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TECHNOLOGY ACTION PLAN FOR CLIMATE CHANGE TECHNOLOGIES, ADAPTATION

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This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP Risoe Centre (URC) in collaboration with Environmental Development Action in the Third World (ENDA Senegal), for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein is a product of the National TNA team, led by the National Environment Management Authority-Kenya (NEMA-Kenya).

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This report has assessed the technology needs for climate change adaptation in Kenya. The report has further prioritized technology needs for adaptation within the water and agriculture sectors using a multi-stakeholder process and a linear additive Multiple Criteria Analysis Framework. A Barrier Analysis and Enabling Framework for the prioritized technologies have been done and measures identified to overcome these barriers. Finally, Technology Action Plans and Project Concepts have been developed. It is my sincere hope that these 4 part report findings will prompt all stakeholders to take timely action in climate change adaptation and that the reports will form an important reference tool to spur all actors to implement the prioritized technologies in order to build the resilience of our country in a changing climate.

PROF. GEOFFREY WAHUNGU
DIRECTOR GENERAL, NEMA

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LIST OF ACRONYMS

AFC	Agricultural Finance Corporation
AfDB	African Development Bank
AG	Attorney General
ASALs	Arid and Semi-arid Lands
CBA	Cost Benefit Analysis
CBOs	Community Based Organizations
CDKN	Climate and Development Knowledge Network
CIDA	Canadian International Development Agency
DANIDA	Danish International Development Agency
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GoK	Government of Kenya
JICA	Japan International Cooperation Agency
KARI	Kenya Agricultural Research Institute
KENFAP	Kenya National Federation of Agricultural Producers
KRA	Kenya Revenue Authority
KShs	Kenya Shillings
MCA	Multi Criteria Analysis
MDGs	Millennium Development Goals
MHEST	Ministry of Higher Education Science and Technology
MOA	Ministry of Agriculture
MOF	Ministry of Finance
Mm	Millimetres
MSPND&V2030	Ministry of Planning National Development and Vision 2030
MW&I	Ministry of Water and Irrigation
NARs	National Agricultural Research Stations
NARL	National Agricultural Research Laboratory
NASEP	National Agricultural Sector Extension Policy
NCCRS	National Climate Change Response Strategy
NEMA	National Environment Management Authority
NGOs	Non-Government Organizations
NIB	National Irrigation Board
NPV	Net Present Value
PTC	Professional Training Consultants
SRA	Strategy for Revitalizing Agriculture
TNA	Technology Needs Assessment
UNEP	United Nations Environment Programme
VAT	Value Added Tax

EXECUTIVE SUMMARY

This Action Plan looks at the barriers to the transfer, adoption and diffusion of climate change adaptation technologies and the required measures and enabling framework for overcoming the barriers in the water and agriculture sectors. These two sectors were identified in a consultative and participatory process, based on their contribution to the country's economy, relevance to development priorities and their vulnerability to climate change. The Action Plan has two main chapters, chapter 1 dealing with the water resources sector and chapter 2 deals with the agriculture sector.

Water Resources Sector

The Kenya Government policies, including the Vision 2030, recognize water as the key to all anticipated economic and social developments (GOK, 2007). Adequate quantity and quality of water is a basic requirement for Kenya's economic growth and performance. However, water endowment in Kenya is low and the demand for renewable freshwater outstrips supply, with only 57% of households using water from sources considered safe (MW&I, 2010). The distribution of water availability is dependent on rainfall patterns in the country, which varies from (0) to about 250 mm in the Arid and Semi arid areas (ASAL) to 2,000 mm in high potential areas (MW&I, 2010). Kenya is therefore vulnerable to climate variability and change. According to NEMA (2008), climate change projections show that most of the country will experience lower mean annual rainfall.

In the water sector, the technologies identified for adaptation to climate change are surface run-off water harvesting and roof rainwater harvesting technologies. The preliminary targets for the transfer and adoption of these technologies are to construct 100,000 community surface run-off rainwater harvesting systems, each with a capacity of about 30,000 m^3 in ASAL areas and to install roof rainwater harvesting systems in 500,000 households each with a capacity of 10 m^3, in the same regions.

Surface Run-off Rainwater Harvesting Technology: Surface runoff water harvesting is the collection, accumulation, and storing of storm-water for its eventual reuse. Small reservoirs with earthen bunds or embankments to contain runoff are built from soil excavated from within the reservoir to increase storage capacity and a spillway or weir allows controlled overflow when storage capacity is exceeded (Elliot et al. 2011). The cost of construction a surface runoff water harvesting system (including harvesting channels, sediment traps and storage dam) for serving 200 households is estimated based on expert knowledge, to cost about US$75,000.

The most important financial and economic and non-financial barriers to the adoption of surface water harvesting technology in Kenya were identified as high initial cost of implementing the technology, lack or inadequate access to financial resources, inappropriate land tenure, unfavorable local geology and insufficient capacity among the local communities. The proposed action plan to overcome the barriers include VAT Waiver on materials for construction of water harvesting systems; introduction of subsidies such as mechanized equipment and fuel; and provision of low interest rate credits to communities implementing surface run-off harvesting systems. The enabling framework for these measures will involve introduction of appropriate policies in consultation with the Central Bank and Ministry of Finance. The other enabling framework is putting in place appropriate land policies to limit size of land subdivision in order to avail land for putting up the water harvesting system.

The projected timeframe for implementing the measures is between 0 to 10 years, with introduction of low interest credits and repossession of community land in private hands taking place within the first two years, the development and implementation of land policies for guiding land subdivision happening over a 10 year period and the implementation of the remaining measures occurring over 0-5 year period. It is estimated that the implementation of the Action Plan will cost KShs 4.05 Billions with financial measures taking the bulk of cost.

The indicators of success include availability of low interest rate credits to individuals and community groups, lowered initial cost of technology, and availability of land for surface run-off water harvesting system. The implementation of the Action Plan will result in wide adoption and diffusion of surface runoff water harvesting technology and lead to increased water availability and associated enhanced socio-economic development, gender empowerment and lower poverty rates in the arid and semi-arid areas.

Roof Rainwater Harvesting Technology: Roof rainwater harvesting has the potential to alleviate water shortage during the dry season and to control the excessive flooding during the rainy season. While this technology has been practised in this country for many years, its diffusion and adoption need to be intensified in view of extreme weather events associated with climate change and variability. Roofs for rainwater harvesting can be constructed with a range of materials including galvanised corrugated iron, aluminium cement sheets, and tiles and slates. Thatch roofs can provide a low-cost alternative but can be difficult to clean and can taint the water. Tiled roofs or those with corrugated mild steel are preferable, since they are the easiest to construct and give the cleanest water.

The identified barriers to adoption of roof rainwater harvesting technology include high cost of initial installation, inadequate incentives and tax rebates and access to credits, inadequate institutional capacity to operationalise the water harvesting policy, poor social awareness and appreciation of water conservation and rainwater harvesting, climate variability, and unsuitable roofs for water harvesting. The proposed Action Plan to overcome the barriers include operationalisation of government policy on water harvesting, awareness creation on rainwater harvesting technology, introduction of subsidies and tax rebates, and promoting the use of local materials.

Agriculture Sector

Agriculture is the mainstay of the Kenyan economy and accounts for about 26% of GDP directly and another 25% indirectly through linkages with manufacture, distribution and other service related sectors (GOK, 2010). The sector provides livelihood to most of our rural population with an estimate of about 80% of the population deriving their livelihood from agricultural activities (SoE, 2004). However, agriculture sector is generally the first economic sector to be affected by climate extremes through drought and floods due to its reliance on rainfall. The greatest impact of drought in the agriculture sector is the associated crop production losses arising from reduced yields of food crops and cash crops.

In the agriculture sector the technologies identified for adaptation to climate change are drought tolerant sorghum varieties and drip irrigation. The preliminary target for drought tolerant sorghum varieties is to introduce the technology to 1 million farmers by the year 2017 and the target for the drip irrigation technology is to introduce 500,000 and 1,000 drip irrigation systems to individual farmers and institutions, respectively by the year 2017.

Drought Tolerant Sorghum Varieties Technology: The drought tolerant sorghum varieties such as Serena, Seredo, super sorghum are produced through plant breeding to enhance their resistance or tolerance to stresses that result from climate variability. The Drought Tolerant Sorghum Varieties technology has been developed by KARI and has been adopted by some farmers in the country. It is estimated that it costs US $ 115 for the adoption of the drought tolerant seeds by a farmer, but this amount does not include the research and development of the drought tolerant sorghum variety by KARI, which is estimated to cost about KShs 3 million over a period of about 7 years.

The identified barriers to the adoption and diffusion of drought tolerant sorghum varieties technology were identified as inadequate financial resources to buy seeds, lack of agricultural credit and loans, market failures associated with unreliable supplies due to absence of stockists, lack of functional markets in Arid and Semi-Arid areas, and poor infrastructure. The proposed Action Plan to overcome these barriers include adequate training to targeted farmers on the technology and its benefits, formulation and enactment of appropriate legislations, regulations and policies to facilitate a conducive environment for research, development and diffusion of the technology, and increased investment in research efforts. The others are provision of agricultural credit and loans for farmers and establishment of functional market outlets for farmers in order to increase demand for seeds and production of drought tolerant sorghum.

The projected timeframe for implementing the measures of this action plan is between 0 – 10 years. The implementation of the action plans for drought resistant, sorghum varieties is estimated to cost Kshs. 7.04 billion with provision of training and agricultural credit and loans to farmers taking the bulk, Kshs 50 billion and KShs. 2.0 billion respectively. The foreseen main risks, which would affect the implementation of action plan, are inadequate funds, lack of cooperation and collaboration of stakeholders, ineffective communications, and inadequate political goodwill and support.

