ISOTOPES IN TROPICAL AGRICULTURE

Ways in which the use of radioisotopes and radiation can help to improve the agriculture of tropical Africa were discussed by a panel of experts assembled by the Agency last December at its Vienna headquarters. The panel, which had thirteen members, included scientists from Africa, Europe, and the United States, most of whom had had actual experience dealing with agricultural problems in various parts of tropical Africa.

The experts agreed that radioisotopes and radiation might now be employed to particular advantage in tropical Africa to improve crop nutrition and combat insect pests. Other applications discussed were in the fields of hydrology, plant breeding and food preservation.

Soil Fertility Studies

There was general agreement in the panel that there is an urgent need in tropical Africa for increased agricultural productivity, in order to feed a rapidly growing population, to provide a basis for expanding industrialization, and to permit attainment of a higher standard of living. A principal obstacle to achievement of the desired productivity is the low fertility of soils, which suffer generally from deficiencies of phosphorus, nitrogen and other nutrients. For example, contents of total phosphorus in the savanna topsoils of Central Africa average as low as 10-20 parts per million, and contain similarly low amounts of total nitrogen.

The principal means for restoring fertility to soils in tropical Africa has been the natural fallow system under which, on a regular rotation basis, part of the land is withdrawn from food crop cultivation each year. This system has had limited successes but has generally proven inadequate when population densities exceeded very low limits. Nevertheless, the fallow system is likely to remain in use over much of Africa in the near future, at least until superior methods can be developed and introduced. In the meantime, members of the panel suggested that isotope-assisted research may be able to contribute toward improvements in the fallow system. For example, one of the main functions of the natural fallow in certain regions is to allow nitrogen to accumulate, and to transfer phosphorus from the subsoil to forms of higher availability in the topsoil. It is clearly important to know the extent to which this occurs under a variety of conditions. There is thus great scope for investigations of the points from which plants are drawing their nutrients. The use of isotope tracers was considered essential for such studies.

Over the long run, the experts agreed, the needed improvements in the fertility of African soils cannot be accomplished without the large-scale use of mineral fertilizers. In some areas the need to fertilize is pressing. For example, one expert stated that in Central Africa, where there is a considerable amount of exchangeable aluminium in the soil the toxicity of which can be specifically neutralized by phosphate, no soil improvement is possible without phosphate manuring.

An obstacle to the widespread introduction of fertilizers is their relatively high delivered price over most of Africa. Under these circumstances, it is a task of agricultural research to work out such effective fertilizer mixtures and such efficient uses of fertilizers that the increased yields will more than compensate for the costs.

It was pointed out that tagged isotopes have a two-fold application in such studies. They may be used to determine the amounts of nutrients, especially phosphorus, already present in soils. Or, by tracing the uptake of fertilizers into plants, they may be used in experiments designed to find the most suitable fertilizers, the best times to fertilize, and the most suitable rates and methods of fertilizer application.

For some of these studies non-isotopic methods have been found inadequate. For example, the problem of economically providing a sufficient amount of phosphate or calcium to a growing plant may be largely a problem of fertilizer placement. Studies of fertilizer placement using conventional means are often inconclusive and sometimes even totally ineffective. Tracers can be used to study this problem.

Entomology

Tropical Africa is particularly beset with insect pests. Most damaging of all is the tse-tse fly, which, by interfering with the raising of livestock, limits the protein available for human diet, and which is also responsible for the spread of sleeping sickness among humans. In this connexion, considerable attention was focussed on the success achieved in the south-eastern United States in eliminating the screw worm by releasing large numbers of males which had been sterilized by radiation. These males then mated with normal females who laid sterile eggs.

It was pointed out that considerable research would be necessary before this method could be applied to the tse-tse fly problem. It would be necessary, for example, to develop mass rearing techniques, to determine whether irradiation impaired the vigour of the insect, to select the proper radiation dosage rate, etc. In spite of difficulties, the experts

felt that research on the sterile-male technique was justified by its potential superiority over alternative methods of dealing with the tse-tse fly. For example, one panel member referred to the fact that it had been possible to eliminate the pest from a part of Southern Sudan by clearing all bushes and planting mango trees, but this had required four years of hard labour and the remedy used was not feasible in other infected areas. As to the use of insecticides, it was pointed out that this never succeeded in completely eradicating an insect population and that it could lead to side effects damaging to other forms of life.

