Water harvesting for rain-fed agricultural production systems

Introduction
In order for agriculture to meet global food demand by an increasing population, projected to reach nine billion by 2050, water productivity needs to be dramatically increased. This is particularly crucial in the arid and semi-arid regions of the world, where a large proportion of cropland (more than 40% in sub-Saharan Africa and South Asia) is located in water scarce areas subject to recurrent dry spells and droughts that seriously affect crop production and farmer livelihoods. In rain-fed agriculture an average of 65% of rainfall is lost to runoff due to the dominance of crust-prone soils vulnerable to erosion during short and intense rainfall. The harvesting and storing of this water in so-called water conservation zones that may be either man-made or natural, and making it available for crop production during dry spells, is one way to compensate soil water deficiencies and to reduce the risk of crop failures. It has been shown that grain yield in crops, such as maize and wheat, can be increased from 1 to 5 tonnes/ha when the crop has access to water.

Importance of water harvesting

Water harvesting has many benefits both in terms of food security and of farmer livelihoods in arid and semi-arid regions:

- It facilitates high value cash crop production in areas that would otherwise lie fallow due to lack of water.
- It improves soil fertility when applied to the fields as it contains soil silt, manure and organic matter harvested along with the water runoff from farm lands into the water conservation zones.
- Water harvesting techniques, such as terracing, retention ditches, stone bunds, and trash lines, reduce soil erosion and siltation downstream, and recharge groundwater aquifers that may be subsequently used for irrigation of crops in the vicinity of the harvested water.
- The prolonged availability of water in the soil and in the water conservation zone ensures better conditions for the formation of stable humus that enhances nutrient availability and the water holding capacity.
- In tropical soils low in organic matter, it plays an important role in capturing atmospheric carbon dioxide through increased biomass production both in the water conservation zones and in the surrounding land.

Nuclear techniques
The soil moisture neutron probe (SMNP) measures soil water content for crop production. During the measuring process, the probe emits neutrons that collide with hydrogen atoms in soil water. This collision slows down the speed of the neutrons. The change in the speed of the neutrons is detected by the probe and provides a reading.
that corresponds to the soil water content. The SMNP is currently the most suitable instrument to accurately measure soil moisture under saline conditions. It is also widely used to calibrate other moisture sensors for direct use in farmers’ fields.

The $^{15}$N stable isotope is used as a tracer to determine the source of the nitrogen (e.g. from chemical fertiliser, soil and water) taken up by the crops. This will assist in the assessment of the efficiency with which the crop uses nitrogen from different sources.

The change in the signatures of water isotopes ($\delta ^{2}$H and $\delta ^{18}$O) in the water conservation zones provides information on the sources of water, such as runoff, rainfall or groundwater, that contribute to these zones. This information is used to develop guidelines that enable farmers to identify the optimal location of such zones.

**Country achievements**¹

**Uganda** captures 50% of 580 million m$^3$ runoff using 340 ha of Riparian wetlands from the 31,400 ha Manafwa catchment. This was able to provide sufficient water for three rice harvests per year delivering a net benefit to farmers of US $1300 to 1800/ha per cropping season.

**Tunisia** captures and stores in farm ponds, with a surface area less than 3% of the 265 ha Kamech catchment area, close to 100% of runoff water generated from this catchment, sufficient to irrigate 9 ha of farmland producing an average of 5 tonnes of tomato and pepper per hectare.

**Iran** harvests 7.5 million m$^3$ of water in 30 artificial ponds, holding an average of 250,000 m$^3$ per pond, from a 14,600 ha catchment. This is sufficient to irrigate 5000 ha of rice paddy fields in northern Iran, and to produce an average of 15,700 tonnes of rice per cropping season.

¹ These country achievements are examples only. For a more complete list see www-naweb.iaea.org/nafa/swmn

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*For further information, please visit:*

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

International Atomic Energy Agency, Wagramer Strasse 5, PO Box 100, 1400 Vienna, Austria

www-naweb.iaea.org/nafa/swmn