Regional Technical Capacity-Building Workshop on Agroecological Practices and Nature-Based Solutions in the Zambezi Basin

TIARA regional training workshop 03-08 November 2025, Zambia

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ACRONYMS

BDBA – Billion Dollar Business Alliance
BCR – Benefit-Cost Ratio
BMT – Build, Manage, and Transfer
CA – Conservation Agriculture
CCP – Community Conservation Plan
CIDPs – County Integrated Development Plans
CIFOR-ICRAF – Centre for International Forestry Research and World Agroforestry
CFMA – Community Forest Management Areas
CFMG – Community Forest Management Group
CFU – Conservation Farming Unit
CGIAR – Consortium of International Agricultural Research Centres
CSA – Climate-Smart Agriculture
CSPs – Community Service Providers
CTDT – Community Technology Development Trust
DARS – Malawian government research Department of Agriculture Research Services
DBF – Deep Bed Farming
DNPW – Department of National Parks and Wildlife
FACHIG – Farmers Association of Community Self-Help Investment Groups
FGD – Focus Group Discussion
M&E – Monitoring & Evaluation
NbS – Nature-based Solutions
NGO – Non-Governmental Organization
PRAs – Participatory Rural Appraisals
PVO – Private Voluntary Organisation
ROI – Return On Investment
SIWI – Stockholm International Water Institute
TIARA – Transforming Investments in African Rainfed Agriculture
WRUAs – Water Resource User Associations

1. Introduction

Across Africa, around 95 per cent of agricultural production depends on rainwater, yet only 5 per cent of public agricultural water investments are directed towards rainfed agriculture. In many Sub-Saharan African countries, smallholder farmers produce as much as 90 per cent of the food supply, but their yields remain among the lowest in the world. Farmers hold the key to sustainable land and water management on the ground, yet they are rarely equipped with the skills and support to fulfil this role effectively. The Zambezi Region faces increasing climatic variability characterised by erratic and shortened rainy seasons, declining soil fertility from continuous cultivation, widespread erosion, and landscape degradation.

The Transforming Investments in African Rainfed Agriculture (TIARA) programme, led by the Stockholm International Water Institute (SIWI), aims to scale up green water management to enhance rainfed agriculture in the Zambezi region, namely in Malawi, Zimbabwe, and Zambia. TIARA builds on existing approaches, including landscape management, sustainable agriculture and agroecology, and complements the work of programs such as the Comprehensive Africa Agricultural Development Programme and the African Union's Agenda 2063. By enhancing water recharge, improving soil health, sequestering atmospheric carbon, and bolstering biodiversity, the program drives the transformation of rainfed agriculture toward significantly higher and more resilient crop yields. TIARA has three components: **1) political leadership and advocacy**, **2) capacity development**, and **3) knowledge generation and business case development**.

Over the past five years, TIARA supported evidence-based decision-making in catchment management, multi-stakeholder coordination platforms, and cross-sectoral learning that links policy, science, and local practice. To consolidate these gains, from the 03rd to the 08th of November 2025 (Annexe 1), TIARA facilitated a Regional Technical Capacity-Building Workshop on agroecological practices and Nature-based Solutions (NbS) with technical support from CIFOR-ICRAF and SIWI. The country implementing partners were NGOs from Malawi (TIYENI), Zimbabwe (CTDT & FACHIG), and Zambia (COMACO). Government representatives from the Ministries of Water Development and Sanitation, Agriculture, Green Economy and Environment, and Lands and Natural Resources in Zambia also attended the event (Annexe 2). The workshop was convened to strengthen the technical and institutional capacities of practitioners in enhanced rainfed agriculture as a vehicle for scaling up sustainable and resilient practices. The goal of this exchange visit was to learn from and share experiences among NGOs.
by:

- Deepening understanding of climate-resilient water governance frameworks that integrate ecological, social, and institutional dimensions.
- Strengthening capacities in landscape-level monitoring tools, data interpretation, and indicator-based performance tracking for resilience building.
- Facilitating cross-country learning and, knowledge exchange.
- Aligning technical lessons with policy and investment pathways, sustaining impact beyond 2025.

The approach of this training emphasised participatory learning, applied field exposure, and joint reflection. Participants engaged in scenario-based exercises, hands-on field demonstrations, and technical discussions on integrated catchment planning, monitoring frameworks, and adaptive management. The workshop took place in Petauke, Zambia. Participants had the opportunity to interact with and learn from smallholder farmers practising agroforestry in Petauke District and land conservation practices in Lusangazi District (Figure 1).

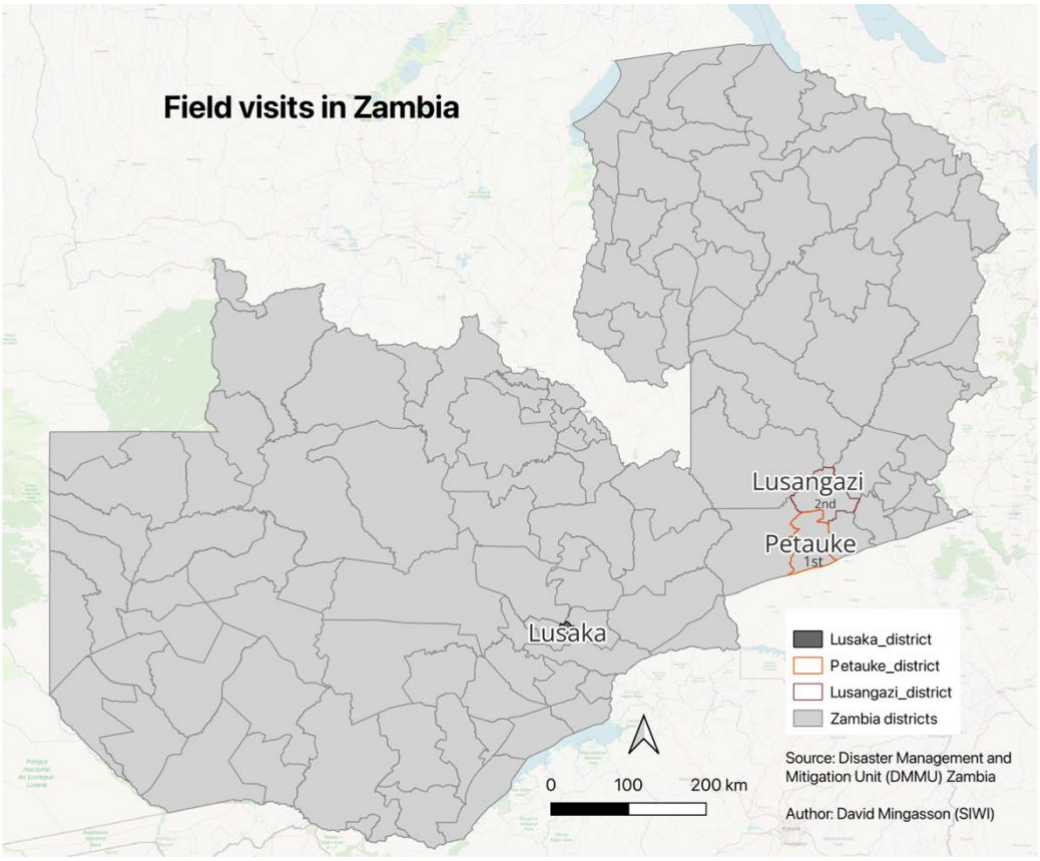

Figure 1: Map showcasing the visited district (Mr David Mingasson, SIWI)

At the two site visits, the delegation met local farmers, traditional leadership, and stakeholders who shared their experiences and reflections on their practices (Figure 2). The target audience included CIFOR-ICRAF and SIWI's partners from Malawi, Zimbabwe, and Zambia (TIYENI, CTDT, FACHIG, and COMACO) working in rural areas on agroecological practices to promote soil and water conservation. Efforts were made to ensure inclusive representation of local communities, youth, and women's groups.

