SPIS-4-FNS

Overview of Rainwater Harvesting Technologies, Practices and Innovations for Smallholder Farming in Kenya

Presentation at the Training Of Trainers (ToT) Workshop

Presentation by: **Prof. Eng. Bancy Mati**

Held in Nanyuki

Dates: **26th June 2026**

WHAT THE SMALL-SCALE FARMER NEEDS

Enable

Food and nutrition security

The Enablers

Building partnerships for WEFE & NbS

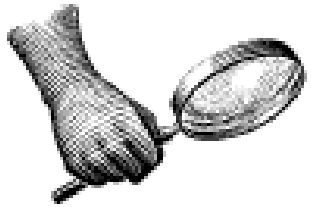
Smart Financing for Agric with co-investment by private entities

Improve access to credit

Water productivity (income per drop) increase for production and value chains that support FLI

DEFINITIONS OF RESEARCH, SCIENCE, TECHNOLOGY & INNOVATION

What is Research

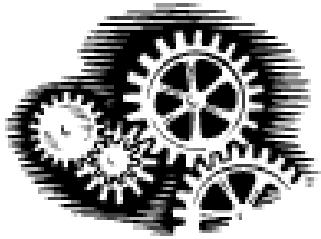


- **Research** is the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings.
- **Research** is about the gathering of data, information and facts for the advancement of knowledge
- **Applied research** is original investigation undertaken to acquire new knowledge but directed towards a specific, practical aim or objective (including a client-driven purpose).

What is Science

- **Science** is a systematic and logical approach to discovering how things work. It is derived from the Latin word “scientia,” which translates to knowledge.
- **Science** is the organized body of knowledge that is derived from such observations and that can be verified or tested by further investigation**.**
- Unlike the arts, **science** aims for measurable results through testing and analysis.
- **Science** is based on fact, not opinion or preferences.

What is Technology?



- Technology is the use of scientific knowledge for improving the way to do things. One would use scientific knowledge to invent machines or devices to make things easier to do

- **Technology** includes the use of materials, tools, techniques, and sources of power to make life easier or more pleasant and work more productive. Whereas science is concerned with how and why things happen, technology focuses on making things happen."

What is Innovation?

Innovation – The fresh/original or radical thinking/idea, or new ways of doing things, creating gadgets or business processes, that adds value, creates wealth or improve social welfare.

- Innovation deviates from “Business as Usual”
- Innovation "*brings ideas to life, through action*
- It improves efficiency, productivity, quality, competitive positioning and market share ,performance and growth .

Creativity is about coming up with ideas… but it requires Action to become Innovation.

- Innovation does not occur in the mainstream but in the interaction of actors in the innovation system.
- Innovation is not learnt in class or college, it is about turning ideas/dreams into substance!

