Managing on-farm water to enhance food production

Introduction
Agricultural water management is an important aspect of efficient crop production. Sufficient water must be present in the vicinity of the crop roots to facilitate absorption of nutrients by plants, to encourage root growth and to aid the proliferation of soil organisms that enhance the availability of these nutrients to meet plant requirements. However, the global average water use efficiency is less than 40%, with some regions being lower than 30%. By 2025, about 1.8 billion people will be living in countries or regions with water scarcity (i.e. the annual availability of water drops below 1000 m³ per person), and two-thirds of the world’s population could be living under water stressed conditions (i.e. an annual water availability below 1700 m³ per person). By improving the retention of soil water in the vicinity of the crop roots, the need for irrigation water will be reduced, hence providing economic benefits to farmers and help protect the environment. Agricultural productivity can be significantly enhanced through the efficient implementation of a series of on-farm water management practices that increase water use efficiency, crop productivity and soil quality.

Technologies for improving on-farm water management

Water harvesting and storage in man-made farm ponds or in wetlands offer ideal solutions to the storage of water in areas with unreliable or inadequate water supplies. The captured water can sustain crop growth during droughts and dry spells. Water harvesting also provides an effective means to recharge the groundwater and to reduce surface runoff and soil erosion resulting from sudden and intense rainfalls on dry lands.

Accurate irrigation scheduling, through applying water where and when it is needed, maximises water use efficiency, reduces surface runoff and drainage, minimizes water-logging, controls salinity in the vicinity of the crop roots and enhances energy efficiency by reducing the water pumping cost.

Conservation tillage, in which crops are grown in soils with minimal disturbance, increases soil organic matter levels through reduced soil cultivation and decomposition. This practice also reduces soil compaction and facilitates deep root development and water movement. The increase in soil organic matter encourages the infiltration of rainwater into the soil and further increases the water holding capacity of the soil and makes more water available for crop growth.

Organic mulch and manure applications reduce water requirements by binding moisture in the soil and reducing the amount of water lost through evaporation. It also helps to improve the structure of clay and sandy soils, thereby enhancing the water holding capacity of these soils.
Permanent cover crops, such as red fescue, perennial rye grass and spring oats, improve soil structure and water movement within the area of the crop roots and reduces compaction. They also reduce surface evaporation and soil erosion and enhance soil organic matter, thereby improving the water holding capacity and the quality of the soil.

Nuclear techniques in agricultural water management

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 variation in the isotopic signatures ($\delta ^{2}H$ and $\delta ^{18}O$) in the water vapour surrounding plants makes it possible to separate evapotranspiration into its individual components of soil evaporation and plant transpiration. Through this information, guidelines are provided to farmers that enable them to minimise the evaporative losses in their efforts to optimise water use efficiency.

Country achievements

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.

Pakistan reduced extreme soil moisture variations through the retention of crop residues thereby increasing crop productivity by 18% over a four-year period and improving water use efficiency by 34%.

Vietnam reduced water use in coffee plantations by 66% during the bud development and flowering stage from December to January merely by covering the soil between trees with old branches and tree leaves, amounting to a potential saving of 66 million m$^3$ of irrigation water. This will save farmers time and costs in transporting water over large distances. It will also provide a strong economic incentive to local farmers to increase water use efficiency in coffee plantations.

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

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