THE HISTORY OF

THE JOINT FAO/IAEA DIVISION

OF

NUCLEAR TECHNIQUES IN

FOOD AND AGRICULTURE

AND ITS ALLIED LABORATORY

(1964 - 1994)

BY
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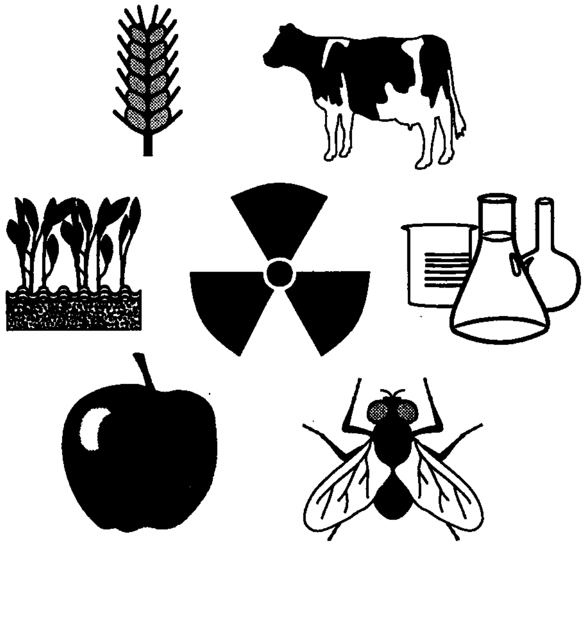

RIFA / AGE

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PROLOGUE
(very freely after Hans Christian Andersen)

Once upon a time - indeed over 30 years ago - there was a mother duck sitting on her nest, - busy hatching her little ducklings. She was getting rather tired of it because it was taking so long.

At long last the eggs began to crack, one after the other, and small duckling heads were popping out. "Quack! Quack!" she said, "Quick! Quick!". And they were as quick as they knew how.

"Well now, I hope you are all here", said their mother and got up from the nest to have a look. "Why no, I haven't got you all yet! The biggest egg's still there"!

And it took quite a long time before that egg finally cracked, and the last duckling was born.

But all the other ducks in the pond found it was a strange and ugly looking creature made for pecking and they turned against it. The ugly duckling only survived because of the loving care of its proud mother, but it also quickly learned how it had to fend for itself and the necessity of always having to prove its worth among the other ducks in the pond.

This story is analogous to the birth of the Joint FAO/IAEA Division: how two International Organizations joined forces some 30 years ago to assist food and agriculture at institutions in developing countries to make the best use of the then new isotope and radiation tools to improve yields and quality. That joint programme also had to fight hard for its survival because nuclear techniques in agricultural research usually got low priorities when methodology and funding became the issue. In effect, when the programme was born it shared the fate of the ugly duckling.

But the duckling in the pond grew up from a clumsy, grey-black bird - plain and ugly - into a beautiful white and proud swan.

And, likewise, today the Joint FAO/IAEA programme - born as an ugly duckling - has proven to be a beautiful white and proud swan.

It doesn't matter if you are born in a duckyard, when you have been hatched out of a swan's egg.

INTRODUCTION

The objective of this book has been to write up the history of the Joint Division and its allied laboratory, which celebrates its 30th birthday on 1 October 1994, and to throw light on the Division's rise from obscurity to distinction; - just as the "ugly duckling" in the fairy tale paraphrased in the Prologue.

The material has been compiled on the basis of information available from FAO and IAEA documents such as Annual Reports, Reports from formal meetings (General Conferences, IAEA Board and Scientific Advisory Committee Meetings, FAO Council, Programme and Finance Committee Meetings etc.), Manning Tables, Budgets, Administrative Manuals, a variety of technical reports and pamphlets as well as records on technical assistance/ cooperation field projects, fellowships, scientific visits, training courses, coordinated research programmes, publications and scientific meetings. Most of the information in these records has been computerized by the relevant Divisions, but not all information required - especially from the early years - was readily available, and some even inaccessible.

An invaluable additional source of information has been interviews and correspondence with former and present staff members and others close to the Division.

My own association with the Joint Division at intervals during many years since 1962 has been the prerequisite why I agreed to attempt writing this story about a Division very near to my heart.

The material has been arranged in four main groups (ref. List of Contents):

the set-up of the Joint Division and the Agriculture Laboratory, (Chapters 1 - 4)

the activities of the Joint Division, (Chapters 5 - 10)

a chronological description of each of the six Sections of the Joint Division including the relevant laboratory activities. (Chapters 10 - 16)

The Joint Division´s future outlook as perceived by the present Director, Dr. Björn Sigurbjörnsson, (Chapter 17)

It has not been my intention to present a very detailed description of the individual Sections and their allied laboratory units, but rather to highlight the research undertaken, promoted and supported for the benefit of food and agricultural production in the developing Member States. The coordinated research programmes and the international symposia have been emphasized, because the individual research efforts have been trendsetting and provided the backbone to the programmatic activities of the technical cooperation field projects, the curriculae of the training offered and in the contents of the many meeting and publications.

No attempt has been made to compile a complete list of all meetings arranged by the Joint Division. Also, information such as all technical cooperation field projects, all fellowships, and all research contracts and agreements has only been summarized, while details - also of regular and extrabudgetary resources - can be found in the original documentation.

I am indebted to my former colleagues in FAO and IAEA - active as well as retired - for their invaluable help in gathering this material, and for their constructive criticism and the many corrections. Any oversight, omissions, inconsistencies or incorrect information that may still be found in the text is my responsibility, and I can only apologize for such unintentional lapses.

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CHAPTER 1

CONCEPTION, BIRTH and ADOLESCENCE OF THE JOINT DIVISION

CONCEPTION, BIRTH AND ADOLESCENCE OF THE JOINT DIVISION

PEACEFUL USES OF NUCLEAR ENERGY

When Fermi's nuclear reactor reached criticality in Chicago in 1942 the expectations for a peaceful utilization of the energy released by nuclear fission got a significant boost.

Of course, many small laboratory experiments had already been carried out, and noteworthy was de Hevesy's research in Vienna in 1913 with the first radioactive tracer experiments. His pioneering work led to the use of radioisotopes - and later also stable isotopes - as indicators in investigations of chemical and biochemical processes. De Hevesy's classical use of a radioactive lead isotope in Copenhagen in 1934 to study the uptake of nutrients in plants paved the road for numerous practical research applications aiming at optimizing fertilizer uptake.

Likewise, plant breeders had been using the ionizing properties of X-rays to induce mutations in plants as a complementary tool in their efforts to improve crops. The radiation stemming from decay of radioisotopes - and later also neutrons abundant in the fission reactions - would provide a strong physical means of mutation induction, and in this context the pioneering work of Stadler in 1928/30 and Gustafsson ten years later, working with barley improvement deserve mention.

In entomology the Sterile Insect Technique was born in the 1950's through the research of E.F.Knipling, R.C.Bushland and A.W.Lindquist.

Radioisotopes had indeed been rare and costly but harnessing the nuclear fission process in an atomic reactor dramatically changed the picture, and soon after the Second World War radioisotope production started in many laboratories.

Radioisotopes of plant nutrients of agricultural interest such as phosphorus became available at prices within the reach of the scientific community. This enabled experiments in farmers fields - rather than in the laboratory -resulting in unequivocal answers to such practical questions as to which agricultural practice results in the optimal utilization of a fertilizer by the crop, or the availability to the plant of the nutrient found in the soil.

Pioneering research with phosphate - based on the isotope dilution principle - by Fried and Dean in USA with their A-value, Larsen in Denmark defining his L-value and Fredriksson in Sweden became the starting signal of field applications all over the world to solve problems of assessing nutrient availabilities in soils.

Other radioisotopes such as of sulphur and rubidium (to simulate the plant nutrient potassium), as well as of zinc and manganese, both of which are essential micronutrients in plant growth, were also utilized in similar experiments, and when the stable isotope nitrogen-15 became available many years later, research work literally exploded in efforts to measure the amount of nitrogen biologically fixed from the atmosphere by rhizobia/legumes directly in the fields.

In efforts to promote the peaceful applications of nuclear energy on the international scene the US president Dwight Eisenhower took the initiative of establishing what became known as the International Atomic Energy Agency (IAEA) as a Specialized Organization within the UN system, with its HQ's in Vienna.

Also, a series of International Conferences on the Peaceful Application of Nuclear Energy were organized in Geneva to provide a forum for the exchange of information and experience obtained in various fields by scientists all over the world.

CONCEPTION OF THE JOINT DIVISION

In fields of food and agriculture the FAO established an Atomic Energy Branch in 1957 within the Agriculture Department at its HQ's in Rome. Research on using nuclear techniques in food and agriculture was promoted by the IAEA through its then Unit of Agriculture established in 1959 within the Division of Isotopes in the Department of Research and Isotopes. This work was supported by the IAEA Laboratory, which came into being at the Austrian Nuclear Research Centre (Studiengesellschaft für Atomenergie, ÖSGAE), at Seibersdorf outside Vienna on 1 September 1961.

With two international organizations working independently with the similar objectives, overlapping and even duplications were almost unavoidable. As a result it became clear that a substantial coordinating effort was urgently required.

Contacts between the Directors General of FAO (B.R. Sen) and of IAEA (Sigvard Eklund) resulted in detailed negotiations on an agreement for a joint approach to promoting nuclear techniques in food and agriculture in the developing world.

Key professional staff members at that time in the FAO Atomic Energy Branch included Ronald A. Silow, who was Chief of the Branch, Francisco A. Hoyos, Knut Mikaelsen, Gordon E. Wortley, Harry E. Goresline and Hans Broeshart.

Their professional opposites in the IAEA Unit of Agriculture included Harold H. Smith, Nathan Coleman, Maurice (Mac) Fried, Peter Nye, Robert A. Olson, Claude Schmidt, Ed Engelbert, Carl G. Lamm, Björn Sigurbjörnsson, Lars-Eric Ericson and Jack Keller.

The IAEA Laboratory had attracted the following agricultural scientists: Hans Broeshart, Helmut Brunner, Helga Axmann, Kiyoshi Tensho, Chai Moo Cho and John Monroe.

At the administrative supervisory level negotiations included the FAO DDG Oris W. Wells and ADG (Agriculture Department) Otto Fischnich as well as the IAEA DDG (Department of Administration) John Hall and the DDG (Department of Research and Isotopes) Henry Seligman.

Difficult discussions on a 'modus vivendi' for a joint FAO/IAEA approach took place during many meetings between the two organizations. However, a breakthrough is said to have occurred when the two DG's attended the same concert during the Festspiele in Salzburg.

Negotiations to work out an agreement as well as the financial implications continued with renewed force. E. Engelbert of IAEA sat down with R. A. Silow of FAO to prepare details, and Peter Vose was stationed in Rome during the beginning of 1964 as technical liaison officer on behalf of IAEA.

BIRTH OF THE JOINT DIVISION

Satisfactory "Arrangements" were finally concluded. They came into effect on 1 October 1964 for the establishment of the JOINT FAO/IAEA DIVISION OF ATOMIC ENERGY IN AGRICULTURE, (referred to below as the Joint Division).

The Joint Division was to be established to provide an effective service to Member Governments of the two parent organizations by pooling of their technical and financial resources, for the common objective of developing food and agriculture through the application of atomic energy techniques.

The Joint Division was to be located at the IAEA HQ's in Vienna; - one reason for this decision being the existence and availability for agricultural research of the IAEA Laboratory as well as the existing research contract programme offered by IAEA.

The Joint Division was staffed by scientists from FAO as well as from IAEA, with Maurice Fried as its

Director, and Ronald A. Silow as Deputy Director.

The "Arrangements" were ratified in 1966, and the text is found in the Appendix. They essentially spell out that the Joint Division has the overall technical responsibility for the application of nuclear techniques in food and agriculture, and that all its activities are carried out in the name of both its parent organizations, FAO and IAEA. The Agriculture Laboratory at Seibersdorf was to support these activities as appropriate through training, research and services. Budgetary details and a list of professional staff are found in Chapters 2 and 4.

The administrative set-up and the name of the Joint Division have changed over the years as shown in Chapter 2.

The Joint Division is organized to cover six subject areas in six Sections, and their history and activities are dealt with individually below (Chapters 11 - 16). The Agricultural Laboratory is described in Chapter 3. It is presently subdivided into 5 Units, each corresponding to a Section in the Joint Division; their history and activities are shown in the description of the relevant Section. Only the Food Preservation Section is being supported by outside facilities such as those arranged by IFIP and IFFIT and lately by ICGFI.

ACTIVITY COMPONENTS OF THE JOINT DIVISION

The activities of the Joint Division can be subdivided into five components (see also Chapters 5 - 10):

RESEARCH SUPPORT AND COORDINATION

Close to 40% of the work of the Joint Division is devoted to servicing research contracts and cost-free research agreements, all concluded with individual scientists and institutes in Member States.

Almost all of the research contracts and agreements are integrated in a number of Coordinated Research Programmes (CRP). Each CRP has the well defined objective to solve a practical agricultural problem common to all participants. Contracts are concluded almost exclusively with scientists in the developing Member States and involve yearly financial support of some $ 2 - 5000. Cost-free Agreements are generally concluded with scientists in industrialized countries. Each CRP is planned to last no longer than five years.

The results obtained in a CRP are reviewed periodically at a Research Coordination Meetings (RCM) in which all participants are invited to participate at the cost of FAO and IAEA. Renewal of a contract or an agreement is based on a satisfactory progress report. The CRP's are funded either by the Regular Budget or through extrabudgetary resources.

The first research contracts were individual, i.e. not part of a CRP. They were approved by the IAEA during 1959, and were at that time primarily awarded to developed countries. Two of them dealt with radiation induced mutations in plant breeding (Japan, Yugoslavia), and two supported work on fertilizer use efficiency (Japan, Federal Republic of Germany). During the following year individual contracts also included scientists in Italy, UK, China (Taiwan) and Portugal.

The first CRP's were initiated:	Total No. of CRP's during 1962-94
1962 in a subject of soil science,	(28)
1964 in a subject of plant breeding,	(35)
1966 in a subject of animal science,	(32)
1962 in a subject of insect control,	(20)
1970 in a subject of agrochemicals and residues,	(31)
1966 in a subject of food irradiation,	(25)

The figures in parenthesis show the number of concluded and presently operational CRP's in the six main areas of research. In total over 170 CRP's with an estimated total of some 3000 participants have been or are in existence. (See also Chapter 5).

TECHNICAL ASSISTANCE AND COOPERATION

Scientific backstopping of technical assistance activities dealing with nuclear techniques in food and agriculture account for almost 40% of the work of the Joint Division, and include field projects as well as training (see item 3 below).

The majority of the field projects are 'small-scale', i. e. lasting for one or two years and usually comprising only one research area, but several 'large-scale' projects (i. e. lasting for at least three to five years and including several different research objectives) have been or are in operation. They were usually funded by the UNDP (formerly the Special Fund) or through contributions from other extrabudgetary resources. The first large-scale UNDP funded project executed by the IAEA and dealing with nuclear technology applications in agriculture was started in (the former) Yugoslavia in 1961. This project was later followed by similar type projects in India (UNDP and the Swedish SIDA), Brazil (UNDP), Bangladesh (SIDA), Indonesia, Thailand and Korea (all UNDP) as well as Venezuela (Regular IAEA Budget and UNDP), (see also Chapter 6).

TRAINING

This technical assistance activity includes individual fellowships and scientific visits as well as training courses and study tours on regional or interregional basis. The Agricultural Laboratory at Seibersdorf has played an increasingly important role in hosting trainees and interregional training courses.

The first IAEA training course entitled Radio-Isotope Techniques in Agricultural Research was held for 18 participants from developing countries in Cornell University, USA, in July-September 1959. (See also Chapters 7 and 8).