Drip Irrigation Technology: Drip Irrigation is a technique of application of specific and focused quantities of water to soil crops. The technology can provide as much as 90% water-use efficiency in contrast to surface irrigation and sprinkler systems, which provide 60% and 75% efficiency respectively, and can therefore enable farmers to adapt to climate change in crop production under erratic rainfall pattern (Quezada et al., 2012). The initial cost of drip irrigation systems can be higher than other systems, but this cost is compensated by high yields after the development and after the barriers are removed. The Cost Benefit Analysis (CBA) - NPV for 10 years was positive (Kshs 577,273) which clearly shows that the Drip Irrigation is a viable technology.

The identified barriers to the transfer and diffusion of drip irrigation technology include high cost of initial installation, high human skills/trained labour requirements, water scarcity, high maintenance costs, insecurity, and inadequate extension services. The proposed Action Plan to overcome the barriers include information and awareness creation on the existence, use and benefits of drip irrigation, training of technicians in order to increase a pool of experts at local levels, establishment of low interest rates credits, provision of incentives such as tax waivers and rebates, and enhancement of market linkages to connect farmers with outside markets and in order to add value to the products and get better returns.

The projected timeframe for implementing the measures in action plan is between 0 – 15 years. The estimated cost for the implementation of the action plan is Kshs. 2.08 billion with training, provision of incentives and establishment of low interest rates taking the bulk of the funds.

CHAPTER 1: TECHNOLOGY ACTION PLAN FOR WATER RESOURCES SECTOR

1.1 Actions at Sectoral Level

The Kenya Government policies, including the Vision 2030, recognize water as the key to all anticipated economic and social developments (GOK, 2007). Adequate quantity and quality of water is a basic requirement for Kenya's economic growth and performance. There is a strong link between poverty and lack of access to improved water supply and sanitation and diminishing water resources. However, water endowment in Kenya is low and the demand for renewable freshwater outstrips supply, with only 57% of households using water from sources considered safe (MW&I, 2010). The distribution of water availability is dependent on rainfall patterns in the country, which varies from (0) to about 250 mm in the Arid and Semi arid areas (ASAL) to 2,000 mm in high potential areas (MW&I, 2010). However, there can be large seasonal variation in rainfall such that during the long dry season, water shortage is experienced in many river basins, while during the rainy season severe floods cause tremendous damage in the same river basins. Kenya is therefore vulnerable to climate variability and change, and the now recurrent droughts and flush floods is pointer to the evolving and predicted scenario.

According to NEMA (2008), climate change projections show that rainfall patterns in the country will change, with a few areas having increased mean annual rainfall whereas most of the country will experience lower mean annual rainfall. The cumulative effects of climate change will likely lead to increased occurrence of extreme climatic episodes of droughts and floods on varying spatial and temporal scales. Warming associated with climate change accelerates the rate of surface drying, leaving less water moving in near-surface layers of soil, which lead to reduced downward movement of water and so less replenishment of groundwater supplies. In locations where both precipitation and soil moisture decrease, land surface drying is magnified, and areas are left increasingly susceptible to reduced water supplies (MW&I, 2010). Climate change will also affect water quality through increased bloom of microbial populations associated with increased temperatures, and increased salt concentrations in groundwater and estuaries through intrusion of the sea water (NEMA, 2008).

The activities in the water sector related to climate change adaptation include water sector reforms whose main objective is to enhance management of the resource and delivery of quality services to the citizens; groundwater abstraction; rainwater harvesting, and building of water storage capacity (GoK, 2007; MW&I, 2010). The Water Act of 2002 (GoK, 2002) provided a legal framework that guided the creation of institutions to manage water resources. The Vision 2030 (GoK, 2007) recognizes water as the key to all the anticipated economic and social developments and therefore calls for conservation of water resources and development of new ways of harvesting and using rain and groundwater. In line with Vision 2030, the Ministry of Water and Irrigation has developed a National Water Harvesting and Storage Management Policy (MW&I, 2010) whose main objective is to provide a framework for expansion of infrastructure for national water storage capacity from the current 124 Mm^3 to 4.5 Bm^3 in order to ensure an increase in per capita storage from 5.3 m^3 to 16 m^3 over the next ten years. The policy also envisions development of elaborate underground water re-charge systems based on harvesting of at least 15% of surface runoff

in farms and along the road networks. The relevant policies in the water resources sector are presented in Table 1.1.

Table 1.1: Existing Policies Related to Water Sector's Development and Technology Deployment

Name of Policy	Date Enacted	Main Contents	Relationship with the Technology
The Water Act	2002	Provides for decentralization of water resources management and development and spells out institutional and legal framework for water resources management and development	• Water resources conservation and protection • Financing of water development • Institutional and regulatory framework
National Policy on Water Resources Management and Development	1999	Policy enhances a systematic development of water facilities in all sectors for promotion of the country's socio-economic progress.	• Development of water infrastructure, conservation and management
Vision 2030	2007	The Vision 2030 recognizes water as the key to all the anticipated economic and social developments and therefore calls for conservation of water resources and development of new ways of harvesting and using rain and groundwater.	Proposes several flagship projects including constructions of 22 medium-sized multipurpose dams with a total capacity of 2 billion m^3,
National Water Harvesting And Storage Management Policy	May 2010 Ongoing	The overall policy goal, in line with Vision 2030, is to sustainably facilitate the expansion of water harvesting, storage and development of flood capacity to contribute to wealth and employment creation, food security and poverty reduction for national prosperity.	• Construction of large and medium sized dams. • Development of underground water re-charge systems based on harvesting of at least 15% of surface runoff in farms and along the road networks is also envisioned.
The Environment Management and Co-ordination Act, 1999	1999	States that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment.	• Emphasizes the importance of environmental protection and wise-use of resources
Policy Paper on Environment and Sustainable Development	1993	It ensures that from the onset, all development policies, programmes and projects take environmental considerations into account	• Protection and conservation of water resources
Physical Planning Act (Cap286)	1996 (Revised 2009)	Gives provision for the development of local physical development plan for guiding and coordinating development of infrastructure facilities and services within the area of authority of County, municipal and town council and for specific control of the use and development of land. The plan shows the manner in which the land in the area may be used.	• Coordination and control of development including water resources management

Following stakeholder consultations through workshops, administration of structured questionnaires together with review of relevant development and policy documents, the following were selected as key technologies for adaptation to climate change in water resources sector in Kenya:

(i) Roof Rainwater harvesting,
(ii) Surface Runoff Water Harvesting
(iii) Reuse of Treated Wastewater for Irrigation
(iv) Construction of Sand Dams,
(v) Drilling of boreholes,
(vi) Solar powered desalination

The selected technologies were then prioritized using Multi-Criteria Analysis (MCA) in order to identify 3 technologies for further analysis and transfer and adoption in Kenya. The prioritized technologies were Roof Rain Water Harvesting and Surface Runoff Water Harvesting.

The preliminary targets for the transfer and adoption of the selected technologies for adaptation to climate change in the water resources sector are to construct 10,000 community surface run-off rainwater harvesting systems, each with a capacity of about 30,000 m^3 in the ASAL areas and to assist 500,000 households in the ASAL areas to install roof rainwater harvesting systems, each with a capacity of 10 m^3. The key common barriers to achieving these targets include economic and financial barriers associated with high initial cost of installation of the technologies. Other barriers include limited awareness of the technologies, traditional habits and cultural preferences and water resources constraints associated with climate variability.

1.1.1 General barriers and proposed measures

Barriers for the diffusion and adoption of the two technologies can be overcome by putting in place appropriate financial and economic measures such as introduction of financial credits with low interest rates and appropriate subsidies. This will facilitate access to finances to install the water harvesting technologies. The non-financial measures include public awareness and sensitization on the technologies. The proposed measures to overcome barriers to technology adoption and diffusion in the sector are presented in Table 1.2. Once the measures are put in place, the outcome will be improved water supply, and improved hygiene and livelihoods which will set pace for the communities' social and economic development.

Table 1.2 Proposed measures to overcome technology adaptation and diffusion barriers in the water resources sector

Technology	Economic & financial measures	Non-financial measures
Surface Runoff Rainwater Harvesting Technology	• VAT waiver for construction materials. • Introduction of low interest credits. • Providing appropriate subsidies.	• Prioritise community land use for surface runoff water harvesting projects. • Reposes community land in private hands. • Change of cultural values through sensitisation on the negative economic impacts of sub-division of land into small units. • Introduction of appropriate land policy to discourage subdivision of land into small uneconomic units and protect community land from land grabbers.
Roof Rainwater Harvesting Technology	• Give incentives for initial installation of rain water harvesting systems • Reduce cost of initial installation of rain harvesting systems by introducing tax rebate and waivers. • Reduce cost of importation of materials for constructing water harvesting components	• Promote construction of special structures for water harvesting • Create awareness on water conservation and rainwater harvesting. • Promote appropriate housing design

1.2 Action Plan for Surface Run- off Water Harvesting Technology

1.2.1 About the Technology

Most precipitation that falls on human settlements is lost to the atmosphere through evapotranspiration, or runs into rivers away from settlements before it can be used. However, if the rain is collected using appropriate infrastructure, it can contribute greatly to the volume of freshwater available for human use. This is particularly relevant in arid and semi-arid regions, where the little rainfall received is usually very intense and often seasonal (Elliot et al 2011).

Surface runoff water harvesting is the collection, accumulation, and storing of storm-water for its eventual reuse. It can also include other catchment areas from manmade surfaces, such as roads, or other urban environments such as parks, gardens and playing fields. Small reservoirs with earthen bunds or embankments to contain runoff are built from soil excavated from within the reservoir to increase storage capacity and a spillway or weir allows controlled overflow when storage capacity is exceeded (Elliot et al. 2011). The reservoirs can vary in size from less than a hectare to up to 12 ha.