Figure 2: Farmers and workshop participants (Mr Chenda Charles, Photographer)

The expected outcome of this workshop and field visit was to learn from and share experiences, achievements, lessons learned over the last five years and explore ways forward beyond 2025 to improve (1) livelihoods, (2) rural economy and (3) environmental benefits through enhanced rainfed agriculture and agroecological approaches in terms of water, carbon and biodiversity.

2. Regional exchange of best practices

2.1. Farmers Association of Community Self-Help Investment Groups (FACHIG), Zimbabwe

FACHIG is a trust and a private voluntary organisation (PVO) based in Bindura, the provincial capital of Mashonaland Central Province in Zimbabwe. Currently, FACHIG's activities focus on Mashonaland Central Province**;** however, it has worked in almost all provinces of Zimbabwe. FACHIG seeks to transform the lives of smallholder women and men farmers and others in rural communities across Zimbabwe through agro-ecological interventions and gender- and climate-sensitive value chain development initiatives. FACHIG has reached more than 12,000 farmers, of whom 73% are women.

FACHIG promotes a government-initiated rainfed agricultural practice called Pfumvudza, which integrates conservation agriculture (CA) and precision agriculture to enhance water management, soil health, yields, and ultimately promote food security. The Pfumvudza concept incorporates techniques such as potholing, mulching, cover cropping, and the use of organic manure from vermi compost. These techniques increase soil moisture retention and enhance soil fertility and structure. Farmers use readily available, relatively inexpensive resources to improve soil health, and ultimately food and nutrition security, as well as income generation through selling surplus produce.

FACHIG conducted field data collection over three years (from 2022 to 2024) to compare the yield between (1) Pfumvudza organic, (2) Pfumvudza inorganic, (3) Conventional practice (including the use of synthetic fertilizer and mechanization such as rippers, ploughs), and (4) Farmer practice (including the use of manual tools such as hoe, and minimum to no use of fertilizer). Results demonstrate that the Pfumvudza organic plot has always had the highest yield per hectare, followed by the Pfumvudza inorganic plot, the conventional plot and the plot with farmer practices. The benefits of Pfumvudza are already evident in the first year of implementation. Pfumvudza also exhibits greater resilience to climate events. The El Niño-induced drought in 2023/24 adversely affected farmers' yields nationally. In the first-year event, the plot with conventional practices decreased by 5 (from 500 kg to 100 kg). In contrast, it only diminished by 1.5 (from 900 kg to 600 kg) on the Pfumvudza organic plot (Figure 3).

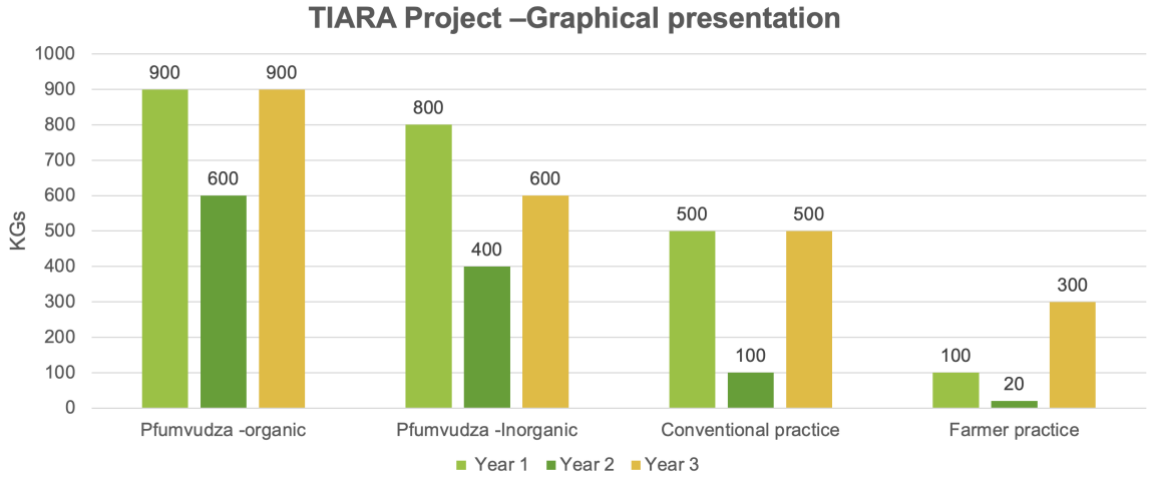

Figure 3: FACHIG data collection on four farming practices (Ms Motsi Evelyne Runyararo, Foundations for Farming)

In addition, FACHIG fosters livelihood diversification by developing horticulture and mushroom hubs, and by establishing on- and off-farm enterprises that support small grains and chilli production, and biodiversity through reforestation activities.

2.2. The Community Technology Development Trust (CTDT), Zimbabwe

CTDT is a Non-Governmental Organization (NGO) based in Harare, Zimbabwe, which reached approximately 900,000 farmers in eight out of the 10 Provinces of Zimbabwe. CTDT promotes integrated agrobiodiversity management, environmental management, food and seed security, water and sanitation, and policy and advocacy programmes with the objective of promoting sustainable livelihoods.

As part of TIARA, CTDT has promoted water harvesting technologies, CA, conservation works such as trenching to regulate runoff and improve soil moisture retention (green water), and weir dam construction. These practices have increased crop yields, food diversity, consumption of nutrition-dense foods, and income generation, and have improved soil nutrition and vegetation cover. They have also enhanced access to water for domestic and environmental requirements and bolstered livelihood diversification through market gardening.

RETURN ON INVESTMENT

CTDT conducted field data collection assessing the Return On Investment (ROI) between conventional farming practices and CA. Figure 4 is a case study of one of the farmers in Mutoko district in Zimbabwe.