MEETINGS

Dissemination of information is achieved through scientific meetings which include International Conferences, Symposia, Seminars (often regional), Panels of Experts, Advisory Group Meetings or Consultant Meetings in addition to the already mentioned RCM's.

The first IAEA meeting in a field of food and agriculture was an International Conference on the Preservation of Foods by Ionizing Radiation (cosponsored by Massachusets Institute of Technology and the United States Atomic Energy Commission) held in July 1959 in Cambridge, USA. (see also Chapter 9.)

PUBLICATIONS

Information dissemination is further carried out through publications such as proceedings or technical documents. Important are also the many laboratory training manuals issued as textbooks for the training courses. In addition, each of the Joint Division Sections distribute cost-free Newsletters to subscribers, the purpose of which is to establish and maintain contact with individual scientist who have a chance of reporting on their own research.

Finally, staff members of the Joint Division are encouraged to submit manuscripts on relevant research to international scientific journals, and very many such publications have appeared over the years.

In 1960 FAO published a report: "Radioactive Materials in Food and Agriculture", FAO Atomic Energy Series, Nr. 2, pp 123. (see also Chapter 10.) The first IAEA publication on food and agriculture was a review entitled "Radiation in Agricultural Research and Practice" from 1961.

THE IAEA SCIENTIFIC ADVISORY COMMITTEE, (SAC)

In 1958 the IAEA established SAC which was composed of nuclear scientists of international eminence serving in their individual capacity and not as representatives of their Governments. The Committee was to meet periodically to provide advice to the Director General on the IAEA technical programme.

In particular, SAC would consider and make recommendations on proposed scientific conferences and meetings. Advice was also to be given on the research contract programme as well as the Laboratory activities and the proposed publications.

The first SAC committee consisted of the following 7 members:

- Professor H. J. Bhabha, India.
- Sir John D. Cockcroft, UK.
- Professor V. S. Emelyanov, USSR.
- Professor B. Goldschmidt, France.
- Dr. B. Gross, Brazil.
- Dr. W. B. Lewis, Canada.
- Professor I. I. Rabi, USA.

SAC met in Vienna once a year until the Committee was abolished in the late 1980´s. SAC has had a substantial influence on the programmatic activities of the Joint Division.

Similarily, the Joint Division´s programme has been regularly reviewed by FAO through its Committee on Agriculture (COAG), and Commission II of the FAO General Conference and the FAO Programme Committee.

REVIEWS OF THE JOINT DIVISION

The Governing bodies of FAO as well as IAEA have required periodic reviews of the Joint Division. Thus:

1966
A review was undertaken by Sir John Cockcroft, UK, Professor C. Dakshinamurti, India, Professor Åke Gustafsson, Sweden, and Professor A. W. Lindquist, USA. Their comprehensive report dated 29 September 1966 was submitted to the Directors General of IAEA and FAO, and was subsequently distributed to the 14th Session of the FAO Conference, November 1967.

The report represents a generally very positive assessment of the Joint Division´s programme. In particular, the report spells out the different administrative procedures, budgets and policies of the two parent organizations as well as noting that the terms of reference, outlook and philosophy of the organizations are somewhat different.

Two paragraphs from the report are quoted here:
§84. "We think that there has been some misunderstanding of the nature of the work of the Joint Division. The whole of the work has the practical objective of increasing food supplies or reducing losses. No fundamental research is carried out......"§86. "The overall budget of the Joint Division is about $ 800.000 per annum. We consider that the Joint Division is doing a remarkably good job with very modest resources......"

1968
This was the year for an in-depth review of the Joint Division requested by FAO. The report was submitted to the Program and Policy Advisory Board (PPAB) on 21 March 1968. Particular attention was paid to the need for close contacts between the Joint Division and the FAO HQ´s, as well as the matching of equal funding from FAO and from IAEA for new or enlarged work in the Joint Division.

1972
A special FAO review was undertaken and the report was submitted to the 22nd Session of the Programme Committee in October 1972. §6 is quoted here: "After a few years of finding its footing within the framework of reference and the structure of two very different Organizations, the Joint Division has developed into a single unit operating in harmony, with each staff member, regardless of his source of salary, equally dedicated to the objectives and ideals of both parent organizations has increased markedly. Understandably, the Joint Division was accepted and accomodated more quickly by the IAEA because it was administratively set up within that Agency and daily contacts were possible with staff of other units of the IAEA. Because of its location in Vienna, it took longer for the Division to become truly integrated into FAO´s setup and activities. Visits by Joint Division staff to FAO are encouraged as far as the Division´s budget will allow. Such visits have been extremely useful and the personal contacts have resulted in close and effective cooperation with related sectors of FAO".

The report also cites several examples of the contribution of the Joint Division to the work of FAO, and acknowledges that: "all these activities regardless of the source of funds are carried out in the name of FAO as well as IAEA".

1973
A review had been requested by the Directors General of FAO and IAEA, and the review took place during February 1973.

The review Committee comprised Professor Bruno Straub, Hungary, Ing. Ewald A. Favret, Argentina, Dr. Faustino T. Orillo, Philippines, and Dr. Ralph W. Phillips, USA.

As was the case in some of the previous reviews, their report discussed the different terms of reference, philosophy and outlook of the two organizations, coupled with the fact that the FAO and IAEA programme years are out of phase. This all greatly increases the workload of the Joint Divisions Director´s office compared with other divisions of either organization.

Thus, §39: "FAO is primarily oriented to application of known information to agriculture, fisheries and forestry, while IAEA was established to develop and encourage the peaceful uses of atomic energy, if necessary by carrying out itself, or through contractors, research and development of such uses for the benefit of Member States."

§40: "This dichotomy of approach has led from time to time to criticism by the Governing Bodies of both organization of the Joint Division´s method of operation and the priority assigned to its various activities. This dichotomy is also partly due to the fact that there is frequently competition or misunderstanding at national level between atomic energy authorities and ministries or departments of agriculture."

The Committee recommended that the Director General call to the attention of the Member States the need for adequate coordination within countries in respect of matters concerning application of nuclear science in food and agriculture.

The Committee also addressed the often made allegation that over-selling of nuclear techniques has sometimes taken place through the Joint Division´s activities. However, the Committee recognized that in the development of new techniques this is perhaps an inevitable tendency, and recommended a careful preparation of all presentations and evaluations to avoid any accusation of over-selling.

Finally, the Committee expressed its satisfaction that strong efforts had been made to ensure cooperation between divisions in the two organizations, and also stressed the need to re-examine the basis for establishing the contribution to the Joint Division's budget from both organizations.

1985
Two consultants, Dr. D. T. Canvin, Canada, and Dr. D. L. Umali, Philippines, were invited to appraise the impact in Member States of the Joint Division's training and research activities. The review was partly based on some 400 replies to questionnaires, which had been sent to former IAEA fellowship trainees and training course participants. Likewise, over 600 research contract and agreement holders participating in CRP's were approached. The Consultant Report to FAO was submitted in January 1985.

The great majority of trainees - 94% - reported that the training received had been "useful" or "very useful". Also, the review of the questionnaires returned from participants in CRP's showed that "Overall, the national research contractors claimed that the Joint Division's programmes were very satisfactory", and in addition agreement holders uniformly praised the value of the RCM's.

1988
Six consultants, Drs. A. O. Abifarin, (WARDA, The West African Rice Development Association, Monrovia, Liberia), Jorge de Alba (Mexico), W. Klassen (USA), E. D. Magallona (Phillipines), Max Whitten (Australia) and D. Zwart (Netherlands) constituted an 'ad hoc' Group of Experts to Review the FAO/IAEA Agricultural Programme, during 28 November to 2 December 1988 in Vienna.

In its comprehensive report the review team expressed satisfaction with the Joint Division's activities and concluded that on the whole the Member States are receiving a very good return on their investments in the Division. Virtually all of the problems tackled by the Joint Division are of significance to the economic progress of developing countries. All of these efforts are based on nuclear techniques of various types.

Specifically, the review team found that a limited laboratory based on molecular biology capability should be acquired immediately to bring fresh scientific perspective into all Sections. Areas which could potentially benefit included: animal disease diagnosis; - animal vaccines; - genetic methods of insect pest control; - biological control of plant pathogens; - nitrogen fixing microorganisms; - plant protection against pests and diseases using genetically engineered plants; - and, improvement of plant and animal production using genetically engineered plants and animals.

ADOLESCENCE AND DEVELOPMENT OF THE JOINT DIVISION

The Unit of Agriculture and subsequently the Joint Division was given office space at the temporary IAEA HQ's on Kärntnerring in the heart of Vienna. The old Grand Hotel had been assigned to the IAEA and the agricultural staff occupied space on the fourth and the fifth floors, which one could reach by elevators to the fourth and then by a staircase.

All offices in the old building had been hotel rooms, lounges etc. and most of the rooms had an adjacent bathroom. These were big and spacy with goldplated faucets and absolutely unfit to serve as modern offices except as storage and file rooms. Nevertheless, as the IAEA and also the Joint Division grew, more and more bathrooms were turned into office cubicles for some unfortunate staff.

Harold H. Smith was the first Head of the Unit of Agriculture during 1958, and he devoted much effort on missions to develop appropriate contacts with agricultural communities in developing Member States.

He was succeeded by Nathan Coleman in 1959. This was the year of the first formal cooperation with FAO through the joint organization of an international training course with the cooperation of the Government of USA. The course was held from 20 July to 10 September at Cornell University, and it was the first internationally organized training course on radioisotope techniques to be designed specifically for the needs of research workers in agriculture, forestry, fisheries and nutrition. Training courses with relevance to nuclear techniques in agriculture were then held in November/December in

Argentina and in India during January/February 1960.

Maurice Fried became the third Head of the Unit from 1960 until four years later he took over as Director of the Joint Division. Under his leadership the Unit of Agriculture and later the Joint Division's training, meeting but especially the research activities took off. 1961 saw the second practical example of FAO/IAEA cooperation through studies of the application of radioisotopes in the investigation of the suitability of certain fertilizers in tropical and subtropical conditions, and also of the use of radiation for the improvement of crop plants. A substantial amount of bibliographic work was undertaken to supplement these studies.

Three cornerstones characterized Maurice Fried's philosophy, which he faithfully and consistently adhered to during his twenty years tenure as Director, thereby leaving his lasting mark on the Joint Division:

- to maintain and secure the closest possible liaison and collaboration with FAO in Rome.
- to always stress that the Joint Division's programme is problem oriented rather than technique oriented.
- never to over-sell the application of nuclear techniques in research on food and agriculture.

Maurice Fried's philosophy has been followed ever since.

The concept of coordinated research was born in 1962, when three CRP's were initiated; - one on application of isotopes in studies of rice fertilization, one on plant nutrient supply and movement in soil systems, and one entitled "insect control using radiation". Two years later a CRP was started on the use of induced mutations for rice improvement.

Training had always been emphasized and the programme of training courses in food and agriculture grew during the early years with one international course in 1959, two in 1962, three in 1963, one in 1964 and five in 1965. Likewise, the fellowship programme increased with 17 trainees in 1958, 27 in 1959, 43 in 1960, 40 in 1961 and 50 in 1962.

While two international conferences were arranged in the period 1959 - 64, the same years saw 5 symposia in addition to many smaller meetings. During those years 4 publications appeared in subjects of soil science, 1 in plant breeding, 4 in insect and pest control and 1 in food irradiation.

The first large-scale UNDP/Special Fund project executed by IAEA was started 1962 in Yugoslavia. The purpose of this technical assistance project was the creation of an institute for the application of nuclear energy in agriculture, veterinary sciences and forestry at Zemun outside Belgrade. Several other similar type projects were to follow. (See also Chapter 6.).

Francisco Hoyos became attached to the Director's office in 1964 to 1968 and Peter Vose was appointed Assistant to the Director 1966-68. When Ronald A. Silow retired as Deputy Director in 1968 Björn Sigurbjörnsson took over this post for the next six years.

The activities of the Joint Division were steadily consolidating and the years 1971/72 will exemplify this:

Three main priorities were identified by FAO and emphasized in the FAO/IAEA programme on food and agriculture:

- increase yields of important crops
- close the "protein gap", and
- prevent waste of food.

During the period five RCM's were convened in Tokyo, Nairobi, Seoul and Munich on different research subjects, and five panels were held - mostly in Vienna - to consider the use of isotopes in the study of fertilizer utilization by leguminous crops; the use of non-protein nitrogen in cattle nutrition; studies on pesticide problems; the use of computer models to help in applying the sterile male technique; and to consider the use of radiation and isotopes to control parasitic and associated diseases in domestic animals.

Three symposia were convened, eight new CRP's were started, six interregional training courses and two study tours were held, and eighteen priced and unpriced publications appeared

Programmatic trends during the period included: an expansion of the programme for using nuclear techniques in studies of pesticide residues (replacing former activities on nuclear fall-out) and the CRP on plant protein improvement. Its main objective was to use induced mutations not only to improve protein content and quality of cereals but also to breed for higher yields and disease resistance in legumes. The programme was supported by FRG and later also by SIDA.

Furthermore, the International Food Irradiation Project, IFIP, was launched in 1971 with 21 participating countries; - its main objective being wholesomeness testing of irradiated food.

The Joint Division has always been a supporter of ESNA, the European Society of Nuclear Techniques in Agriculture, and has once hosted its annual meetings as well as several meetings of the ESNA secretariat. The main purpose of ESNA has been to bridge the exchange of scientific information between Eastern and Western European Countries.

A similar organization, ISNA, Indian Society of Nuclear Techniques in Agriculture, was established during the inauguration ceremony of the NRL, the Nuclear Research Laboratory, at IARI in 1971 (see Chapter 6).

In 1974 Carl G. Lamm replaced Björn Sigurbjörnsson as Deputy Director of the Joint Division and he also served as Acting Director during Maurice Fried's one year sabbatical leave in 1974. During that period Robert A. Olson was also attached to the Director's office.

New trends during the following years were dictated by the concern about the environment, which stimulated interest in the joint FAO/IAEA programme in such areas as pesticide residues, sterilization of insects as a means of selectively controlling individual species, and the induction of disease resistance in crop plants by mutation breeding.

At that time, also the impact of the higher energy costs on nitrogen fertilizers triggered increased emphasis on isotope aided work to establish the most efficient and economical methods of using nitrogen fertilizers and optimizing the biological nitrogen fixation.

Thus, while following the recommendations of the World Food Conference in Rome in 1974, the FAO/IAEA programme gave priority to research on how to conserve and make better use of fertilizers to improve crops, to develop and make better use of ground and irrigation water, and to prevent contamination of farm products and pollution of rivers and lakes.

The increased use of induced mutations in plant breeding programmes, largely stimulated by the activities of the Joint Division resulted during 1976 in the release of further 16 improved varieties, bringing the total crop varieties which had been officially reported to have resulted from induced mutations to 126.

One day in 1977 the IAEA had grown out of its temporary HQ's on Kärntnerring, and as a result a couple of divisions, including the Joint Division, were moved to even more temporary offices in Wasagasse in the IXth district as neighbours to the Siegmund Freud museum.

Work in developing Member States through technical assistance field projects and coordinated research kept increasing as illustrated in Table 1 below covering the period 1977-89.

The figures in Table 1 are approximate but clearly indicate the trend of growth.

TABLE 1

Year	Technical Assistance		Coordinated Research	
	No. of field projects	No. of countries	No. of collaborating laboratories	No. of CRP's
1977	71	40	200	24
1978	87	46	200	25
1979	96	48	200	25
1980	134	48	250	25
1981	120	51	300	25
1982	130	50	350	27
1983	141	57	350	27
1984	158	58	400	35
1985	180	62	441	35
1986	191	65	450	43
1987	203	68	480	35
1988	215	69	447	41
1989	229	68	350	45
1990	207	68	375	42
1991	254	72	562	41
1992	212	70	538	35
1993	273	74	578	36

1978 was the year when FAO/IAEA started assisting a large-scale project in Mexico, which used the Sterile Insect Technique in order to stop the northward migration of the Mediterranean fruit fly. The project became a success resulting in the complete eradication of the Medfly from Mexico.

