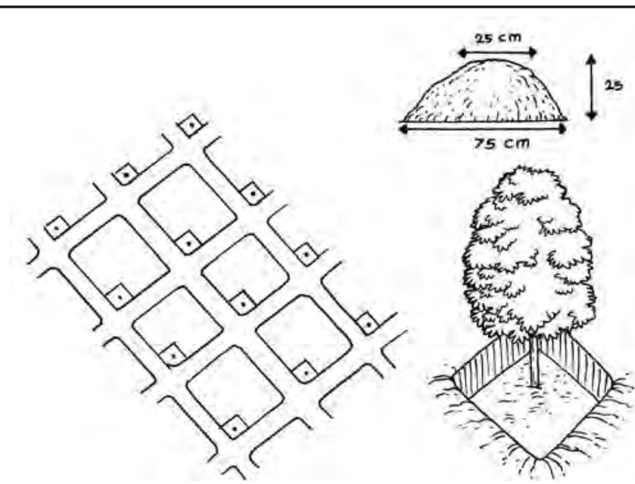
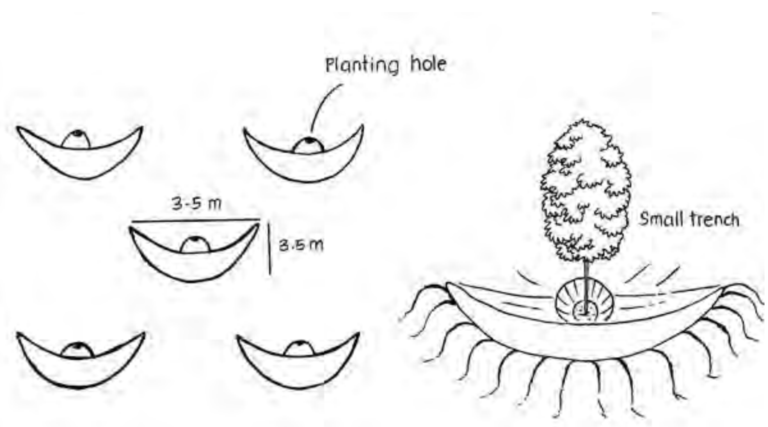
Some Interventions for Managing Water for Agriculture in Eastern and Southern Africa

The water resources of Eastern and Southern Africa (ESA) are considerable and, if managed more effectively, could make a substantial contribution to rural poverty reduction. Within the region, major opportunities to increase food security and household incomes are being missed because of inadequate management of agricultural water, especially in rainfed systems. Yet, evidence from the region shows that the technologies and approaches for agricultural water management (AWM) are known and have been practiced in the region. However, this knowledge is scattered in various places, publications, and locations around the region, even though much has been published. To bring it together, a study covering the ESA region was done to compile a compendium of technologies, practices, and approaches in AWM in the ESA region, in a one-stop-drop publication.

Interventions, description, where found, and references.

1.	**Basins** are normally small, circular, square, or diamond-shaped microcatchment systems, intended to capture and hold rainwater and/or runoff for plants (especially for growing fruit crops) and seedling establishment. Basins are constructed by making low earth ridges on all sides to keep rainfall and runoff in the mini-basin. Runoff water is then channeled to the lowest point and stored in an infiltration pit. The size of the basins may vary between 1 m and 2 m in width and up to 30 m in length for large external catchments.
2.	**Bench terraces** are made by reshaping 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 labor demand, they are usually made for high-value crops such as irrigated vegetables and coffee. The benches are normally designed with vertical intervals that may range from 1.2 m to 1.8 m.
3.	**Broad-bed and furrow** systems are a modification of contour ridges, with a deliberate effort to ensure that there is a “catchment” ahead of the furrow. It is a within-field microcatchment water-harvesting system. The catchment area is left uncultivated and clear of vegetation to maximize runoff. Crops can be planted on the sides of the furrow and on the ridges. The distance between the ridges varies between 1 m and 2 m, depending on the slope gradient, size of catchment area desired, and amount of rainfall available. The system is suitable where annual rainfall is from 350 mm to 700 mm, land is of gentle slope (about 0.5-3% steepness), and soil is fairly light.
4.	**Charco dams** are small, rectangular, excavated pans or ponds, which are constructed at well-selected sites on 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 the village level with minimum engineering requirements.
5.	**Chololo pits** are so named after the village where they were invented, in Dodoma Region of Tanzania. These 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 (to expel termites), farmyard manure, and crop residues are added, then covered with the requisite amount of soil while retaining sufficient space in the hole for runoff to pond. These preparations ensure that the water infiltrated is held by organic materials.
6.	**Contour bunds** (ridge terraces) 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. Contour bunds are used for prevention of flooding and erosion control. They are popular in the highland areas of Ethiopia, where they are usually designed with a standard 1-m vertical interval.
7.	**Contour furrows** are small, earthen ridge and furrows, which are essentially microcatchment or within-field systems for small-scale production of food crops. In design, the ridges are about 0.15 m – 0.2 m in height and spaced at approximately 1.5 m apart on the contour. The furrow, which is upslope, accommodates runoff from the uncultivated microcatchment strip between the ridges. Small earthen ties were made within the furrow at a spacing of 4–5 m to prevent lateral flow. The objective of the system is to concentrate local runoff and store it in the soil profile, close to the plant roots. A cereal intercropped with pulse is usually recommended (Critchley *et al.*, 1992; Mati, 2005).
8.	**Contour stone bunds** are buffer strips created by arranging stones 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. Stone bunds are commonly placed in areas receiving 200–750 mm of annual rainfall and are usually spaced about 15–30 m apart, with narrower spacing on steep slopes. They can be reinforced with earth or crop residues to make them more stable.
9.	**Cutoff drains** (also known as diversion ditch or storm-water drain) is a channel, made across the slope, with the ridge of the downhill side. It is meant to intercept surface runoff and convey it safely to an outlet such as a waterway, usually above cropped land.