Surface runoff water harvesting is a good alternative to using piped drinking water. If properly designed, surface runoff catchment systems can collect large quantities of rainwater. The technology involves harnessing surface run-off from ground surfaces and directing the water into a retention earth pan (dam) for storage. Harnessing of the surface runoff involves construction of channels to direct water into the retention dam and sediment traps to reduce sediment loading into the dam. The dam is usually constructed by excavating the earth followed by impoundment and water proofing the surface either using impermeable clay soil or polythene sheets. The water can then be used directly for livestock, irrigation or for drinking, after appropriate treatment. The technology can be applied for small household dams or large communal dams. The cost of construction a surface runoff water harvesting system (including harvesting channels, sediment traps and storage dam) for serving 200 households is estimated based on expert knowledge, to cost about US$75,000. Detailed information on the technology is presented in the technology Fact-Sheet; Annex 1.1 of the TNA Report I.

A cost-benefit analysis was done by first identifying both direct and indirect costs and benefits associated with current water sources and the implementation of the surface water runoff harvesting technology, based on establishing a surface runoff harvesting unit for supplying water to 200 families. The Net Present Value (NPV) for a 10 year period was Kshs 71,031,195 indicating that the surface water harvesting technology has large cost benefits and it is therefore viable, despite the high initial cost, which was identified as a major barrier.

1.2.2 Target for Technology transfer and Diffusion

The targets for the transfer and adoption of the surface run-off water harvesting technology for adaptation to climate change in the water resources sector are to establish 100,000 community surface run-off rainwater harvesting systems, each with a capacity of 30,000 m^3 for serving two hundred households, by the year 2017. In order to achieve these targets the stakeholders and players to be involved include policy makers in the water and finance sectors, who will be responsible for formulation and implementation of relevant policies; relevant government ministries and departments including ministries of Water and Irrigation,

Agriculture, Housing and Human Settlements, whose role will be to provide technical and extension support; and manufacturers of technology components, wholesalers and retailers, technicians and experts in water and irrigation sector. The implementers will include women and youth groups at local level, who will also benefit from socioeconomic opportunities including employment; CBOs and NGOs dealing with water issues at local and national levels, who will provide technical and community sensitization and education services; and community leaders who will be key players in the transfer and diffusion of the technologies in the water sector.

1.2.3 Barriers to Technology's Diffusion

The most important financial and economic and non-financial barriers to the adoption of surface water harvesting technology in Kenya were identified as high initial cost of implementing the technology, lack or inadequate access to financial resources, inappropriate land tenure, unfavorable local geology and insufficient capacity among the local communities.

The high initial cost is associated with high cost of material and labour for the construction of harvesting channels, sediment traps and storage dam, estimated to cost US$75,000 for a system serving 200 households. It is also associated with high cost of obtaining financing for individuals and communities since financial institutions charge interest of up to 30% on credits. Analysis of the barriers showed that the high cost of materials is as a result of high VAT (16 %) and that the high labour cost is due to lack of government subsidies through provision of mechanized equipment for dam construction. The effects of the high initial cost for surface runoff water harvesting are inadequate water for domestic use and livestock which lead to malnutrition and associated poor health for the communities. The other effect is negative impacts on gender and children education since women and children are forced to spend many hours of the day looking for water, which lead to loss of opportunities. Barrier decomposition found lack of or inadequate access to financial resources to be a sub-barrier of the high initial cost barrier.

The inappropriate land tenure barrier is associated with small land holdings by many individual households leading to lack of land for establishment of surface runoff water harvesting facility, lack of community land for establishment of community surface runoff water harvesting facilities due to allocation of available community land for other social or individual uses and also due to the location of land being inappropriate for surface runoff water harvesting. Analysis of the insufficient capacity among the local communities barrier showed that the lack of community capacity is easily complemented by availability of technical experts from relevant government departments. However, since unfavourable Local Geology barrier is a killer (non-starter) barrier, it was not analysed further.

1.2.4 Proposed Measures and Enabling Framework

The measures and enabling framework for overcoming barriers to the adoption and diffusion of surface water harvesting technology were identified through stakeholder consultation, review of relevant policy documents, expert knowledge and analysis using objective trees for each barrier according to Boldt et al. (2012). The identified economic and financial and non-financial measures and framework for overcoming the barriers to the adoption and diffusion of surface water harvesting technology are:

(i) **VAT waiver for construction materials.** This will result in lowering of the construction cost of surface runoff water harvesting systems and hence make the initial cost of the technology low. This will be done through introduction of appropriate policy to waive VAT, currently at 16%, on materials used for implementation of run-off water harvesting systems.

(ii) **Introduction of low interest credits.** Low interest credits will increase access to affordable financing for communities and individuals for development of surface runoff water harvesting systems. This will be done through introduction of appropriate policy to encourage lowering of interest rates by financial institutions and provision of low interest government credits.

(iii) **Providing appropriate subsidies.** Subsidies include availing free government technical and professional services and advice, and subsidized mechanized equipment and fuel to help lower labor costs during the implementation.

(iv) **Repossession of community land in private hands.** Through enforcement of relevant land laws, community land in private hands will be reverted back to the community and be availed for surface runoff water harvesting technology projects.

(v) **Change of cultural values** through sensitization on the negative economic impacts of sub-division of land into small units. It will also involve introduction of appropriate land policy to discourage subdivision of land into small uneconomic units and protect community land from land grabbers.

The impact of implementing the identified measures is availability of adequate water for domestic use and livestock which will consequently result in improved women welfare and children education and improved nutrition and health for the communities. The overall results are lower poverty levels and child mortality and improved local economy.

1.2.5 Proposed Action Plans for Surface Run-off Water Harvesting Technology

The proposed action plans for surface run-off water harvesting technology include introduction of VAT Waiver on materials for construction of water harvesting systems; introduction of government subsidies on mechanized equipment and fuel; and provision of low interest rate credits to communities implementing surface run-off harvesting systems (Table 1.3). The enabling framework for these measures will involve introduction of appropriate policies in consultation with the Central Bank and Ministry of Finance. The other enabling framework are putting in place appropriate land policy to limit size of land subdivision in order to avail land for putting up the water harvesting system and to repossess community land in private hands in order to make land available for community water harvesting projects.

The projected timeframe for implementing the measures is between 0 to 10 years, with introduction of low interest credits and repossession of community land in private hands taking place within the first two years, the development and implementation of land policies for guiding land subdivision happening over a 10 year period and the implementation of the remaining measures occurring over 0-5 year period. It is estimated that the implementation of the Action Plan will cost KShs 4.05 Billions with financial measures taking the bulk of cost (Table 1.3). The main sources of funding include GoK, Private sector through corporate responsibility initiatives, developments partners (such as World Bank; DANIDA; CIDA; JICA) and contribution by the local communities.

The indicators of success include reduced VAT on material for water harvesting systems and consequent reduction on cost of materials for surface run-off water harvesting systems, availability of low interest credit and of mechanized equipment and subsidized fuel to communities and, availability of land for surface run-off water harvesting system. The risks associated with the implementation of the action plan are:

(i) Lack of political goodwill for VAT waiver,
(ii) Inadequate available technical and financial resources for provision of mechanized equipment and fuel subsidies,
(iii) Lack of goodwill by the financial institutions to provide low interest rate credits,
(iv) Resistance to change by community and high population density, whose associated pressure on land may complicate land policy implementation,
(v) Lack of political will and Legal challenges during the repossessing of community land.

The implementation of the Action Plan will result in wide adoption and diffusion of surface runoff water harvesting technology and lead increased water availability and associated enhanced socio-economic development, gender empowerment and lower poverty rates in the arid and semi-arid areas.

Table 1.3: Proposed Action Plans for Surface Run-off Water Harvesting Technology

Measure	Why measure	Main Actor (s)	Time Frame (Years)	Indicative Cost (Million KSh)*	Source of Funding	Indicators of success	cators of
VAT Waiver	Currently VAT on materials stands at 16% and is a major factor contributing to high initial cost of the technology. Waiving of VAT will lead to low cost of materials which will make surface run-off water harvesting technology affordable	• Policy formulation (Ministry of Water & Irrigation; Ministry of Finance; Kenya Revenue Authority (KRA)) • Policy implementation (KRA; suppliers & retailers) • Technology implementation (Retailers and suppliers; Local communities)	Within first 5 years	2000	• GoK	• Reduced VAT on material for water harvesting systems • Reduced cost of materials for surface run-off water harvesting systems	• Lack of political goodwill
Government subsidies on mechanized equipment and fuel	In order to lower the labor costs for building a run-off harvesting system, appropriate subsidies including provision of mechanized equipment and fuel subsidies will be put in place	• Funds allocation (Ministry of Finance); Mechanized equipment and fuel (Ministry of Public Works) • Technical support (Ministry of Water & Irrigation; Local NGOs & CBOs) • Technology implementation (Local communities)	Within first 5 year	500	• GoK UK/Netherlands Climate and Development Knowledge Network (CDKN)	• Mechanized equipment and subsidized fuel available to communities • Reduced labor costs for surface run-off water harvesting systems	• Inadequate available technical and financial resources
Introduction of low interest rate credits	Currently, interest rates on credits from local financial institutions stand at 25 to 30 % which is well above what local communities can afford. To make credit affordable appropriate policy will be put in place in consultation with the Central Bank in order to lower interest rates for credits to individuals and individuals implementing surface run-off harvesting systems	• Policy formulation (Ministry of Finance; Ministry of Water & Irrigation) • Policy implementation (Ministry of Finance; Ministry of Water & irrigation; Local financial institutions) • Technology implementation (Local youth and women groups and community organizations)	Within first 2 year	1500	• GoK • Private sector through corporate responsibility initiatives • GEF (Adaptation Fund); AfDB (African Development Fund)	• More individuals and community groups accessing credits from financial institutions	• Lack of goodwill by the financial institutions

