



THE KINGDOM OF SWAZILAND

TECHNOLOGY ACTION PLAN FOR ADAPTATION

REPORT III OF TECHNOLOGY NEEDS ASSESSMENT

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Technology Action Plans for Water Sector
Report III of Technology Needs Assessment
The Kingdom of Swaziland

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Acronyms

ACAT	Africa Cooperative Action Trust
AfDB	African Development Bank
BAEF	Barrier Analysis and Enabling Framework
CA	Conservation Agriculture
CAADP	The Comprehensive Africa Agricultural Development Programme
CANGO	Coordinating Assembly of NGOs
CBD	Convention on Biological Diversity
COSPE	Cooperation for the Development of Emerging Countries
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EU	European Union
FANR	Food, Agriculture and Natural Resources
FAO	Food and Agricultural Organization
GCM	Global Climate Change Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
IEC	Information Education and Communication
IK	Indigenous Knowledge
IMF	International Monetary Fund
KOBWA	Komati Basin Water Authority
LUSIP	Lower Usuthu Smallholder Irrigation Project
MNRE	Ministry of Natural Resources and Energy
MOA	Ministry of Agriculture
NBSAP	National Biodiversity Strategy and Action Plan
NDP	National Water Policy
NDS	National Development Strategy
NEP	National Environmental Policy
NGO	Non-Governmental Organization
NLP	National Land Policy
PRSAP	Poverty Reduction Strategy and Action Plan
PVC	Polyvinyl Chloride
RAP	Regional Agriculture Policy
RISDP	Regional Indicative Strategic Development Plan
RWH	Rain Water Harvesting
SADC	Southern African Development Community
SADP	Swaziland Agricultural Development Project
SARUA	Southern African Regional Universities Association
SEA	Swaziland Environment Authority
SEAP	Swaziland Environment Action Plan
SNAS	Swaziland National Agricultural Summit
SNAU	Swaziland National Agricultural Union
SNL	Swazi National Land
SNTC	Swaziland National Trust Commission
SPGRC	Swaziland National Plant Genetic Resource Centre

SWADE	Swaziland Water and Agricultural Development Enterprise
TAP	Technology Action Plan
ToR	Terms of References
UDP	UNEP – DTU Partnership
UNDP	United Nations Development Programme
UNEP-DTU	United Nations Environment Programme- Denmark Technical University
WASH	Water Sanitation and Hygiene
WRP	Wetlands Restoration and Protection

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Report III

Technology Action Plan

Executive Summary

This Technology Action Plan (TAP) report provides a short comprehensive description of the action plan for adaptation technologies in the Water Sector, which can be read and understood as a stand-alone document. It was developed with guidance from the *Technology Needs Assessments: Preparing a Technology Action Plan* document provided by UNEP-DTU (United Nations Environment Programme and Denmark Technical University partnership). The TAP report is partly based on condensed and edited content from report number II, the *Barrier Analysis and Enabling Framework* report and partly based on stakeholder consultations at a TAP workshop and further bilateral meetings held. The audience (target group) for this report is national policy makers, national stakeholders and national and international donor institutions. The TAP report is supplemented by specific project ideas, submitted in separate chapters after each TAP, outlining concrete actions that can contribute to meet the identified ambitions of the TAP (UDP, 2016).

Stakeholders in Swaziland had prioritised the sectors of water, agriculture and forests and biodiversity under adaptation for the Technology Needs Assessment (TNA) project. Under the water sector, technologies Wetlands Restoration and Protection (WRP) as well as Rain Water Harvesting (RWH) were retained for the TAP phase. The ambition WRP technology deployment and diffusion is to restore and protect five medium sized wetlands and total budget for this is \$344,700. The rationale for choosing the five medium sized wetlands was due to availability of data for estimating costs for technology use as well as their socio-economic and environmental benefits. Many people living around the wetlands use them for collecting natural products such as medicinal plants, wild animals, fungi, reeds and birds.

The ambition for up-scaling RWH technology is subsidizing 5000litre tank and some supporting implements such as gutters, filters and pipes (costing E10,000) by 50% of its cost for 20,000 households, building of RWH systems for 100 institutions and improving awareness of the technology amongst the public. The total budget expected is \$6,782,334. This will address the barriers of lack of finance for building RWH structures as well as poor awareness as a barrier, as the RWH structures built in 100 institutions will act as demonstration sites. Furthermore, RWH will be included into an existing WASH forum, thereby creating greater dialogue and awareness.

Under the agriculture sector, conservation agriculture and drip and micro irrigation were technologies retained for the TAP phase. Both these technologies have a myriad of benefits. Conservation agriculture principles can be applied to all agricultural landscapes and land uses with locally adapted practices. Agriculture is the mainstay of the Swaziland economy and is critical for the achievement of the overall development objectives of the country. Climate change induced dry spells and erratic rainfall patterns are affecting crop production in Swaziland. The cost of mechanized planters was too high according to stakeholders and it posed a barrier to adoption of conservation agriculture technology, as farmers want to move away from manual to mechanized methods. The ambition of the TAP is for scaling-up conservation agriculture through setting up demonstration sites to be used for training farmers and

providing 200 mechanised planters to farmers through the Government tractors hire system and create awareness of this technology through site visits and IEC materials. The total budget is \$814,400.

Drip and micro irrigation are water saving and efficient methods that can help farmers in Swaziland to adapt to changing climate and substantially improve food production. The major barrier for micro and drip irrigation technology use was financial, as the equipment are considered expensive by farmers. The ambition is promotion of micro and drip irrigation through subsidy of the kits for 1,000 vegetable farmers at 50% of its cost and creating awareness of the technologies. The total cost calculated to be \$751,349. The Government of Swaziland has identified the development of smallholder agriculture from subsistence farming to commercialization and intensification farming as the main element in its aims to alleviate poverty. Irrigation plays an important role in achieving this and is a priority for the Government of Swaziland.

For the forestry and biodiversity sector, stakeholders prioritised agroforestry and conservation of genetic resources as technologies for the TAP phase. Agroforestry can improve the resilience of agricultural production to current climate variability as well as long-term climate change through the use of trees for intensification, diversification and buffering of farming systems. Conservation of genetic resources is important as even maintaining productivity requires constant input of new genetic material to over-come crop losses due to pests that become pesticide resistant. This also helps with climate change as higher diversity in crops will make the farmer more resilient to changing weather and climate patterns. This also helps improve yields and withstand shocks of climate change.

The ambition for agroforestry technology deployment and diffusion is to scale up through a training programme for 2,000 farmers and providing them free seedlings by 2020. The total budget for this is only \$154,000. The training should be conducted by Department of Forestry and Ministry of Agriculture's Extension Officers. The ambition for conservation of genetic resources technology use is to set up a National Botanical Garden and Field Gene Bank which will act as a training center for farmers and help in conserving Swaziland's genetic diversity in-situ. The cost for this is estimated to be \$6,146,000. Furthermore, capacity building of relevant Government officials from SPGRC, SNTC, SEA, National Tree Seed Center and National Gene Bank will done in Plant Genetic Resources Management, Plant Ecology, and Plant Taxonomy and Ethno botany.

The TAP includes detailed sequencing, costing and timing of the actions and activities for deployment and diffusion of the six technologies in the water, agriculture and, forests and biodiversity sectors. The responsible organizations and rationale behind choosing them is also provided. Risks and contingency planning is also incorporated and immediate next steps identified. Project ideas are presented in brief, which can be developed further when applying for specific funds and calls for proposals. For further details on economic analysis or information on the technologies, please refer to BAEF report and factsheets. Some cross cutting issues across all six technologies have also been identified in the TAP. The technologies and action plans in this TAP is expected to help Swaziland reach an enhanced adaptive capacity to climate change impacts for the sectors water, agriculture and forests and biodiversity.

Chapter 1 Technology Action Plan and Project Ideas for Water Sector

1.1 TAP for Water Sector

1.1.1 Water Sector Overview

Swaziland is blessed with water resources, with surface water resources estimated at 4.5 km³/year (Manyatsi and Brown, 2009). There are eleven dams which are important for water supply and irrigation and agriculture and tourism sector depends highly on this resource. Water resources in Swaziland are vulnerable to climate variability such as changing rainfall patterns (SARUA, 2014). The average rainfall in Swaziland is about 788 mm per annum ranging from as low as 500 mm in the dry Lowveld region to 1,500 mm in the wet and cooler Highveld region. Swaziland has experienced droughts in the recent past (2016 El-Nino effect) and due to Swaziland's river basins not being developed to full potential, during dry periods water rationing was imposed and water scarcity was often experienced. This has had widespread impacts on food production and caused deaths of thousands of cattle. According to Swaziland Environment Authority (SEA, 2014), over the years, the country has been able to store 765,000m³ per annum in major dams and reservoirs, which represents 17 per cent of the available renewable water resources. Presently, consumption of water is 1.5 million m³ per annum dominated by irrigation, which takes about 96 per cent of the surface water resources mostly for growing sugarcane. Domestic and industrial uses only take about 2 per cent, respectively each (Ibid). With climate change, managing Swaziland's water resources and usage of water becomes imperative as growing population and increased economic development has led to higher water utilization and increased competition amongst water users for the scarce water resources.

The largest user of water remains agriculture sector in Swaziland, largely through irrigated plantations. Irrigation utilises about 96% of the surface water resources for growing mostly sugarcane. Therefore, water efficient irrigation technologies such as drip and micro irrigation is needs to be promoted. Water for domestic use is prioritised by Government and according to the Poverty Reduction Strategy and Action Plan (Government of Swaziland, 2006) only 45% in of rural areas population has proper sanitation facilities, while 63% of households in urban areas use flush-toilets. The Department of Water Affairs (DWA) aims to ensure a minimum of 30 litres of safe and clean water per capita per day for every person in Swaziland at a distance of no more than 200 metres. However, challenges remain in a number of water supply systems which are not serviced due to problems of management, maintenance, affordability and water quality. Inadequate access to water can cause conflict amongst communities. Furthermore, without access to water Swaziland will not be able to meet the Sustainable Development Goals, as water is necessary for many sectors. Hence, using technologies that aid the water sector in adapting to climate change and variability are essential and this Technology Action Plan (TAP) provides information in the form of a concept note for selected technologies under the Technology Needs Assessment project.

Swaziland's water systems face a number of challenges and threats. According to Swaziland's Fifth National Report to Convention on Biological Diversity (CBD), aquatic water systems in Swaziland are under threat from agricultural development. Wetlands are being drained for development including for farms, roads and settlements (SEA, 2014). Swaziland has a water dependency ratio of over 50 percent, which implies that the country relies on water generated outside their borders to supply more than half of their total water resource stock. Challenges in water resources management include water quality

problems, priority in water allocation, trans-boundary obligations, development of infrastructure, stakeholder participation as well as the introduction of the environment as a water user. Water quality issues have been alluded to by Swaziland's State of Environment Report (2012) where it was stated that intensive agricultural activities due to the application of agro-chemicals and poor land use practices contributed to pollution and sediment yield. Industrialisation has caused waste water discharges from industries and commercial farming has contributed to pollution of waterways (Government of Swaziland, 2015). Furthermore, there is ever increasing demand for water in Swaziland due to population growth and economic development (SEA, 2012).

Climate change will affect Swaziland's water sector. Projections of annual rainfall variations for 2020, 2050 and 2080 respectively indicate steady decreases in the mean annual rainfall, particularly in lowveld and Lubombo areas (Government of Swaziland, 2015). An overall average reduction in runoff is expected ranging from 2-6% in a normal year and higher for dry years. There is need for promotion of efficient water use, and promotion of water harvesting technologies and negotiating for greater shares from the trans-boundary rivers (SEA, 2014). Furthermore, there is need to address water scarcity and related issues at ecosystem level to make lasting impact and in this regard, managing wetlands and river basins becomes important at the ecosystem level. However, small actions which conserve water at local level and can be easily up-scaled to cover many households (such as rooftop rainwater harvesting) must also be undertaken to contribute to a suite of solutions for water sector in Swaziland. In the BAEF phase three technologies were analysed and they were Integrated River Basin Management, Wetlands Restoration and Protection and Rooftop Rainwater Harvesting. For this TAP report, two technologies of Wetlands Restoration and Protection and Rooftop Rainwater Harvesting were analysed in further detail and action plans created.

Policies, strategies and legislative instruments help guide the management of water resources in this sector. Existing policies and measures related to Water Sector development and technology deployment is given in table below.

Table 1 Policies and Measures Related to Water Sector for Swaziland

Name of policy/measure	Year enacted	Main contents
Southern African Development Community (SADC) Regional Water Policy	2005	Providing a framework for sustainable, integrated and coordinated development, utilization, protection and control of national and transboundary water resources in the SADC region, for the promotion of socio-economic development and regional integration and improvement of the quality of life of all people in the region.
SADC Regional Water Strategy	2006	The SADC Regional Water Strategy (2006) covers a wide range of topics from infrastructure development, information exchange, capacity building to gender aspects and stakeholder involvement. It is an important guide for the ongoing harmonisation of national water policies of the SADC member states, many of which are still based on the water policies and laws developed under colonial rule (SADC, 2006).

SADC Revised Protocol on Shared Watercourses	2003	The main objective of this protocol is to foster closer cooperation for judicious, sustainable and co-ordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation. Mainly, it seeks to promote and facilitate the establishment of shared watercourse agreements and Shared Watercourse Institutions for the management of shared watercourses; advance the sustainable, equitable and reasonable utilisation of the shared watercourses; promote a co-ordinated and integrated environmentally sound development and management of shared watercourses (SADC, 2003).
Joint Water Commission Treaty	1992	The Government of the Kingdom of Swaziland and the Government of the Republic of South Africa established a Joint Water Commission to act as technical adviser to the Parties on all matters relating to the development and utilisation of water resources of common interest to the Parties (FAO, 1997).
Komati Treaty	1992	The treaty on the development and utilisation of the water resources of the Komati River Basin between the government of the Kingdom of Swaziland and the Government of the Republic of South Africa was signed on 13 March 1992. The purpose of Komati Basin Water Authority (KOBWA) was to oversee design, construction, operation and maintenance of the Driekoppies Dam in South Africa and the Maguga Dam in Swaziland (KOBWA, 2017).
Pigg's Peak Agreement	1991	This Agreement aims to promote co-operation among the Parties to ensure the protection and sustainable utilisation of the water resources of the Incomati and Maputo watercourses (DWAF, undated).
Inco-Maputo Interim Agreement	2002	This Agreement aims to promote co-operation among the Parties to ensure the protection and sustainable utilisation of the water resources of the Incomati and Maputo watercourses (DWAF, 2002). The agreement gives guidelines to prevent, reduce and control pollution of surface and ground waters, and protect and enhance the quality status of the waters and associated ecosystems for the benefit of present and future generations.
The Water Act	2003	This act is intended to harmonize the management of water resources in Swaziland. Its provisions include the establishment of a National Water Authority and a Water Resources Master Plan. The Water Act established the Department of Water Affairs, the National Water Authority and five River Basin Authorities (Government of Swaziland, 2003).
The National Development Strategy (NDS) 1999 and Vision 2022	1999	They are the Government's official long-term strategy and overall planning framework for Swaziland. The NDS gives broad objective of promoting conservation and management of water resources (Manyatsi and Brown, 2009). The NDS and Vision 2022 calls for efficient use of water resources, review regulations, institutional

		strengthening, promoting water harvesting, improving delivery and improve participation in water resources management.
Swaziland National Water Policy	2009	The water policy has produced a number of policy statements and strategies that related to water usage permits. The Swaziland National Water Policy (NWP) sets out the vision, intention and strategy of the Kingdom of Swaziland on the development and management of water resources. The NWP is based on the concept enshrined in the National Development Strategy (NDS), whereby the goal is poverty eradication and economic prosperity. The water sector as expressed in the NDS is about the development and implementation of strategies for poverty alleviation and drought mitigation, with the main objective of improving water availability for both socio-economic and economic productivity (Government of Swaziland, 2009).
The Integrated Water Resources Master Plan	2009	The primary objective of the Integrated Water Resources Master Plan is to provide strategic guidance to decision makers and water users on how best to develop and manage the country's water resource within the framework for the implementation of existing policies and legislation (Manyatsi and Brown, 2009).

Majority of the policies and measures call for efficient use of water alluding to use of water saving/efficient technologies. The National Biodiversity Strategy and Action Plan (NBSAP) 2016 includes strategies on sustainable utilization and conservation of aquatic resources including wetlands and river basins. The Third National Communication to UNFCCC (2016) also talks about the need for water saving technologies and improving adaptation in the sector. Swaziland submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC, which is now in force as the Nationally Determined Contribution. It prioritized adaptation technologies including rainwater harvesting and wetland restoration and called for integration of water resource management across all sectors. The two technologies discussed in detail in this TAP are wetlands restoration and rehabilitation and rain water harvesting and they are elaborated next.

1.1.1.1 Wetlands Restoration and Protection

Wetlands have important ecological functions of maintaining biodiversity and act as a sponge in regulating water flow thereby controlling floods. The dense root mats of wetland plants also help to stabilize shore sediments, thus reducing erosion. Wetlands can be of many types and sizes. Wetland restoration relates to the rehabilitation of previously existing wetland functions from a more damaged to a less damaged or operational state of overall function. Human activities of farming on wetlands, filling wetlands for using the land for settlements and allowing livestock to drink water in wetlands, all upset the soil conditions and damage its ecological functions.

Wetland rehabilitation and restoration helps maintain its ecological functions of flood control and biodiversity maintenance. It also helps maintain the micro climate and allow vegetation to thrive. Some special vegetation such as reeds and medicinal plants grow on wetlands which have human well-being benefits. Wetlands are aesthetically pleasing. Wetland restoration needs expertise especially if transplantation of wetland plants is needed. Activities include planting wetland plants and providing

fencing around wetlands to prevent livestock from entering. The advantages of wetland restoration and protection far outweigh the disadvantages.

Communities tend to allow their livestock to graze on wetlands during dry spells which causes negative impacts as the soil in wetlands is compacted by livestock. The importance of wetland restoration needs to be elevated and awareness raised in Swaziland in this regard. If communities are made aware of the economic benefits of restoring wetlands, then there is potential for self-help groups undertaking this at their own expense. Furthermore, through eco-tourism and sustainable harvesting of products, communities will be able to offset the cost of restoration. With climate change, it is expected that wetlands will face drying up, but this will accelerate if human activities are degrading wetlands. Conservation of wetlands helps build ecosystem resilience as well as resilience of humans through hazard mitigation and biodiversity and micro climate maintenance.

Awareness raising on wetlands have been done to some extent in Swaziland through the commemoration of World Wetlands Day. The Water Act of Swaziland promotes the need for protecting water resources including wetlands. In many of Swaziland's regulations (e.g. National Climate Change Strategy and Action Plan), ecosystem approach is recommended and in this approach, maintaining ecological functions of important natural areas such as wetlands comes in. But, more needs to be done to ensure wetland's ecosystem functions remains protected in Swaziland.

1.1.1.2 Rain Water Harvesting

Due to climate change, rainfall patterns are expected to change and water stress may be experienced in Swaziland (Government of Swaziland, 2016). Hence it is vital that rain-water be stored, conserved and reused. Collecting rainwater from rooftops is an easy and fairly inexpensive way to increase amount of water availability in a household. Furthermore, harvesting rainwater has been listed as a method of helping communities adapt to water scarcities in several Government documents. The harvested water can be used for a myriad of uses from domestic to irrigation uses, depending on how it is filtered and treated.

Rain water harvesting (RWH) helps households adapt to climate change primarily through two mechanisms: (1) diversification of household water supply; and (2) increased resilience to water quality degradation. Harvesting rainwater helps reduce the pressure on surface and groundwater resources by decreasing household demand. With climate change affecting rainfall patterns, storage of rainwater can provide short-term security against periods of low rainfall and the failure or degradation of other water supplies. Water scarcity impacts of hindering economic development and affecting human health and well-being can be reduced using RWH.

A rooftop RWH system includes: (1) a catchment surface such as the roof of a house where precipitation lands; (2) a conveyance system of gutters and pipes to move and direct the water; and (3) containers such as tanks to store the water for later use. It is important to protect and maintain water quality in RWH systems and it can be done through filtration/screening, chemical disinfection, or a "first flush" system. First flush systems rejects the first rainwater volume which may contain impurities. Harvested rainwater can be used with proper filtration for potable use, or with no treatment for watering gardens and flushing toilets. Construction and repairs should be done/managed by households and there must

be some training provided in this regard. It is suggested that households must install the RWH tanks as far as possible without external “experts” as it is a simple technology and this will help up-scale the technology. A simple plastic tank RWH system is fairly easy to install with minimal training. The Department of Water Affairs can provide technical advice whenever necessary by their skilled personnel. Arrangements should be provided by the Department of Water Affairs to test quality of stored water on a regular basis.

The hard roof of a house or building is the catchment area should not have paint on roofs which is toxic. Roofs made out of organic materials such as a thatched roof are also suitable for RWH provided they have guttering and in some instances one may use polythene coverings or other materials to reduce the permeability of thatched structures. Capture of the runoff via gutters or tanks is done and gutters and pipes can be of aluminium or PVC. Maintenance is required especially to ensure that contaminants present on the roof do not fall into the storage tank. This can be done by closing the downpipe with an end cap or valve and discarding the first flush of rainwater. Chemical disinfectants may be used to maintain water quality. Cleaning of screens and filters is essential. Storage tank should be closed using a lid and should not allow sunlight to enter to prevent algal growth. The whole rainwater collecting system should be cleaned at least 2-3 times per year, especially prior to the rainy season and after a long period of dry weather or after strong winds. Catchment surface and gutters have to be kept free of bird droppings, leaves and rubbish. The filter should be changed once in every three months. Mosquitoes can also breed in tanks if lids are not provided. Rooftop harvesting of rain water can be done at scale of households. A typical operating lifetime of a rooftop RWH system is about 15 years and can be more, if maintained well. Operational costs are minimum aside from regularly changing the filter, cleaning for debris and sediments, and repairs of potential leaks.

Singwane, and Kunene (2010) argue that rainwater harvesting is a viable technology for Swaziland. It is being used in a number of households, but only a few households who have tanks large enough to store water for the whole year. The authors argue that “if households could afford big storage facilities the acute water shortage problem could be averted especially when there is adequate rainfall during the wet season” (Ibid, 2010). Furthermore, this technology can provide water for household gardens where vegetables can be grown, which have positive impacts on nutrition (Ibid, 2010). The technology is viable because of Swaziland’s subtropical climate with summer rains (75% in period of October till March). “The long-term average rainfall figure for the Highveld, the Middleveld, the Lowveld, and the Lubombo Plateau are 950 mm, 700 mm, 475 mm, and 700 mm respectively” (Manyatsi and Brown, 2009). RWH systems if large enough can store enough water for a household to supplement piped systems and for extra water use such as for household vegetable gardens and for sanitation during dry periods. During dry periods water may also be used for domestic purposes.

1.1.2 Current Level of Uptake of Technologies

In order to make targets for technology diffusion which will help with adaptation, it is important to understand the current level of uptake of technologies. For this TAP, the two technologies prioritised, their current level of uptake and future targets are provided in table below.

