
- integrated pest and disease management (incl. organic agriculture)
- wetland protection/ management

SLM measures

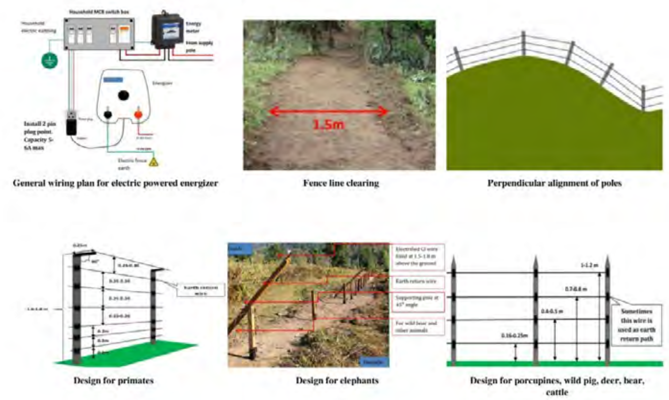


structural measures - S6: Walls, barriers, palisades, fences, S10: Energy saving measures

TECHNICAL DRAWING

Technical specifications

Insulators are prepared using HDPE pipes (32 mm or 25 mm in diameter, with a pressure capacity of 10 kg/cm2). These pipes are cut into 10-11 cm lengths, with holes drilled at the center, and then secured with two 3-inch nails at both ends, maintaining a 1.50 cm distance from edges. The fencing process involves clearing a fence line with a width of at least 1.5 m. Wooden poles (10 to 18 cm in diameter) are erected perpendicular to the ground, spaced 2.5 to 3 m apart in flat lands and 2 m or less in sloped areas.
For fences designed to control smaller species like rabbits and porcupines, the first wire is positioned about 0.14 to 0.16 m from the ground. Fences for larger animals such as wild boars, deer, and bears require 3 to 4 strands of wires positioned at 0.25, 0.4 to 0.5, 0.7 to 0.8, and 1 to 1.2 m from the ground. In the case of elephants, one or two strands of wire should be positioned at 1.5 to 1.8 m from the ground, and supporting poles should be erected at 45-degree angles from the entrance side of the field.
The height of the fence is adapted based on the target animals, such as monkeys. Typically, the 7th strand is supported on a 25 cm HDPE pipe fixed on top of the wooden pole at a 90-degree angle to the entrance side of the field. This design prevents monkeys from climbing the wooden posts and jumping into the field.



Author: National Plant Protection Centre (NPPC), DoA, MoAL

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **kilometre**)
- Currency used for cost calculation: **Ngultrum (Nu.)**
- Exchange rate (to USD): 1 USD = 80.0 Ngultrum (Nu.)
- Average wage cost of hired labour per day: 250

Most important factors affecting the costs

The primary factor incurring the cost, according to the beneficiaries, was the energizer set, which necessitates frequent replacement.

Establishment activities

1. Area identification through Google Map by ARDC-Yusipang (Timing/ frequency: 2013, Winter)
2. Cleaning of vegetation along the identified fence line (10 m width) (Timing/ frequency: 2013, Winter (after crop harvest))
3. Ground clearing and levelling (2 m width) (Timing/ frequency: 2013, Winter (after crop harvest))
4. Gathering of fencing poles (Timing/ frequency: 2013, Winter (after crop harvest))
5. Procurement and facilitation of materials (energizers, solar panels, nails, GI wire, insulation pipes) (Timing/ frequency: 2013, Winter (after crop harvest))
6. Execution of fencing activities (Timing/ frequency: 2013, Winter (after crop harvest))

Establishment inputs and costs (per kilometre)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Man	Person-days	1600.0	250.0	400000.0	100.0
Equipment					
Energizer	No.	6.0	9500.0	57000.0	
GI wire (SWG 16)	Kg	356.0	95.0	33820.0	
Nail (3 inch)	Kg	106.0	82.0	8692.0	
Solar Panel (20 watts)	No.	6.0	7000.0	42000.0	
Charge controller	No.	6.0	1800.0	10800.0	
Acidic Battery	No.	6.0	2800.0	16800.0	
Lubricants (Gear oil)	Litre	6.0	254.0	1524.0	
Insulators (HDPE pipe [32 mm])	Metre	781.0	48.0	37488.0	
Construction material					
Wooden poles	No.	1400.0			100.0
Other					
Other accessories	NA	1.0	1000.0	1000.0	
Total costs for establishment of the Technology				**609'124.0**	
Total costs for establishment of the Technology in USD				*7'614.05*	

Maintenance activities
1. Replacement of energizers during breakdowns (Timing/ frequency: As and when breakdown occurs)
2. Fence line clearing (Timing/ frequency: Monthly)

Maintenance inputs and costs (per kilometre)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Nu.))	Total costs per input (Ngultrum (Nu.))	% of costs borne by land users
Labour					
Labor	Person-days	59.0	700.0	41300.0	100.0
Total costs for maintenance of the Technology				**41'300.0**	
Total costs for maintenance of the Technology in USD				*516.25*	

NATURAL ENVIRONMENT

Average annual rainfall
- ✓ < 250 mm
- ✓ 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- ✓ humid
- sub-humid
- semi-arid
- arid

Specifications on climate
The most recent climate data 2017, published by NCHM was used.
Name of the meteorological station: Station: Bhur, Type: Class A, Station ID: 23310046
The area falls under the humid subtropical zone from the six Agro-ecological zones in Bhutan.

Slope
- flat (0-2%)
- ✓ gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landforms
- ✓ plateau/plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- ✓ 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- ✓ not relevant

Soil depth
- very shallow (0-20 cm)
- ✓ shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- ✓ high (>3%)
- medium (1-3%)
- low (<1%)

Groundwater table
- on surface
- < 5 m
- 5-50 m
- > 50 m

Availability of surface water
- excess
- ✓ good
- medium
- poor/ none

Water quality (untreated)
- ✓ good drinking water
- poor drinking water (treatment required)
- for agricultural use only (irrigation)
- unusable

Water quality refers to: surface water

Is salinity a problem?
- Yes
- ✓ No

Occurrence of flooding
- Yes
- ✓ No

Species diversity
- ✓ high
- medium
- low

Habitat diversity
- ✓ high
- medium
- low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- subsistence (self-supply)
- ✓ mixed (subsistence/ commercial)
- commercial/ market

Off-farm income
- ✓ less than 10% of all income
- 10-50% of all income
- > 50% of all income

Relative level of wealth
- very poor
- poor
- ✓ average
- rich
- very rich

Level of mechanization
- manual work
- animal traction
- ✓ mechanized/ motorized

Sedentary or nomadic
- ✓ Sedentary
- Semi-nomadic
- Nomadic

Individuals or groups
- individual/ household
- ✓ groups/ community
- cooperative
- employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- children
- ✓ youth
- ✓ middle-aged
- elderly

Area used per household

- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale

- [x] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership

- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family land ownership

Land use rights

- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights

- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

Comments

The community is striving for the upgradation of the present primary school to high school.

IMPACTS

Socio-economic impacts

Crop production	decreased							✓	increased	Quantity before SLM: 219 kg paddy from one acre wetland Quantity after SLM: 1090 kg of paddy from one acre wetland There is a significant increase in the crop production. The production before electric fencing was almost zero due to wild elephant attacks. However, the issue is resolved due to the electric fence intervention.
crop quality	decreased							✓	increased	The beneficiaries believe that the quality of the crop has improved based on visual observation and sensory evaluations (taste). This could be due to reduced trampling of the crop by wild animals.
risk of production failure	increased							✓	decreased	Quantity before SLM: 20% of paddy harvest from one acre wetland Quantity after SLM: 100% of paddy harvest from one acre wetland The human-wildlife conflict was the major factor causing production failure in the past. The risk of production failure is reduced by 100% as the land is secured from wild animal intrusion.
product diversity	decreased						✓		increased	Quantity before SLM: Ginger cultivation was not possible Quantity after SLM: Now the land users cultivates ginger Ginger cultivation before electric fencing was not possible due to wild elephants straggling in the fields. Currently, the land users grow ginger leading to product diversity.
production area (new land under cultivation/ use)	decreased							✓	increased	A major portion of the arable land was not cultivated in the past due to wild animal depredation, now the land users engage in various agricultural activities in that land.
land management	hindered							✓	simplified	The electric fencing technology has made the land suitable for agricultural activities. Motivating the land users to manage the land better by sourcing irrigation and reducing land degradation. However, the land users are not able to manage landslides in the area.
expenses on agricultural inputs	increased							✓	decreased	The expenditure of money and time to guard the field is significantly reduced as the crop destruction by wild animals was eradicated with electric fence intervention.
farm income	decreased							✓	increased	The technology enabled the land users to engage in commercial farming. Further, the time required to guard the crop can be dedicated to other productive farm activities.
diversity of income sources	decreased							✓	increased	The land users are engaged in diverse crop cultivation leading to diversified income sources.

workload	increased							✓	decreased	The workload involved in guarding the crop is significantly reduced.

Socio-cultural impacts

food security/ self-sufficiency	reduced							✓	improved	The land users in the Laptsakha community are self-sufficient in cereals and most vegetables. Before the technology introduction, the land users were not involved in cultivation of crops and approximately 70% of the land was left fallow. The land users were dependent on imported food products. However, the technology has enabled farming activities including cereals and vegetable production making the land users self-sufficient. The surplus produce is sold in the market fetching good income with which the land users can purchase quality food products that are not grown in the field increasing the food security of the community.
health situation	worsened							✓	improved	The land users believe that the health situation of the community has improved. The possible reason could be due to the consumption of diverse and organic food products available from their field.
recreational opportunities	reduced					✓			improved	The time required to guard the field previously can be utilized in recreational activities.
SLM/ land degradation knowledge	reduced							✓	improved	The electric fence and land degradation do not exhibit a direct relationship. However, the technology encourages the land user to value their land and implement management practices ultimately improving the knowledge and skills SLM.
conflict mitigation	worsened							✓	improved	There is a significant improvement in human-wildlife conflict management.
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened							✓	improved	Disadvantaged land users having inadequate human resources benefit from the technology leading to improved situation of the household.

Ecological impacts

vegetation cover	decreased						✓		increased	The land users' involvement in the destruction of the forest cover surrounding the farm is reduced. The practice was aimed at chasing wild animals. However, with the reduction of this practice, there is higher vegetation cover.
biomass/ above ground C	decreased						✓		increased	There is enhanced vegetation cover in the surrounding forest and on the crop land leading to increased biomass.

Off-site impacts

Biological diversity conservation outside farmland	Decreased					✓			Increased	The area protected by the electric fencing covers farmland and forest areas. Therefore, the flora diversity is improved as it is not lost to wildlife depredation.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative							✓	very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative							✓	very positive
Long-term returns	very negative							✓	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all						very well	Answer: not known

Climate-related extremes (disasters)

local rainstorm	not well at all					✓	very well
local thunderstorm	not well at all		✓				very well
local windstorm	not well at all					✓	very well
flash flood	not well at all	✓					very well
landslide	not well at all	✓					very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

The 7 km electric fencing program has benefitted 60 households.

Has the Technology been modified recently to adapt to changing conditions?

- [x] Yes
- [ ] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)
- [x] Due to target animal species

The existing electric fence, operational up to now, underwent significant modifications, incorporating a chain-link fence valued at 1.10 million between February and May 2023. This alteration is intended to deter active wildlife pests, specifically monkeys and elephants.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Electric fencing aligns with the convictions of the land users, avoiding harm to wildlife as a means of protecting the land from wild animals.
- Scaring wild animals with a mild electric shock, the technology deters them from approaching due to the fear of the electric shock from the fence.
- Creating a favorable environment for agricultural activities, the technology encourages land users to participate in farming, resulting in increased production and household income.

Strengths: compiler’s or other key resource person’s view

- Reduced risk of loss of life: Wild animals, particularly elephants, pose a threat to the lives of land users, with some reported fatalities. The technology can help mitigate or prevent such incidents.
- The replication of this technology can eliminate fatal attempts made by land users in various parts of the country to control wild pests.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Continuous break down of energizers has incurred high maintenance costs Solar-powered fencing has been the best alternative as implemented by the community.
- Clearing of the land under the fence is labourious and time consuming. Timely monitoring of the clearing activity should be done.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- The GI wire experiences swift rusting. Timely greasing and utilizing superior quality GI wire.

REFERENCES

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Last update: May 30, 2024

Resource persons
Tshering Tashi - land user
Thinley Wangdi - Gewog Agriculture Extension Officer

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6830/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Technical Reference Manual for installation and maintenance of Electric Fence, National Plant Protection Centre (NPPC), n.d.: https://www.nppc.gov.bt/electric-fencing-manual/
- Implementation Guidelines for Electric Fencing System, National Plant Protection Centre (NPPC), 2015: https://www.nppc.gov.bt/electric-fencing-manual/
- EF accessories, National Plant Protection Centre (NPPC), 2015: https://www.nppc.gov.bt/ef-accessories/

Farmers collecting leaf litter (Niki Rai)

Leaf Litter Collection for FYM Production (Bhutan)

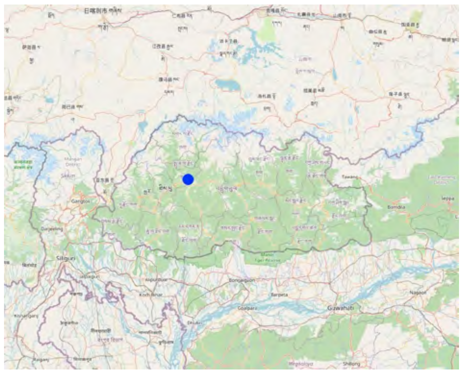
Sochhag Tey Nor Lue Zhoni (གསོ་འཕྱུག་སྟེ་ནོར་ལུད་བཟོ་ནི།)

DESCRIPTION

Leaf litter collection is the practice of collecting leaf litter from a designated forest area called sokshing and using it as bedding material for cattle. It then forms a constituent of farmyard manure which is applied to farmland.

Leaf litter collection, is the practice of collecting leaf litter from a designated forest area called sokshing and using it as bedding material for cattle. It then forms a constituent of farmyard manure which is applied to farmland. The term 'sokshing' comes from 'sok' meaning leaf litter and 'shing' meaning tree. The tradition of harvesting leaf litter from a designated forest area for agricultural use has been in practice for decades in the life of Bhutanese farmer (Chettri et al., 2012). According to BHUCAT, 2012, the use of sokshing is a widely used traditional farming practice in Bhutan with dominance in temperate regions but spreading into more humid subtropical areas. Leaf litter from the forests is used for the purpose of livestock bedding and then farmyard manure (FYM) production. Leaf litter as animal bedding is kept for a few months to almost a year. In Bhutanese society leaf litter is an important component of agriculture because of its contribution to manure production with most communities having designated specific forest management units for its production and collection for individuals or for communities. Sokshing is an important and highly relevant system and it continues to be important for villagers, even in the face of changing livelihood and institutional orientations. The government recognises sokshing and its institutions as a relevant mechanism for community forest management (Dorji et al., 2003).
Leaf litter, predominantly gathered during the winter when the leaves have fallen, is collected from the forest floor by cleaning the entire understorey. It is carried to the farm and stored before being used as bedding material for cattle, providing comfort and insulation from cold. It is then mixed with cattle manure to form farmyard manure (FYM), (BHUCAT, 2012). FYM and mineral fertilizers are the two main sources of plant nutrients in Bhutan. Farmers not only depend on forests for leaf litter but also for livestock feed and construction materials (Gautam, 2009). FYM is a mixture of animal dung, crop residues, and other organic materials and plays a vital role in enhancing soil fertility and improving crop productivity. Its application to agricultural fields provides numerous benefits. Recent research by Gupta et al. (2022) demonstrated the positive impact of FYM on soil health and crop yields. The study found that FYM application significantly increased soil organic carbon content, which is essential for soil structure, water holding capacity, and nutrient retention. Furthermore, FYM enhanced the availability of essential nutrients such as nitrogen, phosphorus, and potassium, promoting optimal plant growth and development. Additionally, FYM improved soil microbial activity, leading to enhanced nutrient cycling and improved nutrient uptake by plants.
Leaf litter collection plays a role in ecosystem health and functioning. The accumulation of fallen leaves on the forest floor contributes to nutrient cycling, soil health, and moisture retention. Despite its benefits, the sokshing process exposes the forest's soil to erosion because all the leaves, debris, and undergrowth are removed. Nutrient mining occurs over time as a result of the annual removal of leaf litter, and many sokshing forests exhibit stunted growth and other signs of forest degradation. However, on balance, when used in conjunction with dairy production, sokshing offers a low-cost, readily available supply of bedding and then organic fertilizer, although it is labour-intensive.
In some situations, there may be specific benefits in removing the litter. A recent study by Jiang et al. (2021) emphasized the importance of leaf litter collection for mitigating the negative impacts of invasive species. The research found that invasive plants can alter the decomposition rates of leaf litter, disrupting nutrient cycling and leading to changes in soil properties. By collecting leaf litter, especially in areas where invasive species are prevalent, we can minimize their detrimental effects and help preserve the ecological balance.

LOCATION



Location: Punakha, Lingmukha, Bhutan, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.90991, 27.56226

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: more than 50 years ago (traditional)

Type of introduction
- [ ] through land users' innovation
- [x] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

Leaf litter stock (Niki Rai)

Owners cattle shed (Niki Rai)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact
- [x] Bedding materials for cattle

Land use

Cropland

- Annual cropping: cereals - barley, cereals - other, potatoes, chili and beans. Cropping system: Vegetables - wheat/barley/oat/upland rice

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? Yes

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [x] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

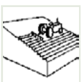
soil erosion by wind - Et: loss of topsoil

biological degradation - Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bl: loss of soil life

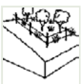
SLM group

- natural and semi-natural forest management
- integrated crop-livestock management
- integrated soil fertility management

SLM measures



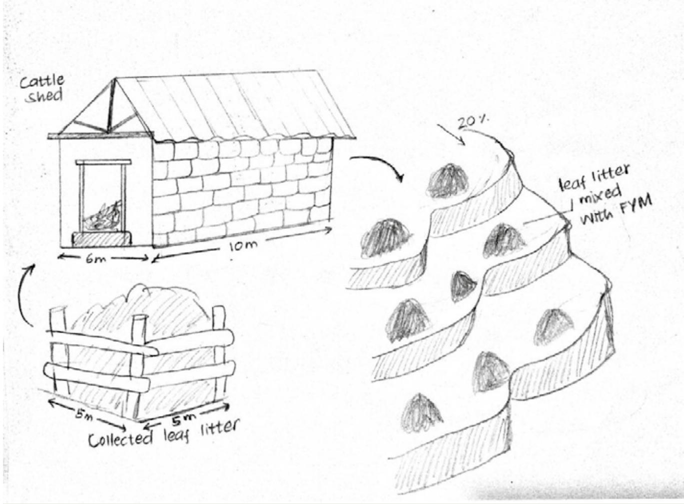
agronomic measures - A2: Organic matter/ soil fertility, A6: Residue management (A 6.3: collected), A7: Others



management measures - M6: Waste management (recycling, re-use or reduce)

TECHNICAL DRAWING

Technical specifications
Technical specifications as given above



Author: karma Wangdi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology unit (unit: **Cattle shed area** volume, length: **15/10**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 82.0 Ngultrum
- Average wage cost of hired labour per day: 800

Most important factors affecting the costs
There are no additional off-farm income-generating activities besides vegetable production, which has an impact on the overall costs.

Establishment activities
1. Site selection (Timing/ frequency: Winter)
2. Collection of cosnstruction materials (Timing/ frequency: Before on set of rain)
3. hiring of labors (Timing/ frequency: Before the cultivation)
4. Construction of the cow shed (Timing/ frequency: winter)
5. collection of leaf litters from the forest (Timing/ frequency: winter)
6. Stocking and use of leaf litter as bedding materials in the cow shed (Timing/ frequency: winter)
7. Let the leaf litter decompose for a month or more (Timing/ frequency: anytime)
8. Application of FYM during the field preparation (Timing/ frequency: Before the cultivation of crops)

Establishment inputs and costs (per Cattle shed area)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
	person days	15.0	800.0	12000.0	100.0
Equipment					
Spade	no.	6.0			100.0
crowbar	no.	3.0			100.0
pickaxe	no.	2.0			100.0
sickle	no.	3.0			100.0
wire	metre	50.0			100.0
knife	no.	3.0			100.0
Power chain	no.	1.0			98.0
Construction material					
nail	kg	1.0	500.0	500.0	100.0
Timber	nos.	150.0	350.0	52500.0	100.0
CGI sheet	nos.	20.0	780.0	15600.0	100.0
Other					
Working Lunch and Refreshment	person day	15.0	410.0	6150.0	100.0
Total costs for establishment of the Technology				**86'750.0**	
Total costs for establishment of the Technology in USD				*1'057.93*	

Maintenance activities
1. Timber/wood change after damage caused by rain and heat (Timing/ frequency: None)
2. CGI sheet replacement (Timing/ frequency: None)
3. Leaf litter collection (Timing/ frequency: None)
4. FYM production (Timing/ frequency: None)

Maintenance inputs and costs (per Cattle shed area)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
	person	10.0	800.0	8000.0	100.0
Equipment					
spade	nos	5.0			100.0
crowbar	nos	3.0			100.0
pickaxe	nos	2.0			100.0
sickle	nos	3.0			100.0
wire	metre	20.0			100.0
knife	nos	3.0			100.0
Fertilizers and biocides					
Urea	packets	2.0	1300.0	2600.0	100.0
Construction material					
Nail	kg	0.5	250.0	125.0	100.0
Timber change	nos.	30.0	150.0	4500.0	100.0
CGI sheet change	nos.	8.0	780.0	6240.0	100.0
Other					
Working lunch and Refreshment	Per Person	10.0	410.0	4100.0	100.0
Total costs for maintenance of the Technology				**25'565.0**	
Total costs for maintenance of the Technology in USD				*311.77*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 1000.0
Annual rainfall ranges from 500 mm to 1500 mm
Name of the meteorological station: National center for hydrology and metrology
This area probably falls under warm temperate zone which is one of the Bhutan's agro-climatic zone.