10.	**Excavated bunded basins** (*majaluba*) are small basins that usually utilize an external catchment. They are constructed by digging to a depth of 0.2–0.5 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 and 0.7 m above the ground. Farmers usually start with small-sized basins, for example, 10 m by 10 m, and then go into large areas of about 1 ha. This system is one of the methods of runoff utilization, management, and storage for the production of paddy rice and is widely used in the semiarid areas of Mwanza, Shinyanga, Tabora, Singida, and Dodoma regions of Tanzania (Hatibu *et al.*, 2000).
11.	***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 cropland. *Fanya juu* terraces are suitable on slopes with annual rainfall of 500 – 1,000 mm.
12.	**Grass strips** is a vegetative buffer, in which grass is planted in dense strips, about 0.5–1 m wide, along the contour, at intervals equivalent to calculated terrace spacing. These lines create barriers that minimize soil erosion and runoff, through a filtering process. Silt builds up in front of the strip, and with time, benches are formed.
13.	**Gully control and utilization.** This involves rehabilitating gullies and converting them into productive land. Most of the gully control work involves creating check dams with locally available materials (stones, brushwood, or living vegetative hedges). The check dams are built in stages by raising the height of the check dam by about 0.3 m each year. As runoff flow velocities within the gully are reduced, deposition causes soil buildup to adequate depth. The excess flow over the gully is trapped, allowing for water harvesting, conservation, and the growing of crops even in marginal rainfall areas.
14.	**Hafir dams** are found in eastern Ethiopia and are used for human and livestock watering. Generally, they are excavated reservoirs with a water volume ranging from 500 to 10,000 m^3. Hafirs are located in natural depressions and the excavated soil is used to form an embankment around the reservoir to increase its capacity. Bunds and improvements to the catchment apron may help increase runoff into the reservoir, but seepage and evaporation are often high in the dry season. Hafirs differ from other earthen dams in they are generally bigger and also have good sedimentation basins.
15.	**Infiltration ditches** are used for harvesting water from roads or other sources of runoff. They consist of a ditch, 0.7–1.5 m deep, dug along the contour, upslope from a crop field. Water is diverted from the roadside into the ditch, which is blocked at the other end. Water trapped in the ditch seeps into the soil, raising the soil moisture storage in adjacent land.
16.	**Microcatchment systems** are runoff farming techniques in which a relatively small portion of upslope land is allocated for runoff collection, which is "harvested" and directed to a cultivated area (cropped area) downslope. The cropped area may be basins, pits, bunds, or ordinary tilled land. Microcatchments are normally within-field systems since runoff comes from within the vicinity of the cropped area.
17.	**Negarims** are a newer microcatchment method of designing basins used for the establishment of fruit trees in arid and semiarid regions where seasonal rainfall can be as low as 150 mm. In design, they are regular square earth bunds, which have been turned 45 degrees from the contour to concentrate surface runoff at the lowest comer of the square. They are, therefore, efficient in land utilization. Negarims are practiced in Kitui, Thika, and Meru districts of Kenya for fruit tree production (Hai 1998; Critchley and Siegert 1991; Thomas 1997). 