Development of land policy on minimum land size and land consolidation	The current unlimited sub-division of land is an impediment to the adoption of surface run-off water harvesting technology. There is need to develop appropriate policy to limit size of land subdivision in order to avail land for putting up the water harvesting system.	• Policy formulation (Ministry of Lands & Settlements) • Policy implementation (Ministry of Lands & Settlements; County authorities)	Within 10 years	30	• GoK • EU (Global Climate Change Alliance fund)	• Land for surface run-off water harvesting system available and secured	• Resistance to change by community • High population density and associated pressure on land
			Total (Million KShs)	**4030**			

*Indicative costs were arrived at during brainstorming sessions with stakeholders and input from various experts

1.3 Technology Action Plan for Roof Rain Water Harvesting

1.3.1 About the Technology

In Kenya, only 57% of total households use water from sources considered safe (MW& I, 2010). The country is also water scarce as the annual per capita availability of renewable freshwater is only 647 cubic meters (m^3), which is lower than the UN recommended amount of 1000 m^3 (MW& I, 2010). The water situation is made worse by large seasonal variation in rainfall, manifested through frequent, severe and long dry seasons that lead to water shortage. Roof rainwater harvesting has the potential to alleviate water shortage during the dry season and to control the excessive flooding during the rainy season. While this technology has been practised in this country for many years, its diffusion and adoption need to be intensified in view of extreme weather events associated with climate change and variability.

Rainfall can provide some of the cleanest naturally occurring water that is available and roof rainfall harvesting is particularly suitable for areas where there is no surface water, particularly in the ASALs. Harvested rainwater can be used for domestic use, irrigation, or both, in whole or in part. Rainwater harvesting technologies are simple to install and operate. Use of roof rainwater harvesting technology promotes self-sufficiency and has minimal environmental impacts and running costs are reasonably low. Construction, operation and maintenance are not labour-intensive. Local people can be easily trained to implement the technology, and construction materials are usually readily available.

Roofs for rainwater harvesting can be constructed with a range of materials including galvanised corrugated iron, aluminium cement sheets, and tiles and slates. Thatch or palm leafed roofs can provide a low-cost alternative but can be difficult to clean and can taint the water. Tiled roofs or those with corrugated mild steel are preferable, since they are the easiest to construct and give the cleanest water.

1.3.2 Targets for Technology Transfer and Diffusion

The targets for the transfer and adoption of the roof rainwater harvesting technology for adaptation to climate change in the water resources sector are to establish rainwater collecting systems, each with a capacity of 10 m^3, in 500,000 households by year 2017. To achieve these targets the stakeholders to be involved include policy makers in the Ministries of Water, Environment, Housing and Human Settlements and Ministry of Health. The National Environment Management Authority, Meteorological Departments and Ministry of Commerce are also to be involved. Others to be included are the representatives of manufacturers, wholesalers and retailers roof rainwater harvesting, conveyance and storage systems. The implementers of the technology will also be comprising, women and children, local NGOs and CBOs will also be involved.

1.3.3 Barriers to Technology's Diffusion

Despite the awareness and existence of roof rainwater harvesting technology in the country there is limited adoption and diffusion of the technology due to several key barriers, which are related to policy, legal and regulatory framework, economic and financial issues, and social cultural and environmental conditions:

(i) **Policy, Legal and regulatory framework** for operationalising roof rainwater harvesting has been inadequate in the country. There is also inadequate institutional capacity to support and propagate roof rainwater harvesting and storage technology.

(ii) **Economic and financial** issues have been a barrier to harvesting of adequate rain water as this requires installation of water harvesting facilities that include suitable roofs, gutters and water storage facilities. Initial installation of suitable roofs catchment, adequate water harvesting facilities is expensive and the government has not put in place financial incentives for rain water harvesting facilities. Many households therefore, have not been able to increase their capacity to harvest rainwater and have over the years been using all sorts of small containers such as jerry-cans to harvest rain water and this cannot meet their long-term needs.

(iii) **Social cultural and environmental conditions** have been a barrier to the diffusion of roof rainwater harvesting. The type of roofs is determined by prevailing weather conditions, affordability and lifestyle. In hot places like the Coast and North Eastern Kenya people have grass thatched houses to regulate temperatures. Migratory lifestyle of the pastoralist community also dictates their building materials and they mainly thatch their houses with grass or twigs. In other parts of the country people use what they can afford for thatching and roofs range from tiles, corrugated iron sheets and grass thatch. Only about 20% of the population has corrugated iron sheets which is suitable for rain water harvesting.

1.3.4. Proposed Measures and Enabling Framework

The identified measures to overcome barriers to the adoption and diffusion of roof rainwater harvesting technology include:

(i) Policy, Legal and Regulatory Measures

The government should provide economic incentives and come up with necessary policy to facilitate provision of affordable loans by local financial institutions in order to enable local people install water harvesting facilities. Related water provision agencies, including relevant government departments and NGOs, should also act as conduit of water harvesting technologies to the grassroots level.

(ii) Economic and Financial

The government should provide economic incentives and come up with necessary policy to facilitate provision of affordable loans by local financial institutions to enable local people install water harvesting facilities. The government should also put in place financing facilities and introduce tax waivers and rebates for water harvesting facilities.

(iii) Information and Awareness

Stakeholders need to be provided with relevant information on the technology and its benefits, sources of financing, and maintenance of the facilities.

(iv) Environmental Measures

Unpredictability of the amount and duration of rainfall is a big handicap to roof rain water harvesting and potential users need to be updated on weather forecast by relevant authority.

The implementation of the proposed measures will enhance adoption of roof rainwater harvesting technology by households for domestic and economic purposes. Consequently there will be adequate water, better hygiene, improved social welfare and income from time budgeting and farming. Enhancement of information and awareness on the technology will reduce social and cultural barriers and promote use of rainwater.

1.3.5 Proposed Action Plan for Roof Rainwater Harvesting

The proposed action plan will start by operationalising the existing Government policy on water harvesting. This is to enable policy guidance in diffusion of the technology. In this case, the ministries responsible for water, environment, housing and trade will play a big role. The indicators of success are diffusion of roof rainwater harvesting and the risk would be lack of goodwill. This project will take 2 years and will run at a cost of Ksh 200 million.

Awareness creation on rainwater harvesting technology: The purpose of this action plan is to inculcate positive attitudes on rainwater harvesting and to enhance diffusion of the technology. The government agencies that will be involved are ministries incharge of environment, water, housing, and health and the National Environment Management Authority (NEMA). The source of funding for this activity will be the GoK with assistance from the donors. This activity continuous through the project life of 5 years and it will cost Kshs 300 million. The indicator of success will be adoption of the roof rain water harvesting technology by the local people and the risk associated with the project is lack or inadequate rainfall which can lead to stalling of the project.

Facilities and materials for roof rainwater harvesting are expensive and in order enable diffusion of the technology, the Government will need to put in place appropriate subsidies. These will be in form of tax waivers and rebates. Currently VAT on materials stands at 16% and is a major factor contributing to high initial costs of the technology. Waiving of VAT will make installations, harvesting and storage of rainwater materials affordable to local people. The government agencies concerned are the ministries dealing with water, environment, housing, and finance and NEMA. The indicators of success of this project will be more people adopting and harvesting rainwater harvesting technology for domestic purposes and the risk is low adoption of the technology due to poor attitudes. The project will run for 5 years at a cost of Kshs 500 Million.

Promotion of local materials for construction of roofs for rainwater harvesting: The use of locally available roofing materials such as plastic papers, cocoanut leaves among others will be promoted for adoption in order to lower the cost. The ministry concerned is Ministry of Trade and Industry and the project activity will cost Khs800 and will last for 5years. The measure of success is adoption of local materials for rain water harvesting by households, institutions, local communities, CBOs and NGOs. The indicators of risks of are poor attitude towards adoption of local materials for rain water harvesting and lack of adequate rainfall to meet local needs.

The proposed action plan for rain water harvesting technology is summarized in Table 1.4.

Table 1.4: Proposed Action Plan for Roof Rainwater Harvesting Technology

Name of Measure	Why the action/ measure is needed	Main Actors	Time frame	Indicative Cost in Million KShs	Source of Funds	Indicators of Success	Indicators of risks
Operationalisation of Government policy on water harvesting	To guide implementation of the policy	• Implementation • Ministry of water, environment, • Housing	Up to 2 years	200	GoK	Operational water harvesting and storage policy in place	Inadequate political will
Creation of awareness on rain water harvesting and conservation	To inculcate positive attitudes on rain water harvesting.	**Policy formulation** Ministry of Environment, Water, Housing and Human Settlements. • Implementation -National Environment Management Authority -Related NGOs and CBOs.	Up to 5 years	300	GoK and Climate and Development Knowledge Network (CDKN) GEF(Adaptation Fund)	Water harvesting attitudes are inculcated and the technology is operational	Lack of adequate rainfall
Introduction of subsidies on materials for roof water harvesting and storage	To make suitable materials for rain water harvesting and storage affordable to local communities	• **Policy** -Ministries of Housing, -Water and environment, • **Implementation** - Ministry of Trade and Treasury.	Up to 5 years	200	GoK	• Subsidies for suitable materials for roof rainwater harvesting available • Lowered cost of initial installation	Competing government priority projects for available funds
Introduction of tax waivers and rebates for water harvesting facilities	Currently VAT on materials stands at 16% and is a major factor contributing to high initial costs of the technology. Waiving of VAT will make installation of rainwater harvesting and storage affordable to local communities	• **Implementation:** -Ministries of Water and Irrigation, Environment, Housing, Health and Finance -National Environment Management Authority • Implementation Stage -Ministry of Finance -Kenya Revenue Authority	Up to 5 years	500	GoK	• Reduced VAT on material for water harvesting and storage systems • Reduced cost of materials for roof rainwater water harvesting systems	Competing government priority projects for available funds