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [x] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [x] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual
- [x] Family

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor			✓	good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor			✓	good

Comments

Many of the household are average earned farmers so they are accessible to good infrastructure facilities.

IMPACTS

Socio-economic impacts

Crop production

decreased ☐☐☐☐☐✓☐ increased

After the SLM technology, crop production doubled in case of chili and cole crops.

crop quality

decreased ☐☐☐☐☐✓☐ increased

The introduction of hybrid crops has enhanced crop quality, but it is challenging to quantify this improvement in terms of specific quantities.

animal production

decreased ☐☐☐☐☐✓☐ increased

Enhanced bedding materials and improved living conditions for livestock animals have led to increased product production.
well this is professional estimates.

expenses on agricultural inputs

increased ☐☐☐☐☐☐✓ decreased

They are continuing the traditional farming practices

farm income

decreased ☐☐☐☐☐☐✓ increased

Farm production costs are minimal as they can produce their own organic manure directly from the field

diversity of income sources

decreased ☐☐☐☐☐✓☐ increased

The integration of livestock and agriculture production provides farmers with various sources of income, including earnings from animal products

Socio-cultural impacts

food security/ self-sufficiency

reduced ☐☐☐☐☐☐✓ improved

The impact of technology on food security or self sufficiency cannot be quantified however in their opinion there is increase in food production after the technology. Now they can commercialized their product as well as adequate for self consumption.

Ecological impacts

soil moisture

decreased ✓ increased

Soil moisture has been improved in the applied field where they are practising from olden days

soil cover

reduced ✓ improved

The forest's land cover has reduced because of leaf litter collection.

Off-site impacts

downstream siltation

increased ✓ decreased

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Benefits compared with maintenance costs

Short-term returns — very negative ✓ very positive

Long-term returns — very negative ✓ very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all ✓ very well

annual rainfall decrease — not well at all very well — Answer: not known

Climate-related extremes (disasters)

drought — not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Number of households and/ or area covered

29 households

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Soil fertility improvement
- Improved crop production.
- Minimise the cost for buying chemical fertilizers.

Strengths: compiler’s or other key resource person’s view

- Enhance soil structure
- Sustainable nutrient recycling
- Cost effective option or low cost technology

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Habitat alteration Reforestation and one alternative can be use of kitchen waste
- Labor intensive Labor exchange and power tillers for transportation

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- Depletion of forest recourses Strong policy on leaf litter collection

REFERENCES

Compiler
Karma Wangdi

Editors
Tashi Wangdi

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: July 5, 2023

Last update: April 1, 2024

Resource persons
Dawa Norbu - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6818/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
- NSSC Bhutan catalogue of soil and water conservation approaches and technologies, 2012: Website

Links to relevant information which is available online
- Traditional practice of leaf litter harvesting and utilization by farmers in west-central Bhutan: Paving the way for sustainable management: https://ag2.kku.ac.th/kaj/PDF.cfm?filename=07-Rekha.pdf&id=825&keeptrack=8

The photo is from the Official Facebook page of Desuung (Guardians of Peace) taken during the launch of the million fruit trees plantation and geocoding that followed after a year. (Desuung Facebook Page)

Geocoding of Million Fruit Trees for Monitoring and Tracking (Bhutan)

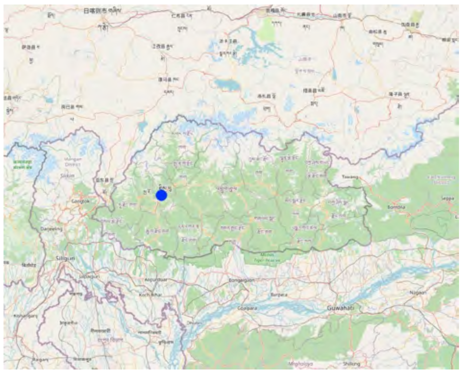
Shingdrey Changm Saya Zukchong Tatok Gi Dhoen lu Sa Chhai Dhadhoen Dhulen (ཤིང་འབྲས་ལྡངམ་ས་ཡ་འཛུགས་སྐྱོང་བལྟ་རྟོག་གི་དོན་ལུ་ས་ཆའི་བརྡ་དོན་བསྡུ་ལེན།)

DESCRIPTION

Geocoding of fruit trees allows remote monitoring and progress tracking of the growth of seedlings. The Smart App MoDA (Mobile Operation and Data Acquisition) is used in geocoding.

Geocoding of the “million fruit trees” initiative has been carried out across Bhutan. Different fruit trees suitable for particular agroecological zones were planted in farmers' fields in twenty districts and each sapling was geocoded.
The main elements of geocoding fruit trees involve assigning unique geographical codes or coordinates to individual trees within an orchard, utilizing technical specifications and equipment such as handheld GPS to accurately determine the location. The potential benefits of this form of geocoding include:
1. Location Mapping: Geocoding allows fruit trees to be accurately located on a map, providing a visual representation of their spatial distribution. This mapping can help identify patterns, clusters, and gaps in tree distribution.
2. Data Integration: Geocoded data can be integrated with geographic information systems (GIS) and other data sources, such as climate data, soil information, and topography. This integration provides a holistic view of the factors influencing fruit tree growth and productivity.
3. Precision: Geocoding provides precise coordinates for each fruit tree, enhancing the accuracy of data collection and analysis. This precision is crucial for making informed decisions regarding tree management and resource allocation.
4. Monitoring and Management: Geocoded fruit tree data enables efficient monitoring of tree health, growth, and potential issues. It facilitates targeted interventions, such as irrigation, fertilization, and pest control, based on the specific needs of individual trees or clusters.
5. Yield Estimation: By combining geocoded data with relevant environmental and growth information, it's possible to estimate the potential fruit yield in specific areas. This information aids in resource planning and harvest predictions.
6. Disease and Pest Management: Geocoded data can help identify patterns of disease or pest infestations. Early detection through geocoded monitoring can enable prompt intervention and prevent the spread of pests or diseases.
7. Biodiversity Analysis: Geocoding allows researchers to study the diversity of fruit tree species in different regions. This analysis can be useful for conservation efforts and understanding the ecological impact of specific tree species.
8. Research and Analysis: Geocoded fruit tree data serves as a valuable resource for scientific research. Researchers can study the effects of climate change, urbanization, and land use changes on fruit tree populations and ecosystems.
9. Decision-Making: Geocoded data assists farmers, agricultural agencies, and policymakers in making informed decisions about land use, tree planting initiatives, and resource allocation for sustainable agriculture.
10. Community Engagement: Geocoded maps of fruit trees can be shared with communities, promoting awareness of local resources, fostering community engagement, and encouraging initiatives like urban orchards or community gardens.
11. Data Visualization: Geocoded data can be visualized using maps and spatial tools, making it easier to interpret and communicate information to various stakeholders.
12. Long-Term Tracking: Geocoded data allows for long-term tracking of changes in fruit tree populations, aiding in the assessment of the success of planting initiatives and the overall health of the environment.

LOCATION



Location: Sigay Chiwog, Mewang Gewog, Thimphu Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 449.58953, 27.39046

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2022

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

The major activity of the technology is marking the fruit trees with the help of GPS so that these geocoordinates can be useful in tracking down the exact location of the plant. Geocoding is labour-intensive as the field workers need to be physically present in the field while carrying out the activity. Then the data recorded in GPS is transferred to the computer and analyzed using ArcGIS. This information is available to the policymakers and Agriculture officers and is shared with the Extension Agents through which it is disseminated to the land users.

The photo was taken with the field extension supervisor. (Aum Tshogpa of Sigey Chiwog)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: cereals - rice (upland). Cropping system: Wetland rice - wheat
- Perennial (non-woody) cropping

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

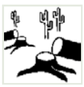
Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

soil erosion by wind - Et: loss of topsoil

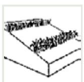


biological degradation - Bc: reduction of vegetation cover

SLM group

- agroforestry
- improved plant varieties/ animal breeds

SLM measures

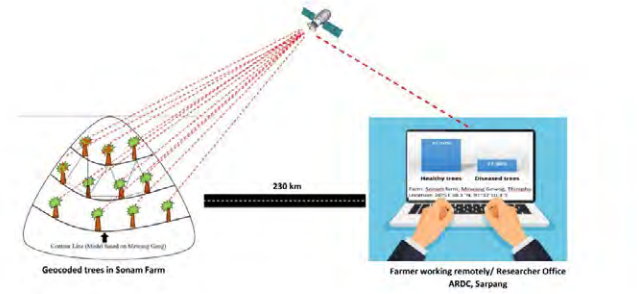


vegetative measures - V1: Tree and shrub cover

TECHNICAL DRAWING

Technical specifications

The technical drawing represents the general method of million fruit tree plantation and geocoding done on each tree. It depicts how geocoding enables the researcher or farmer to remotely check the health of the trees using satellite data. ARDC stands for Agriculture Research and Development Center.



Note: Diseased Trees: Trees with brown spots, **Healthy Trees:** Green tree

Technical Drawing of the Geocoding of Million Fruit Trees for Monitoring and Tracking

Author: Nima Dolma Tamang, Singye Dorji, Tshering Gyeltshen

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **No of Seedlings** volume, length: **8000 seedlings (Only in Mewang Geog)**)
- Currency used for cost calculation: **Ngultrum (Bhutanese Currency)**
- Exchange rate (to USD): 1 USD = 82.62 Ngultrum (Bhutanese Currency)
- Average wage cost of hired labour per day: 800

Most important factors affecting the costs

Most important factors affecting the costs are seedling and labour cost.

Establishment activities

1. Meeting between Gewog leaders and land users (Timing/ frequency: NA)
2. Identified a village for planation (Timing/ frequency: NA)
3. Identified households that wanted the seedings and number of seedlings (Timing/ frequency: NA)
4. Site identification (Timing/ frequency: NA)
5. Orchard layout (Timing/ frequency: NA)
6. Pit digging (Timing/ frequency: NA)
7. Plantation (Timing/ frequency: March- April)
8. Basin making (Timing/ frequency: After planation)
9. Geocoding (Timing/ frequency: After one month of orchard establishment)
10. Growth Tracking (Timing/ frequency: After every six months)

Establishment inputs and costs (per No of Seedlings)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Bhutanese Currency))	Total costs per input (Ngultrum (Bhutanese Currency))	% of costs borne by land users
Labour					
Desuup (Guardians of peace) - Volunteers	Person-days	6.0			
Farmers	Person-days	10.0	800.0	8000.0	100.0
Equipment					
Shovel	No.	10.0			100.0
crow-bar	No.	5.0			100.0
Spade	No.	20.0			100.0
GPS remote	No	6.0	12000.0	72000.0	
Tabs/ mobile phones	No.	6.0	15000.0	90000.0	
Plant material					
Apple	No.	3500.0	70.0	245000.0	
Walnut	No.	1000.0	120.0	120000.0	
Almond	No.	500.0	120.0	60000.0	
Peach	No.	1000.0	70.0	70000.0	
Pear	No.	2000.0	70.0	140000.0	
Fertilizers and biocides					
Manure and fertillizers	Metric Tonnes	16.0	1600.0	25600.0	100.0
Total costs for establishment of the Technology				**830'600.0**	
Total costs for establishment of the Technology in USD				*10'053.26*	

Maintenance activities

1. Weeding (Timing/ frequency: Twice a year)
2. Fertillizer application (Timing/ frequency: Twice a year)
3. Irrigation (Timing/ frequency: Once a week)
4. Replacement of dead plants (Timing/ frequency: After 6 months from plantation)
5. Growth tracking (Timing/ frequency: After every six month)

Maintenance inputs and costs (per No of Seedlings)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum (Bhutanese Currency))	Total costs per input (Ngultrum (Bhutanese Currency))	% of costs borne by land users
Labour					
Weeding and fertilizer application	Per year	4.0	1600.0	6400.0	100.0
Irrigation	Litres				
Geocoding	per plant	8000.0			
Plant material					
Replacement of plants	per plant	10.0	70.0	700.0	
Total costs for maintenance of the Technology				**7'100.0**	
Total costs for maintenance of the Technology in USD				*85.94*	

NATURAL ENVIRONMENT

Average annual rainfall

- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☑ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone

- ☐ humid
- ☐ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate

Average annual rainfall in mm: 2076.0
The rainfall data for Mewang Gewog is not available. The provided data is for Thimphu Dzongkhag as Mewang Gewog is under Thimphu Dzongkhag (Gewog is one of the geographic units below Dzongkhag). Thimphu falls under a temperate region and experiences minimal rainfall compared to the other parts of Bhutan. Thimphu had the wettest month in July with 497 mm and experienced the least rainfall in December with 5 mm.
Name of the meteorological station: National Center for Hydrology and Metoerology, Thimphu.
There are six Agro-ecological Zones (AEZ) in Bhutan and the current place of study falls under warm temperate zone which occurs between 1,800 – 2,500 m. Rainfall is low but the temperature is moderately warm in summer with frost in winter.

Slope

- ☐ flat (0-2%)
- ☑ gentle (3-5%)
- ☐ moderate (6-10%)
- ☐ rolling (11-15%)
- ☐ hilly (16-30%)
- ☐ steep (31-60%)
- ☐ very steep (>60%)

Landforms

- ☐ plateau/plains
- ☐ ridges
- ☐ mountain slopes
- ☑ hill slopes
- ☐ footslopes
- ☐ valley floors

Altitude

- ☐ 0-100 m a.s.l.
- ☐ 101-500 m a.s.l.
- ☐ 501-1,000 m a.s.l.
- ☐ 1,001-1,500 m a.s.l.
- ☐ 1,501-2,000 m a.s.l.
- ☐ 2,001-2,500 m a.s.l.
- ☑ 2,501-3,000 m a.s.l.
- ☐ 3,001-4,000 m a.s.l.
- ☐ > 4,000 m a.s.l.

Technology is applied in

- ☑ convex situations
- ☐ concave situations
- ☐ not relevant

Soil depth

- ☑ very shallow (0-20 cm)
- ☐ shallow (21-50 cm)
- ☐ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☐ very deep (> 120 cm)

Soil texture (topsoil)

- ☐ coarse/ light (sandy)
- ☑ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Soil texture (> 20 cm below surface)

- ☐ coarse/ light (sandy)
- ☑ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Topsoil organic matter content

- ☐ high (>3%)
- ☑ medium (1-3%)
- ☐ low (<1%)

Groundwater table

- ☐ on surface
- ☐ < 5 m
- ☐ 5-50 m
- ☐ > 50 m

Availability of surface water

- ☐ excess
- ☐ good
- ☑ medium
- ☐ poor/ none

Water quality (untreated)

- ☐ good drinking water
- ☐ poor drinking water (treatment required)
- ☑ for agricultural use only (irrigation)
- ☐ unusable

Water quality refers to: surface water

Is salinity a problem?

- ☐ Yes
- ☑ No

Occurrence of flooding

- ☐ Yes
- ☑ No

Species diversity

- ☐ high
- ☐ medium
- ☑ low

Habitat diversity

- ☐ high
- ☑ medium
- ☐ low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [x] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor		good
health			✓
education			✓
technical assistance			✓
employment (e.g. off-farm)		✓	
markets			✓
energy			✓
roads and transport			✓
drinking water and sanitation		✓	
financial services			✓
Internet			✓

Comments

The drinking water is insufficient as some households face scarcity of drinking water.

IMPACTS

Socio-economic impacts

Crop production

crop production	decreased					✓			increased	The technology aids in the monitoring and improves health and ease management of the already established orchard. Therefore, it indirectly increases crop production.
crop quality	decreased					✓			increased	Remote or constant monitoring ensures timely management to prevent biotic and abiotic factors deteriorate the crop quality.
fodder production	decreased				✓				increased	
fodder quality	decreased				✓				increased	
risk of production failure	increased					✓			decreased	Geocoding enables land user to determine potential risk so that the land user can use appropriate methods to prevent crop failure.
product diversity	decreased						✓		increased	The technology is not directly related to the product diversity. However, it provides data on existing fruit tree diversity so that the land user can plan and plant different fruit trees based on the market need which indirectly increases diversity.
production area (new land under cultivation/ use)	decreased					✓			increased	Geocoding enables the land user to remotely view the cropped area and the area where the crop failed (could be due to dying of the seedlings/diseased). It enables the land user to narrow their focus on the specific area, learn about the issues causing the crop loss, provide appropriate management, and conduct plantation in that area which indirectly increases production area.

irrigation water availability

decreased ☐☐✓☐☐☐☐ increased

Due to increased production area with no increase in the quantity of irrigation water, water availability is likely to reduce.

demand for irrigation water

increased ☐☐☐✓☐☐☐ decreased

There is increased demand for irrigation water for new plantations. However, with the use of technology land users can monitor the water requirement and use efficiently based on the need of the tree whereby the land users can avoid watering the trees that require less water and provide to those that require more water.

expenses on agricultural inputs

increased ☐☐✓☐☐☐☐ decreased

Minimal increase in expenses on agriculture inputs as planting materials (except manure) were provided to the land users for free of cost.

farm income

decreased ☐☐☐☐☐✓☐ increased

Once the fruit trees starts bearing fruits, income is expected to increase.

economic disparities

increased ☐☐☐☐✓☐☐ decreased

The technology is expected to reduce economic disparity by providing equal opportunity for the land users to generate income.

workload

increased ☐☐☐☐☐☐✓ decreased

Workload for the project implementors or land users are significantly reduced as they need not go to the actual site to determine the progress of the Million Fruit Trees Plantation Project.

Socio-cultural impacts

food security/ self-sufficiency

reduced ☐☐☐☐☐✓☐ improved

The technology indirectly aids in the increased production making an individual land user and the nation self-sufficient in fruits.

recreational opportunities

reduced ☐☐☐☐✓☐☐ improved

With reduced workload, land users can engage in recreational activities.

SLM/ land degradation knowledge

reduced ☐☐☐☐✓☐☐ improved

The technology will enable the project implementors to determine specific knowledge gaps and provide training in that particular field to the land users. Improving knowledge of both project implementors and land users.

situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)

worsened ☐☐☐☐✓☐☐ improved

Land users willing to be involved in fruit tree plantation are supported without discrimination of their social status or economic background and geocoding services are provided. This leads to the improved situation of socially and economically disadvantaged groups.

Ecological impacts

water quantity

decreased ☐☐✓☐☐☐☐ increased

The total water quantity remains same. However, the available water per tree or sapling is reduced.

surface runoff

increased ☐☐☐☐✓☐☐ decreased

Due to the absorption of water by the roots of the fruit trees, surface run-off is decreased.

evaporation

increased ☐☐☐☐✓☐☐ decreased

Evaporation will be decreased due to an increase in the vegetation cover from the plantation of the fruit trees.

soil moisture

decreased ☐☐☐☐✓☐☐ increased

Slight increase in the soil moisture in long run due to addition of soil organic matter and monitored irrigation.

soil cover

reduced ☐☐☐☐✓☐☐ improved

The technology enhances easy monitoring of the trees and encourages increased soil cover.

soil loss	increased	decreased	The technology enhances soil cover reducing the soil loss from erosion.
nutrient cycling/ recharge	decreased	increased	Geocoding enables the land user to have overview of the nutrient content of the production area aiding land users to add nutrient based on the need.
soil organic matter/ below ground C	decreased	increased	Generally, there will be an increase in the soil organic matter due to an increase in production area and management practice such as the addition of manures by the land user.
vegetation cover	decreased	increased	Increase due to the scheduled irrigation applied to the fruit trees.
biomass/ above ground C	decreased	increased	Slight increase due to proper management and care provided to the orchard.
animal diversity	decreased	increased	Animal diversity in the case of pollinators such as bees increases as the fruit trees mature and start flowering.
beneficial species (predators, earthworms, pollinators)	decreased	increased	Beneficial species such as bees are attracted to the orchards.
pest/ disease control	decreased	increased	Pest and diseases control improves with the use of remote monitoring facilitated by this technology.
landslides/ debris flows	increased	decreased	Once the fruit trees establish themselves, landslides can be reduced significantly due to vegetation cover.
emission of carbon and greenhouse gases	increased	decreased	This technology could potentially reduce greenhouse gas as trees utilize carbon dioxide for photosynthesis.
wind velocity	increased	decreased	In the long run, a well-established orchard can act as a windbreak and reduce wind velocity and damage it poses to the property.
micro-climate	worsened	improved	An orchard can act as a micro-climate harbouring many plants and insect species.