Table 2 Current Level of Uptake for Technologies Prioritized

Technology	Current level of uptake	Future targets
Wetlands Restoration and Protection (WRP)	Currently, the large wetlands Milwane, Hlane and Malolotja are protected, while others are proposed for protection. A large wetland of 2000 hectares called Sukasihambe is being used as a sugar plantation, while the Nyetane wetland is “unlikely to be protected” (Masarirambi et al. , 2010)	According to Masarirambi et al. (2010), eight wetlands need protection in Swaziland (four are already being protected). Support for WRP is found in Swaziland’s Vision 2022 and National Development Strategy (NDS) which calls for wetland restoration and protection through its overall vision of conservation and management of water and land resources. Wetland restoration is targeted through this vision as it contributes to managing, coordinating and monitoring water resources in a systematic and equitable basis. This is synchronous with Swaziland’s Climate Change Strategy and Action Plan and with Swaziland’s Nationally Determined Contributions, where WRP has been mentioned as a technology helping Swaziland to effectively adapt to climate change.
Rain Water Harvesting (RWH)	In the lowveld 31.1% use rooftop RWH systems while in households using the highveld and middleveld it is 26.6 and 21.6%. In the Lubombo Plateau 20.7% use rooftop RWH using corrugated sheets, while 0.1% harvest on grass roofs (bamboo) and 0.3% on vegetated ground catchments. The water stored per household ranged from < 100 L, to > 1,000 L (Vilane and Mwendera, 2011). They use plastic drums, metal drums of about 210 L, buckets of about 25 L, mortar and concrete tanks, plastic (PVC) tanks, metal tanks, and bins (Ibid).	The target is for increasing use of RWH systems in Swaziland. The RWH technology meets the targets set by Swaziland’s National Climate Change policy which includes “Enhance the adoption of rain harvesting technologies” as a policy statement. Furthermore, the Swaziland Vision 2022 and National Development Strategy (NDS) promotes efficient use and conservation of water including emphasising on water harvesting. The Water Act 2003 promotes increasing access to water. The need for ongoing capacity building, training and creating awareness in this sector has been emphasised. Additionally, Swaziland’s Constitution (Section 210) promotes rational use of its water resources. The diffusion of RWH technology achieves these targets laid out in the country’s vision. Access to water is improved in communities through water harvesting and this is also in synchronicity with Swaziland’s Nationally Determined Contributions, where RWH have been mentioned as helping the country adapt better for the water sector.

1.1.3 Action Plan for Wetlands Protection and Restoration

1.1.3.1 *Introduction*

Wetlands are natural flood control mechanisms and provide important ecosystem functions such as maintaining micro climate, and being habitats for animals, birds and microbes. Wetlands can be used as public spaces for recreation and eco-tourism. Restoration provides indirect benefits such as hazard mitigation, biodiversity enhancement and improving aesthetics. Restoration provides a small number of jobs. Other goods and services provided by wetlands, such as the provision of wood, medicinal plants and fibers help in income generation for local communities, thereby aiding in adaptation.

Once restored, long term costs are minimal if wetlands are used properly. Sustainable use of wetlands can be ensured if environmental education and awareness raising can be done in a regular fashion. Thus, costs for environmental education and awareness raising exists for long term. Cost of monitoring wetlands will depend on its location and accessibility. Wetland restoration helps create awareness of environmental issues for people in the area. The case for protecting wetlands is also a biodiversity conservation one. Swaziland has 2,600 species of flowering plants, approximately 121 species of mammals, 153 amphibians and reptiles, and 350 species of birds; making it unique in floral and faunal species richness (UNDP, 2011). Many species need wetlands as habitats for survival and/or breeding.

There are two major sources of funding for the restoration and protection of wetlands, internal/governmental budgets and development partners funds. It is difficult to estimate the cost of a wetland restoration and rehabilitation programme unless the area to be restored is known. For the purposes of economic analysis, two projects were examined, one is a large UNDP implemented project and the other, a smaller National Environment Fund project. Details of economic analysis is given in the BAEF report. The model of Lawuba wetlands protection project implemented by the Environment Fund, Swaziland Environment Authority (SEA) and World Vision was used for budgeting. The total budget for the Lawuba wetland protection (covering 20 hectares) was E278, 000. The project entailed holding awareness raising sessions, fencing the wetland and sustainable harvesting of grasses and reeds for basketry by women in the area.

1.1.3.2 *Ambition for the TAP*

The ambition for this technology deployment and diffusion is to restore and protect five medium sized wetlands. Wetlands were shortlisted based on their size according to Masarirambi et al. (2010) and five wetlands were chosen for protection which range from size of 4 to 22 hectares. The rationale for choosing the five medium sized wetlands was due to availability of data for estimating costs for technology use as well as their socio-economic and environmental benefits. Many people living around the wetlands use them for collecting natural products such as medicinal plants, wild animals, fungi, reeds and birds.

According to Masarirambi et al. (2010), there are 15 wetlands of importance in Swaziland and four of them are protected while eight are recommended for protection, one is unlikely to be protected and one is used as sugar plantation. Out of the eight recommended for protection, five are chosen based on their size being within 22 hectares. Mnjoli wetland has a size of 2,565 hectares, Nyetane is 260 hectares and Pangolo is 492 hectares and they were excluded as their size is large and they need detailed feasibility

studies to know methods and scale of restoration and protection needed. Costs of WRP are calculated approximately using Lawuba wetland protection costs as datum (details in BAEF report). The wetlands chosen are the ones proposed for protection, namely; Mlawula, Ubombo, Ndlotane, Mangwenya and Shovella. Larger wetlands of over 22 hectares have been left out as cost estimation would be difficult. The costs for fencing may reduce in some wetlands if hectarage is low, but community awareness sessions and other expenses remain similar, hence total cost comes to E278,000 x 5 = E1.39million. At the Lawuba wetland in a single year, women weavers reported earnings of E1.2million from selling crafts made from fibres harvested from the wetland.

1.1.3.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

1. Financial barrier identified was inadequate funds for wetland rehabilitation and protection. The measure proposed is to develop proposals and raise funds for WRP.
2. Another barrier, also related to inadequate funds is poor coordination of funds and unclear responsibilities for environmental projects which may entail wetlands protection. Measure recommended is setting up a funds coordination mechanism.
3. Weak awareness of importance of wetlands and tendency to look at short term gains from wetlands (exploitative) as against long term benefits that wetlands provide is another barrier. Measure would be to create awareness of importance of wetlands amongst communities.
4. Poor or inadequate monitoring of health of wetlands was another barrier. Measure is to create a wetlands monitoring system.

Actions selected for inclusion in the TAP

1. Action is to develop proposals for raising funds for shortlisted wetlands Mlawula, Ubombo, Ndlotane, Mangwenya and Shovella by 2022. The rationale for choosing the five wetlands is given in preceding section.
2. Action is setting up a funds coordination mechanism (by 2019) involving stakeholders where meetings are held regularly and synergies in usage of funds for wetlands restoration and protection by agencies working in same areas are realised. This will help attain greater synergies in funds usage and thereby able to stretch the funds for more actions. Activities include holding meetings for this coordination team.
3. Action is to create awareness of importance of wetlands through community level meetings and site visits for communities living near wetlands by 2022. The reason communities are chosen to benefit from awareness raising is because they are the ones utilising the wetlands.
4. Action is to implement WRP activities in the five wetlands by 2022.
5. Action is to create a wetlands monitoring system using remote sensing by 2019. Using remote sensing would be a cost effective way of continuous monitoring as it does not entail costly site visits. Activities include recruitment of a consultant to set up the monitoring system.

Actions were selected based on measures for overcoming the barriers. Stakeholders who were knowledgeable in WRP were present at the workshops, for example the officer responsible for Lawuba wetland project had a chance to present to stakeholders about the successes derived from the project. This influenced the choice of WRP actions.

Activities identified for implementation of selected actions

1. Proposal writing workshops and follow up meetings are to be done to generate funds for WRP.

2. Meetings are to be held for setting up funds coordination mechanism involving stakeholders and a voluntary committee is to be set up who will regularly meet.
3. Meetings with communities living around the chosen five wetlands to be held for raising awareness. In these sessions, long term benefits of wetlands need to be emphasised.
4. Implementing WRP activities for the five wetlands.
5. Recruitment of a consultant to set up the monitoring system using remote sensing to monitor wetlands in Swaziland. Additional activity would be to purchase software and hardware needed for the system and for the consultant to train Government officials to use the system.

Actions to be implemented as Project Ideas

Actions 1 and 4 will be carried forward as project ideas. The rationale for this is that action 1 involved proposal writing to raise funds for WRP. The proposals are expected to include elements of physical work for restoration and protection of wetlands and also activities such as raising awareness (action 3). Secondly, setting up a funds coordination mechanism can be done internally by Government without external assistance as it involved setting up a voluntary committee that will meet regularly to coordinate funds usage for wetlands related actions. This needs to be done in collaboration with the “Wetlands Working Group”. Activities necessary for WRP for shortlisted five wetlands to be implemented. For project idea the next action shortlisted is that of setting up a wetlands monitoring system, which will involve recruitment of a consultant and purchase of hardware and software. This will need external funding and hence necessary to be included as project idea.

1.1.3.4 Stakeholders and Timeline for Implementation of TAP

Overview of Stakeholders for the implementation of the TAP

The table below gives the actions proposed and stakeholders responsible for implementing the actions. The rationale for choosing the stakeholders is also included.

Table 3 List of Actions and Stakeholders Responsible for Implementing

Action	Stakeholders responsible	Rationale for choosing stakeholders
Develop proposals for shortlisted wetlands	Swaziland Environment Authority (SEA) with a consultant who will aid in proposal development	The Lawuba wetland which is used as a model for restoring and protecting five wetlands suggested under this TAP was restored and protected by SEA along with a development partner World Vision.
Setting up a funds coordination mechanism	Ministry of Natural Resources and Energy (MNRE), Department of Meteorology, Department of Water Affairs, SEA and members of “Wetlands Working Group”	These stakeholders work on natural resources management which include wetlands. The Wetlands Working Group is key to helping set up the funds coordination mechanism, as they have institutional memory and knowledge on wetlands management programmes in Swaziland.

Create awareness through community level meetings and site visits	MNRE, Ministry of Tinkhundla, SEA, CANGO and community based organizations	The stakeholders providing policy level guidance on wetlands and water resources are MNRE, Ministry of Tinkhundla and SEA. While CANGO and community based organizations can be working in the site coordinating and providing awareness raising sessions. Ministry of Tinkhundla a key stakeholder who works at community and local level is included.
Implement WRP activities in five chosen wetlands	SEA	SEA using the Environment Fund mechanism have successfully implemented the Lawuba wetlands rehabilitation, which is the model we are following in this project.
Create a wetlands monitoring system using remote sensing	SEA and consultant	Monitoring of wetlands is the responsibility of SEA as the organization that is mandated for this and through the consultant their staff's capacity will be developed for wetlands monitoring systems.

The main institution responsible for this project would be MNRE and others who will play a part in implementation are given in table below.

Table 4 Institutions Responsible and Contact Person for Implementation of Actions

<i>Institutions</i>	<i>Contact</i>
DWA	Edward Mswane - edwardmswane@yahoo.com
Department of Meteorology	Duduzile Nhlengethwa-Masina (Director) dudu@swazimet.gov.sz
SEA	Isaac Gcina Dladla (Director Policy, Research and Information) gdladla@sea.org.sz Clasile Mhlanga (Biodiversity) - cfmhlanga@sea.org.sz Sipho Matsebula (ecologist) - smatsebula@sea.org.sz Mbongeni Hlophe (Environment Fund Officer) - mhlophe@sea.org.sz
SNTC	Sandile Gumedze, gumedzesan@gmail.com
CANGO	Emmanuel Ndlangamandla director@cango.org.sz
	Mphile Sihlongonyane cango@cango.org.sz
Ministry of Tinkhundla	Tami Nkambule nkambuletami@gmail.com

In addition to the above, Traditional Authorities, Community Based Organizations, NGOs who may be relevant, Financial Institutions, private sector partners and Development Partners will be involved. Some may be identified per region, once activities on the ground are planned.

Scheduling and sequencing of specific activities

The sequence and timing of specific activities, as well as the nature and scale of the activity is described in table below.

Table 5 Scheduling and Sequencing of Activities for Implementation of WRP

Activity	Nature of activity	Scale of activity	Start	End
1. Project planning meetings with MNRE, SEA, SNTC, DWA, Department of Meteorology (including Climate Change Unit), CANGO, ministry of Tinkhundla	MNRE as the lead institution will spearhead the project and hold a planning meeting with relevant stakeholders to plan for WRP project. Specific tasks: <ul style="list-style-type: none"> • Project design and scope, • terms of references for consultant for proposal development and • consultant for developing wetlands monitoring systems. 	Meetings (at least 3) with around 12 persons from relevant bodies will be held at Government offices using existing facilities.	Month 1	Month 2
2. Develop Terms Of References (ToR) for consultant who will develop proposals for WRP funds and consultant who will develop wetlands monitoring system	a meeting will be held with relevant stakeholders to develop ToRs for consultant	Meeting will be held at Government offices using existing facilities.	Month 3	Month 6
3. Recruit a consultant to develop proposals for WRP for the five shortlisted wetlands	Advertisement and recruitment of a consultant to prepare proposals	National scale. The advertisement can be put in national newspapers.	Month 7	Month 12
4. Recruit a consultant to set up wetlands monitoring system	Advertisement and recruitment of a consultant to prepare proposals	National scale. The advertisement can be put in national newspapers.	Month 7	Month 12
5. Meetings (at least two) of stakeholders for Funds Coordination Mechanism	MNRE and “Wetlands Working Group” will call all stakeholders working in natural resources management whose work	National level. All stakeholders including development partners working on	Month 7	Month 10

	may overlap with wetlands to set up a Funds Coordination Mechanism. A Coordinator will be nominated and dates of meetings (quarterly basis) will be set up. ToRs for this mechanism will be developed.	areas which overlap on wetlands are included in this.		
6. Hold Funds Coordination Mechanism meetings every quarter and distribute minutes	All stakeholders meet every quarter and report on usage of funds which are pertaining to activities that overlap on wetlands. With discussions, greater synergy of usage of funds is reached.	National scale involving all relevant stakeholders. Discussions of how resources can be shared/pooled continue on ongoing basis.	Month 12	Ongoing
7. Proposal development workshops held	Proposal Development Consultant will hold participatory sessions with relevant stakeholders including Communities, Ministry of Tinkhundla and NGOs to develop proposals for the chosen five wetlands.	Participatory sessions to be held at community level at the five wetlands and a national workshop to be held with stakeholders.	Month 13	Month 19
8. Community level meetings held at all five wetlands to create awareness of wetlands importance	Meetings with community members, community based organizations and NGOs working in the areas around the five wetlands will be held to create awareness of the importance of wetlands. Site visits in the form of walking to the wetlands from the meeting venues to appreciate the benefits provided by wetlands will be held.	Scale is restricted to communities around the five chosen wetlands. Participatory approach where community members, community based organizations and NGOs will be involved is preferred.	Month 13	Month 24
9. Implement WRP activities in all five wetlands	This involved fencing of wetlands, planting wetland plants where necessary, creating	Scale is comprising of areas of all five wetlands	Month 24	Month 60

	management plans with community members etc.			
10. Setting up of wetlands monitoring system.	Purchase of hardware and software for system to undertake monitoring of wetlands using remote sensing.	The scale of setting up the system will be at insitutional level. SEA will be beneficiary of the wetlands monitoring system.	Month 13	Month 20
11. Training of SEA staff on wetlands monitoring system	Consultant will train SEA staff on using and maintaining the system.	The scale will be at institutional level. SEA staff will be beneficiaries, and they will monitor the wetlands at anational level.	Month 20	Month 24
12. Monitoring and Evaluation	MNRE will undertake monitoring and evaluation of the project on an annual basis.	The scale will be national as it pertains to the five wetlands under restoration as well as staff training monitoring.	Month 24	Month 60

The supposition is that once funds are raised for WRP activities, the relevant bodies will be able to carry out restoration and protection using those funds. The main barriers addressed was that of lack of funds for WRP, lack of awareness of importance of wetlands and lack of capacity for wetlands monitoring.

1.1.3.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Capacity needs include consultants for development of proposal for WRP and this involves the consultant undertaking participatory sessions at community level and with national stakeholders to develop the proposals for fundraising. Capacity will be needed to undertake WRP efforts in the five wetlands. This capacity is assumed to be available as evidenced from Lawuba project.

Stakeholders at TAP workshop estimated that capacity of SEA needs to be built in setting up a wetlands monitoring system. Their capacity will be build through purchase of software and hardware of remotse sensing equipment to monitor wetlands. Further, capacity building through training of SEA staff will be needed for them to use the monitoring equipments.

Estimations of costs of actions and activities

An estimate of how much it would cost to implement the TAP developed on basis of the economic assessment undertaken as part of the BAEF report of implementing sets of measures is described here.

Table 6 Estimation of Costs of Actions and Activities

Activity	Cost categories	Total cost
1. Project planning meetings with MNRE, SEA, SNTC, DWA, Department of Meteorology (including Climate Change Unit), CANGO, Ministry of Tinkhundla	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
2. Meeting held to develop Terms Of References (ToR) for consultant to develop proposals for WRP funds and consultant to develop wetlands monitoring system.	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
2. Recruit a consultant to develop proposals for WRP for the five shortlisted wetlands	Staff time Advertisement cost Consultant fees \$20,000	\$25,000
3. Recruit a consultant to set up wetlands monitoring system	Staff time Advertisement cost \$5,000 Consultant fees \$50,000	\$55,000
3. Meetings (at least two) of stakeholders for Funds Coordination Mechanism	Meeting venue Conference package Transport Assuming \$5,000 per meeting for one day non-residential meeting	\$10,000
4. Hold Funds Coordination Mechanism meetings every quarter and distribute minutes	Meeting venue Conference package Transport Assuming \$5,000 per meeting for one day non-residential meeting	\$5,000 every quarter amounting to \$40,000 for two years.
5. Proposal development workshops held	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two days residential meeting	\$40,000
6. Setting up of wetlands monitoring system.	Computer hardware Computer software Consultant fees Assuming a lumpsum of \$50,000	\$50,000
7. Training of SEA staff on wetlands monitoring system	On the job training Consultant fees 30 days @ E1000 per day	\$2,000
8. Awareness meetings held with communities at five wetlands	Transport costs Refreshments Staff allowances Reporting costs, photography Approximately E 150,000 x 5 = E750,000	\$50,000

9. Implement WRP activities in all five wetlands	Cost calculated on basis of Lawuba wetland project model to E278,000 x 5 = E1.39million	\$92,700
10. Monitoring and Evaluation	It is expected that MNRE will use internal funds for monitoring and evaluation, as their in-kind contribution.	0

Assuming exchange rate of 15 Emalangeni (E) to US Dollar (\$).

1.1.3.6 Management Planning

Risks and Contingency Planning

The risks anticipated in the adoption of the technology are:

1. Inadequate cooperation from communities to protect wetland.

Mind-set of people that natural resources such as water and plants are “God-sent” and therefore free for all to extract. Lack of cooperation from communities and community mind-set of water being a freely available resource may hinder progress of activities which support regulation of its use. This can be mitigated through awareness raising sessions and participatory approach where communities are involved in managing the wetlands.

2. Unavailability of funds may hinder progress

Other major challenge is that of raising funds. As Swaziland is not a Least Developed Country, it cannot access funds allocated for those. There is competition to access international development aid. Swaziland needs to prepare good proposals to access climate finance. Through the “Funds Coordination Mechanism” internal country funds can be effectively utilised for adaptation work.

Contingency plans include creating awareness amongst public about importance of wetlands protection and thereby garnering support, and developing proposals to raise funds for this technology. Some advocacy and awareness raising is essential and highlighting successful projects such as the Lawuba wetlands project will be useful.

Next Steps

Immediate requirements to proceed are

1. Development of proposals to raise funds for WRP
 - a. Hold a meeting with key stakeholders including National Wetlands Working Group (includes all relevant stakeholders) and Ministry of Tinkhundla (representing the communities)
 - b. Recruit a consultant to development proposals for the five wetlands and
 - c. Hold proposals development workshop
 - d. Submit proposals to development partners such as African Development Bank (AfDB), World Bank, IMF, EU, UNDP
2. Development of wetlands monitoring system
 - a. Development of ToRs for Assessment, mapping, ground truthing, monitoring of wetlands
 - b. Recruit a consultant to set up a wetlands monitoring system at SEA.

1.1.3.7 TAP Overview Table

TAP overview table								
Sector		WATER						
Sub-sector		Adaptation for water resources through protection of wetlands						
Technology		WETLANDS RESTORATION AND PROTECTION						
Ambition		To undertake WRP for five chosen medium size wetlands						
Benefits		Flood control, biodiversity enhancement, social and economic benefits for communities, micro climate and aesthetics						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1 Develop proposals for shortlisted wetlands	Activity 1.1 Project planning meetings with MNRE, SEA, SNTC, DWA, Department of Meteorology (including Climate Change Unit), CANGO, Ministry of Tinkhundla	AfDB, World Bank, EU, UNDP, IMF	MNRE	2 months	Disinterest of stakeholders	Good participation of stakeholders (number of attendees at meeting)	Minutes of meeting held	\$20,000
	Activity 1.2 Meeting held to develop Terms Of References (ToR) for consultant to develop proposals for WRP funds and consultant to develop wetlands monitoring system.	AfDB, World Bank, EU, UNDP, IMF	MNRE	3 months	ToRs may not be well developed	Good participation of stakeholders (number of attendees at meeting)	ToR document	\$20,000

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	Activity 1.3 Recruit a consultant to develop proposals for WRP for the five shortlisted wetlands. Advertisement and recruitment process.	AfDB, World Bank, EU, UNDP, IMF	MNRE	6 months	There may not be consultant available	Consultant hired	Contract signed by consultant	\$20,000
	Activity 1.4 Proposal development workshops held	AfDB, World Bank, EU, UNDP, IMF	MNRE	7 months	Poor participation by stakeholders	Good participation of stakeholders (number of attendees at meeting)	Proposal documents	\$40,000
Action 2 Implement WRP activities in chosen five wetlands	Activity 2.1 Implement wetlands restoration and protection activities in all five wetlands	AfDB, World Bank, EU, UNDP, IMF	SEA	3 years	Community may resist idea	Wetlands restored and protected according to project design	Report and photographs	\$92,700
Action 3 Set up a funds coordination mechanism	Activity 3.1 Meetings (at least two) of stakeholders for Funds Coordination Mechanism	AfDB, World Bank, EU, UNDP, IMF	MNRE	4 months	Stakeholders may resist coordinating funds	Good participation of stakeholders (number of attendees at meeting)	Minutes of meetings	\$10,000
	Activity 3.2 Hold Funds Coordination Mechanism meetings	AfDB, World Bank, EU,	MNRE	2 years	Stakeholders may resist coordinating funds	Good participation of stakeholders (number of	Minutes of meetings	\$40,000

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	every quarter and distribute minutes for two years	UNDP, IMF				attendees at meeting)		
Action 4 Create awareness through community level meetings and site visits	Activity 4.1 Community level meetings held at all five wetlands to create awareness of wetlands importance	AfDB, World Bank, EU, UNDP, IMF	MNRE	12 months	Communities may resist	Good participation of stakeholders (number of attendees at meeting)	Minutes of meetings	\$50,000
Action 5 Create a wetlands monitoring system using remote sensing	Activity 5.1 Purchase of hardware and software for system to undertake monitoring of wetlands using remote sensing.	AfDB, World Bank, EU, UNDP, IMF	MNRE	8 months	Equipment may not be readily available and importing may cause delays and high costs	Wetlands monitoring system established	Inventory of equipment purchased	\$50,000
	Activity 5.2 Training of SEA staff on wetlands monitoring system	AfDB, World Bank, EU, UNDP, IMF	MNRE	4 months	SEA staff may resist training	Staff begin using wetlands monitoring system	Training reports	\$2,000

1.1.4 Action Plan for Rain Water Harvesting Technology

1.1.4.1 Introduction

Due to climate change, rainfall patterns are expected to change and water stress is predicted to be experienced in Swaziland (Government of Swaziland, 2016). Hence it is vital that rain-water be stored, conserved and reused. Collecting rainwater from rooftops is an easy and fairly inexpensive way to increase amount of water availability in a household. The harvested water can be used for a myriad of uses from domestic to irrigation uses, depending on how it is filtered and treated. A range of rainwater harvesting (RWH) technological options are available and depends on the quality, cost, and sustainability of other residential water supplies, precipitation patterns, household income, and other factors. Furthermore, it depends on rainfall available and this varies with the ecological zones in Swaziland, which are highveld, middleveld, lowveld and lubombo plateau. Table below gives rainfall data for ecological zones of Swaziland.