After an impressive construction period the IAEA Permanent HQ's at the Vienna International Centre across the Danube river were ready and inaugurated, and in 1979 the Joint Division moved into its new and modern offices on the 22nd floor of the A-Tower. Already, a few years later there was a need for further office space, which was subsequently found on the 9th floor of the B-Tower.

In 1983 Björn Sigurbjörnsson replaced Mac Fried as Director of the Joint Division, and in 1986 Carl G. Lamm (who had been seconded to the IAEA Division of Technical Assistance and Cooperation as Acting Director during 1984-85) retired and was replaced by Léo E. LaChance as Deputy Director.

On 1 October 1984 the Joint Division celebrated its 20th birthday, and to mark this event the Director General of FAO Eduard Saouma addressed the opening meeting of the 28th Session of the IAEA General Conference in September. An exhibition of the Joint Division activities had been arranged, and this included a buffet serving various irradiated food imported from Member States.

The United Nations Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy was held in March/April 1987 in Geneva, In the course of the debate, delegates agreed that the IAEA should continue to play its central role in promoting international cooperation in the peaceful uses of nuclear energy, especially for the benefit of developing countries.

Subsequent to the 1988 in-depth examination of the Joint Division and its report by a panel of six international experts in nuclear techniques in agriculture (see above), the programme saw a gradual increase in emphasis on the use of nuclear techniques in agricultural biotechnology. This was also reflected in the laboratory activities and - to a certain extent - in the name of the Division (ref. Chapter 2).

1st. October 1989 was the Joint Division's 25 birthday, and to celebrate this event IAEA Director General, Hans Blix, addressed the 25th Session of the FAO Conference in November in Rome, where an exhibition on the Division's activities was presented.

In 1992 Waldemar Klassen replaced Leo E. LaChance, who retired as Deputy Director of the Joint Division.

The Joint Division has always been served by highly competent Administrative Assistants, AA, whose most important responsibility has always been to keep the flow of funds from the various sources both fused and at the same time separably accounted for. The first AA was Christian Weber (1965-75), followed by Margret Weiner (1975-86) to be replaced by the current incumbent Wieslaw Brennecke (1986-).

CHAPTER 2

THE JOINT DIVISION'S NAME, ADMINISTRATIVE SET-UP AND BUDGET

THE JOINT DIVISION´s NAMES AND ACRONYMS

The Division´s name has changed over the last 30 years:

1964/65: The Joint FAO/IAEA Division of Atomic Energy in Agriculture.

1966/67: The Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture.

1980: The Joint FAO/IAEA Division of Isotopes and Radiation Application of Atomic Energy for Food and Agricultural Development.

1986: The Joint FAO/IAEA Division (ref. IAEA Annual Report).

1989: The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (ref. IAEA Annual Report).

Suggested name to reflect actual research responsibilities during the eighties, but never adopted:

The Joint FAO/IAEA Division of Nuclear and (Related) Biotechnology in Food and Agriculture.

Today, the name:

THE JOINT DIVISION

which is used throughout the text, suffices colloquially to refer to the Division, the responsibility of which is to carry out the

THE JOINT FAO/IAEA PROGRAMME IN FOOD AND AGRICULTURE

Likewise today, the following acronymes are used in the IAEA and FAO respectively:

RIFA and **AGE**

THE JOINT DIVISION´s ADMINISTRATIVE SET-UP

Presently the Joint FAO/IAEA Programme in Food and Agriculture is located under:

the IAEA Major Programme: 2, Nuclear Applications
D, Food and Agriculture

and

the FAO Major Programme: 2.1. Agriculture,

and

Programme 2.1.4, Research
Technology Development
Subprogramme 2.1.4.2, Agricultural
Application of Isotope Research

(During the early 1980's this FAO structure was originally introduced with the only difference being the name of the Programme 2.1.4. Research Support).

The Joint Division presently belongs to:

the IAEA Department of Research and Isotopes, and the FAO Agriculture Department.

- - - - - - - - - - - - - - - - - - - -

In the past, the Joint FAO/IAEA Programme was found in the FAO:

Chapter 2: Technical and Economic Programmes
Programme Objective 2.2. Production and Productivity
Programme 2.2.5. Joint FAO/IAEA Programme
Subprogramme 2.2.5.1. Joint FAO/IAEA Programme (AGE).

Likewise, within the IAEA organizational structure, the Joint FAO/IAEA Programme was referred to in the IAEA Annual Reports as follows:

1959/60:	Chapter II,	The Operations of the Agency, item G, Isotopes and Research, (which included health physics, radioactive waste disposal, radiation protection, radiobiology, safeguards as well as isotope applications in medicine and agriculture).
1961/62:	Chapter II,	Scientific and Technical Work, item 2: Radioisotopes and Radiation, sub-item (b), Agriculture.
1963/64:	Chapter I,	Research and Services in the Life Sciences, item 2, Agriculture.
1965/66:	Chapter III,	Isotopes and Radiation Sources, item (a) Agriculture, and item (b) Food Irradiation.
1968/69:	Chapter:	Programmes of Activity, sub-chapter Food and Agriculture.
1989:	Chapter:	Food and Agriculture, with six sub-chapters corresponding to the six Sections of the Joint FAO/IAEA Division.

It is noted, that the IAEA Annual Report for 1964/65 lists - for the first time - the subdivision of the Joint Division's work in six fields in the following order:

- Soil Fertility, irrigation and crop production;
- Plant breeding and genetics;
- Insect eradication and pest control;
- Pesticide residues and food protection;
- Animal production and health;
- Food preservation.

Today, these fields have become the technical responsibilities of six Sections named and usually listed in the following order:

- Soil Fertility, Irrigation and Crop Production;
- Plant Breeding and Genetics;
- Animal Production and Health;
- Insect and Pest Control;
- Agrochemicals and Residues;
- Food Preservation.

For each of the five first mentioned Sections there is a corresponding Unit in the Agriculture Laboratory:

- Soil Science Unit;
- Plant Breeding Unit;
- Animal Production Unit;
- Entomology Unit;
- Agrochemicals Unit.

The Food Preservation Section does not have a laboratory Unit in Seibersdorf, but has been closely linked with two inter-national organizations, IFIP and IFFIT, both of which were in charge of laboratory investigations.

THE JOINT DIVISION'S BUDGET

The Joint FAO/IAEA programme is financed mainly from the assessed Regular Programme Budgets of its two parent Agencies.

The disparity in the allocations in the Regular Programme Budgets of the two Agencies has a historical basis, deriving from the separate budgets before 1964 of the former IAEA Unit of Agriculture and the former FAO Atomic Energy Branch.

The Agreed Arrangements for the Joint Division of 1966 specify that "the costs shall be borne equally by each Agency for any future programme expansion, over and above the 1966 approved budgetary level for the Joint Division", and "funded by the assessed budgets of both Agencies as distinct from expansions under other possible sources of funds."

Interpretation of these statements have - over the years - caused some discussion, and the issues have been further complicated by the different budgetary systems of the two Agencies. Thus:

- FAO and IAEA work on separate programmatic biennia, which are, furthermore, out-of-step (e.g. the FAO biennium 1966/67 overlap the IAEA biennia 1965/66 and 1967/68).

- While the financial support for the Joint Division is on a biennial basis from FAO, the IAEA appropriations are on an annual basis.

- Comparisons of the budgetary appropriations for the Joint Division from each of the parent Agencies have also been complicated by different views of the IAEA Research Contract Programme and the Seibersdorf Laboratory, in both of which the Joint Division has actively participated as a means of supporting its field activities. There are no equivalent laboratory or research programmes in FAO although the FAO Research Networks later came into being with emphasis on the European region.

- In addition to the direct support of the programme of the Joint Division, there is also support for the technical cooperation activities concerned with isotope and radiation techniques applied to food and agriculture. These activities primarily comprise expert services, fellowship training and provision of equipment in a number of field projects (for which the Joint Division assumes technical responsibility) in developing countries. These projects are primarily funded under the IAEA budget but also from UNDP and other extrabudgetary resources, and in a few cases also by the FAO TCP programme.

The above goes to show that a comparison of the support to the Joint Division's programme by FAO and IAEA, respectively, is by no means an easy task and sometimes meaningless if only based on budget figures without consideration of the individual appropriations.

Considered on the 1966/67 biennium basis the support of the Joint Division was approx. $ 0.7 million from IAEA (which at that time neither included the apportioned laboratory costs, nor the appropriations for research contracts, linguistic, printing, publishing, conference and data processing services) and $ 0.4 million from FAO, - or just over half a million dollars per year.

Occasional subsequent programme increases approved by one agency were usually followed by approval of a programme expansion by the other agency. Taking these and the cost increases into account in spite of the policy of recent years of zero-growth budget, as well as subsequent appropriations for the above services and the Seibersdorf laboratory, the total budget for the Joint Division has - as an example - risen during the following 26 years to an estimated 1992 level of some $ 10 million from IAEA and $ 1.7 million from FAO.

To these figures should be added $ 2.8 million extrabudgetary resources and some $ 10 million for technical assistance field projects including training courses. The total resources for the Joint Division's programme thus amounted to almost $ 25 million in 1992, and included cost for the following manpower:

16 P and 8 GS staff at HQ's, and
13 P, 14 GS and 14 M&O staff at the Seibersdorf Laboratory.
(In addition a few FAO Associate Experts as well as professionals on sabbatical leave, cost-free experts and experts recruited by individual TC Projects contribute to the programme implementation as do also a number of GS and M&O staff paid from extrabudgetary funds).

Distributed at the sectional level, each Section was technically responsible for the following percentages of the estimated total resources in 1992:

Soil Fertility, Irrigation and Crop Production	20.8 %
Plant Breeding and Genetics	14.8 %
Animal Production and Health	21.5 %
Insect and Pest Control	20.5 %
Agrochemicals and Residues	14.3 %
Food Preservation	8.1 %

CHAPTER 3

THE AGRICULTURE LABORATORY AT SEIBERSDORF

THE AGRICULTURE LABORATORY AT SEIBERSDORF

THE BEGINNING

During the Second IAEA General Conference in 1958 the Board recommended that the IAEA should establish a functional laboratory in Austria.

Justification for such a laboratory became obvious in 1959 when a physics and chemistry laboratory as well as an electronics workshop were set up in the basement of IAEA's first HQ's in the Grand Hotel in Vienna to support the IAEA programmes.

Detailed plans for the construction and equipping of a new laboratory were elaborated and approved the following year.In addition to the US$ 400.000 set aside in the IAEA budget, the United States offered US$ 600.000 as a gift towards the costs, enabling construction to be done in one single stage.

The site selected comprised an area of 60.000 square meters on land belonging to the Austrian Studiengesellschaft für Atom-energie (ÖSGAE) about 35 km south-east of Vienna near the village of Seibersdorf.

The IAEA General Conference in 1959 recommended that the function of the Laboratory should not exceed: isotope standardization and preparation; - calibration of measuring equipment; - quality control of special material for nuclear technology; - services to the safeguards and health and safety programmes; - and services to Member States which could be undertaken with the facilities provided to carry out the aforementioned activities. Agricultural activities were to be included under this somewhat cryptic proviso.

Another gift from the United States was two trucks equipped as self-contained isotope laboratories (Mobile labs.) providing facilities for basic training in isotope techniques. After an initial try-out in collaboration with three Austrian Universities, the first Mobile lab. was used during a radioisotope training course in Greece, and then in Yugoslavia in an industrial applications course. Later both vehicles were sent to training courses in Asia and Latin America.

The IAEA Laboratories at Seibersdorf were opened in September 1961. Facilities for physics, chemistry, agriculture, medical applications of activation analysis, electronics and a mechanical workshop were all situated there, while hydrology, medical physics and dosimetry remained housed in the basement at the HQ's.

The Laboratory building had a total floor area of about 2.000 square meters and was built and equipped for low-level radioactive work. Additional buildings were subsequently added as new requirements arose, particularly in agriculture, which acquired a "temporary" building constructed with the income of some 15.000 dollars from isotope analyses performed for the International Rice Research Institute. However unsuitable for its purpose the "barrack" provided the base for the laboratory activities in agriculture for some 24 years.

Hans Broeshart, who previously had been a staff member of the FAO Atomic Energy Branch in Rome, was appointed Head of the Agriculture Section of the Laboratory towards the end of 1961.

During the early years of its existence plant breeding using induced mutations, crop nutrition and entomology constituted the agricultural activities of the laboratory. Initially, Hans Broeshart provided leadership for the first two of these categories whilst in 1963 John Monro took charge of the first insect laboratory located in the basement of the laboratory.

As stated in the 1964 Arrangements between FAO and IAEA for the establishment of the Joint Division, the Division has scientific and technical responsibility for the programme of work for the Agriculture

Laboratory. Thus, the Agriculture Laboratory constitutes an integral part of the Joint Division's programme in such a way that while the Joint Division mainly deals with technically administrative aspects, the Laboratory is purely technical, undertaking research and development work into appropriate technologies for transfer to developing Member States, and providing services such as isotopic analyses, irradiation services, quality assurance services and not least, training.

During the initial phase the Laboratory prepared and distributed isotope labelled fertilizers and carried out model experiments to be used in the various CRP's. It established the optimal doses for mutation induction in crop plants as well as the technology for irradiation, mass rearing and release of insect pests. As an invaluable service to Member States the Laboratory undertook routine chemical and isotope analyses in soil and crop samples received from the contractors. Thus, for example, 2700 determinations of P-31 and P-32 were carried out in 1962 in connection with the CRP on fertilizer utilization in rice cultivation. 1962 was also the year when the first experiments with the stable isotope N-15 were carried out in fertilizer trials.

REVIEWS OF THE AGRICULTURE LABORATORY

In addition to the recommendations of SAC (see Chapter 1), the work of the Laboratory was evaluated in March 1964 by a committee composed of Sir John Cockcroft (UK), Professor W. F. Libby (USA), and Professor J. Minczewski (Poland). This Committee defined the long-term work of the Laboratory.

The next review took place in November 1966 by a Committee consisting of Dr. R. W. Dodson, Dr. T.Nakai, Dr. P. J. Nowacki and Dr. M. Theys. As regards Agriculture the Committee fully endorsed the recommendations made by the September 1966 review of the Joint Division (see Chapter 1).

An ad hoc consultant group was appointed by IAEA to review the Laboratory programme at Seibersdorf in October 1968. The group was composed of Dr. Brahm Prakash (India) as Chairman, Dr. V. Hopf (FRG), Dr. A. K. Krasin (USSR), Dr. G. Rada (Venezuela), Dr. G. F. Tape (USA) and Dr. P. Tétényi (Hungary).

With regard to food and agriculture the Group concluded "that the work of the Agriculture Section is very important, particularly with its emphasis on work in support of food production in the developing countries. There is a definite role here in support of the field programmes: improving irradiation methods; - developing mass insect rearing techniques; - developing analyses; - dispensing active fertilizers; - in-service training etc."

In 1987 a group of consultants: D. Canvin (Canada), M.A. Constenla (Costa Rica), Xu Guanren, (China), D.G. Walker (Chairman, Australia), K.B. David-West (Nigeria) and P.B. Vose (United Kingdom) reviewed the training activities at the Seibersdorf Laboratory. They drew attention to the inadequate facilities for training, although noting that the agriculture programmes were at the leading edge in many cases. This led to proposals for the present training centre at Seibersdorf.

Further reviews of the Agriculture Laboratory have been included in those dealing with the Joint Division (see Chapter 1).