Promotion of local materials for construction of roofs for rainwater harvesting	To reduce cost of roof construction for water harvesting. Local materials are also suitable in hot climates to regulate temperature in houses.	• **Policy** Ministry of Trade. Ministry of Housing • **Implementation** **-**Ministries of Housing, National Environment Management Authority	Up to 5 years	800	GoK • Local community • Private sector • GEF (Adaptation Fund)	• Suitable roofs for rainwater harvesting	• Nomadic lifestyles • Lack of adequate rainfall
			Total (million KShs)	**2000**			

CHAPTER 2: TECHNOLOGY ACTION PLAN FOR AGRICULTURE SECTOR

2.1 Actions at Sectoral Level

The Agricultural Sector was prioritized for the TNA process because of its contribution to the National Economy and vulnerability to climate change. Agriculture is the mainstay of the Kenyan economy and accounts for about 26% of GDP directly and another 25% indirectly through linkages with manufacture, distribution and other service related sectors (GOK, 2010). The sector provides livelihood to most of our rural population with an estimate of about 80% of the population deriving their livelihood from agricultural activities (SoE, 2004). The sector in Kenya comprises crop production, livestock and fisheries. It is estimated that 89% of the land mass in Kenya is used for agriculture and livestock. About 12% of the surface of Kenya is regarded as high potential agricultural land, while 8% is of medium agricultural potential and the rest as Arid and Semi Arid Lands (ASALs) (GOK/MOA, 2004 and 2010).

Agriculture is one of the key sectors in the Economic Pillars of Vision 2030, which is Kenya's blue print for transforming the country to a newly 'Industrialized Middle Income Country' by the year 2030 (GoK, 2007). Agricultural Sector also contributes to the achievement of Millennium Development Goals (MDGs)

Agriculture is generally the first economic sector to be affected by climate extremes through drought and floods due to its reliance on rainfall. The greatest impact of drought in the agriculture sector is the associated crop production losses arising from reduced yields of food crops and cash crops. Floods directly impact on agricultural production by inundating land and flooding of storage facilities, leading to the destruction of crops and harvested food that has been stored. Floods, together with higher temperatures, are also having indirect impacts, such as increase in some crop pathogens.

Livestock in the semi-arid parts of Kenya has in the past been greatly affected by changes in climate, manifested through frequent, intense and long lasting droughts. There are also significant livestock health risks associated with flooding including outbreaks of diseases such as bovine disease. In addition, changes in climate, which has tremendously contributed to water pollution, which subsequently leads to reduction of fish landings (SOE, 2007).

The relevant existing laws and regulations and policies are presented in Table 2.1 below. The Vision 2030 is based on three pillars: Economic, Social and Political. All these pillars are interrelated and the fiber that binds them together is the natural environment with its inherent supply of renewable and non-renewable goods and services (UNEP 2009). In order to meet the obligations of Vision 2030, every Sector has developed individual plans and strategies. Examples are the National Climate Change Response Strategy (NCCRS) and the Strategy for Revitalizing Agriculture (GoK, 2010; Ministry of Agriculture 2004). NCCRS is the first document in Kenya dedicated to addressing the threats posed by climate change, and it emphasizes the vulnerability of the Kenya's economy to climate change. The NCCRS primary focus is ensuring that adaptation measures are integrated in all government plans and development objectives.

Measures required to reduce the negative impacts of Climate Change and to take advantage of its positive impacts have been incorporated in the various developed strategies. The strategies and activities in the Agriculture Sector related to climate change adaptation include:-

a) Crop Production

Strategy for Revitalizing Agriculture (Ministry of Agriculture 2004) emphasizes among others the use of different crops or varieties to match changing water supply and temperature conditions; change farming practices to conserve soil moisture and nutrients; reduce run off and control soil erosion; promotion of small scale irrigation; and conservation agriculture and micro-dosing.

b) Livestock Production

The National Livestock Development Policy proposes participatory breeding involving local breeds, establishment of fodder banks, replanting range lands, and diversification of dairy products as major strategies to revitalize livestock production.

c) Fisheries and Aquaculture

Learning indigenous knowledge from the communities; diversifying livelihoods with aquaculture and salt-tolerant tilapia breeding are emphasized in the Fisheries Development Policy as important strategies for fisheries and aquaculture development.

Table 2.1: Existing Policies Related to Agriculture Sector's Development and Technology Deployment

Name of Policy	Date Enacted	Main Contents	Relationship with the Technology
1. Vision 2030	2007	• Aims at transforming Kenya into a newly industrialized, middle income country providing high quality life to all its citizens in a clean and secure environment • To address such challenge areas/aspects as climate variability, productivity, land use, markets and value addition in Agriculture • Identifies Agriculture as one of the sectors of the Economic pillar • Embraces science, technology and innovation as vital tools for addressing the critical challenges of food security, environment degradation and escalating poverty.	Recognizes the contribution of irrigated agriculture to deliver 10% annual growth of the economy by increasing the support of food, agro industry and raw materials apart from improving income and employment Irrigation is identified as one of the flagship projects which are already under implementation
2. Constitution of Kenya	2010	• Embodies a host of social and economic ground of an environmental character such as right to a clean and healthy environment, water and food security in the Bill of Rights • The devolve system of government will shorten the decision making process on agricultural programmes	Guarantees the right of food which requires enhance food production supported by irrigation and promotion of drought tolerant crop like sorghum

3. National Climate Change Response Strategy (NCCRS)	2010	• The first document in Kenya dedicated to addressing threats of climate change. It emphasizes the vulnerability of the economy to climate change which is a threat to sustainable development • NCCRS primary focus is ensuring adaptation measures are integrated in all government policies, plans and programmes	Calls for enhancement of technical and financial support to the orphaned crops like sorghum and promotion of irrigated agriculture and efficient use for water systems
4. The Agricultural Act Cap 318	1955	• Aims to promote and maintain a stable and sustainable agricultural production • Regulates the destruction of vegetation for agricultural expansion with the aim of promoting and maintaining farm forest cover of at least 10% of every agricultural land holding as a means of preserving and sustaining the environment in combating climate change and global warming	The act recognizes irrigation as a major contributor to food production. Drip irrigation to enhance horticultural and small scale production Advocates for research and adoption of drought resistant technologies Recognizes promotion of irrigation in agriculture and use of drought resistant crops as some of the measures to adapt to impacts of climate change
5. The National Livestock Developme nt Policy	2007	• Status of Kenya's Livestock Industry • Livestock Sub-sector accounts for 40% of Kenya's agricultural GDP hence plays an important role in food security and improved livelihoods. The sub-sector is negatively impacted by effects of droughts	The policy recognizes the need for construction of sub-surface dams, roof water harvesting tanks for provision of water for use by livestock and for growing fodder crops for use by livestock. Technologies are already utilized.
6. Strategy for Revitalizing Agriculture 2004 – 2014 (SRA)	2004	• Provision of Policy and institutional environment conducive to increasing agricultural productivity • Promoting investments • Encouraging private sector involvement in agricultural enterprises	Irrigation and drought resistant crops seen as major contributor for revitalizing Agriculture in Arid & Semi Arid Lands and flood prove areas
7. National Agricultural Sector Extension Services Policy 2005 (NASEP)	2012	• Paves way for more effective promotion of extension services and better co-ordination and regulation of services. • Provides platform for enhanced private sector participation in provision of extension services. • Encourages extension clientele access quality extensions services from best providers to attain higher productivity, increased incomes and improved standard of living. • Empowers the Extension clientele on sharing information and imparting knowledge, skills and changing attitudes for improved management of resources for improving quality of livelihood.	Extension services will be necessary for the use, development, and diffusion of drip irrigation and drought tolerant sorghum for improved food security and livelihoods

8. Agricultural Sector Development Strategy (2010 - 2020)	2010	• Facilitates harmonization with other programmes • Provides means for other financiers e.g. Private Sector to invest in the sector • Aims at transforming agricultural sector into innovating, commercially oriented, competitive and modern industry that contributes to poverty reduction and food security in the rural and urban Kenya • Focus on agribusiness and market development using Value Chain approach	Strategy aim at increased acreage under irrigation and research and adoption of drought resistant crops
9. Fisheries Development Policy		• Increase fisheries by introducing fish farming in farms and aquaculture along the Kenya Coast	Need for water harvesting technologies for use in fish ponds
10. Draft National Policy for Sustainable Development of Arid and Semi arid lands in Kenya	2004	• ASALs occupy over 80% of the country and hosts about 25% of the population and 70% of livestock. The region has the highest incidences of poverty due to impacts of drought • Notes that irrigation efficiency and crop yields per acres is low in ASALs	Prescribed solution includes among others more efficient and modern systems of irrigation schemes. Use of low cost drip irrigation in ASALs will enhance potential of food production and create alternative employment for pastoral community including developing fodder and crop production. To minimize impacts and risks of livestock keeping, pastoralists can practice mixed farming and plant drought tolerant crops like sorghum

The two technologies identified for transfer and diffusion in Agricultural Sector are drought tolerant sorghum and drip irrigation. The current levels of employment and future targets are:

a) **Drought Tolerant Sorghum:** The technology has been developed and adopted by some farmers in the country. Farmers are already using the drought tolerant varieties in drought prone areas to improve sorghum production under drought conditions. Extension agents and NGOs are promoting drought tolerant sorghum for food security and beer brewing. However, studies on the extent of adoption by farmers in the country are still on-going.

b) **Drip Irrigation:** Available statistics show a very low adoption level of drip irrigation in the country. According to GoK (2012), all National Irrigation Board (NIB) schemes are surface irrigated while 88% of the smallholder schemes are surface irrigated, 9% are sprinkler irrigated and the remaining 3% are drip irrigated. The apparent small number of farmers using drip irrigation can be attributed to the high capital investment cost and to some extent the low technical knowhow of the farmers regarding the use of the technology (GoK 2012). Since 1996, the Government of Kenya through KARI developed low-head drip irrigation which

could be adopted by small scale farmers. KARI has established various on-station demonstration sites including at National Agricultural Research Laboratory (NARL) Nairobi, National Dryland Research Centre in Katumani, Regional Research Centre in Mtwapa and Regional Research Centre in Perkerra (Sijali and Okumu, 2002. These centres also stock the kits for sale.