Table 7 Rainfall in Ecological Zones of Swaziland

Ecological zone	Rainfall mm/year
Highveld	700 – 1550
Middleveld	550 – 850
Lowveld	400 – 550
Lubombo Plateau	550 – 850

Source: FAO (2005)

RWH technology has many advantages. It can help augment water supply during dry spells, thus helping households adapt to climate change. Use of RWH for agriculture is complementary to the current practice of irrigation and would strengthen system resilience. Harvesting rainwater also reduces demand from other sources of water such as surface and groundwater which are affected by climatic variations and assures water supply for various uses in a household. With this technology, water resources are diversified and households are better able to adapt to dry spells. Other advantages include improved water security as RWH helps provide extra water for food production and improves household hygiene and health. Households can improve their health from better sanitation using the additional water available from RWH systems. Using water from clean RWH system reduces waterborne diseases compared to usage of unclean sources. RWH helps in reduced ecosystem degradation through preventing siltation and erosion due to reduced runoff and helps to maintain or increase groundwater table, as there would be less reliance on groundwater for household use. Furthermore, RWH can increase job opportunities. Farmers using RWH for augmenting irrigation can lower the risk of their crop failures and thereby raise profits. The cost for water supply in households can be reduced with RWH systems, thereby providing them with extra funds for other economic activities that will improve their wellbeing. It also saves the time taken to collect water from sources far away and ensures continuous supply of water if the tank is large enough.

Rooftop RWH technology often brushed off as insignificant was prioritised by stakeholders who saw the value of harvesting water at household level considering the severe drought experienced in 2016, which

instigated severe water rationing in the city of Mbabane. It became recognised that RWH is a significant part of a sustainable water management strategy. Swaziland has adequate annual rainfall, which makes this technology viable in most places in the country. Furthermore, the advantages of this technology far outweigh its costs. This technology brings “power” (through availability of water) to household level, particularly in places where groundwater supply is not sufficient (or not used) and surface water resource is insufficient (as was the case for Mbabane during water restrictions in 2016). Furthermore, this technology is a lower cost option which is up-scalable to hundreds and thousands of households. It also reduces pressure on water supply as well as provides water for additional uses such as household gardens which have nutrition and food security benefits. Although a fairly simple technology to implement, it has not been scaled up due to cost of tanks which was considered a barrier.

1.1.4.2 Ambition for the TAP

The ambition for up-scaling RWH technology is subsidizing 5000litre tank and some supporting implements such as gutters, filters and pipes (costing E10,000) by 50% of its cost for 20,000 households, building of RWH systems for 100 institutions and improving awareness of the technology amongst the public. This project idea was conceived from stakeholder’s workshops, interviews with key experts and through review of relevant publications and documents and analysis by the Consultant. Cost benefit analysis for this technology is provided in the BAEF report.

1.1.4.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

1. Financial barrier identified was that tanks were not affordable for general public. The measure to overcome this barrier was to subsidize the tanks.
2. Low capacity to build RWH systems. Measures suggested was to create awareness amongst public about this technology through construction of RWH systems in institutions which can be used as demonstration sites.
3. Poor awareness of importance of RWH systems was another barrier identified. Measure suggested was to create awareness through forums and outreach.

Actions selected for inclusion in the TAP

1. Subsidize 5000litre RWH tanks (by 50% of its cost) by providing vouchers to 20,000 households by 2022;
2. Build RWH systems in 100 institutions which will also work as a demonstration site; and
3. Improving awareness as well as including RWH under Water Sanitation and Hygiene (WASH) forum by 2019.

Stakeholders mentioned that most people would be hindered by the cost of RWH systems and therefore do not install them even though they may be aware of its benefits. Therefore, stakeholders suggested providing a subsidy. Other actions were chosen from an identified need (by stakeholders and from literature review) to build capacity in construction of RWH systems in the country.

Activities identified for implementation of selected actions

1. 20,000 subsidy vouchers distributed to selected households in all regions by 2022.
 - a. Identify 20,000 households for providing subsidy for RWH systems
 - b. Develop RWH subsidy vouchers in collaboration with suppliers of tanks
 - c. Solicit funds for subsidy
 - d. Distribute subsidy vouchers to 20,000 households to be utilised within 6 months
2. 100 RWH systems built for institutions by 2022.
3. RWH included under WASH forum by 2019.
4. IEC materials on RWH created by 2019.

Actions to be implemented as Project Ideas

All three actions will be implemented as project ideas. Subsidy vouchers will be distributed to 20,000 households, RWH systems constructed in 100 institutions to act as demonstration sites and awareness will be raised through awareness raising measures including inclusion of RWH in the WASH forum.

1.1.4.4 Stakeholders and Timeline for Implementation of TAP

Overview of Stakeholders for the implementation of the TAP

The table below gives the actions proposed and stakeholders responsible for implementing the actions. The rationale for choosing the stakeholders is also included.

Table 8 List of Actions and Stakeholders Responsible for Implementing

Action	Stakeholders responsible	Rationale for choosing stakeholders
1. Subsidize 5000litre RWH tanks (by 50% of its cost) by providing vouchers to 20,000 households by 2022;	Ministry of Natural Resources and Energy (MNRE), Department of Water Affairs (DWA), Ministry of Tinkhundla	MNRE is the national institution responsible overall policy, development and regulation of land and water sectors in Swaziland. Under the MNRE is DWA, which aims to provide adequate water resources at acceptable standards ensuring sustainable use, development and management taking into account the environment. They are the mandated institutions responsible for promoting technology of RWH. Ministry of Tinkhundla would be responsible for choosing 20,000 households for the subsidy.
2. Build RWH systems in 100 institutions which will also work as a demonstration site;	MNRE, DWA	They are the mandated institutions responsible for managing water resources and promoting technologies which save water, such as RWH. It is assumed that the 100 institutions would be Government institutions (such as offices, schools and hospitals) and hence MNRE would be the right stakeholder being the relevant ministry.

3. Improving awareness and including RWH under Water Sanitation and Hygiene (WASH) forum by 2019.	DWA, Department of Meteorology	These stakeholders can raise awareness of RWH as a climate change adaptation technology.
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The main institution responsible for this project would be MNRE and others who will play a part in implementation. These are given in table below.

Table 9 Institutions Responsible and Contact Person for Implementation of Actions

<i>Institutions</i>	<i>Contact</i>
MNRE	The Principal Secretary, energyswa@realnet.co.sz
DWA	Edward Mswane, edwardmswane@yahoo.com
Ministry of Tinkhundla	Tami Nkambule, nkambuletami@gmail.com
Department of Meteorology	Duduzile Nhlengethwa-Masina (Director) dudu@swazimet.gov.sz

For raising funds, Development Partners such as World Bank, IMF, European Union and UNDP will be approached.

Scheduling and sequencing of specific activities

The sequence and timing of specific activities, as well as the nature and scale of the activity is described in table below.

Table 10 Scheduling and Sequencing of Activities for Implementation of RWH

Activity	Nature of activity	Scale of activity	Start	End
1. Project planning meetings with MNRE, DWA, Department of Meteorology (including Climate Change Unit)	MNRE as the lead institution will spearhead the project and hold a planning meeting with relevant stakeholders to plan for RWH project. Specific tasks: <ul style="list-style-type: none"> • Project design and scope, • Proposal development to raise funds for subsidy • Plans for awareness raising. 	The scale would be national. Meetings (at least 3) with around 12 persons from relevant bodies will be held at Government offices using existing facilities.	Month 1	Month 3

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2. Recruitment of consultant for proposal development	Advertisement and recruitment of a consultant to prepare proposals	National scale, where consultant will be recruited locally	Month 3	Month 6
3. Proposal developed for subsidy of RWH systems	Consultant develops a proposal	National scale, where consultant will, in consultation with all relevant stakeholders, develop a proposal	Month 7	Month 14
4. Proposal presented to development partners to raise funds for RWH systems (subsidy and institutional RWH systems construction)	MNRE will present the proposal to development partners such as World Bank, IMF, European Union, UNDP	International scale. The proposal will be sent to development partners both within the country and internationally.	Month 14	Month 20
5. Identify 20,000 households for providing subsidy for RWH systems	Ministry of Tinkhundla will identify households for subsidy programme	Local scale	Month 21	Month 25
6. Develop RWH subsidy vouchers in collaboration with suppliers of tanks	MNRE and Suppliers of RWH systems	National level	Assuming funds are available Month 26	Month 30
7. Distribute subsidy vouchers to 20,000 households to be utilised within 6 months	MNRE and Ministry of Tinkhundla would have a subsidy distribution system, which could take the shape of temporary distribution centers in local schools	At Tinkhundla level	Month 31	Month 32
8. Transfer funds to suppliers of tanks upon delivery of vouchers collected	MNRE will approach the treasury to transfer funds to suppliers	At Ministry level	Month 33	Month 35
9. Recruit a contractor to build RWH systems for 100 institutions	MNRE to advertise and choose a contractor to build RWH systems in 100 government institutions	At Ministry level	Month 26	Month 30

9. Construct 100 RWH systems in institutions across the country	Contractor to construct 100 RWH systems	At national level	Month 30	Month 40
10. MNRE to make a presentation at WASH Forum on necessity of including RWH into its agenda	MNRE, WASH Forum members	The scale will be national, as WASH forum is national.	Month 1	Month 4
11. Prepare IEC materials for awareness raising on RWH systems	MNRE along with media will develop IEC materials at a workshop	National scale. Media partners from all over Swaziland can be invited to the workshop.	Month 26	Month 48

The supposition is that once funds are raised for RWH activities, the relevant bodies will be able to provide subsidy to 20,000 households, build RWH systems in institutions and create awareness through IEC materials and incorporation of RWH discussions into WASH forum. The main barriers addressed was that of lack of funds for RWH systems and lack of awareness, which will all be tackled through these activities.

1.1.4.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Capacity needs include consultants for development of proposal for RWH systems and this involves the consultant holding meetings or workshops with national stakeholders to develop the proposals for fundraising.

Capacity building of general public is done through the demonstration projects of RWH systems built in 100 institutions. These places will act as study sites for the general public. Schools, hospitals and Government offices will be chosen where accessibility is high for the general public.

Estimations of costs of actions and activities

An estimate of how much it would cost to implement the TAP developed on basis of the economic assessment undertaken as part of the BAEF report of implementing sets of measures is described here. RWH installation costs are assumed to be E10,000 for one 5000litre plastic tank, pipes, guttering, preparation of roofs for harvesting, platform for placing the tank and labour for installation (Bruce Jameson, Pers. Comm). In 2007, Swaziland had 212,403 households with an average household size 4.7 persons (African Health Observatory, 2017). But only 19.5% of Swazis use plastic tanks for rooftop RWH, according to Vilane and Mwendera (2011). More recent data was not available, so this data was used for purposes of this economic analysis. This economic analysis will assess the up-scaling of RWH to 20,000 households in Swaziland. The average life of plastic tank is assumed to be 15 years (although well maintained tanks can last 20 years too).

Stakeholders suggested including soil erosion control and groundwater infiltration methods such as soak-aways as part of the RWH system (Personal Communication, Prince Mngoma). It is anticipated that such structures do not need much external inputs except for labour which we assume the household will provide and hence not included in the economic analysis. For detailed economic analysis refer to BAEF report (however, note that number of households and size of tank was reduced at TAP stage in consultation with stakeholders).

The cost of subsidy is E 100,000,000 and time frame recommended is three years to complete the programme. This will form the bulk of the project cost. Although the water savings are less than the investment costs, there are other benefits that this technology brings which have not been costed. These include improved hygiene and health, improved food security by using rain water for household gardens and access to water during dry periods. During dry periods, usage of contaminated water can have adverse health effects and RWH can prevent this through making water available during such times. Spill-over effects will include saved times for women to collect water, improved attendance at school for children and improved general household hygiene and health.

The cost for constructing tanks in 100 institutions will be E1,000,000, assuming 5000litre tanks are built. A summary of estimated costs for the full programme is given below.

Table 11 Estimation of Costs of Actions and Activities

Activity	Cost categories	Total cost
1. Project planning meetings with MNRE, DWA, Department of Meteorology (including Climate Change Unit)	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
2. Recruitment of consultant for proposal development	Staff time Advertisement cost	\$5000
3. Proposal developed for subsidy of RWH systems	Consultant fees \$20,000	\$20,000
4. Proposal presented to development partners to raise funds for RWH systems (subsidy and institutional RWH systems construction)	No costs anticipated	0
5. MNRE and Ministry of Tinkhundla hold meeting to identify 20,000 households for providing subsidy for RWH systems	Meeting venue Conference package Transport Assuming \$5,000 per meeting for one day non-residential meeting	\$10,000

6. Develop RWH subsidy vouchers in collaboration with suppliers of tanks	Communication/ printing costs \$1000	\$1,000
7. Distribute subsidy vouchers to 20,000 households to be utilised within 6 months	Salaries to temporary officers for two months E 20,000 Rent for hiring rooms for a number of temporary subsidy distribution centers E 50,000	\$ 4,667
8. Transfer funds to suppliers of tanks upon delivery of vouchers collected	Cost of subsidy E 100,000,000	\$6,600,000
9. Recruit a contractor to build RWH systems	\$5,000 for advertisement and recruitment process	\$5,000
9. Construct 100 RWH systems in institutions across the country	E 1,000,000 is cost of construction	\$66,667
10. MNRE to make a presentation at WASH Forum on necessity of including RWH into its agenda	No costs anticipated	0
11. Prepare IEC materials for awareness raising on RWH systems	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting Printing of IEC materials \$30,000	\$50,000

Assuming exchange rate of 15 Emalangeni (E) to US Dollar (\$).

1.1.4.6 Management Planning

Risks and Contingency Planning

The risks anticipated in the adoption of the technology are:

1. The cost for roofing the house is substantial and difficult to estimate. Hence there could be need for contingency costs to be budgetted at 15%.
2. Unavailability of funds may hinder progress

Other major challenge is that of raising funds. As Swaziland is not a Least Developed Country, it cannot access funds allocated for those. There is competition to access international development aid. Swaziland needs to prepare good proposals to access climate finance. This is mitigated through development of high-quality and convincing proposal by the consultant.

3. Choice of households for subsidy may create conflicts amongst communities. This can be mitigated by choosing vulnerable groups such as child headed and grandmother headed households.
4. Households may purchase RWH systems using the subsidy and sell it. There is no contingency plan for this, as anyone else buying this RWH system will still harvest rain, which is the objective we want to achieve.
5. Of the one hundred institutions where RWH systems are built, some may not maintain it well and can become delapidated, becoming a bad example rather than a study site for RWH systems. This

will be mitigated through contractors constructing the systems creating awareness at the institutions to maintain the systems.

6. Theft and vandalism of RWH systems is possible. This can be mitigated through awareness raising and community meetings held during construction.

Next Steps

Immediate requirements to proceed are

1. Hold project planning meetings with MNRE, DWA, Department of Meteorology (including Climate Change Unit).
2. Recruit a consultant to develop a proposal for subsidy of RWH systems and construction in 100 institutions.

1.1.4.7 TAP overview table

TAP overview table								
Sector	WATER							
Sub-sector	Adaptation for water resources through promotion and up-scaling of Rain Water Harvesting systems							
Technology	RAINWATER HARVESTING							
Ambition	To subsidize RWH systems for 20,000 households, build demonstration RWH structures in 100 institutions and create awareness of RWH							
Benefits	Improved access to water, building capacity of general public to carry out RWH and myriad of benefits arising from water availability (improved hygiene, better health, greater adaptive capacity during dry spells, more water for household gardens leading to better nutrition etc.)							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1 Subsidize 5000litre RWH tanks (by 50% of its cost) by providing vouchers to 20,000 households by 2022.	Project planning meetings with MNRE, DWA, Department of Meteorology (including Climate Change Unit)	AfDB, World Bank, EU, UNDP, IMF	MNRE	3 months	Disinterest of stakeholders	Good participation of stakeholders (number of attendees at meeting)	Minutes of meeting held	\$20,000
	Recruitment of consultant for proposal development	AfDB, World Bank, EU, UNDP, IMF	Consultant	3 months	Recruitment process may take longer time	Contract signed by consultant	Contract document signed	\$5000
	Proposal developed for subsidy of RWH systems	AfDB, World Bank, EU, UNDP, IMF	MNRE	7 months	Proposal may not be well developed	Selection of consultant for proposal writing	Proposal document	\$20,000

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Proposal presented to development partners to raise funds for RWH systems (subsidy and institutional RWH systems construction)	MNRE	MNRE	6 months	The response to proposal may not be positive	Proposal getting funded	Offer of funding documents	\$20,000
MNRE and Ministry of Tinkhundla hold meeting to identify 20,000 households for providing subsidy for RWH systems	AfDB, World Bank, EU, UNDP, IMF	MNRE	4 months	Poor participation by stakeholders	Good participation of stakeholders (number of attendees at meeting)	List of 20,000 households	\$10,000
Develop RWH subsidy vouchers in collaboration with suppliers of tanks	AfDB, World Bank, EU, UNDP, IMF	MNRE	1 month	Subsidy vouchers may be forged by third parties	Include anti-forging techniques in subsidy vouchers	Availability of subsidy vouchers	\$1000
Distribute subsidy vouchers to 20,000 households to be utilized within 6 months	AfDB, World Bank, EU, UNDP, IMF	MNRE, Ministry of Tinkhundla	2 months	Conflicts at distribution centers for choice of households	Mitigated by choosing vulnerable households and using transparent process	Report	\$4,667
Transfer funds to suppliers of tanks upon delivery of vouchers collected	AfDB, World Bank, EU, UNDP, IMF	MNRE, DWA	3 months	Funds transfer may get delayed	MNRE to follow up the process	Proof of funds transferred to suppliers	\$6,600,000

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Action 2 Build RWH systems in 100 institutions which will also work as a demonstration site;	Recruit contractor to construction 100 RWH systems	AfDB, World Bank, EU, UNDP, IMF	MNRE	4 months	Recruitment process may take long.	MNRE to follow up speedily for recruitment	Contract signed	\$5,000
	Construction of 100 RWH systems across Swaziland to act as demonstration sites	AfDB, World Bank, EU, UNDP, IMF	MNRE, Ministry of Tinkhundla	10 months	Choice of institutions may be criticized	MNRE and Ministry of Tinkhundla can choose institutions to be spread across all parts of Swaziland	Report on structures built, photographs	\$66,667
Action 3 Improving awareness as well as including RWH under Water Sanitation and Hygiene (WASH) forum by 2019.	MNRE to make a presentation at WASH Forum on necessity of including RWH into its agenda	MNRE	MNRE	4 months	WASH forum members may resist	MNRE can prepare a convincing argument to include RWH into WASH forum	Minutes of meetings	0
	MNRE to meet with media partners to prepare IEC materials and send to suppliers for printing	AfDB, World Bank, EU, UNDP, IMF	MNRE, Media	2 months	Media partners may not be interested	MNRE to collaborate and convince media partners	IEC materials	\$50,000

1.2 Project Ideas for Water Sector

1.2.1 Brief summary of the Project Ideas for Water Sector

The project ideas are concrete actions supporting the realisation of the overall target indicated in the Technology Action Plan for the sector. Project ideas were identified by stakeholders after discussion and deliberations at stakeholder workshops. At one workshop, a stakeholder from SEA presented about a successful wetlands restoration and protection project (Lawuba wetland) which received praise within Swaziland to have achieved both environmental and socio-economic goals improving lives of communities in the area. There was majority consensus amongst stakeholders that the TNA should use this project as an example when developing TAPs for WRP. Soon after Swaziland experienced droughts in 2016, stakeholders felt the need for RWH technology was paramount in the country to help people improve access and storage of water as an adaptation measure. This was accepted and hence RWH was prioritised as a technology. The consultant took these suggestions and developed the TAPs for WRP and RWH for the water sector. How WRP and RWH contributes to Swaziland achieving its targets for adaptation and development is provided in section “Current level of uptake of technologies”.

The project ideas for water sector helps it to achieve its goals of water savings and conserving water resources. They are summarised as two major goals, one to rehabilitate and protect five medium sized wetlands in the country and the other to subsidize RWH systems for 20,000 households, build demonstration RWH structures in 100 institutions and create awareness of RWH.

1.2.2 Specific Project Idea for WRP

Introduction/Background

Water resources management and protection of water sources is essential for adapting to climate change in the wake of water stresses and unreliable rainfall patterns expected. Swaziland’s wetlands are getting affected by development, exploitation through over extraction of natural resources and trampling by livestock. Therefore, stakeholders felt that Wetlands Restoration and Protection (WRP) was a technology to be prioritised. The Environment Fund has supported a successful wetlands restoration and protection project at Lawuba wetland which brought about both environmental and socio-economic benefits. The model of Lawuba wetland was chosen and using economic analysis with this model, five medium sized wetlands prioritised in a national document was chosen as the project idea.

Objectives

The project aims to restore and protect five wetlands namely; Mlawula, Ubombo, Ndlotane, Mangwenya and Shovella, through fencing, planting wetland plants if needed and creating awareness amongst the communities through awareness sessions.

The project will raise funds for restoration and protection of the five shortlisted wetlands. It will undertake restoration and protection activities through fencing of wetland where needed and planting of wetland plants. Furthermore, awareness raising sessions would be held to avoid over extraction of natural resources from the wetlands and avoiding trampling of the wetlands by livestock. Furthermore, communities will sustainably harvest materials such as weed, medicinal plants, mammals and birds from the wetland thereby

allowing habitats for birds, animals and plants to be preserved. This will in turn preserve ecosystem functioning of wetlands thereby contributing to enhanced water resources management.

Outputs

The outputs expected are: five wetlands restored and protected and awareness of wetlands management created amongst relevant stakeholders particularly communities who use the wetlands. Reports and photographs of WRP projects and monitoring and evaluation of the project will help measure success of this project.

The project is in alignment with the National Biodiversity Strategy and Action Plan (NBSAP) 2016 includes strategies on sustainable utilization and conservation of aquatic resources including wetlands. The Third National Communication to UNFCCC (2016) and Swaziland's Nationally Determined Contribution (INDC) to the UNFCCC, prioritized adaptation technologies including wetland restoration. Managing wetlands aids in water resources to remain healthy as wetlands are often the source for rivers and they also act as natural flood control mechanisms. Although this is not a new project, as SEA has undertaken wetlands restoration of selected wetlands in the country, but lack of funds to scale up activities was a barrier this project will address.

Project Deliverables

The values accrued from this project will be both environmental and socio-economic. Taking Lawuba wetland rehabilitation as a model, within a short time (less than a year), local communities generated E1.2million (approximately \$80,000) through using reeds and grasses to make baskets for sale and natural materials from the wetland. The values accrued in terms of maintaining ecosystem functioning of wetlands, preserving habitats for animals and plants and micro climate regulation have not been costed, but are of much value.

Project Scope and Possible Implementation

The scope of the project is to have multiple actions that will contribute towards effective wetlands management in the country. Fund raising through proposal development will be done for WRP of five medium sized wetlands which follows an existing model of SEA and Environment Fund implemented Lawuba wetland rehabilitation project. Setting up a funds coordination mechanism to allow sharing of resources amongst development partners and implementers of projects which overlap on areas with wetlands is included as a long term sustainable method of ensuring that efforts are synergised for WRP. In addition, awareness raising and setting up a wetlands monitoring system using remote sensing will be done.

Project activities

Project activities include developing proposals for funding the project by 2022. Setting up a funds coordination mechanism (by 2019) involving stakeholders for synergies in usage of funds for wetlands restoration and protection by agencies working in same areas are realised. A Funds Coordination Mechanism will be set up where development partners and practitioners will pool resources and share them when possible in order to undertake WRP activities. Another activity is to create awareness of importance of wetlands through community level meetings and site visits and to create a wetlands monitoring system using remote sensing.

Timelines

The timeline for implementation of all the actions in this project is five years (up to 2022). The activities are phased and timed.

Budget/Resource requirements

The total budget is \$344,700, with proposal development and fund raising costing \$100,000, while setting up a funds coordination mechanism taking \$50,000, WRP activities costing \$92,700, awareness raising taking \$50,000 and setting up wetlands monitoring system costing \$52,000. It is expected that once funds are raised there is adequate capacity in SEA to implement WRP projects as evidenced from Lawuba project. A consultant will be hired to develop proposals for raising funds. Another consultant will be recruited for setting up and training staff on wetlands monitoring system.

Measurement/Evaluation

Deliverables from the project include a proposal that is successful in raising funds for WRP, a wetlands monitoring system set up, training of staff on using the wetlands monitoring system completed and reports of awareness raising sessions conducted. In five years, it is expected that the five wetlands shortlisted under this project would all have undergone restoration and protection actions.

Possible Complications/Challenges

The major challenge that the project could face is that of lack of cooperation from communities in the chosen five wetlands. This will be overcome through awareness raising sessions and engagement with communities. Raising funds will be another challenge therefore recruiting a good consultant who can develop good quality proposals is essential.

