Soil physics and agricultural production

by K. Reichardt*

Agricultural production depends very much on the physical properties of the soil, and mainly on those related to the soil's water holding and transmission capacities. These properties affect the availability of water to crops and may, therefore, be responsible for crop yields. The knowledge of the physical properties of soil is essential in defining and/or improving soil water management practices to achieve optimal productivity for each soil/climatic condition. In many parts of the world, crop production is also severely limited by the high salt content of soils and water. Such soils, classified either as saline or sodic/saline depending on their alkalinity, are capable of supporting very little vegetative growth.

According to statistics released by the Food and Agriculture Organization (FAO), the world population is expected to double by the year 2000 at its current rate of growth. This rise in population calls for at least a doubling of world food production during the same period. It is expected that a part of the increase will come from the adoption of more advanced technology, such as the use of high-yielding fertilizer-responsive crop varieties, at least in the developing countries. A significant proportion of the required increase is, however, expected to come from increasing the acreage under cultivation. This would certainly put great pressures on the dwindling amount of agricultural land which is available, and the need to reclaim land which would have been classified as unproductive for agriculture, such as the saline/sodic soils, would assume great importance. In addition, water is often scarce, and this severely limits crop yields. Increased food production will, therefore, be linked in many cases with the provision of water for irrigation; but its quality may not be good and its use may lead to the development of saline/sodic soils.

The FAO and IAEA organized a joint symposium** to assess the recent advances and future trends in the use of isotope and radiation techniques in soil physics and irrigation research, as related to the problems outlined above. The proceedings of the symposium show that a major effort is being made to make soil physics applicable to the analysis of the physical behaviour of field soils in relation to crop production, and to develop effective management practices that improve and conserve the quality and quantity of agricultural lands. Emphasis is being given to field-measured soil-water properties that characterize the water economy of a field, as well as to those that bear on the quality of the soil solution within the profile and that water which leaches below the reach of plant roots and eventually into ground and surface waters. The fundamental principles and processes that govern the reactions of water and its solutes within soil profiles are generally well understood. On the other hand, the technology to monitor the behaviour of field soils remains poorly defined primarily because of the heterogeneous nature of the landscape. Note was taken of the concept of representative elementary soil volume in defining soil properties, in making soil physical measurements, and in using physical theory in soil-water management.

The physical characterization of soil in the field depends strongly on its spatial and temporal variability. If large agricultural fields are to be described successfully from the physical point of view, better ways of handling this variability have to be found. The symposium discussed this subject exhaustively and indicated major lines to be followed in future. It was recognized that the neutron moisture meter is extremely suitable for field use and that methods of scaling data and geostatistical analysis, when applied correctly to soils, will lead to a better understanding of the problem.

Papers focussed on the problems of irrigation-water quality and crop production under saline and sodic conditions. A special Advisory Group delineated areas of research in which appropriate isotope and radiation techniques can be applied successfully and with advantage over other techniques. It was again recognized that salinity of soil and water is a great impediment to the development of agriculture in various countries, particularly those in the semi-arid tropics. The salinity problem was seen as a complex hydrological, pedological, and biological problem, the solution of which requires further research and applied field work.

Interesting results in soil-water studies and management practices were presented. These indicated means of making crops use the available water and added fertilizer more efficiently. The uses of nitrogen-15 as a tracer in fertilizer studies, and of neutron probes in field-water balances, were described.

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New developments and improvements in relevant nuclear methodology were presented: these comprised soil-water content and soil bulk density measurement devices, using either two neutron sources, one gamma source and one neutron source, two gamma sources or multi-gamma-neutron source/beam systems. The symposium showed that progress has been made in the methodology of measuring soil-water content with neutron moisture meters, but also that much remains to be done to improve the equipment and the methodology.

The symposium was hosted by the Government of France. More than 100 scientists from Europe, Asia, Africa, and North and South America took part.

Operational safety of nuclear power plants

by H.A. Wright*

After nearly 3000 reactor-years of operation, was there anything new to discuss at the Symposium on the Operational Safety of Nuclear Power Plants? ** The answer is yes. Although there are no recent dramatic developments in this maturing industry, there are new techniques, new insights and new approaches to old problems. Moreover, since an accident at one nuclear plant can have important repercussions on the operation of other nuclear plants in the world, sharing of information on improvements in operational safety is advantageous for all. The broad areas of interest identified at the symposium included: management of nuclear power plants; training of personnel; human factors and the man/machine interface; design improvements for safe operation; the utilization of operating experience; international activities in the field of operational safety; and emergency preparedness measures.

An accident expert or more highly qualified operators?

The way in which control rooms at nuclear plants in France are staffed was of considerable interest to the participants, partly because many did not understand the precise rôle of the safety engineer. There, the safety engineer is someone who has been given two years of special training in plant behaviour under off-normal conditions, is a university graduate, and may have had experience in operation as a shift supervisor. Under normal plant conditions, the shift supervisor is responsible for the plant. However, as soon as an abnormal condition is identified, the safety engineer is informed and he goes immediately to the control room, where he assumes responsibility for running the plant. When necessary, he instructs the shift supervisor as to what actions to take.

The need for a specially trained safety engineer arises because the shift team in France is generally composed of people with only a high school education who can follow correct procedures, but are not expected to be able to diagnose unanticipated plant conditions. This contrasts with the practice in some countries, where the shift team has qualifications similar to those required for the French safety engineer. Those countries require many more university-trained people with operating experience.

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** The symposium was convened by the IAEA, in co-operation with the Commissariat à l'énergie atomique and Electricité de France. It was held in the Palais des Congrès, Marseilles, France.