FARMER 1: Mutize Audious, Male, 67 years , Location: Rochester Plot Number 1, Village 4, Mutoko

Main crops: maize, cotton, groundnuts, sunflower, sorghum

Season: 2021/2022

BEFORE					
AGRONOMIC PRACTICE	Area	INPUTS	Quantity	Estimate/Ha	COST
Conventional (Ox-drawn/ tractor)	0.5 Ha	seed	10kg	/	
		Fertiliser	20*50kg		$500
		Land Prep + Planting	7 people		$140
		Weeding	7		$140
		Spraying	2		$50
		Harvesting	10		$100
		Manure	4		$40
ROI					
Yield			2 tonnes	4	4*$300= $1200
Farm-gate prices			500 KG	1	$150
Establishment Cost					$140
Cost of Agronomic Inputs					$500
Husbandry Costs					$40
Harvesting costs					$100
Handling and Marketing Costs					$30
Maintenance Costs					$50
Soil moisture					-
Outlay					$1200-$1010= **$190**

Season:2022/2023

AFTER					
AGRONOMIC PRACTICE	Area	INPUTS	Quantity	Estimate/Ha	COST
CA	0.5 Ha	Seed	10kg	/	
		Fertiliser	/		
		Land prep + Planting	4 people		$80
		Weeding	2		$40
		Spraying	2		$20
		Harvesting	4		$80
		Manure/ mulching	2		$20
ROI					
Yield			5 tonnes	10	10*$300= $3000
Farm-gate prices			3 tonnes	6	6*$250= $1550
Establishment Cost					$80
Cost of Agronomic Inputs					$20
Husbandry Costs					
Harvesting costs					$80
Handling and Marketing Costs					$30
Maintenance Costs					$00
Soil moisture					-
Outlay					$3000- $1710=**$1290**

Figure 4: Return On Investment (ROI) case study on a maize field comparing Conventional practice (on the left), and CA (on the right) (CTDT) between seasons 2021/2021 and 2022/2023.

There is a case for promoting investment in rainfed farming. The ROI of CA after a 2-year pilot study was 6 times higher than conventional farming. A farmer is earning more by minimising costs on agronomic practices, fertilisers/chemicals, land preparation and husbandry practices. The yield cost is an estimated price per tonne, assuming the farmers are selling a bucket of maize at $5. This means on average a tonne, which is about 60 buckets multiplied by 5, is equal to $300.

CTDT identified policy challenges working with TIARA:

- Lack of legal recognition and regulation of the Farmer Managed Varieties of seeds
- Limited advocacy on the benefits of Climate-Smart Agriculture (CSA), environmental stewardship and ecosystem services
- Limited research and technological improvements in appropriate mechanization and soil health improvement
- Lack of deliberate effort to finance the transition towards agroecology and agroforestry
- Transboundary regulation of shared river basins – need for a framework to guide land-use practices and share data
- Rainfed agricultural technologies are labour-intensive

Based on the experience with TIARA, CTDT recommends four areas to focus on:

- Research and development on watershed management and water harvesting technologies
- Improve local livestock breeds, manage human-wildlife conflicts, and reduce environmental degradation in the Zambezi Basin.
- Digital innovation for soil testing, soil health analysis, degradation and impact assessments
- Strengthening collaboration and partnerships. Joint proposal development with a regional focus

2.3. TIYENI, Malawi

TIYENI, an NGO operating in Malawi, has reached more than 37,000 farmers, covering between 8,000 and 12,000 ha of land. TIYENI aims to empower smallholder farmers to build self-sustaining livelihoods that equally benefit people and the planet. TIYENI delivers low-cost, low-technology training in CSA and equips farmers with the skills and expertise to build self-sustaining livelihoods that enhance their food and water security, income, and nutrition while simultaneously improving the natural environment.

Deep Bed Farming (DBF) is an NbS pioneered by TIYENI since 2004 to cope with multidimensional poverty and climate change. In 2021, the Malawian Government approved, adopted, and outscaled this practice. DBF addresses soil compaction by breaking the compacted soil hardpan (learn more here). Over the years, TIYENI tested DBF across different agroecological contexts, and it consistently delivered positive results. DBF is combined with other NbS such as intercropping, crop rotation, mulching, composting, and rainwater harvesting. Healthier soil and diversified crops also provide more nutritious, balanced diets, helping address malnutrition. Many Malawian farmers and their families have achieved food security through DBF, eating an average of one additional meal per day compared with peers using conventional farming.

As part of TIARA, TIYENI implemented a 3-year pilot study (2022-2024) with a business case comparing the profitability of DBF and Conventional Ridge (CR) systems in the Eswazini extension planning area in the Mzimba district of Malawi. 10 farmers participated in the pilot, and 4 ha were allocated to DBF and 4 ha to CR. On the DBF plot, TIYENI used an integrated soil fertility management with mechanized tillage and bed making, blended fertilization, organic manure, and agroforestry integration. TIYENI used three Key Performance Indicators (KPI): (1) the ROI as the ratio of net benefits to total investment, (2) yield in kg/ha, and (3) gross revenue USD/ha. Results showed DBF delivered a clear economic and productive advantage over CR beds:

- **ROI**: An average of 131% with DBF versus 25% with CR.
- **Yield per ha**: An average of 4,488 kg/ha with DBF versus 2,303 kg/ha with CR.
- **Revenue per ha**: An average of $2,449 with DBF compared to $1,243 with CR.

Adopting DBF proved **highly profitable** for farmers and led to behavioural change, with farms shifting from subsistence experimentation to market-oriented production. Despite slightly higher establishment costs of DBF ($1,095/ha with DBF vs $1,012/ha with CR), net financial returns far outweighed incremental investment, demonstrating that enhanced rainfed systems strengthen economic resilience and justify scaling across Malawi.

Mr Chavula Isaac also stressed that TIYENI conducted a participatory assessment process involving 14 farmers in the northern and central Malawi, where the Benefit-Cost Ratio (BCR) was computed and compared between crops produced under CR and DBF. The results showed a BCR of less than 1.0 for crops grown under CR, and a BCR of 2.3 for those grown under DBF, showing that there is a high and positive net value of the investment that farmers put in DBF.

Reflections on the pilot study:

- Transforming rainfed agriculture is achievable with participatory, data-driven approaches.
- Farmer-centred learning proved crucial as farmers became **co-researchers** rather than beneficiaries.
- The program built capacity for both technical and financial literacy among participants.
- The success of DBF in Eswazini offers a model for sustainable intensification aligned with Malawi's Vision 2063.

Challenges:

- Resource constraints
- Limited scale and geographic scope
- Limited field accessibility during heavy rains

Recommendations:

- Future programs should emphasize multi-season monitoring, market linkages, and access to financing for mechanization.

- Future programs should target larger, more diverse farmer groups to capture a wider range of agroecological conditions.
- While ROI tracking was robust, more emphasis could be placed on environmental indicators (soil organic matter, infiltration rates, biodiversity).
- The next program must capture key hydrological indicators, e.g. groundwater table changes.

Lessons:

- Adoption curve matters: consistent farmer engagement and visible early gains drive uptake.
- Mechanization (tractor access) is key for timely land preparation, breaking the hardpan and scaling.
- Monitoring ROI alongside yield helps demonstrate the economic logic of climate-smart practices.
- Need for policy integration to support mechanised rainfed-focused systems.

