RAINWATER HARVESTING FOR CROPS

What is this Action Sheet about?

In semi-arid lands – lands which receive only 300-700mm of rain each year – rainwater harvesting can help supply enough water to improve crop yields. In these dry climates, as many as four out of five seasons end up as either total crop failures or the harvest are too low to break-even. However, it is possible to double or triple crop yields through rainwater harvesting, using natural rainfall.

This Action Sheet describes three ways of harvesting rainwater for use in farming: road runoff harvesting, negarims and planting pits. More rainwater harvesting techniques are described in Action Sheet 13-15. If rainwater is to be used for drinking, collecting surfaces must be clean, and the water should at least be passed through a sand filter before consumption (See Action Sheet 23-24).

Where is water harvesting most effective?

SLOPE: Water harvesting is not recommended for areas where slopes are greater than 5% due to uneven distribution of run-off and large quantities of earthwork required which will not be economical.

SOILS: For water harvesting to be effective, the soils need to be suitable for irrigation: they should be deep, not saline or sodic, and ideally be naturally fertile. Water harvesting will not work on soils with a sandy texture, because the infiltration rate will be too high. If the water soaks in as fast as it falls from the sky, no runoff will occur.

COSTS: It is important to work out the financial and labour costs before starting out, by assessing the quantities of earth/stonework involved in construction. The main cost will be for labour to build channels. You can do it yourself or engage local casual labour. The tools needed are: mattock, shovel, machete, and plain/forked jembe.

ROAD RUNOFF HARVESTING

Image: SearNet

What is road runoff harvesting?

Road runoff harvesting 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. For example, it can deliver water to banana trees, pawpaw, mangoes, citrus fruits, maize and beans, increasing yields and farm income.

How do you harvest road runoff?

Road runoff can be harvested with retention ditches or retention basins:

1. Road Runoff Harvesting with retention ditches

- Build a retention ditch/channel next to the road about 50cm wide and 50cm deep.
- Soil is thrown uphill as in *fanya juu* or downhill as in fanya chini (Kenyan contour barriers).
- For a short ditch the channel/canal is level. For a long ditch the channel/canal has a small gradient to allow flow. To reduce erosion of the channel, make steps (drop structures) of about 5cm in height spaced at about 5m intervals. For stability, make the channel walls slope outwards, so they are trapezoid not square in cross-section. Do not dig too deep, as the planting pits must not hit the bedrock.
- Ditches are also made in a zigzag manner in the farm below the road. Build cross ties (barriers across the ditches) to encourage ponding of the water.
- Bananas can be grown in pits built off the main channel/canal. This allows ponding of water in the planting pit as well as flow in the channel. Fruit trees as pawpaws, mangoes, citrus, guava can be grown along the ditch embankment, while crops as maize/beans are grown on the land between the ditches. Planting pits as for bananas be located off the main canal/channel

2. Road Runoff Harvesting (RRH) with retention basins

- Dig square/rectangular basins, measuring about 5mx5m, with small earth bunds (walls) of about 25cm high
- Road runoff water is directed/distributed into the basins by channels leading from the road. To reduce erosion of the channel, make steps (drop structures) of about 5cm in height spaced at about 5m intervals. For stability, make the channel walls slope outwards, so they are trapezoid not square in cross-section. Do not dig too deep, as the planting pits must not hit the bedrock
- Basins need to have spillways (sloping exit channels) on the lower side to allow flow to the next basin or discharge to grassland. This is important to prevent waterlogging of the crop/tree planted in the basin or next to the channel
- Where channels are dug deep into the infertile subsoil, fruit tree pits need a lot of manure to be mixed with the topsoil

How big should the channels be?

The channels width varies depending on the land, but is usually between 1 - 1.5m deep, 1 - 2m wide. The length depends on the size of the farm. Horizontal spacing of the channels also varies depending on the land. 2-18m between channels is common.

Does the system need much maintenance?

- Sediment must be removed from channels to maintain capacity
- Broken sections of the channel and embankment must be repaired
- Fruit trees or grasses will need to be replanted along the embankment to maintain stability
- Basin embankments and spillways need to be repaired and maintained

What are the benefits?

Farmers/land users in places such as Mwingi, Machakos and Kitui in Kenya have more than doubled their banana/pawpaw production and doubled their maize/beans yields. Fodder production has increased and soil loss reduced. The results have been improved food security and farm income resulting from improved yields/production.

NEGARIMS – MICRO-CATCHMENTS FOR FRUIT TREE PRODUCTION

Image: SearNet

What are negarims?

