THE UNITED REPUBLIC OF TANZANIA
VICE PRESIDENT'S OFFICE

COMPENDIUM OF BEST PRACTICES FOR SUSTAINABLE LAND MANAGEMENT IN TANZANIA

DIVISION OF ENVIRONMENT
NOVEMBER, 2014

FOREWORD

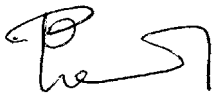
Land degradation is one of the key environmental challenges facing the world today, especially for developing countries where most communities depend directly or indirectly on environmental and natural resources for their survival. The consequences of land degradation include reduced productivity, food insecurity, destruction of important ecosystems, desertification and loss of biodiversity, income and livelihoods.

It is known that quarter of the earth's surface is threatened by desertification; and an area of over 3.6 billion hectares is already affected by desertification. This poses major economic, social, and environmental challenges to over 900 million people world-wide. In Africa, desertification is a chronic problem in dry lands where it has claimed about 73 percent of the total land area. It has reduced and continues to reduce the capacity of land to produce food and thus exacerbating food shortages that lead to frequent famines and starvation. The situation is serious and is becoming worse due to other emerging challenges including climate change, Invasive Alien species and biofuel investments.

At the national level it is estimated that, about 75 percent of the country is dryland. In some parts of the country, land degradation has significantly reduced and continues to reduce land economic productivity and has resulted into desert-like conditions. The affected areas include Dodoma, Shinyanga, Simiyu and Singida regions, and some parts of Mwanza, Mara, Tabora, Kilimanjaro, Manyara and Arusha regions.

It should be noted that land use and other development activities are important but the concern is on how best people can use land sustainably It is expected that these best practices for Sustainable Land Management (SLM) will be used and replicated to other areas in the country in order to combat land degradation challenges. It is on this background, the government embarked on the preparation of this Compendium in order to provide environmental managers, decision makers and the community a better understanding on available best practices.

This study responds to the requirement of the National Action Plan to Combat Desertification (2014) which requires the preparation of a compendium on SLM best practices for different sectors and communities, in the country. The Compendium highlights among other things the background information, important definitions, characteristics of the best practices, principles, criteria for selection of best practices. The best practices selected based on the sectors such as Agriculture, Forestry, Water, Livestock, Fisheries, Wildlife and Energy in the aspects of Integrated Soil fertility management, conservation agriculture, rain water harvesting, and smallholder irrigation management, cross slope barriers, agro-forestry, pastoralism and rangeland Management, Sustainable Forest Management (SFM), and Income Generating Activities (IGAs). Combating Land Degradation in Tanzania needs collective efforts and accountability by all stakeholders in scaling up best practices for SLM. I encourage policy makers, planners, programmes, managers and communities to understand the available best practices for SLM in the country and replicate them in order to ensure that the environment is improved and sustained.



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PERMANET SECRETARY

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The preparation of the Compendium for Best Practices for Sustainable Land Management Report was the product of commitment and devotion of many stakeholders to whom I am deeply indebted. Special thanks and appreciation should go to the task force for drafting and finalizing the document. The task force comprised of Dr. C. M Shayo, Ms. Z. S. Bungwa, Mr. T. Mande, Dr. D, Paul, Mr. J. Enock, Mr. D. D. Nkondola and Mr J. Kihaule from the Vice President's Office; Mr E. Chuma from the Ministry of Agriculture Food Security and Cooperatives; and Mr. John Chikomo, from Journalists for Environment in Tanzania (JET). The Team was guided by Mr. Richard Muyungi, Assistant Director in the Vice President's Office.

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Dr. Julius K. Ningu

DIRECTOR OF ENVIRONMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

FAO	Food Agricultural Organization
BRN	Big Results Now
FYDP	Five Years Development Plan
BP	Best Practices
CBFM	Community Based Forest Management
FBD	Forest and Bee Keeping Division
GEF	Global Environment Facility
HADO	Hifadhi Ardhi Dodoma
HASHI	Hifadhi Ardhi Shinyanga
IGAs	Income Generating Activities
JET	Journalists Environmental Association of Tanzania
JFM	Joint Forest Management
DLDD	Desertification Land Degradation and Drought
DoE	Division of Environment
NSGRP	National Strategy for Growth and Reduction of Poverty
NAP	National Action Plan to Combat desertification
NAPA	National Adaptation Programme of Action
NEAP	National Environmental Action Programme
NGOs	Non-Governmental Organizations
PFM	Participatory Forest Management
SLM	Sustainable Land Management
TAFORI	Tanzania Forest Research Institute
TFCG	Tanzania Forest Conservation Group
URT	United Republic of Tanzania
VLFR	Village Land Forest Reserve
WMAs	Wildlife Management Areas
TFA	Tanganyika Farmers Association
CBOs	Community Based Organizations
REDD	Reduced Emissions from Forest Degradation and Deforestation
VPO	Vice President's Office

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CHAPTER ONE

INTRODUCTION

1.1 Background

Land degradation (LD) is one of a global development and environment challenge, it remains a major threat to the world's ability to meet the growing demand for food and other environmental services. Land degradation directly affects 1.5 billion people around the world with a disproportionate impact on the poor, and has already reduced the productivity of the world's terrestrial surface by about 25% from 1981 to 2003. On the other side, 2.6 billion people depend directly on agriculture, but 52% of the land used for agriculture is moderately or severely affected by soil degradation. Tanzania, not exempted from land degradation. However, the magnitude, rates and negative impact on people's livelihood and environment varies across agro-ecological zones. It is estimated that between 45% and 75% of the total land of Tanzania is degraded. The most affected regions are Dodoma, Shinyanga, Simiyu, Singida, and parts of Arusha, Manyara, Mwanza, Tabora, Mara and Kilimanjaro. The consequences of land degradation include reduced productivity, food insecurity, and destruction of important ecosystems and loss of income, biodiversity, and livelihoods.

Unsustainable human activities have been taking place over the years, and continue to cause an ever decreasing quality and value of land. Several researches have shown that the rate of land degradation and desertification can be reduced and large areas can be restored if concerted efforts are applied. Protecting and storing the functions and services that have been lost by the land and soil is seen as the key to sustainable development and reversing impacts of climate change.

Tanzania's economy is heavily dependent on natural resources utilization such as land, forests, wildlife and water. According to the National Population Census of 2012, about 75% of the country's population lives in the rural areas and depend on natural resources mainly land for their livelihood. Unsustainable exploitation of land frequently driven by poverty and external market forces has resulted in

serious land degradation. Furthermore, the increased unsustainable use of other natural resources coupled with intensification and expansion of agricultural and livestock keeping activities has finally led in land degradation with its consequences.

In Tanzania, land degradation has caused desert like condition which affects large part of the population in various areas of the country. Rapid population growth is also associated with declining area of land for pasture, which triggers seasonal migration of pastoralists with their livestock, notably from the northern (Manyara, Arusha and Shinyanga) to the southern regions (Morogoro, Pwani, Mbeya and Rukwa) in search of water, pasture and agricultural land. This has been one of the causes of land degradation in large areas of the country.

Various efforts to combat desertification and drought have been made nationally which include signing ratification and adoption of the UNCCD Convention. Tanzania ratified the Convention in 1997. Since then, the Country has been participating in the implementation of various activities under the Convention and related initiatives including formulation of the National Environmental Policy (1997); enactment of the Environmental Management Act (2004); mainstreaming of environment into the National Strategy for Growth and Reduction of Poverty I (2005-2010) and II (2010-2015); development of sectoral policies; strategies and plans, including National Adaptation Programme of Action (NAPA) (2007); National Action Plan to Combat Desertification (NAP) (2014); and preparation of Status of Land Degradation (2014). These initiatives aim to ensure environmental sustainability in the country. In spite of the great efforts to address the land degradation problems, Tanzania is still facing barriers in achieving SLM. These barriers among others include inadequate financial resources, low awareness and insufficient quantitative data.

1.2 Justification of SLM BP

The status of land degradation in Tanzania shows that, LD is caused by soil erosion, nutrient depletion, deforestation forest degradation and range land degradation. The need to document SLM best practices is to respond to various national policies as well as international agreements that call for the efforts to combat desertification and Drought. At the national level, there have been various efforts to

address Desertification, Land Degradation and Drought (DLDD). These efforts include Tanzania Development Vision 2025; National Strategy for Growth and Reduction of Poverty (NSGRP) II (2010-2015); the Five Year Development Plan - FYDP (2011/2012 – 2015/2016); The National Climate Change Strategy of 2013; National REDD+ Strategy of 2013; National Environmental Action Plan (NEAP) 2013 -2018; Big Results Now (BRN) Programme (2014); the Strategy for Urgent Action on Land Degradation and Protection of Water Catchment (2006); the National Land use Planning Framework (2010); and National Action Plan to Combat Desertification (NAP) (2014). One of the priority area in NAP 2014 is to strengthen community based awareness campaign on threats, effects and impacts of desertification, land degradation and drought and engage policy and decision makers to make decisions that address DLDD in Tanzania of which one of the activities is to prepare the compendium of best practices for SLM. Therefore, the Compendium is expected to raise further awareness and understanding among the public on SLM best practices for combating DLDD.

1.3 Objectives of the Compendium

This Compendium aims at identifying, compiling and disseminating SLM best practices (technologies and approaches) in the country based on the available studies and experience.

The specific objectives are to:

i) compile the SLM best practices available in the country;

ii) disseminate best practices for sustainable land management to various stakeholders; and

iii) promote the use of sustainable land management best practices for planning and decision making

1.4 Characteristics, Principles and Criteria for SLM BP

Characteristics: Best practices for SLM have various characteristics that include easy to learn; socially and culturally accepted; effectively adopted and taken up; environmentally friendly; productive; profitable; cost-effective; and long-term payback.

General principles of SLM practices: General principles of SLM BP focus on spreading and implementation conditions; Economics (costs and benefits); Impacts on productivity and ecosystem services and conditions for adoption and up scaling should be easy.

Criteria for good SLM practices: SLM BP are based on three criteria which include sustainability, production and scale.

- **Sustainability:** Sustainability includes ecological, economic and socio-cultural aspects. The basis on this aspect was best SLM options which have more benefits basing on the results that increase productivity, improved livelihood and improve ecosystems at the local, national and global scales.

- **Productivity:** This includes food, fodder, fibre and fuel production. In order to increase productivity from land, the following should be addressed: water use, soil fertility, improved crops and micro-climate conditions.

- **Scale:** This includes SLM BP that are easy to replicate, be taken up, cost efficient and possess short and long-term benefits.

1.5 Methodology

The methodology used in compilation of this Compendium was based on literature review (publications, papers, project documents, manuals etc.) and interviews with SLM focal persons, meetings and stakeholders workshops.

CHAPTER TWO

BEST PRACTICES FOR AGRICULTURE

Sustainable land management in agriculture comprises of several practices such as conservation agriculture, soil and water conservation, crop land management, soil fertility management and agro-forestry.

2.1 Conservation agriculture

2.1.1 Minimum Tillage

Minimum tillage is a soil conservation system like strip-till with the goal of minimum soil manipulation necessary for successful crop production. It is a tillage method that does not turn the soil over. It is contrary to intensive tillage, which changes the soil structure by ploughs. Minimum tillage may involve no-tillage whereby there are no cultivations between crops in successive seasons. All weed control is achieved by the use of herbicides or cover crop and the next crop is sown directly into undisturbed soil weed residue or the remaining stubble from the cover crop.

Adoption of minimum tillage practices does involve:

- having a system to control weeds and produce a soil cover easily killed by simply uprooting or by herbicides;
- maintenance of crop residues to serve as cover; and
- a grazing strategy if livestock are kept on the farm (vs herbicide poising)

Approach

Minimum tillage can be achieved by using different tools and techniques as follows: direct drilling which involves no cultivation prior to sowing directly into undisturbed soil; controlling weeds by means other than cultivation significantly reduces the number of cultivations; herbicides can control weeds and this is the essence of reduced tillage practices; and planting cover crops during the dry/ off season that is killed by uprooting thus providing a mulch. The soil is loosened only where the seed is sown.