THE CHALLENGES

THESE ARE OUR OPPORTUNITIES

Climate and Water Challenges facing Dryland zones

Floods occur in both urban and rural areas

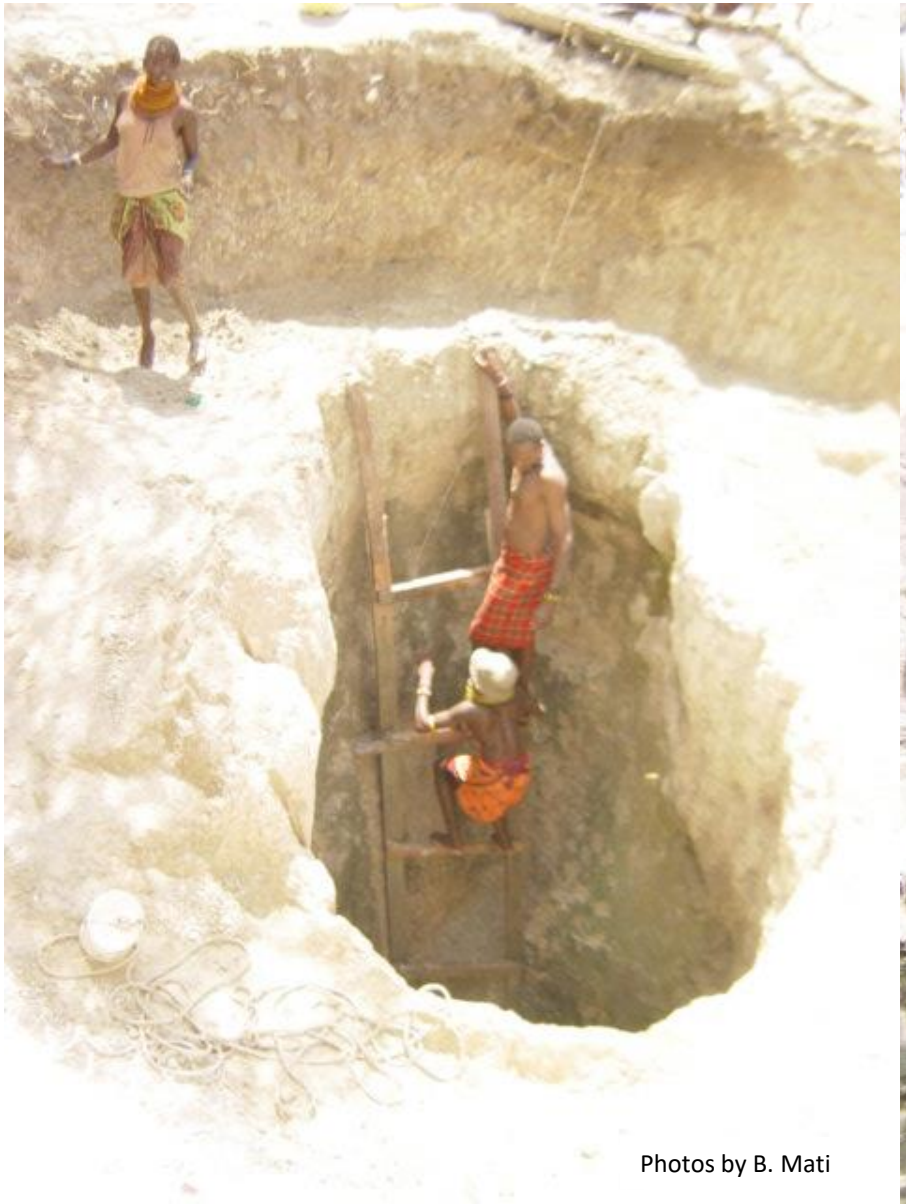
Bundalangi floods– buildings submerged

Flush floods in Narok town

- Flooding occurs in the same areas prone to droughts
- Flood occurrence is **expected yet** nothing is done as mitigation.
- Loss of life and property each year
- Flood management with innovative engineering infrastructure & catchment protection
- Flood is storm water – A resource!

Flooding in Isiolo

Improving water extraction technologies – is this adequate?



Photos by B. Mati

Conventional Water Lifting Technologies – Room for Improvement

Conventional pumps include:

- Manual buckets for water lifting
- Rope & washer pumps (manual)
- Hand pumps e.g. Indian Mark-II
- Treadle pumps (manual) for irrigation
- Motorized petrol or diesel pumps
- Diesel or petrol submergible pumps
- Electric pumps powered from grid

ati

Water supply infrastructure – improved but not still...

Photos by Bancy Mati

Infrastructure failures are scattered throughout

Examples

- Breach of embankments
- Dams/pans silt too soon
- Pollution of water storages
- Dry boreholes
- Abandoned pumps and gensets
- Water deficits/inadequate design