ADMINISTRATIVE SET-UP

The Agriculture Section of the Laboratory originally included two sub-units: AGRONOMY consisting of the present Soil Science Unit and Plant Breeding Unit, and ENTOMOLOGY. Later two new Units were added: the Agrochemicals Unit in 1982 and the Animal Production Unit in 1984. Each of these five Units has a Head, and each Unit maintains very close contact with its corresponding Section in the Joint Division.

Right from the start the IAEA Laboratories were administratively located in the Division of Research and

Laboratories, Department of Research and Isotopes. Therefore, in the case of the Agriculture Section all administrative matters were the responsibility of the Division of Research and Laboratories, whereas its technical direction was the responsibility of the Joint Division.

In 1987 the IAEA Laboratories obtained the status of a Division in the Department of Research and Isotopes. The Agriculture Laboratories Section of the Division now assumed responsibility for the implementation of the scientific and technical aspects related to food and agriculture at the laboratories although the Joint Division still retained overall programmatic responsibility in this area.

ACTIVITIES

This section will only highlight certain selected developments in the Laboratory in a chronological order. Further details are found in Chapters 11-15 dealing with the respective Sections of the Joint Division.

All Laboratory activities were published as annual reports in the IAEA Technical Report Series starting in 1964, but this reporting procedure was abolished 1970/71. Progress reports are now issued regularly.

Work started during 1965/66 in collaboration with ÖSGAE to induce mutations in crop plants by irradiation of seeds with neutrons from the ASTRA reactor as an alternative to gamma irradiation and treatment with chemical mutagens. A new device, a "SNIF" (Standard Neutron Irradiation Facility) was developed and constructed for this purpose.

A new facility - funded by FAO -for the mass-rearing of the Mediterranean Fruit Fly (Medfly) and other insect pests was completed in December 1968. Insects which had been sterilized by gamma irradiation were shipped to countries which were testing the Sterile Insect Technique as a pest control method. In 1970/71 this work included the medfly, the olive fly, some species of the tsetse fly and the almond moth.

In efforts to assess the active root pattern of growing trees a "double tracer technique" was developed during 1970/71. This method made simultaneous use of P-32 and P-33 through soil injections.

In the following years important progress was made in mass rearing of tsetse flies through the development of membranes instead of live animals. This represented a tremendous breakthrough compared with the earlier days, when the first tsetse colonies had to be kept alive by letting the flies feed on live animals such as rabbits, goats and guinea pigs.

The Laboratory also developed routine methods for mass-screening the protein and amino acid content of plant samples in support of a CRP on seed protein improvement, and in 1975 the staff could analyze up to 800 samples per day.

As N-15 began to play an increasingly important role in the Joint Division's programme (particularly dealing with biological nitrogen fixation), the Laboratory developed fast routine methods for N-15 analyses in plant and soil samples. Two methods were used simultaneously, namely mass spectrometry and emission spectrometry, and as an example 7.000 samples were analyzed in 1977 with the former method and 1.000 with the emission spectrometer.

Greenhouse facilities had originally been sparse, but in 1974 new plastic covered greenhouses were erected, and several years later two new greenhouses were donated by the US Government.

Preparations for a large-scale Technical Assistance project in Egypt - "MISR-MED" - were started in 1983. The purpose of the project was the eradication of the medfly from the Nile Valley. This necessitated the release of very large numbers of radiation sterilized flies, and the technique was to be developed in the Laboratory at Seibersdorf. Therefore a mass rearing research facility was constructed on the Laboratory site with funds donated by the Government of Austria, and inaugurated in 1984.

Klaus Reichardt took over the responsibility as Head of the Agriculture Section of the Laboratory from 1983 to 1985.

During these years agricultural biotechnology became part of the laboratory's activities; - for example through the tissue culture technique used for plant propagation. In line with this development the Section was often referred to as the "Agricultural-Biotechnology Section". A laboratory for in-vitro culture applications was completed in 1984.

Thorsten Hermelin became the next Head in 1985.

A new laboratory wing for agricultural and biotechnological work was inaugurated in October 1986. The construction costs were shared equally by FAO and IAEA as a special contribution to the 20th anniversary of the Joint Division, and the laboratory furniture was donated by the Government of Poland.

In 1986, the word "biotechnology" disappeared from official IAEA documents as part of the name of the Laboratory. Instead, reference was again made to: "Agriculture (Laboratory); in support of the Joint FAO/IAEA programme".

Following the Chernobyl accident a programme on the monitoring of fall-out radioactivity in the environment and in food was initiated.

John I. Richards became Head of the Agriculture Laboratory in 1990. At this time the mandate of the Laboratory was more clearly defined. It is the sole UN facility dedicated to the development of new (or modification of existing) nuclear and related techniques that are appropriate for transfer to developing Member States to allow scientists there to address problems affecting agriculture/food production. In other words, the Agriculture Laboratory is a technology development and transfer centre supporting the coordinated research programmes and technical cooperation projects, run by the Joint FAO/IAEA Division.

The major areas of activity are in soil fertility, irrigation and plant nutrition, crop mutation breeding, insect and pest control, pesticide residues analyses and formulations and animal nutrition, reproduction and disease diagnosis.

To complement the technology transfer process the Laboratory provides various services: chemical and isotopic analyses, radiation treatment, assistance with tissue culture and molecular biology techniques, the provision of quality assurance services and reference materials, supply of radiation sterilized insects, mutagen treated seeds, hormone and disease diagnostic kits, isotope labelled compounds, assistance in the procurement of supplies and equipment and the provision of technical/scientific advice to Member States.

The Agriculture Laboratory also supports the projects of the IAEA's Department of Technical Cooperation by offering in-service training for individual fellows, (ca 250 man month per year) who actively participate in ongoing research projects. Further, the Laboratory has technical responsibility for 3-4 international training courses on its premises yearly, and also provides technical and project officers for a number of field projects.

As shown in detail in Chapters 7 and 8 the Laboratory has hosted 380 fellowship trainees and 635 training course students since 1962. These young scientists have become devoted "ambassadors" for the Joint Division and the Agriculture Laboratory all over the world.

An example of the close collaboration between FAO and IAEA is the fact that the coordinator of all training in food and agriculture at Seibersdorf is an FAO staff member.

A further extension of the laboratory and training facilities became operational in 1990, when a Training Centre was inaugurated. Funds for its construction were made available from FAO and the

Governments of Austria, FRG and USA.

A Molecular Biology Laboratory was completed in 1993 to support this rapidly developing technology which shows much promise in helping to resolve the "food gap" problems of developing Member States.

CHAPTER 4

PROFESSIONAL STAFF

PROFESSIONAL STAFF

Close to 250 professional staff members from 49 countries have been or are working in the Joint Division and its allied laboratories. This figure also includes staff assigned to the Unit of Agriculture before 1964.

The following lists show names of staff arranged under the relevant S Laboratory Unit (identified by ref. numbers) and chronologically on the basis of the first EOD (Enter On Duty). In many cases individual staff has served for more than one period, which is then listed below the first period. When a staff member has been assigned to more than one organizational unit, cross references are made.

Related staff of FAO and IAEA are shown in a separate list.

The Joint Division and its laboratories has been able to attract quite a few scientists on sabbatical leave from their home Universities, as indicated by "sabbat".

Regional experts are professional staff, whose salaries are charged to one or several allied technical cooperation field projects (often in a region).

Junior or associate professional officers are shown as JPO's and APO's, respectively. They are contracted through the usual channels - mainly of FAO - to work under the guidance of a professional staff member, and their salaries are reimbursed by their countries.

Only consultants, who have served for several months at a time are shown in the lists.

Finally a word of praise must be expressed to the many GS and M&O staff, who have loyally served in the Joint Division or in the Agriculture Laboratory. It is thanks to their knowledge and experience that smooth operation could be maintained as could full continuity when new professional staff members arrived.

RELATED STAFF - FAO

Directors General:

SEN, B. R.	IND	1956-67
BOERMA, ADEKE H.	NET	1968-75
SAOUMA, EDUARD	LEB	1976-93
DIOUF, J.	SEN	1994 -

Deputy Director General:

HJORT, HINAR	USA	1950
WELLS, ORIS V.	USA	1972

Assistant Directors General, Department of Agriculture:

FISCHNICH, OTTO	FRG	1975
BOMMER, DIETER	FRG	1975-86
BONTE-FRIEDHEIM, CHR.	FRG	1986-90
DE HAEN, HARTWIG	FRG	1990-

RELATED STAFF - IAEA

Directors General:

COLE, STIRLING	USA	1957-61
EKLUND, SIGVARD	SWE	1961-81
BLIX, HANS	SWE	1981-

Deputy Directors General, Department of Research and Isotopes:

SELIGMAN, HENRY	UK	1957-70
FINKELSTEIN, ANDRÉ	FRA	1970-73
GLUBRECHT, HELMUT	FRG	1973-78
KAKIHANA, HIDEAKI.	JPN	1978-80
ZIFFERERO, MAURIZIO	ITA	1980-91
MACHI, SUEO	JPN	1991-

Head/Director; Seibersdorf Laboratory

COOK, JERRY	UK	1962-82
TAYLOR, CHRISTOPHER	UK	1982-87
DANESI, PIERO	ITA	1987-

Director's Office ref. 1

SMITH, HAROLD, H.	USA	1958	Head, Unit of Agriculture	
COLEMAN, NATHAN	USA	1959	Head, Unit of Agriculture	
FRIED, MAURICE	USA	1960-64	Head, Unit of Agriculture	
		1964-83	Director	
SILOW, RONALD A.	UK	1964-68	Deputy Director, (1957-64, Head, Atomic Energy Branch, FAO).	
HOYOS, FRANCISCO A.	CHI	1964-68		
VOSE, PETER BROWNHILL	UK	1966-68	Assistant to Director	ref.1.1
SIGURBJÖRNSSON, BJÖRN	ICE	1968-74	Deputy Director	ref. 1.2
		1983-	Director	
OLSON, ROBERT A.	USA	1974-75		ref.1.1
LAMM, CARL GÖRAN	DEN	1974-86	Deputy Director, (1984-85 also seconded to TCAC as Acting Director, 1992 Acting Deputy Director, RIFA)	ref. 1.1
LACHANCE, LEO E.	USA	1986-92	Deputy Director	ref.1.4
KLASSEN, WALDEMAR	USA	1992-94	Deputy Director	ref.1.4

Soil Fertility, Irrigation And Crop Production Section ref. 1.1

NYE, PETER	UK	1960	Unit of Agriculture	
ENGELBERT, ED	USA	1962-64	Unit of Agriculture	
OLSON, ROBERT A.	USA	1962-63	Unit of Agriculture	ref. 1
LAMM, CARL GÖRAN	DEN	1962-64	Unit of Agriculture	ref. 1
HOWARD, FREDERICK	USA	1964-65		
CALDWELL, ALFRED	USA	1964-66	Head	
VOSE, PETER BROWNHILL	UK	1964-68		ref. 1
BARRADA, YEHIA	EGY	1964-75		
		1975-80	Head	

HANWAY, JOHN	USA	1966-68	Head	
RENNIE, DONALD A.	CAN	1968-70	Head	
NETHSINGHE, DOUGLAS	SRL	1970-77	(transferred to TCAC as Head, Asia and Pacific Section)	ref.2.1
SOPER, ROBERT	USA	1970-73	Head	
GARDNER, WALTER	USA	1971-72	Sabbat.	
MACRAE, IAN	AUL	1973-74	Sabbat.	
HALSTEAD, EDWARD	USA	1973-75	Head	
NIELSEN, DONALD	USA	1974-75	Sabbat.	
EDWARDS, ARTHUR	CAN	1975-77		ref. 2.1
MELLADO, LUIS	SPA	1976-77		
MISTRY, KEKHUSHROO	IND	1977-79		
LADONIN, VADIM	USSR	1977-82		
L'ANNUNZIATA, MICHAEL	USA	1977-80	(tranfsferred to TCAC, Fellowship. Section).	
BROADBENT, FRANCIS	USA	1977-78	Sabbat.	
WAGNER, GEORGE	USA	1979-80	Sabbat.	
BOLE, JAMES	CAN	1979-80		
		1980-82	Head	
DANSO, SETH K.	GHA	1980-		
KALININ, KIR	USSR	1982-86		
REICHARDT, KLAUS	BRA	1982-83	Head	ref. 2
ATKINS, CRAIG	AUL	1984-85	Head	ref. 2.1
BOWEN, GLYNN	AUL	1986-91	Head	
ESKEW, DAVID	USA	1987-89		ref. 2.1
SAXENA, MOHAN	IND	1987-88	Sabbat . (part time in 2.1)	
KIRDA, CEVAT	TUR	1987-92	(in Instrumentation Unit, IAEA Laboratory, 1984-87)	
		1992	Regional Expert, (RER/5/004)	
ASTVATSATRIAN, BOGDAN	USSR	1987-90	Visiting Professor	
KUMARASINGHE, SALIYA	SRI	1987-89	Regional Expert, Africa	ref. 2.1
		1989-		
SALEMA, MANASE P.	URT	1990-	Regional Expert, Africa	
HERA, CHRISTIAN	ROM	1991-	Head	
MOUTONNET, PIERRE	FRA	1994-		

Plant Breeding And Genetics Section ref. 1.2

SIGURBJÖRNSSON, BJÖRN	ICE	1963-64	Unit of Agriculture,	ref.1
		1964-69	Head	
		1980-81	Sabbat.	
KONZAK, CALVIN	USA	1965-66	Sabbat.	
		1973-74	Sabbat.	
AHNSTRÖM, GUNNAR	SWE	1967	Sabbat.	
OSBORNE, THOMAS	USA	1967-68	Sabbat.	
GACITUA, HERNAN	CHI	1968-70		
BOGYO, THOMAS	USA	1968-69	Sabbat.	
LUSE, ROBERT	USA	1968-73		
MICKE, ALEXANDER	FRG	1969-91	Head	
HSIEH, SUNG CHING	CHA	1970-73		ref. 2.2
RABSON, ROBERT	USA	1973-76		
BHATIA, CHITTRANJAN	IND	1974-76		
MIKAELSEN, KNUT	NOR	1975-80	(I962-64 in FAO Atomic Energy Branch).	ref. 2.2
BROCK, R. D.	AUL	1976-79		

KAWAI, TAKESHI	JPN	1979-83		
DONINI, BASILIO	ITA	1980-85		
MALUSZYNSKI, MIROSLAW	POL	1983-91		
		1991-	Head	
ASHRI, AMRAM	ISR	1985-86	Sabbat.	ref.2.2
		1989-90	Sabbat	
MURATA, NOBUO	JPN	1986-89		
AMANO, ETSUO	JPN	1989-94		
JEFFERSON, RICHARD	USA	1989-91		
SITCH, LESLEY	UK	1991-92		
KAMRA, OM P.	CAN	1991	Sabbat	.ref. 2.2
VAN ZANTEN, LEONARD	NET	1992-	APO	
AHLOOWALIA, BEANT S.	IRE	1993-		