Benefits

i) requires less labour, fuel and hence less total cost;

ii) reduces the effect of raindrop impact on the soil surface;

iii) reduces surface sealing of soils;

iv) increases infiltration of water into the soil;

v) reduces runoff from the soil surface;

vi) reduces the rapid breakdown of soil structure;

vii) slows the breakdown of organic matter in the soil;

viii) reduces the formation of hard pan layers in soils;

ix) provides a better soil environment for crop growth;

x) slows down overland flow of surface runoff; and

xi) reduces likelihood of erosion

Area of applicability

Minimum tillage practice is applicable in semi-arid areas such as Arusha, Dodoma, Singida, Shinyanga and some parts of Kilimanjaro, Tanga, Iringa, Mwanza and Tabora Regions.

Minimum tillage practice

2.1.2 Cover crops

This is a practice where soil is covered by multipurpose crops, like nitrogen fixing, soil-porosity-restoring, pest repellent so as to optimize crop rotations in spatial, timing and economic terms. A cover crop can be planted both in annual/seasonal and perennial crop systems

Approach

Cover crops need to be managed before planting the main crop. The important point is that the soil is always kept covered. It is advised to apply targeted herbicides for controlling cover crop and weed development.

Benefits

i) improved infiltration and retention of soil moisture resulting in less severe, less prolonged crop water stress and increased availability of plant nutrients;

ii) source of food and habitat for diverse soil life;

iii) creation of channels for air and water, biological tillage and substrate for biological activity through the recycling of organic matter and plant nutrients;

iv) increased humus formation;

v) reduction of impact of rain drops on soil surface resulting in reduced crusting and surface sealing;

vi) consequential reduction of runoff and erosion;

vii) soil regeneration is higher than soil degradation;

viii) mitigation of temperature variations on and in the soil; and

ix) better conditions for the development of roots and seedling growth.

Area of applicability

This can be applied throughout the country particularly in semi-arid areas for the purpose of retaining soil moisture.

Cover crops

2.1.3 Crop rotation

Crop rotation is a practice of growing a series of different types of crops in the same area in sequential season so as to maintain or increase fertility and to control weeds, diseases and pests. The rotation of crops is not only necessary to offer a diverse “diet” to the soil micro organisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients. Nutrients that have been leached to deeper layers and that are no longer available for the shallow rooted crop, can be “recycled” by the crops in rotation.

Approach

Crop rotations re design according to various objectives: food and fodder production (grain, leaf, stalks); residue production; pest and weed control; nutrient uptake and biological subsurface mixing / cultivation, etc. Use of appropriate / improved seeds for high yields as well as high residue production of above-ground and below-ground parts, given the soil and climate conditions.

Benefits

i) attracts different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients;

ii) It offers phytosanitary function as it prevents the carryover of crop-specific pests and diseases from one crop to the next via crop residues;

iii) enhances better distribution of water and nutrients through the soil profile;

iv) explores nutrients and water of diverse strata of the soil profile by roots of many different plant species resulting in a greater use of the available nutrients and water;

v) increases nitrogen fixation through certain plant-soil biota symbionts;

vi) improves balance of N/P/K from both organic and mineral sources; and

vii) increases humus formation.

Area of applicability

This practice can be applied all over the country.

2.1.4 Contour bunds (ridge terraces or stones)

The farming practice of ploughing or placing stones across the slope following its elevation contour line for the purpose of controlling soil erosion. These contour lines create a water break which reduces the formation of rills nd gullies durin times of heavy water runoff, which is a major cause of soil erosion.

Approach

Contour bunds are constructed of earth, by excavating a channel and creating a small ridge on the downhill side across the slope for soil conservation. The contour bunds resemble narrow channel terraces, while contour stone bunds contrary to contour bunds/ridge terraces they have buffer strips created by arranging stones in across the slope on the contour to form a barrier. However, the crop is grown

just ahead of the stone bund, leaving the upper end of the terrace free to make a catchment. Since the bunds are permeable, they slow down the runoff rate, filter it, and spread the water over the field, thus enhancing water infiltration and reducing soil erosion.

Small ridges (called “cross-ties”) can be made at right angles to the contour to make the contour ridges more effective at trapping water. These cross-ties prevent the water from flowing along behind the contour ridge and collecting at the lowest point – where it may break through the ridge and start a gully. Space the cross-ties 10 m apart (closer on steeper slopes and in areas with heavy rainfall).

Benefits

i) prevents flooding and controls erosion;

ii) slows down the runoff rate; and

iii) enhances water infiltration, thus reducing soil erosion.

Area of applicability

This method is widely used all over the country particularly in slopy and mountainous areas.

Contour bunds in Ruvuma

Digging contour band

Contour Stone bunds western of Mount Uluguru

Contour Stone bunds western of Mount Uluguru

2.1.5 Mulching

Mulch is a covering placed around plants (or covering the ground in lieu of plants), to prevent loss of soil moisture and growth of weeds. It is a protective covering practice, usually of organic matter such as leaves, crop residues, or cut grass, placed around plants or on soil surface to prevent the evaporation of moisture, and to suppress the growth of weeds. Increasingly even plastic mulches (predominantly black) are used to control weeds. Wood chips and shavings from carpentry works can also serve as mulch.

Approach

Type of mulch to use depends on its availability. In villages cut grass mulch and litter from tree leaves are commonly used. Pruned agro-forestry tree branches is one of the sources of mulch. Organic mulches are more effective when they are thick enough (5 to 10 cm) to cushion against impacts of radiation energy and raindrops.

Benefits

i) prevents the growth of weeds;

ii) regulates soil temperature;

iii) improves soil fertility when the mulch decomposes, it releases valuable nutrients into the soil;

iv) controls erosion;

v) improves moisture-retention in the soil; and

vi) reduces the chances of the cropped area/garden developing compacted soil.

Area of applicability

Mulching can be used almost in all parts of Tanzania depending on their availability and other competing uses including among others- as livestock feed or as fuels for domestic cooking.

Banana Mulching in Kagera region

2.1.6 Intercropping with leguminous cover crops

Intercropping is the cultivation of two or more crops simultaneously on the same field with the planting of the second crop after the first one has completed its development. Intercropping with the leguminous cover crops is a viable option for maintaining soil fertility and crop yield.

Approach

Common practice is to intercrop a cereal (maize, sorghum) with a legume (bean, pigeon pea, cow pea).

Benefits

i) improves stability of the farming system;

ii) reduces risk of disease spread and incidences of pests;

iii) increases yield;

iv) enables nutrients availability for deep rooting crops; and

v) improves soil fertility through nitrogen fixation.

Area of applicability

Intercropping can be practiced almost everywhere in the country.

Maize intercropped with leguminous crop (Mucuna pruriens) in Babati District

2.2 Soil and water conservation

2.2.1 Crop residues management

This is the practices where by crop residues are left in the field /farm after the crops have been harvested. These residues include sticks and stubble/stems, leaves and seed pots. In rural areas the important aspect in residue management is to ensure that residues are used in the crop fields from where they originated. Crop residues can also

be used as animal feed. Maize and rice straw is used as fodder in Mwanza, Shinyanga, Singida and the resulting FYM is used in the crop fields. Good practice is to collect and transport the residues outside the crop field. Allowing animals to graze directly in crop field can cause soil structure deterioration resulting in soil erosion and take them out of the field for livestock. In Kilimanjaro among the chagga, residues from legume and maize crops can be used as fodder by transporting to intensively kept dairy cattle. The FYM produced is used in the intensive coffee-banana-fruit trees home gardens.

In Morogoro among the Waluguru (Mgeta) and Kilimanjaro among the Pare, residues from Lablab purpureus (butterbean), Viginia unguiculata (cow pea) and vegetable crops are fed to livestock and the produced FYM used in maintaining soil fertility in vegetable gardens.

Approach

This approach ensures recycling of nutrients in the system. Residues can similarly be used as surface mulch or as a component in compost making. Burning of crop residues should be avoided except in when there are incidences of pest and disease infestation.

Damaged fruits and vegetables in urban markets are used as feed in peri-urban agriculture. More commonly they are for feeding pigs and the resulting manure used in vegetable and potted seedling production.

Residues from crops can be obtained by three main approaches: (a) what remains after harvesting the target or economic component of annual or seasonal crops e.g. straw from maize, sorghum, beans among others, (b) through pruning of perennial crops e.g. fruit trees, bananas (c) litter falling from both annual and perennial crops as leaves reach maturity, (d) damaged fruits and vegetables in urban markets.

Area of Applicabilitry

This practice can be practiced almost everywhere in the country.

Crop residue in the field

2.2.2 Rice intensification

This is the method aimed to increase rice yield produced by the farmer. It is a low water, labour intensive, organic method that uses younger seedlings singly spaced and typically hand weeded with special tools.

Approach

Plant young seedlings carefully and singly, giving them wider spacing usually in a square pattern, so that both roots and canopy have ample room to spread. The methods use 25 to 40 percent less water, and make crops more resilient to temperature and precipitation stresses.

Keep the soil moist but not inundated. Provide sufficient water for plant roots and beneficial soil organisms to grow, but not so much as to suffocate or suppress either, e.g., through alternate wetting and drying, or through small but regular applications. Add as much compost, mulch or other organic matter to the soil as possible, 'feeding the soil' so that the soil can, in turn, 'feed the plant.'

Control weeds with mechanical methods that can incorporate weeds while breaking up the soil's surface. This actively aerates the root

zone as a beneficial by-product of weed control. This practice can promote root growth and the abundance of beneficial soil organisms, adding to yield.

Benefits

i) enhances the capacity of soil systems to absorb and provide water hence requires less water;

ii) Increases yield and greater productivity from land, labor, seeds, water and capital; and

iii) increases in the abundance, diversity and activity of soil organisms.

Area of applicability

Suitable for lowland regions

Rice Intensification at Kiroka in Morogoro rural District

2.2.3 Rainwater harvesting

Rainwater harvesting (RWH) is a method of inducing, collecting, storing and conserving local surface runoff for different uses including agricultural production. RWH becomes necessary when rainfall lasts for a short time or where the partitioning of rainwater is unfavorable.

Approach

Rainwater harvesting involves practices to increase the amount of water stored in the soil profile by trapping or holding the rain where it falls. This is referred to as in-situ rainwater harvesting. It may involve small movements of rainwater as surface runoff in order to

concentrate the water where it is wanted most. A storage structure (e.g. tank, earth dam, pond) should be constructed where water is required for irrigation or livestock.

RWH techniques facilitate water infiltration and reduce or prevent runoff. Infiltrated water is usually stored in the soil and thus will help crops and vegetation to flourish between rainfall events. In those areas where soil is covered by vegetation, even fast flowing runoff cannot wash away the soil as it is protected.

Benefits

i) Prevents net runoff from a given cropped area by holding rain water and prolonging the time for infiltration;

ii) enables agriculture and livestock production in dry areas where water is limiting;

iii) controls soil erosion;

iv) increases availability of drinking water for livestock and wild animals; and

v) improves environment through tree planting in semi-arid and arid areas.

Area of applicability

RWH can be practiced all over the country.

Rainwater harvested for agriculture

2.2.4 Pit and trench farming

Pit and trench farming is a technique where the soil is removed during excavation and used to make a small bund around the hole, e.g. Chololo pits in Dodoma region.

Approach

Chololo pits comprise a series of pits, which are about 22 cm in diameter and 30 cm in depth. The pits are spaced 60 cm apart within rows, and 90 cm between rows, with the rows running along the contour. The soil removed during excavation is used to make a small bund around the hole. Inside the pit, ashes are used to remove termites, farmyard manure and crop residues are added, and then covered with the essential amount of soil while retaining sufficient space in the hole for runoff to pond. One or two seeds of either maize/ millet or sorghum are planted per hole.

Benefits

i) allows moisture retention;

ii) increases productivity;

iii) reduces runoff water;

iv) reduces soil erosion; and

v) retains soil fertility.

Area of applicability

The method can be practiced all over the country particularly in arid and semi-arid areas.

Typical Chololo pits in Dodoma Region

2.2.5 Terracing

Terracing is a soil conservation practice applied to prevent rainfall runoff on sloping land from accumulating and causing serious erosion. Terraces consist of ridges and channels constructed across-the-slope. Different types of terraces exist; bench terraces, fanya juu and fanya chini terraces.

