The Joint FAO and IAEA programme

by M. Fried and C.G. Lamm*

World food and agricultural production will have to increase substantially if the demand created by the combination of growing populations and rising incomes is to be met. Large-scale improvements in technology are needed if production targets are to be reached. But now that energy is so expensive, the new agricultural techniques and technologies must be as energy-efficient as possible. Research to provide the technology and policies needed is hampered because not enough is known scientifically about biological and behavioural factors.

To improve food supply, from production to consumption, existing techniques and resources have to be adapted to local needs, technologies have to be improved as far as present scientific knowledge allows, and research must be carried out to extend our biological and physical knowledge. In addition, the infrastructure necessary to make use of these technologies must be strengthened. Fundamental work with large potential to improve technology should be pursued now because results typically will not affect food supplies for 10–20 years [1]. At the same time, the environment has to be protected from any harmful effects that may result from an intensified agricultural production.

It is only through strong national agricultural research systems that research done elsewhere can be evaluated, adapted and effectively used in national programmes thereby speeding up the process from research to production and reducing the cost of research for national programmes [2].

The need to increase agricultural production without consuming too much expensive energy, and a general concern for the environment, means that all resources and efforts should be mobilized. To this end isotopes and radiation techniques have – for almost two generations – proven a valuable tool to supplement conventional methods of solving particular problems.

G.V. Hevesy was a pioneer in the use of radioactive isotopes as tracers in studies of chemical and biological pathways. After 10 years of successful work in purely chemical systems, he used a lead isotope as a tracer to study the uptake of lead by the roots of plants. This classic experiment was carried out in Copenhagen in 1923 and signified the start of widespread application of radio-isotopes to soil, plant, and animal sciences. Direct determination of the radioactivity in a sample became an easy, sensitive, and direct method of determining the amount and the movement of a given nutrient element. With this technique it became possible for the first time to distinguish between the same nutrient element derived from different sources like the soil or a fertilizer.

Studies of the interaction of ionizing radiation with matter also led to important applications with agricultural significance such as: induction of mutations in plants; sterilization of insects; killing of micro-organisms, or slowing down of natural processes such as ripening of fruits. Through their work during the 1920s, H.J. Muller and L.J. Stadler became the fathers of mutation induction. In 1937 Knipling suggested that with small populations of insects, it would be possible to rear, sterilize, and release males in an effort to control or eradicate them. Finally, X-rays were demonstrated to have a lethal effect on pathogenic bacteria in 1898, and further studies have led to practical and important applications, such as: therapeutic X-ray treatment of diseases in animals and man, and a method of preserving food and other agricultural products by irradiation.

Widespread applications of nuclear techniques to problems of food and agriculture gained pace after the Second World War when artificially produced radio-isotopes of many important elements became available. More recently, stable isotopes of agriculturally important elements such as hydrogen, oxygen, carbon, nitrogen, and sulphur have become available at prices within the reach of the scientific community. Today, the use of isotopes and radiation in food and agriculture has meant faster solutions to a number of practical problems, allowed a more direct approach to others, and in some cases was the only way to solve basic and applied problems. Such a claim is not based on theoretical speculation, but on the results of profitable applications which have benefited agricultural production in developed and developing countries alike over many years. However, attention has turned increasingly towards the developing countries which often require these efficient tools to be applied to help solve as quickly and as effectively as possible their pressing problems of food production and storage.

Foundation of the Joint Division

In 1964 two international organizations within the UN system, the Food and Agriculture Organization and the International Atomic Energy Agency, decided to establish a joint programme for the specific purpose of assisting Member States in applying nuclear techniques to develop their food and agriculture. As a result, the

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More productive varieties of crops can be developed through the use of nuclear techniques. Here the participants in a FAO/IAEA/SIDA regional training course in Indonesia in 1979 learn about the use of induced mutations in plant breeding.

Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development was established at the IAEA Headquarters in Vienna. Connected with this Division is the Agriculture Section of the IAEA Laboratory at Seibersdorf, outside Vienna.

The agreement between FAO and IAEA has functioned remarkably well thanks to the good will and co-operative spirit of the governing bodies and administrations of both organizations. The agreement and the joint programme are still a unique example of inter-agency co-operation within the UN system.

A very real and satisfying result of this joint operation is the way it has been possible in most Member States to combine the interests of the two separate national authorities for atomic energy and for agriculture, in the application of nuclear techniques to food and agriculture. There are many examples which show that anything but a joint approach would have been unsuccessful.

The objectives of this joint FAO/IAEA programme are to exploit the potential of isotopes and radiation applications in research and development to increase and stabilize agricultural production, to reduce production costs, to improve the quality of food, to protect agricultural products from spoilage and losses, and to minimize pollution of food and the agricultural environment. The programme supplements and supports priority areas of FAO and IAEA activities where isotope and radiation methods are particularly promising.

