THE GOVERNMENT OF THE REPUBLIC OF MALAWI

BARRIER ANALYSIS AND ENABLING FRAMEWORK FOR TECHNOLOGY TRANSFER AND DIFFUSION IN AGRICULTURE AND WATER SECTORS - ADAPTATION

March 2021

DISCLAIMER

FOREWORD

Malawi is a party of the United Nations Framework Convention on Climate Change (UNFCCC). In 2017, the country ratified the Paris Accord, which is the first ever universal, legally binding global climate change agreement which sets out ambitious targets for climate change mitigation, adaptation, transparency and role of different stakeholders in addressing climate change. In tandem with the UNFCCC and Paris Agreement, the Government of Malawi has prioritised climate change both in its vision, Malawi vision 2063 and in its medium-term development agenda, Malawi Growth and Development Strategy III, as a deterrent, and opportunity to achieve an inclusive wealth, resilient and reliant nation. The Nation further highlights climate technologies as a vehicle and an enabler to achieve development vision and agenda

The Ministry of Forestry and Natural Resources (MoFNR) through Environmental Affairs Department, has frequently reported UN Climate Change Convention on efforts the country is undertaking to contribute to the global efforts of mitigating climate change and building resilience of the communities to the effects and hazards exacerbated by climate change. Climate technologies among other climate change initiatives, offer an opportunity and innovate ways to reduce greenhouse gas (GHGs) emissions and enhance resilient nations and communities.

My Ministry with support from the Global Environment Facility (GEF) is implementing a Technology Needs Assessment (TNA) Project. Through a participatory and gender inclusive, Malawi has prioritised climate technologies, identified their barriers and developed an enabling framework with measures to enhance their adoption and diffusion. The technologies are anticipated to contribute to national climate change management efforts and strides towards implementation of the Paris Agreement.

The Government of Malawi, through My Ministry, is committed to support the development, upscaling and diffusion of climate technologies. It is my sincere hope that the stakeholders will coordinate and utilise the knowledge presented in these TNA reports to inform our efforts as we strive to reduce GHG emissions and enhance resilient societies.

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PREFACE

Malawi is among the countries that have and continues to experience climate related shocks. These shocks have exerted pressure on the development of the country and increased the vulnerability of the communities and ecosystems.

The Government of Malawi, through the National Climate Change Management Policy (NCCMP) of 2016, sets out an ambitious strategy to tackle climate change and its impacts. The Policy also provides an enabling framework for a pragmatic and coordinated approach to resilience building and mitigating greenhouse gases and climate shocks.

Climate technologies play an important role towards resilient building of the communities and enhancing Malawi's development agenda. The Government of Malawi through the Malawi Vision 2063 and its medium-term development plan, Malawi Growth and Development Strategy III, underscores climate technologies as foundations for development gains. Being fully aware of the prioritised technologies in the adaptation and mitigation sectors under Technology Needs Assessment (TNA) Reports, the Barrier Analysis and Enabling Framework (BAEF) report provides decision makers, national planners and stakeholders with barriers, measures and enablers for enhancing the development, transfer, diffusion and uptake of climate technologies.

The process for developing the BAEF report for Malawi in the adaptation (water and agriculture sectors) theme was guided by international good practices and methodologies. Stakeholder participation and feedback have been key in the process to ensure all considerations are incorporated including gender. It is my sincere hope that the BAEF report will support the country to adapt to the effects of climate change through enhancement of the contribution of climate technologies.

Yanira M. Ntupanyama, PhD
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ACRONYMS AND ABBREVIATIONS

AFRI	=	Africa Forest Landscape Restoration Initiative
BAEF	=	Barrier Analysis and Enabling Framework
CASA	=	Centre for Applied Systems Analysis
CPAR-Malawi	=	Canadian Physicians for Aid Programme
EAD	=	Environmental Affairs Department
EDRP	=	Emergency Drought Recovery Programme
FIDP	=	Farm Income Diversification Programme
FLR	=	Forest Landscape Restoration
GCF	=	Global Climate Fund
GDP	=	Gross Domestic Product
GEF	=	Global Environment Facility
GoM	=	Government of Malawi
ICLAF	=	Integrated crop-livestock-aquaculture-forest
IFM	=	Integrated Flood Management
IPCC	=	Intergovernmental Panel on Climate Change
IUFRO	=	International Union of Forest Research Organisations
IRLADP	=	Irrigation Rural Livelihood and Agriculture Development Programme
IRBM	=	Integrated River Basin Management
LUANAR	=	Lilongwe University of Agriculture and Natural Resources
MCA	=	Multi-Criteria Analysis
MDRRP	=	Malawi Drought Recovery and Resilience Programme
MFERP	=	Malawi Floods Emergency Recovery Project
MGDS	=	Malawi Growth and Development Strategy
MUST	=	Malawi University of Science and Technology
MWK	=	Malawi Kwacha
NAP	=	National Agriculture Policy
NAIP	=	National Agriculture Investment Plan
NAPA	=	National Adaptation Programmes of Action
NCCMP	=	National Climate Change Management Policy
NDRM	=	National Disaster Risk Management
NGO	=	Non-governmental Organisations
PCI-USAID	=	Project Concern International
RHAM	=	Rainwater Harvesting Association of Malawi

SDG	=	Sustainable Development Goals
TAPs	=	Technology Action Plans
TNA	=	Technology Needs Assessment
UNFCCC	=	United Nations Framework Convention on Climate Change
UCT	=	University of Cape Town
UDP	=	UNEP DTU Partnership
UNDP	=	United Nations Development Programme
UNEP	=	United Nations Environment Programme

EXECUTIVE SUMMARY

This report presents a wide variety of barriers that hinder transfer and diffusion of nationally selected climate technologies best suited to adapt the agriculture and water sectors to climate change impacts. The report includes possible measures to address and overcome these barriers, including policy options to create enabling environment that can facilitate their widespread transfer, adoption and diffusion in the country.

The agriculture and water sectors in Malawi are most vulnerable to climate change impacts. This is due to their extensive reliance on precipitation as the principle source of surface and ground water resources, and agriculture being largely rain-fed in the country. Through the TNA process, Malawi identified six priority climate technologies that can help the agriculture and water sectors to adapt to climate change impacts. These prioritized climate technologies are presented in **Table 1**.

Table 1. Prioritized climate technologies for adaptation in the agriculture and water sectors in Malawi. ***Source****: Malawi Technology Needs Assessment report – Adaptation. 2020.*

Sector	**Priority (rank)**	**Adaptation Technology**
Agriculture	1	*Landscape restoration for improved land productivity*
	2	*Integrated crop-livestock-aquaculture-forest production systems*
	3	*Community-based agricultural extension*
Water	1	*Rainwater harvesting*
	2	*Integrated river basin management*
	3	*Integrated flood management*

The success to widespread transfer, adoption and diffusion of these climate technologies across the country is generally obstructed by a multitude of barriers. In this study, we identified these barriers and analysed them. We determined their possible measures to address and overcome them, including policy options that can create enabling environments to facilitate transfer, adoption and diffusion of these technologies. .

The identification of the barriers to each of the priority technologies in the agriculture and water sectors was done through desk review of peer-reviewed and gray literature. The findings were supplemented by interviews with experts and stakeholders from the agriculture and water sectors in the country. A stakeholders' workshop was held to review and assess the identified barriers for their significance in hindering the transfer and diffusion of the prioritized technologies, and propose measures and enabling framework to facilitate their widespread transfer and diffusion.

Barriers to transfer and diffusion of adaptation technologies in agriculture sector

Barriers were identified for each of the three priority adaptation technologies in the agriculture sector. These barriers are summarised in **Table 2**.

Table 2: Barriers identified for priority technologies in agriculture sector

Barrier category	**Barriers**	**Technologies affected**
Economic and Financial	*Limited access to credit and finance*	*i. Landscape restoration* *ii. Integrated farming system,* *iii. Community-based agricultural extension*
Non-financial	*Limited human and institutional capacity*	*i. Landscape restoration,* *ii. Integrated farming system*
	Inadequate information and awareness	*i. Landscape restoration,* *ii. Integrated farming system*
	Lack of appreciation of local knowledge	*i. Community-based agricultural extension.*
	Lack of local reference projects	*i. Community-based agricultural extension*
	Unclear and irregular land tenure rights	*i. Landscape restoration,* *ii. Integrated farming system*
	Inadequate legislative framework	*i. Landscape restoration*
	Gender inequality	*i. Landscape restoration,* *ii. Integrated farming system*

From **Table 2**, we observe that some barriers are common to all the three priority technologies in the sector, e.g. *limited access to credit and finance*; while others were common to two technologies, e.g. *limited human and institutional capacity* or *unclear and irregular land tenure rights*. The common barriers suggest that overcoming these barriers in one technology will result in clearing the way for the smooth transfer and diffusion of the other technologies in the sector.

For each of the barriers presented in **Table 2**, its corresponding measure(s) to address and overcome such barriers are presented in **Table 3**. It is observed from **Table 3** that some barriers can be overcome by different measures depending on the desired ultimate result. For example, the barrier owing to limited access to credit and finance can be addressed by different measures such as providing subsidy to farm inputs so that

farmers can access them at lower prices (e.g. integrated farming system), or engage in blended financing mechanism – a financing mechanism which involves blending public development financing and public climate financing with the private capital. Such a mechanism can effectively work in financing landscape restoration technology.

Table 3: Proposed measures to overcome the barriers identified for the priority technologies in agriculture sector

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Limited access to credit and finance*	*i. Blended finance mechanism* *ii. Access low-cost inputs through farm input subsidy program (FISP)* *iii. Engage in village savings and loans (VSL) groups.*
Non-financial	*Limited human and institutional capacity*	*Capacity development programmes to enhance technical and analytical skills and competencies in the technologies*
	Inadequate information and awareness	*i. Access appropriate information and communication about specific technologies.* *ii. Adopting a community-based agricultural extension model*
	Lack of appreciation of local knowledge	*Piloting the implementation of the technology*
	Lack of local reference projects	
	Unclear and irregular land tenure rights	*Land tenure to secure farmers' rights to land*
	Inadequate legislative framework	*Regulatory reforms*
	Gender inequality	*Transformative gender programmes and awareness raising*

During the study we also analysed the enabling framework that can facilitate the widespread transfer and diffusion of the priority adaptation technologies in the agriculture sector. The enabling framework denotes the entire range of institutional, regulatory and political framework conditions that are conducive to promoting and facilitating the transfer and diffusion of technologies (IPCC, 2000). In this study, four major elements of enabling framework were identified to be particularly important for promoting and facilitating transfer and diffusion of adaptation technologies in the

agriculture. These include the national macroeconomic conditions, human and institutional capacity, public awareness and learning, and gender and other social-cultural issues. In the course of the analysis, we observed that the enabling framework for the agriculture sector were similar to that of the water sector. Consequently, we developed a common enabling framework for both agriculture and water sectors. This is presented as **Table 6**.

Barriers to transfer and diffusion of adaptation technologies in water sector

Similarly, some barriers were common to the three priority technologies in the water sector (e.g. *limited human and institutional capacity*). Some barriers were common to two of the three technologies (e.g. *unclear and irregular land tenure rights*). These barriers are presented in **Table 4**. It follows that overcoming these barriers in one technology will lead to clearing the path for the transfer and diffusion of the other technologies in the sector.

Table 4: Common barriers identified for the priority technologies in water sector

Barrier category	**Barriers**	**Technologies affected**
Economic and Financial	*Limited access to credit and finance*	*i. Rainwater harvesting* *ii. Integrated river basin management, and* *iii. Integrated flood management*
Non-financial	*Limited human and institutional capacity*	*i. Rainwater harvesting* *ii. Integrated river basin management,* *iii. Integrated flood management*
	Inadequate information and awareness	*i. Rainwater harvesting* *ii. Integrated river basin management,* *iii. Integrated flood management*
	Unclear and irregular land tenure rights	*i. Integrated river basin management,* *ii. Integrated flood management*
	Inadequate legislative framework	*i. Integrated river basin management,*
	Gender inequality	*i. Integrated river basin management,*

The measures to address and overcome the barriers presented in **Table 4** were identified and analysed. These are presented in **Table 5**. Some barriers can be addressed and overcome by complimentary measures, e.g. proposed measures to overcome gender equality which include undertaking a gendered approach in the design and implement of

the technology and gender awareness raising to change altitudes, behaviours and beliefs that reinforce inequalities between women and men.