Off-site impacts

water availability (groundwater, springs)	decreased	increased	Fruit trees require irrigation which reduces the availability of water for other purposes.
impact of greenhouse gases	increased	reduced	Having a land cover with vegetation compared to barren land reduces greenhouse gases.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Although the initial establishment of the orchard is costly considering the labour charge, it is expected to have positive income and impact once the fruit trees start bearing.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all ☐☐☐☑ very well	
seasonal temperature increase	not well at all ☐☐☐☑ very well	Season: summer
annual rainfall increase	not well at all ☐☐☐☑ very well	
seasonal rainfall decrease	not well at all ☐☐☐☑ very well	Season: summer

Climate-related extremes (disasters)

local hailstorm	not well at all ☐☐☐☑ very well
epidemic diseases	not well at all ☐☐☐☑ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 11-50%
- ☑ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ☑ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Number of households and/ or area covered

Total 8000 fruit trees are planted in the five Chiwogs (third level administrative division under Gewog) under Mewang Gewog.

Has the Technology been modified recently to adapt to changing conditions?

- ☐ Yes
- ☑ No

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- 1. Precision Mapping: Geocoding allows for accurate mapping and identification of fruit trees. By assigning specific geographic coordinates to each tree, it becomes easier to locate and monitor individual trees or orchards.
- 2. Efficient Resource Allocation: Geocoding helps optimize resource allocation by providing information on tree density and distribution. Land users can identify areas with high fruit tree concentrations and strategically allocate resources such as labour, water, fertilizers, and pesticides, leading to improved productivity and reduced costs.
- 3. Data-driven Decision Making: Geocoded data on fruit trees can be analyzed to gain insights into their distribution patterns, growth rates, and health status. This information enables land users, researchers, and policymakers to make informed decisions regarding fruit tree cultivation, pest control, and disease management.

Strengths: compiler’s or other key resource person’s view

- 1. Conservation and Biodiversity Analysis: Geocoded fruit tree data aids in the conservation and analysis of biodiversity. By mapping the locations of different fruit tree species, experts can assess the distribution and abundance of specific varieties, identify endangered local or traditional landraces varieties, and develop strategies for their preservation.
- 2. Targeted Marketing and Distribution: Geocoded fruit tree data facilitates targeted marketing and distribution strategies. By understanding the location of fruit trees and their yields, producers can identify potential markets and plan transportation logistics more effectively, minimizing waste and ensuring timely delivery to consumers.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Geocoding large numbers of fruit trees can be a time-consuming and resource-intensive task, particularly when manual processes are involved. It may require extensive fieldwork and manual data entry, making it impractical or costly for large-scale fruit tree inventories.
- Privacy Concerns: Geocoding fruit trees raises privacy concerns, particularly when tree locations are associated with specific individuals or properties. Care must be taken to ensure that privacy is respected and sensitive information is appropriately handled An updated and secured security-protected website can be used.
- Lack of knowledge of geocoding by the farmers. Provide awareness trainings

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- The higher expense of the geocoding in terms of labour cost for geo-coding Train land users on geocoding, instead of using trained professionals.
- Difficult to constantly update information on time.

REFERENCES

Compiler
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Resource persons
Thuji Penjor - Agriculture Extension Officer

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6829/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
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Links to relevant information which is available online
- Million Fruit Trees Plantation Initiative launched: http://www.bbs.bt/news/?p=166763
- Kuensel. (2022). Million Fruit Trees Plantation Initiative launched. Thimphu.: Website: https://kuenselonline.com/414000-fruit-trees-planted-in-45-days/
- Geocoding of trees from street addresses and street-level images: https://www.fs.usda.gov/psw/publications/vandoorn/psw_2020_vandoorn001_laumer.pdf

A dummy tiger guarding crops (Kuenzang Nima)

Use of Dummy Tigers to Repel Wild Animals (Bhutan)

Tag Zuenma Laglen Thabtey Lothog Sungni (སྟག་རྫུན་མ་ལག་ལེན་འཐབ་སྟེ་ལོ་ཐོག་སྲུང་ནི།)

DESCRIPTION

Dummy tigers are used to scare off crop predators. This can be considered a SLM technology because it protects the crops from wild animals which in turn prevents erosion (both soil and water), adds nitrogen to the soil (i.e., by leguminous crops), and helps in nutrient cycling. Furthermore, time is freed up for the farmer to carry out other SLM activities.

In the region of Drochukha, Bhutan, the foremost challenge faced by rural communities is crops damage by wildlife. Land users in this area contend with damage inflicted by a variety of wild animals, including wild boar, barking deer, sambar deer, monkeys, porcupines, bears, and rats. To mitigate crop damage by wildlife, the land users of Drochukha have implemented a unique solution by strategically placing dummy tigers to deter these animals and safeguard their crops.

In 2018, a woman from Drochukha initiated the idea of using dummy tigers to protect crops, and it proved to be highly successful. Following this, other residents also adopted the practice. Farmlands situated near the forest's periphery experience the most significant crop damage by wild animals. By placing dummy tigers near the forest's edge, the land users have not only reduced wildlife attacks in the peripheral regions but also significantly decreased such incidents in the central areas. To protect their crops from wild animals, they procured a dummy tiger at a cost of Nu. 3,380 (about USD 40) from Bajo town in Wangduephodrang Dzongkhag and another dummy tiger costing Nu. 2,000 (about USD 25) from the Indian market in Jaigaon. The land users constructed a raised wooden platform by placing four wooden poles in the ground and adding planks over them to support the dummy tigers, ensuring that they faced the forest.

The implementation of dummy tigers (two) has yielded numerous benefits for 21 households in the region. With the adoption of this innovative approach, Drochukha farmers have been able to increase their crop production and rejuvenate previously unused lands. Dummy tigers effectively safeguard standing crops and prevent wildlife depredation. Maintaining standing crops in the fields is essential to prevent erosion, both of soil and water, while also contributing nitrogen to the soil through the cultivation of leguminous crops and facilitating nutrient cycling. An important aspect of employing dummy tigers is that it prevents land users from resorting to fatal methods of crop protection that may involve the killing of wildlife. Human-wildlife conflicts have thus been reduced. The primary current concern of the land users of Drochukha is the fading colour of the dummy tigers, and they are eager for improved interventions that may involve mobile and sound-producing tigers.

The Agriculture Machinery Centre (AMC) and the Dzongkhag Agriculture Office (DAO) have joined forces to create an IoT-based animal-repellent system. This system, positioned at the field's periphery, comprises three primary components: a speaker, a receptor card, and an amplifier. Once connected to an owner's smartphone, the system allows for the remote playback of various animal sounds. One system, consisting of a single receptor card, can be linked to up to five users. Additionally, two LED flashlights are integrated into the system to deter wild boars at night through powerful pulse flashes. The complete system comes at a cost of Nu. 30,000. Moreover, in their most recent endeavors, AMC and DAO are currently developing a robotic tiger capable of moving its head and limbs, enabling it to patrol the guardhouse and serve as a further deterrent to wildlife. The technology is being piloted as a project to evaluate its effectiveness in the field through trials.

LOCATION

Location: Drochukha Chiwog, Goenshari Gewog, Punakha Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.74066, 27.7269

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: Yes

Date of implementation: 2018

Type of introduction
- [x] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

IoT-based animal repellent (Kuenzang Nima)


IoT-based animal repellent - Flash light (Kuenzang Nima)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use
Land use mixed within the same land unit: Yes - Agroforestry

Cropland
- Annual cropping: cereals - barley, cereals - maize, cereals - rice (wetland), cereals - wheat (winter)
- Perennial (non-woody) cropping: banana/plantain/abaca, herbs, chili, capsicum
- Tree and shrub cropping: avocado, citrus

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Forest/ woodlands
- (Semi-)natural forests/ woodlands. Management: Selective felling, Non-wood forest use

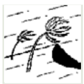
Tree types (mixed deciduous/ evergreen): n.a.
Products and services: Timber, Fuelwood, Other forest products

Water supply
- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation
- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

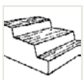


soil erosion by wind - Et: loss of topsoil

biological degradation - Bc: reduction of vegetation cover

SLM group
- Human-wildlife conflict management

SLM measures



structural measures - S11: Others

TECHNICAL DRAWING

Technical specifications

The tiger toys are placed 3 meters above the ground. To ensure stability, the toys are placed on the planks supported by strong poles.

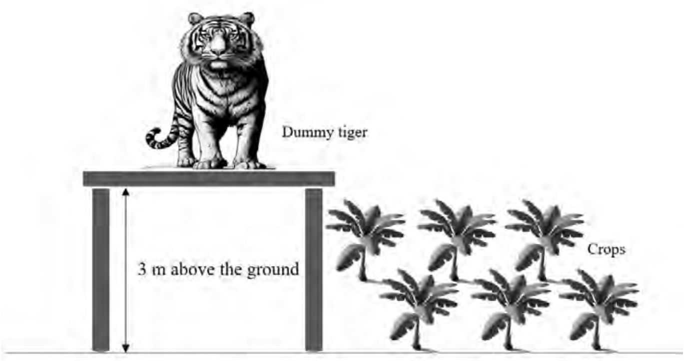


Figure: Representation of how farmers place the dummy tiger to scare other wild animal.

Author: Ongpo Lepcha

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit
- Currency used for cost calculation: **Nu.**
- Exchange rate (to USD): 1 USD = 80.0 Nu.
- Average wage cost of hired labour per day: 800

Most important factors affecting the costs

n.a.

Establishment activities

1. Procurement of tiger toys. (Timing/ frequency: Before cropping season)
2. Construction of guard houses using any available materials to place the tiger toys. (Timing/ frequency: Before cropping season)
3. Placing the tiger toys. (Timing/ frequency: Cropping season)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Nu.)	Total costs per input (Nu.)	% of costs borne by land users
Labour					
Labor	man/day	1.0	800.0	800.0	100.0
Other					
Tiger toy	No.	1.0	3380.0	3380.0	100.0
Tiger toy	No.	1.0	2000.0	2000.0	100.0
Total costs for establishment of the Technology				**6'180.0**	
Total costs for establishment of the Technology in USD				*77.25*	

Maintenance activities

n.a.

Total maintenance costs (estimation)

5346.0

NATURAL ENVIRONMENT

Average annual rainfall

- ☐ < 250 mm
- ☐ 251-500 mm
- ☑ 501-750 mm
- ☑ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone

- ☐ humid
- ☐ sub-humid
- ☑ semi-arid
- ☐ arid

Specifications on climate

Dry sub tropical

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [x] rolling (11-15%)
- [x] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [x] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [x] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family land

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor		✓		good
education	poor			✓	good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production

decreased — increased

Quantity before SLM: 125kg
Quantity after SLM: 250kg
Previously, farmers could only harvest approximately 125 kg of potatoes when planting 250 kg of seeds. Now, they can harvest nearly 1500 kg of potatoes from the same amount of seeds.

expenses on agricultural inputs

increased — decreased

Daytime crop guarding against monkeys is no longer necessary, allowing land users to allocate their time to other productive activities.

farm income

decreased — increased

With no need for daytime crop guarding, land users can engage in off-farm activities, earning up to Nu. 800 per day. This has proven to be advantageous in increasing their overall farm income.

diversity of income sources

decreased — increased

Off-farm earning has become possible. Production and marketing of other seasonal crops and high-value crops are possible.

workload

increased — decreased

The continuous daytime guarding is not required anymore.

Socio-cultural impacts

food security/ self-sufficiency

reduced — improved

The land users can produce enough for self-consumption and commercialization.

cultural opportunities (eg spiritual, aesthetic, others)

reduced — improved

The use of lethal methods for crop protection is no longer necessary, thus preventing the killing of wild animals

Ecological impacts

pest/ disease control

decreased — increased

The control of vertebrate pests, especially monkeys, has been very successful.

Off-site impacts

Protection of farms further from the land users' farms

None — None

Toy tigers protect farms further from the land users' farms also. There is no intrusion of wild animals into the villages.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns: very negative — very positive
Long-term returns: very negative — very positive

Benefits compared with maintenance costs

Short-term returns: very negative — very positive
Long-term returns: very negative — very positive

The technology is cost effective and every individual can afford it easily.

CLIMATE CHANGE

Gradual climate change

annual temperature increase: not well at all — very well
annual rainfall increase: not well at all — very well

Climate-related extremes (disasters)

local rainstorm: not well at all — very well
local thunderstorm: not well at all — very well
local hailstorm: not well at all — very well
local windstorm: not well at all — very well
extreme winter conditions: not well at all — very well
epidemic diseases: not well at all — very well
insect/ worm infestation: not well at all — very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [x] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

Number of households and/ or area covered

Out of the 21 households, 10 have embraced the technology. The reason for this is primarily that the remaining 11 households have their lands situated in the central part of the community and do not share boundaries with the forests.

Has the Technology been modified recently to adapt to changing conditions?

- [x] Yes
- [ ] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)
- [x] Modern technology integration

The Agriculture Machinery Centre (AMC) and the Dzongkhag Agriculture Office (DAO) have joined forces to create an IoT-based animal-repellent system. This system, positioned at the field's periphery, comprises three primary components: a speaker, a receptor card, and an amplifier. Once connected to a owner's smartphone, the system allows for the remote playback of various animal sounds. One system, consisting of a single receptor card, can be linked to up to five users. Additionally, two LED flashlights are integrated into the system to deter wild boars at night through powerful pulse flashes. The complete system comes at a cost of Nu. 30,000. Moreover, in their most recent endeavors, AMC and DAO are currently developing a robotic tiger capable of moving its head and limbs, enabling it to patrol the guardhouse and serve as a further deterrent to wildlife. The technology is being piloted as a project to evaluate its effectiveness in the field through trials.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The crop production is enhanced.
- Lethal methods for crop protection have been avoided.
- Overall farm income is increased after the adoption of technology.

Strengths: compiler's or other key resource person's view

- No major threats to the external environment and user friendly technology.
- Tiger toy protects the crops from wild animals. Standing crops in the field is important to prevent erosion (both soil and water), add nitrogen to the soil (e.g., by leguminous crops), and for nutrient cycling. The other important aspect is toy tiger prevents wildlife depredation.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The colour fading of tiger toys could be a problem in the future. Repaint toy tigers.
- Financial burden on the land users. Implement a cost-sharing mechanism.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- The wild animals especially the monkeys might get used to tiger toys. A robotic tiger producing sounds in certain intervals would be the next best innovation, which is already under process.

REFERENCES

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Reviewer
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Last update: June 4, 2024

Resource persons
Tshering - land user
Kinley Tshering - land user
Kinzang Dorji - land user
Namgay Tenzin - land user
Kinzang - land user
Gyeltshen Tshering - land user
Dorji Lhamo - land user
Tshewang Gyeltshen - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6860/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Introduction – Jigme Dorji National Park: https://www.dofps.gov.bt/introduction-jigme-dorji-national-park/

Technologies
Livestock

Improved Dairy Shed full view (Tshering Yangzom)

Improved Dairy Shed (Bhutan)

Rigsar Gi Nor Khim (རིགས་གསར་གྱི་ནོར་ཁྱིམ།)

DESCRIPTION

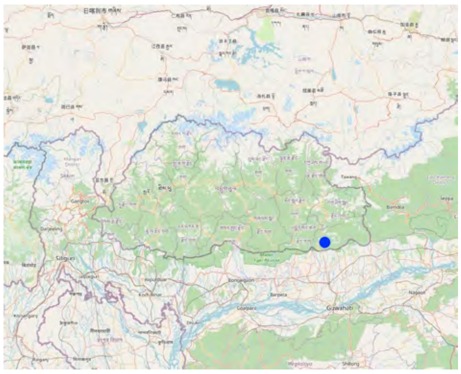
An improved dairy shed in Bhutan is characterized by concrete floors, cement pillars and troughs, enough sunlight and ventilation, adequate water, ample space for cattle movement, as well as urine and dung collection gutters and a farmyard manure collection area.

The main characteristics of the improved dairy shed are concrete floors, cement pillars and troughs, enough sunlight and ventilation, adequate water, ample space for cattle movement, urine and dung collection gutters, and a farmyard manure (FYM) collection area. The main purposes are to (a) enhance the overall well-being of animals, (b) optimize animal production, (c) minimize forest grazing and promote stall feeding, (d) increase the availability of FYM and urine for application to croplands, (e) develop pasture with fodder grasses, and (f) provide a comfortable working environment for land users.

The main inputs needed for establishment are cement for concrete floors, pillars, and troughs, and corrugated galvanised iron (CGI) sheets for roofing. The principal activities needed to maintain the technology are undertaking stall feeding instead of forest grazing, developing improved pasture with fodder grasses and trees, replacing low-yielding local cows with improved breeds dairy breeds such as Jerseys through buying or breeding (naturally or through Artificial Insemination [AI]), and better waste management.

The benefits of the technology include (a) the addition of nutrients to fields through the application of FYM and cattle urine, (b) an associated increase in organic matter, (c) better soil moisture retention, (d) availability of good quality fodder and a diverse range of forage options, (e) reduced labour due to less wild fodder collection and herding in the forest, (f) efficient waste utilization, (f) the potential manufacture and use of renewable biogas instead of liquid petroleum gas (LPG), (g) reduced land degradation due to reduction in forest grazing, (h) increased vegetation cover due to improved pasture development, (i) less soil compaction through decreased trampling by animals, (j) more comfortable working environment for land users, (k) improved livestock health and animal welfare, and (l) improved livelihoods of farmers through higher farm income. Besides these benefits, land users like the durability of the new sheds. However, one of the constraints of the technology is that the land users may lack funds to construct the sheds, or for improved cattle breeds, to justify the extra investment. These can hopefully be overcome by government support to land users through cost-sharing measures.

LOCATION



Location: Martang village, Dewathang gewog, Samdrup Jongkhar Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 91.56569, 26.88633

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2014

Type of introduction
- [x] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Improved Dairy Shed full view (Tshering Yangzom)

Improved Dairy Shed closer view (Tshering Yangzom)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - maize, legumes and pulses - beans, vegetables - leafy vegetables (salads, cabbage, spinach, other), Cole crops, root crops, Solanaceous crops, Mustard Green
- Perennial (non-woody) cropping: fodder crops - grasses
- Tree and shrub cropping: avocado, citrus, Mango, pomegranate, jackfruit

Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing

Is integrated crop-livestock management practiced? Yes
Products and services: milk

Species	Count
cattle - dairy	7

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

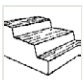
Degradation addressed

chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

SLM group

- pastoralism and grazing land management
- integrated crop-livestock management
- integrated soil fertility management

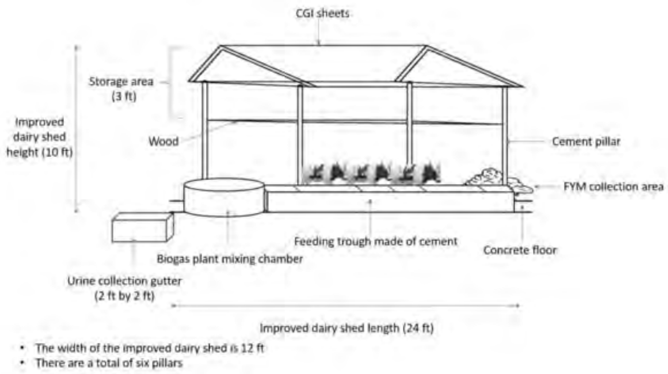
SLM measures



structural measures - S9: Shelters for plants and animals

TECHNICAL DRAWING

Technical specifications
None



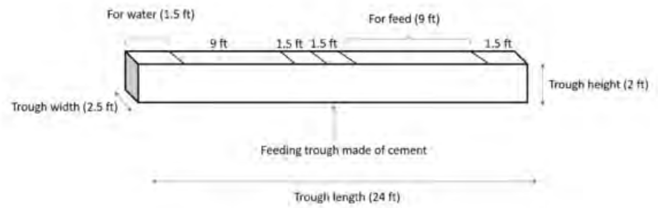


Figure 1: Technical drawing of the technology (improved dairy shed)

Author: Tshering Yangzom

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology unit
- Currency used for cost calculation: **Nu**
- Exchange rate (to USD): 1 USD = 82.0 Nu
- Average wage cost of hired labour per day: 500

Most important factors affecting the costs
Materials and transportation cost

Establishment activities
1. Deconstruction of old dairy shed that was made of wood and lacked cemented floor and pillars. (Timing/ frequency: 2013)
2. Collection of raw materials to construct an improved dairy shed such as sand, stones, cement, and CGI sheets for roofing. (Timing/ frequency: 2013)
3. Construction of the improved dairy shed (pillars, soling, roofing, storage area) (Timing/ frequency: 2013-2014)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Nu)	Total costs per input (Nu)	% of costs borne by land users
Labour					
manpower	person-days	15.0	700.0	10500.0	
Construction material					
CGI sheet (8", 0.05mm)	No	31.0	900.0	27900.0	
Boulder	Truck load	1.0	7000.0	7000.0	
Gravel	Truck load	0.5	17000.0	8500.0	
Sand	Truck load	0.5	22000.0	11000.0	
Cement	Bag	25.0	400.0	10000.0	
Planks	Cft	150.0	350.0	52500.0	
Iron road	Kg	150.0	75.0	11250.0	
Total costs for establishment of the Technology				**138'650.0**	
Total costs for establishment of the Technology in USD				*1'690.85*	

Maintenance activities
n.a.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
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- [ ] > 4,000 mm

Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
1200-2500 mm

Name of the meteorological station: The rain estimate has been derived based on the agro-ecological zone (AEZ) the area falls under.

Bhutan is divided into six AEZs (source: https://www.fao.org/3/ad103e/AD103E02.htm).