Activities

The Joint Division is organized by subject into six sections: soil fertility, irrigation, and crop production; plant breeding and genetics; animal production and health; insect and pest control; agrochemicals and residues; and food preservation. In addition, the Agriculture Section of the IAEA Laboratory plays an active supporting role whenever requested by the Member States. Although most of the research and development work using nuclear techniques is carried out in the countries themselves, the Laboratory provides various services, such as training, and carries out analyses and supplemental investigations on request.

The activities of the joint programme can be grouped under three main headings: co-ordination and support of research; technical assistance including training; and dissemination of information.

- Presently over 300 research institutions or experimental stations in Member States are co-operating in some 25 co-ordinated research programmes. Each such programme attempts to solve a practical problem of economic significance for developing countries. Institutes in developing countries are normally given research contracts with nominal financial support, whereas institutes in the developed countries participate without payment. The participants in such a programme meet periodically to review results and to discuss and decide on the future approach. Each programme usually has about 15 research contract and agreement holders, and can last up to five years. Table 1 gives a breakdown of the research contracts and agreements held with institutes in Member States.

- The joint FAO/IAEA programme is currently responsible for the technical management of some 86 technical assistance projects in 46 developing countries, providing training, expertise, and specialized equipment (Table 2). Among these there are four large-scale projects in Brazil and Peru (UN Development Programme) and in Bangladesh and India (Swedish International Development Authority). Large-scale projects in Indonesia, Sudan, and Thailand are being planned. In addition to fellowship training, three or four international training courses are arranged annually. Since its inception, the Joint Division has helped organize, supervise, or has participated in

Table 1. Research contracts and agreements in food and agriculture active May 1981

Member State \ Subject	Soil science	Plant breeding	Animal science	Entomology	Agrochemicals and residues	Food preservation	Total
Argentina	1	3	1			1	6
Australia	2	3	4				9
Austria		1		2	1		4
Bangladesh	4	1	2	1		3	11
Belgium	1			2			3
Brazil	3	1	2		1	1	8
Bulgaria		1					1
Canada		2		2	3		7
Chile	2	2				1	5
Colombia			1				1
Costa Rica					1		1
Cyprus	1	1					2
Czechoslovakia		1		1			2
Denmark		3					3
Dominican Republic			1				1
Egypt	3	5	1		6	3	18
France	3			1			4
German Democratic Rep		1					1
Germany, Fed.Rep of	3	2	1	1	3		10
Ghana					1		1
Greece	1						1
Hungary		4	1	1	1	1	8
India	9	11	4	2	5	2	33
Indonesia	1	4	3	2	1	3	14
Iraq					1		1
Ireland			1				1
Israel	2	2	1	2	1	1	9
Italy	1	4		1		1	7
Ivory Coast	1						1
Japan		1				1	2
Kenya	1	1	2	2			6
Korea, Rep of	1	2	1	1	1	1	7
Lebanon		1					1
Malaysia		3	1		1		5
Mauritius	1	1					2
Mexico	1						1
Netherlands	1				1	1	3
Nigeria	2		1	1		1	5
Pakistan	1	5			1	1	8
Panama	1						1
Peru		1					1
Philippines		1	1		1	3	6
Poland		1			2	1	4
Romania	4						4
Senegal	2						2
Sri Lanka	2	1	5	1		1	10
Sudan			1		1		2
Sweden	1	1				1	3
Syrian Arab Republic	2	1					3
Thailand	2	4	1			4	11
Trinidad	1						1
Turkey	1				1		2
USSR					2		2
UK	3	3	3	2	2		13
United Rep of Tanzania	1	1					2
USA	6	5	2	1	7	1	22
Uruguay	1		1				2
Venezuela			1				1
Yugoslavia		2			3		5
Zambia	1						1
Total	74	87	43	26	48	33	311

Research agreements awarded to institutes in developed Member States are normally on a cost-free basis

Table 2. Technical assistance projects in food and agriculture operational June 1981

Member State \ Subject	General	Soil science	Plant breeding	Animal science	Entomology	Agrochemicals and residues	Food preservation	Total
Algeria							1	1
Bangladesh	1			1			2	4
Bolivia		1						1
Brazil	1							1
Bulgaria			1					1
Burma			1					1
Chile							1	1
Colombia				1				1
Costa Rica						1		1
Cuba							1	1
Cyprus						1		1
Czechoslovakia							1	1
Ecuador				1				1
Egypt		2		1				3
Ghana	1				1			2
Greece		1						1
Iceland	1							1
India	1							1
Indonesia				1				1
Israel						1		1
Ivory Coast		3						3
Kenya		1						1
Korea, Rep. of	1			1				2
Libyan Arab Jamahiriya			1					1
Malaysia		2	1	2		1		6
Mali		1	1					2
Mauritius		1						1
Mexico					1			1
Morocco		1		1				2
Nicaragua	1							1
Nigeria				1	1			2
Pakistan		1					1	2
Panama		1						1
Peru	1							1
Philippines		1	1	1				3
Senegal		3						3
Sri Lanka		2		1				3
Sudan			1	2		1		4
Thailand			1	1		1		3
Turkey				2				2
United Rep. of Tanzania		2						2
Uruguay		2		1		1		4
Venezuela		1	1					2
Vietnam			1					1
Zaire		1	1				1	3
Zambia		2		1	1			4
Total	8	29	11	19	4	7	8	86