Wasteful water application methods

Flood irrigation

Hosing wastes water

Basin irrigation

Over-irrigation

Photos by B. Mati

RAINWATER HARVESTING, CONSERVATION, STORAGE AND SUSTAINABLE UTILIZATION

Domestic water supplies, rural solutions

Develop waster supplies in stand pipe or water kiosk

Roof water harvesting – a viable business line

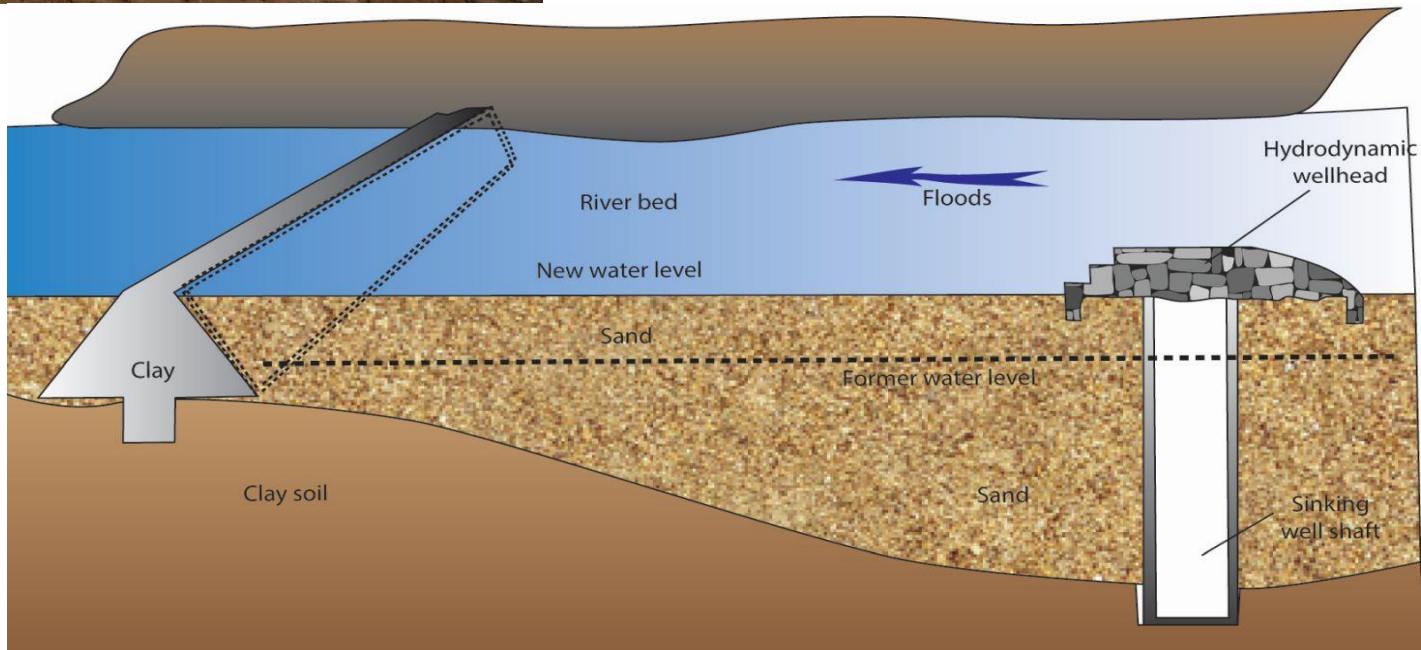
Farm ponds water harvesting- Jobs & business lines

- The country is currently experiencing a boom in water harvesting projects
- Job & business opportunities

Water pans and farm ponds are in big demand

Water pans, weirs and sand dams

Water pans, weirs and sand dams can be constructed by youth



Soil and water conservation structures – Conserving every drop where it falls

Bench terraces

Artificial waterways

Stone bunding solutions

Cutoff drain to protect land from erosion

Water Harvesting with storage in tanks, cisterns, ponds

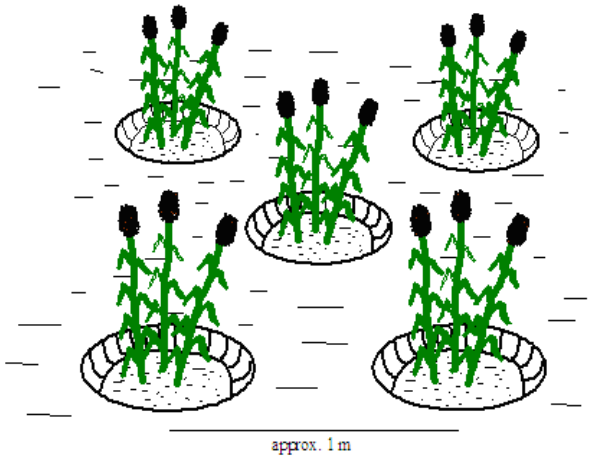
Household water harvesting with surface tank

Runoff harvesting with plastic-lined pan

A lined underground tank with silt trap & net covering

Unlined pond for road-runoff harvesting

Pitting Methods of Runoff Farming – The (real) Zai Pit



The "real" Zai pit is really small, *measuring about:*

- Diameter: 20-30 cm in
- Depth: 10-20 cm deep
- Spacing: 60-80 cm apart
- Manure is added (handful)
- About 4 seeds of grain planted