Bhutan has six AEZs. The wet sub-tropical zone is from 150 to 600 m, followed by the humid sub-tropical zone from 600 to 1,200 m. The dry sub-tropical zone starts at 1,200 m and extends to 1,800 m, followed by the warm temperate zone, which reaches 2,600 m. The cool temperate zone lies between 2,600 and 3,600 m and, finally, the alpine zone between 3,600 m and 4,600 m.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
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- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

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- [ ] poor drinking water (treatment required)
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- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

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- [ ] groups/ community
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- [ ] employee (company, government)

Gender
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- [x] men

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- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

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- [ ] < 0.5 ha
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Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
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- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor			✓	good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS

Socio-economic impacts

Crop production	decreased ✓ increased	Crop production has increased due to the use of FYM and urine from improved cattle shed.
crop quality	decreased ✓ increased	Crop quality has increased due to the use of FYM and urine from improved cattle sheds. These organic fertilizers add nutrients to the soil and enhance crop growth and development.
fodder production	decreased ✓ increased	Fodder plantation has been encouraged due to stall feeding under the improved dairy shed technology. The land user has planted fodder grasses on 1.2 acres of land. The fodder grasses grown include Napier, Super Napier, Guatemala grasses.
fodder quality	decreased ✓ increased	The land user has planted fodder grasses (a mix of Super Napier, Napier, and Guatemala) on 1.2 acres of land to be fed to cattle. A variety of fodder grasses are grown for stall feeding of cattle.
animal production	decreased ✓ increased	Animal production has increased due to improved fodder production and quality. The technology promotes integrated crop-livestock farming whereby the crop residues are fed to the cattle as feeds, another source of nutrients for the animals. Under the improved dairy shed, the animals have access to proper sunlight and ventilation, adequate water, and ample space for their movement resulting in the overall well-being of the animals.
product diversity	decreased ✓ increased	Milk production has increased due to improved fodder production and quality grown for stall feeding. The milk provides raw material to produce a wide variety of dairy products.
production area (new land under cultivation/ use)	decreased ✓ increased	Production area has increased with the land user growing fodder grasses in 1.2 acres of land. The land user feeds 7 dairy cattle with these fodder grasses.
energy generation (e.g. hydro, bio)	decreased ✓ increased	The dung from shed is used in biogas plant to produce biogas. Biogas has reduced the use of LPG gas.
farm income	decreased ✓ increased	Farm income has increased due to integrated livestock farming that has been promoted by improved dairy shed. Crop production and quality have improved due to the use of FYM and cattle urine. The increased milk production from stall feeding of good quality fodder grasses has enabled the land user to become a member of a milk group where the land user earns some amount every month.
diversity of income sources	decreased ✓ increased	The land user is now a member of a milk group. The increase in milk has encouraged the land user to join the group.

Socio-cultural impacts

food security/ self-sufficiency	reduced ✓ improved	Food security and self-sufficiency have increased due to increased animal production and crop production.
recreational opportunities	reduced ✓ improved	Stall feeding has provided an opportunity for the land user to engage in recreational activities. Earlier when there was no stall feeding, the land user had to take cattle to a nearby forest and tend them for hours.
SLM/ land degradation knowledge	reduced ✓ improved	The land user realizes the benefits of FYM application, stall feeding, fodder production, and biogas plant usage.

conflict mitigation

worsened improved

When stall feeding was not practised, land user had issues with his cattle entering into neighbours' fields and damaging their fields. This problem has been mitigated by the practice of stall feeding.

situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)

worsened improved

The situation of socially and economically disadvantaged groups has improved due to increased farm production.

Ecological impacts

soil cover

reduced improved

Soil cover has increased due to fodder grass cultivation on 1.2 acres of land.

nutrient cycling/ recharge

decreased increased

Nutrient cycling has increased due to integrated livestock farming.

soil organic matter/ below ground C

decreased increased

Soil organic matter has increased due to the addition of FYM to fields.

vegetation cover

decreased increased

Vegetation cover has increased due to fodder grass plantation on 1.2 acres of land.

emission of carbon and greenhouse gases

increased decreased

Biogas plant has reduced the use of LPG gas and methane emissions.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns very negative very positive

Long-term returns very negative very positive

Benefits compared with maintenance costs

Short-term returns very negative very positive

Long-term returns very negative very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase not well at all very well

seasonal temperature increase not well at all very well Season: summer

annual rainfall increase not well at all very well

seasonal rainfall increase not well at all very well Season: summer

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 11-50%
- ☑ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ☑ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Number of households and/ or area covered

25 households out of 28 households have adopted the technology

Has the Technology been modified recently to adapt to changing conditions?

- ☐ Yes
- ☑ No

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- An improved dairy shed made of cement, gravel, and stones is more durable than the old dairy shed made from wood.
- Addition of nutrients in fields through application of FYM and cattle urine.
- Increase in organic matter due to FYM application in the field.
- Availability of good quality fodder and a diverse range of forage options.
- Reduced labour due to reduced fodder collection and herding in the forest.

Strengths: compiler's or other key resource person's view

- Efficient waste utilization.
- Biogas has reduced the use of LPG gas.
- Reduced land degradation due to reduction in forest grazing
- Increased vegetation cover due to improved pasture development and reduction in forest grazing.
- Stall feeding reduces soil compaction through trampling by animals.
- Better soil moisture retention by increased soil organic matter.
- Comfortable working environment for land users.
- Improved livelihood of farmers through higher farm yields and better household income.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The land user has designed the slurry inlet chamber of the biodigester plant near feeding troughs so the inlet chamber has to be relocated. Relocate the biodigester.
- Lack of funds to buy improved breeds. Government support to land users through cost-sharing measures.
- Lack of funds for improved dairy shed construction. Government support to land users through cost-sharing measures.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
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Editors
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Reviewer
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Rima Mekdaschi Studer
Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Shacha Zangpo - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6898/

Linked SLM data
Approaches: Improved Livestock Farming System https://qcat.wocat.net/en/wocat/approaches/view/approaches_6895/
Approaches: Dairy Cooperatives and KOUFUKU linkage for milk marketing https://qcat.wocat.net/en/wocat/approaches/view/approaches_6889/

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Thapa, L., Choden, D., & Tamang, N. B. (2019). Adoption of Improved Dairy Production Practices by Dairy and Non- Dairy Farmers' Groups.: https://www.researchgate.net/profile/Lokey-Thapa/publication/334507972_Adoption_of_Improved_Dairy_Production_Practices_by_Dairy_and_Non-_Dairy_Farmers'_Groups/links/5d2ec146299bf1547cbd248a/Adoption-of-Improved-Dairy-Production-Practices-by-Dairy-and-Non-Dairy-Farmers-Groups.pdf

Links to relevant information which is available online

- National Soil Services Centre. (2011). Bhutan Catalogue of Soil and Water Conservation Approaches and Technologies. National Soil Services Centre, Department of Agriculture, Ministry of Agriculture and Forests, Royal Government of Bhutan, Thimphu.: https://www.wocat.net/library/media/95/

fully functioning biogas at one of the landusers house (Ongpo Lepcha)

Biogas plant (Bhutan)

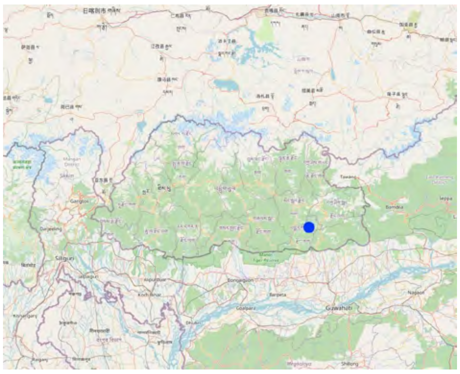
Kayden meylung (སྐྱེས་ལྡན་མེ་རླུང་།)

DESCRIPTION

Biogas is a renewable fuel generated through the anaerobic digestion of organic matter like food or animal waste, typically within a biogas plant. The biogas plant is adapted to household conditions and animal waste production. While this technology benefits small-scale farmers, challenges include the cost of establishment and the need for consistent waste input. Adoption has significantly reduced costs for users, lowered greenhouse gas emissions, and provided organic fertilizer, enhancing crop productivity and livestock health.

Biogas is a renewable fuel produced through the anaerobic digestion of organic matter, such as food or animal waste. Typically, biogas is intentionally generated in an enclosed environment (a biogas plant) for household consumption. This plant is constructed near a livestock shed for easy collection of animal waste and in proximity to households, mainly used for cooking, heating, and as an alternative to commercial LPG gas.
The plant can be adjusted based on the amount of animal waste, making it viable for smallholder farmers with just a few cows. In most parts of the country, the technology is modified so that even a small amount of animal waste can produce some gas. The digestion chamber is made smaller in diameter and height to generate enough pressure for the gas to reach the stove through the pipe. Initially, the Biogas project started to promote clean and renewable energy for household cooking, reducing the consumption of firewood. Currently, there are more than 8000 biogas plants of different sizes - 4 m3, 6 m3, 8 m3, and 10 m3, and a few large-scale biogas greater than 50 m3 in large individual dairy farms and government livestock farms.
The major activities and inputs required to establish and maintain the technology include having ample space around the residential area for the plant's construction. Additionally, materials such as cement, sand, gravel, stone, iron rods, pipes, pressure gauges, and a stove are necessary. Human resources are needed for the construction of the plant, and land users should have livestock (cows, buffaloes, horses, etc.) that can provide dung/waste for gas generation.
There are numerous benefits and impacts of the technology, including its positive effects on rural communities, greenhouse gas emission reduction, maintaining carbon neutrality, and minimizing the use of imported LPG gas and chemical fertilizers. It also reduces electricity bills needed for operating electric heaters, saving time for land users who would otherwise collect firewood. The by-product (bio-slurry) from the digester is used as organic fertilizer, enhancing crop productivity and serving as a nutritious feed supplement for animals.
Land users both appreciate and have concerns about the technology. They acknowledge the cost reduction benefits, citing the significant savings compared to market-priced commercial LPG gas and reduced expenses on operating electric heaters. The technology has also provided them with additional time by eliminating the need to gather firewood. The bio-slurry, a by-product of the biodigester, serves as fertilizer to enhance crop production and contributes to livestock waste management, improving livestock health and production.
However, land users note that biogas plant establishment is expensive and may not be suitable for economically disadvantaged individuals. Some users experience challenges, such as the biodigester chamber failing to produce enough gas despite being constructed according to technical specifications. The daily requirement of adding animal waste to the input tank is perceived as tedious, and for land users with only one or two milking cows, supplying the required amount of animal waste for the biodigester chamber is often a problem.

LOCATION



Location: Darchung under Shumar Chiwog (Community), Shumar Gewog (Block), Pemagatshel Dzongkhag (District), Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 91.38722, 27.05001

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2021

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Officials from CNR interacting with land user on biogas plant (Ongpo Lepcha)

Different components of biogas plant (Chogyel Wangdi)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

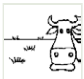
- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact
- [x] The main purpose as discussed by the land user was to reduce the cost and effort invested in getting LPG. Getting LPG was difficult becuase of the distance.

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland
- Annual cropping
- Perennial (non-woody) cropping
- Tree and shrub cropping

Number of growing seasons per year: 3
Is intercropping practiced? No
Is crop rotation practiced? Yes



Grazing land
- Land user allow six months of grazing in pasture land. Six months cattle are stall fed.

Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, manure as fertilizer/ energy production, milk

Species	Count
cattle - dairy	8

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

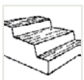
Degradation addressed

physical soil deterioration - Pu: loss of bio-productive function due to other activities

SLM group

- integrated crop-livestock management
- waste management/ waste water management
- energy efficiency technologies

SLM measures

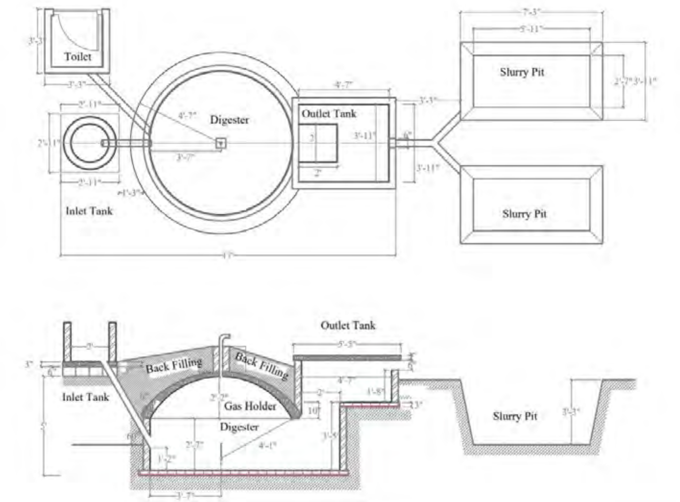


structural measures - S9: Shelters for plants and animals, S10: Energy saving measures

TECHNICAL DRAWING

Technical specifications

Technical design and specification of 4 cubic meter biogas plant capacity



Author: Bhutan Biogas Project, Department of Livestock, Ministry of Agriculture & Livestock

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **inlet tank (mixing tank), inlet pipes, Digester, gas holder, manhole, outlet, main gas pipe turret, main gas valve, pipeline, water outlet, pressure gauge, gas tab, gas stove, gas lamp, slurry pit** volume, length: **Dimensions of unit is given in technical diagram.**)
- Currency used for cost calculation: **Bhutanese Ngultrum**
- Exchange rate (to USD): 1 USD = 82.73 Bhutanese Ngultrum
- Average wage cost of hired labour per day: Nu 350

Most important factors affecting the costs

Raw materials, transportation cost, labour charges.

Establishment activities

1. Selection of construction site and layout of the plant (Timing/ frequency: 1st March)
2. Digging of pits (Timing/ frequency: 15th April)
3. construction of digester (Timing/ frequency: May)
4. construction of gas holder (dome) (Timing/ frequency: May)
5. Plastering of Digester and gas holder (Timing/ frequency: May)
6. construction of turret, manhole and outlet tank (Timing/ frequency: May)
7. Construction of Inlet Tank (Timing/ frequency: June)
8. Fitting pipelines and appliances (Timing/ frequency: June)
9. Construction of compost pit (Timing/ frequency: June)
10. Finishing and instruction to users (Timing/ frequency: July)

Establishment inputs and costs (per inlet tank (mixing tank), inlet pipes, Digester, gas holder, manhole, outlet, main gas pipe turret, main gas valve, pipeline, water outlet, pressure gauge, gas tab, gas stove, gas lamp, slurry pit)

Specify input	Unit	Quantity	Costs per Unit (Bhutanese Ngultrum)	Total costs per input (Bhutanese Ngultrum)	% of costs borne by land users
Labour					
Labour	person-days	18.0	350.0	6300.0	
Masion	person-days	12.0	1000.0	12000.0	
Equipment					
Mixture machine	no	1.0	1740.0	1740.0	
GI nozzle	no	1.0	113.0	113.0	

Plant material					
water draining pipe	no	1.0	262.0	262.0	
Main gas valve	no	1.0	523.0	523.0	
Paint brush	no	1.0	85.0	85.0	
Iron brush	no	1.0	85.0	85.0	
CPVC glue (50gm)	Jar	1.0	390.0	390.0	
Teflon tape	roll	1.0	25.0	25.0	
PVC pipe 4"10' (inlet)	no	1.0	1050.0	1050.0	
Construction material					
Cement	Bag	18.0	380.0	6840.0	
Bricks	No	1000.0	11.0	11000.0	
Gravels	Truckload	0.5	5000.0	2500.0	
Sand	Truckload	0.25	6000.0	1500.0	
Arcrylic paint	litres	3.0	350.0	1050.0	
Iron rod	kg	10.0	70.0	700.0	
Dome pipe	No	1.0	1170.0	1170.0	
Other					
Stove	No	1.0	1399.0	1399.0	
CPVC Pipe (10')	No	10.0	350.0	3500.0	
Gas tap	No	1.0	465.0	465.0	
Pressure meter	No	1.0	320.0	320.0	
Elbow joint	No	4.0	350.0	1400.0	
T - union	No	2.0	150.0	300.0	
Total costs for establishment of the Technology				**54'717.0**	
Total costs for establishment of the Technology in USD				*661.39*	

Maintenance activities
n.a.

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- ✓ 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- ✓ sub-humid
- semi-arid
- arid

Specifications on climate
The study area is located in sub humid area

Slope
- flat (0-2%)
- gentle (3-5%)
- ✓ moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landforms
- plateau/plains
- ridges
- ✓ mountain slopes
- hill slopes
- footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- ✓ not relevant

Soil depth
- very shallow (0-20 cm)
- ✓ shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- ✓ fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- coarse/ light (sandy)
- ✓ medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- ✓ high (>3%)
- medium (1-3%)
- low (<1%)

Groundwater table
- on surface
- < 5 m
- 5-50 m
- > 50 m

Availability of surface water
- excess
- good
- medium
- poor/ none

Water quality (untreated)
- ✓ good drinking water
- poor drinking water (treatment required)
- for agricultural use only (irrigation)
- unusable

Water quality refers to: surface water

Is salinity a problem?
- Yes
- ✓ No

Occurrence of flooding
- ✓ Yes
- No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [x] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor			✓	good
markets	poor			✓	good
energy	poor			✓	good
roads and transport	poor		✓		good
drinking water and sanitation	poor			✓	good
financial services	poor			✓	good

Comments

The hospital is located 10 km away from Land users' places. Which makes it a little difficult during emergencies. The school is 2 Km away which is very near. There are also Gypsum Mining which provides off-farm activities to many land user in the locality. The land user is trained in making Biogas plants, this also provides him the opportunity to work off-farm. When it comes to energy, apart from energy to light the house, energy is required for cooking purposes. This energy was previously derived from LPG, however, after the Biogas plant land user is not having any difficulties with energy shortage. Land users have their own water source and the same water is used to feed Jersey cows. Land users also said that they get financial assistance from Bhutan Development Bank Limited.

IMPACTS

Socio-economic impacts

Crop production

decreased					✓			increased

Land users didn't keep a record of the production, however, it was reported that crop production has improved.

crop quality

decreased						✓		increased

land users reported that crops are healthier and green when manure prepared from cow dung/ biogas plants is applied on the land.

fodder production

decreased						✓		increased

Land user is also members of milk cooperatives. He maintains different fodder species to have feed for his cows throughout the years. He said fodder production has increased over the years.

fodder quality

decreased							✓	increased

Different species of fodder species like Napier, Ruzi, Guatemala, Super Napier, Banana, Rice straw, maize, and fooder tree species like Ficus auriculata, Ficus simicordata, etc., were observed.

energy generation (e.g. hydro, bio)

decreased							✓	increased

Quantity before SLM: 6 LPG cylinder per annum
Quantity after SLM: 0
Each LPG cost around Nu. 1000. LPG is completely replaced by biogas technology.

drinking water quality

decreased ✓ increased

Water was not a problem from the beginning. However, with an improved breed of cow (jersey), water sanitation is also given more importance. Because water can bring diseases to family members and livestock.

farm income

decreased ✓ increased

Land user don't have to buy LPG cylinders. He saves around 7000 in a year.

workload

increased ✓ decreased

Workload has increased since the biogas plant was constructed. Every day the land user have to collect cow dung and add it to the plant. He also has to collect slurry and add to the land to improve fertility.

Socio-cultural impacts

Ecological impacts

Off-site impacts

impact of greenhouse gases

increased ✓ reduced

Scope to conduct research to estimate GHG emission reduction from biogas technology

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative ✓ very positive

Long-term returns — very negative ✓ very positive

Benefits compared with maintenance costs

Short-term returns — very negative ✓ very positive

Long-term returns — very negative ✓ very positive

The investment cost is shared by the Government. Therefore, the land users felt the benefits are very positive.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all ✓ very well	
seasonal temperature increase	not well at all ✓ very well	Season: summer
annual rainfall increase	not well at all ✓ very well	
seasonal rainfall increase	not well at all ✓ very well	Season: summer

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [x] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

Only two households were interviewed, alothough, there are more than 300 households who have adopted biogas technology under study area (Shumar Gewog).

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Land user need not buy LPG cylinders because the Biogas plant
- No need to go to collect firewood

Strengths: compiler's or other key resource person's view
- Efficient use of livestock (cow dung) for generation energy which is used for cooking.
- The technology is not easily damaged by pests, temperature, rainfall, etc.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- Cow dung has to be collected, and put into a mixing tank and mixing has to be done manually which is hectic.
- A huge amount of cow dung is required.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- Sometimes, despite good construction material, small calculations in biodigester and gas compartments can lead to a technical error, and this can inhibit gas production. In such cases, the biogas plant becomes nonfunctional. Being extra careful with the design and consulting the biogas focal person to monitor the construction work.
- Low temperature has a deleterious effect on methanogenesis and can cause decreased gas yields. So the technology may not work effectively in winter. Maintaining the temperature by covering the tank with warm material.

REFERENCES

Compiler
ONGPO LEPCHA

Editors
Tashi Wangdi

Reviewer
Rima Mekdaschi Studer
William Critchley

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Resource persons
Rangsem Tshojay - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6865/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
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Links to relevant information which is available online
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- Biogas Project Overview: Bhutan, Dawa Penjor Dawa Zam (presentation): https://www.saarcenergy.org/wp-content/uploads/2016/07/Bhutan%20presentation.pdf
- Biogas system at household level fed daily with cattle manure [Cambodia]: https://qcat.wocat.net/wocat/technologies/view/technologies_1645/
- Domestic Biogas Plant for Fuel and fertilizer[Uganda]: https://qcat.wocat.net/wocat/technologies/view/technologies_3371/

Entrance to the stall-feeding unit of Mr. Hemlal Chettri (karma Wangdi)

Stall-Feeding of Dairy Cows (Bhutan)

Tsa Chhag Jin Tey Nor So Chong (རྩ་ཆག་བྱིན་སྟེ་ནོར་གསོ་སྐྱོང་།)

DESCRIPTION

Stall-feeding is an improved cattle production system, which is increasingly being adopted with a growing population of high yielding exotic dairy breeds. Thus, most improved dairy cattle in Nepal are being reared under confinement with limited access to grazing, as it allows for easy and optimal supplementation of fodder.