Negarim are diamond shaped micro-catchments enclosed by small earth bunds (walls), with an infiltration pit at the lowest corner. They are one way to harvest rainwater runoff and deliver it to fruit-trees such as citrus, pawpaw, and mangoes.

What do you need for effective negarims?

Soils of about 2m deep are needed to allow the storage of runoff rainwater. The slope of the land must be between 1 and 5%, and the average annual rainfall should be between 300-700mm.

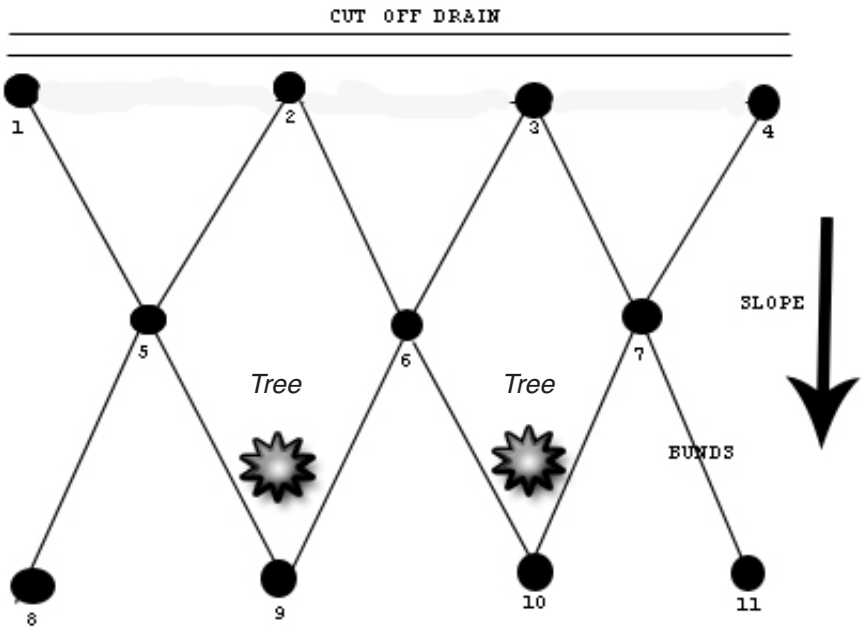
How do you layout and construct a negarim?

Tools needed: A-line level (See Action Sheet 42: Saving soil and water on sloping land) and cotton string; Measuring tape, Pegs, Simple hand tools: jembe, shovel, panga, mallet/hammer.

First, clear the vegetation from the site. Then protect the field from runoff with a cut-off drain or retention ditch (CoD/RD), at the higher end of the field. A cut-off drain or retention ditch dug along the top side of the field will prevent water from reaching the land below, and so stop water-logging in the negarim.

Layout and construction procedure:

- Step 1: Mark a contour line below the CoD/RD and smooth it out to a straight line
- Step 2: Mark the planned bund ends with pegs (peg No. 1,2, 3,4) along the contour by spacing at predetermined intervals (most commonly 4-10m) to form row 1
- Step 3: Using a string twice the length of one side of the negarim, mark the centre of the string. Hold the sting tips at the pegs (peg No. 1 and 2) and pull the mid point tight down slope (peg No. 5). This marks the lower corner of the negarim and the beginning of the next row (row 2) of negarims
- Step 4: Complete the row as in step 3 to the required length (peg No. 6 and 7)
- Step 5: Repeat step 3 and 4 to mark row 3 (peg No. 8,9,10,11) and other rows as required
- Step 6: Make trapezoid bunds of at least 25cm high and 25cm top width and bottom width of about 75cm
- Step 7: Mark a planting hole about 50cm from the bund on the lowest corner
- Step 8: Dig planting hole of size 60 x 60 x 60cm and apply manure
- Step 9: Plant fruit trees during the rains



Negarim layout

What are the benefits of planting in negarims?

Negarims improve fruit tree establishment by 60% leading to increased yields and improved farm income. They works in areas with very low rainfall (300mm).

How do you maintain negarims?

- Repair broken embankments and keep the bund height at the recommended 25cm by topping up with soil
- Keep catchment area clear of vegetation
- Keep fruit trees well manured
- Desilt the CoD/RD regularly and repair embankments

PLANTING PITS

Image: SearNet

What are planting pits?

Planting pits are also known as zai (or zay) pits or 5 x 9 pits depending on shape and size. The method involves growing field crops in holes of various sizes. The zai system has been practiced for many years in the Sahelian region of West Africa. In Kenya, planting pits are not commonly used, although trials by researchers and farmers have produced good results, showing that the system has great potential for improving crop production in dry areas. Planting pits increase crop yields by a combination of moisture conservation and harvesting of runoff from the spaces between the pits. In addition, soil fertility is restored since the manure and fertilizer cannot be lost through surface runoff.