Approach

Bench terraces are made by re-shaping a steep slope to create flat or nearly flat ledges or beds, separated by vertical or nearly vertical risers. They are made on very steep slopes. Due to the high labour demand, they are usually made for high-value crops such as irrigated vegetables. The benches are normally designed with vertical intervals that may range from 1.2 m to 1.8 m. The terraces are found in high slopes such as Mgeta area in Morogoro Region and Same District.

The Fanya juu terraces are earthen embankments, created by digging a trench about 60 cm wide along the contour, and throwing the soil upslope to form a ridge. This effectively reduces slope-length, and hence soil erosion from steep croplands. Fanya juu terraces are suitable on slopes with annual rainfall of 500 -1,000 mm. Planting grass, trees and bushes along the terrace banks stabilizes the bunds, while contributing to productivity and biodiversity such as fodder, fuel and fruits. In some cases, enlarged embankments are made to allow ponding of harvested runoff and, therefore, the structure can be used in water harvesting systems having external catchments. Fanya juu terraces are practiced in sloppy areas particularly in the south-western side of Uluguru Mountains.Fanya juu can develop into bench terraces.

Fanya chini is a system whereby soil is piled below contour trench. They are used to conserve soil and divert water and can be used up to slope of 35%. Fanya chini involves less labour than Fanya juu but they do not lead to bench terraces over time.

Benefits

i) reduces soil erosion and prevents land degradation;

ii) increases soil moisture; and

iii) increases productivity.

Area of applicability

Bench, Fanya juu and Fanya chini terraces can be practiced in all sloppy and mountainous areas, ranging from arid to humid areas.

Bench terraces -Chome village, Same District

2.2.6 Excavated bunded basins (majaruba)

Excavated bunded basins (majaruba) are small basins that usually utilize water outside catchment.

Approach

Excavated bunded basins are constructed by digging to a depth of 0.2 m to 0.5 m, and by using the scooped soil to build a bund around the field perimeter. Normally, the bunds have a height of between 0.3 m to 0.7 m above the ground. Farmers usually start with small-sized basins, for example, 10 m by 10 m. Depending on the general slope

of the area, the bund size should be such that water is uniformly distributed within the bunded area. Generally bunds are smaller on steep slopes and large on flat land.

Benefits

i) reduces runoff; and

ii) increases crop production particularly paddy;

Area of applicability

It can be practiced in most regions particularly in semi-arid areas.

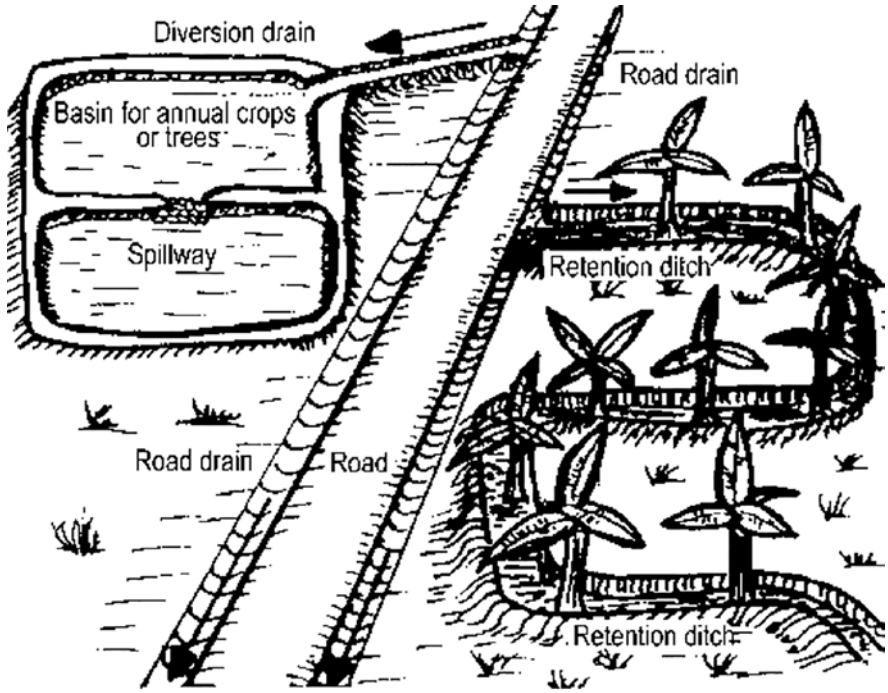


Illustration of excavated bunded basins (majaruba)

2.2.7 Composting

Compost is a natural process of rotting/decomposition of organinic matter by microorganism under controlled condition. Raw organic materials such crop residue, animal wastes and food gabbage, enhance their suitability for application to the soil as a fertilizing resource after having undergone compost.

Approach

Compost is produced in shallow pits, approximately 20 cm deep and 1.5 m by 3 m wide. During the dry season after harvesting, layers of chopped crop residues, animal dung and ash are heaped, as they become available, up to 1.5 m high and watered. The pile is covered with straw and left to heat up and decompose. After 15–20 days the compost is turned over into a second pile and watered again. This is repeated up to three times as long as water is available. Composts heaps are usually located close to the homestead. Alternatively, compost can be produced in pits up to 1 m deep.

Benefits

i) increases crop yield;

ii) increases farm income (by several times in dry years, compared to no compost use);

iii) increases fodder production and fodder quality;

iv) increases soil moisture;

v) increases soil fertility; and

vi) improves soil cover; and reduces soil loss.

Area of applicability

It can be applied all over the country.

Demonstration of composting practice

2.3 Cropland management

2.3.1 Crop diversification

This refers to the raising of varieties of crops in a given area in a crop season. The more is the number of crop grown in an area, the higher is the crop diversification.

Approach

Planting varieties of crops simultaneously or alternating.

Benefits

i) increases productivity and food security;

ii) improves stability of the farming system;

iii) reduces risk of disease spread and incidences of pests;

iv) enables nutrients availability for deep rooting crops; and

v) improves soil fertility through nitrogen fixation.

Area of applicability

This technique can be practiced almost everywhere in the country.

Crop diversification involving beans and cassava

2.3.2 Green manuring

Green manuring are usually leguminous plants that cover the ground as runners, grown together with other crops. They are sometimes also termed as green mulches because of the ability of the companion legume to fix nitrogen in the soil.

Approach

The legume could be cut and incorporated into the soil while green as manure. Alternatively the legume is used as a cover crop. Crops such as mukuna, pumpkins or water melons have proved useful green mulches.

Benefits

i) reduces weeds;

ii) Increases crop yields;

iii) Improves soil fertility; and

iv) Increases soil moisture.

Area of applicability

This technique can be practiced all over the country.

Green manuring at Mbozi district, Mbeya

2.4 Soil fertility management

2.4.1 Integrated Plant Nutrient Management

Integrated Plant Nutrient Management (IPNM) embraces soil, nutrient, water, crop, and vegetation management practices, tailored

to a particular cropping and farming system, undertaken with the aim of improving and sustaining soil fertility and land productivity and reducing environmental degradation.

It aims to optimize the condition of the soil, with regard to its physical, chemical, biological and hydrological properties, for the purpose of enhancing farm productivity, whilst minimizing land degradation.

Approach

The field level management practices considered under IPNM include the use of farmyard manures, natural and mineral fertilizers, soil amendments, crop residues and farm wastes, agro-forestry and tillage practices, green manures, cover crops, legumes, intercropping, crop rotations, fallows, irrigation, drainage, plus a variety of other agronomic, vegetative and structural measures designed to conserve both water and soil.

Benefits

i) sustained high yield;

ii) improves soil health (physically, chemically and biologically); and

iii) reduces inputs and hence cost of mineral fertilizer.

Area of Applicability:

This technique can be practiced in most farming systems in the country. A typical example is the banana-coffee-livestock-agroforestry system in high rainfall areas.

2.4.2 Ngoro pits

Ngoro or Matengo pit system is technique for soil fertility and crop yield enhancement, mainly found on steep slopes of Mbinga District of Southwest highlands of Tanzania, has been in use for at least 200 years and currently has been extended to some other part of the country with steep slopes.

The practice is characterized by a pattern of square pits and ridges, created using crop residues and weeds, on slopes about 35-60 percent steepness.

Approach

The Ngoro system involves a crop rotation of mainly maize and beans, with specific activities to maintain the pits throughout the season. It consists of a series of regular pits, 1.5m square and 10-50cm deep, which from a distance resemble a honeycomb. The ridges are built on top of lines of cut grass which decomposes to release nutrients to the soil. Crops are only grown on the ridges, not in the pit itself. Soil and water conservation are result of water being trapped in the pits, hence reduces erosivity.

Benefits

i) Increase soil fertility;

ii) Reduce Soil erosion;

iii) Increase yield and crop production; and

iv) Increase Soil moisture.

Area of Applicability

The technique can be practiced all over the country in steep slopes areas.

Ngoro Pits Practice in Ruvuma

2.5 Agro-forestry

Agro-forestry is a land use management system in which trees or shrubs are grown around or among crops or pastureland or land management involving the growing of trees in association with food crops or pastures. Agro-forestry is considered as a means of preserving or enhancing the productivity of the land.

Tanzania is home to several traditional agro-forestry systems that have been in practice for hundreds of years. Some have been documented and others are not documented.

Approach

For the system to be called Agro-forestry typically must satisfy the "four Is" which are intentional, intensive integrated and interactive. The main component in agro-forestry is perennial plant that is tree or shrubs. The components of agro-forestry should be arranged in such a way that there will be no competition among them by considering spatial arrangement and time. The agro-forestry structure means composition, stratification and dimension of crops, example of agro-forestry structure based on composition are as follows: Agro-silvicultural system (this refers to the use of land for the production of agriculture and forest crops either simultaneous or alternately); Silvo-pastural system (this refers to land management system in which forests are managed for production of wood as well as for rearing for domestic animals); and Agro-silivopastural system (this is the combination of Agro-silvicultural and Silvo-pastoral system). The following are steps for establishing agro-forestry system:-

i) Select the area;

ii) Characterize its strengths and weaknesses with respect to existing soil, water, and crops;

iii) Select the trees, shrubs, or grasses to be used (consider similar local plants); and

iv) Characterize the minimum space requirements, water and fertilizer needs, and shade tolerance of the desired crops.

Benefits

i) ensures a continuous food supply and economic returns;

ii) increases efficiency in use of land;

iii) improves soil fertility and reduces soil degradation; and

iv) creates and ensures more diverse, productive, profitable and sustainable land-use systems.

Area of applicability

This technique can be practiced all over the country.

Example of agro-forestry systems in Tanzania

A section of Shinyanga region before (Left) and after (Right) introduction of Agro-forestry system by HASHI Programme

CHAPTER FOUR

BEST PRACTICES FOR LIVESTOCK

4.1 Water melons *(Citrullus vulgaris)* as an alternative source of water for livestock

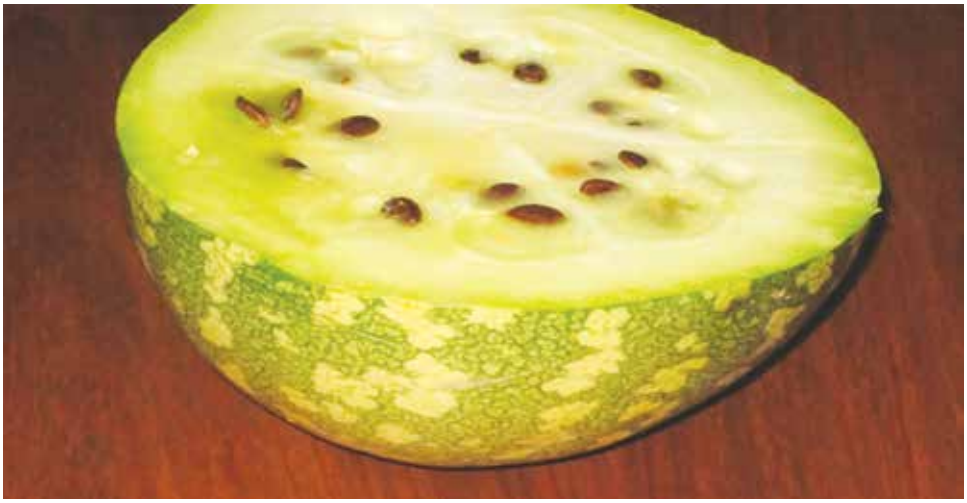
In semi-arid areas, water content of forages is very low during the dry season, when drinking water becomes the main source of water for livestock. Water points in semi-arid areas are generally far apart, and productivity in the dry season is reduced as animals expend a lot of energy in walking to water and have reduced forage consumption. Moreover, due to high evaporation rates, water sources may contain high concentrations of salt and often toxic elements, which can increase water demands but inhibit water intake.