Stall-feeding, or “zero-grazing”, is a livestock management approach that confines animals within stalls or pens for feeding. It offers various advantages, such as improved waste management, precise nutrition control, and reduced risk of overgrazing. It allows farmers to carefully regulate their animals' diets to ensure they receive the necessary nutrition for optimal growth and productivity (Hadush, 2002). To effectively implement stall-feeding, several key components are required. Firstly, animals must be housed in separate stalls of appropriate size to facilitate cleaning and waste collection. Secondly, a well-planned feeding system is essential, which may involve the use of automatic feeding equipment, or alternatively manual distribution of hay, grains, and supplements tailored to each breed's unique nutritional needs. Thirdly, a comprehensive waste management system is crucial to handle the manure produced by confined animals, which involves thorough stall cleaning and composting, transforming waste into organic fertilizer. Proper water supply and ventilation are also imperative for the animals' health and well-being. Adhering to these technical requirements (Garber, 2010) ensures optimal productivity and animal welfare in the stall-feeding system.

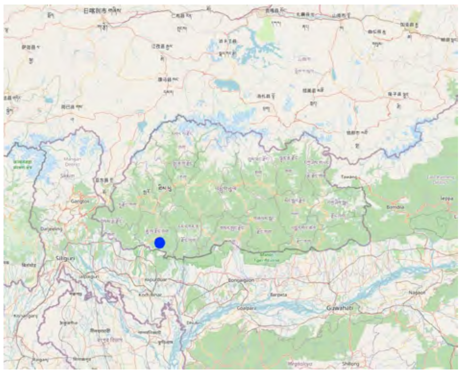
Stall-feeding is employed in various agricultural contexts worldwide, particularly where traditional open grazing is impractical or unsustainable. It is applied in areas with limited grazing land and high population density, such as urban and peri-urban settings. Moreover, it may be used in arid or semi-arid regions with scarce natural pastures, as well as during dry seasons when grazing resources are scarce. Smallholder farms and intensive livestock production systems aim to maximize output while optimizing resource usage, making stall feeding a prevalent practice. Dairy farming employs stall-feeding to boost milk production and enhance the quality of dairy products (Oosting et al., 2021).

According to Sahoo et al. (2015), the primary objective of stall-feeding is to provide controlled and ideal conditions for managing and feeding cattle. This approach ensures that animals are housed indoors according to their age, sex, breed, and weight, preventing them from grazing outdoors. To establish a well-functioning system, several crucial steps must be taken. First and foremost is the construction of individual stalls or pens, with careful consideration of size and design to accommodate different animals comfortably. The implementation of a reliable and well-planned feeding strategy is equally crucial. Adequate water supply and optimal ventilation within the stalls are also vital considerations (Van Eerdenburg & Ruud, 2021).

One of the primary advantages of stall feeding is its ability to provide animals with controlled and balanced nutrition, resulting in improved growth rates and higher-quality products like milk or meat. It also aids in disease prevention and mitigates the environmental impact of overgrazing. However, the main drawback lies in the additional effort and expense associated with feeding, cleaning, and waste management. Improperly managed confinement can limit animals' freedom of movement, potentially affecting their behavioral and psychological well-being. Proper ventilation and hygiene within the stalls are essential to address these concerns (Sahoo et al., 2015).

The type of fodder grown for dairy cattle primarily includes a variety of grasses and legumes suitable for the region's climate and terrain. Common fodder crops grown for dairy farming include Napier grass (Pennisetum purpureum), Rhodes grass (Chloris gayana), Alfalfa (Medicago sativa), Clover (Trifolium spp.), Ryegrass (Lolium spp.) sorghum (Sorghum bicolor). Additionally, Bhutan's traditional agroecological practices may also involve grazing on natural pastures and feeding on crop residues such as maize stalks and rice straw.

LOCATION



Location: Arekha, Darla,, Chukha, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 89.57025, 26.88136

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2016; less than 10 years ago (recently)

Type of introduction
- ☑ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

In Bhutan, traditional cattle breeds such as the Jersey, Brown Swiss, and local breeds are commonly raised for milk production. The milk yield per cow varies significantly based on factors such as breed genetics, nutrition, health, and management practices. On average, dairy cows in Bhutan may produce anywhere from 5 to 10 liters of milk per day, although some high-yielding breeds or well-managed farms may achieve higher yields. However, it's essential to note that these figures are approximate and can vary widely.

Cattle shed with stall-feeding by Mr. Hemlal Chettri (karma Wangdi)

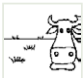
Jersey cows inside stall-feeding shed (Tshering Zangmo)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use



Grazing land

- Cut-and-carry/ zero grazing

Animal type: cattle - dairy
Is integrated crop-livestock management practiced? No
Products and services: manure as fertilizer/ energy production

Species	Count
cattle - dairy	18

Water supply

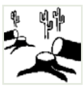
- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wm: mass movements/ landslides

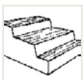


biological degradation - Bc: reduction of vegetation cover

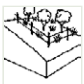
SLM group

- integrated crop-livestock management
- improved plant varieties/ animal breeds
- energy efficiency technologies

SLM measures



structural measures - S9: Shelters for plants and animals

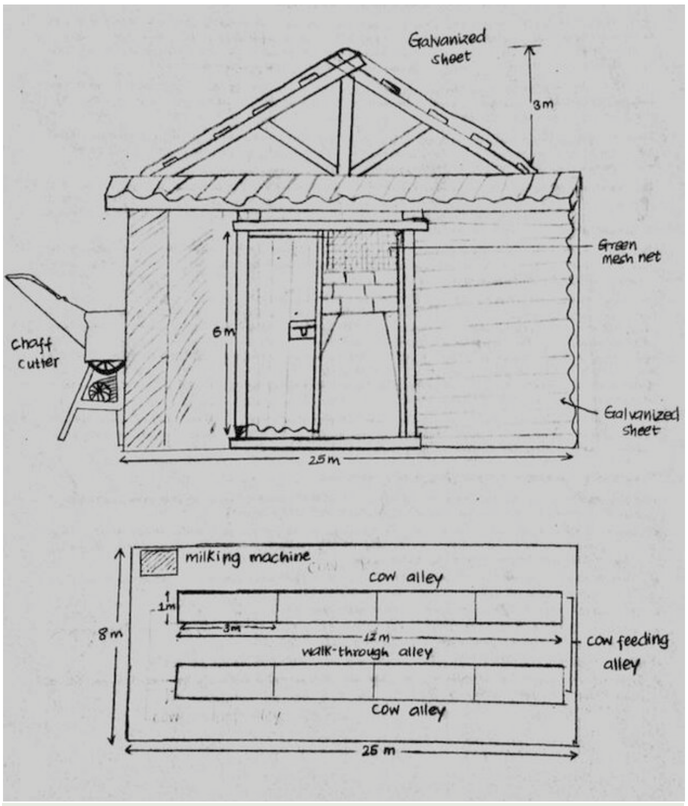


management measures - M1: Change of land use type, M2: Change of management/ intensity level, M3: Layout according to natural and human environment

TECHNICAL DRAWING

Technical specifications

None



Author: Niki Rai

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Stall-feed unit** volume, length: **approx 3500 metres squared (Stall-Feeding unit)**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 80.0 Ngultrum
- Average wage cost of hired labour per day: 500

Most important factors affecting the costs

Lack of materials and procurement of materials is expensive

Establishment activities

1. Site selection (Near the road) (Timing/ frequency: Winter)
2. Gathered raw materials (Timing/ frequency: winter)
3. Construction of shelter (Timing/ frequency: winter)
4. Construction of individual stalls with proper size and design to comfortably accommodate the cattles (Timing/ frequency: winter)
5. Set up a dependable and well thought feeding strategy (Timing/ frequency: winter)
6. Roofing of the stalls with CGI sheets (Timing/ frequency: winter)
7. Installation of proper ventilation for cattles (Timing/ frequency: winter)
8. Installing of water pumps to clean the areas (Timing/ frequency: winter)
9. Installing of miliking machine and chaff cutter (Timing/ frequency: winter)

Establishment inputs and costs (per Stall-feed unit)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
labor	per head	150.0	500.0	75000.0	100.0
Equipment					
Spade	numbers	10.0	300.0	3000.0	
Crowbar	numbers	10.0	500.0	5000.0	
Construction material					
Cement	bags	50.0	390.0	19500.0	100.0
CGI sheet	number	117.0	750.0	87750.0	100.0
iron rod	piece	14.0	600.0	8400.0	100.0
Bricks	piece	1000.0	7.0	7000.0	100.0
Stones	trucks	16.0	6700.0	107200.0	100.0
Wood	CFT	250.0	450.0	112500.0	100.0

Other					
Cattle	numbers	8.0	75000.0	600000.0	100.0
Chaff cutter	number	1.0	50000.0	50000.0	100.0
milking machine	number	1.0	35350.0	35350.0	100.0
water pump	number	1.0	8000.0	8000.0	100.0
Total costs for establishment of the Technology				**1'118'700.0**	
Total costs for establishment of the Technology in USD				*13'983.75*	

Maintenance activities

1. Floor cracking repair (Timing/ frequency: December, 2020)

Maintenance inputs and costs (per Stall-feed unit)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
Helper	per head	30.0	500.0	15000.0	100.0
Construction material					
cement	bags	8.0	390.0	3120.0	100.0
Total costs for maintenance of the Technology				**18'120.0**	
Total costs for maintenance of the Technology in USD				*226.5*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 1800.0
rainy in monsoon season. (may- August)
Name of the meteorological station: National center for hydrology and metrology
humid subtropical agro climatic zone.
Elevation range from 500 to 1000 m

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [x] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [x] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [x] children
- [x] youth
- [x] middle-aged
- [x] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

	poor			good
health			✓	
education			✓	
technical assistance			✓	
employment (e.g. off-farm)			✓	
markets		✓		
energy			✓	
roads and transport			✓	
drinking water and sanitation				✓
financial services		✓		

IMPACTS

Socio-economic impacts

fodder production	decreased						✓		increased
animal production	decreased						✓		increased

Socio-cultural impacts

food security/ self-sufficiency	reduced							✓	improved

Ecological impacts

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

If he can expand the farm he seeslong term benefits to access to market

CLIMATE CHANGE

Gradual climate change

seasonal temperature increase	not well at all			✓			very well	Season: wet/ rainy season
seasonal rainfall decrease	not well at all			✓			very well	Season: summer

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [x] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [x] Yes
- [ ] No

To which changing conditions?

- [x] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

Stalls designed: to ensure proper ventilation and drainage to maintain optimal living conditions for the animals. Cemented the flooring of the shed. Feed Management: The availability and affordability of feed ingredients in Bhutan which influence the composition of the diet provided to dairy cattle. Local feed resources such as grasses, legumes, crop residues, and agro-industrial by-products utilized efficiently.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Employment opportunities (Farm attendant)
- Income generation
- Community service

Strengths: compiler's or other key resource person's view

- Ease management - ensures that the animals to be kept inside the shed or house as per their age, sex, weight and breed.
- ensures to keep away the animals from grazing outside.
- Proper care, appropriate feeds for better growth of the cattle and production

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Diseases of animals Proper management

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- High investment Land support from government and other projects Subsidy support

REFERENCES

Compiler
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Resource persons
Hemlal Chettri - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6869/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
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Links to relevant information which is available online
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Winter pasture lands for the nomads of Dhur (Dr Jigme Thinley, Department of Livestock)

Managed Burning of Rangeland (Bhutan)

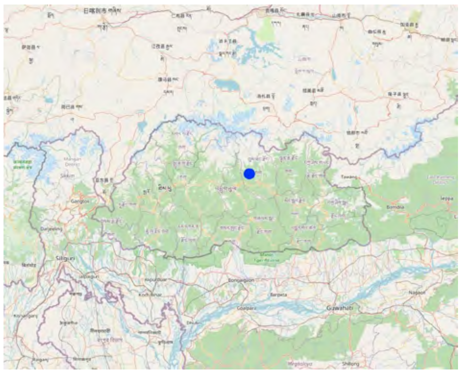
Tshaezin Gi Thogley Meytang Tey Tsadrok Zinchong (ཚད་འཛིན་གྱི་ཐོག་ལས་མེ་བཏང་སྟེ་རྩྭ་འབྲོག་འཛིན་སྐྱོང་།)

DESCRIPTION

Burning of rangeland (“tsamdro”) is a traditional management practice adopted by highlanders to control unpalatable grass and shrub species. This helps them produce adequate fodder for their yaks, cattle, horses, and sheep by creating a favorable environment for palatable grasses.

The practice of burning rangeland (“tsamdro”) is a longstanding tradition among highlanders, whose livelihoods depend on livestock including yaks, cattle, horses and sheep. It is mainly practiced by transhumant communities or individuals who rely on livestock for their livelihoods. They follow a migratory livestock husbandry system that takes them from the highlands to the lowlands dependent on the availability of fodder resources, while simultaneously avoiding the extremes of climate. In the past, rangeland was allocated to individuals, communities, or religious bodies through payment for a minimal annual grazing permit, granting grazing rights. When pasture was scarce, controlled fires were intentionally set in specific areas to rejuvenate the rangeland with fresh grass and control unpalatable grasses and shrubs. For instance, the transhumant nomadic communities of Dhur village, Choekhor Gewog, in Bumthang have adopted the practice of burning rangeland. This practice is implemented during the winter months, dependent on weather, vegetation status, and wind patterns. Rooted in traditional knowledge and cultural practices, the practice is slowly diminishing nowadays due to environmental concerns and labour shortages as young nomads migrate - seeking better employment in towns.
The technique serves multiple purposes. These include promoting the growth of fresh and palatable pasture rich in protein, increasing plant diversity, adding nutrients to the soil through ash, and reducing dead plant material that inhibits new plant growth. Additionally, rangeland burning contributes to the control of livestock pests, especially ticks and flies. While rangeland burning is a straightforward process, it requires careful planning of time and location, creation of fire breaks to prevent uncontrollable spread, and leaving the land fallow for 2 to 3 years after burning to encourage grass growth.
Land users appreciate the technology for reducing their workload in collecting wild fodder grasses, enhancing visibility by removing trees and shrubs, and reducing the risk of predators. However, risks include the potential for uncontrolled fires if not properly managed and harm to the ecosystem and biodiversity in and around the pastureland. Burning also contributes to the loss of carbon dioxide (a greenhouse gas) to the atmosphere.

LOCATION



Location: Dhur village, Choekhor Gewog (Block), Bumthang Dzongkhag (District), Bhutan

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 90.65579, 27.61877

Spread of the Technology: evenly spread over an area (approx. 0.1-1 km2)

In a permanently protected area?: No

Date of implementation: more than 50 years ago (traditional)

Type of introduction
- [ ] through land users' innovation
- [x] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

Enumerators and land user, who practiced rangeland burning for pasture land establishment (Tshewang Phuntsho)

Winter pastureland of one of the nomads in Dhur (Tshering Zangmo)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ☑ improve production
- ☐ reduce, prevent, restore land degradation
- ☐ conserve ecosystem
- ☐ protect a watershed/ downstream areas – in combination with other Technologies
- ☐ preserve/ improve biodiversity
- ☐ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ☐ create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Silvo-pastoralism

Grazing land

- Nomadism
- Pasture grass is natural grown and livestock are allowed to graze on it

Is integrated crop-livestock management practiced? No
Products and services: meat, milk, skins/ hides

Species	Count
cattle - dairy	50
cattle - dairy	55

Forest/ woodlands

- (Semi-)natural forests/ woodlands: temperate mountain systems natural vegetation. Management: Dead wood/ prunings removal

Tree types (evergreen): n.a.
Products and services: Nature conservation/ protection

Water supply

- ☑ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Purpose related to land degradation

- ☐ prevent land degradation
- ☐ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☑ not applicable

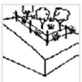
Degradation addressed

other - Specify: Revitalise and regenerate growth of palatable grass species to be used for livestock grazing

SLM group

- pastoralism and grazing land management

SLM measures

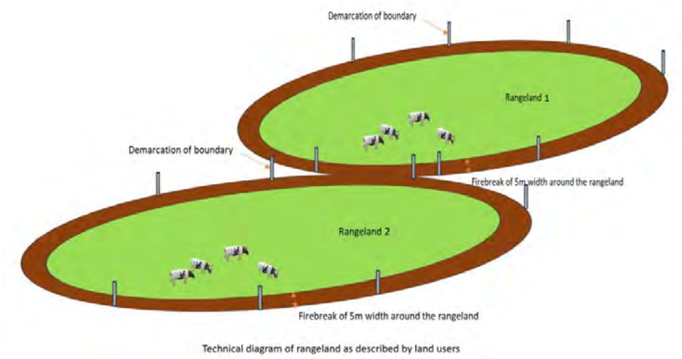


management measures - M5: Control/ change of species composition

TECHNICAL DRAWING

Technical specifications

Firebreak of 5 m are kept to control the burning



Author: Ongpo Lepcha

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 acres**; conversion factor to one hectare: **1 ha = 0.4 hectare**)
- Currency used for cost calculation: **Bhutanese Ngultrum**
- Exchange rate (to USD): 1 USD = 82.08 Bhutanese Ngultrum
- Average wage cost of hired labour per day: 1200

Most important factors affecting the costs

Labour cost

Establishment activities

1. Creating fire break around the pasture land (Timing/ frequency: During the winter season)
2. Burning of the pasture land (Timing/ frequency: During the winter season)
3. After burning the land is left fallow for the pasture land to establish (Timing/ frequency: Kept fallow for the next 2 to 3 years)

Establishment inputs and costs (per 1 acres)

Specify input	Unit	Quantity	Costs per Unit (Bhutanese Ngultrum)	Total costs per input (Bhutanese Ngultrum)	% of costs borne by land users
Labour					
Labours	person-days	9.0	1200.0	10800.0	98.0
Equipment					
grass cutter	No	1.0	15000.0	15000.0	
Pipe	Bundle	1.0	3000.0	3000.0	
Spade	No	3.0	500.0	1500.0	
Total costs for establishment of the Technology				**30'300.0**	
Total costs for establishment of the Technology in USD				*369.15*	

Maintenance activities

1. Land is left fallow (Timing/ frequency: For 2 to 3 years)

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [x] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate

The data was used from the National Center for Hydrology and Meteorology from the nearest weather station.
Name of the meteorological station: https://www.nchm.gov.bt/home/pageMenu/906
Cool temperate zone

Slope

- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [x] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms

- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude

- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
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- [ ] 2,501-3,000 m a.s.l.
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- [ ] > 4,000 m a.s.l.

Technology is applied in

- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [x] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [x] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [x] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [x] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [x] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor				good
health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor			✓	good
markets	poor		✓		good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

Comments
Access to these services and infrastructure were based on their winter home, during the summer they would travel to the more higher altitudes where none of these services are available except for drinking water.

IMPACTS

Socio-economic impacts

fodder production	decreased							✓	increased	The land users shared that fodder production is relatively higher when practicing rangeland burning.
fodder quality	decreased							✓	increased	When comparing cut grass and grass in burned rangeland, the land users prefer the grass in the burned rangeland.
animal production	decreased							✓	increased	According to the land users, milk yield is better and higher from cattle fed on grasses from rangeland, which was burnt previously.

risk of production failure	increased						✓		decreased
farm income	decreased						✓		increased

Land user also shared that burning rangeland provides enough food for their livestock which is sufficient throughout the year. This reduces the risk of production due to a shortage of grasses/feed.

Farm income is higher when compared to dairy supplemented with commercial feed in the winter. In addition, the establishment cost and implementation cost is also very low.

Socio-cultural impacts

Ecological impacts

vegetation cover	decreased		✓						increased
plant diversity	decreased		✓						increased
habitat diversity	decreased		✓						increased
pest/ disease control	decreased						✓		increased

Vegetation cover is reduced because of this technology. This is because shrubs and trees are intentionally removed from the rangeland.

Plant diversity is also very minimal since tree saplings and shrubs are burned leaving only the pasture grass to grow on the land

Only grass is maintained as part of the technology. Habitat diversity is very low as trees and shrubs which also serve as habitats for many insects and arthropods are removed from rangeland.

It is reported in the literature that rangeland burning can reduce pest like tick and flies.

Off-site impacts

impact of greenhouse gases	increased		✓						reduced

Burning of the rangeland leads to the production of several greenhouse gases, inevitably.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative							✓	very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative							✓	very positive
Long-term returns	very negative							✓	very positive

Since minimal cost goes into implementing the technology, the income earned from it is high. Further, the land users also earn income from cordyceps, therefore, off farm income is very high than from dairy produced from the cattles.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all				✓		very well
annual rainfall decrease	not well at all				✓		very well

Climate-related extremes (disasters)

local rainstorm	not well at all				✓		very well
local thunderstorm	not well at all					✓	very well
local hailstorm	not well at all				✓		very well
local snowstorm	not well at all				✓		very well
local windstorm	not well at all					✓	very well
cold wave	not well at all				✓		very well
drought	not well at all				✓		very well
forest fire	not well at all		✓				very well
landslide	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [x] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

Number of households and/ or area covered

17 households from a total of 105 household in the village are land users and practice rangeland burning.