Table 5: Proposed measures to overcome the barriers identified for the priority technologies in agriculture sector

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Limited access to credit and finance*	*i. Engage in cost-sharing mechanism* *ii. Develop fundable project proposals* *Blended finance mechanism*
Non-financial	*Limited human and institutional capacity*	*i. Build capacity of the project designers and implementers, including institutions on technical aspects of the technologies.*
	Inadequate information and awareness	*i. Establish a network of actors of rainwater harvesting to allow for better communication and collaboration among actors*
	Unclear and irregular land tenure rights	*i. Land tenure reforms*
	Inadequate legislative framework	*i. Regulatory reform that will allow the National Environment Policy become an overarching framework instrument for the technologies*
	Gender inequality	*i. Undertake a gendered approach in the design and implementation of the technology* *ii. Gender awareness raising to change attitudes, behaviors and beliefs that reinforce inequalities between women and men*

As it was the case with the agriculture sector, we also analysed the enabling framework that can facilitate the widespread transfer and diffusion of the priority adaptation technologies in the water sector. The same elements of enabling framework identified in the agriculture sectors were identified in the water sector a well. As a result, we developed a common enabling framework for both agriculture and water sectors. This is presented as **Table 6**.

Table 6: Enabling framework for common barriers identified for the priority technologies in the agriculture sector

Broad/common barriers addressed	**Enabling environment**	**Areas of influence to facilitate transfer and diffusion of the water technologies**
1. Limited access to credit and finance	*National macroeconomic conditions*	i. *Regulation of financial sector institutions* – these largely aim to maintain financial stability and consumers' protection. Inclusive financial regulation that allows small farmers access credit from banks are required if we are to enhance transfer and diffusion of the climate adaptation technologies. ii. *Public investment policies* – policies guiding how the government spends money on public services. Funding from government is usually allocated firstly to immediate concerns and revenue-generating projects. Little or no funding is available to projects whose outcomes or effects are not immediate or are long-term. This affects investments in climate adaptation technologies. Reforms in public investment policies are therefore needed. iii. *Reforming farm input subsidy programme (FISP)* – the program aims to enhance food self-sufficiency by increasing smallholder farmers' access to and use of improved agricultural inputs. In its current form, *FISP* only provides subsidized farm inputs related to crop production (i.e. fertilizers, maize/crop seed). The programme can be expanded to include all components of farm production systems, making low-cost inputs available to many farmers for the expanded adoption and diffusion of integrated farming systems. iv. *Adopting a blended finance mechanism* – A blended finance is the use of catalytic capital from public or philanthropic sources to increase private sector investment in climate technologies. It involves blending public development financing and public climate financing with the private capital. Blended finance creates investable opportunities and reduces investment risks for individual investors

		v. *Capacity to develop fundable project proposals* There are some funding agencies and mechanisms, e.g. the adaptation fund, the green climate fund (GCF), or the global environment facility (GEF), which fund climate-related projects. The country needs to develop capacity to competitively solicit grants from these agencies and mechanisms.
2. *Limited human and institutional capacity*	Human and institutional capacity	i. *Public sector reform programme* – to improve public sector governance, efficiency and effectiveness that are crucial for the delivery of quality services, including climate adaptation related actions. Malawi government is already implementing the programme. *ii.* *Capacity-building programmes of governmental agencies and institutions* – to obtain, strengthen and maintain the capabilities to set and achieve national development objectives of climate adaptation technologies over time. iii. *Enhance publicly funded research and development and training programmes* – to support pilot implementation of climate technologies in the country. Execution of the pilot allows risks associated with the technology to be identified, documented, authenticated, mitigated, tested, or possibly solved in a less intense environment, thereby lowering risk of failure of the main technology.
3. *Inadequate public awareness and learning*	Public awareness and learning about the technologies	*i.* *Build effective public awareness and learning about climate adaptation technologies* – the much-needed political will for the transfer and diffusion of climate technologies requires informed public support. Information is a valuable resource and lack of it will hinder widespread transfer and diffusion of the technologies.
4. *Gender inequality*	Gender and other socio-cultural issues	i. Gender roles, identities and expectations are socially, culturally and politically constructed. Therefore *gender transformative programming* and *awareness raising* can overcome gender inequality, hence promoting climate technology transfer and diffusion.

CHAPTER ONE: CONTEXT

1.1 Background

This report presents a wide variety of barriers (economic, legal, institutional, social, cultural, market, technical, etc.) that hinder transfer and diffusion of nationally selected climate technologies best suited to improve resilience to climate change impacts in agriculture and water sectors of Malawi. The report includes possible measures for addressing these barriers, including policy options for creating enabling frameworks, and facilitate widespread transfer, adoption and diffusion of these climate technologies in the country.

This report is the second of a series of Technology Needs Assessment (TNA) reports under the TNA project coordinated by the Environmental Affairs Department of the Malawi Government. TNA is a set of country-driven activities leading to identification, prioritization, and diffusion of environmentally sound technologies for mitigation and adaptation to climate change. The TNA project is implemented by the United Nations Environment Programme and the UNEP DTU Partnership on behalf of the Global Environment Facility. For the implementation of the project in Africa, UNEP DTU Partnership works with the Energy Research Centre of the University of Cape Town, South Africa, to provide technical support to countries in the region during the TNA process.

The TNA process has three main steps. These steps are shown in **Figure 1**.

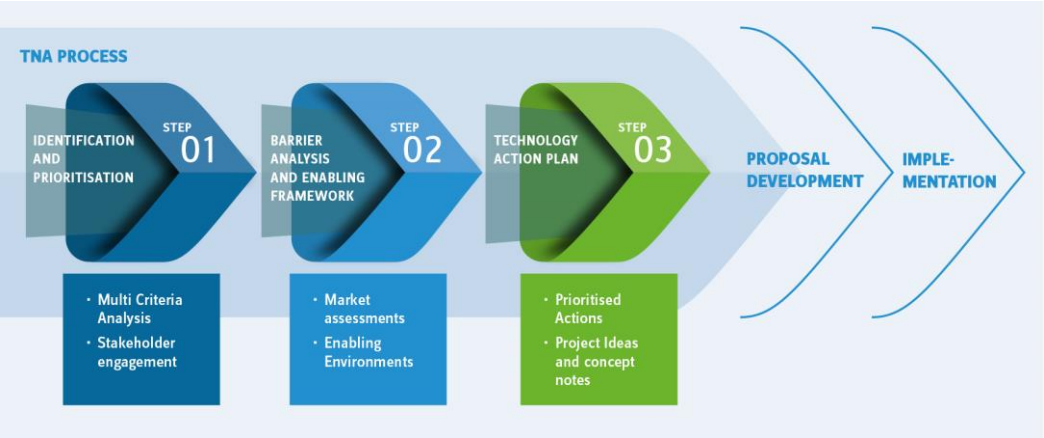

Figure 1. Steps in the TNA Process (***Source***: Canu, FA *et al*. 2020)

The first step is the identification and prioritization of climate technologies within the selected and prioritized sectors, i.e. agriculture and water sectors for adaptation in Malawi. Using multi-criteria analysis (MCA), this step was successfully completed and the output report "*Malawi Technology Needs Assessment Report – Adaptation, 2020*" was produced and published. The report identified six priority climate technologies for addressing climate change impacts in the agriculture and water sectors in Malawi. These prioritized climate technologies are presented in **Table 1**.

Table 1. Prioritized climate technologies for adaptation in the agriculture and water sectors in Malawi. ***Source****: Malawi Technology Needs Assessment report – Adaptation. 2020.*

Sector	**Priority (rank)**	**Adaptation Technology**
Agriculture	1	*Landscape restoration for improved land productivity*
	2	*Integrated crop-livestock-aquaculture-forest production systems*
	3	*Community-based agricultural extension*
Water	1	*Rainwater harvesting (RWH)*
	2	*Integrated river basin management*
	3	*Integrated flood management*

The second step constitutes identification and analysis of barriers hindering the transfer and diffusion of the prioritized climate technologies presented in **Table 1**, and possible means to address and overcome these barriers. This reports presents the results of this step. The actions emanating from step 2 will form activities in the step 3 - Technology Action Plans (TAPs). The TAPs will further be developed to become project ideas, concepts and full proposals for submission to donors and financiers to enable their implementation for the enhancement of adaptation to climate change impacts in agriculture and water sectors of Malawi.

1.2 Transfer and diffusion of climate technologies

Transfer and diffusion of climate technologies is generally understood as the exchange of the technical artefacts (hardware), knowledge (software) and organisational elements (orgware), both across and within countries (Bell, 1990; Wei, 1995; Levin, 1997). This understanding follows the definition of technology transfer by the IPCC (2000) as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders [which] encompasses [the] diffusion of technologies and technology cooperation across and within countries". The success to transfer and diffusion of climate technologies in a country is generally obstructed by a multitude of factors including economic, legal, institutional, social, cultural, market, technical, etc. In this report we refer to these obstructing factors as barriers to transfer and diffusion of climate technologies.

1.2.1 Barriers to technology transfer and diffusion

Barriers can be understood as the reasons that are obstructing the transfer and diffusion of technologies (Painuly, 2001). A thorough understanding of these barriers is key to designing the appropriate portfolio of measures and enabling environment that can adequately address and overcome these barriers. The primary task is to understand the nature of the individual barriers and the relations between barriers, determine which barriers are important, and identify barriers that are easier to remove.

It is generally accepted that the barriers to transfer and diffusion of particular climate technologies are intrinsically linked to market characteristics in which these technologies are transferred and diffused (Nygaard and Hansen, 2015). Nygaard and Hansen (2015) identified two generic market-based categories within which the climate technologies are transferred and diffused. These categories are: 1) *Market-based,* and 2) *Non-market-based* categories.

Market-based categories contain tradable technologies which are diffused in market settings, either as *consumer goods* or *capital goods*. An example can be 'seed for drought resistant crops' which are diffused in a mass market with large supply chains and a large number of customers. *Non-market-based* are non-tradable technologies transferred and diffused under non-market conditions, either as *publicly provided goods* or *other non-market goods*. An example can be 'seasonal forecast of rain for optimal planting'. The technologies under the *non-market goods* category serve overall political objectives, such as food security, and are often financed by donors and public entities (Nygaart and Hansen, 2015).

It is reasonable to expect that there are common features within each category as to which barriers predominate and how these particular barriers need to be addressed. This approach was therefore followed in the current study, where the prioritized technologies presented in **Table 1** were first assessed and categorized based on the market characteristics in which they are transferred and diffused in the country. It was observed that all our prioritized technologies in both agriculture and water sectors fall in a *non-market* category, specifically under the '*other non-market goods'*. This categorization facilitated ease of identification and analysis of the barriers, and the measures thereof to address them. 0884542136

1.2.2 Barrier categorization

In order to facilitate thorough identification of barriers in this study, we perceived two major categories of barriers, i.e. financial barriers, and non-financial barriers. We defined financial barriers as lack of access to available and affordable finance to procure, implement and sustain particular climate technologies. While non-financial barriers **(Table 2)** were defined as barriers that are not financial in nature. These barriers are in the categories of legal and regulatory; institutional capacity; human capacity; information and awareness; social, cultural and behavior; technical; and environmental barriers. These categories guided the identification of the non-financial barriers in each of the prioritized technologies.

Table 2. Categorization of barriers. ***Source****: Nygaart and Hansen, 2015.*

Non-financial barrier category	**Description**
1. Legal & regulatory	*Legal framework supporting the technology*
2. Institutional capacity	*Availability of professional institutions and capacity of these institutions*
3. Human capacity	*Skilled technical personnel for particular technologies*

4. Information and awareness	*Information about the technology and its awareness*
5. Social, cultural and behavioral	*Social biases, traditions and preferences*
6. Technical	*Performance and local references of the technology*

CHAPTER TWO: METHODS

2.1 Methods for barrier identification and analysis

The identification of barriers hindering the transfer and diffusion of the prioritized technologies in both agriculture and water sectors was done using a stepwise approach. The steps involved included the following:

2.1.1 Desk review

We conducted a desk review of policy papers and other pertinent documents to identify the primary reasons why each of the prioritized technologies in the two sectors were not currently in the widespread use in the country. The identification of the barriers from various policy documents was guided by the categories presented in Table 2. The barriers were sequentially identified for each category on each prioritized technology.