Zai is used to grow cereal grains (maize, sorghum millet)

It is used for two crop seasons

http://farmingafrica.net/2014/09/zai-system-overcomes-desertifacation/?lang=en

Simple Pitting: Auger-hole cultivation (Spot tillage) for annual crops

- Smaller pits may be dug for just one or two crop seeds, usually maize
- The small pits, areabout 15-30 cm deep,
- The land between pits may not be tilled and the holes are dug over the old crop residues
- This saves labour (conservation tillage)
- Auger-hole cultivation can also be mechanized

Spot tillage is a form of pitting

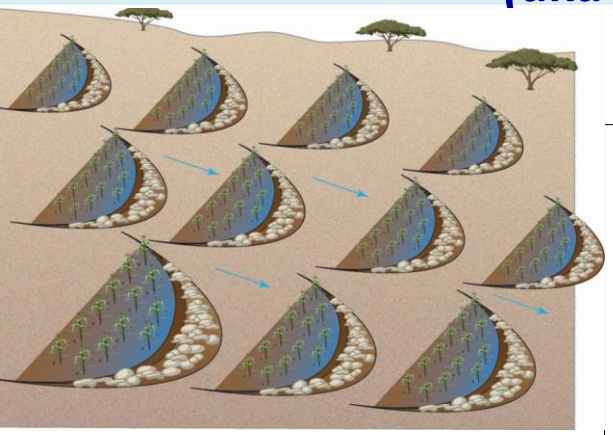
(Source: CFU Zambia, 2007)

Rectangular micro-basins dug with hoe

Photo by B. Mati

Runoff Farming using micro-basins (semi-circular bunds) for crops

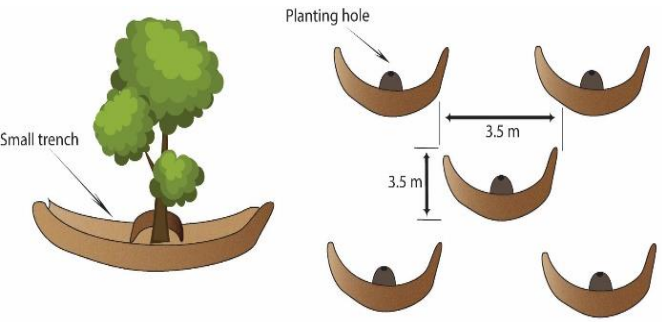
(aka Demi-lunes, half moon, half-circle)



Semi-circular bunds for annual crops are wide, *measuring about:*

- Diameter: 4 – 20 m
- Depth: 10-20 cm deep
- Manure is added (wheelbarrow)
- Can achieve 200 semi-circular bunds/ha
- A number of rows grain planted
- Used for cereals (sorghum millet or maize)
- Require 200-750 mm rainfall
- Slope steepness less than 2%

Micro-basins for trees (semi-circular bunds and V-basins)



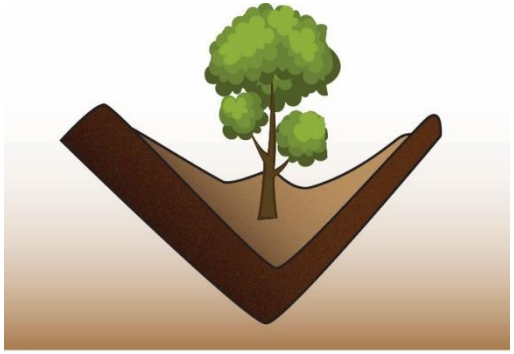
Semi-circular bunds for trees in semi-arid zone

Semi Circular bunds for trees are narrower-measuring:

- Diameter: 3 m to 6 m facing upslope.
- Bund height is about 0.25 m high.
- The tips of each bund are set on the contour,
- The excavated planting pits is filled with a mixture of organic manure and topsoil
- Runoff water collects in an infiltration pit where the tree is planted.