Animal Production And Health Section ref.1.3

ERICSON, LARS ERIC	SWE	1962-64	Unit of Agriculture, in charge	ref. 1.6
KNUTSSON, PER-GÖRAN	SWE	1965-68	Head	
BLACK, L. A.	USA	1965	Sabbat.	
LENGEMANN, FREDERICK W.	USA	1966-67	Sabbat.	
		1976-77	Sabbat.	
WARD, GERALD	USA	1968-70	Head	
HÖLLER, HUGO	FRG	1970-72	Head	
VERCOE, JOHN E.	AUL	1972-74	Head	
		1978-80	Head	
HAMEL, HANS	FRG	1974-77	(started as APO, served in the BICOT project in NIR 1977-79)	
HOPKINS, LEON	USA	1975-78	Head	
KALLFELZ, FRANCIS	USA	1977-78	Sabbat.	
GIACINTOV, PAVEL	CSSR	1978-79	Sabbat.	
DARGIE, JAMES	UK	1978-80		
		1982-	Head	
YOUNG, BRUCE	CAN	1980-82	Head	
EDQVIST, LARS ERIC	SWE	1983-87		
CZERKAWSKI, JULIAN	UK	1983-84	Sabbat.	
JAYASURIYA, MARSHALL N.	SRL	1984-85	Sabbat.	
		1985-88		
		1993-	Regional Expert, Africa.	
RICHARDS, JOHN I.	UK	1986-89		ref. 2.3 and 2
JEGGO, MARTYN	UK	1986-91	Regional Expert	
		1992-		
ROBERTSON, HAMISH	CAN	1987-88	Sabbat.	
MATHER, EDWARD	USA	1987-88	Sabbat.	
OOIJEN, CAMILLE	NET	1987-92	.	
PLAIZIER, JAN	NET	1987-92	.	
PERERA, B. M. OSWIN	SRL	1988-	Regional Expert, Asia	
OWEN, EMYR	UK	1988-89	Sabbat.	
YILALA, KASSU	ETH	1989-90	Sabbat.	
WILSON, TREVOR	UK	1990-91		
BRYANT, MICHAEL	UK	1990-91		
MORENO LOPEZ, JORGE	SWE	1990-	Regional Expert, Latin America	
GARCIA, MARIO	PER	1990-		
GEIGER, ROLAND	FRG	1990-92	APO	
		1993-	Regional Expert, Africa	

GALINA, CARLOS	MEX	1990	Consultant	
CAGNOLATI, VITTORIO	ITA	1990-91	APO	

Insect And Pest Control Section ref 1.4

SCHMIDT, CLAUDE	USA	1962-64		
KELLER, JACK	USA	1963-65	Head	
PROVERBS, MAURICE D.	CAN	1965-66		
CUTCOMP, LARRY K.	USA	1965-67	Head	
ERDMAN, HOWARD	USA	1966-68		
LINDQUIST, DONALD A.	USA	1967-69	Head	ref. 1.5
		1971-75	Head	
		1982-90	Head	
		1992-94	Head	
ENKERLIN, DIETER	MEX	1968-70		
LACHANCE, LEO	USA	1969-71	Head	ref. 1
		1985	Consultant, (EGY/5/013)	
OUYE, MILTON	USA	1970-72		ref. 2.4
MOORE, ISAAC	ISR	1972-77		ref. 2.4
VAIL, PATRICK	USA	1975-78	Head	ref. 2.4
SERGHIOU, CONSTANTINOS	CYP	1977-79		
LABRECQUE, GERMAIN	USA	1978-82	Head	
		1983-84	Consultant, (EGY/5/013)	
OFFORI, EVANS	GHA	1980-88	(transferred to Africa Sect. TCAC)	ref. 2.4
HAILE, DANEL G.	USA	1984-85	Sabbat	
VAN DER VLOEDT, ANDRÉ M.V.	BEL	1987-91		ref. 2.4
BUTT, BILL A.	USA	1988-90	Sabbat	ref. 2.4
KLASSEN, WALDEMAR	USA	1990-92	Head	ref. 1
CHIRICO, JAN	SWE	1992-93	Expert (LIB/5/007)	
FELDMANN, UDO	FRG	1993-		

Agrochemicals And Residues Section ref. 1.5

WORTLEY, GORDON E.	UK	1964-69	Head (coming from FAO, Atomic Energy Branch).	
MARCHART, HERWIG	AUS	1970-74	(1965, Chemistry Unit, Seibersdorf)	
WINTERINGHAM, PETER	UK	1969-80	Head (1967-69, Plant Production and Protection Division, FAO)	
AL-BADRI, JAWAS	IRQ	1971-72	Sabbat.	
LESKI, RYSZARD A.	POL	1974-76		
KOKKE, ROBERT	NET	1977-81		
HASSAN, ALADIN A.	EGY	1977-		
LINDQUIST, DONALD A.	USA	1980-82	Head	ref. 1.4
PLIMMER, JACK	USA	1983-87	Head	
DAUGULIS, ANDREW	CAN	1986-87	Sabbat.	
EVELEIGH, DOUGLAS	UK	1987	Sabbat.	
TJELL, JENS CHRISTIAN	DEN	1987-90	Head	
VETROV, VLADIMIR A.	CIS	1990-92	Consultant	
WIKTELIUS, STAFFAN C.	SWE	1990-94		
HANCE, RAYMOND	UK	1991-	Head	

Food Preservation Section

ref. 1.6

ERICSON, LARS ERIK	SWE	1962-64	Unit of Agriculture, In charge	ref. 1.3
GORESLINE, HARRY E.	USA	1963-66	Consultant (previously Atomic Energy Branch, FAO).	
HOWARD, FRED D.	USA	1964		
VAS, KAROLY	HUN	1964-66	Head	
		1972-78	Head	
DE PROOST, MAURICE	BEL	1966-71	Head	
BEDNARCZYK, W.	POL	1966-68		
CLARKE, IAN	UK	1967-69	Sabbat.	
SHEA, KEVIN	USA	1969-71		
FAWI ABDU, MOHAMED-T.	SUD	1970-74		
LOAHARANU, PAISAN	THA	1974-85		
		1985-	Head	
MATSUNAGA, RYUJI	JPN	1976-78		
VAN KOOIJ, JAN	NET	1978-85	Head	ref. 2.6.2
DOLLAR, ALEXANDER	USA	1986	Consultant	
URBAIN, WALTER	USA	1986	Consultant	
RIGNEY, CHRISTOPHER	AUL	1986-89		
LAPIDOT, MORDECAI	ISR	1986-87	Sabbat	
AHMED, MAINUDDIN	BGD	1987-		ref. 2.4
LADOMERY, LESLIE	AUL	1989-94	(previously FAO in Rome)	
DELINCEE, HENRY	DEN	1989	Consultant	
GIDDINGS, GEORGE	USA	1991-92	Interregional expert	
BRYNJOLFSSON, ARI	USA	1991-92		ref. 2.6.2

Agriculture Laboratory

ref. 2

BROESHART, HANS	NET	1961-83	Head (1959-60, Atomic Energy Branch, FAO)	ref.2.1
REICHARDT, KLAUS	BRA	1983-85	Head	ref. 1.1
HERMELIN, THORSTEN	SWE	1985-89	Head	ref. 2.2
RUHM, MARIA ESPERANZA	AUS	1986-	(in 2.4 1971-86 as GS)	
RICHARDS, JOHN I.	UK	1990-	Head	

Soil Science Unit

ref. 2.1

BRUNNER, HELMUT	AUS	1961-64	(1961-64 as GS)	ref. 2.2
BROESHART, HANS	NET	1961-83	in charge	ref. 2
CHO, CHAI MOO	DRK	1962-64		
TENSHO, KIYOSHI	JPN	1963-64		
VOSE, PETER BROWNHILL	UK	1964	Consultant	
NETHSINGHE, DOUGLAS	SRL	1966-70		ref. 1.1
MIDDELBOE, VICTOR	DEN	1967-68		
KETCHESON, JOHN	CAN	1967-68	Sabbat.	
TILLER, KEVIN	AUL	1970	Sabbat.	
CANVIN, DAVID T.	CAN	1971-72	Consultant	
ATKINS, CRAIG	AUL	1972-74		ref. 1.1
STRYKER, R. B.	USA	1974-76		
RENNIE, ROBERT J.	CAN	1976-78		
SHAH, MUHAMMAD	PAK	1978	Cost-free expert	
ZAPATA, FELIPE	PER	1979-83		
		1983-	Head	

HARDARSON, GUDNI	ICE	1981-		
KUMARASINGHE, K. SALIYA	SRL	1983-84	Consultant	ref. 1.1
		1986-87	Consultant	
AXMANN, HELGA	AUS	1984-	(1963-83 as GS)	
ESKEW, DAVID	USA	1984-87		ref. 1.1
SEPETOGLU, HASSAN	TUR	1987	Cost-free expert	
SANGINGA, NTERANYA	ZAI1	1987-89		
VENTURA, WILBUR	PHI	1988	Consultant	
CRASSWELL, ERIC	AUL	1987-88	Sabbat.	
AKKERMANS, ANTON	NET	1989	Consultant	
NITSCHE, WOLFGANG	GDR	1989	Consultant	
DAVIS, JOHN	UK	1990	Consultant	
FISCHER, HEINZ	GDR	1990	Consultant	
MEIER, GÜNTHER	GDR	1990	Consultant	
WILSON, KATHERINE	UK	1990	Consultant	
AWONAIKE, OLUFEMI	NIR	1990-		
CORBO, J.	USA	1990-91	APO	
VAN CLEEMPUT, OSTWALD	BEL	1991	Consultant	
STONE, CAROL E.	UK	1991	Consultant	
HOLMGREN, EVA	SWE	1991-93	APO	
QUIST, MARIUS WILLEM	NET	1992-94	APO	
NILSON, KATE	UK	1990		
KATO, NAOTO	JPN	1992-93	Sabbat	

Plant Breeding Unit ref. 2.2

BRUNNER, HELMUT	AUS	1984-	(1965-83 as GS)	ref. 2.1
MIKAELSEN, KNUT	NOR	1965-73	(1962-64 in FAO, Atomic Energy Branch, 1974 UNDP project in Brazil)	ref. 1.2.
VAIDYANATHAN, L. V.	IND	1969-70	Sabbat.	
KAMRA, OM P.	CAN	1969-70	Sabbat.	ref. 1.2
MC KENZIE, RON	CAN	1970-71	Sabbat.	
JANSSON, GUNNAR	SWE	1971-75		
HSIEH, SUNG CHING	CHA	1973-74	Head	ref. 1.2
HERMELIN, THORSTEN	SWE	1975-85	Head	ref. 2
BRUNORI, ALBERTO	ITA	1976-79		
GEORGI, BERND	FRG	1978	Consultant	
ASHRI, AMRAMI	SR1	1980	Consultant	ref. 1.2
DASKALOV, STEFAN	BUL	1980-86		
NAKAI, HIROKAZU	JPN	1981-83	Sabbat.	
NOVAK, FRANTISEK	AUS	1983-85	Sabbat.	
		1985-93	Head	
LUCRETTI, SERGIO	ITA	1984	Cost-free expert	
		1991	Consultant	
CONGER, B. V.	USA	1986-87	Sabbat	
MORPURGO, RICCARDO	ITA	1989-		
SACCHI, MARINA	ITA	1990-92	JPO	
UPADHYAY, RAJEEV K.	IND	1991-92	Sabbat	
DOLEZEL, JAROSLAV	CZE	1992	Consultant	
ROUX, NICOLAS	BEL	1993-	APO	
CHEN, QIUFANG	CPR	1993-94	Cost-free consultant	
FLANDERS, DAVID	UK	1993	Consultant	

Animal Production Unit ref. 2.3

NACHREINER, RAYMOND	USA	1985-86	Sabbat.	
		1987	Consultant	
		1990	Consultant	
OSCHMANN, STEFAN	FRG	1985-87	APO	
RICHARDS, JOHN I.	UK	1985-86	Regional Expert	ref.1.3 and 2
UNGER, HERMANN	FRG	1987-89	APO	
MURPHY, BRUCE	USA	1988	Sabbat.	
CASTRIGNANO, FRANCESCO	ITA	1987-90	JPO	
WRIGHT, PETER	CAN	1987	Consultant	
		1990-	Head	
SHARP, DANIEL	USA	1989-90	Sabbat.	
RE, GIOVANNI	ITA	1989-91	JPO	
EISLER, MARK	UK	1989-90	APO	
ADACHI, ANNE-MARIE	CAN	1989	Consultant	
FADLY, ALY	USA	1989	Consultant	
VAN ROOIJ, EUGENE	NET	1990-94	APO	ref. 2.3
NILSSON, ERNST	SWE	1991-	APO	
KELLY, WALTER	CAN	1991	Consultant	
REBESKI, DIERK	FRG	1992-	APO	
BARMASCH, MARTHA	ARG	1992-94	cost-free expert	
NIELSEN, KLAUS	CAN	1993	Consultant	

Entomology Unit ref.2.4

MONROE, JOHN	AUL	1963-67		
		1970-72	Head	
MOORE, ISAAC	ISR	1966-68		ref. 1.4
TZANAKAKIS, MINOS	GRE	1967-68	Sabbat.	
LANGLEY, PETER	UK	1967-69	Head	
NADEL, DAVID	USA	1967-82		
HOOPER, GORDON	AUL	1968-70		
		1982-84		
OUYE, MILTON	USA	1969-70		ref. 1.4
MEWS, ALASTAIR	UK	1969-73		
AHMED, MAINUDDIN	BGD	1970-72	(fellowsh. Seibersdorf before 1969-70)	ref. 1.6
OFFORI, EVANS	GHA	1971-74		ref. 1.4
BUTT, BILL A	USA	1972-74	Head	ref. 1.4
MALEKGHASSEMI, BEHROUZ	IRA	1973-76		
WETZEL, HARTMUT	FRG	1973-81		
GEORGE, JOHN	CAN	1974-75	Sabbat.	
BAUER, BURKHARD	FRG	1974-76		
VAN DER VLOEDT, ANDRÉ M.V.	BEL	1974-87		ref. 1.4
VAIL, PATRICK	USA	1975	Head	ref. 1.4
GINGRICH, RICHARD	USA	1976-77	Sabbat.	
		1980-92	Head	
KAPLANIS, JOHN N.	USA	1976-77	Head	
WEISS, MICHAEL	FRG	1977-80	APO	
TAKKEN, WILLEM	NET	1977-80	APO	
		1983	Expert NIR/5/011	
CALKINS, CARROL	USA	1977-80	Head	
GRINGORTEN, LAWRENCE	CAN	1978-82		
JAENSON, THOMAS	SWE	1979-81		

GREILING, JÜRGEN	FRG	1979	Consultant
FELDMANN, UDO	FRG	1980-84	JPO, (transf to NIR/5/011 1984-87)
		1988-93	ref.1.4
DELOACH, JOHN	USA	1981	Sabbat.
HAMANN, H. JÜRGEN	FRG	1981-82	(transf. to NIR/5/011)
		1984-85	
KAPATSA, GEOFFREY	ZAM	1981-82	
KAISER, PAUL	USA	1981-83	(MEX/5/009 and EGY/5/012)
KABAYO, JOHN	UGA	1982-89	
BUSCH-PETERSEN, ERIK	DEN	1982-89	
FAY, HARRY	AUL	1983-84	Sabbat.
		1990	Consultant
BRUZZONE, DOMENICO	ITA	1984-87	APO and EGY/5/013
ECONOMOPOULOS, A. P.	GRE	1985-90	
MABRY, HAROLD E.	USA	1987	Consultant
EL-ABBASI, TALAL	EGY	1985-87	
GALUN, RACHEL	ISR	1987-88	Sabbat.
ANOUCHINSKY, RICCARDO	ITA	1987-89	JPO
KERREMANS, PHILIPPE	BEL	1987-92	APO
		1993	Consultant
VREYSEN, MARC	BEL	1987-90	APO
ZACHAROPOULOU, ADIGONE	GRE	1988	Consultant
LAMBREMONT, EDWARD	USA	1988-89	Sabbat.
FRANZ, GERALD	FRG	1989-	
RIVA, ELVIRA	SPA	1989	Consultant
WOLF, WAYNE	USA	1989	Consultant
CARPENTER, JAMES	USA	1990	Sabbat.
HENDRICHS, JORGE	MEX	1991-	(previously Project Manager EGY/5/013), Acting Head from 1992
PARKER, ANDREW	UK	1991	TC Expert
MANSOUR, MOHAMMED	SYR	1993-	
WILLHOEFT, UTE	FRG	1993-	JPO
DJITEYE, ALIGUI	MLI	1993	Consultant
LUX, SLAWOMIR	POL	1993	Consultant

Agrochemicals Unit ref. 2.5

PERSCHKE, HELMUT	AUS	1984-93	(1962-82 as GS in Chemistry Unit and 1982-84 as GS in 2.5)
PASTI, MARIA	ITA	1982-86	TC expert INT/5/084
PASCUCCI, CARLO	ITA	1982-84	APO, (1984 in Physics Unit)
		1985-87	TC expert INT/5/094
VOLLNER, LAJOS	FRG	1982-87	Head
BELLI, MARIA LAURA	ITA	1983-84	cost-free research scientist
KRATZER, RUDOLF	FRG	1984	TC expert INT/5/094; then transferred to project site 1985-
PERUFFO, ANGELO	ITA	1985-86	TC expert INT/5/084
		1988	Consultant
HUSSAIN, MANZOOR	USA	1987-	Head
GHODS-ESPHAHANI, AHMAD	IRA	1993-	

IFIP ref. 2.6.1

HICKMAN, ROY	UK	1971-74	Project Leader	
CLEGG, DAVID	CAN	1974-76	Project Leader	
ELIAS, PETER S.	FRG	1976-81	Project Leader	

IFFIT ref. 2.6.2

FARKAS, JOZSEF	HUN	1980-85	Project Leader	
OOSTERHEERT, W	NET	1985	Project Leader	
VAN KOOIJ, JAN	NET	1985-88	Project Leader	ref. 1.6
BRYNJOLFSSON, ARI	USA	1988-90	Project Leader	ref. 1.6

CHAPTER 5

COORDINATED RESEARCH PROGRAMMES

COORDINATED RESEARCH PROGRAMMES

This chapter shows the Coordinated Research Programmes, CRP's, for which the Joint Division has or has had technical responsibility. The CRP's are listed chronologically for each Section.