18.	*Ngolo* **pits** or *Matengo* pits, are a special type of soil and water conservation practiced in the Mbinga highlands of Tanzania. This is characterized by a pattern of square pits and ridges, created using crop residues and weeds on slopes with about 35-60% steepness. The ngolo system involves a crop rotation of mainly maize and beans, with specific activities to maintain the pits throughout the season. It is labor-intensive but quite effective in controlling soil erosion on very steep slopes.
19.	**Permeable rock dams** are long, low structures consisting of well-packed stones, creating contour bunds across valley floors. In design, they are 0.5–1 m in height and can be up to 50 m wide and 300 m in length. They are used for controlling gully erosion while causing deposition of silt and spreading and retaining runoff for improved plant growth. They are popular in semiarid areas, especially for rehabilitation of denuded rangeland.
20.	**Runoff harvesting from hillsides and open surfaces.** Runoff may be harvested from rocks, hillsides, and open surfaces and channeled into large basins or directly onto cropped land. Research in Baringo District of Kenya showed that due to the high runoff-producing characteristics of the hillsides, rainfall storms of as little as 8 mm were able to initiate surface runoff.
21.	**Semicircular bunds** (also known as demi-lunes or crescent-shaped bunds) involve making earth bunds in the shape of a semi-circle with the tip of the bunds on the contour. The dimensions of the holes and the spacing of the contours are dictated by the type of crop or the farming system. In design, the holes are made with a radius of at least 0.6 m and a depth of 0.6 m. The subsoil excavated from the pit is used to construct a semicircular bund with a radius ranging from 3 m to 6 m on the lower side of the pit. Bund height is normally 0.25 m. The excavated planting pits are filled with a mixture of organic manure and topsoil to provide the required fertility and also to help retain moisture. 
22.	**Spate irrigation** or diversion of flood flow from highlands into lowlands and "wadis" has a long history in the Horn of Africa. It still forms the livelihood base for rural communities in arid parts of Eritrea and the upper rift valley in Ethiopia. Storm-floods are harvested from rainfall-rich highlands and diverted into leveled basins in the arid lowlands. In Eritrea, the embankments conveying the storm-water can be extremely large (5–10 m high) and are built by shoveling the sandy soil using animal traction.
23.	**Tied ridging** are a modification of the normal contour ridges used for water conservation in dry areas. The technique involves digging major ridges that run across the predominant slope and then creating smaller sub-ridges (or cross-ties) within the main furrows. The final effect is a series of small microbasins that store rainwater in situ, enhancing infiltration. Depending on the system, the crop is planted at the side of the main ridge, to be as close as possible to the harvested water, while also avoiding waterlogging in case of prolonged rains. Tied ridges have been found to be very efficient in storing rainwater, which has resulted in substantial grain yield increase in some of the major dryland crops such as sorghum, maize, wheat, and mungbean in Ethiopia.
24.	**Zai pits** (or zay pits) utilize shallow, wide pits that are about 0.6 m in diameter and 0.3 m in depth, in which four to eight seeds of a cereal crop, (e.g., maize) is planted. Manure is usually added into the pit to improve fertility. It works by a combination of water harvesting and conservation of both moisture and soil fertility in the pit. There have been some modifications of the zai system in the ESA, for instance, the "katumani pit", which is wider than the zai. In southern Tanzania, the pits are made bigger and deeper (at least 0.6 m deep), with some 20-liter volume of manure added. The zai system has been adopted from the Sahel Region of West Africa and is commonly practiced in the ESA (Critchley and Siegert, 1991; Reij *et al.*, 1996; Malley *et al.*, 1998; Hai, 1998).

25.	**Zero tillage** or no-till system is minimum tillage at its most absolute. It involves growing a crop in a field that has had no tillage operations preceding the planting. The land is planted by direct seed drilling without opening any furrows or pits. Old crop residues act as a mulch and weeds are controlled using herbicides. In the dry areas of East Africa, zero tillage has not worked well due to poor infiltration, since most ASAL soils have surface-sealing problems, and the costs of herbicides are prohibitive to smallholder farmers.

Note that this article only includes a small section of the original 100 interventions covered in the IMAWESA study. Refer to the full study for complete information including references.

Source

The original article consisted of 100 interventions. These can be found in the original article. *100 ways to manage water for smallholder agriculture in Eastern and Southern Africa: a compendium of technologies and practices.* SWMnet Working Paper 13 by Bancy M. Mati. March 2007. (This article only highlights a few of the interventions.)

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