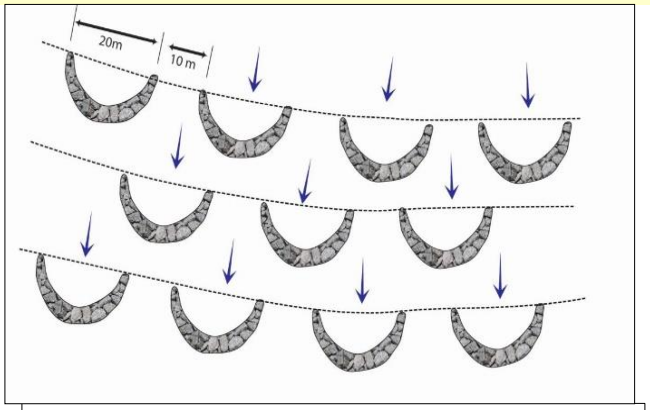
V-Basin

- V-shape basins on contour but larger
- Length (distance between the tips of each bund) is about 10 m
- Can hold up to 2.5 cu.m of water
- Suited to arid zones with deep soils



V-basin for trees used in arid zones

Semi-circular Bunds for Rangeland rehabilitation



Sketch of semi-circular bunds for rangeland rehabilitation

Eye-brow bunds for pasture reseeding in Marsabbit *(photo: B. Mati)*

Semi-circular bunds for rangelands are large, *measuring:*

- Diameter: 5 – 20 m
- Depth: 30 - 50 cm deep
- Rainfall: about 200 - 750 mm
- Slope gradient – Less than 2%
- Grass may establish naturally or may be re-seeded

There are two variants:

a) **Eye-brow** (Crescent-shaped) bund in which a narrow channel is made which collects the water

b) **Demi-lune** (half-moon) bund which has a basin for runoff to collect – can pond more water

Semi-circular bunds for rangeland rehabilitation (Demi-lune)

Photo credits: https://justdiggit.org/project/kenya-kuku/

Sunken Beds (Micro-basins) for Water Conservation

Sunken bed with vegetable crop

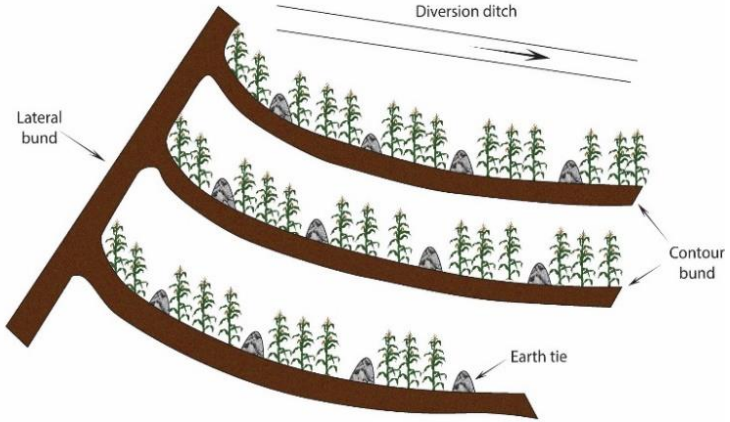
Sunken beds

- Are water-retaining pits designed to trap runoff and allow it to seep into the soil.
- Also used as micro-basins for surface irrigation.
- Size: 2 m square and 1 m deep.
- Pits are dug into the ground where runoff occurs.
- The soil from the pits is used to make banks around the pits.
- The pits are enriched with manure and used for vegetables or field crops

Sunken bed with maize crop *(Photo: B. Mati*)

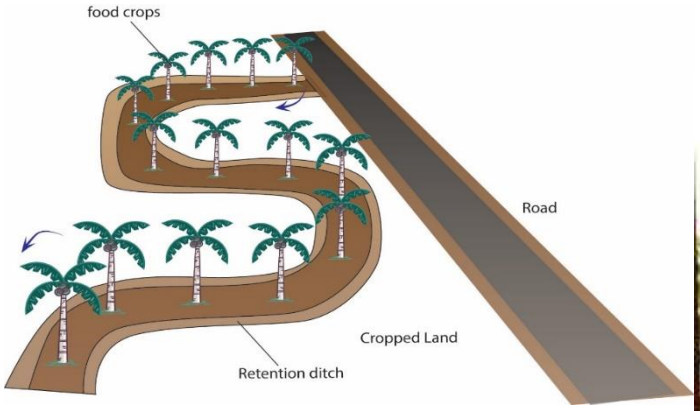
Sunken bed with amaranthus *(photo: Kilifi County WFP –AC project)*

