The Use of Neutron Moisture Meters in Irrigation Studies in Egypt

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INTRODUCTION

Egypt has one of the oldest histories of irrigation, however, until comparatively recent years the principal method of irrigation relied on the annual flooding of the fields by the Nile River. The water was retained on the land in basins, saturating the soil and providing enough moisture to grow an annual crop. The construction of the first Aswan Dam and various barrages on the river permitted an extension of the irrigated areas within the river flood plain, and made the irrigation of two crops in the year in the greater part of the flood plain possible. But river conditions were in general little changed: a high level and flooding some of the land in mid-summer, and a low level for the rest of the year. This permitted a replenishment of humus, silts and essential elements, and a continuous draining of the soils between floods. A reasonable state of equilibrium was established with a high level of fertility.

More recently with the construction of the Aswan High Dam and the large storage of flood waters which could be released under control throughout the year, the possibility arose to provide continuous irrigation for two principal crop seasons, not only for the old irrigated areas of the Nile flood plain, but also for new land above the level of the flood plain. The subsequent overuse of irrigation in the absence of drainage caused a rise in the ground water-level, and has led to waterlogging of the soil and to salinity problems.

In response to the problem, the Government of Egypt has launched a 10-year tile-drainage programme. Water-use efficiency studies are also being carried out by the Soil and Water Institute of the Ministry of Agriculture, by universities and by other institutes in co-operation with the Food and Agriculture Organization (FAO), which is managing three projects funded by the United Nations Development Programme. Technical assistance is being provided by the IAEA on the use of neutron moisture meters, which will facilitate soil moisture measurements on a large scale – studies essential for more rational use of the limited water resources.

PROBLEMS FACING AGRICULTURAL PRODUCTION

A total of 54 billion m^3 of Nile water, as measured at the Aswan High Dam, is being used to irrigate about 6.5 million acres, with an average water duty of slightly more than 800 m^3/acre/year.

About one million acres of the total irrigated area is newly reclaimed. The Nile water has an average concentration of 200 p.p.m. of dissolved salts. The present perennial system of irrigation and the absence of adequate drainage in the flood plains has caused salinity and waterlogging problems. The total area affected by salinity is estimated at 2 million acres or about 20% of the old flood plain, and the rest of this area may suffer from the presence of permanent waterlogging or a high water table. The newly reclaimed land of almost one million acres above the flood plain is also starting to suffer varying degrees of waterlogging and salinization.

In the Delta, the problem is aggravated by the very poor internal drainage of the fine-textured soils. In the newly reclaimed desert areas, following the introduction of irrigation, the overuse of water and soils of low water-holding capacity in the absence of field drainage led to waterlogging and subsequent solution of salts of marine origin. Seepage of saline water to the low-lying irrigation canals in the North West has resulted in the salinization of the irrigation waters and hence of the soil.

The drainage programme undertaken by the Government of Egypt will cost at least $500 million over the next 10 years. This will be combined with the soil improvement programme, including the use of subsoiling (ploughing the subsoil to depths of from 40 to 100 centimeters with a special machine), the use of gypsum and intensive use of fertilizers. Also, other activities are planned by the Government in the field of water use. These activities, which all aim at saving water and increasing productivity, include the development of new irrigation methods, better water distribution systems and obtaining more accurate estimates of the optimum water requirements of crops, so that water – the main limiting factor for agricultural production – could be used more efficiently. This is of prime importance to achieve the badly needed increase in crop production in Egypt, where only about 3% of the total area of the country is under cultivation and vast areas of land could be utilized if irrigation water could be made available through savings achieved as a result of more rational use of water. The warm arid climate of Egypt emphasizes the great importance of water-use efficiency, as the average annual rainfall amounts only to 150 mm on the Mediterranian coast and drops gradually to 25 mm at Cairo, which is about 200 kilometers from the sea.

The water-use efficiency studies in Egypt have the following goals:

1. The application of adequate amounts of irrigation water with the proper flow-rate, at the right time, and this would lead to

(a) Increased crop yield through providing plants with adequate water supply, as well as avoiding the harmful effects of both drought and excess water.

(b) Considerable saving of water, thus allowing for improving the water supply of other irrigated areas, or for providing an additional area with irrigation water.

(c) Drainage and salinity problems would lose much of the importance they have now.

2. The capability to make quantitative predictions for the need for irrigation water, which would provide valuable information for planning new irrigation projects.

3. Obtaining experimental results that will make it possible to assign a definite recurrence value to the measured yield-depression of crops resulting from lack of soil moisture. When

the cost of irrigation and increase in gross returns are compared, one can estimate the profit that could be expected from a certain irrigation project over a number of years.

4. Comparison of experimental results for various crops and crop rotations so that the best return for a given amount of water in monetary terms could be determined. This allows agricultural planners to choose the most economic crops and crop rotation.

THE ROLE OF RADIATION EQUIPMENT IN WATER-USE EFFICIENCY STUDIES

Portable radiation equipment for soil-moisture measurements now commercially available are valuable tools for agricultural research. The portable radiation equipment has solved the problem of performing a large number of reliable soil-moisture measurements, and opened the way for intensive water-use efficiency studies. The neutron moisture meter is almost insensitive to change in salt concentration in the soil and its readings are not upset by the concentration of fertilizer. In short, it offers reliable, rapid and non-destructive soil-moisture measurements at the desired depth.

Two of the FAO-managed UNDP projects are "Control of Water Logging and Salinity in the Areas West of the Nubaria Canal" and "Improvement of Field Crops Productivity". The third FAO-managed UNDP project is aimed at the development of the "New Valley". These UNDP projects have purchased four neutron moisture meters and are now using them in applied research aiming at improving the efficiency of water use. The IAEA has assisted in the training of local scientists on the calibration and use of the equipment, and in planning applied research.

As part of its 1976 technical assistance programme, the IAEA also provided a neutron moisture meter to the Atomic Energy Commission of Egypt. This equipment will be used to carry out studies on water-use efficiency in the western coastal area of Egypt, where a desalination project is planned. A small experimental irrigation farm has been established by the Egyptian Atomic Energy Commission. Water-use efficiency studies will be carried out with Nile water until desalinated water becomes available. Though desalinated water will be very costly, it is hoped that in the future its use might become economical through efficient use of water, growing high-value crops, and making appropriate use of rainfall, which amounts to approximately 200 mm per year on the first 3 kilometers close to the sea, and by cultivating a large area during the rainy, winter season when the rate of evaporation is relatively low.