2.4. CIFOR-ICRAF, Zambia

In Zambia, CIFOR-ICRAF is a leading research institution that provides NbS to address climate change, biodiversity loss, and soil degradation. Since 1985, it has applied its expertise in agroforestry and landscape management to transform rural value chains and enhance ecosystem services across diverse ecological regions. Led by Country Representative Mr Maimbo Malesu, the Zambia office partners with the Ministry of Agriculture, the Ministry of Green Economy and Environment, and SIWI via the TIARA project. By connecting scientific research with field application, CIFOR-ICRAF promotes climate-smart agriculture and sustainable water use, turning ecological restoration and rainfed productivity into resilient livelihoods for smallholder farmers.

3. Training sessions on climate-resilient water governance and sustainable landscape management

3.1. Participatory approaches to water governance and landscape restoration

Mr Maimbo Malesu, Zambia Country Representative at CIFOR-ICRAF, presented the application of the **Watershed Management Protocol Application (WAMPA)** in three Kenyan counties—Bungoma, Kakamega, and Siaya—as a case study for participatory land and water management. The core objective of the initiative was to conduct a **comprehensive biophysical and socio-economic characterization** of the target watersheds to identify and address issues hindering economic productivity and ecosystem health.

The methodology relied on the **Revised Universal Soil Loss Equation (RUSLE)** to map erosion risks. This model integrates factors like rainfall erosivity (R), soil erodibility (K), slope length (L), slope steepness (S), land cover (C), and supporting practices (P) to estimate average annual soil loss. By analyzing these factors, the CIFOR-ICRAF team

generated thematic maps (Figure 5), particularly identifying cropland as the land use with the greatest degradation risk, despite over 60% of the total area being at low risk.

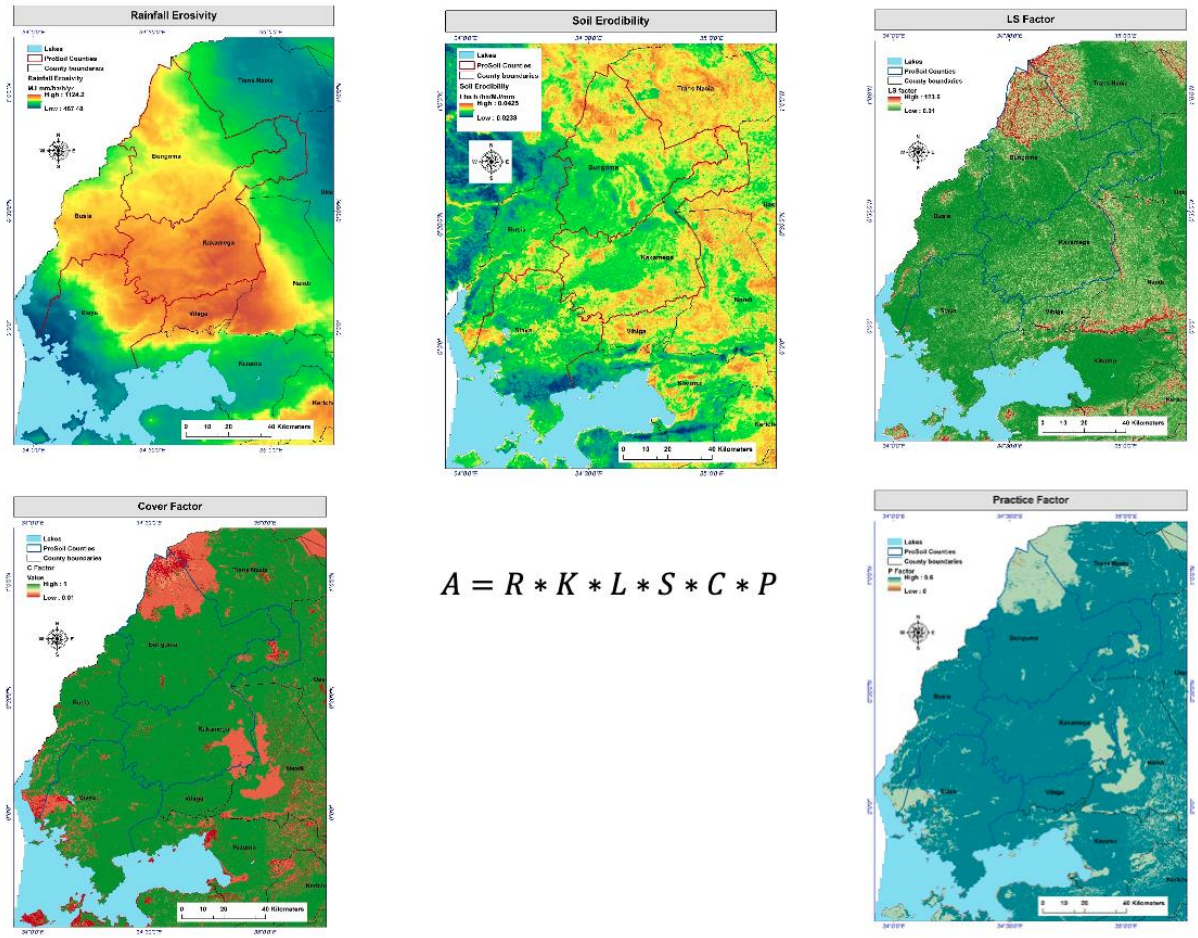

Figure 5: Maps exhibiting factors of the RUSLE model (Mr Maimbo Malesu, CIFOR-ICRAF)

A critical phase was the field validation of these modelled hotspots. The CIFOR-ICRAF team conducted site visits, consulted with Water Resource User Associations (WRUAs) and county staff, and collected soil and water samples to verify map accuracy and gather ground-truth data. This participatory step ensured local stakeholder input and validated the scientific analysis.

The final outputs comprised detailed physiographic maps designed to guide the formulation of actionable watershed management plans. The presentation concludes by emphasising that effective watershed management must be integrated and inclusive, requiring coordinated strategies across all governance levels. It calls for mainstreaming WAMPA's findings into County Integrated Development Plans (CIDPs) and for developing five-year management plans that balance food production with the protection of water, land, and biodiversity. Ultimately, WAMPA is presented as a vital tool for enabling data-driven, participatory restoration and for fostering policy coherence for sustainable landscape management.

Then, Mr Moses Mwenda showed a presentation video of COMACO's model in Zambia that tackles poverty, food insecurity, and conservation as interconnected challenges. COMACO trains farmers in sustainable, climate-resilient agriculture like **agroforestry** and **CA**,

improving their yields, soil health, and income generation and saving. They provide both theoretical and practical training, ensuring knowledge application in the field. To create direct economic incentives for conservation, COMACO purchases the farmers' crops at a premium and processes them into high-value "It's Wild!" (Figure 6) brand foods, such as peanut butter.

Figure 6: "It's wild!" store of COMACO (COMACO)

This integrated approach provides farmers with a reliable income, prevents financial swindles by vendors, and sustains the natural ecosystems on which communities depend. It demonstrates that empowering rural communities economically is fundamental to achieving lasting environmental conservation.

