Inter-Governmental Authority on Development (IGAD)
The Biodiversity Management Programme in the Horn of Africa (BMP)

Rainwater Harvesting Technologies in BMP Project sites

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1.0 Introduction and Background

Kenya is able to feed herself. However the key cause of food insecurity is over-reliance on erratic rainfall. Over 80% of Kenya`s landmass is classified as Arid and Semi-Arid Lands (ASALS) and is prone to drought. A sustainable livelihood in the region is threatened by climate change. The challenge facing this ecosystem is how to enhance communities' resilience whose livelihoods depend entirely on climate sensitive resources. Rain water harvesting and other conservation structures provide opportunities for enhanced sustainable agricultural production.

Water issue was placed as number one in the community Action plan drawn during Broad Based Survey exercise in 2010/2011 financial year by the county government. To support horticultural farming, rainfall remains the main source of water and efforts to promote Rain Water Harvesting (RWH) could significantly enhance access to water for human, livestock and crop production and overly help re-green the environment. Lamu county government have successfully supported construction of water pans for community groups. Recharge of these storage systems have relied on rainfall.

According to the surveys done IGAD BMP Project in Lamu County in, Boni Forest, Dodori National Reserve, Witu forest, Kipini Provisional forest and Kiunga Marine were found to be protected areas that are badly encroached as a result of human settlement. The settlements come in different livelihood systems depending on communities and consist of grazers and farmers who are vulnerable to the climate change experienced in the county. Communities are dependent on rain- fed cropping systems which is characterized by:

1. Low rainfall (in one or two short rainy seasons)
2. the average annual rainfall ranges between 400 – 700mm (Farm Management Handbook-coast)
3. length of ASAL crop growing ranges between 75 – 120 days
4. potential evapotranspiration (PET) is high (5 – 8mm/day or more than 1500mm annually)
5. total crop failure (caused by annual drought) that occurs once every 10 year
6. severe crop reductions caused by dry spells/intra-seasonal dry spells. (1-2 out of 5 years) and

7 prolonged drought (4 seasons) was experience in 2015 and 2017

As a coping mechanism ,'Jambias',plastic tanks, wells and construction of water pans for communities have been used to access water for domestic/drinking and small scale irrigation.

Salinity of ground water has been a major challenge especially due to salt water intrusion from the Indian Ocean. This calls for proper prospecting to identify streams/seepage springs emanating from the mainland en route to the ocean. A cost-effective and sustainable coping mechanism is required. RWH systems like on-farm runoff pond/tanks coupled with in-situ technologies have been known to offer promising adaptation strategies and are essential for supplemental irrigation driven by horticultural market.

There is need to build capacity of local communities in the area on rainwater harvesting technologies to enhance their resilience and coping mechanism to the existing challenges in the area which are associated with salinity, climate change and low and unreliable rainfall.

Rationale for IGAD BMP project

The primary beneficiaries of these forests are women, children and youth who derive their livelihoods from them and will be the first to be adversely affected by continued degradation. As a response to these threats, various Program Based Operations (PBOs) are working to establish conservancies, strengthen land tenure, and improve livelihoods whilst maintaining the ecosystem integrity of the forests in Lamu County. The county government also supports this cause through awareness creation, training and incentives to preserve indigenous trees and support development of market value chains.

Through the project, it is evident that RWH using on-farm household/communal runoff storage

- Increase household resilience (food security, health/nutrition, farmer co-existence with nature/increased bio-diversity conservation
- Improve income earning potential of a family
- Enhance shift from rain-fed cropping and increased farm productivity

- Ensure water availability to either bridge intra-seasonal dry spells or off season dry spells(full irrigation)
- Create water independence through individual ownership (decentralized supply system)
- Provide water for multiple use near homesteads

The project targeted the following groups

1. Existing community groups
2. Individual farmers
3. Local artisans
4. Collaborating institutions/stakeholder

The project focussed on the following technologies

1 Application of promising indigenous water and soil conservation techniques like:-
   - Runoff farming system
   - Soil moisture retention/conservation techniques, contour ridges, Zai pits, contour bands, vegetation, strips and mulching

2 Incorporation of RWH technologies such as, Insitu and ex-situ technologies, supplemental irrigation, conservation tillage and groundwater development in crop production.