In semi-arid areas, succulent plants can offer an alternative source of water as well as feed to grazing animals. Some are sufficiently palatable to be preferred, even when drinking water is available, e.g. the juicy herb Commelina and the swollen stems of Pyrenacantha malvifolia Water melons *(Citrullus vulgaris)* are available in appreciable quantities in some villages of semiarid central Tanzania and are used by livestock as a source of water during the dry season.

Different varieties of water melons are grown in the semi arid areas mainly in Dodoma and Singida regions for human consumption (Tikiti maji) and for livestock feeding (Mahikwi). Production of the livestock variety ranges from 1.6–5.1tonnes/ha, equivalent to 1.5–4.8 tonnes of water. One water melon (mahikwi) can weigh up to 30 kg.

Photos of Mahikwi taken from Berege village, Mpwapwa district June 2012

Experiments to investigate the potential of water melons (Mahikwi) as an alternative to free drinking water for cattle during the dry season in central Tanzania have demonstrated that intakes of free water and water from the water melons were not significantly different and hay intakes of the 2 groups were also similar. Therefore, water melons can be used as an alternative source of water for growing cattle for at least one month during the dry season, with one hectare supplying enough water for a growing bulls for about 3–5 months. Water melons are also used to feed goats, sheep and pigs.



Mahikwi photo from Berege village, Mpwapwa District

Approach

Water melons can be grown and harvested for feeding animals during dry season or can be obtained from naturally growing sources as an alternative to drinking water. It is further suggested that species other than those edible should be grown which when ripe are harvested chopped and fed to livestock as shown in the pictures below.

Benefits

i) Increases of water availability for sustaining livestock during dry season;

ii) They are multipurpose, can be used to feed goats, sheep and pigs; and

iii) Increases livestock production.

Area of applicability

This technology has already spread and adopted by livestock keepers in many other areas, including Hanang district in Manyara region. The following are some of the photos that were taken from Berege village, Mpwapwa district.

Livestock fed with Berege village, Mpwapwa district

4.2 Charco /earth dams

Most of the ruminant livestock are concentrated in the semi-arid areas which are more suitable for ruminant livestock than any other form of agriculture. These areas are characterized by extreme seasonal conditions with relatively low rainfall, a long dry season and high seasonal temperature fluctuations which cannot reliably produce food and cash crops. Concentration of ruminant livestock in these areas is also attributed to low concentrations of tsetse flies and less competition for land for agriculture. The rapidly growing livestock populations and reduced land for grazing arising from expansion of agriculture and shifting cultivation have reduced the grazing area in the agro-pastoral systems forcing livestock herders to migrate to other areas in search for pasture and water. The unauthorized livestock movements have resulted in a number of environmental and social problems including;

- Land use conflicts between livestock keepers, farmers and other land users. Such conflicts have been reported in many parts of the country, including Morogoro (Kilosa district), Dodoma, Mbeya (Mbarali district), and Arusha regions.

- Reduced hydro-electric power generation arising from invasion of livestock in water catchments such as Ihefu wetland, which is an important source of water for the hydro-electricity production in Mtera dam.

- Loss of biodiversity arising from invasion of livestock in the water catchment areas and invasion of livestock from neighbouring countries into the protected forests.

Construction of charco dams in the semi-arid areas is one of the important means to reduce migration of livestock to other areas in search of water and pasture.

Approach

Charco dams are small rectangular, excavated pans or ponds, which are constructed at well-selected sites on a relatively flat topography for livestock watering. They are constructed by hand or by machinery, and can reach depths of 3 m. The design is simple and can be implemented at village level with minimum of engineering requirements. Charco dams receive their runoff mostly from outlaying areas of a rangeland, thus contour bunds are constructed to divert runoff into the dam.

Benefits

i) reduce loss of biodiversity arising from invasion of livestock in the water catchments;

ii) reduces land uses conflicts between livestock keepers, farmers and other land users; and

iii) they are multi-purpose i.e. Can be used for small scale farming.

Areas of applicability

Charco dams are commonly found in Shinyanga, Dodoma, Arusha, Tabora, Singida and Mwanza regions of Tanzania.

A charco dam as a source of water in Same district, Kilimanjaro region.

A charco dam as a source of water in Same district, Kilimanjaro region.

4.3 Traditional fodder conservation-ngitiri

Is an indigenous natural resource management system which involves conservation fallow and rangelands by encouraging vegetation regeneration particularly for browse and fodder. Livestock during dry seasons in the semi-arid areas of Tanzania are limited by low productivity of rangeland forages. To alleviate feed shortages during dry seasons this technologies are implemented. The technology is commonly practiced in Mwanza, Shinyanga and Simiyu regions.

The ownership of ngitiris is usually communal. However, studies have shown that there is an increasing trend for individual ngitiri ownership

in recent years. The use of ngitiri is controlled by by-laws established by the user communities.

Studies have shown that the system been used by Sukuma people for a long time and is very useful for sustaining livestock production for small-scale livestock producers in these regions. The average fodder production in the ngitiris is between 1-1.5 tons of Dry Matter (DM) per hectare per year and the fodder quality is relatively low. This is because fodder is conserved in-situ with no improved management practices.

Approach

The system involves setting aside a portion of land usually ranging from 0.5 ha for individual ngitiris to more than 500 hectares for communal ngitiris. These areas are restricted of any livestock and crop production during the rainy season thus allowing vegetation regeneration. Ngitiris are used for grazing as standing hay during the periods of acute fodder shortage in the months of August to October.

The common practice in these regions is for the agro-pastoralists to select an area for ngitiri. Ngitiris are established in degraded croplands and rangelands. The restriction livestock and cultivation allows regeneration of pastures and trees. Selection of an area for ngitiri is also influenced by proximity to homesteads, production potentials and ease of protection. Usually there is very little management in the ngitiris during rainy season apart from the restriction of livestock and cultivation. Protection of the ngitiris is through identification of landmarks and by-laws which are enforced by local scouts with heavy penalties to the offenders.

Grazing in the ngitiris is done during the driest months of the year August to October particularly when there are no more crop residues in the fields. Grazing is done rotationally in communal ngitiris

Benefits

i) increases regeneration of vegetation;

ii) reduces land degradation;

iii) increases of fodder available for sustaining livestock during dry season; and

iv) Increases livestock production.

Area of applicability

Semi-arid areas of central, western and northern Tanzania where livestock production is highly concentrated.

Example of Ngitiri in Tabora region

Example of Ngitiri in Meatu district, Shinyanga region.

CHAPTER FIVE

BEST PRACTICES FOR WATER RESOURCES

5.1 Subsurface dams

A subsurface dam is a system to store ground water by a: “cut-off wall” (dam body) setup across a ground water channel. Drought is the most serious natural hazard facing most parts of Tanzania in terms of severity and frequency of occurrence. Usually, this technique is commonly used in semi-arid areas that face frequently reduction of water or most of the semi-arid areas such as Dodoma, Singida and Shinyanga regions face frequent reduction of water or moisture to significantly below the normal or expected amount. Pastoralists and agro pastoralists who occupy these areas barely meet basic water requirements. Consequently they suffer from livelihood losses, hunger, diseases and conflicts over land and water uses. The worst affected groups are women, children, and disabled who may have to walk all day long in search of water. Due to limited and unreliable rainfall most rivers are ephemeral seasonal sandy bed streams and only experience heavy water run-off for short periods of time after rain. During such periods of high flows, large quantities of sand are transported downstream while others get trapped on the upstream sides of rocks ledges along the stream. Such sand traps form natural aquifers that are capable of providing clean adequate water if well harnessed. Using appropriate technologies this can be exploited for water storage in the form of sand dams. During the dry periods pastoralists and agro pastoralists get water for themselves and livestock by scooping into the sand beds of the dry streams at upstream sides of ledges cutting across the channel. Water in such sites is usually clean for drinking but quite finite and quickly gets depleted. Sand dams are an artificial enhancement of this traditional practice that puts extra water into these sand beds to recharge and store water for use.

Approach

A concrete wall is constructed across the water runoff channel at specific sites to trap and hold back the sand during flooding; this creates an additional sub surface water bank for harvesting.

Benefits

i) captures thousands of tons of water in the sandy river bed, providing water for domestic use and livestock through the dry season;

ii) captures seasonal rainfall and feeds a hand pump for domestic water supply;

iii) reduces land degradation from soil erosion;

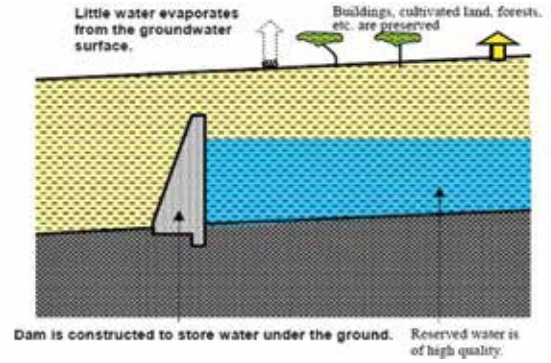
iv) retain soil fertility and the integrity the ecosystem;

v) reduces loss of reserved water by evaporation;

vi) maintains water quality because it is stored underground; and can be used like ordinary well water

Area of applicability

Sand dam technology can be used in semi-arid areas of the country, including Chololo village in Dodoma Municipality and in other semi-arid areas such as Singida, Shinyanga, Manyara , Igunga district and some parts of Simiyu.



Principles of a subsurface dam

A subsurface water dam in Chololo village, Dodoma Municipality

5.2 Rain water harvesting

Rain water harvesting is accumulation and deposition of rain water for reuse on site, rather than allowing it to run off. Its uses include water for garden, water for livestock, water for irrigation and water for domestic use with proper treatment.

Approach

Rain water harvesting techniques is divided into two types depending on source of water collected; namely, the in situ and the ex situ types of rainwater harvesting, respectively.

The in-situ rainwater harvesting technologies are soil management strategies that enhance rainfall infiltration and reduce surface runoff. The in situ systems have a relatively small rainwater harvesting catchment typically not greater than 5-10 m from point of water infiltration into the soil. The rainwater captures area within the field where the crop is grown or point of water infiltration.

Ex-situ technique is systems which have rainwater harvesting capture areas external to the point of water storage. The rainwater capture area varies from being a natural soil surface with a limited infiltration capacity, to an artificial surface with low or no infiltration capacity. Commonly used impermeable surfaces are rooftops can provide the platform to collect substantial amounts of water for different uses. As the storage systems of ex situ systems often are Tanks, wells, dams, ponds, water can be abstracted easily for multiple uses including irrigation or domestic, public and commercial uses through centralized or decentralized distribution systems.

Benefits

In-situ rain water harvesting technology often

i) serves primarily to recharge soil water for crop and other vegetation growth in the landscape;

ii) easy to abstract water for multiple uses including irrigation, domestic, public and commercial uses.

iii) easy to maintain;

iv) reduces water bills; and

v) reduces floods and soil erosion

Area of applicability

Rain water harvesting is good source of water supply, throughout the country and especially in arid and semi-arid areas.

Rain water harvesting from Kabungu Secondary School roof top, Mpanda district, Katavi region

Rain water harvesting from roof top in Ibwera village, Kagera Region

5.3 Road runoff harvesting

It is the diversion of runoff water from the road into channels/ canals and distribution into ditches/ basins or farmland for fruit tree or crop production. This technique is becoming increasingly important in arid and semi-arid lands for crop production, due to increased benefits and farm income resulting from high yields.