3.2. Integrating climate adaptation in agricultural and landscape planning

Mr Maimbo Malesu delivered a comprehensive presentation on climate-resilient water governance and sustainable landscape management in Africa, focusing on farm pond technology and CA. He highlighted the critical need and opportunity in Africa, where drylands, low rainfall, and economic water scarcity contribute to chronic hunger, poverty, and vulnerability. The core problem was identified as poor water access due to inadequate harvesting infrastructure and extremely low agricultural productivity, exacerbated by intra-seasonal dry spells and poor rainwater management, which led to floods and erosion.

3.2.1. Farm pond technology

A key technological solution is **rainwater harvesting** from farm ponds (Figure 7). Thus, Mr Maimbo Malesu detailed a holistic scaling model developed from experiences in Kenya (Lare, Nakuru). This model was not just about digging ponds; it was an integrated system that connected input suppliers (liners, solar pumps, shade nets), Community Service Providers (CSPs) for design, construction, and maintenance, and farmer organisations,

with training and demonstration hubs at Community Learning and Service Centres. This ecosystem is supported by government and NGO extension services to enable climate-smart production, ultimately aiming for food security and rural economic growth.

Figure 7: Construction steps of a farm pond (Mr Maimbo Malesu, CIFOR-ICRAF)

A valuable insight to take away from this operation is the **tailored financing strategy**. The model proposed graduated subsidies based on land holding, pond size, and poverty index. Small-scale, high-poverty farmers may receive 50-75% grants, while larger, wealthier farmers transition to self-financing with minimal subsidy. This is coupled with a Build, Manage, and Transfer (BMT) business model to reduce financial risk by ensuring farmers build management capacity during a supported "Built" phase before full ownership transfer.

Mr Maimbo Malesu provided concrete data on investment costs for integrated pond systems (from \$1,370 for a 50 m^3 pond to over \$7,000 for a 1,000m^3 pond) (Figure 8) and showcased impacts.

Size of Investment	Farm pond volume (m^3)	Irrigated area (m^2)	Cost of aggregated components (USD)			Total Cost (USD)
			Complete farm pond	*Drip irrigation*	*Lift pump*	
Small	50	230	1,050	220	100	**1,370**
	75	345	1,450	300	100	**1,850**
	100	460	1,650	375	100	**2,125**
Medium	120	550	1,900	450	300	**2,650**
	150	690	1,400	550	300	**2,250**
	180	830	1,475	670	300	**2,445**
	200	950	1,550	700	300	**2,550**
	250	1,150	1,835	875	300	**3,010**
Large	300	1,400	1,970	1,050	400	**3,420**
	400	1,850	2,400	1,250	400	**4,050**
	500	2,300	2,725	1,500	400	**4,625**
	600	2,750	3,025	1,750	400	**5,175**
	700	3,200	3,350	1,900	400	**5,650**
	800	3,700	3,675	2,000	400	**6,075**
	900	4,150	4,000	2,250	400	**6,650**
	1,000	4,600	4,300	2,500	400	**7,200**

Figure 8: Different investment costs for integrated farm pond system technological package (Malesu Maimbo, CIFOR-ICRAF)

Evidence from the CIFOR-ICRAF-led Drylands Development Programme (DryDev) in Eastern Kenya demonstrates the transformative potential of the "Lare Model" for rainfed agriculture, as exemplified by the Peace Women Group in Kitui. By investing $33,000 in 15 lined household ponds, the group enabled intensive irrigation of 4.5 hectares of high-value vegetables and fruits, generating a monthly income of $3,525 and annual revenue of over $42,000. This model not only achieved a capital payback period of less than 10 months but also reduced average household food expenditure by $18, providing a proven, scalable blueprint for converting climate-vulnerable subsistence farming into profitable, climate-smart commercial production.

Thus, farm pond technology can positively impact livelihoods, food security, income, women & youth employment while combating climate change.

How to scale up the initiative?

- Consider the dependence on **labour availability** or **mechanization** excavation
- Support **enterprises** and **crops** where women and youth have traditionally more control can enhance benefits and empower them
- Markets with well-developed **value chains** are critical drivers
- Ensure **minimum quality standards on design and construction** for long-term ROI (HoPPA protocol defines these standards, and all stakeholders should follow it)
- Assist with **decision-support tools** and **farmer-to-farmer** extension (farmer pond planner)
- **Private-public partnerships,** such as the Billion Dollar Business Alliance (BDBA), are necessary

3.2.2. Conservation agriculture in Zambia

Mr Maimbo Malesu explained that since the 1990s, Zambia has scaled CA to over 250,000 smallholder farmers by adhering to three core principles: (1) Permanent soil cover, (2) Crop rotation (minimum of 30% legumes), and (3) Minimum soil disturbance (Figure 9). Success is attributed to strong, long-term government policy support, dedicated units such as the Conservation Farming Unit (CFU), donor partnerships, private-sector engagement (e.g. tool supply), and extensive farmer training. Additionally, CIFOR-ICRAF advocate for valorizing crop residues rather than burning, establishing permanent planting basins correctly spaced and dug before the rains, and early planning and weeding.

CIFOR-ICRAF have also used agroforestry practices (Figure 9) as part of CA, which demonstrated a gradual, significant yield increase. Using Faidherbia albida trees on a maize plot without fertilizer has more than doubled the yield compared with a plot without Faidherbia albida trees (5.6 tons/ha vs. 2.6 tons/ha). This can mainly be explained by the natural nitrogen provided by the trees, which enriches the soil, as well as the increased soil permeability thanks to the tree roots.

Figure 9: Conservation agriculture practices. A = Permanent ground cover; B = Crop rotation; C = Minimum soil disturbance; D = Agroforestry (Mr Maimbo Malesu, CIFOR-ICRAF)

How to scale up the initiative?

- Ensure the availability of crop residues
- Consider the labour-intensiveness, and the need for tools and mechanization
- Support access to markets

3.3. Monitoring tools and indicators for climate-resilient landscapes

Building climate-resilient landscapes across Africa is a foundational pillar of the continent's sustainable development, food security, and adaptation to a changing climate.

However, resilience cannot be managed without being measured. **Effective monitoring systems**, combining practical tools and context-specific indicators, are essential to (1) track progress, (2) inform adaptive management, and (3) secure continued investment. In African contexts, where data scarcity, institutional capacity, and diverse agro-ecological zones pose unique challenges, these systems must be robust yet accessible, inclusive, and scientific while grounded in local reality.

A climate-resilient landscape is a complex socio-ecological system. Monitoring must therefore capture not only **biophysical parameters** (e.g. soil health, water availability, vegetation cover) but also **socio-economic outcomes** (e.g. livelihood security, adaptive capacity) and **institutional strengthening** (e.g. governance, knowledge sharing). The challenge is to untangle this complexity into a manageable and understandable set of metrics that are meaningful to everyone, from farmers to policymakers. Below is a proposed list of key indicators:

1) **Biophysical metrics**: These measure the ecological health and resilience.