2.1.2 Interviews

The findings of the desk review were supplemented by the interviews with experts and stakeholders from the two sectors, i.e. agriculture and water. In addition to screening the barriers identified through the desk review, the experts provided insights of the context in which the said barriers hinder the widespread diffusion of the technologies.

2.1.3 Workshop

Further barrier review was done at a stakeholders' workshop which was organized to review the completeness of the already identified barriers and assess them for their significance in hindering the transfer and diffusion of the prioritized technologies. The workshop was held at the Hillside Lodge in Mponela, approximately 50 km to the North of Lilongwe City. The workshop was held on 24th and 25th September 2020. **Figure 2** show stakeholders who attended the workshop. Their contact details are presented as **Annex 1**. **Figure 2** shows workshop participants discussing and screening the barriers that hinder transfer and diffusion of the climate technologies.

2.1.3.1 Screening the barriers

The list of the barriers identified by the consultant for each of the technologies were presented to the workshop participants in a plenary. Sectoral groups, i.e. agriculture and water, were formed to thoroughly review and screen the barriers for each of the sectoral technologies. The screening of the long list of barriers was done according to their relevance and significance to obstruct the transfer and diffusion of a given technology. This was achieved through discussion and reaching consensus. The final list of screened barriers were now taken for analysis by the workshop participants.

Figure 2: Stakeholders who attended the barrier analysis and enabling framework workshop at Hillside Lodge in Mponela, Malawi (24-25th September 2020).

Figure 3: Workshop participants discussing and screening the barriers to transfer and diffusion of technologies at the Hillside Lodge in Mponela, Malawi (24-25th September 2020).

2.1.3.2 Participant barrier analysis

Barrier analysis by workshop participants started with discussing whether some barriers were composite and needed decomposition into other barriers, or whether one barrier was just a more concrete formulation of an overall barrier category. At the lower level of the analysis, we identified the elements that constituted each of the barriers and their related dimensions. This analytical process followed the recommendations of Painuly (2001). The results of the analysis of the barriers of each of the prioritized technologies are presented in their respective sections of **Chapters 3** and **4**.

CHAPTER THREE: AGRICULTURE SECTOR

3.1 Introduction

Agriculture is the most important sector of Malawi's economy. Over the last ten years, the agriculture sector has consistently generated the highest contribution to gross domestic product (GDP) of the country, generating about 20 percent of the country's GDP. **Table 3** shows sectoral contribution to GDP of Malawi's top 5 sectors.

Preliminary targets for technology transfer and diffusion

Table 3: Sectoral contribution to Malawi's gross domestic product (GDP) (*Source:* Reserve Bank of Malawi, 2019).

Sector	**Percent (%) contribution to GDP**
1. Agriculture	20.1
2. Wholesale and Retail	15.8
3. Manufacturing	9.5
4. Real estate activities	7.9
5. Forestry and logging	6.7

In order to sustain the contribution of the agriculture sector to the country's economy and livelihoods, the 2016 National Agriculture Policy (NAP) and its subsequent operationalization plan – the National Agriculture Investment Plan (NAIP) – provides a clear direction and guides all players in agriculture sector towards accelerating agricultural transformation in the face of climate change. The NAIP recognizes climate change as the main challenge in the agricultural transformation process and it has prioritized building resilience of agricultural systems as a key program for the 5 year period of its implementation (2017/18 – 2022/23).

Through the Technology Needs Assessment (TNA) process, Malawi prioritized three climate technologies for building resilience to climate change impacts in the agriculture sector (Malawi Government, 2020). These prioritized climate technologies are presented in **Table 4**.

Table 4: Prioritized climate technologies for adaptation in Malawi's agriculture sector (*Source:* Malawi Government, 2020).

Priority	**Climate Adaptation Technology**
1	Landscape restoration for improved land productivity
2	Integrated crop-livestock-aquaculture-forest (ICLAF) production system

3	Community-based agricultural extension

However, success to widespread transfer and diffusion of these climate technologies across the country is generally obstructed by a multitude of barriers, which can broadly be categorised as financial and non-financial barriers (Painuly, 2001). Financial barriers are defined as lack of access to available and affordable finance to procure, implement and sustain particular climate technologies, e.g. high cost of capital. While non-financial barriers are those barriers that are not financial in nature, e.g. unskilled technical personnel. A thorough understanding of these barriers is key to designing the appropriate portfolio of measures and enabling environment that can adequately address and overcome the barriers and facilitate transfer and diffusion of these technologies.

This chapter presents key barriers that were locally identified to significantly hinder the transfer and diffusion of each of the priority adaptation technologies presented in **Table 4.** It also presents possible measures to address and overcome these barriers, including policy options to create enabling environment that can facilitate the widespread transfer and diffusion of these technologies in the country.

3.2 Preliminary targets for technology transfer and diffusion

Several policy documents, strategies and plans of the Malawi Government have set preliminary national targets for the deployment of each selected technology. These preliminary targets are presented given below.

3.2.1 Landscape restoration for improved land productivity

This is a technology that will enable Malawi regain, improve, and maintain vital ecological functions and enhancing human wellbeing in the long-term leading to more resilient and sustainable landscapes (GPFLR, 2020). Nearly 8 million hectares or 80% of the total land area of Malawi are degraded and deforested. As a response, the Malawi government has pledged to restore 4.5 million hectares of degraded and deforested lands across landscapes by 2030. Five interrelated landscape restoration interventions were identified and their targets in terms of the hectares to be restored by the year 2030 were specified. **Table 5** presents these intervention targets.

Table 5: Landscape restoration targets for Malawi by 2030 (*Source:* National Forest Landscape Restoration Strategy, 2017).

Intervention	**Target by 2030**
1. Agricultural technologies (Conservation agriculture, farmer managed natural regeneration, and agroforestry)	Achieve at least 10% tree cover on 80% of cropland (approx. 3 million ha).
2. Community forests and woodlots	Increase area of community forests and woodlots to 600,000.
3. Forest management	Improve protection and management of 2 million ha of natural forest, restore 500,000 ha

	of degraded forest, and establish 100,000 ha of commercial plantations.
4. Soil and water conservation	Apply soil and water conservation measures on 500,000 ha.
5. River- and stream-bank restoration	Regenerate or plant 50 million trees along river- and stream-banks.

3.2.3 Integrated crop-livestock-aquaculture-forest (ICLAF) production system

The 2016 National Agriculture Policy (NAP) and its accompanying 2018 National Agriculture Investment Plan (NAIP) recognizes that in the context of Malawi's strong population growth and limited and fragile natural resource base, agricultural growth has to come from productivity gains rather than through an expansion of the area under production. Programme C of the NAIP specifically seeks to increase production and productivity of crop, livestock and fishery enterprises and support farmers in diversifying their production systems. The programme had set production and productivity targets to be achieved by the year 2023. These are presented in **Table 6.**

Table 6: Average crop yields and livestock populations by 2023 (*Source:* National Agriculture Investment Plan, 2018).

Production category	**Baseline 2018**	**Target 2023**
Average farm yields of crops	Maize: 2.2 t/ha Rice: 2.0 t/ha Groundnuts: 1.0 t/ha Soybeans: 1.1 t/ha Common beans: 0.5 t/ha	Maize: 4 t/ha Rice: 4.0 t/ha Groundnuts: 1.0 t/ha Soybeans: 2 t/ha Common beans: 1 t/ha
Livestock and fisheries	Chicken stock: 97 million Goats stock: 7 million Pigs stock: 4 million Cattle stock: 1.5 million Dairy cattle: 80,000 Aquaculture catch: 4,987 MT/year	Chicken stock: 110 million Goats stock: 10 million Pigs stock: 5.5 million Cattle stock: 2 million Dairy cattle: 106,000 Aquaculture catch: 10,000 MT/year

An integrated farming system, an agricultural technology that integrates a broad range of crops, livestock types and breeds, aquaculture, and forest trees and shrubs within the same area or farmland and implemented simultaneously was prioritized as one technology that can increase the system's overall productivity. The technology can therefore significantly contribute to achieving the production and productivity targets presented in **Table 6**. The transfer and widespread adoption and diffusion of the technology will maximize the returns from the limited land available, thereby increasing the overall productivity.

3.2.3 Community-based agricultural extension

Agricultural production and productivity in Malawi has not increased sufficiently over time to match growing domestic demand and available export opportunities. A key constraint has been weak agricultural extension services delivery, due to, among others, inadequate extension staff. In 2014, the ratio of an extension worker to farming households was 1:3000 (DAES, 2014), implying that one extension worker was responsible to 3,000 farming households.

The inadequacy of extension service delivery has curtailed progress on dissemination and adoption by farmers of improved farming technologies, including climate smart agriculture practices such as use of drought tolerate seed, rainwater harvesting practices, and farm machinery use. During the extensive consultation process to develop Malawi's first National Agriculture Policy in 2015, extension services were highlighted as the most important priority area for increasing agricultural productivity in the country.

The 2016 National Agriculture Policy had therefore set a target of reducing the ratio of extension worker to farming households from 1: 3000 to 1:1000 by 2020 (NAP, 2016). As at the end of 2020, this target was far from being realized. A new model of extension – *Community-based agricultural extension* - has a potential to fast-track and increase the number of locally trained extension workers on the ground across the country. The model is based on the idea of providing specialized and intensive technical training to 1 or 2 people in a community to become rural extension agents who are well trained in both technical and facilitation skills and are embedded in the communities where they serve. The model involves establishing appropriate training entities/centres in the rural communities, including development of training modules focusing on local contexts.

3.3 Barrier analysis and possible enabling measures for Landscape Restoration

Figure 4. A typical Malawian landscape

3.3.1 General description of the technology

This is a technology that will enable Malawi regain, improve, and maintain vital ecological functions and enhance human well-being across deforested or degraded landscapes of the country. Recent studies show that Malawi landscapes are degraded (Ministry of Natural Resources, Energy and Mining – Malawi, 2017). Nearly 8 million hectares or 80% of the total land area of Malawi are degraded and deforested. This has resulted in declining agricultural productivity and decreasing food security, increasing water scarcity, declining supply of biomass energy, and most importantly escalating vulnerability of Malawians to climate change impacts and other weather related shocks.

Nonetheless, these degraded and deforested landscapes can potentially be restored through a wide range of landscape restoration interventions. By adopting landscape restoration, Malawi will have the potential to mitigate the underlying conditions of soil degradation, and nutrient depletion, and enhance the opportunity for obtaining greater output from degraded lands and forests through this technology. This will create significant social, economic, and environmental benefits that will include increased food, water, and livelihood security for many Malawians. Restoration of degraded and deforested lands has an unparalleled potential to use nature-based solutions to achieve Malawi's Vision 2063, Growth and Development Strategy III, and several national environment and development goals in a number of policies such as the National Agriculture Policy (2016), the National Forest Policy (2016), the National Climate Change Management Policy (2016), among others.

Landscape restoration activities are already being implemented in Malawi. However, upscaling from the current restoration activities remains a challenge, and the current implementation rates still leave 2030 targets unattainable. Various barriers and measures to upscaling landscape restoration implementation on the ground have been cited in both peer-reviewed and gray literature (e.g. Schweizer et al. 2019; Mansourian et al. 2017; Sabogal et al. 2015; Stanturf. 2015; and Cordingley et al. 2015). Under the current study, key and relevant barriers to restoration of Malawi's landscapes and the measures to address and overcome them were identified and analyzed using the methods described in **Chapter two**.

3.3.2 Identification of barriers for the technology

Using the methods described in **Chapter Two**, we identified five key barriers that hinder accelerated implementation of landscape restoration on the ground in Malawi. These barriers were categorised as economic/financial and non-financial (**Table 7)**.