Approach

The technique of road runoff harvesting usually involve external catchment systems that capture, divert and store storm-water flows from roads, footpaths, railway lines and other paved surfaces. They range from simple diversion structures directing surface water into crop fields (as green water), to deep trenches with check-dams in order to enable both flood and subsurface irrigation. Where surface conditions permit, storage in tanks, pans and ponds can be quite cost-effective. Thus, road runoff harvesting is considered to offer a large untapped potential for “greening” the dry lands areas.

Benefits

i) increases crop production and income;

ii) increases fodder production; and

iii) reduces soil erosion.

Area of applicability

This technology is usefully in most of semi-arid areas especially by farmers and pastoralists whose is located in the proximity of a road.

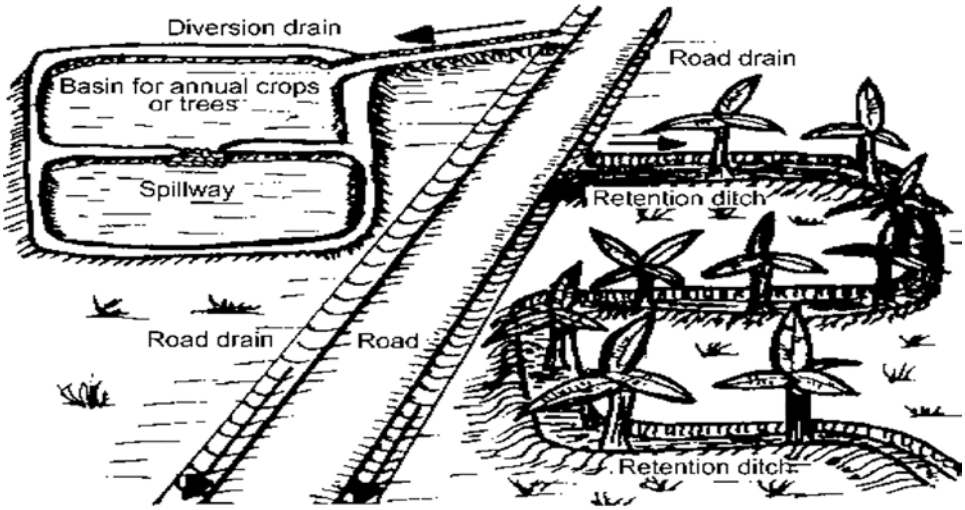


Illustration of road runoff

5.4 Silt trapping

A silt trap is a designated area where water that is contaminated with suspended sediments as a result of water runoff is contained. While the water is in the trap sediments can settle to the bottom of the trap until it can be removed.

Approach

The silt trapping technique, normally involves creation of temporary barriers across a seasonal stream, to divert the flood waters. On the allocated land, the flow is reduced speed with tree branches and other impediments, allowing the silt within it to be trapped and to settle over. The excess water is re-directed back to the watercourse. Over time, a fertile layer of soil builds up, which can hold moisture more effectively and enable crop production.

Benefits

i) enhances fish and other aquatic life;

ii) provides deep pools as fish habitat;

iii) control soil erosion;

iv) control waste management and materials pollution; and

v) ensures availability of water.

Area of applicability

This technology is more appropriate in dry areas and most of semi-arid areas of Tanzania such as Dodoma.

5.5 Stream-flow Diversions (Ndiva)

Stream flow diversion is the water harvesting system where reinforced concrete based reservoirs are build on catchments to trap runoff water oozing from springs located upstream. The stream flow diversion get field up during the night and the stored water is utilized for irrigation during the day. In the Pare Mountains of Tanzania, stream flow diversion and water storage in reservoirs during the night is known as “Ndiva”. This is an indigenous technique which has been applied in water scarce areas with good result

Approach

A small dyke is usually constructed across the stream to raise the water level and allow some storage. Usually, the water diverted from the stream is stored in the reservoir before being released for irrigation. Smallholder farmers divert streams either as individuals or a small group schemes, to irrigate crops.

Benefit

i) increase local water supply within an area;

ii) reduces environmental impacts of dry season abstraction;

iii) minimizes the risk associated with potential water conflicts in the catchments; and

iv) Increases water security by balancing water supply with demand.

Area of applicability

This technology can be practiced throught the country in most of Tanzanian regions that practices irrigation like in Same and Mwanga Districts, Kilimanjaro Region.

Stream flow diversion (Ndiva) at Mwembe village, Same district, Kilimanjaro

CHAPTER SIX

BEST PRACTICES FOR FISHERIES

6.1 Aquaculture

Aquaculture, also known as aqua farming, is the farming of aquatic organism such as fish, crustaceans, molluscs and aquatic plants. It involves cultivating of fresh and marine water organisms. Aquaculture in Tanzania is dominated by freshwater fish farming in which small-scale farmers practice both extensive and semi-intensive fish farming. Small fish ponds of an average size of 10 m x 15 m (150 m2) are integrated with other agricultural activities such as gardening and animal and bird production on small pieces of land. There are about 14,740 earthen fish ponds in Tanzania, most of which are stocked with Oreochromis niloticus, and it is estimated that the industry produces about 9500 tons of fish annually, from more than 14,740 ponds scattered all over the country. However, there are four regions which have more than 1 000 fish ponds each. These are Ruvuma (4 942), Iringa (3 137), Mbeya (1 176) and Kilimanjaro (1 660).

Approach

There are several methods employed in developing aquaculture depending on kind of species to be cultivated. The common method involve pond establishment where by a suitable area is identified and ponds are excavated. The ponds can be in series or parallel depending on topography of the area and the water source. Pond excavation involves transferring of soil from pond surface to pond walls. The pond walls are compacted to make it stronger to resist water pressure. The size of the water pond can be of any how depending on the available space, but the depth should range between 1m to 2 m. There after the water inlet and outlet of the pond are constructed. The water inlet should be 15cm above of the intended water level to allow mixing of water and oxygen. Water from the water source is allowed to fill in the ponds and finally ponds are conditioned for fish stocking.

Earthen Pond integrated with other agricultural crops at Kiwira village, Mbeya region.

A series of earthen ponds at Mbinga, Ruvuma region which allows independent draining and filling.

The country also farms seaweeds along the Indian Ocean coastline. Two species are involved these are Eucheuma spinosum and Eucheuma cotonnii. In terms of production 8,000 tones are produced per year, where Eucheuma spinosum account for 75% of the production.

Approach

The method of farming seaweed in Tanzania is the peg and line or off-bottom method carried out in shallow intertidal areas. In this method, nylon ropes with seaweed are tied between two wooden pegs. The pegs are from mangroves or land-based plants. The seaweed branches, usually about 100 g, are tied to the lines and allowed to grow for six weeks before they are harvested. When harvesting, farmers remove the lines and the seaweed and then tie-in new seaweed branches. Recently, however, other methods have been developed. These include the deep-water floating line technique where the seaweeds are planted in water of 2-5 m, depending on the tidal range, and the cast method where the seaweeds are bound to rocks using rubber bands and allowed to attach and grow.

Seaweeds farming in Ushongo village, Pangani, Tanga Region

Other aquaculture activities though to a small extent are crab fattening and milkfish farming in the coastal areas.

Approach

Crab fattening can be carried out in Cell-type Cane/plastic Cages of 1m (L) X 1m (W) X 20 cm (H) size. Each of these cages should be provided with a lid to prevent the escape of crabs. A gap of 5 mm is to be provided between the canes at the top and 2.5 cm at the sides of the cages to enable free movement of water through the cages. But, no gap should be provided at the bottom to enable easy movement of the crabs.

Crab fattening at Msimbati village, Mtwara region.

Crab cages with individual compartment

Although very profitable internationally, shrimp farming is still in the experimental phase in Tanzania, a number of private companies have acquired plots and permits for the culture of shrimp. Shrimp farming has the potential to be a profitable activity in Tanzania but there are widespread concerns about its potential environmental and socio-economic impacts based on observation of the global industry.

Shrimps farming in Bagamoyo, Pwani region.

At present aquaculture is largely a subsistence activity practiced by poor households in the coastal and inland areas but the benefits arising from it are many. Moreover, declining fisheries resources from capture fisheries, and ever increasing demand for fish has created an urgent need to promote aquaculture.

Benefits

i) contributes to people's requirements for animal protein, particularly in the rural areas where there are no capture of fisheries,

ii) provides employment opportunities and is a source of income.

Area of applicability

Can be practiced all over the country especially in the Coastal areas and Lake shore line.

CHAPTER SEVEN

BEST PRACTICES FOR ENERGY

7.1 Energy efficient cooking stoves

An estimated 90 % of Tanzania's energy needs are met through the use of wood fuels. Firewood remains the most common source of fuel for cooking in rural areas whereas charcoal is mostly used in urban areas. Approximately half of Tanzania's annual charcoal consumption, amounting to approximately 500,000 tons, takes place in Dar es Salaam. The amount of charcoal consumed is expected to further rise in future. With continued heavy dependence on charcoal and firewood as sources of energy for domestic use, coupled with absence of affordable alternative energy sources, the forest resources remain in jeopardy. While it is practically impossible to ban the use of fuel wood for energy, it is important to promote the use of fuel efficient stoves in order to safeguard the forests.

Approach

Various types with varied sizes of fuel efficient stoves are available (ready-made) in the country. Some of the stoves are shown below

Efficient cooking stoves which utilize few pieces of fire wood for cooking

Efficient cooking stoves which utilize wood briquettes for cooking at Chisenga Secondary School

Some types of Fuel efficient stoves can be fabricated by users or local funds as shown in the picture below.

A man in Kambai village, Tanga making energy saving stoves.

Energy saving stoves in Kambai village, Muheza Tanga

Benefits

i) It is economical in terms of fuel consumption as it uses less charcoal or firewood as compared to traditional cookers;

ii) conserves forests by making sustainable use of firewood and charcoal;

iii) reduces burden to women for searching firewood; and

iv) improves indoor air quality and therefore improve the health of the cooks.

Area of Applicability

This technology can be applied all over the country.

7.2 Renewable Energy Sources

There are many sources of energy that are renewable and considered to be environmentally friendly and harness natural processes. These sources of energy provide an alternate 'cleaner' source of energy, helping to negate the effects of certain forms of pollution. All of these power generation techniques can be described as renewable since they are not depleting any resource to create the energy. While there are many large-scale renewable energy projects and production, renewable technologies are also suited to small off-grid applications, sometimes in rural and remote areas, where energy is often crucial in human development.

7.1.1 Photovoltaic Solar power

Photovoltaic (PV) Solar power is harnessing the suns energy to produce electricity. One of the fastest growing energy sources, new technologies are developing at a rapid pace. Solar cells are becoming more efficient, transportable and even flexible, allowing for easy installation. PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array.

Approach

Solar-powered photovoltaic (PV) panels convert the sun's rays into electricity by exciting electrons in silicon cells using the photons of light from the sun. This electricity can then be used to supply renewable energy for domestic use or business. In most solar systems, solar panels are placed on the roof. The panels are then connected to a battery, Net meter and an inverter which are all connected to appliances for lighting and other uses.

Benefits

i) provides energy reliability. The rising and setting of the sun is extremely consistent. With advancement in technology solar panels are consistent in extracting solar energy even in cloudy days;

ii) conserves forests by reducing dependence on trees/fire wood for lighting in rural areas; and

iii) helps to slow-down global warming by reducing the amount of using fossil fuel as source of energy.

Area of applicability

Solar power technology can be applied all over the country

7.1.2 Wind power

Wind power involves converting wind energy into electricity by using wind turbines. A wind turbine is composed of 3 propellers-like blades called a rotor. The rotor is attached to a tall tower. The tower looks like a very tall pole. On average wind towers are about 20m high. The reason why the tower is so tall is because winds are stronger higher from the ground. Wind power is the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation. The effects on the environment are generally less problematic than those from other power sources. Generally wind farms installed on agricultural land or grazing areas, have one of the lowest environmental impacts of all energy sources.