Where are planting pits likely to improve yields?

Planting pits are recommended for relatively low rainfall areas, or where moisture conservation is desired, to enable a crop survive drought and increase production.

How do you make planting pits?

A: LAYOUT OF THE PITS

- Select a part of the farm that is not too steep and neither on very flat ground. If land is on a slope, terraces should first be made. It is important that the pits are dug at alternate positions behind each other to allow enough catchment area for sufficient runoff to be generated
- Starting at one end of the field, use a tape measure or a marked string, to fix pegs 150cm apart on the first row
- Measure a row spacing of 75cm downhill
- On the 2nd row, place the first peg 75cm from the line of the first peg.
- Continue to place pegs 150cm apart as with row 1, so that all the pegs in row-2 are at alternate positions behind row-1
- Continue measuring and pegging in this way until you have a network of pegs at alternate

positions as shown here:

Planting pits layout

B. PREPARATION OF THE PITS

At each peg position, prepare a planting pit measuring 60cm deep x 60cm diameter as follows:

- Dig a hole 60cm diameter, placing topsoil (about 20cm depth) on the uphill side
- Dig the subsoil, to a depth of 60cm and place the spoil on the downhill side
- Reshape this spoil to resemble a semi-circular bund to enable better water storage
- Mix the topsoil with one medium size bucket of well-composed manure and return to hole. Ensure that the hole is not refilled to the top so that some space remains to collect and store runoff water
- Plant 5-12 seeds of maize or sorghum or millet in at the hole. The number of seeds per hole depends on crop type, its variety and climate. If you plant seeds in pairs, remember to thin to single plants later

C. LOOKING AFTER YOUR CROP

Once the crop is growing in the planting pit, the following management practices are needed:

- Keep the field clear of weeds. Outside the pits (catchment), do not dig with a jembe, clear the weeds with a panga to leave a firm compacted catchment
- Inside the pits, you can weed normally to encourage infiltration
- Protection of the crop from pests and diseases

What are the limitations of planting pits?

The main limitation with planting pits is the heavy labour demanded in preparing the pits the first time. Also, they may not work well in soils which tend to get water logged. However, the benefits using planting pits far outweigh the limitations. Therefore, Do-It-Yourself (D-I-Y) and see!

What are the advantages of planting pits?

- Once prepared, planting pits can be re-used for up to four crop seasons or two seasons without the need to add more manure
- Increased crop yield and better crop survival in time of drought. Planting pits can make a difference between getting a harvest or nothing at all in a low rainfall season
- Weed control is easier
- Water is conserved in the pit, thus reducing soil erosion carried by runoff on other parts of the farm
- Improved soil fertility

Doesn't harvesting rainwater have impacts downstream?

Runoff harvesting will affect the amount of rainwater reaching rivers, and the more people doing it, the more effects will be seen. Less water in downstream rivers could affect water availability for household and livestock needs, and could have other impacts on human health and wildlife. In Laikipia district of Kenya, there is already conflict over runoff diversion and utilization for crop production (Kihara, 2002). In order for sustainable river basin water resource management, new policies and legislation will be needed. There is need for research to provide information to help decision and policy makers develop sustainable water management strategies as more farmers develop rainwater-harvesting techniques (Ngigi, 2002).

ACKNOWLEDGEMENTS: This Action Sheet was prepared by Nancy Gladstone, and is based on the following sources:

SEARNET Rainwater Harvesting Technologies Database

A Manual for the Design and Construction of Water Harvesting Schemes for Plant Production by Will Critchley - Conservation Agronomist Centre for Development Cooperation Services Free University, Amsterdam and Klaus Siegert - Water Resources Engineer Land and Water Development Division FAO, Rome with contributions from: C. Chapman, FAO Project Manager M. Finkel, Agricultural Engineer, Yoqneam, Israel; FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS - Rome, 1991 (www.fao.org/docrep/U3160E/u3160e07.htm)

Ngigi, S. N. 2002, What is the Limit of Up-Scaling Rainwater Harvesting in a River Basin? *3rd WaterNet/Warfsa Symposium 'Water Demand Management for Sustainable Development', Dar es Salaam, 30-31 October 2002*

Kihara, F.I. 2002. Evaluation of rainwater harvesting systems in Laikipia District, Kenya. GHARP case study report. Greater Horn of Africa Rainwater Partnership (GHARP), Kenya Rainwater Association, Nairobi, Kenya.

FOR MORE INFORMATION

CONTACTS

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WEBSITES

www.searnet.org
www.drylandfarming.co.zw