Table 7: Barriers to upscaling *landscape restoration* in Malawi.

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Inadequate investment into landscape restoration activities*	*Blended finance mechanism*
Non-financial	*Lack of capacity in landscape restoration*	*Expanded capacity development for landscape restoration*
	Inadequate information and awareness	*Adopting a community-based agricultural extension model*
	Unclear and irregular land tenure rights	*Land tenure reforms* to enhance individual rights to ownership and access to and use of the land.
	Inadequate legislative framework	*Regulatory reform* to allow the Environment Management Act become an overarching legislative framework for landscape restoration.

3.3.2.1 Economic and financial barriers

3.2.2.1.1 Inadequate investment into landscape restoration activities

For Malawi to achieve the ambitious national target of 4.5 million hectares of deforested and degraded lands restored by 2030, significant investment is required. It is estimated that the level of finance needed to achieve the stated target would cost at least 279 billion MWK or approximately 62,000 MKW per hectare (Ministry of Natural Resources, Energy and Mining – Malawi, 2017). With the government facing more and more funding shortages and development cooperation having limited growth margins, it is unlikely that adequate funding will be available for landscape restoration in the country. This will hinder large-scale upscaling of the technology.

3.3.2.2 Non-financial barriers

3.3.2.2.1 Lack of capacity in Landscape Restoration

Technical skills and knowledge about, for example, development of green finance and bankable projects to fund landscape restoration activities is limited in Malawi. In addition, knowledge and skills in designing successful landscape restoration projects, technical aspects of landscape restoration implementation, including monitoring results of the restoration efforts are also limited. These capacity limitations will hinder expanded implementation of landscape restoration activities on the ground to meet the stated country target of 4.5 million hectares by 2030.

3.3.2.2.2 *Inadequate information and awareness*

The main channel of reaching out to the rural farming households in Malawi with information and awareness about new technologies or practices is through the agricultural extension services of the Ministry of Agriculture and Food Security. However, according to the 2014 Welfare Monitoring Survey, only 17% of the rural households in Malawi received advice on farm planning and practices, while on 7% received information on forest and woodlot management (MNSO 2014). It is a known fact that people will not adopt activities they do not know about or lack the skills to implement them. Therefore, poor extension and outreach coverage limit the transfer and widespread diffusion of the technology.

3.4.2.2.3 Unclear and irregular land tenure rights

Land in Malawi is largely under customary tenure system. Customary tenure is a set of rules and norms that govern community allocation, use, access, and transfer of land (Admas, 2001). The customary tenure system is seen to vary widely across the country according to tribal lines and in many places the system lacks clarity. For example, persons who hold land under customary tenure enjoy differentiated security depending on their status in the village where the land is held. Members of core lineages have the right to lifetime use and occupation. Immigrants do not enjoy much security, especially in the early years of settlement. Because of unclear and irregular customary tenure rights, many people are unwilling to make long-term investments in land-related projects, including landscape restoration (McLain et al., 2018). This limits widespread adoption of the technology.

3.4.2.2.2 Inadequate legislative framework

Since the birth of forest landscape restoration two decades ago, Malawi has designed and implemented landscape restoration within the realm of the existing forestry legislation. Forestry legislation in its narrow sense usually has the owners as their primary target group, by issuing prohibitions, restrictions and mandatory actions, as well as incentives such as subsidy and advisory services (de Burca et al., 2013). This form of legislation has increasingly been criticized as insensitive to local contextualities (Nylund and Gowda, 2011). Landscape restoration involves multiple actors from multiple sectors operating at multiple scales, which implies that the forestry legislation in its current form cannot adequately provide conducive environment for expanded landscape restoration in the country.

3.3.3 Identified measures

3.3.3.1 Economic and financial measures

3.3.3.1.1 Blended finance mechanism for landscape restoration

There are diverse financing and market-based sources to raise funds for landscape restoration, among them: development cooperation resources, climate finance, non-governmental (NGO) resources, state budgets, environmental funds, crowdfunding, and private sector investments. With the government facing more and more funding shortages and development cooperation having limited growth margins, long-term financing solutions may increasingly rely on the private sector and on instruments enabling self-sustained financing such as environmental funds. Although private sector investment is advocated for long-term financing solutions, opportunities for private investors to fund restoration projects are limited to very specific circumstances. This is due to the high uncertainties and risks of financial returns from the technology.

The Sustainable Infrastructure Imperative Report (NCE, 2016) suggests that scaling up investment in landscape restoration will require a '*blended finance*' mechanism. The '*blended finance*' mechanism involves integrating a package of financing mechanisms from the public development finance (targeting the agriculture and forestry sectors) and public climate finance (targeting at mitigation and adaptation) with the private capital. The deployment of the *blended finance* mechanism can enable multiple issues to be addressed and the diverse needs of local actors to be met. A diverse spectrum of landscape restoration investment can also maximise the leverage of finance and adoption of practices at scale across the landscape, reducing the investment risk for individual investors. This innovative investment model needs to be piloted on the ground to demonstrate its effectiveness to achieving these desired goals.

3.3.3.2 Non-financial measures

3.3.3.2.1 Capacity development for landscape restoration

Given the urgent need to obtain progress on the ground, increased capacities in landscape restoration across society in Malawi are required. A wide array of landscape restoration-relevant subjects need to be addressed in capacity building programmes, ranging from global policies and governance issues to project planning, facilitation of multi-stakeholder processes and implementation on the ground. In addition, the capacity building programmes should include social skills such as methods of science communication, science-policy and science-society interactions

Some aspects of capacity building in landscape restoration are currently underway in Malawi. For example, the country is currently implementing a mentorship programme on landscape restoration which aims to develop a critical mass of well-trained landscape restoration practitioners and facilitators. The mentorship programme is implemented by the Centre for Applied Systems Analysis (CASA), a local knowledge Centre in Malawi, with expert support from the International Union of Forestry Research Organizations (IUFRO). Fifty (50) local landscape restoration practitioners will be mentored under this programme. However, the number of trained local practitioners would not be sufficient to significantly roll out expanded landscape

restoration implementation on the ground. Expanded capacity development programme would be required if Malawi is to achieve its national target.

3.3.3.2.2 A community-based agricultural extension model

As the main channel of reaching out to the rural farming households with information and awareness about new technologies or practices is through the agricultural extension services. Agricultural extension services are largely provided by technically qualified individuals from the government. The government-based extension services have proved to be ineffective in terms of outreach coverage. A new model of delivering extension services – *community-based agricultural extension* – is believed to overcome the challenges faced by the government-based extension. The model is based on the idea of providing specialized and intensive technical training to 1 or 2 people in a community to become rural extension agents within their communities (*ref. section 3.4*). These rural extension agents will provide ease reach to farming households with information and awareness of the landscape restoration technology, thereby enhancing its widespread diffusion.

3.3.3.2.3 *Land tenure reforms to enhance and secure peoples' land rights*

Clear and secure land tenure is extremely important to restoration work because disputes over land ownership and control create uncertainty and drive away investors in landscape restoration. Investors are deterred from funding potential projects and works involving landscape restoration when risk assessments reveal insecure land titles and unclear land control (Milder, et al., 2011).

With land tenure reforms, i.e. converting a more informal tenancy into formal property rights, the land ownership of smallholder farmers, including access to and use of the land is clear and secured. The Malawi government has taken significant steps to reforming customary land tenure system in the country. However, realising that customary land tenure systems are embedded within wider social and cultural settings, further work needs to be undertaken to increase awareness among tribal leaders and reduce potential conflicts as the reforms are implemented.

3.3.3.2.4 Regulatory reforms

The Environment Management Act is the principal legislation guiding environmental management in the country. The legislation is cross-cutting and is well suited to regulate implementation of landscape restoration on the ground. As landscape restoration involves multiple actors from multiple sectors operating at multiple scales, this implies that the environment management legislation can adequately provide conducive and neutral regulatory platform on which these diverse stakeholders can freely participate in the restoration of Malawi's degraded and deforested landscapes.

3.4 Barrier analysis and possible enabling measures for an integrated crop-livestock-aquaculture-forest production systems

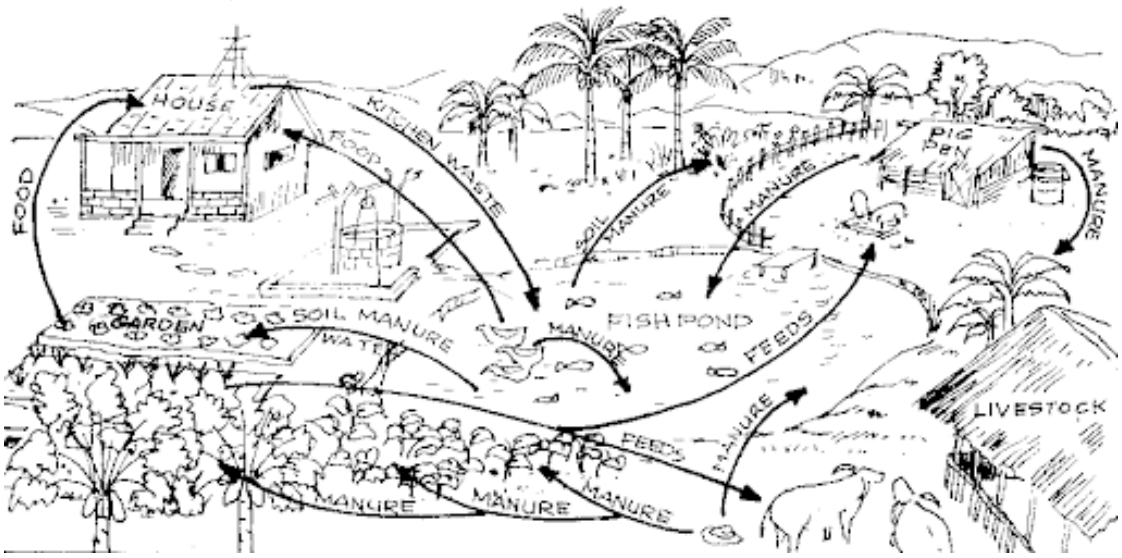

Figure 5. An integrated cop-livestock-aquaculture-forest system (*Source:* http://www.nzdl.org/)

3.4.1 General description of the technology

An integrated crop-livestock-aquaculture-forest (ICLAF) is an agricultural technology which integrates different production systems within the same area or farmland and implemented simultaneously. The technology integrates a wide range of crops and a variety of animal, fish and tree species in one production arrangement (**Figure 5)**. The combination can be in different configurations, i.e. combining any of the two, three or all four production systems in one production arrangement according to availability of resources to sustain and satisfy the needs of the farmer.

A diversified portfolio of productive enterprises ensures increased resilient of the farming systems and people's livelihoods from climate variability and changes. For instance, if one enterprise (e.g. crop cultivation) fails due to drought or climate-induced pest or disease infestation, the farming household will still survive on production from the other enterprises. In addition to climate benefit, as we are using the waste material of one enterprise as input into production function of other type of enterprise, so waste pollution is minimized and hence environmental safety of the production site is ensured. Economically, the technology increases the system's overall productivity, hence profitability and food security of the farming households is enhanced.

Some components of the technology are already in use in Malawi. For example, some farmers are already practicing integrated aquaculture-agriculture, crop-tree combination referred to as *agroforestry*, or mixed farming. The technology is therefore not new in the country. The technology needs upscaling to enhance wide-spread adoption and diffusion across the country, thereby maximizing the returns from the

limited land available to many farming households in Malawi and build their resilience to the impacts of climate change.

Many scholars (e.g. Coulibaly et al., 2017; Dougill et al., 2017; James et al., 2015; Mwase et al., 2015) have reported a suite of barriers that have hampered the widespread adoption and diffusion of the technology in Malawi and across Sub-Saharan Africa. This section provides the results of the analysis of the barriers we conducted, including measures to address and overcome them in order to enhance upscaling of the technology in the country.

3.4.2 Identification of barriers for the technology

Using the methods described in **Chapter Two**, we identified five key barriers hindering the upscaling of the technology in the country. We decomposed the barriers into two broad categories, i.e. economic/financial and non-financial. These barriers are presented in **Table 8**.

