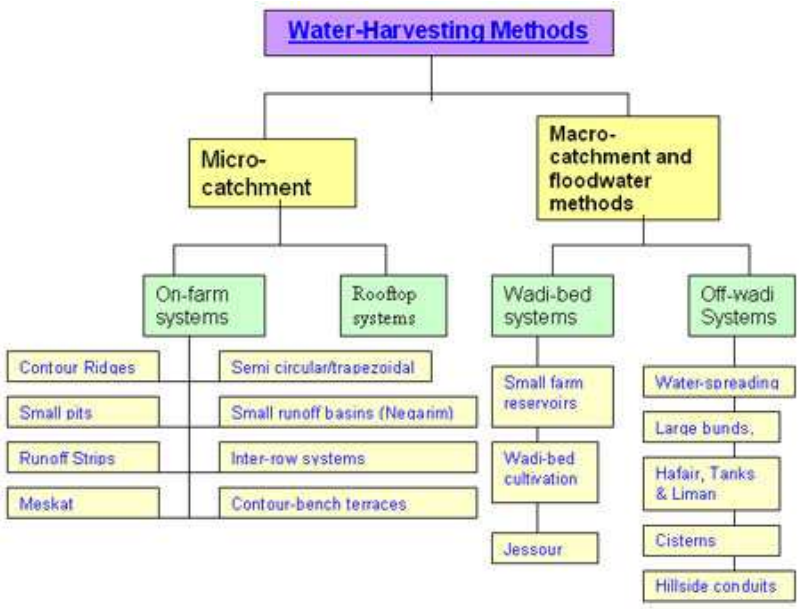
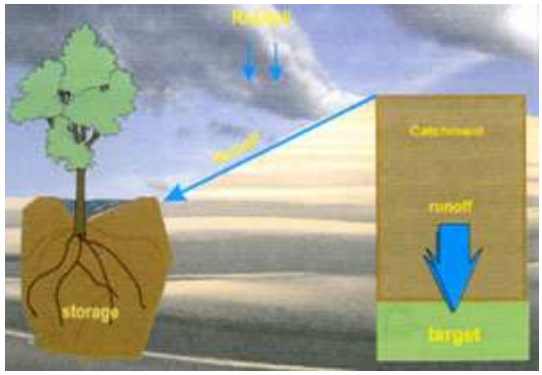
Rainwater harvesting in dry lands



Micro catchments:
This system collects surface runoff, as sheet flow over a short distance, from a small catchments area (around 1000 sq m). Runoff water is usually applied to agriculture area where it is stored in root zone that can be used directly by the plants and also can be stored in small reservoir around the plant for later use.



On-farm systems
On farm systems are designed and constructed at low-cost, making them easily replicable and adaptable. It can be applied for any crop or any slope. They have higher runoff efficiency than macro-catchment systems and do not usually need water conveyance system. The most important land-based micro catchments or on-farm water harvesting systems in the dry areas of Wana are described below:

1. Contour ridges: These are bunds or ridges constructed along the contour line, usually spaced between 5 and 20m apart. The first 1-2 m above the ridge is for cultivation, whereas the rest is the catchment. The height of each ridge varies according to slope's gradient and the expected depth of the runoff water retained behind it. They may be constructed on wide range of slopes, from 1% to 50%. The key success of

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these systems is to locate the ridge as precisely as possible along the contour. In the semi-arid tropics, this system is sometimes combined with other techniques, such as the zay system or the tied-ridge system.

2. Semi-circular and trapezoidal bunds: These are usually earthen bunds in the shape of semi-circle, a crescent, or a trapezoid facing directly upslope. They are created at spacing that allows sufficient catchment to provide the required run-off water, which accumulates in front of the bund. Usually they are placed in staggered rows. The diameter or the distance between the two ends of each bund varies between 1 and 8 m and bunds are 30-50 cm high. The greater the slope, the more the bunds have to be strengthened with stones. In this way the technique can be used on level land, but it can be used on slopes up to 15%. The establishment and maintenance of this system is labor-intensive.

3. Small pits: Pitting is very old technique used mainly in western and eastern Africa, but adopted in some Wana areas. The pits are 0.3-2 m in diameter. The most famous pitting system is the zay system used in Burkina Faso. This consists of digging hole to a depth of 5-15 cm. Pits are applied in combination with bunds to conserve runoff.

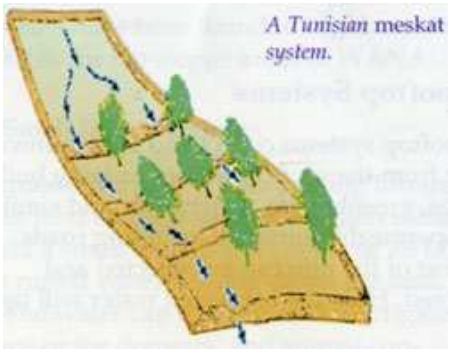
4. Small runoff basins: It is also called as negarim; small runoff basins consist of small diamond shaped-or rectangular-shaped structures surrounded by low earth bunds. This is best used on grounds and the usual dimensions are 5-10 m in width and 10-25 m in length. The soil should be deep enough to hold water for whole dry season.

5. Run-off strips: The techniques for runoff strips are suitable for gentle slopes. The strips are used to support field crops in the drier environment (such as barley in the badia), where production is risky yields are low. The farm is divided into strips along the contour. An upstream strip is used as catchments, while a downstream strip supports crops.