Responsibilities and Coordination

The main responsibility rests with MNRE who will oversee the project, coordinate it and undertake monitoring and evaluation. While implementing WRP actions will be done by SEA.

1.2.3 Specific Project Idea for RWH

Introduction/Background

RWH technology can help with climate change adaptation through augmenting water supply during dry spells. It provides additional water to households for household gardens through which nutrition is improved. Increasing access to water in this manner also improves hygiene. With this technology, water resources are diversified and households are better able to adapt to dry spells. Households save the time taken to collect water from sources far away and ensure continuous supply of water if the tank is large enough. In this project, to overcome the barrier of the unaffordability of tanks, it is recommended to subsidise the tanks to 20,000 households, construct RWH systems in 100 institutions to act as demonstration sites for training and create awareness of the technology amongst general public.

Objectives

The project aims to increase access to water for households through promotion of RWH systems through a subsidy and build capacity in construction of RWH through setting up demonstration systems in 100 institutions and creating awareness about the technology as well as include it into the national WASH forum.

The project will raise funds for providing subsidy for 50% of the cost of RWH systems for 20,000 households. The project will also construct RWH systems in 100 institutions which will act as demonstration sites. Furthermore, awareness raising sessions would be held to promote the technology. Additionally, RWH will be inserted into the National WASH forum agenda.

Outputs

The outputs expected are: 20,000 households will set up RWH systems, 100 institutions will have RWH systems and awareness will be raised about this technology including insertion of RWH agenda into National WASH forum.

The project is in alignment with the Poverty Reduction Strategy and Action Plan (Government of Swaziland, 2006) which calls for increasing access to water. Furthermore, the Third National Communication to UNFCCC (2016) and Swaziland's Nationally Determined Contribution (INDC) to the UNFCCC, promotes water saving technologies such as RWH. This technology was prioritised by stakeholders in view of recent water rationing experienced in the country.

Project Deliverables

The values accrued from this project will be both educational and socio-economic. Through harvesting rainwater, access to water will be improved, which helps in improving hygiene, having more water for household vegetable gardens leading to better nutrition and improved incomes for some. Through the RWH systems built in 100 institutions around the country, communities can learn about the systems as use them as demonstration sites. The deliverables are funds raised for providing subsidy, subsidy vouchers, RWH systems built in 100 institutions and awareness raising sessions done. RWH will be included into WASH forum.

Project Scope and Possible Implementation

The scope of the project is to subsidize RWH systems at 50% of its cost to 20,000 households, to build 100 RWH systems in institutions across the country and to create awareness of the technology. The project will be implemented across the country and subsidy will be provided equitably to households around the country. RWH will also be included into the National WASH forum.

Project activities

Project activities include developing proposals for subsidy of RWH systems for 20,000 households, distributing the subsidy to chosen households (vulnerable), developing proposal to raise funds for 100 RWH systems in institutions and creating awareness through road shows and IEC materials and including RWH agenda into WASH forum.

Timelines

The timeline for implementation of all the actions in this project is five years (up to 2022). The activities are phased and timed.

Budget/Resource requirements

The total budget is \$6,782,334, of which \$6,600,000 is for the subsidy of RWH systems for 20,000 households and \$66,667 is for constructing RWH systems in institutions. Awareness raising will cost %50,000. A consultant would be hired to prepare fundable proposal for subsidy project.

Measurement/Evaluation

Deliverables from the project include a proposal that is successful in raising funds for subsidy, a proposal and plan for building RWH systems in institutions and awareness raising session plans and reports. Subsidy vouchers, RWH systems built and IEC materials provide proof of deliverables.

Possible Complications/Challenges

The major challenge that the project could face is that of conflict amongst communities on the choice of beneficiaries for subsidy. This can be overcome by choosing vulnerable households such as women headed, or child headed or elderly headed households. Availability of funds may also be a challenge, and therefore good fundable proposals would need to be made.

Responsibilities and Coordination

The main responsibility rests with MNRE who will oversee the project, coordinate it and undertake monitoring and evaluation.

Chapter 2 Technology Action Plan and Project Ideas for Agriculture Sector

2.1 TAP for Agriculture Sector

2.1.1 Agriculture Sector overview

Agriculture is the mainstay for Swaziland's economy and contributes 11% to the Gross Domestic Product (GDP) of the country (Food and Agricultural Organization, 2015). Given that the agricultural sector is highly vulnerable to weather related production shocks, it is imperative that the sector adapts effectively to climate change. Swaziland is prone to hydro-meteorological disasters, with drought being most common, according to Manyatsi and Mhazo (2014). Downscaled global climate change models (GCMs) predict a temperature rise of 1 to 1.5oC across Swaziland for the years 2000 and 2050, and a reduction of up to 200mm in annual rainfall over much of the country (Manyatsi et al., 2012). The high rate of poverty and large number of subsistence farmers that depend on rain fed agriculture, compromises their ability to adapt to climate change. The El Niño weather phenomenon has been associated with reduced rainfall levels and Swaziland experienced this in year 2015, when poor crop production was experienced. In 2014/15, a prolonged dry spell between January and March had a severe impact on yields and it reduced production by 31% (Food and Agricultural Organization, 2015). With climate change, extreme weather events, dry spells, higher temperatures and climate induced risks such as increased pests and higher evaporation will all affect agriculture, livestock included. Swaziland has reported 25.6% under five years stunting rate, which is indicative of poor nutrition. Swaziland needs to improve the capacity of its small scale farmers, particularly in the light of climate change. Therefore, technologies such as irrigation and improved land management are vital for the sector to effectively adapt and ensure food security in the country.

Swaziland has been implementing projects that help the agricultural sector adapt to climate change and this includes conservation agriculture which was introduced in 2002 by the Ministry of Agriculture with support from Food and Agricultural Organization and the Cooperation of the Development of Emerging Countries (COSPE). Drought tolerant varieties have been introduced through the Harmonised Seed Security Project (HASSP) and it is estimated that 50% of farmers in Swaziland use recycled seeds, which are cheaper than hybrids and have better post-harvesting qualities (Manyatsi and Mhazo, 2014). Maize yields on Swazi National Land (SNL) are very low and are heavily dependent on rainfall. Maize being the staple crop, is widely cultivated in Swaziland. The average yield of maize varies depending on the area with highest yields obtained in the Highveld and moist Middleveld. The maize yield on Swazi National Land (SNL) which is communal land where rain fed farming is practised mostly, is 4.42 tonnes per hectare (Dlamini and Masuku, 2011). Maize farming on Swazi Nation Land is mainly for subsistence with little intention for commercial purposes.

Irrigation is used by commercial farmers such as the sugarcane estates, however the small scale farmers reported lack of access to water and high costs to be some of the barriers for lack of adoption of this technology. Introduction of new crop varieties have been done in the Rural Development Areas to improve diversity and improve production, and these include baby vegetables, cassava, Irish potatoes, sorghum, fruit trees, mushrooms, beans and cotton. Use of animal dung as manure and agroforestry are some of the practices also being done in the country. However, unreliable rainfall patterns, persistent

droughts and pests and diseases have all affected agriculture in Swaziland. The TNA and BAEF reports provides deeper insight on the agriculture sector and its challenges in Swaziland. Policies, strategies and legislative instruments help guide the management of water resources in this sector. Existing policies and measures related to Water Sector development and technology deployment is given in table below.

Table 12 Policies and Measures Related to Agriculture Sector for Swaziland

Name of policy/measure	Year enacted	Main contents
The King's Order in Council	1953	In 1953 the King of Swaziland issued an order commanding the Swazi nation to observe and perceive some soil conservation measures on arable land. The nation was ordered to leave grass filter strips between ploughed lands at such intervals as advised by agricultural extension officers. This makes Swaziland one of the few mountainous countries with low soil erosion, a commendable achievement.
The Plant Control Act	1981	The object of this Act is to provide control, movement and growing of plants and matters incidental thereto. It creates a Nursery Registration Board who shall be responsible for the registration of new nurseries. This is particularly important as invasive alien species are wreaking havoc on agriculture in the country by affecting arable land and grazing land.
Livestock Development Policy	1995	The major goal of this policy, which was approved in 1995, is to achieve an efficient and sustainable livestock industry contributing to economic development. The policy objectives relate to improving the national herd and animal health, nutrition, meat hygiene standards, marketing, processing industries, commercialization and promotion of entrepreneurship, range management, legislation and communication.
Grass Fires Act	1995	The Grass Fires Act of 1955 is being administered by the Ministry of Tourism and Environmental Affairs of Swaziland (Forestry Department). It prohibits the burning of grass and other vegetation without permission or notification. It restricts owners and any person from setting fires wilfully or negligently and obligates persons to extinguish wild fires to prevent their spread.
The Swazi Administration Order 6	1998	This Order-in-Counsel is being administered by the Ministry of Home Affairs. It provides for the incorporation and appointment of Chiefs and Tindvuna in environmental management issues. This is relevant to the agriculture sector as a lot of land for farming is within Swazi National Land.
The National Environmental Policy	1999	The objective of this policy is to 'promote the enhancement, protection and conservation of the environment and the accomplishment of sustainable development in Swaziland. It puts down the principles to be used in the undertaking of environmental

		conservations in the country. This is relevant as it promotes environment friendly farming techniques such as conservation agriculture and agroforestry, which aids in adaptation.
The National Development Strategy (NDS) 1999 and Vision 2022	1999	This is a long-term strategy developed by the Swaziland Government in 1999 to guide the course of socio-economic development of the Kingdom over a twenty five-year period up to 2022. The NDS stipulates that, “By the year 2022, the Kingdom of Swaziland will be in the top ten percent of the medium human development group of countries founded on sustainable economic development, social justice and political stability.” Food security is of utmost importance and hence this strategy is relevant to agriculture sector.
Seed Policy	2000	The goal of this policy is to achieve national seed-sufficiency and through extension and research ensure that all farmers develop a high degree of awareness of the role of improved seed as a major input in crop production.
Environment Management Act	2002	The Act establishes the Swaziland Environment Authority as a body corporate. Its purpose is to provide for and promote the enhancement, protection and conservation of the environment and the sustainable management of natural resources. It is the country’s framework environmental legislation which promotes the integrated management of natural resources on a sustainable basis. Agriculture falls within natural resources management and hence relevant.
SADC Regional Indicative Strategic Development Plan (RISDP)	2003	The Regional Indicative Strategic Development Plan (RISDP) is underpinned by the SADC vision, which charts the direction for the development of the region. The Food, Agriculture and Natural Resources (FANR) aspects of interventions of the Regional Indicative Strategic Development Plan (RISDP) can be summarized as ensuring food availability, food access, improved safety and nutritional value of food, disaster preparedness for food security and also strengthens institutional framework and Capacity Building; Moreover, ensuring the equitable and sustainable use of the environment and natural resources.
SADC Declaration on Agriculture and Food Security of 2004		Member States of SADC including Swaziland committed to promote agriculture and ensure provision of key agricultural inputs, agro-industrial development and processing, crop and livestock pests and diseases, crop, livestock and fisheries production, water management and irrigation, sustainable use and management of natural resources, disaster preparedness, market access, private sector involvement in agriculture and rural development.
Food Security Policy	2005	The long-term goal of this policy is to ensure that “All people in Swaziland, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” This goal is based

		on the four pillars of food security, namely, food availability, access to food, food utilisation and nutritional requirements.
Swaziland National Irrigation Policy	2005	The National Irrigation Policy of the Kingdom of Swaziland intends to provide policy direction in the irrigation sub-sector. The overall goal of the 2005 National Irrigation Policy is to ensure that the irrigated agriculture sub-sector in Swaziland contributes fully to economic growth and poverty alleviation in accordance with national development goals, the Water Act of 2003 and the need to use the country's resources in a sustainable fashion.
National Food Security Policy for Swaziland	2005	This policy, which is an integral part of the Comprehensive Agriculture Sector Policy and National Development Strategy, is aimed at addressing the threats and opportunities relating to food security in Swaziland.
Comprehensive African Agriculture Development Programme (CAADP)	2005	The Comprehensive Africa Agricultural Development Programme (CAADP) has been endorsed by the African Heads of State and Government as a framework for the restoration of agriculture growth, food security, and rural development in Africa. The primary CAADP goal is agriculture led development that eliminates hunger, reduces poverty and food insecurity, opening the way for export expansion.
Comprehensive Agricultural Sector Policy	2005	The objectives of the Comprehensive Sector Policy of 2005 include the increase of agricultural outputs and productivity and to ensure sustainable use and management of land and water 34 resources. The broad objective is to provide clear guidance on policy options and measures necessary to enhance sustainable agriculture sector development.
Poverty Reduction Strategy & Action Plan	2006	This programme was specifically developed to address the high incidence of poverty. The key element of the Poverty Reduction Strategy and Action Plan (PRSAP) is the empowerment of the poor to generate income through improving access to land, increasing income from agriculture and reducing unemployment. The implementation of PRSAP is seen as crucial in achieving the goals of the National Development Strategy (NDS) (Government of Swaziland, 2006).
Swaziland Agricultural Development Project	2007	The Swaziland Agricultural Development Project (SADP) 1 was conceived in 2007/2008 following the Swaziland National Agricultural Summit (SNAS) held in mid-2007. The objective of the SADP programme is to develop improved smallholder production and marketing systems which lead to sustainable food security and an improved quality of life for rural households in Swaziland. SADP was designed in a top-down fashion, in part due to the haste required in meeting EU funding deadlines. Perhaps as a consequence, the project document ² articulated an impressive vision of Swazi

		agricultural development possibilities, but also displayed an extremely weak understanding of the run-down state of the extension, research and marketing services, and the mechanisms necessary to resuscitate these.
National Agriculture Summit Action Plan	2007	The National Agriculture Summit was a direct Government response to the plight of the Swazi farmers who are increasingly operating in an environment that is challenging and militating against normal agricultural production as we have known it for decades.
Water Policy	2009	A National Water Policy in Swaziland has been crafted and finalised with the incorporation of inputs from stakeholders in the water sector. The policy promotes sustainable water development and management in the interest of the whole nation and region without abdicating state integrity and responsibility towards neighbouring countries. This is relevant as irrigation contributes to highest demand for water in the country (Government of Swaziland, 2009).
Draft Agriculture Diversification Strategy	2009	The draft Agricultural Diversification Strategy developed in 2009 is a statement of Government's intent promote agriculture diversification. Adoption and implementing the strategy will complement Government's efforts of creating employment and increasing incomes of rural population.
SADC Regional Agriculture Policy (RAP) Framework	2010	Swaziland unanimously agreed, and confirmed the earlier position that the region requires a common agricultural policy that should be a formal policy arrangement, a Law (legally binding) instrument with appeal mechanisms based on subsidiarity and budgetary provisions linked to Member States' own planning and budget frameworks. The SADC Regional Agricultural Policy (RAP), in support of regional integration and in contribution to the attainment of the SADC Customs Union and Common Market, is a regional instrument for stimulating sustainable agricultural development and food security in the SADC region. It defines common agreed objectives and measures to guide, promote and support actions at regional and national levels in the agricultural sector.
Input Support Programme	2010	The main objective of this is to identify small scale farmers that will be assisted with Input Support Programme (ISP) to improve maize production in order to attain food self-sufficiency and food security for the country by subsidizing the basic inputs of seed and fertilizer.

The two technologies discussed in detail in this TAP for agriculture sector are Conservation Agriculture and Micro and Drip Irrigation. The measures include promotion of micro and drip irrigation through subsidy of the kits for 1,000 vegetable farmers at 50% of its cost and creating awareness of the technologies and up-scaling conservation agriculture through setting up demonstration sites to be used for training farmers and providing 200 mechanised planters to be provided to farmers through the Government tractors hire.

2.1.1.1 Conservation Agriculture

According to FAO (2017), Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely:

(1) Continuous minimum mechanical soil disturbance; (2) Permanent organic soil cover; and (3) Diversification of crop species grown in sequences and/or associations. Agriculture alters land forms and using tillage disturbs soil and may contribute to increased runoff and erosion. Tillage of the soil stimulates microbial decomposition of soil organic matter, which results in emissions of carbon dioxide to the atmosphere. Therefore, minimising the amount of tillage promotes sequestration of carbon in the soil, increases water retention and reduces erosion. Thus it has consequences for both climate mitigation and adaptation. With rising temperatures in the wake of climate change, there will be higher need for water for agriculture and this technology helps in water retention in soil, thus aiding in adaptation. In conservation tillage, the soil should remain permanently covered by crop residues from previous cash crops or green manure cover crops, and most of these residues will remain undisturbed on the soil surface after seeding. Maintaining soil fertility, reducing runoff and erosion will have positive climate change adaptation values for agriculture. Conservation agriculture leaves the previous year's crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop to reduce soil erosion and runoff, as well as other benefits such as carbon sequestration. Climate change will also cause more weed growth and pest infestation and this technology reduces growth of weeds and pests, thus helping in adaptation.

CA principles can be applied to all agricultural landscapes and land uses with locally adapted practices. Very little external inputs such as agrochemicals and plant nutrients of mineral or organic origin are needed. CA facilitates good agronomy, and complemented by other known good practices, including the use of quality seeds, and integrated pest, nutrient, weed and water management, it is a base for sustainable agricultural production intensification. It also allows for integration of production sectors, such as crop-livestock integration and the integration of trees and pastures into agricultural landscapes. Stakeholders prioritised this technology as an adaptation measure for Swaziland. CA increases the ability of soil to store or sequester carbon, enrich the soil, improve soil surface stabilization, reduce leaching of nutrients, decreases evaporation and hereby improve water retention, increase yield and reduces the need for tractors to pass on farm thus reducing use of fossil fuels. Furthermore, CA reduces labour by up to 40%. In this technology burning crops and residue is avoided and it is a truly sustainable technology.

2.1.1.2 Micro and Drip Irrigation

Agriculture is the mainstay of the Swaziland economy and is critical for the achievement of the overall development objectives of the country. Climate change induced dry spells and erratic rainfall patterns are affecting crop production in Swaziland. Most farmers are dependent on rainfall for crop production and are therefore vulnerable to reduced rainfall and accompanying moisture stress on crops. Irrigation can help farmers in Swaziland to adapt to changing climate and substantially improve food production. The goal of efficient irrigation is to supply each plant with just the right amount of water it needs, thereby reducing wastage of water. Micro irrigation systems include drip irrigation which target roots of field crops, and sprinklers, which are pressurized irrigation systems that use moving platforms or devices to stimulate natural rainfall. Water efficiency for sprinklers is 50-70%, while for drip irrigation

it is up to 90% and can also be used in greenhouses, nurseries, orchards and plants in containers. Both systems can be gravity fed or pressurized. Adaptation of this technology promotes sustainable management of energy, water, land, and labor. Under conditions of increased water stress resulting from climate change the benefits of the technology rises quite significantly.

Drip irrigation is based on the constant application of a specific and focused quantity of water to soil crops. A drip irrigation system typically consists of pumps or pressurised water system, filtration systems, nutrients application system, backwash controller, pressure control valve, pipes, control valves and safety valves, poly fittings and accessories and emitters. A wide range of components and system design options is available. The wetting pattern of water in the soil from the drip irrigation tape must reach plant roots. Emitter spacing depends on the crop root system and soil properties.

Micro sprinklers, sprayers, and jets are available in in a wide variety and many configurations. Like drip emitters, micro sprinklers and sprayers operate at low pressure and are designed for areas where drip irrigation is not advisable, for keeping plant foliage constantly moist or when overhead watering is required. The micro sprinklers and micro sprayers are rated by flow rate, wetting diameter and the spray method (moving parts for micro sprinklers, versus non-moving parts for sprayers). Like conventional sprinkler systems, micro sprinklers and sprayers are available in 360°, 180°, 90° and strip patterns that aim left and right like a bow tie. Micro sprinklers and micro sprayers provide low precipitation rates, allowing longer watering time with less runoff.

2.1.2 Current level of uptake of technologies

In order to make targets for technology diffusion which will help with adaptation, it is important to understand the current level of uptake of technologies. For this TAP, the two technologies prioritised, their current level of uptake and future targets are provided in table below.

Table 13 Current Level of Uptake for Technologies Prioritized

Technology	Current level of uptake	Future targets
Conservation Agriculture	Swaziland Agricultural Development Programme (SADP) has trained 2118 farmers in sustainable agriculture. Fifty youth groups were trained in vegetable and poultry production. A total of 1600 farmers were trained and 1200 prepared 288 ha using conservation agriculture techniques. Through LUSIP-GEF, a total of 1,205 households are practising conservation tillage in the host area. There are over 30 CA demonstration sites established in Swaziland with the help of close to 300 farmers according to FAO (2011).	The Swaziland National Development Strategy advised preliminary targets for transfer and diffusion of technology as it prioritises agriculture as a means to reduce food insecurity and improve nutrition security and commercialisation of agriculture in Swazi National Land. Furthermore, Swaziland’s Constitution says, “The State shall take appropriate measures to promote the development of agriculture and industry”. The technology measures of providing subsidies for planters and creating awareness of CA through training are

		addressing this vision (Government of Swaziland, 2005).
Micro and Drip Irrigation	Out of the 52,000 ha under irrigation in Swaziland, only about 1,300 ha is under small-scale farming (excluding those under commercial irrigation schemes). Through LUSIP-GEF, two vegetable production (powered by solar energy). At Tikhuba, 17 farmers and at Maphungwane, 3 farmers are using drip irrigation. NGOs are supporting farmer groups with drip irrigation, but scale of use of this technology needs to be expanded.	The National Development Strategy (NDS) advocated for expansion of smallholder irrigation within a national irrigation development plan use. Cultivated land accounts for 191 500 ha or 11% of the total land area of Swaziland. Irrigated land is only 47% of the total cultivated land. The target is to help farmers who are depending on rain fed agriculture to use efficient irrigation technologies such as drip and micro systems. Increasing irrigation has been emphasised under Vision 2022.

2.1.3 Action Plan for Conservation Agriculture

2.1.3.1 Introduction

In Swaziland, CA has been practised for over 10 years, with the use of champion farmers, demonstrations and continuous extension contact training for farmers in all four regions of the country. However, most of the training and practice has been on manual / hand-operated implements such as jab planter and hoe. But mechanisation has caught on with Government led tractor system in place. CA has been promoted through the European Union and FAO funded project Swaziland Agricultural Development Programme (SADP) which began in 2009. The objectives of the 5-year programme were to improve the food security and nutrition of the vulnerable, and to help transform agriculture into a vibrant commercial sector. More than 20 000 smallholder farmers have learned to produce larger quantities of high-quality food and connect with new markets. In addition, construction and rehabilitation work in the livestock sector, water infrastructure and government services have also been top priorities for SADP. Under the programme, 800 backyard vegetable gardens have been established for vulnerable households, and 60 youth groups have been established, reaching 2,250 young people (FAO, 2017). Swaziland's Ministry of Agriculture has been supported by FAO and Cooperation of the Development of Emerging Countries (COSPE) in implementing conservation agriculture since 2002. In addition, World Vision International have also implemented similar programmes and Africa Cooperative Action Trust (ACAT) has brought out a CA Compendium and raised awareness of CA. Whilst all initiatives have tried to promote CA, stakeholders indicated that the up-take is not adequate and there is a need to mechanise it. This will make it attractive to a broader spectrum of farmers and thrust it into the commercial front.

2.1.3.2 Ambition for the TAP

The ambition of the TAP for CA technology is scaling-up CA through setting up CA demonstration sites to be used for training farmers and providing 200 mechanised planters to farmers through the Government tractors hire system and create awareness of this technology.

2.1.3.3 *Actions and Activities selected for inclusion in the TAP*

Summary of barriers and measures to overcome barriers

The major financial barrier identified by stakeholders was that the cost of mechanised planter was too high and farmers wanted to take advantage of the Government's tractor schemes (where farmers can rent tractors for their use as subsidised rates) and use planters to reduce labour and increase production. This is due to high interest rate (around 14%) to borrow money from bank and cost of importing from South Africa (14% VAT is added to the cost). According to Manyatsi and Mhazo (2014) hardly any CA equipment is manufactured in Swaziland, they are all imported.

The next barrier noted by stakeholders is that awareness remains low and many farmers are yet to take up this technology. Furthermore, capacity building needs to be done for extension staff and ways to mechanise CA using mechanised planters is suggested. Creating awareness amongst farmers through setting up demonstration sites and conducting site visits to demonstration plots will help in improving awareness.