Table 8: Barriers to upscaling of *integrated farming technology* in Malawi.

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Limited credit and finance*	*Access low-cost inputs* through an existing farm input subsidy programme *Engage in village savings and loans groups*
Non-financial	*Poor access to information and communication*	*Enhance capacity to collect, interpret, and internalize* on-line data and information about integrated farming system.
	Limited technical skills of the extension workers	*Expanded mentorship of frontline staff in integrated farming system*
	Gender inequality	*Transform gender relations* through providing incentives and participatory education and training oriented specifically to women
	Unfavorable customary land tenure system	*Secure farmers' rights to land* by issuance of authoritative certificates of land ownership

3.4.2.1 Economic and financial barriers

3.3.2.1 Limited credit and finance

Smallholder farmers aiming to adopt integrated farming practices often are constrained by inadequate cash to invest in the land, crop and tree seeds/seedlings, fingerings, livestock, equipment, labor and other farm inputs. This is aggravated by lack of access to credit from commercial banks and other financial lending institutions. This

is mainly due to the fact that the majority of the smallholder farmers lack of appropriate collaterals to acquire loan facilities from financial lending institutions. The lack of or inadequate financial means to acquire farm inputs constitute an important barrier to smallholder farmer adoption of integrated farming technology in Malawi.

3.4.2.2 Non-financial barriers

3.4.2.2.1 Poor access to information and communication support

Many smallholder farmers in Malawi have limited access to appropriate information and communication support about the socio-economic, climate and environmental benefits of the technology, including technical aspects of its implementation and market conditions of the farm produce realised from the technology. Successful adoption and diffusion of any agricultural technology requires recognition of benefits of the technology, the technical aspects of its implementation, and its market aspects (Lee, 2007). Inadequate access to relevant information on the benefits, technical and market aspects of the integrated farming technology therefore hinders the widespread diffusion of the technology across farming households in the country.

3.4.2.2.2 Limited technical skills of the extension workers

Technical skills and knowledge about, for example, appropriate combination of the enterprises to maximise productivity of the overall production arrangement, is limited among the agricultural extension workers. Agricultural extension workers are front-line staff who directly interact with smallholder farmers and provide them with extension messages about particular farming technologies. With limited technical know-how about the technology, these front-line staff would not be able to effectively offer the required services for the promotion of the technology. This therefore constitutes one major limiting factor to adoption of the technology among farming households in the country.

3.4.2.2.3 Gender inequality

Gender remains a significant barrier to the adoption of many land-based technologies by women; stemming largely from customary gender roles. This is irrespective of their significant contribution to agricultural production at a household level. For example, due to customary gender roles, women in the northern region of Malawi often have less access to land than men, of which is important to engage in the technology. In addition, gender biases in institutions often reproduce assumptions that it is men who are the farmers. As a result, new agricultural technologies, including the replacement of plant types and animal breeds with new varieties intended for higher drought or heat tolerance are rarely available to women farmers. This limit women' participation in technology advancement, including integrated farming.

3.4.2.2.4 Unfavorable customary land tenure

As customary land tenure varies widely across tribal lines in Malawi, the system lacks clarity. People holding land under customary tenure enjoy differentiated security depending on their status in the village where the land is held. Because of unclear and irregular customary tenure rights, this occasionally lead to disputes over land ownership

and control, creating uncertainty and discourage long-term investments on land such as deployment of the integrated farming systems (McLain et al., 2018). This therefore limits widespread adoption of the technology.

3.4.3 Identified measures

3.4.3.1 Economic and financial measures

3.4.3.1.1 Subsidized farm inputs

Expansion of the existing Farm Input Subsidy Programme (FISP) of the Ministry of Agriculture and Food Security of the Malawi government to include inputs for the components of the integrated farming technology such as tree seed/seedlings, fish and animal feed, etc. In its current form, FISP only provides subsidized farm inputs related to crop production (i.e. fertilizers, maize/crop seed), and no subsidized inputs for aquaculture and animal production, including tree cultivation. Access to low-cost inputs for the technology will enable many farmers to adopt and practice the technology.

3.4.3.1.2 Village Savings and Loans (VSL) schemes

As smallholder farmers have limited access to formal credits from banks and other financial lending institutions due to lack of appropriate collaterals, promotion of village savings and loans (VSL) schemes provides smallholder farmers access to small-scale loans that can help to finance the purchase of farm inputs for the technology. The VSL schemes pool household resources and agricultural profits to create a structured collective mechanism for savings, short-term lending and investment in household economic activity. The VSL schemes have been widely promoted in Malawi through ".

3.4.3.2 Non-financial measures

3.4.3.2.1 Access to appropriate information and communication

Access to appropriate information and communication support is critical for enabling smallholder farmers to enter into informed dialogue about decisions to the adoption of the integrated farming technology. Information comes in many different forms of varying relevance, accessibility and quality. Such information needs to be assessed, synthesized, translated, and simplified for the ordinary farmers to easily understand and use it. Presenting the information in a vernacular language using appropriate mode of communication would enhance assimilation and use of the information for appropriate decision-making at a farm level. The media and other entities, such as community spokespersons, local government officials and CSOs can play this critical role.

3.4.3.2.2 Capacity development of the front-line staff

Building the capacity of the extension workers and other front-line staff on the technical aspects of the technology will enable them to adequately facilitate the widespread adoption of the technology among the farmers through demonstration and farmer exchange visits. Technology transfer should embrace participatory and cross-sector approaches to ensure effective smallholder involvement and sustainability. Overall, enhanced farmer education can speed up technology transfer and diffusion.

3.3.2.2.2 Gender transformative programmes and awareness raising

Since gender roles, identities and expectations are socially, culturally and politically constructed, gender transformative approaches and awareness raising can overcome gender inequality, hence promoting transfer and diffusion of the technology. Gender transformative approaches are programmes and interventions that create opportunities for individuals to actively challenge gender norms, promote positions of social and political influence for women in communities, and address power inequalities between persons of different genders.

3.4.3.2.4 Reform customary land tenure system

Issuance of authoritative individual, household or community level certificates of land ownership by government authorities would secure farmers' rights to land and encourage investment in integrated farming system. In communities where certificates of land ownership may not be feasible, for example where land is communally owned and rights to the land are defined by written or unwritten customs and governed by decision-making authorities at the extended family, clan, chief, or village levels, adoption of perennial systems including agroforestry may help individuals and/or households establish, claim and exercise tenure rights that can encourage them to adopt integrated farming system.

3.5 Barrier analysis and possible enabling measures for Community-based agricultural extension

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Figure 6. Community members at an agricultural extension meeting

3.5.1 General description of the technology

Agricultural extension describes the services that provide rural people with access to knowledge and information they need to increase productivity and sustainability of their production systems and improve their quality of life and livelihoods. Extension services to rural people are mostly provided by technically qualified individuals from the government. The models of extension based on government services are not sufficient to meet the needs of farmers in rural areas. This is due to a number of factors including the necessity to respond to the specific technological needs of farmers in different agro-ecological zones; high transaction costs of reaching remote areas; the need for localized crop and livestock management solutions suited to local conditions, which are often not understood by extension agents trained for work in high potential areas; and the challenge of finding professional extension specialists willing to live and work in remote, and sometimes insecure areas.

The community-based agricultural extension is a technology based on the idea of providing specialized and intensive technical training to 1 or 2 people in a community to become rural extension agents. The technology involves establishing appropriate training entities/centres in the rural communities, including development of training modules focusing on local contexts. Communities select candidates against a list of agreed criteria for the training to become rural extension agents. Upon completing the training, the new graduates go back to their communities to provide extension services. Technical experts from the training centres are made available to provide ongoing

support to newly trained rural extension agents. Periodic refresher courses are offered to ensure the extension agents are current in their extension messages.

The community-based extension model is not completely new to Malawi. Malawi has used a *Lead Farmers approach* since 2009 to build capacity of local innovative farmers to effectively share knowledge and skills with farmers within their localities. However, most capacity building efforts offered to *lead farmers* are intermittent and informal or conducted during meetings. The *lead farmers* are not fully grounded in the theory and practice of agricultural extension, including technical aspects of the target technology for effective delivery of extension services. The community-based agricultural extension has the potential to provide the required knowledge and skills to the rural extension agents.

3.5.2 Identification of barriers for the technology

Using the methods described in **Chapter Two**, we identified three key barriers according to decision to procure or implement the technology. These barriers are both financial and non-financial in nature. **Table 9** lists these barriers.

Table 9: Barriers for *community-based extension* in Malawi.

Barrier category	**Barriers**	**Measures**
Economic and financial	*Limited access to finance*	*Lobbying* government to prioritize investing in community-based rural extension
Non-financial	*Lack of local reference projects*	*Piloting the* implementation of the technology
	Lack of appreciation of local knowledge	*Develop appropriate technologies* that combine local knowledge and modern strategies.

3.5.2.1 Economic and financial barriers

3.5.2.1.1 Limited access to finance

Funding for establishing new institutions, e.g. extension delivery services, may not lately be a key priority for government. Funding from government is usually allocated firstly to immediate concerns and revenue-generating projects. Currently, the government funding priority is on Covid-19 related interventions. Limited funding is available to projects whose outcomes or effects are not immediate or are long-term. As a consequence, this technology may not be readily procured and implemented despite its benefits to enhance adoption and diffusion of many climate adaptation technologies. .

3.5.2.2 Non-financial barriers

3.5.2.2.1 Lack of local reference projects

Lack of locally contextualised evidence to demonstrate technical feasibility, economic viability and social acceptability of community-based agricultural extension technology poses a challenge for governments and development partners to invest in such technology as a means to adapt to impacts of climate change. Such a technology lacks solid local experience or reference.

3.5.2.2.2 Lack of appreciation for local knowledge

Local knowledge encompasses the skills, experiences, practices, and insights of local people, applied to maintain or improve their livelihood. Conventional approaches imply that development processes always require technology transfers from places that are perceived to be more advanced. This practice has often led to overlooking the potential of local experiences and practices. Lack of appreciation of the local knowledge will therefore hamper the decision to procure or implement the technology on *community-based agricultural extension,* which largely focuses on developing local actors to become rural extension agents.

3.5.3 Identified measures

3.5.3.1 Economic and financial measures

3.5.3.1.1 *Utilizing existing Day and Residential Training Centres*

Due to funding constraints, Government may not be able to build new infrastructure for training rural extension agents. Instead, the existing Residential Training Centres (RTCs) at a district level in all districts, and Day Training Centres (DTCs) located at each of the 154 Extension Planning Area (EPA) of the Ministry of Agriculture and Food Security can be rehabilitated and utilised as training centres for the rural extension agents from surrounding communities of these centres. This would cut down the costs for establishing new infrastructures.

3.5.3.1.2 *Blended financing mechanism*

Because of the significant role this technology can play in the adoption and diffusion of both public development and public climate initiatives, a '*blended finance*' mechanism can be established to funding for the technology. The blended finance involves integrating a package of financing mechanisms from the public development finance (targeting the agriculture and forestry sectors) and public climate finance (targeting at mitigation and adaptation) with the private capital. The deployment of the *blended finance* mechanism can enable multiple issues to be addressed and the diverse needs of local actors to be met.

3.5.3.2 Non-financial measures

3.5.3.1 Pilot project

As a measure to overcome the barrier of lack of reference projects, there is a need to set up pilot implementation of the technology in selected Extension Planning Areas of the country. The pilot project will evaluate feasibility, assess and assist process design, and guide implementation of the technology in the country. Execution of the pilot will allow risks associated with the technology to be identified, documented, authenticated, mitigated, tested, or possibly solved in a less intense environment, thereby lowering risk of failure of the main technology.

Pilot projects will also overcome the barrier on lack of appreciation of the local knowledge. The success of the pilot project will entail that engagement of local extension workers with local knowledge of their area can enhance facilitation of the adoption and diffusion of the climate technologies.

3.6 Linkages of the barriers identified

During the barrier analysis process, we observed that some barriers were common to all the three priority technologies in the agriculture sector, while others were just common to only two technologies (**Table 10**). The common barriers suggest that overcoming these in one technology will result in resolving them for the other technologies which could lead to clearing the way for the smooth adoption and diffusion of these technologies in the sector.