    - Soil and water: Soil organic carbon content, water infiltration rate, dry-season river flow, groundwater table levels.
    - Biodiversity and biomass: Tree canopy cover, above-ground biomass, prevalence of native vs. invasive species.
    - Erosion and degradation: Percentage of bare soil, sediment load in waterways, extent of gullies
    - Ecological resilience: Potential depth and distance to threshold, duration of persistence, skewness

2) **Socio-economic metrics**: These track the stability and sustainability of food and income systems

    - Yield resilience: Crop yield variance across seasons, adoption rates of drought-tolerant varieties
    - Livelihood diversification: Number of on- and off-farm income sources per household, diversity of crops and livestock
    - Input efficiency: Water productivity (crop per drop), efficiency of fertilizer use

3) **Institutional metrics**: These gauge the social environment necessary for long-term benefits.

    - Knowledge and practice: Percentage of farmers using climate-smart practices
    - Governance: Existence and functionality of multi-stakeholder landscape governance platforms
    - Economic buffer: Access to climate funds, climate insurance, community savings, or emergency funds.

No single tool can capture this multi-dimensional picture. We therefore recommend a use of multiple tools and methods, such as remote sensing and geospatial platforms (GIS, Collect Earth Online), on-the-ground biophysical tools (rain gauges, weather stations, soil test, infiltrometers), and participatory monitoring and social science methods (focus group discussions, household surveys, Participatory Rural Appraisals (PRAs)).

Harmonizing indicators and using internationally approved methodologies is critical for scaling climate action and sustainable development. It transforms isolated data into a coherent and shared language for progress. By aligning on core definitions, and measurement methods, we unlock transparency, understanding, reliability, credibility, and traceability. This standardization will attract larger investments, and enable true landscape-scale learning. Thus, harmonization turns scattered successes into collective, verifiable impact, ensuring every dollar and every effort contributes to a common, measurable goal.

The future of monitoring lies in **integrated data platforms** that combine satellite alerts, field sensor data, and community reports into intuitive dashboards for local managers and national planners. It is fundamental to **co-design** these systems with the communities and institutions that will use them. Capacity-building in data interpretation and adaptive management is also crucial to ensure progress.

Investing in context-sensitive monitoring tools and indicators is critical to create mechanisms for Africa's journey toward climate-resilient landscapes. It transforms abstract data collection and learning into lasting change. Lessons learned will empower stakeholders to invest wisely, adapt proactively, and ensure that resilience is collectively built.

4. Field visits

Field visits were part of the Regional Technical Capacity-Building Workshop. They provided firsthand experience with agroforestry and land conservation practices through interactions with farmers and an on-the-ground perspective on the transformative potential of these two techniques. The field visit enabled farmers to share their experiences in soil and water conservation, yield improvement, resilience, livelihoods, and food security.

4.1. Site visit 1 on agroforestry

The workshop participants, led by Mr Soko Isaac and Mr Moses Mwenda from COMACO, were warmly welcomed by the farmer group. Farmers outlined that they started collaborating with COMACO three years ago with a pilot plot to implement **agroforestry** (Figure 10). Agroforestry is the intentional integration of trees and shrubs into agricultural landscapes and livestock systems. This ancient yet innovative practice is key to **sustainable land management**, creating **resilient** and **productive ecosystems**. Farmers combined agroforestry with the principle of CA, ensuring minimum tillage through a 15 cm deep ripping, crop rotation, and land cover. The plot size was 50 x 50 m, and rows of 50 trees, spaced by 1 m, were planted every 5 m.

Figure 10: Agroforestry plot (Mr Chenda Charles, Photographer)

COMACO provided farmers with extension services three years ago, and bought tree seeds to implement agroforestry. Then, COMACO created farmers' cooperatives and gave training on how to use and maintain trees to reap the most benefits. Farmers were also supported in establishing tree nurseries, with full ownership granted after the training, thereby diversifying and expanding their livelihoods by selling seeds to COMACO and other farmers. Farmers also began trading among themselves: labour for tree seeds.

Farmers have used Gliricidia Sepium trees and have already reaped significant benefits after two planting seasons, as it is a fast-growing species. They identified a lot of advantages of this practice:

1) **Nutrient recycling and improvement in soil microorganisms**. Tree leaves are collected and applied to the field as a fertilizer, which enriches the soil in nitrogen.
2) **Soil erosion protection**. Tree leaves create a protective layer that prevents raindrops from impacting and high-speed rainwater flow.
3) **Moisture retention and improvement**. Roots create cracks in the soil, enabling water and air to infiltrate. During rainy seasons, water droplets are captured in leaves that decompose, providing sustained, natural irrigation over an extended period. Tree leaves also create a barrier to solar radiation, helping the soil remain at an adequate temperature and conserve moisture.
4) **Insect repellent**. Tree leaves contain pest-repelling compounds that protect crops.
5) **Shade**. Trees provide shade for field workers.
6) **Live fencing**. Timber from tree pruning can be converted into live fencing.
7) **Firewood**. Wood can be used as firewood for cooking or heating.
8) **Carbon sequestration**. Trees mitigate climate change by sequestering CO2.

9) **Micro-climate**. Trees create a micro-climate, enabling crops to perform better.
10) **Windbreak**. Trees act as windbreakers, preventing soil erosion and dry soil.
11) **Medicine**. Tree barks have medicinal properties.
12) **Beekeeping**. Beekeeping houses can be installed in trees, improving biodiversity and providing additional income from honey production.
13) **Stockings**. Twigs can be used as stockings, especially for tomatoes.
14) **Granaries**. Storage of human foods.
15) **Source of income.** Tree seeds are collected and sold.

As additional fertilizers, farmers make their own **organic manure** with a compost made of food leftovers and droppings from livestock. After harvesting, farmers also use **crop residues** to protect soil from sunlight, improve soil moisture, and reduce fire risk during the dry season. Every second year, farmers "**coppice**" the trees, which consists of pruning them to enable the appropriate amount of sunlight to reach the soil and to make space for livestock tillage. Every four years, farmers convert their cropland into fallow land for land repair. Farmers underscored that agroforestry is not labour-intensive because it requires minimal maintenance. Some of the crops grown in this field are maize, groundnut, and cowpeas.

Farmers highlighted that agroforestry was life-changing since all the above benefits contributed to boosting their food security, creating more stable livelihoods, and alleviating poverty in rural areas. Indeed, their crop yield doubled, enabling them to transition from subsistence farming to business farming. Additionally, farmers stressed that climate resilience increased thanks to agroforestry. Despite a devastating drought in 2024, declared as national climate disaster by the Zambian Government, this group achieved a harvest, albeit seeing their yields diminished. This outcome stood in stark contrast to the total losses suffered by surrounding communities. This event shed light on agroforestry as it convinced neighbouring farmers that this practice provides significant benefits.

COMACO emphasized that the adoption rate is higher when farmers learn from fellow farmers. Thus, they acknowledged that to maximize the impact, they generally only work with a few groups of farmers, as they know that as time goes by, knowledge will be shared among farmers, and the adoption of agroforestry will happen incrementally. Ministry representatives stressed that the Government can support agroforestry by sending field officer trainers, nonetheless, it should always be a farmer-driven initiative.