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Feed security for livestock: Land users have high-quality grasses in enough quantity to feed his/her cattle for the seasons.
- The land is revitalized for better growth of the pasture grass: fresh and healthy grasses growing after the burning of rangeland are rich in protein and enhanced digestibility
- Less workload: Implementation of this technology is easy and land users have enough time to di off-farm activities.

Strengths: compiler's or other key resource person's view

- Rangeland burning helps control the spread of woody plants and invasive species.
- Rangeland burning has cultural significance and is deeply rooted in traditional knowledge and practices.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Can lead to forest fire Land users should create fire break to prevent the fire from becoming uncontrollable
- Affect ecosystem and biodiversity in and around the pasture land Using better varieties of pasture grass.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Intense fires or repeated burning in the same areas can lead to increased soil erosion. Implementing proper rotational burning practices, where different areas of the rangeland are burned in a planned sequence.
- Rangeland burning can produce smoke and affect air quality and add carbon dioxide (green house gases) to the atmosphere. Burns should be carried out under favorable weather conditions, taking into account wind direction and dispersion patterns.

REFERENCES

Compiler
ONGPO LEPCHA

Editors
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Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 15, 2023

Last update: June 4, 2024

Resource persons

Phurba - land user
Kelzang Phuntsho - land user

Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/technologies/view/technologies_6855/

Linked SLM data

n.a.

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references

- Mapiye, C., Mwale, M., Chikumba, N. & Chimonyo, M. (2008). Fire as a Rangeland Management Tool in the Savannas of Southern Africa. Tropical and Subtropical Agroecosystems, 8, 115-124.: https://www.redalyc.org/pdf/939/93980201.pdf
- Sabiiti, E. N., Wamara, J. B., Ogen-Odoi, A. A. & Wein, R. W. (1992). The Role of Fire in Pasture and Rangeland Management. Nomadic Peoples, 21, 107-110.: https://www.jstor.org/stable/43123378

Links to relevant information which is available online

- Management Strategies for Rangeland and Introduced Pastures: https://extension.okstate.edu/fact-sheets/management-strategies-for-rangeland-and-introduced-pastures.html
- Fire as a Tool in Land Management: https://rangelandsgateway.org/topics/rangeland-ecology/fire-tool-land-management

Calves produced through artificial insemination (AI) using sexed semen. (Damcho Zam)

Sexed semen technology (Bhutan)

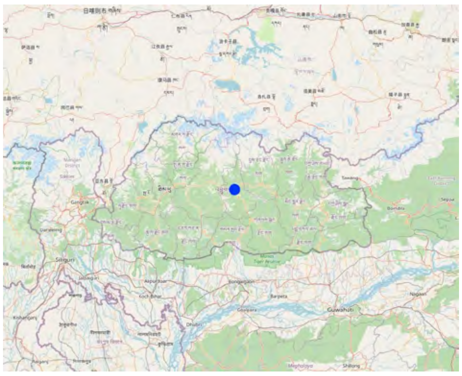
Phomo Yewa Chheyti Yoe Pai Khab Soen Gi Thruel Rig (ཕོ་མོ་དབྱེ་བ་ཕྱེ་དེ་ཡོད་པའི་ཁབ་སོན་གྱི་འཕྲུལ་རིག།)

DESCRIPTION

Sexed semen technology produces gender-selected semen for artificially insemination of dairy cows. It ensures a higher proportion of female calves (more than 90%) which will ultimately contribute to the enhancement of milk production in the herd.

The Artificial Insemination (AI) program, initiated in 1987, has helped AI evolve into a widespread practice for dairy farms across Bhutan, with increasing accessibility due to improved road and transportation networks. The surge in demand for dairy products has positioned AI technology as key in transforming dairy farms from subsistence to market-oriented production systems.
A recent addition to the programme is the use of sexed semen, meaning sorting of semen before artificial insemination. Semen sorting involves categorizing bull semen based on the X and Y chromosomes, thus granting dairy land users control over calf gender. This empowers them to engage in selective breeding, enhancing desired traits and overall quality of dairy production.
Several key activities are integral to this technology:
•Rigorous selection of bulls with desirable traits related to milk production and overall health.
•Collection and preservation of semen from selected bulls.
•Semen sorting technology to separate X and Y chromosome-bearing sperm.
•Artificial insemination of dairy cows by extension agents who use sorted semen.
The benefits are multiple because achieving a higher proportion of heifer calves helps dairy land users to enhance breeding strategies and maintain desired traits within the herd. Economic benefits follow through increased dairy production and improved cattle health.
Land users express satisfaction with the technology and its impact. However, some households report problems with conception rates after AI with sexed semen. Despite these drawbacks, the overall benefits to dairy land users and the industry outweigh the limitations.

LOCATION



Location: Tshangkha, Tangsibji, Trongsa, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.47158, 27.46431

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 10-50 years ago

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Enumerators meeting with the land user. (Damcho Zam)

The area where the land user keeps their dairy cattle. (Damcho Zam)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact
- [x] Improves dairy production

Land use

Land use mixed within the same land unit: No

Cropland

- Annual cropping: cereals - maize, cereals - wheat (spring), root/tuber crops - potatoes, vegetables - leafy vegetables (salads, cabbage, spinach, other), vegetables - root vegetables (carrots, onions, beet, other)

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [x] not applicable

Degradation addressed

biological degradation - Bc: reduction of vegetation cover, Bl: loss of soil life

other - Specify: There is very minimal land degradation.

SLM group

- integrated crop-livestock management
- improved plant varieties/ animal breeds

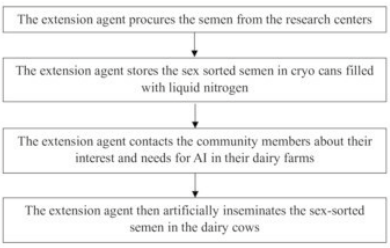
SLM measures

agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter soil fertility

TECHNICAL DRAWING

Technical specifications

Since sexed semen technology was not directly established in the community members, the product of the technology was used in the field through AI. Therefore, a flow chart of how the technology is implemented in the field was not created



Author: Palden Wangchuk Dorji

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology unit (unit: **Number** volume, length: **AI straw**)
- Currency used for cost calculation: **Ngultrum**
- Exchange rate (to USD): 1 USD = 79.62 Ngultrum
- Average wage cost of hired labour per day: 600

Most important factors affecting the costs
Material cost, heat detection, distance

Establishment activities
1. Procurement of sexed semen (Timing/ frequency: Based on indent or the annual requirement at National level)
2. Storage of sexed semen (Timing/ frequency: After procurement until distributed to dzongkhags at Central level)
3. Transportation and Distribution of sexed semen (Timing/ frequency: As per schedule, every 45 days)
4. Storage of semen (Timing/ frequency: semen bank at Veterinary Hospital and AI centre on regular basis)
5. Render Artificial insemination services to farmers by AI technician (Timing/ frequency: Based on request of farmers reporting on animal showing heat signs)
6. Follow up on AI services (monitoring) (Timing/ frequency: 18-22 days, repeat case, monthly report, ad hoc through phone call)

Establishment inputs and costs (per Number)

Specify input	Unit	Quantity	Costs per Unit (Ngultrum)	Total costs per input (Ngultrum)	% of costs borne by land users
Labour					
Community AI Technician	person/Day	2.0	1000.0	2000.0	
Equipment					
Sexed semen AI	per straw	1.0	1500.0	1500.0	
golves	No	1.0	5.0	5.0	
AI sheath	No	1.0	16.0	16.0	
LN2	litre	300.0	35.0	10500.0	
LN2 container (55 litre)	No	2.0	25050.0	50100.0	
Portable AI container (5 litres)	No	1.0	11200.0	11200.0	
Water boiler (3 litres)	No	1.0	2800.0	2800.0	
Jug	No	1.0	30.0	30.0	
Plant material					
Funnel	No	1.0	150.0	150.0	
Towel	No	1.0	100.0	100.0	
Flexible Dip stick	No	1.0	2500.0	2500.0	
Construction material					
AI crates	No	1.0	45000.0	45000.0	
Other					
Travel	km	15.0	30.0	450.0	
Total costs for establishment of the Technology				**126'351.0**	
Total costs for establishment of the Technology in USD				*1'586.93*	

Maintenance activities
1. Storage of the sex sorted semen (Timing/ frequency: When the semen is procured by the extension agent and before conducting AI)

NATURAL ENVIRONMENT

Average annual rainfall
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- [ ] 251-500 mm
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Specifications on climate
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The data was used from the National Center for Hydrology and Meteorology from the nearest weather station.
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- [ ] employee (company, government)

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Access to services and infrastructure

health	poor		✓		good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor		✓		good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor	✓			good

IMPACTS

Socio-economic impacts

fodder production	decreased					✓			increased	Quantity before SLM: The cattle were normally grazed in the forest, so no fodder were produced. Quantity after SLM: Some of the land that were left fallowed were used for fodder production.
fodder quality	decreased						✓		increased	Quantity before SLM: Local cattles can feed on wild fodder grasses and trees Quantity after SLM: Improved cattles require quality fodder so they started growing improved fodders species like Super Napier grass, Napier grass, etc.
animal production	decreased							✓	increased	Quantity before SLM: 5 liters of milk were produced from each dairy cow every day Quantity after SLM: 15 liters of milk are produced by each dairy cow everyday The quantification was based on the amount of milk produced.
production area (new land under cultivation/ use)	decreased		✓						increased	Quantity before SLM: 5 acres of cultivated land Quantity after SLM: 1 acre of cultivated land The land user now focuses mostly on dairy production and has converted some of the lands into pasture for grazing purposes while the rest has been left fallow. This is due to the absence of labour in the household.
expenses on agricultural inputs	increased						✓		decreased	This is due to the decrease in the cultivated land.
farm income	decreased						✓		increased	Due to the increase in dairy production, the land user is greatly benefited from it.

workload

increased ✓ decreased

Since the land user focuses primarily on dairy, the amount of workload has relatively increased compared to the past, where she would only focus on agriculture, only.

Socio-cultural impacts
food security/ self-sufficiency

reduced ✓ improved

Quantity before SLM: Mostly consumed food they produced in their household.
Quantity after SLM: Diverse food products are available, together with dairy products.

Ecological impacts
plant diversity

decreased ✓ increased

Quantity before SLM: Maize, wheat and potatoes were the only primary crops grown.
Quantity after SLM: Maize, wheat, potatoes and several other cole crops and legumes are now cultivated by the land users.

Off-site impacts
impact of greenhouse gases

increased ✓ reduced

Quantity before SLM: more than 30 cattles including dairy cows and bulls
Quantity after SLM: around 15 dairy cows
There is decrease in the number of cattle and they are mostly female.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative ✓ very positive
Long-term returns — very negative ✓ very positive

Benefits compared with maintenance costs

The benefits of the technology are very high. The recurrent cost of AI is very low as it is provided for free by the Royal Government of Bhutan. The land users also get the desired sex of the cattle they want (female cattle). The return they get from improved cattle is very high(high milk yield).

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all ✓ very well
annual rainfall decrease — not well at all ✓ very well

Climate-related extremes (disasters)

local rainstorm — not well at all ✓ very well
local thunderstorm — not well at all ✓ very well
local hailstorm — not well at all ✓ very well
epidemic diseases — not well at all ✓ very well
insect/ worm infestation — not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered
28 households

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Produces desirable traits of offspring
- Improved breed quality
- Enhances dairy production
- Produces female cattle
- Manure from the cattle is used for revitalising the farmland.

Strengths: compiler's or other key resource person's view
- It helps improve the land users livelihood by benefiting them economically.
- Sexed semen technology produces desired sex cattle which also reduces the recurrent cost of doing AI again and again to get desired sex cattle.
- Sexed semen technology can ultimately reduce number of unproductive cow which can reduce land degradation and reduce greenhouse gas emmission.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- Sometimes the cattle do not conceive even after insemination. The possibility of a cow not conceiving after an AI is very low, but it is recommended that the land user consult with the livestock agent or conduct AI again.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- Sexed semen technology reduces the male population, getting quality breeding bull will be difficult in future. Allow the dairy cow to mate naturally once in their lifetime
- Semen produced from the technology may become ineffective during the sorting procedure. Follow appropriate procedures and double-check equipment.

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Compiler
ONGPO LEPCHA

Editors
Kuenzang Nima

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

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Last update: May 30, 2024

Resource persons
Tenzin Pem - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6823/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

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Links to relevant information which is available online
- TASHI: The First Woman Community AI Technician in the East. /Dzongkha language/: https://www.youtube.com/watch?v=gk_iXm94ZQQ
- Koufouku International Limited - A Link in the Dairy Value Chain in the East: https://www.youtube.com/watch?v=JLB_3fdz3ag

Technologies
Forests

Yakpugang village where the water source protection has been established (Damcho Zam)

Water Source Protection (Bhutan)

Chhu Ka Soongchop (ཆུ་བཀག་སྲུང་སྐྱོབ།)

DESCRIPTION

Water source protection involves protecting lakes, rivers, springs, or man-made reservoirs to avoid water pollution and damage by livestock and wild animals. In the past, the emphasis was on fencing and improving vegetation cover at the discharge point itself, but a recent focus is on groundwater recharge areas.

Water source protection involves protecting lakes, rivers, springs or man-made reservoirs to avoid water pollution and damage by livestock and wild animals. In the past this included fencing and enhancing vegetation cover at the discharge point – that is, where the water starts flowing. However, today, water source protection also focuses on improving groundwater recharge areas. The water source protection technology has many benefits. In addition to providing a clean and regular supply of drinking and irrigation water, it also enhances the vegetation cover of the catchment area.

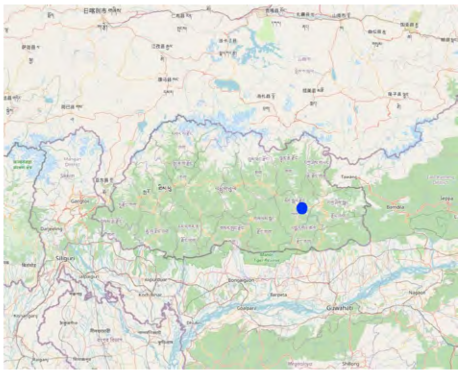
Strategies target maintaining adequate water levels in underground water reservoirs to ensure a continuous flow of streams and springs. In Yakpugang Community Forest, the technology has been applied specifically in the southern mountainous part of the village. An area of 638 acres (255 hectares) has been established as the recharge zone, and three springs have been identified for source protection. Native tree species have been planted annually in the degraded watershed to improve forest conditions. The main purpose is to protect the quality and quantity of the water for both drinking and irrigation purposes. The technology is supported by an approach that involves collective efforts of the community who realize that if their drinking and irrigation water supply is to be sustainable, they must work together.

The main purpose is to ensure a continuous supply of water for drinking and irrigation to the community. This is achieved through managing the catchment areas where rainwater soaks through the ground to reach a groundwater reservoir, and one of the key interventions is protecting the water sources from wild animals and livestock.

The water source protection technology involves 1) meeting different stakeholders, 2) signing agreements between the stakeholders, 3) site selection and survey, 4) planting of native tree species, and 5) conducting annual monitoring and evaluation. Inputs like fencing materials, planting materials, and human resources are required for the implementation and maintenance of the technology.

The technology is liked because it helps provide a continuous supply of both clean drinking and irrigation water. Furthermore, protecting water sources by the community is rewarded in monetary form by the nearby town as part of the Payment for Environmental Services (PES). This incentive helps the community to generate income which is ploughed back into the improvement and maintenance of water sources. What is disliked is the reduction in grazing land since the land users are not allowed to graze their cattle inside the water source areas.

LOCATION



Location: Yakpugang village, Mongar Dzongkhag (District), Bhutan

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 91.29394, 27.25762
- 91.29394, 27.2535
- 91.29291, 27.24808

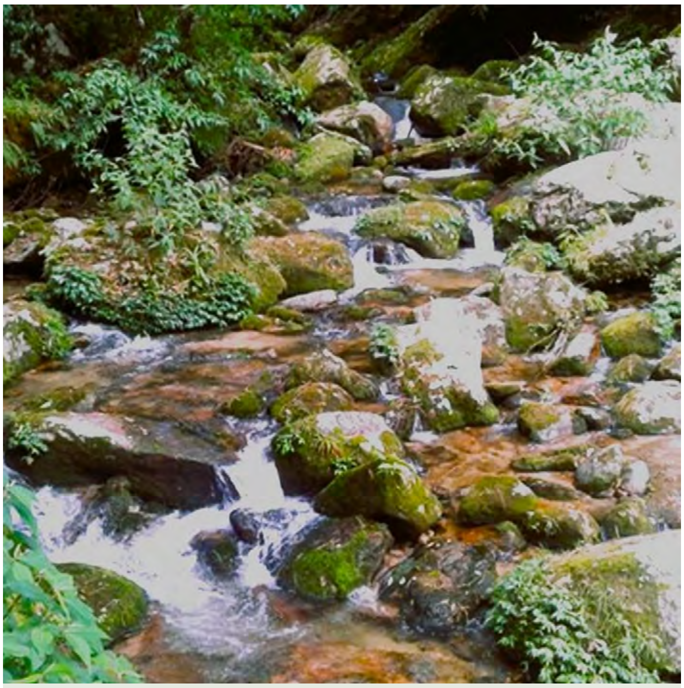
Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2007; less than 10 years ago (recently)

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions


Water Source (Tashi Phuntsho, Kuensel)


One of the stream of the PES in Tsirang (Divisional Forest Office (DFO), Tsirang)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [ ] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [x] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: No

Cropland

- Annual cropping: vegetables - leafy vegetables (salads, cabbage, spinach, other), vegetables - root vegetables (carrots, onions, beet, other), Chillies
- Tree and shrub cropping: pome fruits (apples, pears, quinces, etc.), stone fruits (peach, apricot, cherry, plum, etc)

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? Yes

Waterways, waterbodies, wetlands - Drainage lines, waterways
Main products/ services: Irrigation channels for farming and drinking water pipes

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

water degradation - Ha: aridification, Hs: change in quantity of surface water, Hp: decline of surface water quality

SLM group

- improved ground/ vegetation cover
- irrigation management (incl. water supply, drainage)
- surface water management (spring, river, lakes, sea)

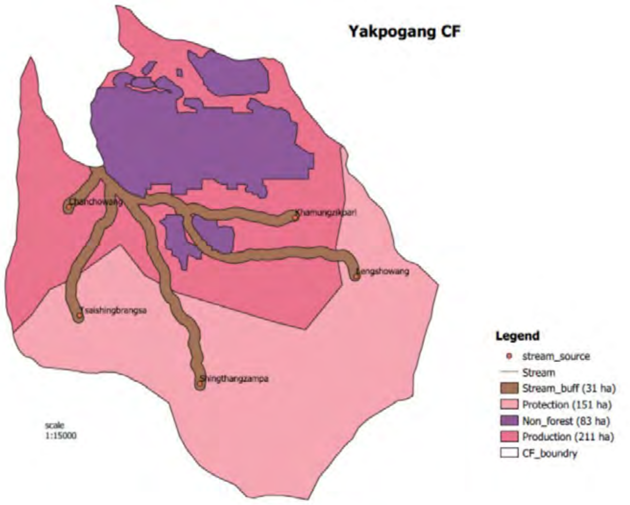
SLM measures

vegetative measures - V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants

TECHNICAL DRAWING

Technical specifications

GIS map of the recharge zone of the Yakpugang spings
Yakpugang village, Mongar Gewog (Block), Mongar Dzongkhag (District), Bhutan



Author: Ugyen Norten

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Recharge zone of 638 acres (255 hectares)** volume, length: **638 acres (255 hectares)**)
- Currency used for cost calculation: **n.a.**
- Exchange rate (to USD): 1 USD = 82.08
- Average wage cost of hired labour per day: 1000

Most important factors affecting the costs

None.