Table 10: Common barriers identified for the priority technologies in agriculture sector

Barrier category	**Common barriers**	**Technologies affected**
Economic and Financial	*Limited access to credit and finance*	*All - Landscape restoration, Integrated farming system, and Community-based agricultural extension*
Non-financial	*Inadequate information and awareness*	*All - Landscape restoration, Integrated farming system, and Community-based agricultural extension*
	Limited human and institutional capacity	*Two of the three - Landscape restoration, and Integrated farming system*

3.6.1 Limited access to credit and finance

This is one of the major barriers in adopting the climate adaptation technologies in agriculture. Owing to the sector being highly dominated by smallholder farmers, lack of finance and access to credit remain the leading obstacle to technology transfer and diffusion in the sector. Smallholder farmers are often constrained by inadequate cash to

invest in agriculture due to their low income levels. This is aggravated by lack of access to credit from banks due to higher transaction costs on the part of the financial institutions, lack of appropriate collaterals from the farmers, including lack of vital banking information. This implies that agricultural lending remains mostly an uncharted territory for development finance, despite a large majority of the poorest households are directly linked to agriculture in many ways.

3.6.2 Inadequate information and awareness

Many smallholder farmers in Malawi do not have access to appropriate information and lack awareness about climate smart agriculture technologies. Successful transfer and diffusion of any technology requires recognition of benefits of the technology, the technical aspects of its implementation, and its market aspects (Lee, 2007). Inadequate access to relevant information and awareness on the benefits, technical and market aspects of the technologies therefore hinders the widespread transfer and diffusion of the technologies in the sector.

3.6.3 Limited human and institutional capacity

Despite the country having a number of agricultural training institutions, the curricula in many of these institutions are generic and not transformative: they do not provide specific technical skills, knowledge and disposition required for local transformation in the agriculture sector, especially in the face of climate change. For example, the agriculture and forestry programmes at the Lilongwe University of Agriculture and Natural Resources offer generic programmes in agriculture and forestry – without giving particular attention to designing and implementation of landscape restoration as a holistic approach to addressing land degradation and improve human well-being. Effective diffusion of a climate technology requires know-how and capacity of technological adaptation.

3.7 Enabling framework for overcoming the barriers in the sector

The enabling framework denotes the entire range of institutional, regulatory and political framework conditions that are conducive to promoting and facilitating the transfer and diffusion of technologies (IPCC, 2000). In this study, four major elements of enabling framework were identified to be particularly important for promoting and facilitating transfer and diffusion of adaptation technologies in the agriculture sector, i.e. national macroeconomic conditions, human and institutional capacity, public awareness and learning, and gender inequality. **Table 11** provides areas of political influence that can facilitate the transfer and diffusion of the adaptation technologies in the agriculture sector.

Table 11: Enabling framework for common barriers identified for the priority technologies in the agriculture sector

Broad/common barriers addressed	**Enabling environment**	**Areas of influence to facilitate transfer and diffusion of the water technologies**
5. Limited access to credit and finance	*National macroeconomic conditions*	vi. *Regulation of financial sector institutions* – these largely aim to maintain financial stability and consumers' protection. Inclusive financial regulation that allows small farmers access credit from banks are required if we are to enhance transfer and diffusion of the climate adaptation technologies. vii. *Public investment policies* – policies guiding how the government spends money on public services. Funding from government is usually allocated firstly to immediate concerns and revenue-generating projects. Little or no funding is available to projects whose outcomes or effects are not immediate or are long-term. This affects investments in climate adaptation technologies. Reforms in public investment policies are therefore needed. viii. *Reforming farm input subsidy programme (FISP)* – the program aims to enhance food self-sufficiency by increasing smallholder farmers' access to and use of improved agricultural inputs. In its current form, *FISP* only provides subsidized farm inputs related to crop production (i.e. fertilizers, maize/crop seed). The programme can be expanded to include all components of farm production systems, making low-cost inputs available to many farmers for the expanded adoption and diffusion of integrated farming systems. ix. *Adopting a blended finance mechanism* – A blended finance is the use of catalytic capital from public or philanthropic sources to increase private sector investment in climate technologies. It involves blending public development financing and public climate financing with the private capital. Blended finance creates investable opportunities and reduces investment risks for individual investors, especially in landscape restoration.

		x. *Capacity to develop fundable project proposals* There are some funding agencies and mechanisms, e.g. the adaptation fund, the green climate fund (GCF), or the global environment facility (GEF), which fund climate-related projects. The country needs to develop capacity to competitively solicit grants from these agencies and mechanisms.
6. *Limited human and institutional capacity*	Human and institutional capacity	iv. *Public sector reform programme* – to improve public sector governance, efficiency and effectiveness that are crucial for the delivery of quality services, including climate adaptation related actions. Malawi government is already implementing the programme. *v.* *Capacity-building programmes of governmental agencies and institutions* – to obtain, strengthen and maintain the capabilities to set and achieve national development objectives of climate adaptation technologies over time. vi. *Enhance publicly funded research and development and training programmes* – to support pilot implementation of climate technologies in the country. Execution of the pilot allows risks associated with the technology to be identified, documented, authenticated, mitigated, tested, or possibly solved in a less intense environment, thereby lowering risk of failure of the main technology.
7. *Inadequate public awareness and learning*	Public awareness and learning about the technologies	*ii. Build effective public awareness and learning about climate adaptation technologies* – the much-needed political will for the transfer and diffusion of climate technologies requires informed public support. Information is a valuable resource and lack of it will hinder widespread transfer and diffusion of the technologies.
8. *Gender inequality*	Gender and other socio-cultural issues	ii. Gender roles, identities and expectations are socially, culturally and politically constructed. Therefore *gender transformative programming* and *awareness raising* can overcome gender inequality, hence promoting climate technology transfer and diffusion.

CHAPTER FOUR: WATER SECTOR

4.1 Introduction

Malawi has abundant surface water and groundwater resources in the form of lakes, streams, rivers, reservoirs, and aquifers (Wada et al., 2012). These water resources are of variable quality and quantity, unevenly distributed in time and space, and are subjected to poor conservation and management. They are considered vulnerable to climate change due to extensive reliance on precipitation as the principle source of their availability. The quantity of surface water resources, especially rivers, is highly dependent on the availability of rainfall which sustains runoff (Bates et al. 2008). Erratic rains, extended dry periods, and increased evapotranspiration, combined with increased demand for water for different uses, are increasingly exerting pressure on freshwater availability and rapidly turning Malawi's historical water abundance into water stressed country. For example, between 1972 and 2017, freshwater resources per capita in Malawi declined from 3,321 cubic metres to 866.7 cubic metres (Government of Malawi, 2020).

In terms of future climate change impacts, using the downscaled climatological data from six general circulation models under the most extreme future emission scenario, Adhikari et al. (2016) showed that the southern region of Malawi will face increased water stress and the region will be more prone to droughts. Whereas the northern region of the country will generally have increased precipitation in the mid of the century (2050s). The region may become more prone to stormy rains, landslides, and floods. The adaptation technologies implemented in the water sector should therefore aim to promote adaptation of the sector to these changes in climate. For example, the southern region of the country would require adaptation technologies that can conserve water from erratic rainfall the region will receive, whereas the adaptation technologies that can minimize damages and losses associated with floods, and maximize the net benefits from the use of the floodplains would be required for the northern region of the country.

Through the TNA process, Malawi prioritized three climate technologies for adaptation of the water sector to these climate change impacts (Malawi Government, 2020). These prioritized climate technologies are presented in **Table 12**.

Table 12: Prioritized climate technologies for adaptation in Malawi's water sector (*Source:* Malawi Government, 2020). .

Priority	**Climate Technology**
1	Rainwater harvesting
2	Integrated river basin management
3	Integrated flood management

The success to widespread transfer and diffusion of these climate technologies is generally hindered by a number of barriers. This Chapter provides a thorough understanding of these barriers as key to designing appropriate portfolio of measures that can adequately address and overcome these barriers.

4.2 Preliminary targets for technology transfer and diffusion

The Malawi government's policy documents, strategies and plans for the water sector and other related sectors (e.g. irrigation) have set national targets with regards to implementation of these technologies. These targets are given below.

4.2.1 Rainwater harvesting

This is a technology through which rainwater is captured from manmade surface catchments such as rooftops, and road drainage and culverts, and stored in storage tanks or reservoirs for use during water-stressed period of the year. The technology can be defined as the collection, conveyance, and storage of rainwater for an intended use.

The promotion of rainwater harvesting is in line with the government developmental agenda as outlined in the Malawi Growth and Development Strategy III under the Agriculture, Water Development and Climate Change Management key priority area. The Priority Area calls for enhanced rainwater harvesting and conservation as a way of mitigating water shortages and augmenting current supplies for domestic use and for agricultural production. The Strategy had set a target a 47 percent increase of cultivated land put under irrigation in the country through its 5-year period of implementation (2017 – 2022), i.e. from 107,991 hectares in 2017 to 158,791 hectares of cultivated land in 2022. The capture and storage of rainwater and water runoff either in pond or dam structures for use in small scale irrigation can significantly contribute to achieving this target.

Similarly, the Strategy had set a target of 90 percent of the Malawi households to have access to safe and reliable water resources by 2022 from 87% in 2017. Rooftop rainwater harvesting provides a secure, safe, and convenient source of water to satisfy domestic needs such as drinking, cooking, and basic hygiene. Therefore widespread diffusion of the technology across households in the country will significantly contribute to this target.

4.2.2 Integrated river basin management

Integrated river basin management is a technology that integrates management of all surface and subsurface water resources, land and other natural resources within hydrologic boundaries of river basins with due attention to water quality, water quantity and environmental integrity. Many river basins in the country are under severe pressures due to deforestation, unsustainable agriculture, settlements and mining, subjecting them to become more vulnerable to climate change impacts. Implementing integrated river basin management will address and overcome these underlying causes of the river basin degradation.

Promotion of integrated river basin management is in line with the government resilience agenda as outlined in the National Resilience Strategy (2018 – 2030) under the Catchment Protection and Management. Pillar 4 of the Strategy specifically calls for enhanced integrated watershed management of the catchments in order to build the catchments' socio-ecological resilience. The Strategy had set a target of 15,000 hectares of catchments to be put under sustainable land and water management on annual basis from 2018 through to 2030. This entails scaling up of integrated river basin management will annually contribute to this national goal.

4.2.3 Integrated flood management

Integrated Flood Management (IFM) is a new approach to flood management. While traditional flood management has focused on defensive practices (flood control and protection by structural measures, e.g. dykes), integrated flood management is a proactive management of risks due to flooding. IFM emphasizes the links between flood management and the socio-economic development as well as the protection of natural ecosystems. IFM joins the sum of all operational activities to be taken before, during and after an event as well as political and administration decisions that are aimed at preventing or mitigating a flood event or even a flood disaster.

Floods are common in Malawi. Between 1946 and 2013, floods accounted for 48% of major disasters, causing extensive harm and damage to peoples' lives and property. For example, the 2015 floods caused 523,347 houses partially or completely damaged representing the largest single sector affected by the size of loss. In the wake of past floods, the government embarked on flood management, investing in measures such as flood preventions, early warning and evacuation planning, with the ultimate aim of better protecting the inhabitants and assets from flood hazards. The 2018 National Resilience Strategy (NRS) had set a 10 percent annual reduction in loss of crops, livestock, and assets from flood damage up to 2030.

However, the interventions advocated under pillar two of the NRS - *Risk reduction, flood control , early warning and response systems* – lack actions on maximizing the net benefits from using the floodplains for agricultural production and food security in order to enhance socio-economic development and wealth creation of the communities living in the floodplains. The adoption of IFM will provide for maximizing and efficient use of the floodplains and simultaneously addressing the negative aspects of flooding in one management system.