3 The technologies aimed at;
   - Maximizing water availability by; maximize infiltration of rainfall, minimising unproductive water losses and increasing water holding capacity hence capitalizing on maximum rooting depth.
   - Maximizing on plant uptake capacity through timeliness of operation, improved crop management, soil fertility management
   - Dry spell mitigation using supplemental irrigation.

4 Great emphasis on WHM will consider water for:-
   - Crop/tree production
   - Domestic uses
   - Supplemental irrigation/off season irrigation system
   - Livestock watering

- Ground water recharge

The methodology used involved;

- Assess current water situation in Boni Forest, Dodori National Reserve, Witu forest, Kipini Provisional forest and Kiunga Marine.
- Identification of hotspot farms/sites and suggest appropriate interventions for soil water management
- Collect baseline information on RWH technologies and identify alternative, sustainable, efficient RWH technologies for piloting on selected farms
- Support design and installation of identified RWH technologies in 5 demo sites (zai holes, trenches, contour raised/sunken beds, half-moons/negarims, ponds, water pans, water tanks and roof catchment systems
- Support farmer's field days within and without the focal area.

The project was based on assumption that;

- The population will maintain an interest in RWH
- The land tenure system will not affect the demonstration process
- Labour will be readily available whenever required
- Replication of introduced technologies will occur
- Financial flow and administrative procedures will operate smoothly
- The programme can benefit from relevant experiences from similar programmes in other areas or from programmes supportive to this programme.

Table 1: Proposed BMP demonstration sites

No	Site name	Project type	Activities(for discussion)	Remarks
1 a	Witu-Soroko/TCN Farm Witu Ward, Pandanguo Sub location & Dide waride sub location, Soroko & Hindiwa villages GPS- Lat. 2:24:4.59 Longi. 40:27:28.9988 Alt. 7m	Forestry ,Agroforestry and RWH	Shallow well development Central Nursery establishment Communal nursery establishment Demonstration on Agroforestry practices Road runoff management In situ /ex situ RWH Technologies Solar water pumping	Main demonstration site a).1 Central and 1 community nursery *Shallow well excavation/development to act as water source* b).Agroforestry practices in farms neighboring TCN: RWH for crop production and tree planting with emphasis on; -In situ technologies/drip irrigation -Agroforestry tree establishment practices in farms
1 b	Witu-Witu Secondary Witu Ward, Soroko sub location sub location, Hindiwa village *GPS,Lat.2:52.126,* *Long,40:27.22.39,* *Alt.13 m*	Roof caught runoff management for crop production and tree planting	190m^{3}pond development Installation of water collection /abstraction systems Nursery establishment Vegetable garden development Boundary tree planting Capacity building on RWH(collection, storage,	Cost sharing basis- 1. School=gutters, excavation, farm fencing land preparation ,establishment/management of Vegetables and trees 2.ICRAF-Plastic liner, pond fence, abstraction mechanism, capacity building

			abstraction and irrigation techniques	Target students, agric./environment conservation teachers ,Neighboring schools
1c	Lamu Conservation Trust Witu Ward,Witu Sublocation,Witu Centre	Household approach;	Construction of a $25m^3$ plastic lined roof tank	On-the -job training for artisans drawn from groups working with ICRAF within Witu LCT/groups-ICRAF Cost share LCT/groups to do establishments ICRAF-Plastic liner roofing, stones, Hand pump and capacity build
2a	Tangeni/Back to Eden Youth and Women Organization (*Witu Ward, Pandaquo sub location, Sendemke village-GPS,Lat.2:22.922, Long,40:25.17.32, Alt.12m*	a. Runoff management for crop production b. RWH for domestic uses C. Shallow well development	Runoff pond system development-excavation/lining, abstraction and application on nursery/vegetable garden Demonstration on In situ /Ex situ RWH technologies Site fencing off $25m^3$ Plastic lined tank construction	*Group to do excavation of a $120m^3$ runoff pond* Farm layout for 1 acre agroforestry demonstration- $500m^2$ drip Irrigation plot, $3500m^2$ supplemental irrigation Boundary tree planting Alley fruit tree planting