Further applications of radioisotopes in entomology were also discussed by the experts. It was noted that radioisotopes have proved helpful in studies to determine the action of insecticides. Tagging insects with radioisotope tracers is also an excellent method of determining their dispersal range, population density, food preferences, and predatory habits. Advantages of radioisotope tagging over conventional methods of ecological investigation were noted, as follows: the recognition of the labelled insect is usually quicker, easier, and more definitive; insects can be detected even when hidden by foliage, bark, or ground litter; and the same insect can be followed through successive stages of development. An insect which plays a role in a seasonal virus disease of the peanut was suggested as one whose ecology might be studied with radioisotopes.

The possibility of using gamma irradiation to control insects which attack stored grains was also discussed by the panel. It was noted, for example, that the Sudan is sustaining great losses as a result of insect infestation of stored grains, especially sorghum, and that control of such insects by conventional means has hitherto been unsuccessful. Although evidence was cited showing that the technical feasibility of this use of ionizing radiation has been established, the feeling was also expressed that the method required larger scale storage and more progressive commercial practices than now exist in tropical Africa.

Hydrology

It was pointed out that advancement of the living standards of several million people in tropical Africa, large areas of which have less than 35 inches of annual rainfall, depends on irrigation development and the better control of water resources. Members of the panel felt that the time was now ripe for increasing the use of tritium as a tracer of underground water supplies. There appears to be no suitable conventional alternative for this technique.

Another suggested use of radioisotopes was to measure the torrent flow and sediment load of flooding rivers. Here also it appeared that alternative chemical methods were not accurate enough, although some progress had been made on them in studies conducted in French-speaking West Africa.

One expert described plans to use carbon-14 counting techniques to measure the age of water accumulations under new villages being established in semi-arid regions where the efficiency of replenishment from rainfall is doubtful. Radiation methods for determining the moisture of irrigated soils were also discussed. These were expected to be particularly advantageous in tropical soils.

Other Uses of Radiation

There is need in tropical Africa to introduce new plant varieties which will be more productive, grow faster, be more resistant to disease, and have other improved characteristics. In this connexion, the irradiation of seeds to induce useful mutations was discussed by the panel. The view was expressed, however, that existing genetic variability in many cultivated species had not been fully exploited in tropical Africa and that, if mutations were needed in such species, classical methods of plant breeding should be tried first.

Use of radiation to preserve food was also considered. One application suggested was a method of sterilizing meat so that it can be carried without refrigeration from producing areas to markets. At present, for example, it is necessary to drive cattle on the hoof some 600-800 miles to Accra from the Sudanese belt to the north of Ghana. Much research is needed, however, before the sterilization method of meat preservation reaches practical realization.

A further possibility considered was the use of irradiation to check the sprouting of potatoes and onions. Due to the seasonality of production, these crops must be stored for a long period to satisfy market demands. It was noted that the use of chemicals to prevent sprouting has proven unsuccessful in the Sudan. It was pointed out, however, that further research is necessary in this field and that the decentralized organization of African markets does not always favour the use of advanced techniques.

Practical and Economic Considerations

One expert observed that the actual costs of equipment for use of isotopes in a research laboratory are not necessarily high, and that the basically important costs, as in most research, are in providing scientists to direct and carry out the research. Various practical problems in operating and maintaining radioisotope equipment have, however, been encountered in African laboratories. These include unsuitable and unreliable electric power supply, damage to equipment from tropical humidity, lack of spare parts, and shortage of electronic engineers able to service equipment. Pooling of research efforts in larger establishments was suggested as one way of overcoming some of these difficulties.

Before leaving Vienna, the panel submitted a report to the Director General suggesting ways in which the Agency might assist in the application of isotopes and radiation to problems in the agriculture of tropical Africa. This report is now under consideration by the Agency.