In total 167 CRP's are or have been in force, with the following distribution:

Soil Fertility, Irrigation and Crop Production	28
Plant Breeding and Genetics	33
Animal Production and Health	31
Insect Pest Control	20
Agrochemicals and Residues	30
Food Preservation	25

SOIL FERTILITY, IRRIGATION AND CROP PRODUCTION

Application of isotopes to rice fertilization, 1962-68, D1.

Plant nutrient supply and movement in soil systems, 1962-68, D1.

Maize fertility using fertilizer containing labelled nutrient elements, 1963-68, D1.

Application of radiation techniques in water use efficiency studies, 1965-71, D12001.

Use of isotopes and radiation in studies on physico-chemical relationships of soils and plants, 1966-71, D11002.

Use of isotopes to study the efficient use of fertilizers in tree cultures, 1966-72, D11003.

Wheat fertility using fertilizers containing labelled nutrient elements, 1968-72, D11001.

Use of isotopes in rice production studies, 1969-74, D11004.

Use of isotopes in fertilizer efficiency studies on grain legumes, 1972-77, D11005.

Use of radiation and isotope techniques in studies of soil-water regimes, 1972-78, D12002.

Isotope aided micronutrient studies in rice production with special reference to zinc deficiency, 1973-79, D11006.

Agricultural nitrogen residues with particular reference to their conservation as fertilizers and behaviour as potential pollutants (jointly with the Agrochemical and Residues Section), 1976-82, D15001.

Isotope techniques in studies of biological nitrogen fixation for the dual purpose of increasing crop production and decreasing nitrogen fertilizer use to conserve the environment, 1978-84, D11007.

Isotope and radiation techniques for efficient water and fertilizer use in semi-arid regions, 1979-84, D12003.

Nuclear techniques in development of fertilizer and water management practices for multiple cropping systems, 1980-85, D11009.

Isotopic tracer-aided studies of the rôle of herbicides and related chemicals in soil and fertilizer nitrogen management, 1981-83, D11008.

Nuclear techniques in improving pasture management, 1982-87, D14001.

Isotopic studies of nitrogen fixation and nitrogen cycling by blue-green algae and *Azolla* 1983-89, D14002.

The use of isotopes in studies to improve yield and nitrogen fixation in Latin America with the aim of increasing food production and saving N-fertilizer, 1985-90, D14003.

Evaluation and calibration of nuclear techniques compared with traditional methods in soil-water studies, 1985-89, F21006

Nuclear techniques to improve crop production in salt-affected soils, 1985-92, D12004.

The use of isotopes in studies to improve yield and nitrogen fixation of grain legumes with the aim of increasing food production and saving N-fertilizer in the tropics and subtropics of Asia, 1986-93, D14004.

Use of isotope studies on increasing and stabilizing plant productivity in low phosphate and semi-arid and sub-humid soils of the tropics and sub-tropics. 1989-94, D15002.

The use of nuclear and related techniques in assessment of irrigation schedules of field crops to increase effective use of water in irrigation projects, 1990-95, D12005.

The use of nuclear and related techniques in management of nitrogen fixation by trees for enhancing soil fertility and soil conservation in fragile tropical soils, 1990-95, D14005.

Enhancing soil-fertility and crop production by better management of *Rhizobium*. 1990-93, D14006.

The use of nuclear and related techniques for evaluating the agronomic effectiveness of phosphate fertilizers, in particular rock phosphates, 1993-98, D15003.

The use of nuclear techniques for optimizing fertilizer applications under irrigated wheat to increase the efficient use of fertilizers and consequently reduce environmental pollution, 1994-99, D14007.

PLANT BREEDING AND GENETICS

Use of induced mutations for rice improvement, 1964-70, D23002.

Methods of production and use of induced mutations in plant breeding, 1965-69, D24002.

Use of neutrons in seed irradiation, 1966-71, D24001.

Nuclear techniques for seed protein improvement, 1968-78, D21002

Effects of low doses of radiation on crop plants, 1970-74, D24003.

Use of induced mutations in rice breeding and production, 1971-79, D23002.

Use of induced mutations for disease resistance in crop plants, 1971-81, D22001.

Improvement of mutation breeding techniques, 1972-78, D24004.

Improvement of vegetatively propagated crops and tree crops through radiation induced mutations, 1972-79, D24005.

Use of aneuploids for wheat protein improvement, 1975-79, D21001.

Use of induced mutations for improvement of grain legume production in South East Asia (RCA), 1978-84, D23003.

Induced mutations for disease resistance in grain legumes, 1978-84, D22002.

Use of nuclear techniques for cereal grain protein improvement, 1979-83, D21002.

Evaluation of semi-dwarf cereal mutants for cross breeding, 1980-85, D25001.

Improvement of leguminous food crops in Africa and the Near East through induced mutations, 1981-86, D23005.

Improvement of leguminous and oil seed crops in Latin America through induced mutations, 1981-86, D23006.

Semi-dwarf mutants for rice improvement in Asia and the Pacific region (RCA), 1981-86, D25002.

Improvement of root and tuber crops and similar vegetatively propagated crop plants in tropical countries by induced mutations, 1983-88, D23008.

In-vitro technology for mutation breeding, 1983-89, D24006.

Tissue culture applications through mutation breeding to increase resistance in rice against adverse soil factors, 1985-89, D25003.

Improvement of rice and other cereals through mutation breeding in Latin America (ARCAL), 1986-92, D25004.

Use of induced mutations in connection with haploids and heterosis in cereals, 1986-92, D24007.

Use of induced mutations and in-vitro culture techniques for improving crop plant resistance to diseases, 1987-92, D25003.

In-vitro mutation breeding of bananas and plantain, 1988-93, D23014.

Mutation breeding of oil seed crops, 1988-93, D23011.

Improvement of root and tuber crops in tropical countries of Asia by induced mutations, 1988-93, D23013.

Improvement of basic food crops in Africa through plant breeding including the use of induced mutations, 1989-94, D23010.

Application of deoxyribonucleic acid (DNA) based marker mutations for improvement of cereals and other sexually reproduced crop species, 1992-97, D24008.

Use of novel DNA fingerprinting techniques for the detection and characterization of genetic variation in vegetatively propagated crop plants, 1992-97, D23015.

Induced mutations for sesame improvement, 1993-98, D23012.

Induced mutations in connection with other biotechnology for crop improvement in Latin America (ARCAL), 1993-98, D23016.

In-vitro techniques for selection of radiation-induced mutants adapted to adverse environmental conditions, 1993-98, D23017.

Radiation-induced mutations and other advanced technologies for the production of seed crop mutants suitable for environmentally sustainable agriculture, 1993-98, D24009.

ANIMAL PRODUCTION AND HEALTH

Use of isotopes and radiation in studies on the etiology, effects and control of parasitic diseases in domestic animals, 1966-73, D32001.

Trace element metabolism and disease in animals of agricultural importance, 1968-72, D32002.

Use of tracer techniques in studies on the use of non-protein-nitrogen (NPN) in ruminants, 1972-76, D31001.

Isotopes and radiation in animal parasitology and immunology, 1973-76, D32003.

Water requirements of tropical herbivores based on measurements with tritiated water, 1975-79, D31002.

Use of isotopes to diagnose moderate minerale imbalances in farm animals, 1976-80, D31005.

Use of isotopic techniques in research and control of ticks and tick-borne diseases, 1977-79, D32004.

Use of radioimmunoassay and related procedures to improve reproductive performance of domestic animals, 1978-81, D31004.

Use of nuclear techniques to improve domestic buffalo production in Asia (RCA), 1978-83, D31003.

Isotope-aided studies on non-protein-nitrogen and agro-industrial by-products utilization with particular reference to developing countries, 1981-85, D31006.

Optimizing grazing animal productivity in the Mediterranean and North African regions with the aid of nuclear techniques, 1982-87, D31006.

The application of radioimmunoassay to improve the reproductive efficiency and productivity of large ruminants, 1982-88, D31009.

Use of nuclear techniques in the study and control of parasitic diseases of farm animals, 1982-87, D32005.

Improving sheep and goat productivity with the aid of nuclear techniques, with particular reference to Africa and the Middle East, 1983-89, D31008.

Use of nuclear techniques to improve domestic buffalo production in Asia (RCA) - Phase II, 1983-88, D31010.

Regional network for improving the reproductive management of meat and milk-producing livestock in Latin America with the aid of radioimmunoassay techniques (ARCAL), 1983-89, D31011.

Regional network for Latin America on animal disease diagnosis using immunoassay and labelled DNA probe techniques, 1986-90, D32006.

Sero-surveillance of rinderpest and other diseases in Africa using immunoassay techniques, 1987-90, D32008.

Improving the productivity of indigenous African livestock using radioimmunoassay and related techniques, 1987-93, D31012.

Development of feeding strategies for improving ruminant productivity in areas of fluctuating nutrient supply through the use of nuclear and related techniques, 1987-92, D31013.

Strengthening animal reproduction research in Asia through the application of immunoassay techniques, 1988-93, D31014.

Strengthening animal disease diagnosis in Asia through the application of immunoassay techniques, 1988-93, D32010.

Improving the diagnosis and control of trypanosomiasis and other vector-borne diseases of African livestock using immunoassay methods, 1988-93, D31015.

Development of feed supplementation strategies for improving ruminant productivity on small-holder farms in Latin America through the use of immunoassay techniques (ARCAL) - Phase III, 1989-94, D31016.

Inter-regional research network for improving the productivity of camelids, 1990-93, D31017.

Immunoassay methods for the diagnosis and epidemiology of animal diseases in Latin America (ARCAL), 1991-96, D32011.

Sero-surveillance of rinderpest and other diseases in Africa using immunoassay techniques - Phase II, 1991-94, D32012.

Development of supplementation strategies for milk-producing animals in tropical and subtropical environments through the use of nuclear and related techniques, 1992-97, D31018.

Development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa, 1993-98, D31019.

Use of immunoassay methods for improved diagnosis of trypanosomiasis and monitoring tsetse and trypanosomiasis control programmes, 1993-98, D32013.

INSECT AND PEST CONTROL

Rice insect control and eradication, 1967-72, D41001.

Fruit fly eradication or control by the sterile insect technique, 1968-77, D41003.

Ecology and behaviour of the *Heliothis* complex as related to the sterile insect technique, 1969-75, D41002.

Use of the sterile insect technique for control of Lepidopterous insects attacking fruit and forest trees, 1972-78, D41004.

Tsetse fly control or eradication by the sterile insect technique, 1974-84, D42001.

Use of isotopes in pest management with emphasis on rice insects, 1979-84, D43001.

Using radiation and isotopes to develop diets for mass-rearing haematophagous insects for sterile insect releases and to study disease transmission by these vectors, 1981-84, D42002.

Development of sexing mechanisms in fruit flies through manipulation of radiation induced conditional lethals and other genetic measures, 1981-88, D41005.

Development of methodologies for the application of the sterile insect technique (SIT) for tsetse eradication or control, 1984-88, D42003.

Radiation-induced F-1 sterility in *Lepidoptera* for area-wide control, 1986-91, D41007.

Standardization of medfly trapping for use in sterile insect technique programmes, 1986-90, D41006.

Laboratory and field evaluation of genetically altered medflies for use in sterile insect technique programmes, 1988-93, D41010.

Genetic engineering technology for the improvement of the sterile insect technique, 1988-93, D41009.

Development of practices for area-wide tsetse eradication or control with emphasis on the sterile insect technique, 1988-93, D42004.

Evaluation of insect population suppression by irradiated lepidoptera and their progeny, 1992-97, D41011.

Enhancement of the Sterile Insect Technique through genetic transformation using nuclear techniques, 1993-98, D41012.

Development of female medfly attractant systems for trapping and sterility assessment, 1993-97, D41013

Medfly mating behaviour studies under field cage conditions, 1993-97, D41014.

Genetics application to improve the SIT for tsetse control/eradication including genetic sexing, 1993-97, D42005.

Automation in tsetse fly mass-rearing for use in sterile insect techniques programmes, 1994-99, D42006.

AGROCHEMICALS AND RESIDUES

Isotopic tracer-aided studies on the origin and fate of foreign chemical residues in the agricultural environment, 1970-75, D52001.

Isotopic tracer-aided studies of foreign chemical residues in food, 1970-75, D52002.

Isotopic tracer-aided studies of the biological side-effect of foreign chemical residues in food and agriculture, 1973-77, D52003.

Agricultural nitrogen residues with particular reference to their conservation as fertilizers and behaviour as potential pollutants (jointly with the Soil Fertility, Irrigation and Crop Production Section), 1973-83, D15001.

Isotopic tracer-aided studies of chemical residues in cotton seed, feed, oil and related products, 1974-80, D52004.

Isotopic tracer-aided research and monitoring programme on agricultural residue-biological interactions in aquatic ecosystems, 1975-82, D52005.

Isotopic tracer-aided studies of agrochemical residue-soil biota interactions, 1977-82, D52006.

Isotopic tracer-aided studies of atmospheric pollutant-plant interactions, 1978-82, D52007.

Development and application of nuclear techniques for improved utilization of agricultural residues, 1979-82, D52008.

Isotopic tracer-aided studies of un-extractable or "bound" pesticide residues in soil, plant and food, 1980-85, D52009.

Development of improved rural methane production from biomass utilizing nuclear techniques, 1980-86, D53001.

Isotopic tracer-aided studies of the role of herbicides and related chemicals in soil and fertilizer nitrogen management. 1981-83, D51008

Studies of agricultural chemical residues in meat, milk and related products of livestock with the aid of nuclear techniques, 1981-86, D52010.

The fate of persistent pesticides in the tropics using isotopic techniques, 1982-87, D52011.

Isotopic tracer-aided studies of pesticide residues in stored products, 1982-87, D52012.

Research to develop and evaluate controlled-release formulations of pesticides to reduce residues and increase efficacy, utilizing radioisotopes, 1982-90, D54001.