4.3 Barrier analysis and possible enabling measures for Rainwater harvesting

Figure 7. Rooftop rainwater harvesting

4.3.1 General description of the technology

Rainwater harvesting is a technology through which rainwater is captured from manmade surface catchments such as rooftops, and road drainage and culverts, and stored in storage tanks or reservoirs for use during water-stressed period of the year. The technology can be defined as the collection, conveyance, and storage of rainwater for an intended use. Most often, the intended uses are for agricultural production or for domestic needs (Malesu et al. 2007).

The technology is in two main categories: rooftop rainwater harvesting and surface rainwater harvesting. Rooftop rainwater harvesting (**Figure 7**) is the practice of capturing the rainfall from roofs of homes or any other structures, diverting it through gutters and drains, and storing the water in tanks of various sizes for later use. Tanks are more often constructed using ferro-cement and plastic, and can be constructed above ground, below ground, or some combination of the two. The most common tanks are circular in shape and enclosed (**Figure 7**). Rooftop rainwater harvesting provides a secure, safe, and convenient source of water to satisfy domestic needs such as drinking, cooking, and basic hygiene.

Surface rainwater harvesting, on the other hand, is the capture and storage of rainwater and water runoff either in a pond, pan or dam structure **(Figure 8).** Minimizing seepage is usually a main priority for these structures and can be done by compacting clay soil at the base, or by lining it with impermeable material such as plastic pond lining. The rainwater stored in these structures is usually used for small scale irrigation, livestock, or domestic purposes if needed.

Figure 8. Surface rainwater harvesting

Rainwater harvesting is a known technology in Malawi. A number of projects and NGOs have been promoting rainwater harvesting in the country including: Irrigation Rural Livelihood and Agriculture Development Programme (IRLADP), Farm Income Diversification Programme (FIDP), Emergency Drought Recovery Programme (EDRP), Malawi Drought Recovery and Resilience Programme (MDRRP), Department of Irrigation Services, Land Resources Conservation Department, World Vision Malawi, Alliance One Tobacco, Canadian Physicians for Aid Programme (CPAR-Malawi), Project Concern International (PCI-USAID).

Recently, the Rainwater Harvesting Association of Malawi (RHAM) embarked on a campaign to create a mass movement on rainwater harvesting to adopt the practice at a wider scale. However, the widespread adoption and diffusion of the technology is far from being realized across the country. A suite of barriers have been identified to hinder the widespread transfer and diffusion of the technology. This section of the chapter presents these barriers and the measures to be undertaken to overcome these barriers and enhance widespread adoption of the technology in the country.

4.3.2 Identification of barriers for the technology

Using the methods described in **Chapter Two**, we identified four key barriers to upscaling rainwater harvesting technology in Malawi. These barriers were identified to be financial and non-non-financial in nature. **Table 13** presents these barriers.

Table 13: Barriers to upscaling of *rainwater harvesting* in Malawi.

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Limited credit and finance*	*Engage in cost-sharing* mechanism
Non-financial	*Limited skilled technical personnel*	*Build capacity of the project designers and implementers* on technical aspects of the technology
	Gender inequality	*Undertake a gendered approach* in the design and implementation of the technology
	Inadequate information and awareness	*Establish a network* of actors of rainwater harvesting to allow for better communication and collaboration among actors

4.3.2.1 Economic and financial barriers

4.3.2.1.1 Limited credit and finance

The water harvesting technology requires initial capital investment to procure, for example, water storage tanks and construction of surface water reservoirs. The technology also incurs maintenance costs during implementation and use. For example, the plastic pond lining that is put to minimize seepage in surface rainwater harvesting ponds often contracts and rips during the dry season, when the sun dries out the pond and surrounding soils. The pond lining therefore requires periodic replacement in the course of implementation. Many potential adopters of the technology are constrained by inadequate cash to pay for such costs. This is aggravated by lack of access to credit from commercial banks and other financial lending institutions due to lack of appropriate collaterals. The lack of or inadequate financial means to invest and meet the operation costs of the technology constitute an important barrier to widespread transfer and diffusion of the technology across the country.

4.3.2.2 Non-financial barriers

4.3.2.2.1 Limited skilled technical personnel

The ability to design and implement the water harvesting technology is an important determinant of the transfer and diffusion of the technology, including its sustainability. For example, due to poor knowledge and lack of technical skills of proper tank construction methods by local artisans and foremen, many problems can come about from shoddy construction works. Such poor structures do not last long and fail to provide long-term solutions to water resource problems, i.e. water storage for future use. This becomes a barrier to widespread adoption of the technology.

4.3.2.2.2 Gender inequality

Gender remains a significant barrier to the adoption of rainwater harvesting technology; stemming largely from gender biases in technology transfer which mostly favours men (Ngingi, 2009). Despite women being the main actors in sourcing water for household use in rural areas, the rooftop rainwater harvesting technology is rarely available to women, particularly to women-headed households. Women have the knowledge and understanding of the water needs of the household/community and to come up with practical solutions. But they still remain untapped resource in the design and implementation of the water harvesting technologies. This result in rainwater harvesting technologies which are ill-designed and fail to deliver their intended purposes.

4.3.2.2.3 Inadequate information and awareness

Many Malawians do not have adequate information and awareness about the potential of rainwater harvesting as a means to diversify household water supply and provide a convenient and reliable source of water for domestic needs, livelihoods, and small-scale irrigation food security during seasonal dry periods and droughts. This has therefore hindered widespread diffusion of the technology across among households and institutions in the country.

4.3.3 Identified measures

4.3.3.1 Economic and financial measures

4.3.3.1.1 Cost-sharing mechanism

To overcome the barrier of limited credit and finance for the technology, the government and/or development partners can engage in cost-sharing mechanism in the procurement and implementation of the technology with local people interested in rainwater harvesting. It is commonly believed that cost-sharing mechanisms instil ownership and responsibility in a project and thus longer lasting effects (Critchley 1991). However, this is not always possible when implementing projects among poorer populations, and so determining the best level of cost-sharing or incentive base is an important determinant that must be analysed. Too little incentive might prove adoption unaffordable and impossible, while too much incentive might create reliance on project funds for continued operations.

4.3.3.2 Non-financial measures

4.3.3.2.1 Capacity development for local artisans and foremen

Building the capacity of the local artisans and foremen on technical aspects of the rainwater harvesting technology will enable them design and implement rainwater harvesting structures to the required standards. In addition, a standardized framework for various sized tanks or ponds is needed in order to cut down on shoddy construction jobs and designs being carried out in the country.

4.3.3.2.2 Gender transformative programmes and awareness raising

Gender transformative approaches and awareness raising can overcome gender inequality, hence promoting transfer and diffusion of the technology. Gender transformative approaches are programmes and interventions that create opportunities for individuals to actively challenge gender norms, promote positions of social and political influence for women in communities, and address power inequalities between persons of different genders. Whereas gender awareness raising plays an important role in informing women and men about gender equality, the benefits of a more gender-equal society and the consequences of gender inequality. Gender awareness raising intends to change attitudes, behaviors and beliefs that reinforce inequalities between women and men. This will result in women and men having equal participation in the technology and ensure its success.

4.3.3.2.3 Rainwater harvesting community of practice

As a way to overcome inadequate information and awareness, establishing a rainwater harvesting network of various actors of the technology can allow for better communication and collaboration among actors. Through the network, successful rainwater harvesting projects at all levels throughout the country would act to increase awareness of these achievements and drive donor and government support. When individuals and groups at the grassroots level start demanding support for rainwater harvesting structures, there will be increased pressure on governments and organizations to act and invest in the technology. An improved rainwater harvesting network can act as the arena to facilitate this process and to lobby support. Furthermore, enhancing information dissemination to the grassroots level could be a useful improvement to the network.

4.4 Barrier analysis and possible enabling measures for Integrated river basin management

Figure 9. Community engagement in Shire River Basin

4.4.1 General description of the technology

Integrated river basin management is a technology that integrates management of all surface and subsurface water resources, land and other natural resources within hydrologic boundaries of river basins with due attention to water quality, water quantity and environmental integrity. The physical river system is generally complex: there is exchange of groundwater and surface water and vice versa and the continuous interaction between environmental elements, e.g. land and forest/vegetation. To be effective, water resources planning and management should consider all these interactions. A system of integrated planning is therefore needed in which water quality, water quantity and environmental integrity are managed in an integrated way on hydrological boundaries (Jaspers, 2003).

Malawi has some experiences with the integrated river basin management of its major rivers, for example, the Shire River Basin Management Programme and the Songwe River Basin Development Programme. The programmes emphasized cross-disciplinary coordination of major actors in the river basin to balance their expectations from the basin in order to achieve long-term socio-economic and environmental benefits.

4.4.2 Identification of barriers for the technology

Using the methods described in **Chapter Two**, we identified five major barriers that hinder upscaling of the technology in the country. These barriers are presented in **Table 14**. The description of each of the barriers and the measures to overcome them follow.

Table 14: Barriers to upscaling of integrated river basin management.

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Limited access to finances*	*Develop fundable* project proposals
Non-financial	*Inadequate human and institutional capacity*	*Build both human and institutional capacities* in aspects of integrated river basin management
	Inadequate information and awareness	*Enhance awareness raising about the technology*
	Inadequate legislative framework	*Regulatory reform* that will allow the National Environment Policy become an overarching framework instrument for landscape restoration.
	Insecure land tenure	*Clear and secure land tenure*.
	Gender inequality	*Gender awareness raising* to change attitudes, behaviors and beliefs that reinforce inequalities between women and men

4.4.2.1 Economic and financial barriers

4.4.2.1.1 Limited access to finances

Funding for non-marketed technologies, such as the integrated river basin management - is normally accessed from governments and development partners. The Covid-19 pandemic has increased pressure on the already constrained budgets of the government and its allied development partners as the funding priority is on Covid-19 related interventions. Accessing finances to fund the upscaling of the integrated river basin management can therefore be a challenge. Limited access to finances will therefore hinder the transfer and diffusion of the technology in the country.

4.4.2.2 Non-financial barriers

4.4.2.2.1 Limited human and institutional capacity

To start and sustain the process of integrated river basin management, sufficient level of relevant human and institutional capacities at the right time and in the right place has to be available. With regards to human capacity, it is not enough to train experts in the relevant technical disciplines only. There is also a need to train and foster experts in integration, i.e. the production of river basin plans in which the aspects of water quantity, water quality and environmental integrity are maximally integrated. In terms of development of institutional capacity, a sufficient level of relevant technical, organisational, administrative, social and financial capacity has to be available. However, these capacities - human and institutional - are currently not sufficiently available in Malawi to adequately foster the widespread implementation of integrated river basin management in many river basins.

4.4.2.2.2 Inadequate legislative framework

Despite the fact that the integrated river basin management activities involve multiple actors from multiple sectors operating at multiple scales, the regulations guiding the technology in Malawi are contained in a Water Resources Act (2013) – a water sector legal framework. This constrains full engagement and participation of actors from other sectors, e.g. lands, agriculture, forests, etc. who would regard the technology as a water issue – while in actual fact the technology focuses on all aspects of the entire river basin including the inhabitants of the basin. The current legal instruments can therefore hinder the technology to realize its intended outcomes and inspire its scaling up in other river basins of the country.

4.4.2.2.3 Insecure land tenure

As the technology involves land use in the river basin, land tenure has a significant effect on the success of the technology. Unclear and insecure land tenure results in disputes over land ownership and control, and this creates uncertainty and drives away investors. Investors are deterred from funding potential projects and works involving land when risk assessments reveal insecure land titles and unclear land control (Milder, et al., 2011).

4.4.2.2.4 Gender inequality

Gender inequality refers to unequal treatment or perceptions of individuals based on their gender. Despite women being the main actors in household water security and have the knowledge and understanding of the water needs of the household / community, they are not fully engaged in the design and implementation of interventions related to water. Their knowledge and understanding resulting from experiences of their direct contact with water and water related issues remain untapped for successful designs and implementation of water projects on the ground. As a consequence, many water projects have failed to succeed in many instances.

4.4.3 Identified measures

4.4.3.1 Economic and financial measures

4.4.3.1.1 Financing from funded projects

The strategy here is to develop capacity of proponents of the technology to be able to develop strong project proposals that can competitively be funded by funding agencies and foundations. Despite changes in priorities, some development partners and foundations continue to provide competitive grants to support river basin management. A well-articulated project proposal, which is technically feasible, economically viable and socially acceptable, can attract funding from such foundations.