The preliminary target for the transfer and diffusion of drought tolerant sorghum varieties is to introduce the technology to 1 million farmers by the year 2017. The preliminary target for the drip irrigation technology is introduction of 500,000 and 1000 drip irrigation systems to individual farmers and institutions, respectively by the year 2017.

2.1.1 General Barriers and Proposed Measures

General barriers for the transfer and diffusion of drought resistant and drip irrigation technologies and proposed measures to overcome the identified barriers are summarized as follows:

(i) **Economic and Financial Barriers -** These are associated with inadequate financial resources, credit, and loans. These barriers can be overcome by provision of adequate financial resources and reduction of interest rates on credits and loans. If these measures are adopted there will be sufficient financial resources for the transfer and diffusion of the two technologies and therefore more farmers will be able to access credit and loans and take up the technologies. The overall outcome of these measures is enhanced adoption and diffusion of these technologies leading to improved incomes and food security.

(ii) **Human Skills –** Though these technologies exist in Kenya, their uptake is low due to inadequate training and low adaptive capacity by the local communities. This barrier can be overcome by providing adequate and relevant training at all levels. The overall outcome will be more trained personnel, and farmers, resulting in better uptake of these technologies.

(iii) **Information and Awareness –** Inappropriate communication and extension approaches as well as inadequate awareness of the technologies were identified as major barrier. The proposed measures to overcome these barriers include promotion of awareness and effective extension services and creation of sufficient awareness of the existence and use of the technologies. This results in improved response in the adoption and diffusion of the technologies.

The overall outcome applying the measures and associated overcoming of the barriers will be enhanced adoption and diffusion of the technologies by the local communities resulting in enhanced incomes and food security

2.2 Action Plan for Drought Tolerant Sorghum Varieties Technology

2.2.1. About the Technology

Due to global warming and climate change, the country has frequently been faced with drought and hence there is need to lay emphasis on drought tolerant plants and crops especially in areas where rains are not sufficient. Sorghum is grown in areas with as little as 250mm of rainfall. The drought tolerant sorghum varieties such as Serena, Seredo, super sorghum are produced as a result of plant breeding to enhance their resistance or tolerance to stresses that result from climate variability. Drought is a major constraint to rain-fed crop

production. Yield losses vary according to severity and type of drought. Prolonged drought at any stage will result into crop failures.

The Drought Tolerant Sorghum Varieties technology has been developed by KARI and adopted by some farmers in the country. Farmers are already using the drought tolerant varieties in drought prone areas to improve sorghum production under drought conditions. Extension agents and NGOs are promoting drought tolerant sorghum for food security and beer brewing. However, studies on the extent of adoption by farmers in the country are still on-going.

The direct and indirect benefits of drought tolerant sorghum include water use efficiency improved; expands arable land; reduce soil erosion, improvement of soil fertility and improvement in food security. It is estimated that it costs US $ 115 for the adoption of the drought tolerant seeds by a farmer, but this amount does not include the research and development of the drought tolerant sorghum variety by KARI which is estimated to cost about KShs 3 million over a period of about 7 years.

2.2.2 Target for Technology Transfer and Diffusion

The preliminary target for the transfer and diffusion of drought tolerant sorghum varieties is to introduce the technology to 1 million farmers by the year 2017. In order to achieve these targets the stakeholders and players to be involved include policy makers and implementers such as Ministries of Agriculture, Finance and Trade and Industry; research institutions such as KARI; seed multipliers, handlers and distributors such as Kenya Breweries Limited and Kenya Seed Company; wholesalers and retailers; and farmers who grow the crop. The other stakeholders are the millers who make floor for humans and animal feeds and service providers including financial institutions and local NGOs and CBOs

2.2.3 Barriers to Technology's Diffusion

The barriers to the transfer and adoption of drought tolerant sorghum varieties technology include inadequate financial resources which is associated with lack of available capital to buy seeds and agricultural credit including low affordability amongst rural farmers. The other identified barriers are:

a) Market failure associated with inaccessibility of seeds to farmers caused by lack of functional seed market, unreliable suppliers, uncertainty on demand and late release of seeds
b) Inadequate policy, legal and regulatory framework due to inadequate government commitment associated leading to lack of patenting of research findings.
c) Technical barriers including inefficient seed production, distribution and delivery associated with delayed release of varieties and complexity of the technology
d) Lack of human capital associated with inadequate training on seed multiplication and lack of early involvement of farmers in variety selection
e) Inadequate information and awareness associated with inappropriate communication and extension approaches
f) Inadequate institutional and organization capacity to carryout agricultural research
g) Network failures due to lack of collaboration between national agricultural research institutions, extension officers and other stakeholders.

The barriers were then screened in order to identify the most important barriers to the adoption and diffusion of the technology. The most important economic and financial

barrier was identified as inadequate financial resources. Decomposition of the barrier showed that inadequate financial resources is due to lack of available capital to buy seeds, lack of agricultural credit and loans and low affordability amongst rural farmers. These hinder the adoption of the drought tolerant sorghum technology.

The main identified non-financial barrier to adoption and diffusion of drought tolerant sorghum technology is market failures. Analysis of the barrier showed the elements of the barrier to be associated with unreliable supplies due to absence of stockists; lack of functional markets in Arid and Semi-Arid areas; uncertainty on the demand for seeds; low seed demand; and poor infrastructure.

2.2.4 Proposed Measures and Enabling Framework

After identification, categorization and description of the barriers, the measures for addressing the barriers were formulated. They include economic and financial measures, which makes it easier for farmers to access affordable agricultural credit and loans. The non-financial measures are establishment of reliable supplies of inputs, functional seed market and efficient seed production and mounting adequate training and education on seed multiplication. They also include making available human labour and draught animals; improving communication and extension techniques; involvement of farmers in varietal selection; and integration between formal and informal seed systems improving agricultural research and timely release of varieties.

The proposed enabling framework includes establishment of necessary policy to enable financial institutions to provide affordable capital and putting in place relevant policies on land ownership, customer rights, quality control, business permits, business ethics, and taxation.

2.2.5 Proposed Action Plan for Drought Tolerant Sorghum Variety Technology

The proposed Action Plan for drought tolerant sorghum variety technology include adaptation interventions and provide for the enabling framework required to effectively respond to impacts of climate change. These in sequential order include:

(i) Provide adequate training - Provision of adequate training will improve farmers' skills in adoption and diffusion of drought tolerant sorghum variety technology. It will also enable effective communitarian between farmers, extension staff and researchers.

(ii) Formulate and enact appropriate legislations regulations and policies - This will facilitate in a conducive environment for research, development and diffusion of the technology. It will also improve extension services and facilitate harmonization of strategies and policies of all key players for enhancement of the technology at all levels.

(iii) Intensify coordination - Intensification of coordination will improve collaboration, integrate formal and informal markets, and provide adequate technological information. This will lead to collaboration of all key players and harmonization of their policies for use and diffusion of the technology.

(iv) Intensify research efforts - This will result in increased release of drought tolerant sorghum varieties in time, enhance research capacity, and provide adequate technological information. This will lead to release of improved

varieties of drought tolerant sorghum for various ecological regions on time and therefore enhance the use and diffusion of the technology.

(v) Provision of agricultural credit and loans for farmers - Provision of agricultural credit and loans to farmers will increase accessibility of financial resources and facilitate purchase of inputs. It will also facilitate training of farmers on agricultural credit management systems. These actions will lead to accessible and affordable credit including efficient use of such funds for the use and diffusion of drought tolerant sorghum variety technology.

(vi) Establishment of functional agricultural produce market outlets and agribusiness for farmers - Enhance use and diffusion of the technology will lead to increased demand for seeds and production of drought tolerant sorghum which requires access to markets. The establishment of functional agricultural market outlets and agri-business for farmers will improve marketing and value addition strategies including infrastructure for transport and distribution of the sorghum.

The projected timeframe for implementing the measures of this action plan is between 0 – 10 years. Provision of adequate training, formulation and enactment of relevant legislation, intensification of research coordination and formulation of policies on provision of agricultural credit and loans to farmers will be undertaken in a short-term period, between 0 – 5 years. Implementation timeframe of development of functional markets outlets and intensification of research efforts is envisaged to be medium-term period of up to 10 years. The implementation of the action plans for drought resistant, sorghum varieties is estimated to cost Kshs. 7.04 billion with provision of training and agricultural credit and loans to farmers taking the bulk, Kshs 50 billion and KShs 2.0 billion, respectively.

The implementation strategy of this action plan will involve various actors involving Public Private Sector, Civil society and community participation. Government ministries will provide the necessary policies, infrastructure, and funding; public institutions like KARI, Universities and private sector will undertake research and training while business community will facilitate agri-business initiatives. The donors will collaborate with the government financial institutions and private sector to provide the required funding for the action plan. The farmers will implement the policies through use and adoption of technology and also provide human and financial resources.

The foreseen main risks, which would affect the implementation of action plan, are inadequate funds, lack of cooperation and collaboration of stakeholders, ineffective communications, and inadequate political goodwill and support.