3	HVC Groups a)New Kumekucha Maisha Masha Bee Keeping cooperative Witu Ward, Pandanguo location, Maisha Masha Sub location, Maisha Masha Village GPS Lat.-2:23:47.6232 Longi 40:32:21.624 Alti 16m asl	Bee Keeping	Apiary establishment. RWH for Nursery establishment/management Tree/shrubs establishment(bee forage enrichment) RWH for bees, tree/forage establishment Fencing out apiary site	Livestock technician to work with the groups to have the apiary ready for placement of hives Shallow well found to be the most ideal in the site. Technology on Plastic lined tank required Group to provide labour, sand ballast, (stones) ICRAF-cement, roofing material, stones and technology
4	b)Witu Nyongoro Bee Keeping and Ecosystem Conservation Witu Ward Dide Waride Sub location Kakate GPS—Lat. 2:20:5.7012 Longi. 40:23:45.764 Alt 14m asl	Bee keeping	Apiary establishment RWH for bee keeping and tree planting Farm Tree nursery establishment Tree planting for bee forage improvement and biodiversity conservation	Apiary site preparation 25m^3 Plastic lined Plastic lined tank construction Cost share ICRAF –Lining, roofing material Pump, stones Cement ,Capacity building Group-provide labor ,sand, ballast Apiary management by group

Table 2: Cost-Benefit analysis

System	Investment cost	Funding cost	Expected income	Payback	Remarks
25m3 plastic lined roof tank	80m^2 dam line 24000 Roof, Wall, labour, pump ,Gutter system 43600 Total Ksh.**67600** **Cost /m3=(67600+8112)/25m^3=3030/m^3**	@12% interest **(8112)=75,712**	Crop-Tomato **30,000**	3 seasons	a) @60cm spacing 10m^{2}plot will support 60 plants b) Take5kg/plant= 300kg production in 5 months c) Farm gate price ksh 100/kg=30,000
120m3 pond	214m^2 dam liner 64200	@12% interest **(39,864)**	Tomato crop (1/4 acre) **1,066,600**	1 season	No of plants possible=2133
	Silt trap 8000				Production at 5kg/plant=10666 kg
	Treadle Pump 20000				Farm gate price 100/kg=**1,066,600**
	1000m^2 drum drip kit 80,000		Other benefits		Water requirement by tomatoes=(4mm/day=**0. 2826 lts/plant/day=33lt over the growing period** **2133 plants will require 70389 lt** **Add 20%losses (14078 lt)=90 m^3**
	Labour(exc.land,mgt) 100,000		Capacity building 30m3 water available for other uses		
	Fencing 60,000				
	Total **332,200**	**372,064**			
150m3 pond	Fence 60,000	@12% interest	Tomato crop ¼ acre	3seasons	No of plants possible=2133