Establishment activities

1. Community meeting (Timing/ frequency: Conducted several times)
2. Survey of the recharge zone and site selection (Timing/ frequency: The survey took around 2 to 3 weeks)
3. Agreement between the stakeholders (Timing/ frequency: Agreement done thrice)
4. Native tree species plantation around the watershed (Timing/ frequency: Based on a specified date and each individuals from household came)

Total establishment costs (estimation)

258500.0

Maintenance activities

1. Clearing of the water source (Timing/ frequency: Thrice annually)

Maintenance inputs and costs (per Recharge zone of 638 acres (255 hectares))

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)	% of costs borne by land users
Labour					
Community Forest members	person/day.	102.0			

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

The data was used from the nearest weather station of the National Center for Hydrology and Meteorology (NCHM).
Name of the meteorological station:
https://www.nchm.gov.bt/home/pageMenu/906
Warm temperate zone

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [x] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [x] concave situations
- [ ] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [ ] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [x] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor				good
health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor			✓	good

IMPACTS

Socio-economic impacts

Crop production

Crop production	decreased	increased	Quantity before SLM: 15 baskets of maize Quantity after SLM: 20 to 25 baskets maize There has been an increase in the amount of maize, which has been credited to the increase in the amount of water than in the past.
crop quality	decreased	increased	According to the land user, crop quality has been relatively better after the implementation of the technology than in the past.
risk of production failure	increased	decreased	Due to the presence of water in the community, production has decreased.
product diversity	decreased	increased	Quantity before SLM: maize and some other cereals and vegetables were grown Quantity after SLM: maize together with cole crops, tubers and fruits are grown
production area (new land under cultivation/ use)	decreased	increased	Quantity before SLM: 1 acres Quantity after SLM: 1.5 acres In the past, the lack of water would lead the land users to keeping some of the land fallow.
drinking water availability	decreased	increased	Quantity before SLM: Water would be scarce periodically Quantity after SLM: Water is now available throughout the community Drinking water availability has increased compared to the past. This is mainly due to the protection of water sources. In addition, now community members also go for regular clearing of irrigation channels, drinking water pipelines, and sources to keep the supply steady.
drinking water quality	decreased	increased	Quality in terms of cleanliness of drinking water was reported to have enhanced because in the past nearby streams from where they get their drinking water used to get polluted by rainwater, animals, etc.
water availability for livestock	decreased	increased	Quantity before SLM: Water would be taken to the nearby streams Quantity after SLM: Water is now provided near there house Since supply is continuous the water availability for livestock also increased.
water quality for livestock	decreased	increased	Water for livestock are also improved than in the past.
irrigation water availability	decreased	increased	Quantity before SLM: Focused more on growing crops requiring less water Quantity after SLM: Now grows variety of diverse crops Since the water flow is continuous, there is enough water to carry out multiple cropping.
irrigation water quality	decreased	increased	Water quality for irrigation is better than the past
farm income	decreased	increased	Quantity before SLM: focuses mostly on commercialising maize Quantity after SLM: now commercialises diverse vegetable crops as well

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved	The availability of water in the community, allowed for the land users to grow a diverse vegetable crops in large amount.
health situation	worsened	improved	Quantity before SLM: Community members prone to water related disease Quantity after SLM: Water is relatively cleaner
land use/ water rights	worsened	improved	Agreement for water source protection is conducted after every end of the agreement year, where water use rights are also discussed.

Ecological impacts

water quantity

decreased ✓ increased

Quantity before SLM: water from the source would dry up most of the times
Quantity after SLM: water in the water source is almost always filled.

water quality

decreased ✓ increased

Quantity before SLM: Would be dirty due to wild animals and grazing cattle
Quantity after SLM: Since water source is protected, water is relatively cleaner

drought impacts

increased ✓ decreased

Quantity before SLM: in the past, drought would occur periodically
Quantity after SLM: Even during the absence of rain, water is still available

Off-site impacts

groundwater/ river pollution

increased ✓ reduced

Quantity before SLM: Would normally be polluted due to wild animals and grazing cattles
Quantity after SLM: Water is now clean and also drinkable

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative ✓ very positive
Long-term returns — very negative ✓ very positive

Benefits compared with maintenance costs

Short-term returns — very negative ✓ very positive
Long-term returns — very negative ✓ very positive

The income earned from the project goes into community development and the community forest, and the expense for the project is already funded.

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all ✓ very well
annual rainfall increase — not well at all ✓ very well

Climate-related extremes (disasters)

local rainstorm — not well at all ✓ very well
local thunderstorm — not well at all ✓ very well
local hailstorm — not well at all ✓ very well
local windstorm — not well at all ✓ very well
drought — not well at all ✓ very well
forest fire — not well at all ✓ very well
land fire — not well at all ✓ very well
general (river) flood — not well at all ✓ very well
flash flood — not well at all ✓ very well
landslide — not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Number of households and/ or area covered

102 households

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Continuous supply of both drinking water and irrigation water
- Water is supplied to Mongar town, and income is earned from it under Payment for Environmental Services (PES) arrangement b
- Has helped in community development and improvement of community forest

Strengths: compiler's or other key resource person's view

- Water quality is preserved, and pollution and contamination of the water sources are prevented.
- The plantation of native tree species helps conserve the ecosystem.
- Long-term sustainability and enhanced climate resilience of the water source

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Decreased grazing land Shift the grazing area outside the community forest or establish improved pasture land in their registered land

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
ONGPO LEPCHA

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Last update: Feb. 24, 2024

Resource persons
Sangay Dorji - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6842/

Linked SLM data
n.a.

Documentation was faciliated by

Institution

- National Soil Services Centre, Department of Agriculture, Ministry of Agriculture & Livestock (NSSC) - Bhutan

Project

- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

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- WWF. (2017). Valuing Ecosystem Services in Chamkharchhu Sub Basin: Mapping Sediment Using InVEST. WWF.: https://wwfasia.awsassets.panda.org/downloads/final_invest_report_final_draft_may_17_spread_compressed_2.pdf

Links to relevant information which is available online

- Source Water Protection: https://www.nrcs.usda.gov/programs-initiatives/source-water-protection
- Water Source Protection: https://sswm.info/arctic-wash/module-4-technology/further-resources-water-sources/water-source-protection
- Basic Information about Source Water Protection: https://www.epa.gov/sourcewaterprotection/basic-information-about-source-water-protection
- Conserving water resources with PES, an example from Yakpugang: https://kuenselonline.com/conserving-water-resources-with-pes-an-example-from-yakpugang/

This is a trenches build to check the spring water flow and the water is stored in a pond . (Tshering Gyeltshen)

Springshed Revival through Trenches and Checkdams (Bhutan)

Sa Hoka Koni Dang Tsip Chabtey Chhuka Sa Khong Nyam Soong (ས་ཧོག་ཀ་བཀོ་ནི་དང་རྩིགཔ་རྒྱབ་སྟེ་ཆུ་ཁ་ས་ཁོངས་ཉམས་སྲུང་།)

DESCRIPTION

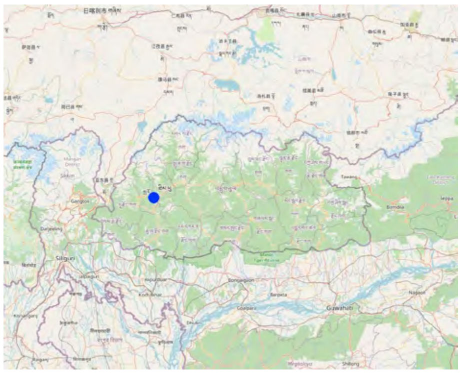
Springshed revival through trenches and check dams is associated with a nature-based solution approach to reviving more than 20 springsheds. These were widened with the occasional construction of check dams to prevent rill erosion from the newly revived spring waters.

Trenches and check dams play a vital role in the implementation of the springshed revival technology in the picturesque hilly village of Lholing. This innovative approach to rejuvenating springsheds has extended its reach from the lush pasturelands above the village all the way down to the very first household of Lholing, resulting in the construction of approximately 20 ponds of varying sizes, replenished by springsheds. In some instances, the creation and expansion of these springsheds required the utilisation of mechanical excavators, emphasising the magnitude of the project.
The revitalised springsheds now produce an array of springs, each contributing water that eventually converges into a common tributary meandering towards the village. This valuable water is collected and stored in purposefully constructed water harvesting ponds, serving as a reliable source for kitchen garden irrigation and cattle feeding. While the primary objective was to address the pressing issue of drinking water scarcity in the community, it also yielded secondary benefits. These encompassed the provision of a drinking water source for the wildlife inhabiting the area, as well as supporting the irrigation needs of the kitchen garden.
The implementation of check dams yielded additional advantages by mitigating rill and gully erosion and serving as effective filters for muddy spring water. This sustainable land management strategy was accomplished through a series of distinct activities. Firstly, an exhaustive survey and assessment of the springshed area was conducted to identify suitable locations for trenches and check dams. This process took into account factors such as the topography of the terrain, the hydrological dynamics, and the composition of the soil. Subsequently, a comprehensive plan and design was developed for the trenches and check dams, including their dimensions, spacing, and alignment. The involvement of experts and stakeholders during this stage ensured that the chosen design was optimal in terms of its effectiveness (Sameul, 2008).

The execution phase involved the excavation and shaping of the trenches according to the design, followed by the construction of check dams. Trenching are required in open areas (where there is no vegetation cover) to trap surface runoff and enhance infiltration. Trenches can be dug along contour lines in a staggered or continuous pattern. However, the size of the trench is determined based on the site conditions. The number of trenches/pits depends on size, annual precipitation and the slope gradient of the recharge area in smaller area. Wedge shaped trenches are recommended for open areas while staggered or continuous trenches are recommended on slopy areas. Trenches are recommended in larger open area, while pits these check dams were specifically devised to retain water and control its flow. As part of gully treatment and to increase water infiltration, check dams are constructed. Typically, walls or barriers were built using locally available materials such as stone, wood, or concrete.

The advantages and benefits derived from this technology are manifold. In addition to the aforementioned advantages associated with springsheds, the implementation of trenches and check dams significantly contributed to the preservation and conservation of the fertile topsoil, preventing its degradation and erosion. The land users in the village expressed contentment with the successful revival of the springsheds, recognising their multifaceted contributions. Furthermore, they were duly impressed by the check dams' efficacy in preventing soil erosion and their ability to filter muddy water, ensuring a reliable and clean water supply (RSPN, 2023).

LOCATION



Location: Shaba, Lholing., Paro, Bhutan

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites
- 89.50238, 27.36699

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2017; less than 10 years ago (recently)

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

The creation of the ponds was especially appreciated as they served as a convenient water source for grazing cattle in the nearby jungle. However, despite the numerous benefits, there was a sense of dissatisfaction among many villagers due to the increasing number of wild animals, including wild boar and deer that frequented the ponds to quench their thirst. This unexpected influx of wildlife posed a significant threat to farms located in close proximity to the open springsheds.


The photo displays one of the springshed revived through check dams. (Tshering Gyeltshen)


Revived springshed provide drinking water to local communities and livestock (Thinley Tshering)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [ ] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [x] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact
- [x] To find another alternative source of water for cattle, laundry and other washing alternatives.

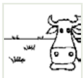
Land use

Land use mixed within the same land unit: No


Cropland

- Annual cropping: cereals - rice (wetland)

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes


Grazing land

- Ranching
- Cut-and-carry/ zero grazing

Animal type: cattle - dairy
Is integrated crop-livestock management practiced? Yes

Species	Count
cattle - dairy	n.a.


Waterways, waterbodies, wetlands - Ponds, dams, Swamps, wetlands
Main products/ services: Many small patches of wetlands are there.

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

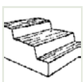

soil erosion by water - Wt: loss of topsoil/ surface erosion


water degradation - Hq: decline of groundwater quality

SLM group

- water harvesting
- surface water management (spring, river, lakes, sea)
- ground water management

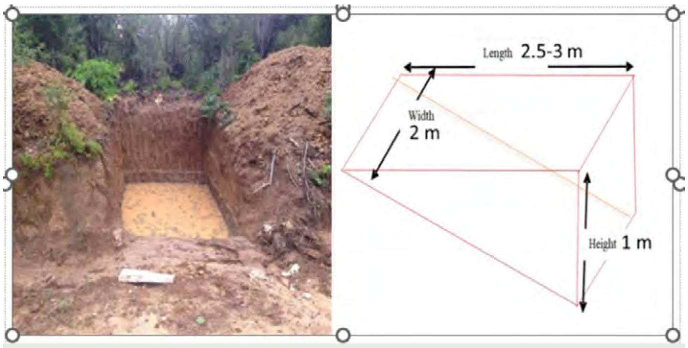
SLM measures


structural measures - S2: Bunds, banks, S4: Level ditches, pits, S7: Water harvesting/ supply/ irrigation equipment

TECHNICAL DRAWING

Technical specifications

Design for the trenches as adapted from spring revival pilot site at Lholing, Paro



Author: Water management Division

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit
- Currency used for cost calculation: **Bhutanese Currency (Ngultrum)**
- Exchange rate (to USD): 1 USD = 82.25 Bhutanese Currency (Ngultrum)
- Average wage cost of hired labour per day: 700

Most important factors affecting the costs

The most important factor that contributed to the huge cost was from machine hiring charges. The community usually cost minimum of Nu. 15000 in an hour and some of them can hire it counting the number of days.

Establishment activities

1. conducting a thorough survey and assessment in spring shed area (Timing/ frequency: -)
2. Develop a comprehensive plan and design for the check dams and trenches. (Timing/ frequency: -)
3. Gathering of labor and constructing materials. (Timing/ frequency: -)
4. Excavate the trenches according to the planned design and shape the trenches to facilitate proper waterflow and retention. (Timing/ frequency: started in March)
5. Build check dams across the trenches to impound water and control its flow. (Timing/ frequency: -)
6. Install the check dams in the designated locations along the trenches and ensure proper alignment and stability of the structures (Timing/ frequency: -)
7. Regularly monitor the check dams and trenches for any signs of damage or erosion. (Timing/ frequency: -)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Bhutanese Currency (Ngultrum))	Total costs per input (Bhutanese Currency (Ngultrum))	% of costs borne by land users
Labour					
labour	person	22.0	700.0	15400.0	
Technical Person (Forester)	person	8.0	1500.0	12000.0	
Equipment					
Excavator	number	1.0	15000.0	15000.0	
Barbed wire	meter	2.0	5500.0	11000.0	
Tarpauline sheet	meter	2.0	4200.0	8400.0	
Construction material					
Mud					
Boulders					
Total costs for establishment of the Technology				**61'800.0**	
Total costs for establishment of the Technology in USD				*751.37*	

Maintenance activities

1. Farmers Gathering (Timing/ frequency: Thrice (spring, Summer, winter))
2. visiting each of the constructed site and they removed the sedimented particles in the trenches. (Timing/ frequency: Thrice(before onset of monsoon season)
3. Substituting the worn out plastic if in case it was damaged (Timing/ frequency: once)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Bhutanese Currency (Ngultrum))	Total costs per input (Bhutanese Currency (Ngultrum))	% of costs borne by land users
Labour					
Farmers	person	22.0			100.0
Equipment					
spade and shovel	numbers	10.0			100.0

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [x] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
The area experienced low rainfall being in the cool temperate region.
Name of the meteorological station: Weather station, Paro
The area falls on Cool Temperate region as per the Agro-ecological Zones of Bhutan

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [x] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [x] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: both ground and surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor		✓		good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

Comments
The farmers of Lholing have to avail services like bank, health, technical assistance and education in Shaba as the households were less to get the government support.

IMPACTS

Socio-economic impacts

drinking water availability	decreased					✓		increased	In winter the spring water could be also used for drinking purposes. This is expert estimates
water availability for livestock	decreased					✓		increased	The water availability drastically increased for the livestock feeding through direct supply from the springshed ponds or spring water collected near the village in water harvesting pond. This is expert estimates
irrigation water availability	decreased					✓		increased	Available Irrigation water for both wetland and kitchen garden are drastically improved with springshed. This is expert estimates

Socio-cultural impacts

health situation	worsened				✓			improved	Improved with improved hygiene. This is expert estimates
conflict mitigation	worsened				✓			improved	Reduced water related conflicts. This is expert estimates

Ecological impacts

water quantity	decreased					✓		increased	This is expert estimates
harvesting/ collection of water (runoff, dew, snow, etc)	reduced					✓		improved	This is expert estimates
surface runoff	increased						✓	decreased	Surface run-off especially during monsoon is drastically reduced with both trenches and check dams.This is expert estimates

Off-site impacts

water availability (groundwater, springs)	decreased				✓			increased	The technology has been beneficial for the near by spring revival
reliable and stable stream flows in dry season (incl. low flows)	reduced			✓				increased	The effect wasn't effective when water source was totally dried up during the winter

		1	2	3	4	5	6	7		
downstream flooding (undesired)	increased				✓				reduced	No effect at all
downstream siltation	increased				✓				decreased	
groundwater/ river pollution	increased					✓			reduced	
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced						✓		improved	Checkdams sometimes served as a filtration for the residue and reduces the velocity of flow
wind transported sediments	increased				✓				reduced	
damage on neighbours' fields	increased				✓				reduced	
damage on public/ private infrastructure	increased				✓				reduced	No damage has been recorded after an application of the technology
impact of greenhouse gases	increased					✓			reduced	

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

		1	2	3	4	5	6	7	
Short-term returns	very negative				✓				very positive
Long-term returns	very negative						✓		very positive

Benefits compared with maintenance costs

		1	2	3	4	5	6	7	
Short-term returns	very negative				✓				very positive
Long-term returns	very negative						✓		very positive

CLIMATE CHANGE

Gradual climate change

		1	2	3	4	5	
annual temperature increase	not well at all			✓			very well
annual rainfall decrease	not well at all			✓			very well

Climate-related extremes (disasters)

		1	2	3	4	5	
local snowstorm	not well at all		✓				very well
extreme winter conditions	not well at all		✓				very well
flash flood	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [x] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

Almost 20 individuals household has participated in implementation of the technology

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Water availability to some extent was helpful
- Farming and irrigation support

Strengths: compiler’s or other key resource person’s view

- Underground water recharge
- Water conservation
- Flood mitigation

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Need huge labor contribution. Each of the household should be well coordinated
- Need huge investment. The support from government and other grants can be helpful.

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s viewhow to overcome

- Is the long process and immediate result cannot be seen. Can continue for the longer duration.
- Sediment buildup. Need constant removal.
- Environmental impacts. Good research and planning

REFERENCES

Compiler
Karma Wangdi

Editors
Haka Drukpa

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 14, 2023

Last update: June 4, 2024

Resource persons
Kinkhen Tenzin - SLM specialist
Chencho Dorji - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6853/

Linked SLM data
n.a.

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Institution
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Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Key references
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- RSPN. (2023). Introduction of Check-dams in Wamrong.: Free website

Links to relevant information which is available online
- Rejuvenation of water bodies by adopting rainwater harvesting and groundwater recharging practices in catchment area-a case study.: https://doi.org/10.1016/j.jenvman.2020.111679
- Introduction of Check-dams in Wamrong.: https://www.rspnbhutan.org/introduction-of-check-dams-in-wamrong/

Bamboo rhizomes distributed to land users for plantation (Haka Drukpa)

Cane and Bamboo Plantation to Sustain Raw Materials (Bhutan)

Ba Dang Pa Tshar Zuk Chong Bae Dhi Thoen Koed Yuen Ten Zho Ni (སྦ་དང་སྦ་ཚར་འཛུགས་སྐྱོང་འབད་དེ་ཐོན་སྐྱེད་ཡུན་བརྟན་བཟོ་ནི།)

DESCRIPTION

Cane and bamboo plantations are managed by land users and indigenous communities to sustain these valuable raw materials for making handicraft items. Tsharzo (bamboo craft), is one of the main sources of income for land users. Tsharzo makes use of cane and bamboo to weave products such as backpacks, baskets (for winnowing, for carrying fodder, fruits, shoots, etc.), and mats. These plantations are effective in conserving land and water.

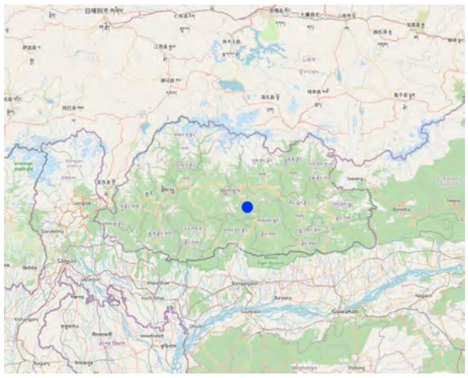
Tsharzo (bamboo craft), is one of the main sources of income, besides agriculture, for the land users of the Monpa community of Jangbi, Wangling, and Phrumzur in Trongsa. Tsharzo makes use of cane ("rattan": Calamus spp.) and bamboo to weave products such as orongbhazib (backpacks), lapchu (hand baskets), chungchu (baskets), bechab (winnowing baskets), tsew (baskets to carry fodder, fruits, shoots etc.) and pari (mats). The technology of maintaining bamboo and cane plantations has been adopted by the land users to ensure a sustainable harvest of natural raw materials and to maintain germplasm for bamboo and cane. This helps to uphold ancestral arts and crafts skills, and to improve livelihoods.

Jangbi chiwog has 59 households (HH). The land users are members of Monpa Selwai Yoezer Tshogpa, a Community Forest Management Group which was formed to sustainably manage bamboo and cane resources, to preserve and promote age-old cane and bamboo handicraft skills and increase household income. The group is one of the most successful in promoting Tsharzo in the country. The group was formed under the United Nations Development Programme (UNDP) on 14 April 2000, and officially came into play in 2007, upon drafting bylaws. The bylaws were revised after the need for further improvement in the year 2018. The group received initial support from UNDP and Bhutan Orchids, a non-governmental organization (NGO). The government has given a total of 45 acres (18 ha) of land to the land users of Jangbi Chiwog to plant bamboo and cane. Out of the total, 15 acres (6 ha) are collectively managed as a nursery. About 10 acres (4 ha) are managed by each village as a plantation. The land users have planted three varieties of bamboo on the land.

The benefits of the technology include the establishment of dedicated germplasm for bamboo and cane, sustainable harvest of natural raw materials, conservation and promotion of ancestral arts and crafts skills, social cohesion through group formation, and employment opportunities.

Bamboo and cane plantations play a great role in preventing soil degradation. Bamboo and cane have extensive root systems that help prevent erosion, stabilize soil, and reduce landslide risks. They are excellent for revegetation as they quickly establish themselves. Bamboo is also an efficient carbon sink, absorbing significant amounts of carbon dioxide from the atmosphere. This helps mitigate climate change by reducing greenhouse gas concentrations. Bamboo and cane provide habitats for various organisms thereby increasing biodiversity. Products made from bamboo and cane are biodegradable, minimizing any potential environmental impact.