4.4.3.2 Non-financial measures

4.4.3.2.1 Human and institutional capacity development

As a measure, there is need to build and enhance both human and institutional capacities in aspects of integrated river basin management in the country. The focus of the capacity building should be both on human and institutions to allow the aggregated sectors to be able to perform sufficiently in river basin management. It is recognized that the development of capacities is a long-term effort, complex in nature and very resources demanding. The government and the development partners can collaboratively finance the capacity building aspects of the technology. .

4.4.3.2.2 Legislative reforms

In order to create an appropriate environment for full participation of varied stakeholders of the technology from the water, agriculture, and forestry sectors, there is need to reform the regulatory provisions in the National Water Resources Act to allow the Environment Management Act to become a principal legislation guiding integrated river basin management in the country. The legislation is cross-cutting and is well suited to regulate implementation of the technology.

4.4.3.2.3 Land tenure reforms

With land tenure reforms, i.e. converting a more informal tenancy into formal property rights, the land ownership, including access to and use of the land is clear and secured. Clear and secure land tenure is extremely important to implementation of appropriate sustainable management practices. The Malawi government has taken significant steps to reforming customary land tenure system in the country. However, realising that customary land tenure systems are embedded within wider social and cultural settings, further work needs to be undertaken to increase awareness among tribal leaders and reduce potential conflicts as the reforms are implemented.

4.4.3.2.4 Awareness raising on gender issues

Gender awareness raising plays an important role in informing women and men about gender equality, the benefits of a more gender-equal society and the consequences of gender inequality. Gender awareness raising intends to change attitudes, behaviors and beliefs that reinforce inequalities between women and men. This will result in women and men having equal participation in water projects and ensure their success.

4.5 Barrier analysis and possible enabling measures for Integrated flood management

Figure 10. Floods from tropical cyclone Idai in the Lower Shire

4.5.1 General description of the technology

Integrated Flood Management (IFM) is a technology that integrates land and water resources development in a river basin in order to minimize damages and losses associated with floods, and to maximize the net benefits from the use of the floodplains for economic growth and sustainable livelihoods. At a specific river basin, The technology aims to arrive at a well-balanced, optimal combination of measures, providing reduction of flood risk to an acceptable level of economic, societal and environmental costs.

The technology calls for a paradigm shift from the traditional fragmented approach of flood management whose measures largely address negative aspects of flooding. Such measures may include, for example, construction of flood embankments and dikes to reduce physical exposure of human settlement, assets, infrastructure and ecosystems to flood hazards, or flood proofing to reduce asset vulnerability to damage by flooding. It is, however, recognized that flooding is also associated with nutrient and sediment flows from the upper catchments of the river and are deposited in the floodplains. These nutrient and sediment flows are rich alluvial soils, most appropriate for agricultural production and food security. The objective in IFM is therefore not only to reduce flood damages and flood losses, but also to maximize the productivity and efficient use of floodplains for economic growth and sustainable livelihoods of the people living in these floodplains.

4.5.2 Identification of barriers for the technology

Using the methods described in **Chapter Two**, we classified the barriers according to decision to procure or implement the technology. These barriers are presented in **Table 15**. The description of each of the barriers and the measures to overcome them follow.

Table 15: Barriers to upscaling of integrated flood management in Malawi.

Barrier category	**Barriers**	**Measures**
Economic and Financial	*Limited government funding for flood management measures*	*Lobbying* government to prioritize investing in the technology.
Non-financial	*Limited technical capacity to design and implement IFM technology*	*Enhance both human and institutional capacities* in integrated flood management
	Inadequate information and awareness	*Enhance awareness raising about the technology*
	Lack of harmonized legislative framework	*Regulatory reform*

4.5.2.1 Economic and financial barriers

4.5.2.1.1 Limited government funding for flood management

Funding from government is usually allocated firstly to immediate concerns and revenue-generating projects in the country. Limited funding is available to projects whose outcomes or effects are not immediate or are long-term. As a consequence, Malawi has relied on international aid regarding upgrade and acquisition of the necessary technologies related to flood management. This has prevented rapid implementation of IFM measures in the country.

4.5.2.2 Non-financial barriers

4.5.2.2.1 Limited personnel with technical skills

IFM is a new approach to flood management. The technology integrates different elements in one management system in order to maintain or augment the productivity of floodplains, while at the same time providing protective measures against human losses and damage to assets due to flooding. A well-balanced, optimal combination of measures, providing reduction of flood risk to an acceptable level of economic, societal and environmental costs is required in IFM. This calls adequate technical and analytical skills to design and implement IFM, which currently is missing in Malawi. This will hinder the diffusion of the technology to effectively manage the floods in Malawi.

4.5.2.2.2 Lack of harmonized legislative framework

There are numerous sectoral-based legal instruments that have an impact on the IFM in Malawi. For example, the National Physical Planning Act regulates the development of land use plans for disaster risk management, the National Forestry Act limits a 30-metre riparian zone on both sides of the river to offer flood storage within which all structures and cultivation are deemed illegal. In addition the National Housing Act provides building codes. Being sectoral in nature, the effectiveness of these legal instruments in creating a favourable legal environment for transfer and diffusion of IFM is limited.

4.5.3 Identified measures

4.5.3.1 Economic and financial measures

4.5.3.1.1 Fundable proposals for grant acquisition

As limited funding from government is available for technologies whose outcomes or effects are not immediate, the alternative funding for such projects is from grants from development partners and foundations. The Department of Disaster Management Affairs and other related institutions in the country should consider setting up grants offices. The grants office will take overall responsibility to coordinate development of fundable project proposals for IFM interventions in the country. Building capacities in writing fundable project proposals should be one priority area for the grant offices.

4.5.3.2 Non-financial measures

4.5.3.2.1 Technical capacity development for IFM

Human and institutional capacities on technical aspects and analytical skills to design and implement IFM need to be developed if Malawi is to successfully embrace IFM technology. A well-balanced, optimal combination of measures, providing reduction of flood risk to an acceptable level of economic, societal and environmental costs is required in IFM. The capacity of institutions offering training programmes in disaster management in the country (e.g. The Malawi University of Science technology-MUST) must be enhanced so that these institutions are able to provide technical support through teaching, research and outreach services in IFM. The technical training can be both vocational training in terms of short courses and long-term.

4.5.3.2.2 Harmonization of legislative frameworks

As different provisions from different legislative Acts, .e.g. Disaster Preparedness and Relief Act, National Physical Planning Act, National Forestry Act, National housing Act, regulate activities and actions in flood management in the country, there is a need to harmonise these and develop a single Act that can regulate IFM technology in the country. Disaster Preparedness and Relief Act is well suited for the purpose. This is because the Act cuts across sectoral boundaries (e.g. agriculture, water, land, forestry, and housing) and would create a favourable environment to promote the IFM technology.

4.6 Linkages of the barriers identified in the water sector

During the barrier analysis process, we observed that some barriers were common to all the three priority technologies in the water sector, while others were just common to only two technologies. The barriers common to the three technologies in the sector are presented in **Table 16**.

Table 16: Common barriers identified for the priority technologies in water sector

Barrier category	**Barriers**	**Technologies affected**
Economic and Financial	*Limited access to credit and finance*	*i. Rainwater harvesting* *ii. Integrated river basin management, and* *iii. Integrated flood management*
Non-financial	*Limited human and institutional capacity*	*i. Rainwater harvesting* *ii. Integrated river basin management,* *iii. Integrated flood management*
	Inadequate information and awareness	*i. Rainwater harvesting* *ii. Integrated river basin management,* *iii. Integrated flood management*
	Unclear and irregular land tenure rights	*i. Integrated river basin management,* *ii. Integrated flood management*
	Inadequate legislative framework	*i. Integrated river basin management,*
	Gender inequality	*i. Integrated river basin management,*

The fact that these barriers are a common factor in the three priority technologies of the sector, this suggests that overcoming these barriers in our technology will lead in clearing the way for the smooth adoption and diffusion of the other technologies in the sector. For example, gender inequality is a common barrier to all priority technologies in the water sector. By addressing and overcoming gender inequality, women and men and young people will equally participate and contribute to the design and delivery/implementation of the water related technologies, thereby benefiting the knowledge and experiences of women and girls who traditionally walk to the shallow wells and boreholes to collect water for household use, especially in rural areas. This equal participation of all gender groups will enrich project design and implementation, hence the success and sustainability of such water projects will be realized.

Similarly, if the local masses have inadequate information and awareness about any of the priority climate related water technologies with regards to the technologies' benefits such as: adequate supply of water of good quality throughout the year by use of rainwater

harvesting and through integrated river basin management; and protection of life and assets from disastrous flood waters, and the harnessing the opportunities such flood waters bring to floodplains for increased agricultural production, the local masses cannot see the value of engaging in such technologies. This will limit the transfer and diffusion of the technologies. It therefore important to ensure that the local masses have adequate and relevant information and awareness about the water relate climate technologies for widespread adoption and diffusion.

4.7 Enabling framework for overcoming the barriers identified in the sector

In this study, four major elements of enabling framework were identified to be particularly important for promoting and facilitating transfer and diffusion of adaptation technologies in the water sector, i.e. national macroeconomic conditions, human and institutional capacity, public awareness and learning, and gender and other social-cultural issues. These are presented in **Table 17**.

Table 17: Enabling framework for common barriers identified for the priority technologies in the water sector

Broad/common barriers addressed	**Enabling environment**	**Areas of influence to facilitate transfer and diffusion of the water technologies**
1. Limited access to credit and finance	*National macroeconomic conditions*	i. *Regulation of financial sector institutions* – these largely aim to maintain financial stability and consumers' protection. Inclusive financial regulation that allows small farmers access credit from banks are required if we are to enhance transfer and diffusion of the adaptation climate technologies in the water sector, e.g. rainwater harvesting. ii. *Public investment policies* – policies guiding how the government spends money on public services. Funding from government is usually allocated firstly to immediate concerns and revenue-generating projects. Little or no funding is available to projects whose outcomes or effects are not immediate or are long-term, e.g. integrated river basin management. This affects investments in the technology. Reforms in public investment policies are therefore needed. iii. *Adopting a cost-sharing* – Government can establish a cost-sharing mechanism whereby the capital investment of the technology, e.g. rainwater harvesting, are shared with local people interested in investing in the technology. This measure is being piloted under the World Bank funded Agricultural Commercialization Project of the Malawi government. iv. *Capacity to develop fundable project proposals* - The country needs to develop capacity to competitively solicit grants from funding agencies and mechanisms. Some of these agencies and mechanisms include: the adaptation fund, the green climate fund (GCF), or the global environment facility (GEF).

2. *Limited human and institutional capacity*	Human and institutional capacity	i. *Public sector reform programme* – to improve public sector governance, efficiency and effectiveness that are crucial for the delivery of quality services, including climate adaptation related actions. Malawi government is already implementing the programme. *ii.* *Capacity-building programmes of governmental agencies and institutions* – to obtain, strengthen and maintain the capabilities to set and achieve national development objectives of climate adaptation technologies over time. iii. *Enhance publicly funded research and development and training programmes* – to support pilot implementation of a climate technology in the country. Execution of the pilot will allow risks associated with the technology to be identified, documented, authenticated, mitigated, tested, or possibly solved in a less intense environment, thereby lowering risk of failure of the main technology.
3. *Inadequate public awareness and learning*	Public awareness and learning about the technologies	*i.* *Build effective public awareness and learning about climate adaptation technologies* – the much-needed political will for the transfer and diffusion of climate technologies requires informed public support. Information is a valuable resource and lack of it will hinder widespread transfer and diffusion of the technologies.
4. *Gender inequality*	Gender and other socio-cultural issues	i. Gender roles, identities and expectations are socially, culturally and politically constructed. Therefore *gender transformative programming* and *awareness raising* can overcome gender inequality, hence promoting climate technology transfer and diffusion.

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ANNEXES

Annex 1: List of stakeholders and their contacts

Technology Needs Assessment (TNA), Climate Technologies Barrier Analysis and Enabling Framework (BAEF) Meeting
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