The proposed action plan for drought tolerant sorghum varieties technology is summarized in Table 2.2.

Table 2.2: Proposed Action Plan for Drought Tolerant Sorghum Variety Technology

Measured/ Actions Needed	Why the Measures/Actions Needed	Main Actors	Timeframe	Cost (Million Kshs)	Sources of Funds	Indicators of Success	Indicators of Risks	Outcome
1. Provide adequate training	To improve farmers skills	• Ministry of Agriculture and KARI – Develop training curriculum • KARI – Trainers using the curriculum developed • Kenya Breweries and Kenya Seed Company – training on effective planting and management of drought tolerant sorghum • Farmers-beneficiaries	Within 5 years	5000	• Government • AfDB (ClimDev Africa Special Fund) • Private Sector like Kenya Breweries, Kenya Seed Company • Communities	• Targeted farmers trained on the technology • Improved communication and extension services on sorghum varieties • Awareness on the technology and its benefits created	• Inadequate funds • Lack of cooperation and collaboration • Ineffective communication, extension and training approach • Inadequate awareness	Improved farmers skills in use and diffusion of the technology
2. Formulate and enact legislations, regulations and policies on research and multiplication and marketing of drought tolerant sorghum varieties	• To provide enabling environment for research, development and multiplication of drought tolerant sorghum varieties • To encourage participation of other investors e.g. Private Sector into the Agricultural Sector	• Ministry of Agriculture – Policy and legislation formulation • Min. responsible for ASALs –Policy on effective management of ASAL areas • AGs office – Advise and drafting of Legislations and regulations • Private sector, farmers and business communities – implementers of policy	Within 5 years	5	• Government • EU (Global Climate Change Alliance) • Civil Societies lobby groups • Private Sector	• Policies, legislation and regulations formulated, enacted and operationalised	• Inadequate government commitment • Lack of promotion of unreleased technology	Conducive policy and legislation framework for adoption of drought resistant sorghum

3. Intensify co-ordination between research institutions, seed multipliers and marketers	• To improve collaboration and cooperation e.g. research/Extension/Farmers • To integrate formal and informal markets • To provide adequate technological information	• Ministries of Agriculture, ASALs and research institutions – spearhead policy and implementation coordination, and networking • Private sector, farmers, civil society and business community – enhance networking and collaboration • Farmers – Formulation of active groups like cooperatives and associations for networking amongst themselves and with government, private sector (wholesaler, retailers and distributors) and business communities.	Within 5 years	10	• Government • Farmers Cooperative Societies • Private Sector like Kenya Breweries and business communities • Civil Society organizations • Communities • AfDB (ClimDevAfrica Special Fund)	• Collaboration improved • Markets intergraded • Improved collaboration and cooperation	• Lack of good will • Poor communication and approach • Poor collaboration and cooperation	Collaboration of all key players including harmonization of their policies in development and adoption
4. Intensify research efforts and funding	• To release varieties in time • Increase research funding • To enhance capacity for research	• Min. of Agriculture in collaborations with MHEST – develop research policy and guidelines. • Private sector and farmers – implement research findings and also identify research gaps	Within 10 years	20	• Government • Germany (International Climate • Initiative) • Private Sector	• Varieties released in time • Sufficient research funding available • Enhanced capacity for Research • Adequate and easily accessible technological information	• Lack of goodwill and support • Inadequate funds • Prematurely released varieties • Inadequate information and communication	Release of improved varieties of drought resistant sorghum for various ecological regions on time.

5. Provision of agricultural credit and loans to farmers	• To increase accessibility of financial resources to farmers • To facilitate purchase of inputs • To train farmers on agricultural credit management system	• MOF and Central Bank of Kenya – Policy formulation • Financial institutions including AFC and micro-finance institutions policy implementation. • Farmers, agri-business communities and traders – beneficiaries of policies	Within 5 years	2000	• Government • Financial Institutions including Micro-finance • Agri-Business Communities GEF (Adaptation • Fund (AF))	• Loans and credits available to target farmers • Agricultural credit funds in financial institutions available • Trained of Farmers on Agricultural Credit Management Systems	• Lack of political good will • Poor loan recovery mechanisms • High default rates	• Accessible and affordable credit to farmers for purchase of inputs and efficient use of funds
6. Establishment of functional agricultural produce market outlets and agribusiness for farmers	• To improve agricultural marketing, agribusiness and income for farmer s • To improve infrastructure for transport, distribution, and marketing of drought tolerant sorghum variety	• Ministry of Trade and Industry – lead agency and set standards • Min. of Local Government – provision of market centres • Min. of Cooperatives – helping farmers to develop marketing cooperative societies • Private Sector and business community value addition, research, market networks, wholesalers and retailers of seeds and produce and trading partners • Farmers – beneficiaries	Within 5 years	10	• Government • Marketing Cooperative Societies • Private Sector • Business Communities • Farmers	• Functional seed and produce markets established • Improved infrastructure • Improved supplies of inputs	• Inadequate involvement of key stakeholders • Lack of market regulations	• Functional market outlets established leading to improved incomes
		Total (Million KShs)		**7045**				

2.3 Action Plan for Drip Irrigation Technology

2.3.1 About the Technology

Persistent droughts and recurring floods due to climate change have led to food insecurity and exacerbated poverty in the country. The importance of irrigation and efficient use of water is being addressed through development of more efficient irrigation systems and methods such as drip irrigation. Drip Irrigation is a technique of application of specific and focused quantities of water to soil crops. The system uses pipes, valves and small drippers or emitters transporting water from the source to the root area and applying it under particular quantity and pressure specifications.

Drip irrigation is beneficial to environment, economic and social development. The technology can provide as much as 90% water-use efficiency in contrast to surface irrigation and sprinkler systems, which provide 60% and 75% efficiency respectively, and can therefore enable farmers to adapt to climate change in crop production under erratic rainfall pattern (Quezada et al., 2012). The drip system technology is adaptable to terrains where other systems cannot work well due to climatic or soil conditions. The technology is also gender sensitive.

Drip irrigation technology has climate change adaptation benefits. It can support farmers to adapt to climate change by providing efficient water use. In seasonal droughts, drip irrigation lowers demand for water and reduces water evaporation. The initial cost of drip irrigation systems can be higher than other systems, but this cost can is compensated by high yields after the development and after the barriers are removed. The Cost Benefit Analysis (CBA) - NPV for 10 years was positive (Kshs 577,273) which clearly shows that the Drip Irrigation is a viable technology.

2.3.2 Target for Technology Transfer and Diffusion

The preliminary target for the drip irrigation technology is introduction of 500,000 and 1000 drip irrigation systems to individual farmers and institutions respectively by the year 2017. To facilitate these users and ensure effective market chain analysis and linkages, the following market actors that are targeted include 200 Drip Irrigation Kit Retailers, 500 Tanks and Pipes Retailers, 100 Maintenance Providers, 50 Wholesalers of Drip Irrigation Kits, Tanks and Pipes, Private Local manufacturers of Tanks, Pipes, Nets, Greenhouses (these are available locally but will need to increase their capacity to meet the increased demand), and 10 Importers of pipes and Kits

In order to achieve these targets the stakeholders and players to be involved include policy makers in water sector, related government ministries and departments including ministries of Water and Irrigation, Agriculture, Northern Kenya & other Arid Lands and Regional Development Authorities, Research institutions like Kenya Agricultural Research Institute (KARI). The technology implementers such as women and youth groups, Amiran Kenya, Drip Grow ApproTech, Irrigation Water Users Associations and Cooperative Societies will be key players in the transfer and diffusion of the technology.

2.3.3 Barriers to Technology's Diffusion

The main barriers to the Drip Irrigation technology transfer and diffusion include high cost of initial installation, inadequate credit and loan facilities for farmers and inadequate incentives, and technical barriers such as extensive maintenance requirement, water quality,

and inadequate extension services. Other barriers include resistance to change, preference to other irrigation methods, inadequate awareness of the existence of technology due to lack of information and awareness, high human skills requirements, inadequate training of the majority of farmers, water scarcity, and inadequate policy..

The identified categorized barriers were screened according to their significance and the most essential barriers, which need be addressed for transfer and diffusion of drip irrigation technology, were identified. High cost of initial installation an economic and financial barrier was identified. The other, non-financial, identified are high human skills/trained labour requirement, water scarcity, high maintenance costs, insecurity, and inadequate extension services.

The screened barriers were decomposed to check whether some barriers are actually composed of some of the other barriers, or whether one barrier is just more concrete. Decomposition was done for both economic and financial and non-financial barriers at four levels including broad category, barrier within barrier, elements of a barrier and dimension of barrier and results are. Decomposition of the economic and financial barrier revealed that the high cost of initial installation is associated with high cost of unit kits because few local manufacturers of local kits and lack of incentives. It is also associated with high maintenance cost for farmers.

Further analysis using casual relations and problem tree showed that the high cost of initial installation of drip irrigation kit is due to cost of components as a result of high cost of credit facilities, which is a result of inadequate credit facilities and high interest rates. The cost is increased further by the need for specialized human skills since training is required. As consequence a few farmers are adopting drip irrigation resulting in reduced acreage in drip irrigation and inadequate income from farmers leading to overall food insecurity.

The main non-financial barrier is human skill which is associated with highly skilled manpower requirement for planning, installation and maintenance of drip irrigation. These include specialized skills for preparing pipes and filters, laying the pipes, technician for repairing the pipes. Few trained technicians. It also includes inadequate awareness by farmers on how to align the pipes with crops.