Bunding: Contour Furrows (Tied Ridges) for Field Crops

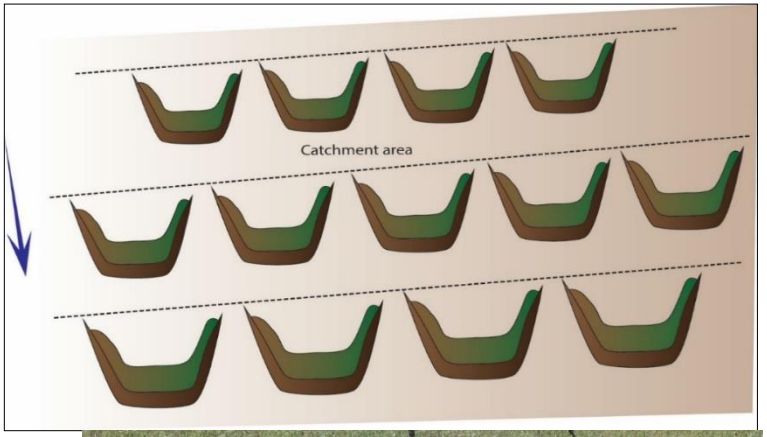


- Contour furrows (tied ridges or micro-watersheds)
- Are small, ridge-and-furrow earthen bunds made along the contour.
- They are an within field system
- Height of bund: 15 - 40 cm
- Inter-row spacing: about 2 to 4 m apart, depending on slope, soil type, crop
- Small earthen ties are made within the furrow spaced about 4.0 to 5.0 m to prevent lateral flow.
- Suitable for semi-arid areas with deep clayey soils

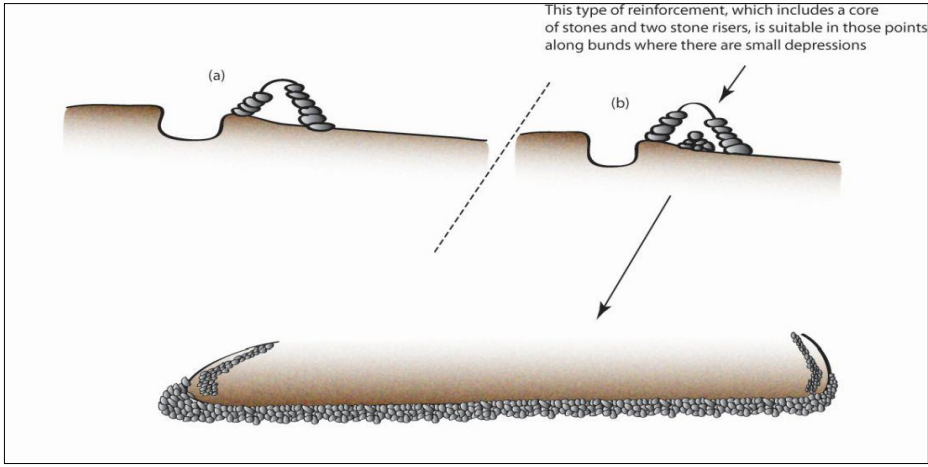
Road Runoff Harvesting with Ditch System ot bench terrace