Actions selected for inclusion in the TAP

1. 200 mechanised planters provided to the Government's tractor pool for hire by farmers.
2. Set up at least two CA demonstration sites.
3. Create awareness by conducting at least five site visits for farmers to CA demonstration sites and using IEC materials.

Activities identified for implementation of selected actions

1. Solicit funds for mechanized planters through developing proposals and holding meetings with development partners.
2. Procure mechanized planters, through inviting tenders, reviewing and selecting supplier.
3. Distribute mechanized planters to Government Tractor pool.
4. Develop IEC materials such as brochures, billboards, posters and media articles.
5. Organize site visits for communities to CA demonstration sites.
6. Organize awareness sessions for communities through road shows where IEC materials such as brochures would be distributed.

Actions to be implemented as Project Ideas

All actions will be carried forward as project ideas. This will need external funding and hence development of a proposal to raise funds would be required. The action of giving mechanized planters was chosen after much discussion and deliberations amongst stakeholders. Prof. Absalom Manyatsi (agriculture specialist) drew upon his extensive experience and informed the workshop that farmers are interested to mechanize and therefore use of planters will be helpful. Although some CA work has occurred in the country, there was still need for demonstration plots, according to stakeholders. Therefore it was included in the actions, along with creating awareness as an action.

2.1.3.4 *Stakeholders and Timeline for implementation of TAP*

Overview of Stakeholders for the implementation of the TAP

The table below gives the actions proposed and stakeholders responsible for implementing the actions. The rationale for choosing the stakeholders is also included.

Table 14 List of Actions and Stakeholders Responsible for Implementing the TAP

Action	Stakeholders responsible	Rationale for choosing stakeholders
1. 200 mechanised planters provided to the Government's tractor pool for hire by farmers.	Ministry of Agriculture, SNAU (Swaziland National Agricultural Union)	Ministry of Agriculture is the mandated entity with the obligation of ensuring food security in the country. The tractor hire scheme is within this ministry and hence it is the right organization to be made responsible for this action.
2. Set up at least two CA demonstration sites.	Ministry of Agriculture Ministry of Tinkhundla, CANGO, SNAU	Ministry of Agriculture has overall mandate for this action as it is falling under the agriculture sector. The selection of locations for setting up CA demonstration sites would be done in consultation with Ministry of Tinkhundla, NGOs and community based organizations working at the grassroot level. CANGO is the coordinating body to which most NGOs are members. SNAU is a farmer-led organization and has the influence to promote sustainable techniques such as CA amongst farmers and they can help utilise the demonstration site for visits by farmers.
3. Create awareness by conducting at least five site visits for farmers to CA demonstration sites and using IEC materials.	Ministry of Tinkhundla CANGO SNAU Media partners	For this particular action, networking with farmers is important and the right organizations with connections at local level are the ones listed. In addition, creating awareness requires partnership with media.

The main institution responsible for this project would be Ministry of Agriculture and others who will play a part in implementation are:

Table 15 Institutions Responsible for Implementing Actions

Institution	Responsible person
Ministry of Agriculture	Bongani Magongo bhmagongo@yahoo.com
Swaziland National Agriculture Union (SNAU)	Jabulani Tsabedze jabuemkholo@gmail.com
Ministry of Tinkhundla	Tami Nkambule nkambuletami@gmail.com

CANGO	Emmanuel Ndlangamandla director@cango.org.sz
	Mphile Sihlongonyane cango@cango.org.sz

In addition to the above, media, Traditional Authorities, Community Based Organizations, NGOs who may be relevant, Financial Institutions and Development Partners will be involved. Some may be identified per region, once activities on the ground are planned.

Scheduling and sequencing of specific activities

The sequence and timing of specific activities, as well as the nature and scale of the activity is described in table below.

Table 16 Scheduling and Sequencing of Activities for Implementation of Conservation Agriculture

Activity	Nature of activity	Scale of activity	Start	End
1. Solicit funds for mechanized planters through developing proposals and holding meetings with development partners.	This involves holding meetings with relevant stakeholders, recruiting a consultant to develop proposals to raise funds for mechanized planters and presenting the proposals to development partners.	The scale would be national. At national level, all stakeholders responsible would be involved. However, fund raising would be done both within country and internationally.	Month 1	Month 12
2. Procure mechanized planters, through inviting tenders, reviewing and selecting supplier.	Procurement process at Ministry of Agriculture.	National scale, as national supplier will be selected, however, the supplier may import from South Africa if needed.	Month 13	Month 24
3. Distribute mechanized planters to Government Tractor pool.	Hold a launch event when planters arrive in order to create awareness amongst farmers. Incorporate planters into Government's tractor pool through discussion with relevant authorities.	National scale. The planters will be distributed equitably amongst the Tinkhundlas.	Month 25	Month 30

5. Set up at least two CA demonstration sites.	In collaboration with Ministry of Tinkhundla, SNAU and CANGO, Ministry of Agriculture will set up at least two demonstration sites for CA, which will be used as study sites for farmers.	National scale.	Month 24	Month 32
6. Organize site visits for communities to CA demonstration sites.	SNAU will organize farmers to visit the CA demonstration sites. At least five visits will be done to cover farmers from all regions of Swaziland.	National scale.	Month 33	Month 60
4. Develop IEC materials such as brochures, billboards, posters and media articles.	Hold meeting with relevant stakeholders, in particular, the media to develop IEC materials. Printing and publishing of IEC materials.	National scale.	Month 24	Month 48
7. Organize awareness sessions for communities through road shows where IEC materials such as brochures would be distributed.	Ministry of Agriculture will conduct a road show where IEC materials will be distributed. In addition, media articles and information sharing sessions during national environment/ agriculture commemoration days will be held.	National scale.	Month 33	Month 60

The supposition is that once the demonstration sites are set up, and initial round of site visits are done, then farmers will continue to visit to learn from them at their own initiative.

1.1.3.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Farmer's capacity needs to be built through visits to CA demonstration sites. It is assumed that there is capacity within the country for a consultant who can develop the proposal for fund raising.

Estimations of costs of actions and activities

The economic analysis provided in the BAEF report gives further details of how estimations of costs of actions and activities were reached at.

Table 17 Estimation of Costs of Actions and Activities

Activity	Cost categories	Total cost
1. Project planning meetings Minsitry of Agriculture, SNAU, SWADE,	Meeting venue Conference package	\$20,000

CANGO. Development of ToRs for consultant.	Transport Assuming \$20,000 per meeting for two day residential meeting	
2. Recruitment of a consultant for developing proposal for CA	Staff time – in kind contribution Advertisement cost \$5000 Consultant fees \$15,000	\$20,000
3. Present the proposal to development partners and raise funds for mechanized planters	Staff time – in kind contribution	0
4. Procure mechanized planters (Invite tenders, review tenders and select supplier)	Advertisement cost \$5000 Staff time – in kind contribution Cost of medium sized planters is assumed to be E42, 180 including VAT (according to suppliers)	\$567,400
5. Distribute mechanized planters to Government tractors pool	Transport cost \$25,000 Launch event to announce arrival of planters \$5000	\$30,000
6. Set up at least two CA demonstration sites	Meetings with local farmers (\$10,000) <ul style="list-style-type: none"> • Refreshments • Transport costs (<i>only approximations, as sites have not been selected yet</i>) Initial farm inputs (\$40,000)	\$50,000
7. Site visits to CA demonstration sites	Transportation cost Subsistence for farmers	\$7,000
8. Develop IEC materials	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting Printing of IEC materials \$50,000	\$70,000
9. Road show as awareness raising held in selected Tinkhundlas	Transport costs Refreshments Staff allowances Reporting costs, photography Approximately E 150,000 x 5 = E750,000	\$50,000

Assuming exchange rate of 15 Emalangenzi (E) to US Dollar (\$).

2.1.3.6 Management Planning

Risks and Contingency Planning

The major challenge expected from this project is the availability of funding to carry out the activities. Another risk is that Swaziland cannot apply for least developed country funds due to its middle income economic status, hence availability of funding will depend on developing good

proposals to access climate finance. Conservation Agriculture may be included in larger projects focusing on livelihoods.

Another risk is the lack of cooperation as some farmers may not be interested in conservation agriculture. Awareness raising sessions and site visits would be done to inform farmers about the benefits of the technology would help mitigate this risk. Risk of planters not being utilised can be mitigated by careful selection of sites where planters would be made available in consultation of Ministry of Tinkhundla and NGOs.

Next Steps

Immediate requirements to proceed are to hold project planning meetings with Ministry of Agriculture, SNAU, SWADE and CANGO for development of ToRs for consultant. Further immediate step would be to call for applicants to develop proposal for CA which may involve putting out an advertisement, following which the recruitment process begins.

2.1.3.7 TAP overview table

TAP overview table								
Sector	AGRICULTURE							
Sub-sector	Improving adaptation in agriculture sector through promotion of conservation agriculture							
Technology	CONSERVATION AGRICULTURE							
Ambition	To provide 200 mechanized planters to the Government’s tractor pool for hire by farmers, set up at least two CA demonstration sites and conduct at least five site visits for farmers to CA demonstration sites.							
Benefits	Improved farming methods which are resilient to climate change, improved yields and thereby food security and nutrition, capacity building of farmers and extension staff.							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1 Two hundred mechanised planters provided to the Government’s tractor pool for hire by farmers.	Activity 1.1 Project planning meetings held with Ministry of Agriculture, SNAU, SWADE, CANGO for development of ToRs for consultant	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	2 months	Disinterest of stakeholders ToRs may not be well developed	Good participation of stakeholders (number of attendees at meeting)	Minutes of meeting held ToR document	\$20,000
	Activity 1.2 Recruitment of consultant for proposal development	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	5 months	Recruitment process may take longer	Contract signed with consultant	Contract	\$20,000 (advertisement cost \$5,000 and Consultant fee \$15,000)
	Activity 1.3 Present the proposal to development partners	AfDB, World Bank, EU,	Ministry of Agriculture	5 months	Swaziland cannot access the LDC funding	Proposal funded	Proposal document, funding received	0

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	and raise funds for mechanized planters	UNDP, IMF						
	Activity 1.4 Procure mechanized planters, through inviting tenders, reviewing and selecting supplier.	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	11 months	Procurement process may take long	Mechanized planters arrive on site	Good received note	\$567,400
	Launch event to announce arrival of planters	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Ministry of Tinkhundla, CANGO, SNAU	1 day	Farmers may not be interested or their turnout may not be high	Good participation of farmers at launch event	Report of launch event	\$5,000
	Distribute mechanized planters to Government tractors pool	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Ministry of Tinkhundla	5 months	Vandalism or mis-management of tractors	Mechanized planters arrive at Government tractors pool	Inventory of planters	\$25,000
Action 2 Set up two CA demonstration sites.	Activity 2.1 Meetings (at least two) with local farmers	AfDB, World Bank, EU, UNDP, IMF	SNAU and Ministry of Agriculture	2 months	Farmers may resist the technology	Good participation of farmers	Minutes of meetings	\$10,000
	Activity 2.2 Set up demonstration sites, provide farm inputs to farmers	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, SNAU	6 months	Farmers may resist the technology	Good participation of farmers	Demonstration site reports, photographs	\$40,000
Action 3 Create awareness through IEC	Activity 3.1 Develop IEC materials	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Media partners	12 months	Media may not prioritise this	Good participation of media partners	IEC materials	\$70,000

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materials and site visits	Activity 3.2 Organize awareness sessions for communities through road shows where IEC materials such as brochures would be distributed	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	27 months	Response to technology may not be high	Good number of farmers show interest to register for site visits	Report from awareness sessions, Number of farmers registering for site visits	\$50,000
	Activity 3.3 Organize at least five site visits for farmers	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	27 months	Response from farmers may not be enthusiastic	At least five site visits conducted to CA demonstration farms	Number of farmers attending site visits	\$7,000

2.1.4 Action Plan for Drip and Micro Irrigation Technology

2.1.4.1 *Introduction*

Climate change is affecting rainfall patterns and reduction in precipitation in some areas. By its design and working principle the drip irrigation system best meet the environmental, energy-efficient and resource-saving requirements. Drip and sprinkler systems are a means for climate change adaptation as they aid in sustainable water use and management, thereby increasing productivity and strengthening the adaptive capacities of people that are heavily dependent on agriculture. When faced with water scarcity, sprinklers and drip irrigation systems allows for efficient use of water and represent an adaptation strategy against scarcity of water.

This technology contributes to improving food security by enhancing food production. Both drip and micro sprinkler irrigation systems use water efficiently and therefore save water by reducing water losses. Water is also distributed more evenly across crops helping to avoid wastage. Both systems increase crop yield and allow for various types of crops including row, field and tree crops that are grown closely together, such as cereals, pulses, wheat, sugarcane, groundnut, cotton, vegetables and fruits. Swaziland is a mountainous country but has varying topographies suitable for agriculture. Both drip and micro sprinkler irrigation technology is well adapted to a range of topographies and is suitable for all types of soil, except heavy clay. Soluble fertilizers may be used in micro sprinkler systems. Since less water is used at a time, there is less risk of soil erosion because soil disturbance is low. There are secondary benefits from improved crop productivity such as income generation, employment opportunities and food security.

Irrigation accounts for 96% of water use in the country and in the wake of climate change it is imperative that this valuable resource be efficiently used and conserved. In this regard, micro and drip irrigation as a technology is useful and was prioritised under the TNA project. The goal of efficient irrigation (micro and drip) is to supply each plant with just the right amount of water it needs, thereby reducing wastage of water. Both systems can be gravity fed or pressurized. Adaptation of this technology promotes sustainable management of energy, water, land, and labour. Under conditions of increased water stress resulting from climate change the benefits of the technology rises quite significantly.

Micro sprinklers (also known as: spray jets, micro sprayers, misters) are a combination of surface spray irrigation and drip irrigation and are rated by flow rate, wetting diameter or radius. They operate at low pressures but create a larger wetted area than drip irrigation and are used when low volume overhead irrigation is desired, and for areas where drip irrigation are not practical. The micro sprinklers and micro sprayers deliver water through micro tubing to a series of nozzles attached to risers, and have small to medium sized droplets with good uniformity of coverage and lower precipitation rate, allowing longer watering time with less runoff. Micro sprayers are used extensively in agriculture using one micro sprayer per tree and under the tree canopy. Both the drip and micro irrigation technology is suitable for various users from small scale to large scale and can be low-cost gravity-fed or automatic and pressurized.

2.1.4.2 Ambition for the TAP

The ambition is promotion of micro and drip irrigation through subsidy of the kits for 1,000 vegetable farmers at 50% of its cost and creating awareness of the technologies. The Government of Swaziland has identified the development of smallholder agriculture from subsistence farming to commercialization and intensification farming as the main element in its aims to alleviate poverty. Irrigation plays an important role in achieving this and is a priority for the Government of Swaziland. Improving irrigation has been mentioned as a priority in various national policies and documents including the National Strategy and Action Plan.

2.1.4.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

The main barrier was financial. The capital costs of buying and installing the irrigation equipment and costs of maintenance are not affordable to many. Since highly skilled labour is needed for installation, operation, storage and movement of irrigation systems, this adds to the costs. The high capital cost is due to few suppliers available for this technology. Often the technology has to be imported from South Africa and transportation to remote areas is costly. Furthermore, the high interest rate for borrowing money (15-17%) and need for collateral as asked by banks, make it difficult for farmers to get loans to buy this technology. To overcome this barrier, subsidy would be given to 1000 vegetable farmers for 50% of the cost of drip and micro irrigation kits.

The non-financial barrier is the lack of legal instrument that encouraged efficient irrigation technology or provides incentives for efficient use of water. Furthermore, there is no Irrigation Act that can control and regulate methods of use of water for irrigation. A measure would be to develop an Irrigation Act and revise existing legal instruments to include incentives for efficient irrigation. However, for this TAP, Stakeholders did not prioritise this and hence this measure is not included.

According to stakeholders, in Swaziland, there is low awareness about this technology and the measure suggested was to create awareness of the technology and how to use it.

Actions selected for inclusion in the TAP

1. Subsidize micro and drip irrigation kits by 50% of its cost for 1,000 vegetable farmers
2. Create awareness of micro and drip irrigation technology through awareness raising sessions, media reports, billboards.

Activities identified for implementation of selected actions

1. Hold a project planning meeting organized by Ministry of Agriculture. Develop ToRs for consultant to develop proposal.
2. Recruit a consultant who will develop a proposal for subsidy of 50% for micro and drip irrigation kits.
3. Consultant and Ministry of Agriculture to meet with development partners to raise funds using the proposal.

4. In consultation with relevant stakeholders, Identify 1,000 farmers who will be recipients for subsidized micro and drip irrigation kits
5. Procure micro and drip irrigation kits.
6. Set up a temporary distribution center and distribute subsidy vouchers to 1,000 farmers to be utilized within 6 months
7. Transfer funds to suppliers of micro and drip irrigation kits upon delivery of vouchers collected
8. Develop IEC materials such as brochures, billboards, posters on drip and micro irrigation technology.
9. Organize awareness sessions for communities through road shows where IEC materials such as brochures would be distributed.

Actions to be implemented as Project Ideas

Both the actions of subsidizing micro and drip irrigation kits and creating awareness will be implemented as project ideas. There was consensus that water savings and water efficient technologies need to be used in Swaziland and there was scope as not many farmers do use micro and drip irrigation. The main barrier in using them was the cost factor, thus it was agreed that subsidy could be given. Initially the ambition was to give subsidy to a large number of farmers (20,000), later stakeholders scaled that down to 1,000 vegetable farmers. Currently Swaziland still imports vegetables from South Africa and only produced enough to meet 20% of the demand in the country. Using this technology, this will improve supply of vegetables providing better economic benefits to farmers.

2.1.4.4 Stakeholders and Timeline for Implementation of TAP

Overview of Stakeholders for the implementation of the TAP

The table below gives the actions proposed and stakeholders responsible for implementing the actions. The rationale for choosing the stakeholders is also included.

Table 18 List of Actions and Stakeholders Responsible for Implementing Actions

Action	Stakeholders responsible	Rationale for choosing stakeholders
1. Subsidize micro and drip irrigation kits by 50% of its cost for 1,000 vegetable farmers	Ministry of Agriculture, SNAU, Ministry of Tinkhundla,	Ministry of Agriculture is the mandated body for ensuring food security in the country and providing support to farmers. Farmers in the country are members of the Swaziland National Agricultural Union. Being a farmer led organization, SNAU promotes good practises in farming and supports farmer groups to obtain technology and insurance to prevent yield losses and improve productivity. At local level, it is Ministry of Tinkhundla through the decentralised and traditional authorities that can facilitate implementing projects at local level.

2. Create awareness of micro and drip irrigation technology through awareness raising sessions, media reports, billboards.	Ministry of Agriculture, SNAU, CANGO, Media partners	Ministry of Agriculture and SNAU works closely with farmers, while CANGO will help in raising awareness of the technology though its network of NGOs and media partners will play a role in making media reports to promote the technology.
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The main institution responsible for this project would be Ministry of Agriculture and others who will play a part in implementation are:

Table 19 Institutions responsible for implementing the measures

<i>Institution</i>	<i>Responsible person</i>
Ministry of Agriculture	Bongani Magongo bhmagongo@yahoo.com
Swaziland National Agriculture Union (SNAU)	Jabulani Tsabedze jabuemkholo@gmail.com
Ministry of Tinkhundla	Tami Nkambule nkambuletami@gmail.com
CANGO	Emmanuel Ndlangamandla director@cango.org.sz
	Mphile Sihlongonyane cango@cango.org.sz

In addition to the above, development partners, Traditional Authorities, Community Based Organizations, NGOs who may be relevant, Financial Institutions and Development Partners will be involved. Some may be identified per region, once activities on the ground are planned. For raising funds, Development Partners will be approached.

Scheduling and sequencing of specific activities

The sequence and timing of specific activities, as well as the nature and scale of the activity is described in table below.

Table 20 Scheduling and Sequencing of Activities for Implementation of RWH

Activity	Nature of activity	Scale of activity	Start	End
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<p>1. Hold a project planning meeting organized by Ministry of Agriculture. Develop ToRs for consultant to develop proposal.</p>	<p>Ministry of Agriculture as the lead institution will spearhead the project and hold a planning meeting with relevant stakeholders. The first meeting will lay out specific tasks:</p> <ul style="list-style-type: none"> • Project design and scope, • Proposal development to raise funds for subsidy (develop ToRs for consultant to make proposal) • Plans for awareness raising. 	<p>The scale would be national. Meetings (at least 3) with around 12 persons from relevant bodies will be held at Government offices using existing facilities.</p>	<p>Month 1</p>	<p>Month 3</p>
<p>2. Recruit a consultant who will develop a proposal for subsidy of 50% for micro and drip irrigation kits.</p>	<p>Advertisement and recruitment of a consultant to prepare proposals</p>	<p>National scale, where consultant will be recruited locally</p>	<p>Month 3</p>	<p>Month 6</p>
<p>3. Consultant and Ministry of Agriculture to meet with development partners to raise funds using the proposal.</p>	<p>Ministry of Agriculture will present the proposal to development partners such as World Bank, IMF, European Union, UNDP</p>	<p>International scale. The proposal will be sent to development partners both within the country and internationally.</p>	<p>Month 7</p>	<p>Month 14</p>
<p>4. In consultation with relevant stakeholders, Identify 1,000 farmers who will be recipients for subsidized micro and drip irrigation kits</p>	<p>Ministry of Agriculture, SNAU and Ministry of Tinkhundla</p>	<p>Tinkhundla scale. Local authorities and local farmers will be contacted to identify beneficiaries.</p>	<p>Month 14</p>	<p>Month 20</p>

5. Procure micro and drip irrigation kits.	Ministry of Tinkhundla will identify households for subsidy programme	At Tinkhundla level	Month 21	Month 25
6. Set up a temporary distribution center and distribute subsidy vouchers to 1,000 farmers to be utilized within 6 months	Ministry of Agriculture and Ministry of Tinkhundla would have a subsidy distribution system, which could take the shape of temporary distribution centers in local schools	At Tinkhundla level	Assuming funds are available Month 26	Month 30
7. Transfer funds to suppliers of micro and drip irrigation kits upon delivery of vouchers collected	Ministry of Agriculture ensures funds are transferred to supplier	National level	Month 31	Month 32
8. Develop IEC materials such as brochures, billboards, posters on drip and micro irrigation technology.	Ministry of Agriculture and media partners	National level	Month 33	Month 35
9. Organize awareness sessions for communities through road shows where IEC materials such as brochures would be distributed.	Ministry of Agriculture, media partners and CANGO undertake road shows and awareness raising	National level	Month 26	Month 30

2.1.4.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Capacity needs include a consultant to develop proposal for raising funds for drip and micro irrigation systems and this involves the consultant holding meetings or workshops with national stakeholders to

develop the proposals for fundraising. Capacity building of general public is done through creating awareness using IEC materials and road shows.

Estimations of costs of actions and activities

An estimate of how much it would cost to implement the TAP developed on basis of the economic assessment undertaken as part of the BAEF report. Assuming equal number of drip and micro irrigation kits, the total cost is as below (for more details, refer to BAEF report).

500 drip irrigation kits would cost E1, 888.98 x 500 = E 944,445.

500 micro irrigation kits would cost E 16,758.93 x 500 = E8,379,465.

Total cost is E 9,323, 910 which is equivalent to \$621,594.

Estimated costs for actions and activities are explained below.