Use of isotopes in studies of pesticide residues in rice-fish ecosystems, 1983-88, D52013.

Radiotracer studies of fungicide residues in food plants, 1984-89, D52014.

Biological activity and bioavailability of "bound" pesticide residues using nuclear techniques 1986-91, D52015.

Radiotracer studies to reduce or eliminate pesticide residues during food processing, 1988-93, D52021.

Development of controlled-release formulations of pesticides utilizing nuclear techniques, 1988-93, D52022.

Radiotracer studies of behaviour of DDT in tropical environments, 1988-93, D52023.

Use of isotopes in studies of pesticide residues in rice-fish ecosystems - Phase II, 1988-91, D52024.

Adverse effects on flora and fauna from the use of organochlorine pesticides on the African continent, 1990-95, D52025.

Development of procedures to stabilize acaricides in livestock dips and of simplified methods to measure their concentrations, 1991-96, D52026.

The use of nuclear and immunochemical methods for pesticide analysis, 1992-96, D52027.

The use of isotopic tracers in studies of herbicide performance on grasses and sedges, 1992-96, D52028.

Agroecological effects resulting from the use of persistent pesticides in Central America, 1993-97, D52029.

Development of improved insecticide formulations for targets used in tsetse control in Africa using nuclear techniques, 1993 -98, D52030.

Distribution, fate and effects of pesticides on biota in the tropical marine environment, using radiolabelled tracers, 1993 -98, D52031.

Impact of long-term pesticide usage on soil properties using radiotracer techniques, 1994-99, D52032.

FOOD PRESERVATION

Shelf-life extension of irradiated fruits and vegetables, 1970-74, D61001.

Technological and economic feasibility of food irradiation, 1975-79, D61003.

Radiation preservation of Asian fish and fishery products, 1975-78, D61004.

Wholesomeness of the process of food irradiation, 1975-79, D62001.

Asian regional cooperative project on food irradiation (RCA), 1978-83, D61005.

Pre-commercial scale radiation treatment of food, 1980-85, D61006.

Factors influencing the utilization of the food irradiation process, 1980-85, D62002.

Insect disinfestation of food and agricultural products by irradiation, 1981-86, D61007.

Use of irradiation as a quarantine treatment of food and agricultural commodities, 1984-90, D61008.

Asian regional cooperative project on food irradiation, with emphasis on technology transfer to local industries - Phase II (RCA), 1985-88, D61009.

Food irradiation for Latin American countries, 1986-90, D62003.

Use of irradiation to control infectivity of food-borne parasites, 1987-91, D61010.

Application of irradiation technique for food processing in Africa, 1988-93, D61011.

Food irradiation for Middle East and Europe (FIPMEE), 1988-92, D61012.

Asian regional cooperative project on food irradiation, with emphasis on process control and acceptance - RPFI, Phase III (RCA), 1989-93, D61013.

Irradiation in combination with other processes for improving food quality, 1990-95, D61014.

Irradiation as a quarantine treatment of mites, nematodes and insects other than Fruit Fly, 1992-96, D61015.

Irradiation as a public health measure to control food-borne diseases (cysticercosis/taeniasis and vibrio infection) in Latin America and the Caribbean, 1993-96, D62005

Standardized methods to verify absorbed dose of irradiated fresh and dried fruits and tree nuts in trade, 1994-98, D61016.

CHAPTER 6

TECHNICAL ASSISTANCE AND COOPERATION

TECHNICAL ASSISTANCE AND COOPERATION

INTRODUCTION

Technical assistance activities have always played a major role in the Joint FAO/IAEA programme accounting for ca. 40% of the staff work load. They include training as shown in Chapters 7 and 8 as well as field projects in developing Member States to be treated in this Chapter.

Field projects can be small - such as making provision for a fellowship or a short-term expert assignment or a piece of equipment - or large comprising funds for several fellowships, experts, equipment and supplies during a period of several years. The latter projects are usually referred to as large-scale.

The majority of field projects dealing with subjects of applying nuclear techniques in food and agriculture have been those administered by the IAEA, either under its own funds or as Executing Agency for projects funded by UNDP or extrabudgetary sources. However, some use has been made of the FAO TCP scheme through "bridging" - projects in entomology and food preservation. Furthermore, FAO has funded a number of young scientists from Europe, who have worked in support on technical assistance activities primarily in the Agricultural Laboratory at Seibersdorf but also in HQ's as associate professional officers, APO's, (see Chapter 4).

TECHNICAL SUPPORT OF AGRICULTURAL FIELD PROJECTS

The technical responsibility for technical assistance projects in food and agriculture rests with the Joint Division. Thus every field project has one or several technical officers assigned among its staff to provide for the necessary technical input and know-how. Most projects have goals commensurate with the objectives of one of the six Sections of the Joint Division, which therefore provides the technical officer among its staff. In cases of multidisciplinary field projects the Deputy Director acts as technical officer in collaboration with technical officers appointed from the relevant Sections as associated staff. The Deputy Director also coordinates all technical assistance activities within the Joint Division.

The technical servicing of field projects is not only limited to desk work but also involves visiting the project sites for planning, advising and monitoring purposes. As an example, in 1978 18 staff members of the Joint Division and the Laboratory went on 25 missions and stayed a total of 60 weeks in the field. The following year, 1979, these figures had grown to include 22 staff spending 195 weeks abroad on 43 missions.

In view of the steadily growing number of field projects in food and agriculture (60 in 1977 rising through e.g. 156 in 1985 to 230 in 1993) their "in situ" servicing by staff members became impossible to handle. The trend therefore became to recruit outside experts for specific technical jobs and let the Joint Division staff concentrate on travels to projects primarily for the purpose of planning and organization. In some cases "regional experts" have been recruited on the staff to service a number of allied projects.

FUNDS FOR IAEA FIELD PROJECTS

The funds available to IAEA for all technical assistance activities originate from four sources: the Technical Assistance and Cooperation Fund (TACF) based on voluntary contributions from its Member States; - in-kind contributions like fellowships from Member States; - UNDP; - and extra- budgetary sources.

Extrabudgetary resources from Member States have been offered as in-kind contributions - such as for fellowship training - or in-cash. Thus, a Member State may decide to fund a so called footnote a) project, which is a technical assistance project approved by the IAEA Board of Governors because of its technical merits, but for which no funds are immediately available. In some cases formal agreements have been concluded such as in 1969 when the IAEA signed an agreement with the Government of Sweden on cooperation in the provision of technical assistance to developing countries. Food and agriculture as well as environmental protection have been the main activities enjoying very substantial Swedish support through SIDA and later also SAREC.

EPTA, the United Nations Expanded Programme of Technical Assistance, was a source of funds for IAEA's field activities in the late 1950's and early 1960's. Thus, a few experts in various agricultural isotope techniques could be recruited for work in Member States with EPTA funds.

The United Nations Special Fund, SF, became another source of funding of IAEA field activities which primarily aimed at regional or national training as well as strengthening of research centres. IAEA soon became represented at the sessions of the Governing Council of the UNDP which administered both EPTA and SF. In 1972 the Special Fund merged with EPTA, and SF-type projects were thereafter referred to as UNDP "large-scale" projects.

The IAEA Reserve Fund was established in 1980 to enable IAEA to make flexible and prompt responses to unforeseen, urgent needs. The fund was approved at the level of 250,000 dollars and quickly proved to be an extremely valuable tool.

There were no funds available in 1958 for technical assistance by the IAEA, but already in May of 1959 the picture changed considerably, and IAEA had at that time received requests for field projects from 22 Member States.

Table 2 illustrates the budgetary development of IAEA technical assistance in some selected years during the period 1958 to 1992.

TABLE 2

Year	Funds available to IAEA 000$					Projects in Food and Agric.	
	Total	TACF	in kind	UNDP	Extra Budgt.	000$	%
1958	0	-	-	-	-	-	-
1959	1637	798	561	277	-	-	-
1963	2728	1230	484	1019	-	-	-
1968	3348	1348	578	1422	-	409	17.0
1973	6384	3123	1297	1964	-	1443	24.9
1978	15100	7116	204	2954	2926	1793	19.9
1983	34513	19241	2172	3706	9394	4982	18.7
1988	45593	34510	2322	3051	5710	7176	15.7
1992	40308	33411	1302	620	4975	9350	23.2

While the table shows the steady average increase in the TACF, the in-kind contributions have varied irregularly. The UNDP share of the total budget started out below 1 million dollars in the late 1950's and early 1960's. It then grew during the 1970's to a high of 5.9 million dollars in 1980, followed by a decrease to its present level of less than 1 million dollars. Funds from extrabudgetary resources from Member States earmarked for specific projects were included in the table as of 1977, at which year the contribution amounted to 1.9 million dollars. Already in 1983 the extrabudgetary contributions had risen to 9.3 million dollars and the figures presently oscillate between 4.5 and 7.5 million dollars yearly.

Overall the USA, FRG, UK, France and Sweden have been the major providers of extrabudgetary funds.

IAEA FIELD PROJECTS IN FOOD AND AGRICULTURE

Table 1 also shows the cost of projects in food and agriculture and their relative share of the total funds available to the IAEA.

The average share of food and agricultural projects during the years 1966-1993 was 20.9 % ranging from minimum 14.9 % in 1966 to 29.7 % in 1971 and 1972. The figures shown in the table must, however, be considered as approximate due to different systems of budgetting and accounting over the years.

The Joint Division´s first technical assistance activities besides training mainly consisted of preliminary missions as requested by Member States to:

- inform about the Joint Divisions programme
- establish close relations with national authorities concerned with agriculture and atomic energy
- collect relevant information on food and agriculture
- advise on development of programmes for the appropriate use of isotopes and radiation in food and agriculture research.
- provide guidance about requests for technical assistance from the IAEA as well as from FAO.

The first IAEA preliminary missions were organized 1958/59 in consultation with the United Nations and included some experts on the application of radioisotopes in food and agriculture. The missions visited Afghanistan, Brazil, Burma, Sri Lanka, China, Indonesia, Iran, Iraq, Japan, the Republic of Korea, the Philippines, Thailand, Turkey, Venezuela, Vietnam and Yugoslavia. The following years similar preliminary missions went to the Federation of Mali, Greece, Ivory Coast, Morocco, Sudan and Tunisia in addition to countries in Latin America.

Since those initial years, the number of IAEA technical assistance projects in food and agriculture has - as already mentioned - grown very fast. This development is illustrated in Table 3, which shows the disbursement for agricultural projects completed from 1978 through 1992.

TABLE 3

Year	No. completed projects, a).	Total Disbursement (all funds), 000 $
1978	21	573
1979	18	759
1980	32	1420
1981	19	536
1982	21	1942
1983	16	1554
1984	19	1193
1985	20	2592
1986	24	1715
1987	19	1124
1988	32	7923
1989	29	3063
1990	20	8001
1991	48	10528
1992	38	6975

a) could be single or multiyear projects.

Disbursements have grown by a factor higher than 10 during the 15 years 1978-92. 376 projects were completed (some of which were large-scale and thereby represented large disbursements during their final year) for a final disbursement of close to 50 million dollars.

The total budget for the 230 agricultural IAEA projects which were operational in September 1993 amounted to close to 42 million dollars. These figures include the total budget during the lifetime of projects, which were close to termination. In addition to the 230 projects as shown in the (regularly issued) Full Status Report, there were 21 not yet upgraded footnote a) projects as well as 19 just completed or cancelled projects still shown in the books, thus bringing the total number of projects mentioned to 270.

The geographical distribution of the 230 operational projects is shown in Table 4, demonstrating the emphasis on developing agriculture in Africa.

TABLE 4

Area	Total No. Projects	%	Regional	No. of countries
Africa	80	34.9	7 (RAF)	24
Asia	49	21.6	2 (RAS)	14
Latin America	72	31.6	2 (RLA)	19
ME & E	27	11.9	2 (RER)	12
Interregnl.(INT)	2			
Total	230	100	13	69

The distribution of the 230 projects according to subject matter is shown in Table 5.

TABLE 5

Subject matter	Projects	%
Soil Fertility, Irrigation and Crop Prod.	54	23.5
Plant Breeding and Genetics	39	17.0
Animal Production and Health	74	32.2
Insect and Pest Control	20	8.7
Agrochemicals and Residues	16	6.9
Food Preservation	11	4.8
General	16	6.9
Total	230	100

In order to illustrate the technical assistance planned for the whole of 1993 for projects in food and agriculture one has to look at the provisions approved in previous programme years as well as new requests appearing for the first time. To these figures should be added the footnote a) projects (approved without funds). Table 6 illustrates the distribution.

TABLE 6

Subject matter	Total Projects	"old"	new	Foot-note a	Value 000$	%
Soil Fertility, Irrigation and Crop Production	36 (23.7%)	12	23	1	1853	20.6
Plant Breeding and Genetics	17 (11.2%)	5	8	4	1086	12.1
Animal Production and Health	64 (42.1%)	26	34	4	3436	38.1
Insect and Pest Control	14 (9.2%)	5	8	1	948	10.5
Agrochemicals and Residues	11 (7.3%)	3	4	4	832	9.2
Food Preservation	6 (3.9%)	2	2	2	342	3.8
General	4 (2.6%)	1	2	1	509	5.7
Total	152 (100%)	54	81	17	9006	100

FIELD PROJECT EFFICIENCY AND IMPACT

The efficiency of technical assistance and cooperation projects has always been a matter of concern and review. Are the projects requested by developing Member States technically appropriate or feasible, and do they have an impact on the economic development of the country and welfare of its people?

Not all field projects have been as successful as others. The reasons could be found at HQ´s as well as in the countries themselves:

Was the project appropriately conceived and well planned? Are the expert recruitments, placements of fellowships or procurements of equipment fast and efficient? Are the evaluations of expert and fellowship candidates or equipment specifications speedy? Is the technical supervision of the project effective and conscientious?

Can the national authorities absorb the project within the existing infrastructure? Are suitable candidates available for training? Do the recipient country authorities clear proposed expert or fellowship candidates without delay? Has the country arranged for a smooth, non-bureaucratic custom clearance procedure of items to be imported under the project? Is the Government contribution (in cash or in kind) readily available as planned and agreed upon?

These are a few of the many relevant questions which need to be addressed on a continous basis. Several mechanisms are put in operation.

The IAEA has established an Evaluation Section under the Office of the Deputy Director General, Department of Technical Cooperation. Under this scheme an interim implementation reporting system was initiated with questionnaires being sent to the national counterparts. In addition a number of sectoral evaluations - either by subject matter or by country - were undertaken each year, as were mid-project and end-of-project evaluations. Training activities were also followed-up with questionnaires sent to the trainees years after the training, to find out which impact the training had had on their projects and their careers. Finally, national and regional courses on project evaluation were initiated.

The IAEA reorganized its Department of Technical Cooperation in 1989, whereby two new divisions dealing with programming and implementation, respectively, were created. Another important development was that the Programme Coordination Section (handling e. g. all UNDP projects) reverted to the Office of the Deputy Director General of the above Department. The computerized recording of all field projects was further intensified and the so-called "Full Status" reports were distributed within the house at about two week intervals.

The in-house TC Implementation Reports were also distributed on a regular basis, making it possible for the Technical Officers to check on the implementation rate of each of the field projects to which they were assigned.

The latest efforts to improve on the impact of field projects was the introduction in 1992/93 of the concept of "Model Projects". A Model Project is i.a. to redirect the programme towards meeting major needs and having a significant impact on the end-users, i.e. beyond the institutes involved in the project.

A limited number of Model Projects were already developed from on-going field projects and approved 1993 for implementation in 1994. Many of the Joint Divisions field projects were considered as Model Projects, - for example livestock disease control or insect eradication projects.

LARGE-SCALE FIELD PROJECTS

The Joint Division has had technical responsibility for several large-scale projects funded primarily by UNDP but also from extrabudgetary sources - such as SIDA - , and with IAEA as the Executing Agency.