Approach

Large-scale wind farms are typically connected to the local power transmission network with small turbines used to provide electricity to isolated areas. Wind energy production is preceded by assessment of the site across geographical areas. Areas for considerations have valuable criteria not included (bear and bird habitat). Wind resources should be of 30m, 50m and 70m wind turbine hub height. These systems combines a numerical weather model and a micro-scale wind flow model to produce a high-resolution (200m) wind resource that accounts for complex flow (i.e. Sea breezes and down slopes).

Benefits

i) free and inexhaustible (“renewable”) source of energy. Wind turbines harness a boundless supply of kinetic energy in the form of wind;

ii) Diversifies the national energy selection and reduces Tanzania’s reliance on imported fuels, stabilizing the cost of electricity (Gives range of choices of power selection); and

iii) reducing vulnerability to deforestation in search for energy source.

Areas of applicability

The technology can be applied in areas where there are potential of winds. In Tanzania there are some initiatives going on in Arusha, Dodoma, Iringa, Makambako and Singida.

7.1.3 Biogas

Basically refers to a mixture of gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from regionally available raw materials such as recycled waste. It is a renewable energy source and in many cases exerts a very small carbon footprint.

Biogas is produced by anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. It is primarily methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes, which can be used in stoves for cooking or in lamps for lighting. Biogas technology can be used for various purposes as explained bellow:-

i) Cooking and heating

Biogas produced from biogas reactors is used for cooking in both domestic and institutions. The quantity of gas depends on the size of the plant in question. For most domestic establishments the quantity varies between 20 to 45m^3 per month.

ii) Biogas stoves

In recent days biogas burning has been possible due to modifications made in stove burners' gas injector, cross section and mixing chambers.

iii) Fertilizers

The digestate left over from the digester is rich in Nitrogen, phosphorus, potassium and is normally used as fertilizer.

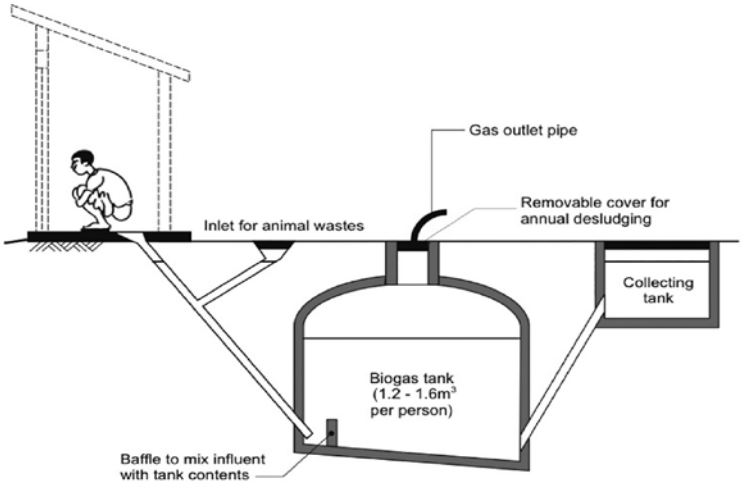
iv) Lighting and power generation

The other major application of biogas is for lighting and power generation. At both domestic/institutional and industrial scale, biogas from the digesters can be sent to a combustion engine to convert it into electrical and mechanical energy.

Approach

Biogas can be produced from different technologies that can be adopted and applied at a wide range depending on the need and income level. Such technologies include Biogas reactors, Ecosan toilets, Upflow anaerobic sludge blanket reactors (UASB), anaerobic baffled reactors (ABR) etc.

Regardless of where biogas plant is operated, the basic principle is relatively simple and similar. Renewable input materials from farming, animal manures and waste materials from the food and agricultural industrial serve as input materials.



Example of bio-latrine for biogas production

a) Feeding of the digester/reactor

In larger biogas units, the dung, urine and other substrate usually enter the plant by pipes, channels, belts or pumps. The available substrate has to enter the digester as soon as it is available to avoid pre-digestion outside the digester. The functioning of the feeding mechanisms has to be checked daily. Separators for unsuitable material have to be checked and emptied. The amounts of substrate fed into the digester may be recorded to monitor the performance of the biogas plant. Smaller plants in developing countries are fed by hand. The substrates often dung and urine, should be thoroughly mixed, plant residues should be chopped, if necessary.

Obstructive materials like stones and sand should be removed from the mixing chamber. Simple tools like a rubber squeegee, a dipper, and forks to fish out fibrous material, proper buckets and shovels greatly facilitate this work. Filling work is further made easier by smooth concrete stable-floors and a minimized distance between the stable and the plant.

b) Agitation

In industrialized countries and for large plants in developing countries, engine driven stirring devices are the norm. Usually, but not always, they are operated automatically. The user, however, should check the operation of the stirring device daily. Small size biogas plants have manual stirring devices that have to be turned by hand as recommended. If there is no stirring device, poking with sticks through the inlet and outlet is recommended. The stick should be strong, long enough but not too heavy. It should have a plate fixed at the end (small enough to fit in the inlet-/outlet pipes) to produce a movement of the slurry. Regular poking also ensures that the inlet/outlet pipes do not clog up. The drums of floating drum plants should be turned several times a day.

Benefits

i) It needs little Capital Investment and skilled labor: Biogas is easy to set up and require little capital investment on a small scale basis. In fact, many farms, households and institutions can become self-sufficient by utilizing biogas plants and the waste material produced from within each day;

ii) Reduction of time and workload for women, in firewood collection and cooking. Normally women can spend up to 2-4 hours per day searching and carrying firewood. Once a biogas unit is installed, women will have more time to engage in other useful activities such as education and interesting activities outside the home;

iii) Protection of environment (soil, water and forests). estimating an average per capita consumption of 3 kg of wood per day for energy (cooking, heating and boiling water) in rural areas, the daily per capita demand of energy equals about 13 kWh which could be covered by about 2 m^3 of biogas. A biogas plant therefore directly saves forest. Annually, each biogas plant can

save more than four tons of firewood and 32 liters of kerosene; and

iv) Reduces greenhouse effects by utilizing the gases that could have been released in landfills and consequently cause greenhouse effect.

Area of applicability

Biogas technology Can be practiced everywhere in the country. it has been in Tanzania since 1975 and has been applied successfully and is still being adopted in several regions in Tanzania at domestic and institutional levels.

Example of biogas production plant in Kilimanjaro

Example of biogas production plant in Dar es salaam

CHAPTER EIGHT

BEST PRACTICES FOR WILDLIFE

The Government of Tanzania is committed to effectively manage the wildlife resources for the benefit of its citizens. This is due various reasons including loss of biodiversity, global climate change and human disruptions. In so doing, it has identified, and adopted the best practices (sustainable development) for wildlife management in the country, including promoting the conservation of wildlife and its habitat outside the Core Protected Areas by establishing Wildlife Management Areas (WMAs).

8.1 Wildlife Management Areas (WMAs)

Wildlife Management Areas (WMAs) are areas where by communities are legal managers and beneficiaries of wildlife on village lands. The underlying assumption is that WMAs would be established where there is a "healthy" population of wildlife, since WMAs, despite their conservation roles, would run as business entities parallel to other production systems in the village land, as will be determined by the land use plans.

Approach

The process of establishing a WMA involves the following main steps: creation of awareness among villagers of the merits and disadvantages of having a WMA; a village assembly's approval of an application for WMA formation taking into consideration village council recommendations; formation of a Community-Based Organization (CBO); preparation of a strategic plan; preparation of a land-use plan; carrying out of an Environmental Impact Assessment (EIA) prior to approval of a land-use plan; preparation of village by-laws that support a land-use plan; and preparation of a resource management zone plan. The CBO then makes application to the director of wildlife for designating part of village land as a WMA; the director considers the CBO's application and sends his recommendation to the Minister of Natural Resources and Tourism; and finally the minister declares a designated WMA by order in the gazette. After this, the CBO applies to become an Authorized Association (AA), and the AA applies for a user right and hunting block to the director of the Wildlife Division.

Benefits

i) Enhance Conservation of wildlife habitat, Sustainable use of wildlife resources, Promotion of ecotourism, Improve livelihood and Enhancing conservation and poverty alleviation;

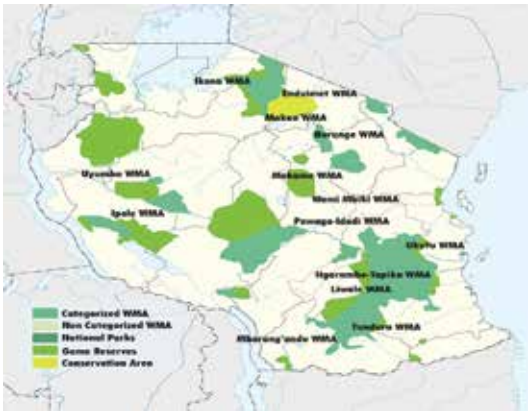
ii) increase community participation in the protection and conservation of wildlife resources;

iii) contribute to improve natural resource management and planning process; and

iv) strengthen local level governance and generate tangible social, economic and financial benefits to communities in harmony with the natural environment.

Areas of applicability

Currently there are 38 WMAs countrywide at different stages of development of which 17 WMAs have attained Authorized Association (AAs) status, namely; namely: Tunduru (NALIKA), Liwale (MAGINGO), Ngarambe/Tapika (MUNGATA), Wami-Mbiki (WAMI-MBIKI SOCIETY), Pawaga-Idodi (MBOMIPA), Ipole (JUHIWAI), Uyumbu (UWIMA), Burunge (JUHIBU), Ikona (JUHIWAIKO), Enduimet (ENDUIMET), Mbarang'andu (MBARANG'ANDU), Ukutu (JUKUMU), Makame (INDEMA), Makao (JUHIWAPOMA), Kimbande (KIMBANDE), Kisungule (KISUNGULE) and Chingoli (CHINGOLI).



A Map of Tanzania showing WMAs with AA status

Burunge WMA - The home of large buffalo population and migratory birds

8.2 Sustainable use of Wildlife in protected areas

Is an approach where by protected areas are set aside for the community livelihoods to focused on wildlife protection into harmony with biodiversity conservation, environmental stewardship and recreational activities.

Approach

Communities living adjacent to the protected areas are involved in management and proper utilization of wildlife resources. Living fences are set around the villagers farms to protect their crops.

Benefits

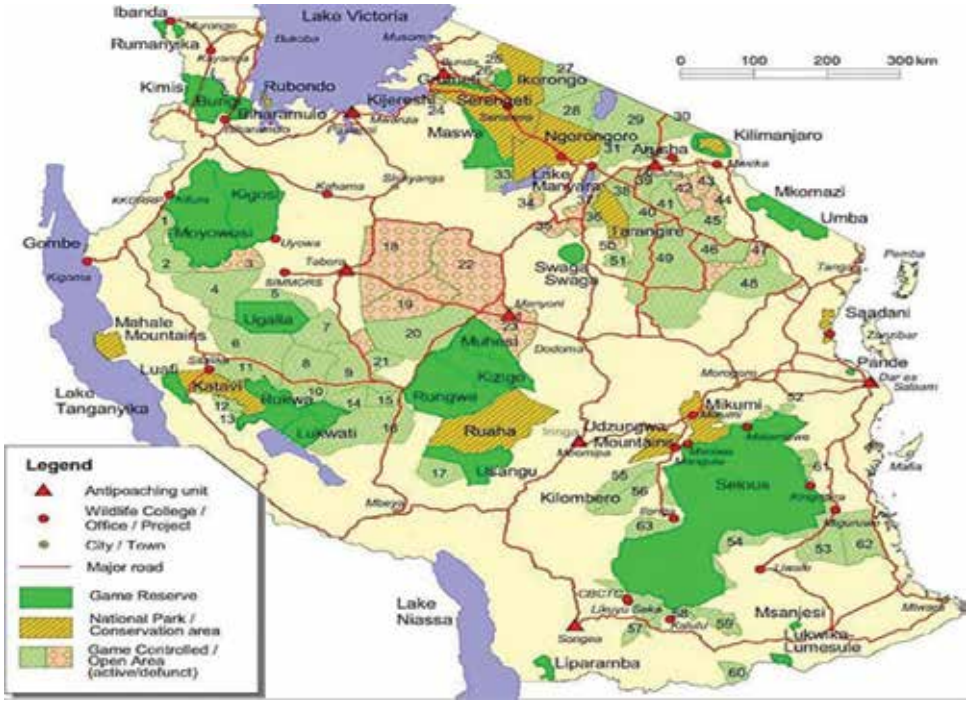
i) a percent of Revenue from protected areas are invested into health, education, and infrastructure;

ii) increase income to local communities; and

iii) living fences are used to support food security by keeping elephants and other wildlife from destroying crops. The association has adopted a “human rights of wildlife” approach, where the protection of wildlife is central to community wellbeing.