Stone Bunding: Water Harvesting Systems for Crops and Pastures

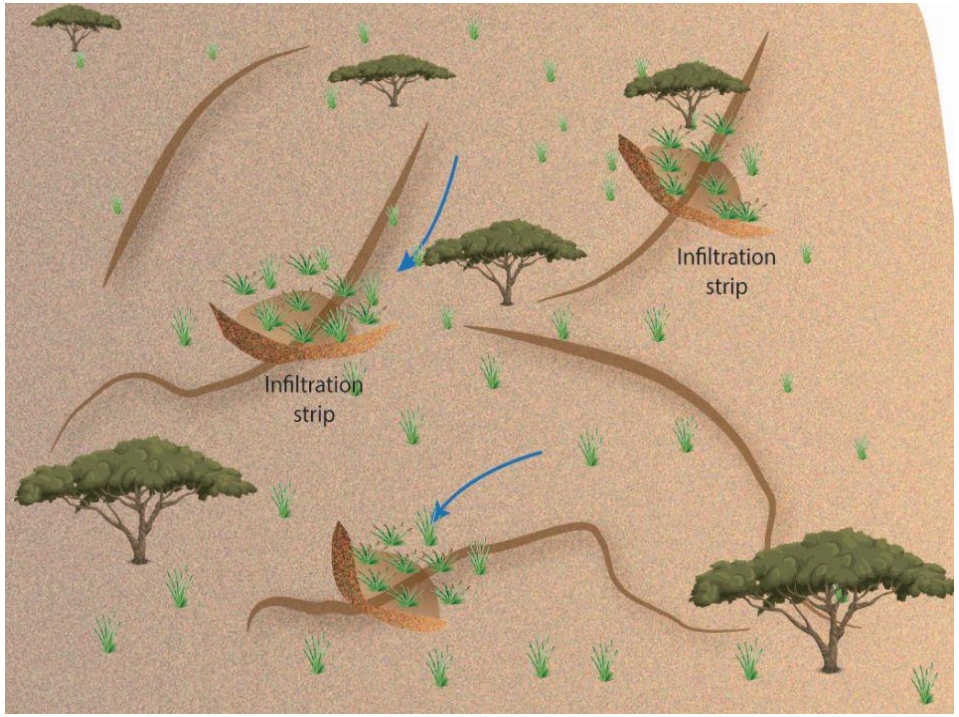


Trapezoidal bunds

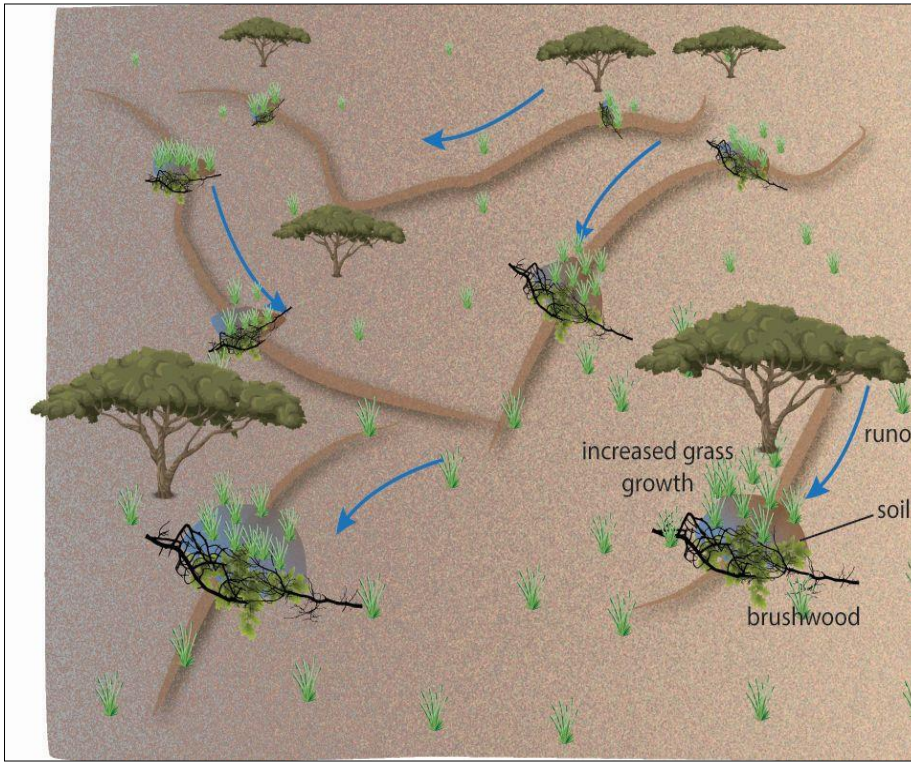


Stone bunding (Caaag system)

