# Water management

by Y. Barrada*

FAO statistics indicate that 48% of the world's cereal grains are now produced in developing countries which contain 60% of the land planted with cereals, and 73% of the world population. Though food production increased 2.4% per annum during the 1970s, the number of people whose food intake is below the critical level also increased, from 360 million in 1970 to 500 million in 1980. We are thus no closer to our goal of erasing world famine.

To cope with the increased demand for food resulting from both the increase in world population and the improvement in the standard of living, it is essential to develop adequate water-management methods which would lead to better use of rainfall under dry farming conditions, and to improving the efficiency of water use on irrigated land. To achieve this target it is imperative to have a better understanding of the soil-water-plant-atmosphere continuum.

The basis for comparing various water management practices is normally provided by a very large number of soil-moisture measurements in soil profiles. This was very difficult, costly, and time-consuming before the development of portable radiation equipment based on neutron moderation for soil-moisture measurement. The use of portable radiation equipment made it possible to follow the moisture changes in soil profiles in a reliable non-destructive way while saving time, effort, and money. Research using these techniques is essential for making more rational use of valuable and limited water resources.

The Joint FAO/IAEA Division has been technically responsible for technical assistance projects aimed at improving water management practices in the following developing Member States: Argentina, Bulgaria, Chile, Costa Rica, Egypt, Greece, India, Ivory Coast, Kenya, Lebanon, Morocco, Niger, Nigeria, Pakistan, Peru, Republic of Korea, Romania, Senegal, Sri Lanka, Sudan, Syria, Tanzania, Turkey, Uganda and Zambia.

The Division has also contributed to the improvement of the efficiency of water use through the implementation of three 5-year co-ordinated research programmes. Participants from eight to 15 countries have conducted research towards a common goal of improving nuclear techniques in water-use efficiency studies and developing practices to increase the food produced from a unit of irrigation water or rainfall.

In many cases this was the first time such techniques have been used in the above countries. It was thus necessary to provide expert assistance to train local counterparts in the safe and efficient use of the equipment. Training courses have also been held in more advanced countries to familiarize young scientists from developing countries with the most modern techniques in soil/water research.

Results obtained through the nuclear techniques-aided research programmes will, when applied in farmers' fields on irrigated land, lead to increased yields, to reduced losses of nutrients through leaching below the rooting zone, and to conserving soil through avoiding the accumulation of salts close to the soil surface. Under rainfed agriculture, research results would help controlling erosion, conserving water, and ensuring sustained production at acceptable yield levels.

## Rainfed agriculture

Seven eighths of the world's cultivated land is under rainfed agriculture where yields vary greatly, depending on the amount, distribution, and intensity of rainfall and the soil's physical and hydraulic properties. In most cases irrigation water is not available or is unnecessary, and in some cases the soil is unsuitable for irrigation. These vast areas of cultivated land have received little attention from researchers. Appropriate management practices could reduce the hazards of crop failure and ensure sustained agricultural production of acceptable yields. Research in which the IAEA has co-operated has quantified the benefit of various practices designed to conserve rainfall. These have included:

Various crop rotations, some of which included a period of fallow;

Various levels of weed control during the periods of fallow;

Chemical or mechanical weed control during the cropping season;

The use of plant residues, organic by-products, or the soil itself, to produce a mulch which will reduce evaporative water loss;

Tillage practices to produce ridges perpendicular to the direction of the slope to prevent run-off and increase infiltration;

Land-shaping to provide catchment basins for "water harvesting", or benches, terraces, or residue-filled ditches to prevent run-off, conserve water, and control erosion;

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**Young engineers from Israel, Ivory Coast, Yugoslavia, Mauritius, and India study infiltration of water into soil with a neutron moisture meter at an FAO/IAEA training course in Cadarache, France.**

Optimum combination of plant population and fertilizer application for a given crop;

Adjusting the initiation and length of the growing season so as to increase the probability of a successful crop; and

Using non-saline ground-water for supplementary irrigation.

As examples of successful research projects, it was found that the normal, somewhat weedy, fallow in Cyprus was no more effective in conserving water than a crop of vetch. Varieties of upland rice which had deeper root systems and made more efficient use of sub-soil moisture were identified in Ivory Coast. Inter-cropping a legume with a cereal in India allowed less water to be lost below the root region. Although ridges and furrows (especially those with small "dams" in the trough) were effective in conserving water in Israel, more water was conserved with a *flat* soil surface in a dry region of India than when tillage was used to produce beds or ridges

A very large number of soil moisture measurements is required to measure the relative effectiveness of these practices. This can only be done with the aid of portable radiation equipment.

**Irrigated land**

The world's 14% of cropland presently irrigated has received most attention from researchers. It receives a major portion of the inorganic fertilizers and other agricultural chemicals and consequently, it produces most of the food. A yield increase of 300 to 400% or more is commonly encountered as a result of introducing irrigation. The change from dry farming to irrigated farming can, however, create problems of salinization, poor drainage and excessively inefficient water use. Sound applied research programmes should be implemented for each irrigation region to ensure that efficient water use is achieved under the prevailing soil and climate conditions. Studies must be conducted to determine.

- The water requirements of crops and the irrigation frequency to maximize crop yield;
- The interaction between water use, fertilizer application, and plant population so that the optimal combination could be selected for the prevailing conditions;
- The amount of water which must leach through the soil profile to avoid salt accumulation close to soil surface and yet minimize problems of nutrient leaching and high water tables; and
- The need for artificial sub-surface drainage to prevent salinization.

This information can only be obtained with a broad well co-ordinated research programme which can be conducted more effectively with isotope and radiation techniques. As the information is site-specific, the efforts of the Agency have been directed towards providing the equipment and the expertise in its use to scientists in the countries hoping to benefit from major irrigation schemes before the productivity of the land is ruined through improper irrigation practices.