87 agricultural training courses and study tours in 33 Member States. Of the training courses five have been held in the IAEA Laboratory. Since 1969 there have been some 800 fellowships in agriculture with an average length of six to eight months; some 48 of them were in the IAEA Laboratory.

- Scientific meetings are important in giving scientists from Member States the opportunity to exchange views and to keep up-to-date in specialized fields. Approximately two symposia and two seminars annually are organized as part of the joint FAO/IAEA programme. The publication of scientific results of practical importance obtained through the programme is also encouraged and close to 100 publications have been issued since 1964 in fields relevant to the joint FAO/IAEA programme. In many cases these are the only publications on the subject readily available to agricultural research workers in the developing countries. The Joint FAO/IAEA Division also maintains regular contact with Member States by producing periodical Newsletters.

Energy and agriculture

The Joint FAO/IAEA Division aims to solve practical problems in the production and protection of food and agriculture. It seeks to avoid academic questions and encourages collaboration with international, regional, and national organizations.

The Joint FAO/IAEA programme was previously geared towards solving practical problems within the context of the "Green Revolution". As part of this "Revolution", large amounts of fertilizers, pesticides, etc. (which are heavy consumers of energy) were used. Although the emphasis on production must be maintained if people are to be fed, the high cost of energy is leading to a change in emphasis towards agriculture with a minimum of these expensive inputs. Examples are the co-ordinated research programme aiming at increasing the biological fixation of atmospheric nitrogen in field crops; or the programme on efficient fertilizer use in a multiple-cropping system.

The energy crisis will further spur activities to improve the so-called "no tillage" crop-production, whereby crops are grown without energy-demanding soil cultivation and less water is consumed in irrigation. This calls for the use of isotopes to study the fertility of and the cycle of nutrients in the soil under these conditions.

Radio-immunoassay techniques are being used to help solve the problem of poor reproductive performance of livestock. The feed necessary to sustain and increase this production is being sought in better cereal straw and other agro-industrial by-products treated and supplemented with non-protein nitrogen compounds. Isotopes are aiding these investigations.

It is a sad fact that many insects have developed resistance to insecticides, some towards every known insecticide. This has created enormous problems for food production and for human health in the tropics and sub-tropics. It is not unusual, for example, to protect a cotton crop by spraying it 15 to 20 times with various insecticide formulations, and this naturally creates severe economic as well as environmental problems. Joint FAO/IAEA activities therefore include inducing mutations in plants to breed strains that are resistant to diseases and pests, and also include the use of the Sterile Insect Technique to control pests both cheaply and without causing environmental pollution. Similarly, drug resistance is a problem in the control of parasitic and other diseases of animals, and isotope-aided programmes have been started to help resolve these problems.

Finally, the food irradiation activities of the Joint Division should be mentioned as an effective means of preservation of food, because it is an environmentally clean process, which is low in energy requirement and does not leave any residue in the treated product.

Nearly all the joint FAO/IAEA activities can be called technical assistance to developing Member States, not only in the classical sense of covering packages of expert, equipment, and training, but also through financial support of research contracts to help solve priority problems. The co-ordinated research programmes which draw together scientists from developing countries to attack such problems not only contribute to their solution, but also result in an interaction which brings up the level of knowledge and experience of all participants to above that of even the most experienced of the group, and results in co-operative work which lasts well beyond the length of the programme. In many cases the research programme is the trigger for the development of technical assistance projects in the country, the contract holder himself often being a former technical assistance trainee. There are good examples of this pattern developing into comprehensive large-scale projects.

In some of the developed countries nuclear techniques in food and agriculture have been more or less assimilated into standard laboratory techniques as part of the normal university curriculum. This is, however, rarely the case in developing Member States. Unlike most other fields of application, agricultural information is not transferable because the agricultural ecology of developed and developing countries differs and there are also individual differences, sometimes major ones, between developing countries in soils, climate, and crops grown.

The joint FAO/IAEA programme is designed to bridge this gap and to assist research efforts to solve specifically agricultural economic problems under the prevailing socio-economic and ecological conditions.

References

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