Table 21 Estimation of Costs of Actions and Activities

Activity	Cost categories	Total cost
1. Hold a project planning meeting organized by Ministry of Agriculture. Develop ToRs for consultant to develop proposal.	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
2. Recruit a consultant who will develop a proposal for subsidy of 50% for micro and drip irrigation kits.	Staff time Advertisement cost	\$5000
3. Consultant develops proposal and Ministry of Agriculture meet with development partners to raise funds using the proposal.	Consultant fees \$20,000	\$20,000
4. In consultation with relevant stakeholders, Identify 1,000 farmers who will be recipients for subsidized micro and drip irrigation kits	Meeting venue Conference package Transport Assuming \$5,000 per meeting for one day non-residential meeting	\$5,000
5. Procure micro and drip irrigation kits.	Cost of kits \$620,015	\$620,015
6. Set up a temporary distribution center and distribute subsidy vouchers to 1,000 farmers to be utilized within 6 months	Salaries to temporary officers for two months E 20,000 Rent for hiring rooms for a number of temporary subsidy distribution centers E 50,000	\$ 4,667

7. Transfer funds to suppliers of micro and drip irrigation kits upon delivery of vouchers collected.	Staff costs – in kind contribution	0
8. Develop IEC materials such as brochures, billboards, posters on drip and micro irrigation technology.	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting Printing of IEC materials \$30,000	\$50,000
9. Organize awareness sessions for communities through road shows where IEC materials such as brochures would be distributed.	Road show of 7 days costs E350,000 (transport, allowances) E50,000 accommodation and subsistence for staff	\$26,667

Assuming exchange rate of 15 Emalangeni (E) to US Dollar (\$).

2.1.4.6 Management Planning

Risks and Contingency Planning

Swaziland, due to not being a least developed country cannot access some of the climate finance under that category due to its middle income economic status. Thus, good proposals need to be developed to get these actions funded through other sources of funding. Approaching development partners already in the country and incorporating these technologies into planned projects could be a way to mitigate this risk.

There could be conflicts arising from choice of beneficiaries. This can be mitigated by choosing farmers from vulnerable groups, such as elderly female farmers who have orphans under their care. Another risk could be lack of cooperation from farmers as they may be resistant to new technologies and change. Awareness raising sessions would be done to inform farmers about the benefits of the technology. Some beneficiaries may buy the equipment and resell it to others, this can be mitigated through community meetings in the beginning and follow up meetings to check up-take of technology.

Next Steps

Immediate requirements to proceed are:

1. Hold a project planning meeting organized by Ministry of Agriculture. Develop ToRs for consultant to develop proposal.
2. Recruit a consultant who will develop a proposal for subsidy of 50% for micro and drip irrigation kits.

2.1.4.7 TAP overview table

TAP overview table								
Sector	AGRICULTURE							
Sub-sector	Adaptation for agriculture sector through increasing access to irrigation and using efficient irrigation methods.							
Technology	MICRO AND DRIP IRRIGATION							
Ambition	To subsidize micro and drip irrigation kits by 50% of its cost for 1,000 vegetable farmers and create awareness the technology.							
Benefits	Increased access to irrigation technology, improved adaptation for farmers, improved yield and thereby nutrition and enhanced capacity on technology.							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1 Subsidize micro and drip irrigation kits by 50% of its cost for 1,000 vegetable farmers	Action 1.1 Hold a project planning meeting organized by Ministry of Agriculture. Develop ToRs for consultant to develop proposal.	AfDB, World Bank, EU, UNDP, IMF	MNRE	3 months	Disinterest of stakeholders	Good participation of stakeholders (number of attendees at meeting)	Minutes of meeting held	\$20,000
	Action 1.2 Recruit a consultant who will develop a proposal for subsidy of 50% for micro and drip irrigation kits.	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	3 months	Recruitment process may take longer time	Contract signed by consultant	Contract document signed	\$5000
	Action 1.3 Consultant develops proposal and Ministry of Agriculture meet	AfDB, World Bank, EU,	Consultant	7 months	Proposal may not be well developed	Good proposal developed	Proposal document	\$20,000 (consultant fee)

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	with development partners to raise funds using the proposal.	UNDP, IMF						
	Action 1.4 Presentation of the proposal to development partners	Ministry of Agriculture	Ministry of Agriculture	7 months	The response to proposal may not be positive	Proposal getting funded	Offer of funding documents	0
	Action 1.5 In consultation with relevant stakeholders, Identify 1,000 farmers who will be recipients for subsidized micro and drip irrigation kits (preparing to roll out the technology)	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Ministry of Tinkhundla, SNAU, CANGO	6 months	Conflicts amongst farmers in the choice of beneficiaries	Select farmers equitably and with a wide spread across the regions of Swaziland. At end of the project all 1,000 farmers are using this technology as intended.	List of 1,000 farmers	\$5,000
	Action 1.6 Procure micro and drip irrigation kits.	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Ministry of Tinkhundla, SNAU	4 months	Delays in procurement	High quality irrigations kits procured in timely manner	Irrigation kits available	Cost of kits \$620,015
	Action 1.7 Distribute subsidy vouchers to 1,000	AfDB, World Bank, EU,	Ministry of Agriculture, Ministry of	4 months	Conflicts at distribution centers for	Choosing vulnerable households and using	Report of distribution of subsidy	\$ 4,667

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	farmers to be utilized within 6 months	UNDP, IMF	Tinkhundla, SNAU		choice of households	transparent process for selection of beneficiaries		
	Action 1.8 Transfer funds to suppliers of equipment upon delivery of vouchers collected (Rolling out the technology)	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture	2 months	Funds transfer may get delayed	Ministry of Agriculture to follow up the process	Proof of funds transferred to suppliers	Staff time- In kind contribution
Action 2 Create awareness of micro and drip irrigation technology through awareness raising sessions, media reports, billboards.	Action 2.1 Ministry of Agriculture to meet with media partners to prepare IEC materials and send to suppliers for printing	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Media Partners	3 months	Media partners may not be interested	MNRE to collaborate and convince media partners	IEC materials	\$50,000
	Action 2.2 Conduct road shows	AfDB, World Bank, EU, UNDP, IMF	Ministry of Agriculture, Media Partners	4 months	Public may not be interested	Interesting road show attracts public and awareness is raised.	Report and photographs of road show	\$26,667

2.2 Project Ideas for Agriculture Sector

2.2.1 Brief summary of the Project Ideas for Agriculture Sector

The project ideas are concrete actions supporting the realisation of the overall target indicated in the Technology Action Plan for the sector. Project ideas were identified by stakeholders after discussion and deliberations at stakeholder workshops. The proposed project idea for agriculture sector include following project ideas:

- Up-scaling CA through setting up CA demonstration sites to be used for training farmers and providing 200 mechanised planters to farmers through the Government tractors hire,
- Promotion of micro and drip irrigation through subsidy of the kits for 1,000 vegetable farmers at 50% of its cost and creating awareness of the technologies.

This project idea was conceived in a brainstorming session at the TAP stakeholder's workshop and later developed by the Consultant. Economic Analysis information provided in the BAEF report helped make some of these decisions. It is expected that the actions proposed in the project idea will help farmers and in general the agriculture sector effectively adapt to climate change.

Project Idea for Conservation Agriculture

Introduction/Background

Conservation agriculture refers to a number of strategies and techniques for establishing crops in a previous crop's residues, which are purposely left on the soil surface. It improves yield and is suitable for a range of crops including grains, vegetables, root crops, sugar cane, cassava, fruit and vines. In the wake of climate change, conservation agriculture is useful as it requires less labour, stores carbon below ground (good for mitigation too) and improves yields helping people adapt better through improved incomes. In Swaziland, CA has not been up-scaled to a large extent and stakeholders felt this technology needs to be prioritised.

Objectives

The project aims to scale-up conservation agriculture through setting up CA demonstration sites to be used for training farmers and providing 200 mechanised planters to farmers through the Government tractors hire system and create awareness of this technology.

Outputs

The outputs expected are: 200 mechanized planters made available at Government tractors hire, at least two demonstration sites for CA and awareness raising sessions held. Reports and photographs will provide evidence.

The project is in alignment with the National Development Strategy and Vision 2022 which calls for improving food security in the country. The Third National Communication to UNFCCC (2016) and Swaziland's Nationally Determined Contribution (INDC) to the UNFCCC, prioritized adaptation technologies including conservation agriculture.

Project Deliverables

The values accrued from this project will be providing socio-economic benefits to farmers and also have benefits for the environment. Farmers will be better resilient with this technology and it will provide improved yields and thereby greater incomes.

Project Scope and Possible Implementation

The scope of the project includes a mix of a number of actions including providing mechanized planters to farmers, training farmers using demonstration sites and creating awareness about CA technology.

Project activities

Project activities include developing proposals for funding purchase of 200 mechanized planters which will be supplied to farmers through Government's tractors pool. The activities also include setting up two demonstration sites which will act as training centers for farmers and creating awareness through road shows and IEC materials about the CA technology.

Timelines

The timeline for implementation of all the actions in this project is five years and activities are phased and timed.

Budget/Resource requirements

The total budget is \$814,400, with cost of mechanized planters at \$567,400. Other costs include recruitment of consultant to develop proposal, awareness raising costs and demonstration plots costs.

Measurement/Evaluation

Deliverables from the project include a proposal that is successful in raising funds for CA activities, mechanized planters bought, awareness raising done and demonstration sites set up.

Possible Complications/Challenges

The major challenge that the project could face is that of lack of funding as a substantial amount of funds are needed. Good fundable proposals need to be developed. Another challenge could be lack of cooperation from communities in adopting the technology. Setting up demonstration plots where field days will help farmers to appreciate the benefits of CA will help address this challenge.

Responsibilities and Coordination

The main responsibility rests with Ministry of Agriculture who will oversee the project, coordinate it and undertake monitoring and evaluation. During implementation, local authorities, NGOs and communities will be involved.

Project Idea for Drip and Micro Irrigation

Introduction/Background

Water is a finite natural resource and essential for agriculture. Water saving and water efficient technologies such as micro and drip irrigation helps in improving adaptive capacity of farmers. Drip irrigation is a series of carefully placed emitters, water could be delivered right to the root zones of plants. Micro-irrigation is the slow application of water as discrete or continuous drips, tiny streams or miniature spray on, above, or below the soil by surface drip, subsurface drip, bubbler and micro-sprinkler systems. This project involves subsidizing micro and drip irrigation kits to 1000 vegetable farmers and creating awareness about the technology in Swaziland.

Objectives

The project aims to subsidize 1000 farmers with micro and drip irrigation technology at 50% of its cost and creating awareness about the technology.

Outputs

The outputs expected are: 1,000 farmers will be using drip irrigation and micro irrigation at the end of the project and many more farmers would be aware of the technology.

The project is in alignment with Swaziland's National Development Strategy and policies related to agriculture, as the technology promotes efficient irrigation for improved farm yields which lead to greater income for farmers and thereby economic development in the country. The Third National Communication to UNFCCC (2016) and Swaziland's Nationally Determined Contribution (INDC) to the UNFCCC, prioritized adaptation technologies including micro and drip irrigation.

Project Deliverables adequate

The deliverables include 1,000 farmers using micro and drip irrigation and thereby improving their socio-economic status. Furthermore, promotion of this technology will provide environmental benefits through reduced wastage of water for irrigation and building capacity for other farmers to use this technology.

Project Scope and Possible Implementation

The scope of the project is to have many actions that will promote use of water saving and efficient irrigation technology of micro and drip irrigation. Funds would be raised through writing proposals and subsidy of 50% of the cost of irrigation technology would be provided to 1,000 farmers. Awareness would be raised on the technology to promote its widespread use.

Project activities

Project activities include holding project planning meetings, developing ToRs for consultant to develop proposal and raising funds through the proposal for subsidy of 50% of cost of irrigation technology for 1,000 farmers. Once the micro and drip irrigation kits are procured, a temporary distribution center will be set up and subsidy vouchers distributed to 1,000 farmers to be utilized within 6 months. Furthermore, IEC materials such as brochures, billboards, posters on drip and micro irrigation technology will be developed and awareness raising sessions for communities through road shows will be done.

Timelines

The timeline for implementation of all the actions in this project is three years and actions will be phased out over this period.

Budget/Resource requirements

The total budget is \$751,349 and cost of subsidy is \$621,594. A consultant will be hired for developing proposals for funding.

Measurement/Evaluation

Deliverables from the project include a proposal that is successful in raising funds for subsidy of irrigation equipment, the subsidy programme rolled out and awareness raising done through road shows and use of IEC materials. Report and photographs will provide evidence of the work.

Possible Complications/Challenges

The major challenge that there could be conflicts arising from choice of beneficiaries for subsidy. This can be mitigated by choosing farmers from vulnerable groups. Raising funds will be another challenge therefore good consultant who can develop good quality proposals is essential.

Responsibilities and Coordination

The main responsibility rests with Ministry of Agriculture who will oversee the project, coordinate it and undertake monitoring and evaluation.

Chapter 3 Technology Action Plan and Project Ideas for Forestry and Biodiversity Sector

3.1 TAP for Forestry and Biodiversity Sector

3.1.1 Forestry and Biodiversity Sector overview

Forests provide important ecosystem services such as provisioning of food, materials, medicine, have ecological functions of storing water and slowly releasing, detoxifying waste and provides attractions for tourists. Swaziland has a number of national parks such as Malototja, Hlane, Mkhaya, Milwane and other smaller reserves, which host a number of endangered fauna and flora. Healthy forests and ecosystems are vital to implementation of climate change adaptation and mitigation strategies. Forests and ecosystems provide services which are beneficial to ensuring that livelihoods can withstand shocks of climate change and become resilient. Swaziland prides in it being a tourist attraction, which is mostly because of Swaziland's rich biodiversity in its various natural parks where flora and fauna species run into thousands, however they are vulnerable to climate change impacts. As temperatures rise and rainfall patterns change with climate change, these biotic systems will undergo change and will shift habitats of species, which may result in loss of biodiversity. Drier and hotter conditions will trigger wildfires. Invasive alien species will find some areas favourable to their growth with the changing climate and due to the fact that they may not have pests that control their growth, their presence will spread rapidly. When forests are affected, the hydrological functions of forests are also affected and in areas where forests have been affected by fire or deforestation by humans, water runoff will be higher, which may cause localised flooding in some areas. The main decision context for this sector is provided by the National Climate Change Strategy and Action Plan which states the need for an ecosystem based approach to biodiversity conservation and calls for strengthening national forest management and enforcement.

Table 22 Policies and measures related to Forestry and Biodiversity sector for Swaziland

Name of policy/measure	Year enacted	Main contents
Wild Bird Act	1914	The government of Swaziland made an Act to prohibit with certain exceptions the sale and exportation of the plumage and skins of wild birds and to provide for the protection of birds. Legislation relating to wild birds has not been updated since 1914.
Amendment of the Fisheries Act	1937	This emphasises on conservation of indigenous fish species. Permits are issues to fishers before they can go fishing. This a practice for both subsistence and commercial fishers.
The Protection of Fresh Water Fish Act	1938	This is an Act in the kingdom of Swaziland to make provision for the protection of fresh water fish.
The Plant Control Act	1981	The object and main purpose of this Act is to provide control, movement and growing of plants and matters incidental thereto. It creates a Nursery Registration Board who shall be responsible for the registration of new nurseries.

Swaziland Environment Action Plan (SEAP)	1997	This strategy of Swaziland takes cognisance of IK systems that they are excluded in present management of biodiversity activities & that there are biodiversity/community conflicts around CAs where there is denied use (access) to biodiversity resources. It also seeks to achieve a sustainable balance in the use of land, water and other natural resources between production systems, rural settlements and protection of the environment; and to maintain and improve biodiversity of indigenous and introduced systems in agricultural systems.
National Environmental Policy (NEP)	1999	This strategy of Swaziland has an objective to promote the enhancement, protection and conservation of the environment and the attainment of sustainable development in Swaziland. It safeguards rights of communities and ensures that they share in the benefits.
National Development Strategy (Vision 2022)	1999	This is a long-term strategy developed by the Swaziland Government in 1999 to guide the course of socio-economic development of the Kingdom over a twenty five-year period up to 2022. The document emphasises the need to implement the national biodiversity and action plan and talks about afforestation and other measures to protect forestry sector.
Poverty Reduction Strategy and Action Plan (PRSAP)	2007	The strategy and action plans calls for promotion of forestry, addressing bush fires, deforestation, degradation, controlling alien species, promoting awareness about tree planting and income generation activities.
The Flora Protection Act	2000	The legislation for the protection of indigenous flora was updated in 2000. This replaced The Flora Protection Act of 1952. An Act to protect the indigenous flora of Swaziland. This prohibits any person from plucking, gathering, cutting, uprooting, injuring, breaking or destroying a plant of any species that is listed in the Schedule to the Act.
Draft National Land Policy (NLP)	2000	This policy is to maximise benefits to the entire society from land on a sustainable basis. The Draft National Land Policy is a discussion document on the issues and policies surrounding the question of land management in Swaziland. The policy covers human Rights Issues and Policies; Cultural Issues and Policies; Land Tenure Issues and Policies; Land Use and Land Management Issues and Policies; Land Market Issues and Policies; and - Land Administration Issues and Policies.
The Environmental Audit, Assessment and Review Regulations	2000	Regulations that provide the legal framework for undertaking environmental assessments and audits for a variety of project activities. This overlaps with areas of forestry and biodiversity interests.

National Forest Policy	2001	It lays down principles for the protection of the indigenous forest of Swaziland. To very minimal level, the policy lays ground for the equitable sharing of benefits accruing from the conservation of forests.
The Environmental Management Act	2002	Legislation relating to environmental management. This supersedes the Swaziland Environmental Authority Act, 1992. An Act to provide and promote the enhancement, protection and conservation of the environment, sustainable management of natural resources and matters incidental thereto. It is intended to provide and promote the enhancement, protection and conservation of the environment and the sustainable management of natural resources. It also turned the Swaziland Environment Authority (SEA) into a body corporate and established the National Environment Fund.
Biodiversity Conservation and Management Bill	2008	This mandates the state to protect and make rational use of its land, mineral, water resources as well as its fauna and flora, and shall take appropriate measure to conserve and improve the environment for the present. This bill promotes conservation of biodiversity in Swaziland and discourages depleting of environmental resource without sustainable use.
Forestry Bill	2010	It has access to forestry resource is controlled through this bill. It promotes sustainable forest harvesting. Its main focus is on forestry and forest-related public bodies operating at the national and local level. Details on the decentralization processes and structures are also provided, when available.
Forest Preservation Act (No. 14 of 1910)	1910	This Act places restrictions on the cutting of indigenous or government timber and provides otherwise for the protection of such timber. "Government timber" means any trees and bushes planted under the direction of the Minister on government land or on Swazi nation land and "indigenous timber" means forest trees or their saplings growing on Government land or on Swazi Nation Land, not planted by human agency. No cutting or interference with land close to where such timber grows shall take place.
Natural Resources Act	1951	The Act provides for the establishment of the Natural Resources Board, whose functions shall: (a) except in respect of Swazi areas to exercise supervision over natural resources; (b) to promote the conservation and improvement of natural resources; (c) to advise the Minister of Agriculture on the proper conservation, use and improvement of natural resources.
The Private Forests Act	1952	Also known as the Agriculture Act 3 of 1952, the act was commenced on 16th March, 1961. The purpose of the Act is to provide for the better regulation and protection of private forests in Swaziland.
The Game Act, 1953 and The Game 9	1991	This act includes the legislation for establishment of wildlife sanctuaries. The Game Act was modified in 1991 by the introduction of the Game Amendment.

(Amendment) Act, 1991		
The Constitution of the Kingdom of Swaziland Act No. 1 (Government of Swaziland, 2005)	2005	Section 210 (2) mandates the state to protect and make rational use of its land, mineral, water resources as well as its fauna and flora, and shall take appropriate measure to conserve and improve the environment for the present and future generation.
The National Biodiversity Strategy and Action Plan (NBSAP)	2016	The NBSAP recognizes the existence of the 22 pieces of sectoral legislation that need to be harmonized. It calls for the formulation of a comprehensive National legal framework for sustainable use and equitable sharing of benefits arising from the utilization of biological resources. The NBSAP design is to advance the present state of the nation's biodiversity by checking, lessening of dangers and weights, protecting biological systems and setting up and advancing economical usage. It incorporates procedures on reasonable usage and protection of amphibian assets including wetlands and stream bowls (SEA, 2017).

Stakeholders prioritised three technologies under this sector and they were agroforestry, conservation of genetic resources and alien invasive species management. For the TAP phase agroforestry and conservation of genetic resources are covered in detail.

3.1.1.1 Agroforestry

Agroforestry helps restore agro ecosystems degraded due to lack of organic matter from agricultural intensification and poor ecosystem management. It is a land-use practice that encompasses planting of trees along with crops and also keeping livestock in the same field. This practice helps improve soil fertility. Generally, agroforestry systems can be categorised into three broad types: agro silviculture (trees with crops), agri silvipasture (trees with crops and livestock) and silvo pastoral (trees with pasture and livestock) systems. Agroforestry practices include alley cropping, boundary plantings/living fences, multi-strata and scattered farm trees. Agroforestry can improve the resilience of agricultural production to current climate variability as well as long-term climate change through the use of trees for intensification, diversification and buffering of farming systems. Trees have an important role in reducing vulnerability, increasing resilience of farming systems and buffering agricultural production against climate-related risks. Trees are deep rooted and have large reserves, and are less susceptible than annual crops to inter-annual variability or short-lived extreme events like droughts or floods. Thus, tree-based systems have advantages for maintaining production during wetter and drier years.

There is limited adoption of agroforestry in Swaziland, although some programmes are promoting it and it is gaining momentum. However, stakeholders felt that the technology needs to be scaled up. They identified the following barriers:

1. Farmers think of short-term benefits and agroforestry only accrues benefits in the long term. This mind-set needs to be changed and can be changed through training and awareness raising.
2. Extension agents are not promoting agroforestry enough. This could be due to knowledge gap or lack of impetus. Rolling out an agroforestry programme will involve extension agents in providing training to farmers and may give the motivation to promote the technology.

3.1.1.2 Conservation of Genetic Resources

Conservation of genetic resources arose from the thoughts of gene resource conservation which began in the 1910's by agriculturalists who wanted to use wild relatives of crops in breeding programs. This is in response to the worry that scientists had that the genetic diversity of plant and animal breeders was rapidly being lost. Conservation of genetic resources is important as even maintaining productivity requires constant input of new genetic material to over-come crop losses due to pests that become pesticide resistant. This also helps with climate change as higher diversity in crops will make the farmer more resilient to changing weather and climate patterns. This also helps improve yields and withstand shocks of climate change. This technology helps in conservation of biodiversity and reduces species extinction (SEA, 2014). It also helps farmers in building a pool of robust seeds which can withstand varying climatic conditions and thereby help in adaptation.

There are two major alternatives for the conservation of genetic resources and they are in situ and ex situ. In situ conservation refers to the conservation of important genetic resources in wild populations and land races, and it is often associated with traditional subsistence agriculture. Ex situ conservation refers to the conservation of genetic resources off-site in gene banks, often in long-term storage as seed. The focus of conservation of genetic resources in Swaziland is in the forestry sector. In situ conservation and ex situ conservation can be done and the focus in the country is on in situ conservation. Stakeholders at the workshop also suggested in situ conservation which they felt would benefit the local farmer and land user. Furthermore, establishing seed banks and undertaking research would be expensive and not entirely necessary considering Swaziland's neighbour South Africa has capacity to do this and are currently doing it. Stakeholders at the BAEF workshop and in bilateral interview stated that there is need to strengthen and establish in situ methods of genetic conservation. This can be in the form of establishment of botanic gardens and reserves as well as field gene banks. Stakeholders highlighted that there is no national botanical garden in the country. There is also need to train adequate manpower in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethno botany to carry out the above activities.

3.1.2 Current level of uptake of technologies

Swaziland National Plant Genetic Resource Centre (SPGRC) is the unit entrusted with the task of saving through collection and subsequent conservation of the country's biodiversity treasure. The SPGRC operates under the umbrella of the Agricultural Research Division of the Ministry of Agriculture based at the Malkerns Research Station. Swaziland has a Genebank which is operating under the Ministry of Agriculture and Cooperatives, the research division in Malkerns Research Station focuses on the Conservation of threatened indigenous crops and promoting the conservation and sustainable use of plant genetic resources. There is also a Seed Quality Control services, Malkerns Research Station. Under this division, the institution focuses on ensuring that seed supplied to farmers is of high quality, monitoring seed production processing and sale in accordance to standards set. Furthermore the institution is involved in activities of seed certification, seed testing, periodic sampling and germination test of carry-over seed, and registration and monitoring seed stakeholders. Plant Documentation and control division is operating under the Ministry of Agriculture and Cooperatives and located in Malkerns Research Station, the division aims at assimilating and disseminating knowledge and to promote the sustainable usage of plant heritage and the ecosystems in which they live. Furthermore, the

institutions endeavours to conserve the plant biodiversity of Swaziland and to encourage sustainable use of biodiversity in Swaziland through activities of plant collection and identification, plant conservation, documentation of the flora of Swaziland and update legislation for flora protection.