Area of applicability

The approach has proven to be effective witnessed by 22 villages association of Matumizi Bora ya Malihai Idodi na Pawaga (MBOMIPA). Where by Wildlife Management Area works with the 30,000 people living adjacent to Ruaha National Park on sustainable natural resource management and anti-poaching efforts. MBOMIPA Wildlife Management Area is recognized as best practice in Tanzania and is being replicated in other regions to protect wildlife and promote sustainable livelihoods.



Interactive map of Tanzania WMAs

Ikona WMA - spread the wealth in Tanzania

CHAPTER NINE

BEST PRACTICES FOR FORESTRY

9.1 Indigenous vegetation conservation technologies

Indigenous knowledge can be defined as knowledge of indigenous community accumulated over generation of living at a particular environment. It is a broad concept that covers all forms of knowledge or technologies know how, skills, practices and believe that enable the community to achieve stable livelihood in their environment. A main indigenous technology used as an approach to environmental (forest) conservation is forest for spiritual purpose and traditional believes.

9.1.1 Spiritual and traditional believes

Spiritual and tradition believes tied with indigenous knowledge on land management practices in forest conservation using indigenous knowledge know how rules prohibition and taboos all community will practice forest conservation.

Approach

Areas which seem to be potential to community including sacred forest, source of water, big trees and trees with medicinal values are protected and conserved by the community.

Benefits

i) Enhance conservation of biodiversity that is flora and fauna;

ii) provision of habitat needs for high diversity of flora and fauna;

iii) conservation of water sources; and

iv) provision of rain and environmental for recreational.

Area of applicability

In the country almost all communities there are plants and trees that are associated with shrine and water sources therefore are protected. Traditionally thick forest or big trees were not allowed to be cut down or their woods not used for fuel or construction therefore are being conserved. For instance some taboos prevented young people and

women to cut some trees. Sacred forests are found in Iringa, Tanga and Kilimanjaro and other areas with natural forest.

Traditional forest at Pugu kwa Kiki for spiritual purposes

9.2 Participatory Forest Management

Participatory forest management in Tanzania comprises two main approaches in managing forests which are joint forest management and community based forest management. These two different approaches are extremely important but not widely understood. Different models of PFM have been supported by projects, NGOs, districts and national government since the early 1990s, but they were first formalized following the passing the Forest Act in 2002. Over the past fifteen years, PFM has been implemented in a wide range of circumstances and in most of the districts of Tanzania.

4.2.1.1 Community Based Forest Management (CBFM)

Enable local communities to declare – and ultimately gazette – Village, Group or Private Forest Reserves (commonly known as "Community Based Forest Management" – CBFM).

Approach

CBFM takes place on village land or private land, and the trees are owned and managed by the village council (through a village natural resource committee), a group, or an individual. Most of the costs and benefits relating to management and utilization are carried by

the owner. The role of central government and districts is only in monitoring. The community requires to have an approved forest management plan for the forest.

Benefits.

i) Conservation of forest;

ii) reduced rate of deforestation;

iii) improve livelihood;

iv) increase village revenue.

Area of applicability

Community Based Forest Management CBFM has been practiced almost all over the country as reflected in the table below.

Overviews of CBFM in Country

Number of villages with CBFM established or in process	1,102
Area of forest covered by CBFM arrangements	2,060,608 hectares
Number of declared Village Land Forest Reserves	329
Number of Gazetted Village Land Forest Reserves	53
Number of districts where CBFM is implemented 50	50
Primary forest types where CBFM has been promoted	Miombo, coastal and acacia woodlands
Percentage of public land forests now under CBFM arrangements	10.2%
Percentage of villages on mainland Tanzania that are engaged in CBFM activities	10.5%

4.2.1.2 Joint Forest Management (JFM)

Allow communities to sign joint forest management agreements with government and other forest owners (commonly referred to as “Joint Forest Management” or JFM)

Joint Forest Management takes place on “reserved land” land that is owned and managed by either central or local government. Villagers typically enter into management agreements to share responsibilities for the management with the government. That means government is the owner and the community act as co-manager with the government.

Approach

JFM requires villagers signed joint forest management agreement with government or other forest owners in a reserved land.

Benefits

i) provides revenue to the owner;

ii) ensure sustainable forest management;

iii) ensure villagers to benefits on revenue percentage through provision of social services like water, building schools, dispensaries and infrastructure; and

iv) Villagers are allowed to collect dead wood as source of energy.

Area of applicability

Joint Forest Management JFM has been practiced on forest owned by the central government or local government, as reflected in Table 1.

Table 1: Overviews of JFM in Country

Area of forest covered by JFM management plans	1,612,246 hectares
Percentage of total area reserved by National or Local Government under some form of Joint Management Agreement	11.6%
Primary forest types where JFM has been promoted	Montane and Mangrove
Number of National Forest Reserves with JFM	150
Number of Local Authority Forest Reserves with JFM	60
Primary Regions where JFM implemented	Morogoro, Iringa, Pwani, Tanga, Kilimanjaro
Number of villages with JFM has been established or in process	719
Number of villages that have signed JMAs	149

Village assembly getting training on PFM

Village environmental committee

9.3 Alternative Income generating Activities

Income-generating activities (IGA's) are initiatives that affect the economic aspects of people's lives through the use of economic tools such as credit or self-financing. It is incentive for people to stop their current unsustainable livelihood activities and move into other economic activities which are sustainable. For IGAs to work the alternative needs to be more economically profitable. IGAs aim at promoting the understanding of the role of such activities for poverty reduction and development through

There are many alternative income generating activities to the communities but common are; butterfly farming, beekeeping, ecotourism, and mat weaving.

9.3.1 Butterfly farming

The butterfly project, brainchild of Tanzania Forest Conservation Group (TFCG) was meant to provide an additional source of income to individual villagers and communities in general as well as help to conserve the environment. "The butterfly project is synonymous to forest conservation. If we don't have healthy forests, there will be no butterflies and there will be no money for us.

Approach

It involves catching the desired butterflies in the bush and keeping them in special huts where they are fed .The butterflies lay eggs which hatch larva which later develop into pupa. It is this last stage, the pupa, which sold on market. Rearing butterflies is simple and doesn't require much money to start a project. There are many different techniques for farming butterflies; the following routine is the best practice in East Usambara Mountains.

a) Morning activities

i) Collecting seeds and seedlings of host plant species that are needed in the nursery. This task requires a lot of work during the initial few months of preparation for butterfly farming. After a large and healthy nursery is established, this task become unnecessary, except to replace plants that have grown too big every few years.

ii) Watering – If the weather is dry watering might be needed every other morning. If wet watering may not be necessary.

iii) Weeding – Conducted if needed.

iv) Fertilizing – Conducted every month or so.

v) Changing Fake Flowers – Butterflies that are nectar feeders often do not like alcohol so it is important to change fake flowers every day so that the sugar water does not ferment.

vi) Changing Fruit Pieces – Mango is a very good fruit for most butterfly species that enjoy fermenting fruit. However, the fruit pieces should be changed if they are dry or particularly sour.

vii) Checking the Egg Containers – Containers that are used to gather eggs should be checked every morning for newly hatched larvae. These larvae should then be placed on young leaves of their appropriate food plants in the larvae-rearing cage using a small paintbrush.

viii) Checking the Pupae Cage – The small net box used to hold either pinned or glued pupae should be checked every morning for newly emerged butterflies. Newly emerged butterflies should be allowed to dry their wings for at least 2 hours before they are handled.

ix) Hanging New Pupae - The larvae cage should be checked every morning for newly formed pupae. Pupae should be 24 hours old before they are handled to allow sufficient time for their skin to dry. Dry pupae should be glued to a stick or pinned to a board and placed in a net box.

x) Catching Female Butterflies – Female butterflies of most species are most visible at flowers and in sunny areas, in the morning between 8 and 11 AM. This is the period of day when they are loading up on nectar or fruit sources before they enter the forest to begin to lay eggs. This task is the most time consuming in the early phases of farming, and is frequently a futile effort. Fortunately, it becomes unnecessary after captive populations are established from 3 to 6 females of each species.

b) Mid-day activities

Catching male butterflies:- Male butterflies are needed to maintain genetic diversity in the captive populations. For the first generation, which is usually small, it is beneficial to replace all the males in the captive populations with wild caught males. Male butterflies are very active around mid-day, patrolling along the forest edge or on hilltops waiting for female butterflies to pass through their opening.

c) Evening activities

Collecting eggs and removing eggs every day from the fly cages about an hour before dark can greatly decrease the incidence of parasitism in Papilio and Charaxes eggs. The small wasps that lay their eggs on butterfly eggs are small enough to enter into mosquito netting. Collecting other kinds of eggs can help to protect them from spiders and ants, though wasps are generally not a problem.

The eggs should be rolled off the leaves they were laid on and placed in small plastic containers that are ventilated and completely dry. If the weather is not very humid, a small mature lemon leaf should be placed into the container to prevent the eggs from drying. A different container should be used each day for about 10 days to allow for all the eggs in one container to hatch before it is used again. Any eggs that have not hatched after 10 days are probably infected by parasitoid wasps or infertile and should be destroyed.

Benefit

i) Provide employment to the communities;

ii) Increase revenue for the villagers and communities; and

iii) Conservation of environment.

Area of applicability

Butterfly farming can be practiced all over the country.

Butterflies in their breeding shaks-Kwezitu village, Tanga

9.3.2 Beekeeping

Beekeeping is the practice of managing honeybee colonies to attain desired objectives. The most common primary objective for managing colonies is to ensure production of honey. Beekeeping is an important source of income especially for communities living close to forests and woodlands. In Tanzania beekeeping plays a major role in social economic development. Bees kept in Tanzania are stinging and none stinging, honeybees products obtained from beekeeping are honey, beeswax, propolis, pollen, royal jelly and bee-venom.

Approach

Beekeeping involves construction of beehives and site around or in forests. Forests areas with no direct agricultural activities contribute on production of organic nectar for honey production. The presence of both stinging and non-stinging honeybees coupled with existence of indigenous knowledge in beekeeping is also a great potential.

Benefits

i) Honey used as source of food and medicine;

ii) helps in biodiversity by increasing agricultural production through pollination;

iii) increases income; and

iv) Provide employment.

Area of applicability

Beekeeping can be practiced all over the country, however Major areas of honey production in Tanzania are; Tabora, Iringa, Singida, Lindi, Shinyanga, Kagera, Kilimanjaro and Dodoma. The country has about 38,800,000 hectares of forest and woodlands ideally for beekeeping, agriculture areas can also be used as an apiary.

Beekeeping site (apiary) and the bee products

9.3.3 Ecotourism

The International Ecotourism Society, TIES, defines ecotourism as "responsible travel to natural areas that conserves the environment and improves the well-being of local people. These involving visiting fragile pristine and relatively undisturbed natural areas intended as a low impact and often small scale alternative to standard commercial tourism. Ecotourism is intended to offer tourists insights into the impact of human beings on the environment and to foster a greater appreciation of natural habitats.

Approach

Ecotourism typically involves travel to destinations where flora, fauna and cultural heritage are primary attractions.

For practices to be called ecotourism, the seven characteristics must be addressed.

i) Involves travel to natural destinations;

ii) Minimizes impact;

iii) Builds environmental awareness;

iv) Provides financial benefits and empowerment for local people;

v) Provides direct fanatical benefits for conservation;

vi) Respect local culture; and

vii) Support human rights and democratic movement.