6. Inter-row systems: Inter-row systems, also called"roaded catchments", may be the best technique to apply on flat lands. Triangular cross sectional bunds or levees are constructed along the main slope of the land. The bunds height ranging from 40 to 100 cm, are built at distances of 2-10 m, runoff flowing down the slope is collected between the ridges and either directed to a reservoir at the end of a feed canal or to a crop cultivated between the ridges. The catchments area has to be weeded and compacted on a regular basis to maintain high runoff output.

7. Meskat: Meskat is term used in Tunisia for an indigenous water harvesting system supporting mainly olives and figs. This system consists of catchment, or meskat, occupying the slope adjacent to a flat cultivated area called manqa. Sometimes, the catchment areas are surrounded by the bund and may be provided with spillways to let runoff flow between plots without causing erosion. Khushkaba is a similar technique used for growing field crops in Balochistan, Pakistan.

8. Contour-bench terraces: Contour-bench terraces are constructed on very step slopes to combine soil and water conversation with water harvesting techniques. The terraces are usually provided with the drains to release excess water safely. The historic bench terraces in Yemen are good example of this system.



Rooftops systems Rooftops systems collect and store rainwater from roof of the houses or large buildings, greenhouses, courtyards, and similar impermeable surfaces, including roads. Modern roofing materials and gutters, for example, allow the collection of clean water suitable for drinking and other domestic uses, especially in rural areas without tap water. Such systems provide a low cost water supply for humans and animals in remote areas. Although mainly used for domestic purposes, this technique also has agricultural uses.

Macro-catchments and flood water systems
Macro catchments and floodwater harvesting systems are characterized by having runoff water collected from a relatively large catchment. Often the catchment is a natural rangeland, the steppe, or a mountainous area. Generally, runoff capture is much lower than for micro-catchments, ranging from a low percentage to 50% of the annual rainfall. Large macro-catchments systems in steppe areas are often called "floodwater-harvesting systems". According to the location of the target area, two types of macro-catchments exist: wadi-bed systems and off wadi systems.

Wadi-bed systems
In this system, the wadi bed is used to store the water, either on the surface by blocking the water flow, or in the soil profile by slowing down the flow and allowing it to infiltrate the soil. There are some wadi beds found to be most suitable for the steppe areas of Wana:

1. Small farm reservoirs: These reservoirs may range in capacity between 1000 to 500,000 cu.m. The most important feature is to have a spillway with sufficient capacity to allow for the excessive peak flows that may pass through the wadi. Many of the small farms reservoirs constructed in the West Asian badia, have been washed away through lack of, or insufficient, spillway.

2. Wadi-bed cultivation: This technique is very common in wadi beds with gentle slopes. As a result of the slow water velocity, eroded sediments usually settle in the wadi bed and create good agricultural land. This may occur naturally or can be achieved by the construction of a small dam or dike across the wadi to reduce the flow speed and allow soil-sediments to settle. Wadi cross-walls, usually no higher than 1m, are preferably made of permeable stone and may be enforced with gabions. The top of the wall should be all at the same level, so as to create uniform land behind it, allow excess water to overflow along its entire length. Distances between walls along the wadi bed are determined according to the slope of the wadi bed and the height of the wall.

3. Jessour: Jessour is an Arabic term describing the widespread indigenous wall structures built across relatively steep wadis in southern Tunisia. The walls are usually high because the slope is steep. They are made of earth, stones or both, but always have a spillway, usually of stone. This system is similar to wadi-bed cultivation except that it is used on steep wadi beds and always includes a spillway to release the excessive water.

Off-wadi systems
The rainwater harvested in run-off wadi systems is applied outside the wadi bed. Structures may be used to force the wadi water to leave its natural course and flow to nearby areas suitable for agriculture. Similar structures may also be used to collect rainwater from catchments outside the wadi bed. The following are the most important off-wadi techniques:

1. Water-spreading systems: In this technique, part of the wadi flow, is forced to leave its natural course and is then conveyed to nearby areas for the crops. The flow is directed by levee, which should run a little off the contour, away from the wadi path. One important point to consider is that the slope of the conveyance canal should allow a flow velocity sufficient to prevent the accumulation of sediments near the structure, otherwise these will block the flow and entail high maintenance costs.

2. Large bunds: Also called tabia in Tunisia. This system consists of large semi-circular, trapezoidal or open v-shape earthen bunds with a length of about 10-100m and a height of 1-2m.

3. Tanks and hafair: Tanks are usually earthen reservoirs dug in the ground in gently sloping areas that receive runoff water either by diversion from wadis or from a large catchment area. They are known as Roman ponds in North America. The capacity of these ponds ranges from a few thousand cubic meters (hafair) to tens of thousands of cubic meters.

4. Cisterns: Cisterns are indigenous, surface reservoirs with capacity ranging from 10 to 500 cubic meters. They store water for human and animal consumption. In many areas, as in Jordan and Syria, they are dug in the rock, in which case they usually have a small capacity. Runoff water is collected from an adjacent catchment or channeled from a remote one.

5. Hillside-runoff systems: In Pakistan, this technique is also called as

sylaba. Runoff water is directed by small conduits to flat fields at the foot of the slope. Fields are leveled and surrounded by levees with a spillway to drain the excess water to another field downstream. When all fields in a series are filled, water is allowed to rejoin the wadi.

Source: international Centre for agricultural research in the dry areas (ICARDA). Water harvesting, indigenous knowledge for the future of the drier environment by theib oqeis, dieter prinz, ahmed hachum.