The current level of uptake of the conservation of genetic resources technologies are inadequate, according to stakeholders. Swaziland’s National Development Strategy (Vision 2022) and other international obligations such as the Aichi Targets under the auspices of the Convention on Biological Diversity have set targets for the conservation of its ecosystems and species. Furthermore, targets have been set up and needs identified by the Department of Forestry for setting up a botanical garden and building capacity for officers, which are addressed in this TAP.

Table 23 Current Level of Uptake for Technologies Prioritized

Technology	Current level of uptake	Future targets
Agroforestry	The technology has been tested and around 300 farmers already received training in 2011 (pers. comm. Absalom Manyatsi).	The target is for agroforestry technology to be up-scaled following the model of training famers which was done by Forestry Department of the Ministry of Tourism together with the Extension Officers from the Ministry of Agriculture and found successful. This involves training farmers on intercropping, improved fallow, alley planting, live fence/hedge row planting/wind breaks, fodder production and woodlots. The training will be conducted as a package with class room training, site visits and providing ten seedlings per farmer after the training to implement this technology in their farms.
Conservation of Genetic Resources	Swaziland has a National Herbarium Secretariat, a plant genetics research center and a private botanical garden. There is no national botanical garden in Swaziland.	The target for choosing the measure of establishing a national Botanical Garden and Field Gene Bank, was set by Department of Forestry who already had a proposal to set up a botanical garden, but it did not receive funding and therefore did not take off. SEA has indicated the need for capacity building of staff of SEA, SPGRC, National Tree Seed Centre and National Gene Bank in this technology which will ensure sustainable conservation of genetic resources in Swaziland.

3.1.3 Action Plan for Agroforestry

3.1.3.1 Introduction

Manyatsi and Mhazo (2014) states that agroforestry practises in Swaziland include planting beneficial trees such as fruit trees. Fruit trees such as avocados, bananas, peaches were common followed by citrus (oranges, naartjies, and lemons), guava, mango, mulberry, and papaya. The indigenous fruit trees that are left to grow in grass filter strips between ploughed lands include Marula (*Slerocarya birrea*), water berries (*Syzgium cordatum*), figs (*Ficus spp*) and Velvet-Wild-medlar (*Vangueria infausta*)”

(Manyatsi and Mhazo, 2014). In Swaziland, trainings in Agroforestry was held in July 2011. The selected farmers were grouped according to the regions where they came from and the workshops were held in the regional offices so that the farmers could not travel long distances to the training areas. The training's were organized by the Forestry Department of the Ministry of Tourism together with the Extension Officers from the Ministry of Agriculture (personal communication: Wilfred Mbhekeni Nxumalo). The training included theory and practise techniques of intercropping, improved fallow, alley planting, live fence, fodder production and woodlots. There is renewed interest in fodder production for livestock farming and so here is a link between the two sectors. Feed and fodder production for livestock feeding is an important aspect for agriculture and agroforestry technology can help in this regard (personal communication: Roland Xolani Dlamini). Stakeholders stated that this technology needs to be up-scaled in the country as it will provide benefits including diversification of economic activities, diversification of agricultural revenues, increase in yield from conventional agricultural systems, reclamation of fragile or marginal lands, increase in plant diversity, decrease in wind and water erosion, improvement in soil fertility and carbon sequestration amongst other.

3.1.3.2 Ambition for the TAP

The ambition for this technology deployment and diffusion is to scale up agroforestry through an agroforestry programme for training 2,000 farmers and providing free seedlings by 2020. The training should be conducted by Department of Forestry and Ministry of Agriculture's Extension Officers. According to Manyatsi (Pers. Comm), 300 farmers were trained on agroforestry in 2011. Stakeholders suggested to train 1000 farmers and provide them with starter kits which include seedlings in order to effectively up-scale this technology.

3.1.3.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

There is limited adoption of agroforestry in Swaziland, although some programmes are promoting it and it is gaining momentum. However, stakeholders felt that the technology needs to be scaled up. They identified the following barriers:

1. Farmers think of short-term benefits and agroforestry only accrues benefits in the long term. This mind-set needs to be changed and can be changed through training and awareness raising.
2. Extension agents are not promoting agroforestry enough. This could be due to knowledge gap or lack of impetus. Rolling out an agroforestry programme will involve extension agents in providing training to farmers and may give the impetus to promote the technology.

Actions selected for inclusion in the TAP

1. Roll out an agroforestry programme for training 2,000 farmers and providing free seedlings by 2020. The training should be conducted by Department of Forestry and Ministry of Agriculture's Extension Officers.

Activities identified for implementation of selected actions

1. Internal meeting to kick start this project and initiate dialogue with relevant stakeholders MNRE, SEA, SNTC, Department of Forestry, private sector forestry
2. Procure funding and plan for training on agroforestry for 2,000 farmers and source seedlings
3. Organize trainings on agroforestry in all regions of the country in partnership with extension officers.

Actions to be implemented as Project Ideas

The action of providing training to farmers on agroforestry will be carried forward as project idea. The training will be in partnership with extension officers and coordinated and organized by Department of Forestry. As part of the training seedlings will be provided to farmers to encourage agroforestry practises. The action of providing training in this manner was chosen by stakeholders after discussion with Department of Forestry representatives at the workshop. There was clearly a need to up-scale this technology which provides both adaptation and mitigation benefits. Stakeholders felt that this technology will diversify the incomes of farmers, so that if their crops fail, they can still depend on income from fruit trees, medicines and fuel wood derived from the trees.

3.1.3.4 Stakeholders and Timeline for implementation of TAP

Overview of Stakeholders for the implementation of the TAP

The table below gives the actions proposed and stakeholders responsible for implementing the actions. The rationale for choosing the stakeholders is also included.

Table 24 List of Actions and Stakeholders Responsible for Implementing

Action	Stakeholders responsible	Rationale for choosing stakeholders
To scale up agroforestry through an agroforestry programme for training 2,000 farmers and providing free seedlings by 2020. The training should be conducted by Department of Forestry and Ministry of Agriculture's Extension Officers.	Ministry of Natural Resources and Energy (MNRE)	The Ministry's mission is to ensure sustainable development, use and management of natural resources which includes forests. Department of Forestry falls under this ministry.
	Department of Forestry	This is the department that is mandated to promote forestry in the country and it has extension officers who will be involved in providing the training.

The main institution responsible for this project would be Department of Forestry and others who will play a part in implementation are given in table below.

Table 25 Institutions Responsible and contact person for Implementation of Actions

Institutions	Contact
MNRE	Edward Mswane - edwardmswane@yahoo.com
Department of Forestry	Wilfred Mbhekeni Nxumalo, mbhekeninxumalo@gmail.com
SNAU	Jabulani Tsabedze, jabuemkholo@gmail.com
SEA	Isaac Gcina Dladla (Director Policy, Research and Information) gdladla@sea.org.sz Clasile Mhlanga (Biodiversity) - cfmhlanga@sea.org.sz Sipho Matsebula (ecologist) - smatsebula@sea.org.sz Mbongeni Hlophe (Environment Fund Officer), mhlophe@sea.org.sz
Peak Timbers	Mvezi Phindumbutfo Dlamini, mvezi.dlamini@peaktimbers.com
SNTC	Sandile Gumedze, gumedzesan@gmail.com

In addition to the above, Traditional Authorities, Community Based Organizations, NGOs who may be relevant, Financial Institutions, private sector partners and Development Partners will be involved. Some may be identified per region, once activities on the ground are planned.

Scheduling and sequencing of specific activities

The sequence and timing of specific activities, as well as the nature and scale of the activity is described in table below.

Table 26 Scheduling and Sequencing of Activities for Implementation of Agroforestry

Activity	Nature of activity	Scale of activity	Start	End
Internal meeting to kick start this project and initiate dialogue with relevant stakeholders MNRE, SEA, SNTC, Department of Forestry, private sector forestry	MNRE as the lead institution will spearhead the project and hold a planning meeting with relevant stakeholders to plan for agroforestry project. Specific tasks: <ul style="list-style-type: none"> • Project design and scope, • terms of references for consultant for proposal development and training plan. 	Meetings (at least 3) with around 12 persons from relevant bodies will be held at Government offices using existing facilities. ToRs will be developed.	Month 1	Month 2
Recruit consultant to develop proposal for funding and training plan for agroforestry.	Advertisement and recruitment of a consultant to prepare proposals.	Scale remains within institutional level.	Month 3	Month 9
Procure funding and plan for training on agroforestry for 2,000 farmers and providing seedlings.	Consultant will develop proposal and MNRE and Department of Forestry will use the proposal to raise funds.	Scale remains within institutional level.	Month 9	Month 15
Organize trainings and source seedlings for promoting agroforestry in all regions of the country in partnership with extension officers.	Using training plan developed by Consultant, extension officers will provide training to farmers and provide them with seedlings.	National scale. The advertisement can be put in national newspapers.	Month 15	Month 24

Monitoring and evaluation	Surveys pre and post trainings will be done and follow up of farmers agroforestry activities will be done up to a year after the training.	National scale	Month 25	Month 36
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3.1.3.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Stakeholders at the TAP workshops and BAEF workshops, as well as personal communication with the Chairman of SNAU emphasised the need to build capacity of farmers in agroforestry. The Ministry would need assistance in developing a proposal and training plan and therefore a consultant will be recruited.

Estimations of costs of actions and activities

An estimate of how much it would cost to implement the TAP developed on basis of the economic assessment undertaken as part of the BAEF report of implementing sets of measures is described here.

Table 27 Estimation of Costs of Actions and Activities

Activity	Cost categories	Total cost
1. Project planning meetings with MNRE, Department of Forestry, SEA, SNTC, SNAU, Private Sector Forests (preparing to roll out the technology)	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
2. Meeting held to develop Terms of References (ToR) for consultant to develop proposals for funding agroforestry activities.	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
3. Recruit a consultant to develop proposals for agroforestry and training plan	Staff time Advertisement cost \$5,000 Consultant fees \$20,000	\$25,000
4. Present proposals and procure funding for agroforestry activities	Staff time at MNRE as in-kind contribution	0
5. Conduct training in agroforestry for 2,000 farmers (Rolling out the technology)	Training costs \$84,000 Subsistence for trainers from Department of Forestry \$5000	\$89,000
6. Monitoring and Evaluation of the project	Staff time of MNRE as in kind contribution	0

Organize trainings on agroforestry in all regions of the country (details on economic analysis in BAEF, in the BAEF it was suggested to target 20,000 farmers, but at TAP phase it was reduced to 2,000 farmers). The costs will be:

Training session (venue and refreshments) and 10 seedlings provided to farmer
E210 per farmer x 2,000 farmers x 3 days = E 1,260,000 (\$84,000)
Assuming exchange rate of 15 Emalangenani (E) to US Dollar (\$).

3.1.3.5 Management Planning

Risks and Contingency Planning

Challenges anticipated for this project is inadequate cooperation from communities, farmers may not be open to implementing agroforestry and may want to continue their farming status quo. Other major challenge is that of raising funds as Swaziland is not a Least Developed Country, it cannot access funds allocated for those. There is competition to access international development aid. Judicious use of Government budgets can to some extent help in raising funds for this project. The project needs to recruit a consultant to development proposals for funding and submit proposals to development partners such as African Development Bank (AfDB), World Bank, IMF, EU and UNDP. Other challenges include lack of interest in media to highlight such environmental projects, as they tend to focus on sensational stories such as politics and crime. This can be overcome to some extent through having a special write-shop for journalists where they are encouraged to write about the project.

3.1.3.6 TAP overview table

TAP overview table								
Sector	FORESTRY AND BIODIVERSITY							
Sub-sector	Adaptation for Forestry and Biodiversity sector							
Technology	AGROFORESTRY							
Ambition	To provide training to 2000 farmers and provide free seedlings to trainees							
Benefits	Increased crop production, economic gain for farmers, improved soil quality, carbon sequestration, wind and flood protection.							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1 To scale up agroforestry through an agroforestry programme for training 2,000 farmers and providing free seedlings by 2020. (preparing to roll out the technology)	Activity 1.1 Project planning meetings with MNRE, Department of Forestry, SEA, SNTC, SNAU, Private Sector Forests	AfDB, World Bank, EU, UNDP, IMF	MNRE and Department of Forestry	2 months	Disinterest of stakeholders	Good participation of stakeholders (number of attendees at meeting)	Minutes of meeting held	\$20,000
	Activity 1.2 Meeting held to develop Terms Of References (ToR) for consultant to develop proposals for funding agroforestry activities.	AfDB, World Bank, EU, UNDP, IMF	MNRE and Department of Forestry	3 months	ToRs may not be well developed	Good participation of stakeholders (number of attendees at meeting)	ToR document	\$20,000

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	(preparing to roll out the technology)							
	Activity 1.3 Recruit a consultant to develop proposals for agroforestry and training plan	AfDB, World Bank, EU, UNDP, IMF	MNRE	6 months	There may not be consultant available	Consultant hired	Advertisement Contract signed by consultant	\$25,000
	Activity 1.4 Present proposals to procure funding	Internal MNRE funds	MNRE	6 months	Development partners may not be forthcoming with funds	Good quality fundable proposal	Good quality proposal	0
	Activity 1.4 Conduct training in agroforestry for 2,000 farmers (Rolling out the technology)	AfDB, World Bank, EU, UNDP, IMF	MNRE	10 months	Poor participation by farmers and they may sell the seedlings	Good participation of farmers (number of farmers attending the training) At end of the project, 2,000 farmers receive training as intended.	Training report and attendance report	\$89,000
	Activity 1.5 Monitoring and Evaluation	Internal MNRE funds	MNRE	12 months	Farmers may be hard to reach as they are	Good quality monitoring and evaluation data	Monitoring and Evaluation Report	0

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					scattered. SNAU may help in following up with farmers.			
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3.1.4 Action Plan for Conservation of Genetic Resources

3.1.4.1 Introduction

Conservation of genetic resources arose from the thoughts of gene resource conservation which began in the 1910's by agriculturalists who wanted to use wild relatives of crops in breeding programs. This was in response to the worry that scientists had that the genetic diversity of plant and animal breeders was rapidly being lost. Conservation of genetic resources is important as even maintaining productivity requires constant input of new genetic material to overcome crop losses due to pests that become pesticide resistant. This also helps with climate change as higher diversity in crops will make the farmer more resilient to changing weather and climate patterns. This also helps improve yields and withstand shocks of climate change. This technology helps in conservation of biodiversity and reduces species extinction (SEA, 2014). It also helps farmers in building a pool of robust seeds which can withstand varying climatic conditions and thereby help in adaptation.

Swaziland has 464 species of trees and shrubs which are important not only for livelihoods but also for Swaziland's culture, which has entrenched biodiversity in its ceremonies and traditions (Dlamini and Lupupa, 1995). The benefits of conserving genetic diversity are manifold for Swaziland. There will be improved productivity in agriculture, forests and biodiversity sectors. This will boost the economy and livelihoods as well as well-being will improve. Other related sectors such as tourism will benefit from biodiversity conservation through conservation of genetic resources. Biodiversity will be maintained and productivity in agriculture and forestry sector will improve, which will provide ecosystem benefits. Forest genetic resources provide employment in the commercial forests. They are also used in addressing poverty by means of products sold in market and also addressing the food security problems. Commercial forests accounts for diversity of product that earns foreign revenue for Swaziland. The major forestry products include poles for fencing, construction and transmission lines, and sawn timber for furniture making, non-wood forestry products such as foliage, medicine, honey, edible fruits and nuts, mushrooms and silk worms.

Swaziland's plant breeding programme is still young, hence use of genetic resources is small. The existing breeding programme is for cotton (*Gossypium*) and aims to improve the quality of cotton lint, to increase yield and to breed resistance to pests and diseases. Farmers are involved through on-farm trials, field days organized by the extension staff of agricultural Research Division. Swaziland Environment Authority (SEA) is mandated to look at environmental degradation including reduction or complete disappearance of species and a National Plant Genetic Resources Committee is in place to advise government on issues affecting Plant Genetic Resources. Furthermore, the University of Swaziland Agricultural Campus offers training in Plant and Soil Sciences which includes plant breeding as a subject. Swaziland does not have quarantine facilities in the country, however, the Plant Control Act 1981 seeks to control the importation and exportation of plant material without phyto-sanitary certification. Additionally, this Act prevents indigenous or protected flora from being exported as whole plants, seeds or parts thereof without permits from relevant authorities (Dlamini and Lupupa, 1995). Swaziland signed the International Convention on Biological Diversity in June, 1992, and is a member of the SADC Plant Genetic Resources Centre, which

has been supported by Nordic countries since 1988. In addition, there is a network of the SADC Tree Seed Centres which focuses on genetic resources activities of trees.

The Swaziland National Plant Genetic Resources Centre (SPGRC) is located in Malkerns and was set up in 1989. This unit operates under the umbrella of the Agricultural Research Division of the Ministry of Agriculture based at the Malkerns Research Station. It is responsible for collecting and conserving the country's plant genetic resources; to multiply and describe the characteristics of the collected material; to maintain the active collections and send duplicates to the base collection at the SPGRC; to document data on conserved material; to distribute and promote on-farm conservation of crop diversity through community seed banks; to raise awareness on the role and importance of plant genetic resources in ensuring food security in the SADC region and to promote conservation of vegetative propagated material in field gene banks. Currently, the Marula Project which is a brain child of Her Majesty the Queen Mother of the Kingdom of Swaziland, and run under MOAC is working towards commercialising marula (*Sclerocarya caffra*) production while also curbing the dangers that all other indigenous plants exposed to extreme weather events (SPGRC, 2017).

There are two major alternatives for the conservation of genetic resources and they are in situ and ex situ. In situ conservation refers to the conservation of important genetic resources in wild populations and land races, and it is often associated with traditional subsistence agriculture. Ex situ conservation refers to the conservation of genetic resources off-site in gene banks, often in long-term storage as seed. The focus of conservation of genetic resources in Swaziland is in the forestry sector. In situ conservation and ex situ conservation can be done and the focus in the country is on in situ conservation. Stakeholders at the BAEF workshop also suggested in situ conservation which they felt would benefit the local farmer and land user. Furthermore, establishing seed banks and undertaking research would be expensive and not entirely necessary considering Swaziland's neighbour South Africa has capacity to do this and are currently doing it. Stakeholders at the BAEF workshop and in bilateral interviews stated that there is need to strengthen and establish in situ methods of genetic conservation. They suggested setting up a national botanical garden as a measure. The botanical garden will also have a field gene bank and act as a training center for farmers. There is also need to train adequate manpower in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethno botany to carry out the above activities. These are included in the TAP.

3.1.4.2 Ambition for the TAP

The ambition is to set up a National Botanical Garden and Field Gene Bank which will act as a training center for farmers and help in conserving Swaziland's genetic diversity in-situ. Furthermore, relevant Government officials from SPGRC, SNTC, SEA, National Tree Seed Center and National Gene Bank will be sent for further training in Plant Genetic Resources Management, Plant Ecology, and Plant Taxonomy and Ethno botany.

3.1.4.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

The barrier identified was weak capacity in genetic conservation. Furthermore, stakeholders stated that there is inadequate funds for establishment of a national botanical garden and field gene bank. Stakeholders pointed out that Swaziland does not have a National Botanical Garden and Field Gene Bank where farmers could train on genetic conservation and storage of seeds in situ as well as collection of seeds for multiplication. Establishment of a Botanical Garden and Field Gene Bank.

The Botanical Garden for Swaziland would be a garden dedicated to the collection, cultivation and display of a wide range of indigenous plants labelled with their botanical names. The Field Gene Bank would be an area within the Botanical Garden where the plant genetic resources are kept as live plants that undergo continuous growth. The plants would require continuous maintenance. Field Gene Bank will provide an easy and ready access to the plant genetic resources, and the same material is conserved in the form of seeds. However, both the Botanical Garden and the Field Gene Banks require labour and inputs as well as land and are at risk from natural disasters and adverse environmental conditions like drought, floods or attacks from pests and diseases.

A proposal for a National Botanical Garden was developed by the Department of Forestry. It is proposed to be located at Ngwane Park in the Manzini region on Portion 17 of Farm No.6. This site is very suitable and ideal for the project as it is located near the two main cities; furthermore, it is close to University campuses, schools and /colleges of Manzini and Hhohho regions. The site has the Mhlaleni /Nhlangano road on the West and Nazarene and Two Sticks Township on the East, Ngwane Park Complex on the South and Mhobodleni/Mhlaleni on the Northern side. The climate and altitude of the site allows most plants of the Highveld, Middleveld and the Lowveld to be accommodated in the garden. The site covers an area of about one hundred and sixty-four (164) hectares. The site has been generously provided by the Government of Swaziland and it has already been declared a protected site for the Botanical Garden and Herbarium through a government gazette.

Stakeholders and relevant institutions consulted for development of the proposal for Botanical garden were, Botanic Gardens Conservation International, KEW Botanic Gardens, Southern African Biodiversity Network, South African National Botanical Institute, Swaziland's Ministry of Economic Planning and Development and Ministry of Public Works and Transport. The Botanical Garden will include Arboretum, Nurseries, Protected plant species sections, Economic garden section, Medicinal and indigenous edible plant section, Ornamental section, Water feature, Geological section displaying the soils and rocks of the country with their unique features found within the garden area, Grass lawns, Sporting facilities, a Dam, Display house, Amphitheatre and Chalets. Infrastructural Buildings such as Administrative Building and offices, Entrance ticket office, Security Gate and Fencing, Herbarium Building, Seed bank, Storerooms, Restaurant, Park bay, Kitchen, Book store and, Training and conference centre will also be built.

Furthermore, poor awareness another measure would be to train adequate manpower in Plant Genetic Resources Management, Plant Ecology, and Plant Taxonomy and Ethno botany to carry out the above activities. This can be achieved by sending the staff of SPGRC, National Tree Seed Center, National Gene Bank and Swaziland Environment Authority for further training. Through scholarships offered by Government of Swaziland, training could be provided and hence this is not costed.

Actions selected for inclusion in the TAP

1. To establish a national Botanical Garden and Field Gene Bank by 2020.
2. To create awareness amongst farmers to collect seeds and multiply them through field days at the Botanical Garden and Field Gene Bank by 2022.
3. To provide training to staff of SEA, SPGRC, National Tree Seed Center and National Gene Bank in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethnobotany through providing scholarships for further studies by 2020.

Activities identified for implementation of selected actions

1. Internal meeting to kick start this project and initiate dialogue with relevant stakeholders;
2. Recruitment of consultant for detailed costing and proposal development for Botanical Garden;
3. Develop detailed proposal for Botanical Garden and Field Gene Bank;
4. Present proposals to development partners and source funding for setting up a Botanical Garden and Field Gene Bank;
5. Establish the a Botanical Garden and Field Gene Bank.Undertake a rapid training needs assessment for SEA, SPGRC staff, National Tree Seed Center, National Gene Bank;
6. Make proposals for SEA, SPGRC, National Tree Seed Center, National Gene Bank staff to undertake training at higher levels through applying for scholarships;
7. Create awareness amongst farmers to collect seeds and multiply them through field days at the Botanical Garden and Field Gene Bank;
8. Undertake site visits for farmers to Botanical Garden and Field Gene Bank.

Actions to be implemented as Project Ideas

All the three actions will be implemented as project ideas, assuming the country is successful in raising funds. Stakeholders stated that setting up a Botanical Garden was an ambition that the country had, however lack of funding has hindered progress. This action was chosen to be suitable for Swaziland's situation as the Botanical Garden would have multiple benefits of acting as a training center for farmers as well as a tourist attraction. Furthermore, other technologies such as setting up a seed research work and seed bank would not be prioritised, as South Africa is better equipped to set up such technologies and already has them, which Swaziland could easily tap on to.

3.1.4.4 Stakeholders and Timeline for Implementation of TAP

Overview of Stakeholders for the implementation of the TAP

The table below gives the actions proposed and stakeholders responsible for implementing the actions. The rationale for choosing the stakeholders is also included.