COMACO targets vulnerable groups such as women, and farmers, who demonstrate great interest in agroforestry. Additionally, COMACO provides financial safety and reliability in purchasing their raw food items to process them into high-value food products. Then, food items are sold under COMACO's brands "It's wild!", promoted as tasty, nutritious, and affordable food.

Farmers explained that the economic value brought by agroforestry enabled them to **pay for school** for their children, **pay for labour** to help them in their activities, and **diversify their income** by investing in livestock. A remaining issue to address is title deeds, as farmers lack awareness in this area, and are often unaware of their rights.

As an NbS, agroforestry exemplifies how working with natural processes can address pressing challenges of climate change, land degradation, and rural poverty in a holistic manner.

Following the field visit, the workshop participants organized a Focus Group Discussion (FGD) (Figure 11) with farmers to technically assess the implementation, efficiency, and outcomes of the TIARA Project interventions. Specifically, it aimed at understanding (1) implementation progress, (2) technical effectiveness, (3) socio-economic outcomes, (4) inclusivity, (5) operational challenges and constraints, and (6) lessons for scaling. The discussion also explored technical challenges, capacity gaps, and institutional support mechanisms that influenced project outcomes.

Farmers exhibited high interest in the exercise, had adequate technical knowledge of their activities, and a strong awareness of the benefits. The participants created a supportive, open-minded, inclusive, and representative discussion where farmers felt seen, heard, and understood. The results of the FGD will be used as part of the final self-assessment of TIARA and the Triple Bottom Line technical report.

Figure 11: Focus Group Discussion (Mr Chenda Charles, Photographer)

Lastly, participants recommended that the integration of soil and water conservation structures alongside the minimum tillage, such as swales, would also be relevant.

4.2. Site visit 2 on forest conservation

The workshop participants continued the field visit by visiting a Community Forest Management Group (CFMG) to learn more about **forest conservation management**. Due to time constraints, the team did not reach the Nyaphande forest area in Lusangazi district. Nevertheless, a fruitful discussion was held on the road (Figure 12).

Figure 12: Exchange on forest conservation management in Lusangazi district (Mr Chenda Charles, Photographer)

The CFMG explained that activities started in 2018 with the formation of a group of people to conserve and protect this primary forest for future generations. The size of the plot is 11,800 ha and is a protected area, although not fenced. To this day, the group is composed of 2,864 members. They drew up a Community Conservation Plan (CCP) to establish rules and rights of members.

The community representative pointed out that the group benefits from **carbon funds** by protecting this forest. Carbon credits are a financial instrument in the global effort to mitigate climate change, operating on the principle of cap-and-trade. One credit represents one ton of carbon dioxide, or its equivalent in other greenhouse gases, that has been prevented from entering the atmosphere or removed from it. This creates a market where entities that exceed mandated emission limits can purchase credits to offset their excess, while projects that reduce or sequester emissions can generate and sell them for revenue. The system is designed to make emission reductions economically efficient, directing funding towards the most-effective climate solutions, such as forest conservation, renewable energy, or methane capture. Credits must represent real, additional, permanent, and verifiable reductions that would not have occurred without the credit revenue.

Nevertheless, carbon credits face significant concerns. The integrity of the "additionality", proving emissions reductions would not have happened without carbon finance, generates a lot of debate. Questions arise concerning the non-permanent sequestration, the poor monitoring, and the risk of "greenwashing", where companies offset rather than reduce their own emissions. Timescale is also a mismatch since releasing carbon, which was sequestered over millions of years, in an instant, takes decades to be "re-sequestered", creating a risky lag and vulnerability to reversal within a human timeframe.

In the area visited, COMACO supported the application process to carbon funds and brought its GIS expertise to assess the amount of CO2eq available to be sold on the carbon market. The participants noticed a lack of awareness from the farmers about this information, as well as about the source of climate funds. COMACO mentioned that all carbon credits were sold to the World Bank.

Carbon credits provide significant benefits to the community. They buy farming inputs such as seeds and fertilizer, and have drilled many boreholes, 56 to this day, in members' villages to improve their access to water. Funds enable the purchase of vehicles to assist with conducting patrols and paying patrolling staff. Today, there are 13 groups of patrols that, alternatively, control the area. Members are allowed to install beekeeping in the forest to produce honey, as well as develop poultry production, which becomes an additional income. Under supervision, members can also harvest wild fruits, mushrooms, and medicines. Nevertheless, they are not allowed to convert forest land into cropland or poach animals.

Hunting is prohibited, and wild animals are protected by the Department of National Parks and Wildlife (DNPW). Illegal activities, such as charcoal production or poaching, are infrequent and are punished in proportion to the offence, typically with a financial penalty and community service, such as tree planting.

The community also highlighted the **water-related environmental benefits of forest conservation**, noting that the area experiences a microclimate with adequate, stable rainfall. Indeed, **trees act as biological pumps**, drawing water from the soil and releasing it as vapor into the atmosphere through transpiration. This moisture generates clouds and downwind rainfall, thereby recycling water inland and sustaining precipitation patterns. Additionally, **intact forests act as natural sponges and filters**. Their complex root systems and organic soils enhance water infiltration, recharge groundwater aquifers, and ensure steady dry-season streamflow. The canopy intercepts rainfall, reducing erosion and flooding. Furthermore, forests filter pollutants and sediment, naturally improving water quality for downstream communities and ecosystems. By regulating the water cycle, mitigating floods, and providing clean water, forest conservation is a critical, cost-effective NbS for building water security and climate resilience.

The Zambian Government financially supports these forest conservation activities through CFMG and Community Forest Management Area (CFMA) funds for protected areas and issues certificates.

Inclusivity is also a consideration for the CFMG, which delivers training to youth on tree species and wildlife to raise their awareness of the associated benefits.

Mr Maimbo Malesu emphasized the opportunity to develop **ecotourism** activities in the area, similar to a project led by CIFOR-ICRAF in Rufunsa. He introduced this idea as a win-win approach that could incentivise the protection of natural habitats and biodiversity, foster environmental stewardship, and create sustainable economic alternatives to resource exploitation. Game drives, treetop adventures, and forest hiking could be introduced while ensuring forest conservation. This would create local jobs in guiding,

hospitality, and craft-making, providing communities with a compelling financial incentive to protect their natural heritage rather than exploit it. This revenue could fund future conservation and community projects. Furthermore, by fostering meaningful encounters between visitors and their environments, ecotourism builds global awareness of conservation, translating ecological value into tangible appreciation and support.

Additional recommendations from the workshop participants included:

- Community members should be better informed about the buyer of their carbon credits
- Need for a clear monitoring system of the forest.
- Enhance community participation by including them in the identification and prioritizing needs when spending carbon money.