Benefits of Ecotourism

i) provide employment to local people by investors in lodges, camp sites, and tour companies, tour guiding hostels and tent camps;

ii) brings a better standard of living through improved facilities, such as clinics, drinkable water sources, new roads and electricity;

iii) increase income generation for local communities who are involved in tourism activities;

iv) ecotourism not only educates visitors about environmental responsibility, it can also help raise awareness about political and social issues in developing countries;

v) home stays and eco-lodges allow visitors to experience local lifestyles and customs first-hand, and this interest helps to preserve the region's heritage;

vi) helps to create a better appreciation of the world's natural resources, such as landscapes, wildlife and coral reefs; and

vii) Local communities take advantage of the Ecotourism to open up cultural oriented entrepreneur activities.

Area of applicability

Ecotourism is applicable to all forest reserves and nature reserves.

Areas of forest reserve where ecotourism can be done

9.3.4 Pottery

Is an art of making clay object such as ports, plates, bowel, flower case and other domestic things. Pottery also refers to the art or craft of a potter or the manufacture of pottery.

Approach

Pottery is made by forming a clay body into objects of a required shape and heating them to high temperatures to remove all the water from the clay, which induces reactions that lead to permanent changes including increasing their strength and hardening and setting their shape. A clay body can be decorated before or after firing. Normally pottery is done in the village by professional elderly women. At least every region the knowledge is applied.

Benefits

i) create employment especially for women in villages;

ii) Increase income to the community involved in pottery;

iii) contributing to the improvement of community livelihoods; and

iv) pottery has multiple uses, can be used for cooking, serving food, vessels for flowers etc.

Area of Applicability

Pottery can be practiced all over the country.

9.3.5 Mat weaving

Mats weaving are widely used all over the country especially along the coastal of Tanzania for sleeping, sitting, for spreading out food items to dry carpets in praying places. Mat weaving are encouraged

as an alternative livelihood activity to divert away from using natural resources hence conserving environmental.

Approach

Mats are made of palm leaves, bamboo leaves and different types of grass. The same raw materials are used to make hand woven baskets, trays and decorative objects imbedded with beautiful color pattern.

Benefits

i) provide alternative Source of income; and

ii) contributing to the improvement of the livelihoods of communities engaged in mat weaving practices.

Area of Applicability

Can be practised all over the country

Tanga women weaving mat

Mbeya woman weaving mat

9.3.6 Spice growing

A spice is a dried seed, fruit, root, bark, or vegetable substance primarily used for flavoring, coloring or preserving food. Sometimes a spice is used to hide other flavors. Spices farming in most cases are produced organically in the sense of non-use of fertilizers and pesticides. Common spice grown in the country includes; Cloves, Ginger, Paprika, Chilli, Black Pepper, Cardamom, Vanilla, Cinnamon e.tc.

Approach

Spices are mostly intercropped with other crops including banana, citrus, and a variety of tree crop (pawpaw, coconut, mango, etc.). Under situations of intensive intercropping, it becomes more relevant to ascertain individual farmers' scale of production through counting the number of spice trees/bushes/plants or vines owned, rather than farm acreage being cultivated. This is especially relevant for spices like black pepper and vanilla. For others like chilli and turmeric, plot sizes are more relevant, notwithstanding the prevailing intercrop systems. Intercropping is a coping strategy that aims at mitigating the risk of loss in relation to any specific crop, through spreading it over a number of different crops. It is also a direct response to pressure on arable land.

Benefits

i) Spices have a greater potential in contributing to poverty reduction through job creation, as the production techniques employed are labor intensive, more unemployed groups who are mainly youths and women will have greater opportunity of being employed;

ii) Unlike traditional crops spices do not require massive land as repeated harvests during the year to ensure maximum use of land are possible;

iii) Tanzania has abundant places with excellent weather conditions for the sector which guarantees benefits to more rural people; and

iv) Spices, apart from having export potential they do well on the local market as well.

Area of Applicability

Spice farming can be practiced all over the country

CHAPTER TEN

PLANNING PROCESS FOR IMPLEMENTATION OF SLM BEST PRACTICES

10.1 Introduction

The key element in participatory planning for implementation of SLM Best Practices (BP) is the full involvement of the community in the whole exercise of SLM BP planning. In this case the community members participate right from the identification of the problem(s) of their relevance in their particular locality and design ways and means of addressing the problem. The community SLM BP planning should be community-driven in order to ensure ownership by the community.

10.2 Steps in Community SLM BP Planning

The community SLM BP planning process consists of a number of key steps that every community should go through to prepare for dealing with SLM BP. Important features of the approach are recognizing the wide range of stakeholders and their diverse interests in natural resource management and; engaging them fully, where community members are involved from the identification of the problems related to SLM BP, design and implementation of SLM BP.

Step 1: Organize community planning meeting

As a first step, it is important to organize a community meeting to discuss and share issues on SLM BP. The purpose of the meeting would be to develop an effective community SLM BP plan in a participatory manner. It is important that the meeting include a wider spectrum of stakeholders, interested parties and experts to ensure that the action plan to be developed accommodates concerns of the communities. The agreed action plan should be shared and recognized among the community members and other interested stakeholders.

Step 2: Problem identification

After a general discussion on SLM BP, it is important to focus on the challenges related to environmental, farming and natural resource use of the respective community.

Through participatory approach, members of the community should brainstorm and list issues of concern or problems related to DLDD that they think are impacting the local communities and need to be addressed. Wherever possible, a set of criteria may be developed to assist in prioritizing the most pressing problems. A group consensus can also be used to arrive at an agreed priority problems facing the community.

Step 3: Identify the causes of the problem

A clear understanding of a problem is essential when trying to determine what effective actions to take to resolve it. However, gaining that clear understanding can be difficult. Root cause analysis is a useful tool that will enable the community to identify the many parts of a problem, the dominant causes and the most effective areas for action. Apart from using problem tree analysis in identifying causes of problems, community experience and wealth of accumulated knowledge can also be used in identifying causes of the problems in the locality.

Step 4: Identify appropriate SLM BP

Depending on the identified and agreed priority problems related to DLDD that have a consensus of the community, identification of appropriate SLM BP is an important step towards addressing the problems. Through participatory approach, members of the community can brainstorm and develop a list of possible SLM BPs that need to be implemented in order to address DLDD related problems in that particular Community . Then the group should discuss which BP options will be more effective.

Step 5: Identify responsible authorities

As part of planning and to ensure that follow up actions are being implemented, responsible authorities to take lead should be identified and informed. Such responsible authorities may include Village Leaders, Village Planning Committees, Extension Officers, depending on the nature of the actions to be implemented.

Step 6: Identify resources required and sources of each resources

Community members can also identify and indicate resources required to implement the identified actions. Resources may include labour force, financial resources and technical assistance. Potential sources of such resources need also to be identified.

Step 7: Identify key barriers and remedial measures

Once the identified actions have been articulated, the next step involves identifying the set of barriers that must be overcome to effect the BPs. In this case, a comprehensive mapping is required to identify all critical barriers that need to be removed to implement effectively the identified actions or measures. Such barriers may include Weak institutional capacity, Shortage of staff with relevant skills, financial constraints Limited awareness and Cultural beliefs.

Step 8: Develop indicators

Where relevant or applicable, members of the community may develop indicators to assist them in tracking progress in the implementation of the identified actions or measures such as Crop yield; Number of charco dams constructed or rehabilitated; Number of livestock herds; Incidences of diseases (crops and livestock); Community income; Area under irrigation/cultivation and Water availability.

Step 9: Develop Action Plan

This activity helps to arrange systematically the results of the previous steps (step 2-7). Central to this activity is the compilation of a table sometimes called a “log frame” that identifies what we are trying to achieve, how, who is responsible, by when we want to achieve a specific objective or action, and what type of resources are required.

Step 10: Implementation

This step entails implementation of the concrete SLM BP on the ground. Implementation should follow the agreed action plan where the roles and responsibilities of the involved partners are clearly defined in order to facilitate smooth implementation of the actions.

Step 11: Monitoring and Evaluation (M&E)

Monitoring and evaluation is an important step in tracking progress made in the course of implementation of the action(s). It provides the community or individuals with the opportunity to assess, evaluate and propose remedial measures to improve implementation in order to achieve the intended goal(s). The M&E process is important because among other things, it provides consolidated source of information showcasing progress made in the implementation; it allows actors to learn from each other's experiences, building on expertise and knowledge; it reveals mistakes and offers paths for learning and improvements and it provides a more robust basis for raising funds and influencing policy.

CHAPTER ELEVEN

CONCLUSION AND RECOMMENDATIONS

The above technologies and practices commonly found in the area of mountains, high slopes and scarcity of water. However, this list is not exhaustive and many other technologies are existing. These interventions are locally adaptable and do not involve developing expensive engineering infrastructure. The techniques presented here can be merged into following categories and are summarized as follows:

a) The range of techniques, which require some level of slope reduction, and mostly involve terracing. They reduce surface runoff flows, soil erosion and water losses, and thus achieve soil & water conservation by increasing infiltration and soil water storage. The actual technologies could be contour bunds, fanya juu terraces, grass strips, stone lines, bench terracing etc.

b) Runoff harvesting from micro-catchments and storage within the soil profile. This comprises a range of within-field water harvesting techniques in which the land is treated into small runoff producing and run-on areas where the soil can hold moisture relatively well.

c) Another intervention involves runoff diversion from larger external catchments such as roads, open fields into micro-basins for crops, ditches or fields (with storage in soil profile) including paddy production where the profile can hold water relatively well.

d) Runoff harvesting and storage in small ponds and tanks, for use in supplemental irrigation to drought proof dry spells. The water may also be used for livestock watering, Spate irrigation, practiced in dry areas having high flush floods. The runoff water is diverted through canals for irrigation of low-lying lands, sometimes far away from the source of runoff.

e) Conservation tillage has also been gaining attractiveness as a method of reducing labour and improving soil moisture conservation.

f) Diversion of stream-flows of water and utilization in gravity to fed smallholder irrigated fields.

g) The use of low-head and small-powered petrol and electric pumps, to lift water from rivers, small ponds and shallow water tables for irrigation.

h) Lastly the soil fertility applications, manures and mulches have been applied in nearly all over the country. This method can accompany any of the technique which has been mentioned above.

GLOSSARY

a) Sustainable Land Management

Sustainable Land Management (SLM) is defined as "the adoption of land use systems that, through appropriate management practices, enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources" (TerrAfrica, 2005). The focus is on intensifying productive capacity while maintaining the protective functions of healthy ecosystems – ecosystem services realized from the sustainable utilization of locally available ecosystem resources (climate, soils, water, vegetation, wildlife, etc.) (FAO, 2007). SLM seeks to increase production including in traditional systems to combat and increase resilience to food insecurity, land degradation, loss of biodiversity, drought and climate change.

b) Best practices for Sustainable Land Management

Best practices are those SLM practices that should increase production and be profitable, be cost efficient with short payback (economic viability), easy to learn, accepted, effectively adopted and taken up (socially and culturally accepted), environmentally friendly (contributing to the improvement of soils, water, and flora and fauna (biodiversity) and represent all stakeholders including socially marginalized groups (TerrAfrica, 2005).

c) Scaling-up of Best Practices

Under SLM BP "Scaling-up leads to increased and everlasting quality benefits to more people over a wider geographic area quickly, and equitably". Scaling-up of best practices for SLM in Tanzania are of importance in order to improve livelihoods and ecosystem health at local and regional levels. Scaling up of SLM is likely to address several issues such as poverty reduction, food security, biodiversity conservation and climate change mitigation and adaptation.

d) Practices with combined Benefits

SLM interventions need to have combined benefits that must help to prevent, mitigate and reduce land degradation at the local, national and global level. SLM practices such as conservation agriculture, with

reduced labour (and financial) inputs, may have a higher chance of being adopted than SLM practices requiring high labour (or financial) input. Implementation of new SLM efforts should build on existing knowledge from within a location itself or, alternatively, from similar conditions and environments elsewhere.. The main efforts concern water scarcity, soil fertility / organic matter and biodiversity. SLM practices that offer to help adapt to climate change. They include practices that increase the amount of rainfall which infiltrates the soil as well as the soil's capacity to store water, helping protect the soil from extremes of temperature and increased intensity of rainfall. Thus SLM practices for Tanzania need to have a high tolerance to increased temperature, climate variability, and extreme events.