Conserving Water and Soil Using Infiltration Strips in Rangelands

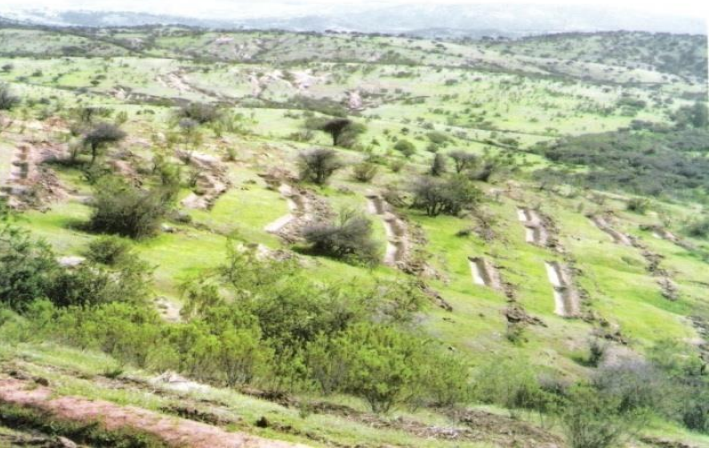


Excavated Infiltration strips in rangelands



Infiltration strips with brushwood

Retention ditches for retarding runoff velocity and water harvesting



Retention ditch *(infiltration ditches or lock-and spill ditch)*

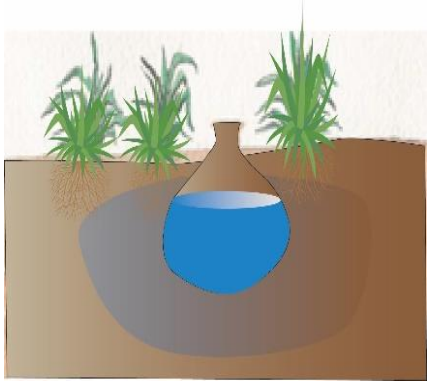
- Are large ditches to catch and retain incoming runoff for infiltration into the soil.
- The ditch has cross-ties to retain water in large micro-basins within the channel
- Constructed on relatively flat areas with closed ends and wide and deep enough to hold all the runoff expected.
- Utilize an external catchment
- Can hold large volumes of runoff
- The Retention Ditch may be **on the contour (see left)** or **graded (at right)**

Micro-Irrigation using Pitcher Pot

Pitcher (buried porous clay pot)

- Is an adaptation of a traditional drip

- A porous clay pot is buried adjacent a tree crop.
- Water is put in the pot, it seeps out slowly due to the pressure created by the plant roots.
- A pitcher pot holding 10 litres of water can support a fruit tree for about a month.
- The water in the pot is kept at a depth of 20-30 cm.
- The pot is filled with water and covered with a clay slab to reduce evaporation losses.
- Water seeps slowly through the porous sides of the pot as the plant roots suck the water from the pots.
- The method encourages deeper rooting and reduced evaporation.
- The method is commonly used for fruit-trees.



Drip Irrigation

Perforated pipe dripper tied with nylon paper

Perforated pipe dripper with knotted thread

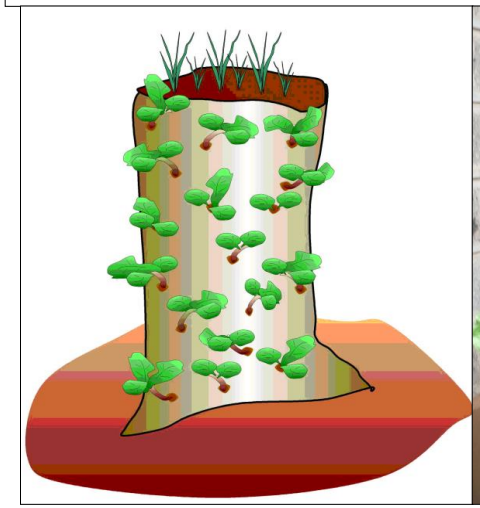
Home-made drippers

Kitchen Gardens and Household Wastewater Re-use

Sunken beds (micro-basins) for vegetables

- **Sunken beds** (micro-basins) are used in Kitchen gardens
- They are designed for retention of irrigation water
- Should be fenced to prevent crop damage by chicken & livestock

Tower Gardens/Bag gardens (Vertical garden)



Vertical gardens come in many shapes and sizes

- A typical garden is utilizes a recycled jute bag
- Holes are punched on the bag, at spacings 0.25 m-0.30 m, starting about 0.15 m from the bottom.
- The bag is filled with soil that contains about 20 percent well decomposed manure.
- A watering shaft is created at the centre of


Declining water availability/ increasing demand
Inefficient technologies and practices
Policy advocacy and institutional support
Markets, food and farmer preferences
Bridging indigenous knowledge with new technologies
Capacity of farmers to adopt new knowledge
Scientific data is downscaled to local contexts
Marginalized communities, youth & women
Climate change, floods and droughts
rd for upscal ing

THANK YOU

bancym@gmail.com