Table 28 List of Actions and Stakeholders Responsible for Implementing

Action	Stakeholders responsible	Rationale for choosing stakeholders
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1. To establish a national Botanical Garden and Field Gene Bank by 2020.	MNRE, Department of Forestry, SNTC, SEA, SPGRC, National Tree Seed Center, National Gene Bank	MNRE is the national institution responsible overall policy, development and regulation of land and water sectors in Swaziland. Department of Forestry, SNTC and SEA are mandated entities working on conserving the biodiversity of Swaziland.SPGRC, National Tree Seed Center and National Gene Bank are responsible entities working on genetics conservation.
2. To provide training to staff of SEA, SPGRC, National Tree Seed Center and National Gene Bank in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethnobotany through providing scholarships for further studies by 2020.	MNRE, Training Consultant	MNRE is the mandated entity to build capacity for its officers within SEA, SPGRC, National Tree Center and National Gene Bank, as they fall under the Ministry. To help in this action, a training consultant will be recruited.
3. To create awareness amongst farmers to collect seeds and multiply them through field days at the Botanical Garden and Field Gene Bank by 2022.	SPGRC, SNAU	The Swaziland National Plant Genetic Resources Centre (SPGRC) is responsible for collecting and conserving the country's plant genetic resources; promoting on-farm conservation of crop diversity through community seed banks; raising awareness on the role and importance of plant genetic resources in ensuring food security and to promote conservation of vegetative propagated material in field gene banks. SNAU is the agricultural union to which farmers are members. They will be able to identify farmers for training and mobilize them.

The main institution responsible for this project would be MNRE and others who will play a part in implementation. These are given in table below.

Table 29 Institutions Responsible and contact person for Implementation of Actions

<i>Institutions</i>	<i>Contact</i>
MNRE	The Principal Secretary, nergyswa@realnet.co.sz

Department of Forestry	Wilfred Mbhekeni Nxumalo, mbhekeninxumalo@gmail.com
SNTC	Sandile Gumedze, gumedzesan@gmail.com
SNAU	Jabulani Tsabedze, jabuemkhola@gmail.com
SEA	Bongani Nkhabindze- bongani@sea.org.sz
SPGRC, National Tree Seed Center, National Gene Bank	(Malkerns Research Centre) - Thembinkosi Gumedze tg.tgumedze@gmail.com

For raising funds, Development Partners will be approached such as FAO, EU, UNDP, World Bank, IMF.

Scheduling and sequencing of specific activities

The sequence and timing of specific activities, as well as the nature and scale of the activity is described in table below.

Table 30 Scheduling and Sequencing of Activities for Implementation of RWH

Activity	Nature of activity	Scale of activity	Start	End
1. Internal meeting to kick start this project and initiate dialogue with relevant stakeholders; (preparing to roll out the technology)	<p>MNRE as the lead institution will spearhead the project and hold a planning meeting with relevant stakeholders. Specific tasks:</p> <ul style="list-style-type: none"> • Project design and scope, • Proposal development to raise funds for Botanical Garden • Plans for awareness raising of conservation of genetic resources • Building capacity through training of staff of SEA, SPGRC, National Tree Seed Center and National Gene Bank in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethnobotany through providing scholarships for further studies by 2020. 	The scale would be national. Meetings (at least 3) with around 12 persons from relevant bodies will be held at Government offices using existing facilities.	Month 1	Month 3

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2. Recruitment of consultant for detailed costing and proposal development for Botanical Garden	Advertisement and recruitment of a consultant to prepare proposals	National scale, where consultant will be recruited locally	Month 3	Month 6
3. Proposal developed for Botanical Garden (Preparing to roll out the technology)	Consultant develops a proposal	National scale, where consultant will, in consultation with all relevant stakeholders, develop a proposal	Month 7	Month 14
4. Proposal presented to development partners and source funding for setting up a Botanical Garden and Field Gene Bank;	MNRE will present the proposal to development partners such as FAO, World Bank, IMF, European Union, UNDP	International scale. The proposal will be sent to development partners both within the country and internationally.	Month 14	Month 20
5. Establish the Botanical Garden and Field Gene Bank.	Contractors will be recruited by MNRE	Local scale	Month 21	Month 33
6. Undertake a rapid training needs assessment for SEA, SPGRC staff, National Tree Seed Center, National Gene Bank;	MNRE will do this Capacity needs assessment skills, using questionnaire survey administered online	National level	Month 7	Month 10
7. Make proposals for SEA, SPGRC, National Tree Seed Center, National Gene Bank staff to undertake training at higher	MNRE will develop a proposal and justification for Government scholarships for staff of listed organizations and actively pursue getting the scholarships	National level	Month 10	Month 17

levels through applying for scholarships;				
8. Create awareness amongst farmers to collect seeds and multiply them through field days at the Botanical Garden and Field Gene Bank;	SNAU and SPGRC will work together to conduct field days for farmers	At local level – at the location of Botanical Graden	Month 33	Month 40 This should be ongoing, field days every year
9. Undertake site visits for farmers to Botanical Garden and Field Gene Bank. (Rolling out the technology)	SNAU and SPGRC will work together to conduct site visits for farmers	At local level – at the location of Botanical Graden	Month 40	Month 48

3.1.4.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Capacity needs include capacity for development of proposal for Botanical Garden, in this case we will be recruiting a consultant. Capacity building of farmers will be done through field days and site visits at the Botanical Garden and Field Gene Bank. Capacity building needs of staff of SEA, SPGRC, National Tree Seed Center, National Gene Bank will be identified through a rapid capacity needs assessment done by administering an online questionnaire.

Estimations of costs of actions and activities

An estimate of how much it would cost to implement the TAP developed on basis of the economic assessment undertaken as part of the BAEF report of implementing sets of measures is described here. The cost for establishment of Botanical Garden and Field Gene Bank is estimated by the Department of Forestry to be \$6,000,000 (Department of Forestry, unpublished). This will be further broken down and detailed costing done when the consultant will prepare the proposal for establishment of Botanical Garden. Cost of training for staff of SEA, SPGRC, National Tree Seed Center, National Gene Bank is not estimated at this point, because it is assumed they would receive Government scholarships for the training. Other costs include costs for meetings, consultant fees and costs related to site visits and field days.

A summary of estimated costs for the full programme is given below.

Table 31 Estimation of Costs of Actions and Activities

Activity	Cost categories	Total cost
1. Internal meeting to kick start this project and initiate dialogue with relevant stakeholders; (Preparing for rolling out the technology)	Meeting venue Conference package Transport Assuming \$20,000 per meeting for two day residential meeting	\$20,000
2. Recruitment of consultant for detailed costing and proposal development for Botanical Garden	Staff time Advertisement cost	\$5000
3. Proposal development for Botanical Garden	Consultant fees \$20,000	\$20,000
4. Proposal presented to development partners and source funding for setting up a Botanical Garden and Field Gene Bank;	No costs anticipated	0
5. Establish the Botanical Garden and Field Gene Bank. (Rolling out the technology)	Cost of setting up a botanical garden as estimated by Department of Forestry's preliminary proposal	\$6,000,000
6. Undertake a rapid training needs assessment for SEA, SPGRC staff, National Tree Seed Center, National Gene Bank;	Communication/ printing costs \$1000	\$1,000
7. Make proposals for SEA, SPGRC, National Tree Seed Center, National Gene Bank staff to undertake training at higher levels through applying for scholarships;	Staff time as in-kind contribution	0
8. Create awareness amongst farmers to collect seeds and multiply them through field days at the Botanical Garden and Field Gene Bank; (Rolling out the technology)	Cost of a Field Day includes IEC materials, contacting farmers through SNAU, holding meetings, inputs for the garden is approximately \$20,000	\$20,000
9. Undertake site visits for farmers to Botanical Garden and Field Gene Bank.	Cost of transport, refreshments, communication, meetings is approximately	\$80,000

	\$20,000 for one site visit. There should be four site visits, one per region.	
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Assuming exchange rate of 15 Emalangeni (E) to US Dollar (\$).

Technical assistance has been offered by Fairchild, which is an organization that backs botanical garden establishment.

3.1.4.6 Management Planning

Risks and Contingency Planning

One major challenge is that of raising funds as Swaziland is not a Least Developed Country, it cannot access funds allocated for those. There is competition to access international development aid. Developing a good proposal will help convince development partners and therefore a consultant will be recruited to develop a fundable proposal for the Botanical Garden. Furthermore, getting training scholarships for staff of SEA and SPGRC may also be challenging as it is a competitive process to access Government scholarships and international scholarships. A justification will be needed to convince to access Government scholarships for the staff of these institutions. Farmers may not be interested to come for field days and site visits to the Botanical Garden and Field Gene Bank. This risk is mitigated through involving SNAU right at the beginning as they have farmers who are members of the union and could persuade other farmers to join the site visits and attend the field days.

Next Steps

Immediate requirements to proceed are

1. Hold project planning meetings with MNRE, Department of Forestry, SNTC, SNAU, SEA, SPGRC, National Tree Seed Center, National Gene Bank.
2. Recruit a consultant to develop a proposal for fundraising for the Botanical Garden.
3. Contact Fairchild, an organization that has offered technical assistance to the TNA Project Coordinator on setting up Botanical Garden.

3.1.4.7 TAP overview table

TAP overview table								
Sector	FORESTRY AND BIODIVERSITY							
Sub-sector	Adaptation for Forestry and Biodiversity sector through conserving genetic resources							
Technology	CONSERVATION OF GENETIC RESOURCES							
Ambition	To build a National Botanical Garden and Field Gene Bank and improve capacity of officials in Plant Genetic Resources Management, Plant Ecology, and Plant Taxonomy and Ethno botany.							
Benefits	Conservation of Genetic diversity of plants in Swaziland. Capacity building of officials in conservation of genetic diversity. Capacity building of farmers in seed collection, storage and seed multiplication.							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
Action 1 To raise funds and establish a national Botanical Garden and Field Gene Bank by 2020.	1. Internal meeting to kick start this project and initiate dialogue with relevant stakeholders;	FAO, AfDB, World Bank, EU, UNDP, IMF	MNRE	3 months	Disinterest of stakeholders	Good participation of stakeholders (number of attendees at meeting)	Minutes of meeting held	\$20,000
	2. Recruitment of consultant for detailed costing and proposal development for Botanical Garden	FAO, AfDB, World Bank, EU, UNDP, IMF	MNRE	3 months	Recruitment process may take longer time	Contract signed by consultant	Contract document signed	\$5000
	3. Proposal development for Botanical Garden	FAO, AfDB, World Bank, EU, UNDP, IMF	Consultant	7 months	Proposal may not be well developed	Rigorous selection of consultant for proposal writing. Success criteria is	Proposal document	\$20,000

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						ability of consultant to develop a good proposal.		
	4. Proposal presented to development partners and source funding for setting up a Botanical Garden and Field Gene Bank;	Internal funds of MNRE	MNRE	6 months	Getting such large funds may prove difficult	Where possible involve private sector and seek for funds through many avenues. Funds committed is the success criteria.	Offer of funding documents	0
	5. Establish the Botanical Garden and Field Gene Bank. (Rolling out the technology)	FAO, AfDB, World Bank, EU, UNDP, IMF. Technical assistance has been offered by Fairchild, an organization that supports botanical garden establishment.	SPGRC	13 months	Contractors may delay the establishment of the Botanical Garden and Field Gene Bank.	Success criteria is having a good contractor recruited. In ten years all farmers in Swaziland must have gone through training at	Botanical Garden built, photographs and report	\$6,000,000

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						the Botanical Garden.		
Action 2 To provide training to staff of SEA, SPGRC, National Tree Seed Center and National Gene Bank in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethnobotany through providing scholarships for further studies by 2020.	6. Undertake a rapid training needs assessment for SEA, SPGRC staff, National Tree Seed Center, National Gene Bank;	MNRE	MNRE	4 months	Responses may be low for online questionnaire	MNRE to follow up with respondents. Success criteria is response of 80%.	Training needs document	\$1,000
	7. Make proposals for SEA, SPGRC, National Tree Seed Center, National Gene Bank staff to undertake training at higher levels through applying for scholarships;	FAO, AfDB, World Bank, EU, UNDP, IMF	MNRE	8 months	Government scholarships may not be available or adequate for such trainings	MNRE to seek for international scholarships and also include training costs into larger projects. Success criteria is proposal developed. In ten years all staff receives higher training.	Proposal document	0
Action 3 To create awareness	8. Create awareness amongst farmers to collect seeds and multiply	FAO, AfDB, World Bank, EU, UNDP, IMF	SPGRC, SNAU	7 months	Farmers may not be interested	SNAU to mobilize farmers. Success	Minutes of meetings	\$20,000

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amongst farmers to collect seeds and multiply them through field days at the Botanical Garden and Field Gene Bank by 2022.	them through field days at the Botanical Garden and Field Gene Bank;				to participate	criteria is good turnout of farmers.		
	9. Undertake site visits for farmers to Botanical Garden and Field Gene Bank.	FAO, AfDB, World Bank, EU, UNDP, IMF	SPGRC, SNAU	6 months	Farmers may not be interested to participate	SNAU to mobilize farmers. Success criteria is good turnout of farmers. In ten years all farmers in Swaziland receive training at Botanical Garden.	Site Visit reports	\$80,000

3.2 Project Ideas for Forestry and Biodiversity Sector

3.2.1 Brief summary of the Project Ideas for Forestry and Biodiversity Sector

The proposed project idea for Forestry and Biodiversity Sector includes the implementation/promotion of the two technologies of agroforestry and conservation of genetic resources. It includes a combination of creating awareness, building capacity through training, institutional strengthening and setting up a Botanical Garden and field gene bank. The overall strategy of agroforestry technology up-scaling is to follow the model of training farmers which was done by Forestry Department of the Ministry of Tourism together with the Extension Officers from the Ministry of Agriculture and found successful. This involves training farmers on intercropping, improved fallow, alley planting, live fence/hedge row planting/wind breaks, fodder production and woodlots. The training will be conducted as a package with class room training, site visits and providing ten seedlings per farmer after the training to implement this technology in their farms. Stakeholders stated that agroforestry as a technology has myriad benefits, not only for adaptation but for mitigation too. The technology has been tested and around 300 farmers already received training in 2011. However, the technology has not spread widely in the country and hence through this TNA project, prioritising it and including it in TAP ensures that it will be up-scaled.

The overall strategy for Conservation of Genetic Resources will include setting up a National Botanical Garden and Field Gene Bank as well as building capacity of Swaziland National Plant Genetics Resources Center and relevant Government institutions through applying for scholarships for further training. The National Botanical Garden and Field Gene Bank will act like an in-situ seed storage place as well as a training site for farmers.

This project idea was conceived from stakeholder's workshops, interviews with key experts and through review of relevant publications and documents and later developed by the Consultant. The Forestry and Biodiversity sector is and will be affected by climate change and has threats such as droughts, wildfires, loss of species diversity and others to manage. For further details, please refer to BAEF report.

Project Idea for Agroforestry

Introduction/Background

Agroforestry was prioritised by stakeholders as a way of improving the resilience of agricultural production to current climate variability as well as long-term climate change. Planting trees for intensification, diversification and buffering of farming systems will help farmers raise incomes and improve their land. In the past there has been limited training to farmers on this technology and according to stakeholders this technology needs to be scaled up in Swaziland.

Objectives

The objective of this project is to train 2,000 farmers in agroforestry and as part of the training package provide them with free seedlings. This type of project has been implemented in Rwanda and found successful and wise use of funds as it is fairly inexpensive technology. The training should be conducted by Department of Forestry and Ministry of Agriculture's extension officers, as one challenge was the lack of participation of extension officers in agroforestry work.

Outputs

The outputs expected are 2,000 farmers trained and provided with free seedlings and awareness of agroforestry raised through awareness raising methods.

The project is in alignment with the Swaziland's National Development Strategy and Vision 2022 which emphasises conserving genetic resources as well as improving food security. Furthermore, it is in alignment with Swaziland's national Climate Change Strategy and Action Plan, Swaziland's Nationally Determined Contribution (NDC) and sectoral plans which emphasise the need to make agriculture more climate resilient. Having agroforestry practises allows farmers to have alternative income if crops fail.

Project Deliverables

The values accrued from this project will be across agriculture, forests and biodiversity sectors. Deliverables include 2,000 farmers trained and awareness raised on agroforestry. Greater values accrued will be improved genetic diversity conservation in the long run, enhanced livelihoods for farmers and a greener landscape for Swaziland.

Project Scope and Possible Implementation

The scope of the project is to have training in agroforestry provided to 2,000 farmers across the country and they be provided with free seedlings. The project will involve extension officers who will be providing the training and will be the implementers of the project essentially.

Project activities

Project activities include having meetings to kick start and plan the project with relevant stakeholders, recruiting a consultant to develop proposal for funding and develop a training plan for agroforestry. Other activities are rolling out the agroforestry training in all regions of the country in partnership with extension officers and conducting monitoring and evaluation.

Timelines

The timeline for implementation of all the actions in this project is three years.

Budget/Resource requirements

The total budget is \$154,000, with meetings taking up \$40,000, consultant developing proposal costing \$25,000 and actual training provided costing \$89,000.

Measurement/Evaluation

Deliverables from the project include funds raised for agroforestry training and 2,000 farmers trained. Monitoring and evaluation will be done through surveys done pre and post trainings and follow up of farmers agroforestry activities will be done up to a year after the training. In three years it is expected that agroforestry activities will spread beyond just the 2,000 farmers trained.

Possible Complications/Challenges

The possible challenge that the project could face is that of difficulty in raising funds and lack of cooperation from farmers. This will be overcome through recruiting a good consultant for proposal development and involvement of extension officers in the training, so that they can easily follow up with farmers and spread the technology further after the training.

Responsibilities and Coordination

The Department of Forestry would be the responsible entity, with overall coordination and oversight from MNRE.

Project Idea for Conservation of Genetic Resources

Introduction/Background

The project idea comprises of establishing a national Botanical Garden and Field Gene Bank and providing training to staff on specific areas of genetic conservation and training to farmers through site visits and field days. The idea came from stakeholders, in particular, Department of Forestry who already had a proposal to set up a botanical garden, but it did not receive funding and therefore did not take off. SEA has indicated the need for capacity building of staff of SEA, SPGRC, National Tree Seed Centre and National Gene Bank in this technology which will ensure sustainable conservation of genetic resources in Swaziland.

Objectives

The objective of this technology is to ensure sustainable conservation of genetic resources in Swaziland. The project aims to establish a Botanical Garden and Field Gene Bank. Capacity building of staff of SEA, SPGRC, National Tree Seed Centre and National Gene Bank in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethno botany will be done. Farmers will be trained in genetic conservation through field days and site visits to Botanical Garden.

Outputs

The outputs expected are: a Botanical Garden and Field Gene Bank set up, staff of SEA, SPGRC, National Tree Seed Centre and National Gene Bank undertake training in Plant Genetic Resources Management, Plant Ecology, Plant Taxonomy and Ethno botany and farmers undertake site visits and participate in field days. Reports and photographs will help to measure success.

The project is in alignment with the country's goals. Stakeholders stated that conservation of genetic resources is inadequate in the country. The project is consistent with targets set up by Swaziland's National Development Strategy (Vision 2022) and other international obligations such as the Aichi Targets under the auspices of the Convention on Biological Diversity. Furthermore, Department of Forestry has been desiring to set up a botanical garden and have recognized the need for building capacity for officers, which are addressed in this TAP.

Project Deliverables

The project deliverables are a botanical garden and field gene bank set up, staff of relevant organizations working on genetic conservation trained and farmers trained.

Project Scope and Possible Implementation

The scope of the project is to have multiple actions that will contribute towards genetic conservation in the country. In this regard fund raising to set up a botanical garden and field gene bank is included and providing training to staff of relevant organizations that participate in genetic conservation is included. In addition, training of farmers will also be done once the botanical garden and field gene bank is established.

Project activities

Project activities include developing proposals for funding and to build a National Botanical Garden and Field Gene Bank at Ngwane Park in the Manzini region. The site covers an area of about one hundred and sixty-four (164) hectares. The site has been generously provided by the Government of Swaziland and it has already been declared a protected site for the Botanical Garden and Herbarium through a government gazette. Other activities include training of Government officials from SPGRC, SNTC, SEA, National Tree Seed Center and National Gene Bank in Plant Genetic Resources Management, Plant Ecology, and Plant

Taxonomy and Ethno botany. Other activity is to train farmers through field days and site visits on genetic conservation at the Botanical Garden.

Timelines

The timeline for implementation of all the actions in this project is four years (up to 2021). The activities are phased and timed.

Budget/Resource requirements

The total budget is \$6,146,000, with proposal development and fund raising costing \$45,000, building the Botanical Garden and Field Gene bank costing \$6,000,000, while training and awareness raising will cost approximately \$ 101,000. A consultant will be hired to develop proposals for raising funds. It is expected that long term training (masters or PhD level) will be done using Government scholarships and hence have not been costed under this project.

Measurement/Evaluation

Deliverables from the project include a proposal that is successful in raising funds for establishing a botanical garden and field gene bank, providing training for staff in genetic conservation related subjects and providing training to farmers through field days and site visits.

Possible Complications/Challenges

The major challenge that the project could face is receiving such large funding to set up the botanical garden. Development of a good proposal is key to address this challenge. Farmers may be not interested to participate in genetic conservation. This may be addressed through awareness raising and partnership with key stakeholders such as SNAU which has clout in influencing farmers.

Responsibilities and Coordination

The main responsibility rests with Department of Forestry under MNRE who will oversee the project, coordinate it and undertake monitoring and evaluation.

Chapter 4 Cross-cutting Issues

There are common enabling measures that cuts across all the six technologies. This includes awareness raising of the technologies. It is possible to have awareness raising done covering all the adaptation technologies during environmental commemoration days. The Ministry of Tourism and Environmental Affairs as well as MNRE do have budgets to commemorate environmental days and part of this budget could serve to publicise about the adaptation technologies. Furthermore, private sector can be involved in sponsorship of IEC materials across all technologies.

Swaziland's development partners, NGOs and community based organizations work independently in various areas such as agriculture, water supply, forestry and conservation of biodiversity. Furthermore, many of the agreements, conventions and protocols that Swaziland is party to require institutions to spearhead activities which contribute to achieving goals of these conventions. Many of these activities may overlap and hence there is opportunity to seek synergies by working together. For example Swaziland is signatory to UNFCCC, UN Convention to Combat Desertification and UN Convention on Biodiversity. For the UNFCCC, Ministry of Tourism and Environmental Affairs, Meteorology Department is the responsible entity who should report, while for the UN Convention to Combat Desertification it is SEA and for UN Convention on Biodiversity, it is SNTC. When cross-cutting activities are to be dealt with, for example in management of wetlands, resources can be pooled from these institutions, and will help particularly when it comes to awareness raising and holding workshops. Achievement of one measure in one technology may give benefits in another technology. For example, conservation of genetic diversity through saving seeds and training people can also benefit for wetlands restoration, as the same communities may now use their knowledge to contribute to conservation of wetlands.

Another cross-cutting area is the overlap between agroforestry and conservation agriculture. When both these technologies are included under a larger umbrella of "Climate Smart Agriculture" there are funding avenues through climate finance that can be tapped into. Thus packaging more than one technologies into larger projects, such as GEF projects can help. Furthermore, agroforestry technology aids in feed and fodder production for livestock feeding (personal communication: Roland Xolani Dlamini).

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Annex I. List of stakeholders involved and their contacts

Stakeholders who attended the TAP workshop on 13th September 2017

Num	Name	Organization	E-mail	Phone
1	Jabulani Tsabedze	National Farmers Association	jabuemkholo@gmail.com	76055943
2	Sipho N. Matsebula	National Herbarium-Swaziland Environment Authority	smatsebula@sea.org.sz	78060236
3	Mvezi Dlamini	Peak Timbers	Mvezi.dlamini@peaktimbers.com	78025935
4	Calsile Mulanga	Swaziland Environment Authority- in charge of wetlands management	cfmhlanga@sea.org.sz	78060234
5	Thabani Mazibuko	Department of Forestry	Tah.mazibuko@gmail.com	76089666
6	Sandisiwe Mamba	Department of Water Affairs	Sanelisiwemamba@gmail.com	76361238
7	Mbongeni Hlophe	National Environment Fund	mhlophe@sea.org.sz	76249547
8	Absalom Manyatsi	University of Swaziland – Professor of Agriculture	manyatsi@uniswa.sz	760431128
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