2.3.4 Proposed Measures and Enabling Framework

Measures and enabling framework for overcoming barriers to the adoption and diffusion of drip irrigation technology were identified by the consultants through review of relevant policy documents, expert knowledge, literature review, and stakeholder consultation and analysis using objective trees. The identified economic, financial, and non-financial measures are:

a) **Economic and Financial Measures**

Policy measures which should be put in place in order to reduce high initial cost of installation include those geared towards reducing interest rates in order to enhance availability of credit facilities and hence financial resources for adoption of the technology. These economic and financial measures include provision of tax rebates and incentives in order to reduce the cost of importing kits and training of technicians at subsidized rates leading to more specialized manpower for kit

manufacturer. This will result in more farmers adopting drip irrigation and increased acreage under drip irrigation. Consequently there will be more income from farming and food security.

b) **Non-Financial Measure**

Non-financial measures which should be put in place include information and awareness initiatives on the use of drip irrigation technology and promotion of effective extension services in order to developed positive attitude to the adoption and diffusion of the technology; improvement of technical services in the use and maintenance of drip irrigation in order to enhance accessibility of kits to farmers and improve diffusion of the technology to local levels; human skills development in the usage and maintenance of the technology leading to enhanced use drip irrigation and removal of negative social-cultural barriers; and development of market linkages involving different actors like cooperative societies, business community and private sector in order to make inputs more available to farmers and effectively market the produce.

Once these measures are put in place the overall outcome are improved incomes, food security and livelihoods leading to poverty reduction and diversification of income generating activities.

2.3.5 Proposed Action Plan for Drip Irrigation Technology

The Action Plan for Drip Irrigation Technology includes adaptation interventions and provision of enabling framework required for effectively responding to impacts of climate change. The measures and enabling framework is to enable key actors, namely policy makers, private sector, communities and relevant institutions adopt the technology as a viable tool to enhance agricultural production and improve livelihoods while being resilient to climate change impacts. These enabling framework in sequential order include:

(i) Information and Awareness Creation - Enhanced information and awareness creation on existence, use and benefits of drip irrigation will enhance the adoption and diffusion of drip irrigation technology at all levels. It will also help policy makers to make informed decisions especially on policy to provide incentives and tax rebates. It will also help in creating linkages between various actors namely farmers, technicians, and manufacturers and distributors of kits.

(ii) Training of more technicians - This measure will increase a pool of experts at local levels to help farmers on the adoption and use the technology effectively and efficiently.

(iii) Training on special skills for farmers and institutions - The purpose of this is to ensure that farmers are able to use the kits properly for efficiency in water use. This will also result in higher crop production leading to more incomes and food security

(iv) Establishment of low interest rates credits - This measure will make credit more accessible to farmers, institutions, and manufacturers and distributors of kits and result in enhanced adoption and diffusion of the technology.

(v) Provision of incentives - This measure includes tax waivers and rebates on drip irrigation kits and other related tools, and establishment of a special fund available to implementers of the technology at lower interest rates. This will reduce the cost of units and components and avail more finances for investment in the technology.

(vi) Enhance Market Linkages - The increased use and diffusion of the technology will lead to more production of food and other agricultural produce which cannot be consumed at household levels. This will require that farmers are linked to outside

market to sell their products to private sector in order to add value to the products and get better returns.

The projected timeframe for implementing the measures in action plan is between 0 – 15 years. Measures to be implemented in the short-term, i.e. 0 – 5 years are establishment of low interest rates, and provision of incentives. The timeframe for the implementation of enhancement of information and awareness creation, training of technicians and farmers; and enhancement of market linkages will be between 0 – 15 years

The estimated cost for the implementation of the action plan is Kshs. 2.08 billion with training, provision of incentives and establishment of low interest rates taking the bulk of the funds.

In all these measures and enabling frameworks, the lead government institutions will create policies and provide technical guidance. The beneficiaries will be the business communities, private sectors and farmers who will implement the policies for the use and diffusion of the technology. Financial contribution will be cost sharing among various actors at all levels including development partners. The implementation of the action plan is expected to be a public, private sectors, local communities and donor partnerships.

The anticipated risks in the implementation of the action plan include lack of funds and political good will, insecurity, poor infrastructure, competition with other sectors requiring funds and incentives, inadequate participation, and shifting donor policies.

The Action Plan is summarized in table 2.3.

Table 2.3: Proposed Action Plan for Drip Irrigation Technology

Measure/actions needed	Why the measure/action is needed	Who? (Main Actors)	Time Frame (when)	Indicative Cost (million Kshs.)*	Source of Funds	Indicators of success	Indicators of risks	Expected Outcome
1.Enhance Information and Awareness creation	• To create sufficient awareness on the existence and use of drip irrigation technology • To create sufficient awareness on the existence technicians • To create awareness on the advantages of drip irrigation technology • To create awareness on interactions between various actors involved in use, manufactures and distribution of kits	• MOA (KARI)- Curriculum development • NGOs – Implementation of Curriculum • Development of Partners – Provision of funds & technical advise • Farmers, institutions & general public – Beneficiaries	Up to 15 years	50	GoK Private Sector NGOs Climate and Development Knowledge Network (CDKN) GEF (Adaptation Fund)	• Number of farmers field days and exchange programmes • Number of demonstration plots • Education materials in both electronic and prints available • 50% of targeted farmers adopting drip irrigation • Increased acreage under drip irrigation • Increased awareness of the benefits of drip irrigation by policy makers	• Lack of funds	• Enhanced general awareness on the existence, use and benefits of drip irrigation technology for climate change adaptation and improved livelihoods • Enhanced awareness about the drip irrigation technology to policymakers who are able to make informed decision on its use including need for incentives and tax rebates. • Wide spread use of drip irrigation technology including knowledge about water use efficiency, and high crop yields

2. Training of more technicians	• To increase number of technicians for assembling and maintaining the kits • To promote effective extension services • More specialized manpower resulting in more manufacturers of kits and better service delivery.	• KARI and Agricultural training Institutions – Training if technicians • MHEST – Provision of technical advise & training institutions • Manufacturers of kits – Provision of training kits and training • Development Partners – Provision of training funds and technical advise	Up to 15 years	20	GoK Green Climate Fund	• Number of technicians trained and able to assemble the kits • More technicians deployed to work as extension officers • Availability of technicians for repairing the kits	• Availability of training funds • Timing and duration of training sessions	• Increased number of technicians able to assemble & maintain the kits and train farmers on effective use of drip irrigation technology • Increased pool of extension services who can be deployed in other areas to diffuse the usage of the technology. • Increased pool of experts as trainers to ensure the diffusion of the technology 1. More manufacturers and distributors of kits devolved to local level
3. Training for special skills for farmers and institutions (Use and maintenance of kits)	• To ensure that farmers are able to use the kits properly for efficiency in water use and crop production	• MOA – Technical advise • KARI – Training of technicians • MHEST - Provision of technical institutions • Technical Training Colleges – Provision of training facilities and training • NGOs – Training of farmers • Farmers – Beneficiaries of the training	Up to 15 years	1000	GoK Green Climate Fund	• % of targeted farmers trained and using the drip irrigation technology efficiently • % reduction in maintenance costs	• Timing and duration of the training • Availability of training funds	• Special trained farmers who are able to use the kits properly & efficiently & do minor maintenance on them • Higher crop production resulting in more incomes and food security
4. Establishment of low interest rates credits for drip irrigation loans	• To make credit accessible to kit and component providers and farmers	• MOF and Central Bank of Kenya – Policy formulation • Commercial Banks and Micro Fin.	Up to 5 years	200	GoK Financial Institutions including micro-finance institutions	• % rate of reduction in lending rates for commercial banks and micro-financial institutions	• Resistance from commercial banks • Political	• Accessible and affordable credit available to kit& component provides as well as farmers

	• Increase credit facilities	Institutions – Policy Implementation • Farmers and Private Sector – Beneficiaries				• Number of new Credit Facilities established	good will • Insecurity and infrastructure	• Number of credit/bank facilities increased & devolved to local level.
5. Provide Incentives (tax waiver on kits; establishment of special irrigation fund) and tax rebates	• To reduce Cost of units and components by providing incentives • To avail more finances for investment by creating irrigation fund	• MOF – Policy on incentives and tax rebates • MW&I – Policy Irrigation and technical advise & negotiations with MOF • MOA- Technical advise and negotiations with MOF • NEMA – Lead Agency on Climate Change Adaptation and technical advise • KRA – Implementation of tax rebates • KENFAP – Private sector and communities – beneficiaries of incentives and tax rebates	Up to 5 years	800	GoK AfDB (Clim.Dev. Africa Special Fund)	• Tax rebates approved by the Treasury • Introduction of tax waiver • 2 % of Government Budget allocated for an Irrigation fund • 50% of small scale farmers accessing irrigation fund Adoption of technology by targeted farmers and institutions	• Political good will • Competition with other sectors requiring incentives and rebates e.g. education, health • Development Partners willing to corporate	• Incentives and tax waiver on kits approved by the Government • Irrigation Fund established & functional
6. Enhance market linkages on farm produce	• To link farmers with markets for sale of their produce • To link farmers with private sector for value addition for better returns for the produce	• Min. of Trade & Industry – Set training of standards • Min. of Local Government – Provision of market centres/trading space & licenses • Min. of Cooperatives –	Up to 5 years	10	GOK, Private Sector, Cooperative Societies and Business Groups	• Number of market outlets established • Number of cooperative and business groups established	• Market failures Poor infrastructure e.g. roads	Functional market outlet established

		Organization of drip irrigation farmers for marketing & value addition • Business community and Private sector – Trading partners & beneficiaries Farmers – Beneficiaries						
Total		**Total (Million KShs)**		**2080**				

*Arrived at during brainstorming sessions with stakeholders and input from various experts

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Annex I: List of Stakeholders involved and their contacts

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Note: The Sector Working Group selected from key institution to edit and finalize the Draft Report during the 4th TNA Stakeholders Workshop. The list of stakeholders which discussed Technology Action Plan was attached to the Barriers Analysis and Enabling Framework Report.