5. Learnings and outcomes

The workshop participants demonstrated strong interest, and dedication to the topic. The interactive workshop led to: (1) Deeper understanding of climate-resilient water governance frameworks, (2) Stronger knowledge on agroecological practices and NbS, (3) Strengthen capacities in landscape-level monitoring tools and indicator-based performance tracking for resilience, (4) Cross-country knowledge exchange, and (5) prompted discussions on how to scale up and strengthen future collaborations.

Agroecological practices implemented by FACHIG, CTDT, TIYENI, and COMACO have resulted in **life-changing benefits** for farmers in terms of yield, livelihood, food and water security, and environmental health. The NGOs unanimously agreed on the importance of scaling up NbS as they deliver **synergistic long-term benefits**. The field visit illustrated that agroforestry can improve and secure harvests while boosting biodiversity, improving microclimates, and providing additional benefits in terms of timber, fuelwood, fodder and medicines. This integrated approach is a key strength: agroforestry can build farm resilience by simultaneously strengthening soil health, water security, climate adaptation, biodiversity, the rural economy and food production. Moreover, **combining practices** can yield even more benefits. The NGOs raised that a follow-up project could involve pilot plots where, for instance, DBF is combined with Pfumvudza and/or agroforestry.

The NGOs stressed that all farmers who implemented agroecological practices became food secure and some transitioned from subsistence farming to **market-oriented farming**. Scaling up of these practices is crucial and requires robust, ongoing Monitoring & Evaluation (M&E) mechanisms for data collection. Metrics harmonization is a key component, enabling transparency, understanding, reliability, credibility, and traceability. To accurately assess landscape health and community adaptation, a holistic monitoring system must integrate biophysical tools, socio-economic indicators, and participatory frameworks.

Participants noted the importance of **farmer-centred, participatory approaches**, where farmers act as co-researchers and trainers, accelerating community adoption.

The path forward requires a concerted effort to strengthen community-based organisations, and integration of agroecological practices more effectively into national agricultural policies, and the development of innovative financial models that support farmers during the initial transition period.

Reflections, observations and additional information
• Evidence have demonstrated that DBF is an NbS that works, which enables doubling of crop yields alongside multiple additional benefits. Normally, yields of crops grown under the DBF more than double at the minimum. The average yield under CR under smallholder farming in Malawi is 2 tons per hectare while on DBF the average yield is 6 tons per hectare (Isaac, TIYENI) • Scientific approaches and local knowledge systems intersect to enhance natural resources governance in terms of access to and sharing of benefits, cooperation, reciprocity and fairness (Noble, CTDT) • Data on Agroforestry is very clear, it is an impactful solution to generate income and sustain the environment (Malesu, CIFOR-ICRAF) • The multi-functionality of NbS makes them uniquely powerful and cost-effective solutions in rainfed agriculture (David, SIWI) • Cross-country transfer of knowledge has been key, now, it is time for cross-country implementation to experiment with agroecological practices in different geographic context. Malawi is divided into three zones agroecologically which are commonly used in research; based on altitude, rainfall, temperature and soils. These are: low altitude (<700 m) which are drought prone areas, medium altitude (700 – 1,300 m) which receive average rains, are maize producing areas, and high altitude (>1,300 m) are high rainfall areas and are cool. Government research department of Agriculture Research Services (DARS) led a research study comparing the DBF against other farming practices in 9 sites across the country and covering all agroecological zones, and found that the DBF was superior in crop yields, soil moisture retention, soil organic matter, biomass, among others (Isaac, TIYENI). • Pfumvudza enables farmers to optimize their resources, and maximize profits, food, and nutrition security outcomes (Runyararo, FACHIG) • Collective action therefore entails addressing issues around motivation, incentives, rewards, leadership, communication, connections and enabling policy (Noble, CTDT) • The largest amount of water resources are found in green water, thus, efforts should concentrate on climate-resilient water governance and sustainable landscape management (Malesu, CIFOR-ICRAF)

6. Next steps

After an insightful week with a mix of training sessions on (1) TIARA achievements and lessons, (2) participatory approaches to water governance and landscape restoration, (3)

integration of climate adaptation in agricultural and landscape planning, and (4) monitoring tools and indicators for climate-resilient landscapes, and (5) a field visit to appreciate agroforestry and forest conservation, the following priorities were identified:

TIYENI	FACHIG	CTDT
- Strengthening evidence & learning. - Scaling DBF adoption. - Climate & environmental impact - Partnerships & Policy Engagement - Resource mobilization & sustainability	- Exacerbation of climate change (lack of rain, and unequal distribution) - Pests and diseases (fall armyworm) - Deforestation - Funding and coordination	- Harvesting renewable energy (solar) to support water-efficient irrigation. - Strengthen the integration of Community Seed Banking, Farmer Field School and NbS - Advocating for the recognition and registration of farmer varieties. - Knowledge management on resilience, agro-ecological practices and NbS

Going forward, participants concurred that future activities would require:

1) Harmonized empirical data production for the business case for investing in rainfed farming,
2) Technology transfer and knowledge sharing among partners,
3) Maintaining a community of practice at the regional level,
4) Strengthening policy support across the region,
5) Improving access to financing and mechanization,
6) Bridging the investment gap in the water and agricultural sector,
7) Documenting lessons learned, best practices, and impact stories.

Scaling these successes will depend on fostering regional collaboration, enhancing knowledge exchange, and aligning interventions with national agricultural and climate resilience goals.

TIARA closes at the end of March 2026 (after a three-month no-cost extension). Below is a list of the final activities that will be conducted under TIARA:

- SIWI will coordinate the completion of the **business case** for enhanced rainfed agriculture in the Zambezi region through the:

    - **Triple Bottom Line assessment framework** for TIARA - led by SIWI's PostDoc Maganizo Kruger Nyasulu with co-authors from FACHIG, CTDO and TIYENI
    - **Scientific paper** on soil and water metrics for monitoring and assessing watershed benefits of enhanced rainfed agriculture - led by SIWI's PostDoc Maganizo Kruger Nyasulu
    - **Policy brief** on the business case for enhanced rainfed agriculture – SIWI

- SIWI, with CIFOR-ICRAF's support, will produce a **Self-evaluation report**
- SIWI will continue promoting TIARA activities through the **web-based campaign**
- All partners will explore **funding opportunities** to elaborate on a follow-up project of TIARA that could involve accessing funding from LBF, IKI, GEF, as well as other relevant multilateral and bilateral donors.

7. Annexes

Annexe 1 – Workshop programme

Annexe 2 – List of participants

- **CTDO** (Zimbabwe):
  - Edson Dhlakama
  - Noble Zvirevo

- **FACHIG** (Zimbabwe):
  - Thomas Mupetesi
  - Runyararo Evelyne Motsi

- **TIYENI** (Malawi):
  - Isaac Monjo Chavula
  - Wesley Kondowe

- **COMACO** (Zambia):
  - Isaac Soko
  - Mwemda Moses

- **Government representatives**:
  - William Phiri
  - Dankwa Hamunjo

- **CIFOR-ICRAF** (Zambia):
  - Malesu Maimbo
  - Hockings Mambwe
  - Chitemwiko Pikiti

- **SIWI** (Sweden):
  - David Mingasson