	Pump 20,000	**(39864)**	Other benefits		Production at 5kg/plant=10666 kg
	252m^2 Dam liner 75,600		Capacity building		Farm gate price 100/kg=**1,066,600**
	Gutter system 24,000		Tree Seedlings pdn		Water requirement by tomatoes=(4mm/day=**0. 2826 lts/plant/day=33lt over the growing period** **2133 plants will require 70389 lt** **Add 20%losses (14078 lt)=90 m^3**
	1000m^{2}Drip kit 160,000		Tree planting/increased survival rate		
	Total 339,600	**372064**			
Shallow well	TCN Farm	@12%=29760	Capacity to produce 100,000 seedlings	1 season	If 1 seedling goes at 20/= One season =2,000,000
	40ft excavation @1200=48000				
	Walling/headworks=60,000				
	Solar pump =140 000				
	Total **248000**	**277760**			
500m2 drip irrigation kit	UNIT			1 season	Possible plant population=1060
	640m dripline@15 =9600	**9600**			Expected production=1060x 5kg/plant=5300kg
	32 pipe-tape connectors@ 200= 6400	**6400**			Produce value@100=530,000
	50m HDPE m 10000	**15000**			
	1 pc end cup 200	**4900**			

	200lt drum 2000	**15000**			
	1 pc screen filter 2500	**24000**			
	Inputs 10000	**74900**			
	80 m dam liner 24000				
Total		**64,900**			

Table 3: Different aspects of project activities

Project aspects	Actions/Activities
Technical	**Baseline survey**: Desk top survey, community sensitization and mobilization and participatory survey will be done. Mapping of water resources, water uses, availability and reliability will be given emphasis. The baseline survey will ensure the development of a flexible technology package suitable for different farming systems and farmers' livelihood status.
	2. **Farmers' mobilization and sensitization**: There need to mobilize and sensitize smallholder farmers to change their attitude and focus more on financial inclusion and sustainability. This will include options for upgrading their farming systems and the benefits of farm pond in terms of increasing access to water for productive uses, livelihood diversification and income generation. This will focus on organized and/or semi-organized farmers' groups to enhance group dynamics, social reciprocity and collective responsibility. Making the farmers understand the technology, its components, functionality and O&M including irrigation water management and expected benefits would enable them make informed decisions on adoption and sustainability. Different demonstration sites different technologies will be set up to promote opportunities.
	3. **Construction process**: Manual labor and/or mechanization will be considered, and evaluated based on type and storage size and financial resources as follows: (a) Small tanks (25-30m^3), self-financing (credit); (b) medium (100- 150m^3),. This is also includes training of local artisans, technical supervision, and linkage to service providers of various components (dam-liner, drip irrigation kits, shade-nets, pumps, etc.). The construction process will ensure that the risks outlined in Table 4 are adequately addressed.
	2. **Entry points**: There is a need to identify best practices and entry points for different target farmers and farming systems. The management structure will be site specific and focus on well-defined landscapes/watersheds. Scaling up becomes possible through a group approach but individual action insight on implementation.

Financial	***1. Cost-benefit analysis:*** To reduce misunderstanding and farmers' averseness, cost-benefit analysis scenarios will be presented to the farmers to aid decision making process and motivate them to adopt business approach and take out a loan (through incentive/smart subsidy) for investment. This can be addressed through structural investment options and financial innovations to create a multiplier effects. Identification of lead/champion farmers as change agents or drivers of change – early adopters to encourage other farmers.

Table 4: Potential risks and mitigation measures Risk Mitigation measure

Stability risk: Collapsing of side walls	Adopting trapezoidal shapes
Safety risk: Drowning for human and domestic animals	Fencing with barbed wire and chain-link around the farm pond
Health risk: Mosquitoes breeding and hence prevalence of malaria	Covering/roofing the open reservoir with shade net (80% to allow direct precipitation to penetrate)
Reliability risk: Water losses through seepage and evaporation	Ultra-violet plastic lining enhanced by adoption of regular truncated pyramid shaped design Covering/roofing the open reservoir– trade-off between bigger ponds with high losses and smaller ponds with evaporation control Planting passion fruit along the chain-link fence
Siltation risk: Runoff carries a lot of sediments and debris	Incorporate double chamber masonry silt traps Integrate biological soil conservation – e.g. vegetation and stone pitching along the water way Incorporate screen filter to prevent debris entering the pond Regular maintenance of water way, silt trap and screen