LOCATION



Location: Jangbi, Wangling and Phrumzur villages under Jangbi Chiwog, Langthel gewog, Trongsa Dzongkhag, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.58576, 27.28966

Spread of the Technology: evenly spread over an area (18.2 km²)

In a permanently protected area?: Yes

Date of implementation: 2000

Type of introduction
- ✓ through land users' innovation
- as part of a traditional system (> 50 years)
- during experiments/ research
- ✓ through projects/ external interventions


Bamboo planted in a farmer's field (Kuenzang Nima)


Bamboo planted along the farm roadside for stabilization and domestic use. (Haka Drukpa)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- [ ] improve production
- [ ] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use
Land use mixed within the same land unit: No

Water supply
- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation
- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wm: mass movements/ landslides


soil erosion by wind - Et: loss of topsoil


biological degradation - Bc: reduction of vegetation cover, Bq: quantity/ biomass decline

SLM group
- natural and semi-natural forest management
- forest plantation management

SLM measures

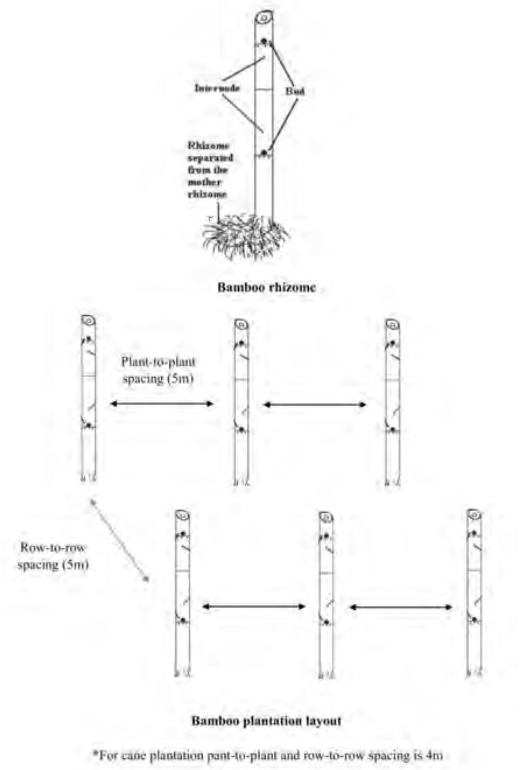
vegetative measures - V1: Tree and shrub cover


structural measures - S6: Walls, barriers, palisades, fences

TECHNICAL DRAWING

Technical specifications

The bamboos thriving in the wild are documented in the community. They are an important source of raw materials for producing bamboo products.



Author: Tshering Yangzom

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **45 acres**; conversion factor to one hectare: **1 ha = 45 acres = 18.2 ha**)
- Currency used for cost calculation: **Nu.**
- Exchange rate (to USD): 1 USD = 82.0 Nu.
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs

n.a.

Establishment activities

1. Attempted to commercialize bamboo and cane products through market exploration (contract) by a few households. (Timing/ frequency: 2000)
2. Gewog and the Forest Office collaboratively explored funds to help the communities. (Timing/ frequency: 2000)
3. Funds sourced from UNDP. The land users were sensitized. (Timing/ frequency: 2000 (summer-during paddy season))
4. The land users were trained on plantations and product development. (Timing/ frequency: 2000)
5. Land users (12 of them) were taken on an exposure tour to India. (Timing/ frequency: 2000)

Total establishment costs (estimation)

2200000.0

Maintenance activities

n.a.

Total maintenance costs (estimation)

20000.0

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

The rain estimate has been derived based on the agro-ecological zone (AEZ) the area falls under. Bhutan is divided into six AEZs (source: https://www.fao.org/3/ad103e/AD103E02.htm).
The site is about 1500 masl. It falls under Dry-Subtropical Zone. Bhutan has six AEZs. The wet sub-tropical zone is from 150 to 600 m, followed by the humid sub-tropical zone from 600 to 1,200 m. The dry sub-tropical zone starts at 1,200 m and extends to 1,800 m, followed by the warm temperate zone, which reaches 2,600 m. The cool temperate zone lies between 2,600 and 3,600 m and, finally, the alpine zone between 3,600 m and 4,600 m.
https://www.fao.org/3/ad103e/AD103E02.htm

Slope

- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [x] rolling (11-15%)
- [x] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms

- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude

- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
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- [ ] > 4,000 m a.s.l.

Technology is applied in

- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
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Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
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CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [ ] less than 10% of all income
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Sedentary or nomadic
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- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
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- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled
- [x] Family land

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
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Access to services and infrastructure

health	poor	☐	✓	☐	good
education	poor	☐	✓	☐	good
technical assistance	poor	✓	☐	☐	good
employment (e.g. off-farm)	poor	✓	☐	☐	good
markets	poor	✓	☐	☐	good
energy	poor	☐	☐	✓	good
roads and transport	poor	☐	☐	✓	good
drinking water and sanitation	poor	☐	✓	☐	good
financial services	poor	☐	✓	☐	good

IMPACTS

Socio-economic impacts

non-wood forest production — decreased ☐☐☐☐✓☐☐ increased

Quantity before SLM: 50 - 60 products in a year
Quantity after SLM: 10 - 15 products in a year
The non-wood forest production has increased due to sustainable plantation, but the number of products developed using the raw materials has decreased. But again, the income has increased. In the earlier years, a household would earn about Nu.10000 by selling 50 - 60 products, whereas a household now earns a minimum of Nu. 25000 by selling 10 - 15 products due to higher prices of the products.

production area (new land under cultivation/ use) — decreased ☐☐☐☐☐☐✓ increased

Quantity before SLM: None
Quantity after SLM: 18.2 ha
With the initiation of bamboo and cane germplasm, the production area has increased and the source of raw materials for the community is sustained. Before the land users were given 18.2 ha by the government, the land users collected cane and bamboo from the forest to make products.

land management — hindered ☐☐☐☐☐☐✓ simplified

The bamboo and cane plantations have prevented soil erosion and stabilized the lands.

diversity of income sources — decreased ☐☐☐☐☐☐✓ increased

The income earned from products sold in the market adds to the annual income of the family.

Socio-cultural impacts

food security/ self-sufficiency — reduced ☐☐☐☐☐☐✓ improved

The higher annual income generation from the sale of bamboo and cane products has assured food security in some ways.

health situation — worsened ☐☐☐☐☐☐✓ improved

Better income and diet have resulted in better health.

SLM/ land degradation knowledge

reduced ✓ improved

The role of plantations in mitigating land degradation is well-instilled in the land users. They now even carry out bamboo plantations along the peripheries of newly constructed roads to stabilize the soil faster.

conflict mitigation

worsened ✓ improved

There is equity in the harvest of raw materials.

situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)

worsened ✓ improved

The land users have been able to improve their livelihood through sustainable management of bamboo and cane and the sale of the finished products.

Ecological impacts

vegetation cover

decreased ✓ increased

The vegetation cover has increased due to the plantation.

biomass/ above ground C

decreased ✓ increased

The biomass has increased due to the increase in vegetation cover.

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative ✓ very positive

Long-term returns — very negative ✓ very positive

Benefits compared with maintenance costs

Short-term returns — very negative ✓ very positive

Long-term returns — very negative ✓ very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all ✓ very well

Climate-related extremes (disasters)

local rainstorm — not well at all ✓ very well

local thunderstorm — not well at all ✓ very well

local hailstorm — not well at all ✓ very well

local windstorm — not well at all ✓ very well

forest fire — not well at all ✓ very well

landslide — not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [x] > 50%

Number of households and/ or area covered

59 HH are part of Monpa Selwai Yoezer Tshogpa

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Preserve and promote ancestral arts and crafts skills.
- Maintain germplasm for bamboo and cane. The raw materials for future use are assured due to the establishment of a 45-acre germplasm.
- Generate income through the sale of bamboo and cane products.
- Sustainable harvest of natural raw materials

Strengths: compiler's or other key resource person's view

- Higher vegetation cover.
- Prevent land degradation (bamboo and cane have extensive root systems that help prevent erosion, stabilize soil, and reduce landslide risks).
- Sustainable utilization of forest resources (bamboo and cane).
- Diversify income sources of the land users.
- Social cohesion through collaboration and coordination among the land users.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- The identified germplasm area lacks suitable places for convenient plantations. The majority of the area is rugged terrain and steep. Exclude the steep and rugged terrains. Explore and identify suitable and more convenient areas for plantation.
- The wooden fencing poles surrounding the germplasm area are not durable (cannot withstand barbed wires for longer periods). Replace the wooden fencing poles with steel posts or other durable materials.
- No funds to scale up. For instance, the canes lost in the 2017 forest fire have not been re-generated like bamboo. Additional funds are to be sought to scale up the plantation programs.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- No funds to scale up. Provision of funds by relevant stakeholders.
- Risk of fire. The Department of Forests and Park Services had initiated Interagency Forest Fire Coordination Group (IFFCG) at Dzongkhag and Gewog level to mitigate fire with involvement of Dzongkhag, Gewogs and relevant agencies. The IFFCG is headed by Dasho Dzongda and the Dzongkhag disaster management committee in coordination with relevant agency are responsible for mitigation and preventing the fire and provide necessary support to the affected individual or community. Several awareness programs and hands on training on fire mitigation and prevention was also provided to the communities by the Department of Forests and Park Services.

REFERENCES

Compiler
Tshering Yangzom

Editors
Tashi Wangdi

Reviewer
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Date of documentation: July 17, 2023

Last update: May 30, 2024

Resource persons
Sonam - land user
Nagari - land user
Chencho - land user
Lethro - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6859/

Linked SLM data
Approaches: Community Forest Management Group https://qcat.wocat.net/en/wocat/approaches/view/approaches_6861/

Documentation was faciliated by

Institution
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bhutan

Project
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Links to relevant information which is available online
- Bamboo and Cane Vulnerability and Income Generation in the Rural Household Subsistence Economy of Bjoka, Zhemgang, Bhutan: https://www.researchgate.net/publication/232663730_Bamboo_and_Cane_Vulnerability_and_Income_Generation_in_the_Rural_Household_Subsistence_Economy_of_Bjoka_Zhemgang_Bhutan
- Bamboo/cane plantation to sustain Monpa livelihood: https://kuenselonline.com/bamboocane-plantation-to-sustain-monpa-livelihood/
- Monpas of Bhutan: A Study of Tribal Survival and Development Responses: https://architales.org/wp-content/uploads/2020/06/03-Raghubir-CHANDp25-37.pdf

Tali Lake (Kuenzang Nima)

Lake Revival: Towards Environmental Conservation (Bhutan)

Tsho Nyam Soong Baedhi Rang Zhin Thakor Dhakzin Thabni (མཚོ་ཉམས་སྲུང་འབད་དེ་རང་བཞིན་མཐའ་སྐོར་བདག་འཛིན་འཐབ་ནི།)

DESCRIPTION

The lake conservation initiative at Tali was conceived with the vision of protecting the lake and transforming the surrounding area into a community eco-tourism hub. The initiative is a testament to how science and spirituality, and culture and the environment can coexist and benefit from one another.

The lake conservation initiative at Tali was conceived with the vision of protecting the lake and transforming the surrounding area into a community eco-tourism hub. The initiative is a testament to how science and spirituality, and culture and the environment can coexist and benefit from one another. The Tali Lake is a major water source (both irrigation and drinking) for the community and both livestock and wild animals.

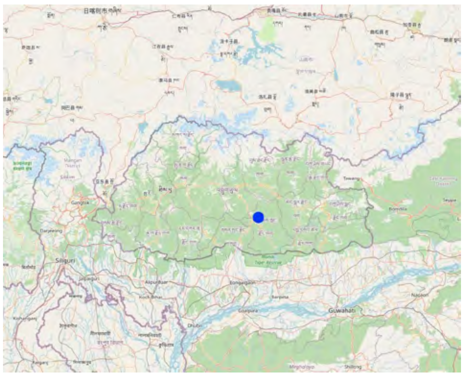
Bhutanese believe lakes to be sacred and religiously significant. Buli Lake and Tali Lake (Tangsibi Tsho) epitomise how nature and culture come together. Tali village under Nangkor gewog in Zhemgang Dzongkhag lies on the shoulder of mountains at an elevation of 1880 m.a.s.l. with broad-leaved forests. It comprises 25 households with around 280 residents. According to local legend, Tangsibi Tsho in Tali is the "Jewellery basket of Buli Tsho which was left behind when Buli Tsho moved from Tali to Buli". Tali Lake is spread over an area of 0.40 ha. The 18.2 ha forest around the lake is dominated by species of oak. The forest around the lake harbours a very rich variety of mammals (22 species) that are ecologically important and visit the lake for water and predation. Also, 70 species of birds have been recorded in the forest around the lake.

The community, along with the Loden Foundation and the monastic body, has been engaged in reviving the lake as 90% of the surface was covered with waterweeds and grasses. The aim was to clean, beautify, and sustain the ecosystem through an integrated and holistic management project by combining scientific, social, and spiritual approaches. There was support of USD 33,550 from the United Nations Development Programme Global Environment Facility (UNDP GEF) Small Grants Programme (SGP) and USD 12,650 from the Loden Foundation and the Community.

Tangsibi Tsho in Tali has significant cultural importance which includes water for irrigation and drinking purposes both for people as well as livestock and wild animals. Thus, the initiative was aimed at conserving the lake and transforming the lake area into a community eco-tourism hub. According to the villagers and senior citizens of the community, the revival of the lake would help in mitigating water shortage problems for irrigation which they require for rice and wheat - as well as preserving the sacred location. The District Forest Division, Zhemgang under the Department of Forests and Park Services (DoFPS) conducted a survey and recorded 21 plant species (trees and shrubs) and 22 orchid species.

To commence the revival activities, meetings were held with the institutions and conservation groups, by-laws were developed, and extensive mapping and demarcation of the area around the lake were done. Then, during the site development phase of Tali Lake area management, there was development of footpaths and eco-cultural trails, identification of plants and trees and name tagging, installation of waste bins and procurement of materials, installation of signboards at the site, and access roads were completed. Research and documentation on the lake and the village were carried out, and audio-video recordings and interviews were done. Advocacy and awareness of output were also accomplished. Through community engagement and religious ceremonies, the lake was successfully cleared after consulting with the National Biodiversity Centre, advice from concerned authorities and local experts as well as recommendations contained in the biodiversity assessment report from Zhemgang Forest Division under DoFPS. Men and women from the village joined together to construct a bamboo raft to transport the weeds across the lake and over three truckloads of

LOCATION



Location: Nangkhor Gewog, Zhemgang Dzongkhag, Tali Community, Bhutan

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 90.74703, 27.17103

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: Yes

Date of implementation: 2020

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

weeds and tree stumps were cleared to revive the lake. The National Environment Commission tested the water quality and the result showed that the pH of the water is slightly acidic (6.49), 0.95mg/L of dissolved oxygen, and chemical oxygen demand of 10.4mg/L. The revival of Tali Tangsibi Lake has benefitted downstream water supplies for irrigation and has prevented the sacred local lake from drying up.

Tali Lake (Kuenzang Nima)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: No

Forest/ woodlands

- (Semi-)natural forests/ woodlands. Management: Selective felling, Non-wood forest use

Tree types (mixed deciduous/ evergreen): n.a.

Products and services: Timber, Fuelwood, Nature conservation/ protection, Recreation/ tourism

Waterways, waterbodies, wetlands - Main products/ services: Lake

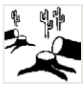
Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [x] not applicable

Degradation addressed



biological degradation - Bh: loss of habitats, Bs: quality and species composition/ diversity decline

water degradation - Hs: change in quantity of surface water

SLM group

- surface water management (spring, river, lakes, sea)
- ecosystem-based disaster risk reduction

SLM measures

other measures - Lake revival

TECHNICAL DRAWING

Technical specifications
None

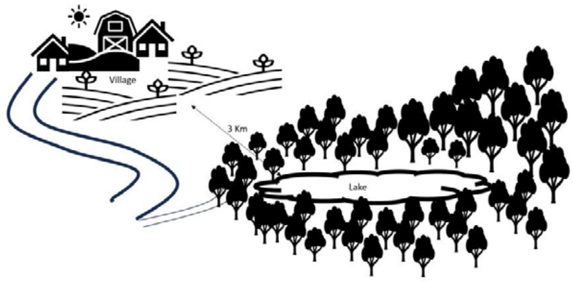


Figure: Diagram representing Tali Lake Revival

Author: Ongpo Lepcha

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology unit
- Currency used for cost calculation: **USD**
- Exchange rate (to USD): 1 USD = 80.0
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs
n.a.

Establishment activities
1. Project inception and area mapping. (Timing/ frequency: None)
2. Lake management and eco-cultural trail development. (Timing/ frequency: After crop harvest (November and December, 2020))
3. Research and documentation phase. (Timing/ frequency: None)
4. Output dissemination. (Timing/ frequency: None)

Total establishment costs (estimation)
46200.0

Maintenance activities
n.a.

NATURAL ENVIRONMENT

Average annual rainfall
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The lake area falls under the Dry Subtropical Zone in Bhutan.

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- [ ] individual, titled
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- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor			good
health		✓		
education				✓
technical assistance		✓		
employment (e.g. off-farm)		✓		
markets		✓		
energy				✓
roads and transport				✓
drinking water and sanitation				✓
financial services			✓	

IMPACTS

Socio-economic impacts

Crop production

decreased ☐☐☐☐✓☐☐ increased

The lake is a critical source of irrigation water. The lake revival has aided in crop production via water availability.

animal production

decreased ☐☐☐☐✓☐☐ increased

The lake is a critical source of drinking water for domestic animals. The lake revival has aided in animal production via water availability.

risk of production failure

increased ☐☐☐☐✓☐☐ decreased

The risk of production failure has decreased as there are enhanced crop and animal productions due to water availability from the lake.

drinking water availability

decreased ☐☐☐☐✓☐☐ increased

The lake is a source of drinking water for the Tali community and because the lake is cleaned and managed the water availability and quality have improved.

water availability for livestock

decreased ☐☐☐☐✓☐☐ increased

The lake is a source of drinking water for domestic animals so the water availability for livestock has increased.

water quality for livestock

decreased ☐☐☐☐✓☐☐ increased

The lake is a source of drinking water for domestic animals and because the lake is cleaned and managed the water quality for livestock has improved.

irrigation water availability

decreased ☐☐☐☐✓☐☐ increased

The lake is a source of irrigation water and because the lake is cleaned, managed, and conserved the availability of irrigation has increased.

irrigation water quality

decreased ☐☐☐☐✓☐☐ increased

The lake is a source of irrigation water and because the lake is cleaned, managed, and conserved the quality of irrigation water has improved.

Socio-cultural impacts

SLM/ land degradation knowledge

reduced ☐☐☐☐✓☐☐ improved

The lake revival has created awareness among the Tali community against the irresponsible exploitation of forests. It has thrown light on the importance of water conservation.

Ecological impacts

animal diversity

decreased ☐☐☐☐✓☐☐ increased

The quantity is not known. However, the beneficiaries believe that the lake revival along with eco-tourism area demarcation followed by enhanced area protection could have improved the animal diversity.

habitat diversity

decreased ☐☐☐☐✓☐☐ increased

The dedicated area (lake and the nearby forest) identified and protected is assumed to have diversified the habitats.

Off-site impacts

water availability (groundwater, springs)

decreased ☐☐☐☐✓☐☐ increased

Increased water availability for drinking and irrigation.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative ☐☐✓☐☐☐☐ very positive

Long-term returns — very negative ☐✓☐☐☐☐☐ very positive

Benefits compared with maintenance costs

No maintenance was carried out until now.

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all ☐☐☐☐✓ very well

Climate-related extremes (disasters)

local rainstorm — not well at all ☐☐☐☐✓ very well

local thunderstorm — not well at all ☐☐☐☐✓ very well

local hailstorm — not well at all ☐☐☐☐✓ very well

local windstorm — not well at all ☐☐☐☐✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 11-50%
- ☑ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ☑ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Number of households and/ or area covered

25 households of Tali

Has the Technology been modified recently to adapt to changing conditions?

☐ Yes
☑ No

To which changing conditions?

☐ climatic change/ extremes
☐ changing markets
☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Enhance the understanding of scientific, cultural, and spiritual ecology for environmental conservation.
- Enhance livelihood through the promotion of community-based ecotourism activities.
- Retaine or increase water volume of the lake.
- Continued transmission of local cultural knowledge and spiritual and scientific practices beneficial for environmental conservation.
- Promote community stewardship of the lake and the environment.
- Revive and conserve lake and the surrounding ecosystem.
- Create awareness against the irresponsible exploitation of forests.
- Increased awareness to sustain watersheds and sources for irrigation.

Strengths: compiler's or other key resource person's view

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Internal conflicts and misunderstandings are common during group labor contribution. Regular group meetings, guidance from District Forest Division

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Weeds cover the lake periodically. Cleaning the lake surface by identifying certain routine time.
- The trails and monuments near the lake are kept unmanaged. Regular clearing of these trails and management of monuments.
- Unmanaged water hole present above the lake. A small water hole present above the lake can be improved and maintained, so that the pressure on the lake will be reduced and can serve as a water reservoir for the lake.

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6857/

Linked SLM data
n.a.

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Links to relevant information which is available online

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