These large-scale projects were usually planned for at least 3-5 years being supported by UNDP or IAEA or extra budgetary funds close to 1 million dollars or more in addition to the Government Counterpart Contribution in kind and in cash.

Some of the largest projects in food and agriculture have dealt with the control and eradication of an insect pest (Medflies, tsetse flies etc., see Chapter 14), wheras other large scale projects have been of a multidisciplinary nature. Mostly, they have dealt with soil science, plant breeding and animal science, but also pesticide research and entomology have been included.

In relation to the multidisciplinary large-scale projects one can discern two distinctly different philosophies as illustrated by the following examples:

I). The Brazilian UNDP/IAEA project at CENA represented the approach that most research efforts should be coordinated and aimed at solving only one problem, namely to improve the productivity and quality of *Phaseolus vulgaris*, the common bean, which constitutes the staple food source of protein for the Brazilian population. All efforts in research on fertilizer application, water use, biological nitrogen fixation and soil chemistry were therefore directed and aimed at increasing the bean production. Likewise, the plant breeders could produce varieties with improved characteristics such as yield, disease resistance, earlyness, nitrogen fixing potential and desired colour. The entomologists attempted development of practical measures to cope with insect pests that could decimate the crop.

In essence, most of CENA´s staff could concentrate on one common goal and did come up with tangible results as package solutions to improve bean production.

II). The entirely opposite approach prevailed e. g. in the large-scale UNDP/IAEA project entitled: "Improving Food and Agricultural Production in Thailand". This project stood among the most extensive and technically complex, encompassing some 60 specific organizational and scientific tasks through field studies, laboratory, greenhouse and animal experiments in addition to many other activities. Three Government Departments, four Universities and OAEP were all involved in the project, which worked in over 30 experimental field stations and 100 villages in Thailand.

The overall objective of the project was to assist a large group of scientists with expertise, training and services in the use of appropriate nuclear techniques as complementary tools in solving practical problems of economic significance in soil science, plant breeding as well as in animal production and health. The project could thus result in many individual achievements in different institutes and with different crops, soils and livestock.

Other large-scale field projects have followed either of the two philosophies or a combination.

All large-scale projects have a Project Committee for overall policy decisions, and in many cases also Technical Committees for scientific planning. The Government nominates a (National) Project Director, and the IAEA appoints its representative. Although the incumbents´ job description remained essentially the same, the title has varied between International Project Director, Project Manager, Coordinator or as in later years Chief Technical Advisor. The (National) Project Director was always Chairman of the Project Committee, and the IAEA representative was usually - but not in all cases - a member of the Project Committee.

The following is a chronological summary of the most important large-scale projects in food and agriculture, for which IAEA was the Executing Agency. Strictly entomological projects are dealt with in Chapter 14.

Yugoslavia (1962-66)

The first large-scale project for which the Joint Division had technical responsibility was approved in May 1962 by the Governing Council of the Special Fund, UNDP. The project supported an extension of research and training facilities at INEP (Institute for the Application of Nuclear Research in Agriculture, Forestry and Veterinary Sciences) situated at Zemun near Belgrade. The UNDP/SF contribution was initially 546,000 dollars.

The project became operational in April 1963, and the first International Project Director Cyril Comar, USA, was recruited. He was later succeeded first by Jefferson, USA, and then by Lars Fredriksson, Sweden. Other notable personalities associated with the project were Johannes Moustgaard, Denmark, and Lars Ehrenberg, Sweden.

The project Plan of Operation identified training and research in soil fertility, in mutation plant breeding as well as in animal nutrition, health and protection with the use of isotope and radiation techniques. A Central Laboratory was completed in 1964 and the following year complemented with a phytotron building, a gamma irradiation facility and an animal housing farm. Noteworthy among the items of equipment was the construction in the country of a nuclear magnetic resonance apparatus for screening of oil seed.

A nine months extension of the project until the end of 1966 was approved, and after that time individual activities were supported through the IAEA.

Turkey (1965-68)

In June 1965 the Governing Council of the Special Fund, UNDP, approved a three year pilot project in Ankara for disinfestation of stored grain by gamma irradiation at a contribution exceeding 1.5 million dollars to purchase a Co-60 gamma source. Turkish public opinion, however, prevented a successful conclusion of the project.

India (1968-74, 1978-82)

A five year project on nuclear research in agriculture, which was approved by UNDP in January 1968, commenced when the Plan of Operation was signed on 10 October of the same year. Lars Fredriksson, Sweden, was appointed International Project Director. UNDP contributed 1.4 million dollars. This was at the time not only the biggest project to be executed by the IAEA, but also the most complex.

The project operated at four centres in India:

IARI, Indian Agricultural Research Institute, in New Delhi. Here, a new laboratory building was constructed and inaugurated in 1971 under the name Nuclear Research Laboratory, NRL. The project head office was located here, and research embraced soil fertility, fertilizer use, plant nutrition and water utilization studies emphasizing ground water recharge problems in addition to mutation plant breeding with cereals, oil seed and pulses and control of insect pests.

BARC, Bhabha Atomic Research Centre, Trombay, outside of Bombay, mainly working on mutation induction for oil seed and rice improvement as well as the sterile male technique and the development of insect attractants, repellents and pathogens.

IVRI, Indian Veterinary Research Institute, in Izatnagar, with studies of trace elements in animal nutrition, research on non-protein-nitrogen diets based on urea and molasses to be used in emergency operations in the Maharashtra State and development of a radiation attenuated vaccine for use against the lung worm disease in sheep and goats in remote regions of Himalayan foothills. In 1973 the Governments of Jammu and Kashmir constructed a facility near Srinagar to mass produce the vaccine aiming at 100,000 doses per year.

NDRI, National Dairy Research Institute, in Karnal, where studies were undertaken of nutrient metabolism and synthesis of milk proteins. Extensive feeding trials designed to improve the nutrition of cattle, water buffalo and sheep by using locally available protein sources were carried out here, and a nearby village was made into a demonstration of what nuclear and other methods can achieve in research to improve the economic situation of the farmers. Cheap Government subsidized bank loans supported the work.

The UNDP project ended in 1974 but a follow-up assistance was negotiated with SIDA, and a second phase of the project started 1978 and lasted for five years with a SIDA contribution of 2.5 million dollars. The objectives were essentially the same as in the previous project, but more emphasis was to be put on the sheep vaccination program.

Brazil (1972-81)

The National Nuclear Energy Commission, CNEN, decided to work together with the IAEA to expand and improve the training and research programmes of the Centre for Nuclear Energy in Agriculture, CENA, of the Luiz de Queiros Agricultural College, Piracicaba, which is a Faculty under the University of São Paulo, USP.

The project became fully operational in September 1972. The first International Project Director was Carl G. Lamm, Denmark. He was succeeded in 1974 by Knut Mikaelsen, Norway, and a year later Peter Vose, UK, took over until the project terminated. The initial UNDP contribution amounted to approx. 1 million dollars.

Project activities included a strong training component as well as support of research in soil fertility, plant nutrition, biochemistry and radiochemistry, analytical chemistry, microbiology, plant breeding, plant pathology, hydrology, ecology, entomology and animal nutrition. As already mentioned most of these areas of research cooperated as relevant with the single goal of increasing and improving the bean production.

The project was designed to strengthen existing facilities to enable CENA serving as the central facility for atomic energy applications in food and agriculture for the whole country. This included many post graduate courses held at CENA as well as research, and several new buildings were erected and equipped.

Many results of practical significance were obtained such as improved mutant bean varieties - one resistant to the *Golden Mosaic virus* - in combination with selected strains of *Rhizobium phaseoli* to ensure optimal nitrogen fixation. Further results were package solutions on soil, fertilizer and water managment practices.

Other results included a stem rust tolerant wheat mutant TICENA-4. Isotope hydrology work in the Amazonas confirmed that about 30% of the rainfall is recycled within the area, and the animal scientists could confirm various mineral deficiencies in cattle.

The UNDP support was extended until the early 1980's as a second phase, and DANIDA further supported the project in the field of isotope use in environmental chemistry. As a recognition CENA was formally designated as the first Specialized Centre of USP.

Bangladesh (1975-80, 1985-90)

Negotiations with SIDA led to a large-scale project to strengthen the development of the (then) Institute of Nuclear Agriculture, INA, in Mymensingh. The institute belonged to the Bangladesh Atomic Energy Commission and was situated near the Bangladesh Agricultural University.

A preparatory SIDA/IAEA mission was provided in 1974, and the project started in 1975 with a SIDA contribution of 1.3 million dollars over five years. Avtar Kaul, India, became the Project Manager. After his resignation Lars Fredriksson, Sweden, and Carl G. Lamm, Denmark, provided coordination on behalf of the FAO/IAEA.

INA was later renamed BINA when - at the insistence of SIDA and IAEA - the institute was formally incorporated under the Bangladesh Agricultural Research Council.

The long-range objective of the project was to further training, research and collaboration with other national agricultural research organizations to help improve the agricultural production in the country through studies leading to improved intensified plant breeding methods, the optimum use of fertilizers, the control of plant diseases and pests and the judicious use of water resources. Work particularly aimed at increasing crop production at the village level.

The project was hampered by delays caused by slow recruitments, strikes and student unrest and therefore had to be rescheduled several times. However, outstanding achievements were the evolution of two new early maturing and high yielding rice mutants IRRATOM-23 and IRRATOM-38 as well as two improved jute varieties ATOMPAT-28 and ATOMPAT-38.

The project at BINA continued as a second phase through IAEA assistance and a footnote a) project, which was mainly funded through an extrabudgetary contribution by the United Kingdom. Soil microbiology and plant tissue cultures were among the activities supported.

Indonesia (1978-88, 1988-93)

This project entitled "Application of Isotopes and Radiation for Increasing Agricultural Production" was approved by UNDP with a contribution of over 1.5 million dollars for the first five years. A second phase was approved with 469,000 dollars.

Under this project, facilities for research applied to practical agricultural problems were strengthened at the Centre for the Application of Isotopes and Radiation, CAIR. Universities and national agricultural research institutes under the Ministry of Agriculture participated in the project. Knut Mikaelsen, Norway, coordinated the project on behalf of FAO/IAEA.

Effective use of nuclear techniques had already been made in support of plant breeding, soil, water, fertilizer and crop management practices, of control of insect pests, including the effective and safe use of pesticides, and of animal nutrition and reproduction, and some of the results are being used by the farmers. For example, improved varieties of wetland rice, soybean, upland rice and mungbean are being cultivated, animal feed supplements in the form of solid urea-molasses and mineral blocks made from agro-industrial by-products have been tested, better soil-moisture control and nitrogen-fertilizer practices as applied to multiple and sequential cropping under rain-fed conditions were introduced, and Azolla is being used as a source of biologically fixed nitrogen in rice-paddies.

Entomological research has provided valuable dispersion data on rice-insect pests, and rice and soybean varieties were screened for insect-pest resistance.

The second phase of the project was geared towards consoli-dating the achievements of the first phase and emphasizing the animal production component.

Republic of Korea (1984-89)

Considerable support for the use of nuclear techniques in agriculture had been provided by and through the IAEA. As a means of consolidation a UNDP project contributing 635,000 dollars was approved and established with the Rural Development Administration, which is the primary institute in the country responsible for agricultural research. Aladin Hassan, Egypt, coordinated the project on behalf of FAO/IAEA.

Experts advised on different aspects of plant breeding, on soil and its relationship to plant nutrition, and on pesticide use. Nineteen fellows were trained abroad, while eight senior scientists were provided with scientific visits to advanced laboratories. Research, which included 16 topics in the three scientific fields, was conducted at six relevant institutes of the Rural Development Organization.

Vietnam (1984-93)

An extrabudgetary project was approved in 1984 for providing assistance to Vietnam in order to develop facilities for semi-commercial studies and demonstration of food preservation (particularly potatoes, onions, fruits, spices and fish) by irradiation. The Vietnam Atomic Energy Commission received the assistance in the order of 1.4 million dollars, and the IAEA was the Executing Agency.

The project supported the establishment of the Hanoi Irradiation Centre with a 110 kCi Co-60 source and an automatic conveyor system as well as with training and expertise. The facility is being used for pilot scale irradiation trials leading to practical application of food irradiation in the country.

Brazil (1984-1993)

The effects of changing land use on the ecology and climate of the Brazilian Amazon was the subject of a large-scale, multidisciplinary project initiated in 1984. The project which was coordinated by the National Atomic Energy Commission, and by Peter Vose, United Kingdom, on behalf of FAO/IAEA, was concerned with isotope aided studies and brought together 80 Brazilian scientists to collaborate in this environmental project.

The project received both regular IAEA funding through a number of small projects as well as extrabudgetary contributions from several Member States. Outstanding was the contribution from the Swedish Agency for Research Cooperation with Developing Countries, SAREC, in the order of 750,000 dollars in support of that part of the project, which was concerned with the hydrological cycle.

A team of experts undertook a study of the increasing salinity of shallow groundwaters in semi-arid areas in the North Eastern Brazil; - the changes resulting from both natural and man-induced causes.

Other topics studied in-depth comprised the nitrogen, carbon, sulphur and phosphorus cycles, fate of pesticides, tree physiology and water vapour routings both in connection with forest water budgets and global climate modelling.

The first planning workshop was held in 1986. Close collaboration was maintained with CENA in Piracicaba, INPA in Manaus, CPATU in Belem and the EMBRAPA system in addition to Universities and other research organizations.

Venezuela (1986-90)

In 1984 the Government requested assistance for the establishment of a nuclear research center in the field of agriculture. This was to be seen as a continuation and consolidation of a number of earlier IAEA projects in fields of soil science, sorghum and sesame breeding and animal production.

A three year project was approved with regular IAEA funds complemented by a UNDP project with a contribution of 279,000 dollars. The purpose of the combined projects was to establish CINAGRI (Center for Nuclear Agricultural Investigations) at FONAIAP of the Ministry of Agriculture in Maracay, and to support relevant research. The Universities primarily in Maracay, Caracas and Maracaibo participated in this multidisciplinary project, which was initially coordinated by Carl G. Lamm, Denmark, on behalf of the FAO/IAEA.

In 1985 and later years groups of experts offered research advice and national training courses on topics such as soil/water/plant relationships, animal health and reproduction, the use of agrochemicals as well as plant mutation breeding with emphasis on tissue culture techniques.

Thailand (1986-90)

As a logical follow-up and consolidation of several small-scale IAEA projects UNDP decided to support a large-scale project for five years providing some 1.4 million dollars. It became operational in 1986 with Carl G. Lamm, Denmark, as Chief Technical Advisor.

The project embraced studies at over thirty experimental field stations as well as in green houses, laboratories and livestock sheds belonging to any of eight participating Thai Institutions:

Department of Agriculture
Department of Land Development
Department of Livestock
Kasetsart University
Khon Kaen University
Chiang Mai University
Chulalongkorn University, and
Office of Atomic Energy for Peace.

The project comprised three main areas of research:

- Mutation Breeding for disease resistance in food legumes, fibre crops, cereal grains (rice), oil crops and vegetatively propagated crops. In-vitro mutation breeding came to play an important role in this work.

- Soil science with development of management practices for better use of fertilizer and water, particularly in acid-sulphate soils, utilization of improved *Rhizobium japonicum* strains in combination with genetically improved food legumes for maximal biological nitrogen fixation, and use of naturally occurring rock phosphates as sources of phosphorus.

- Animal production and health. The improvement of productivity was emphasized through research on nutrition and reproductive performance in cattle and buffalo. Several villages were selected to demonstrate the research results in practice. The Chulalongkorn University was the focal point and provided leadership for this work with an excellent laboratory for progesterone analyses.

The work was supported by services, training and advise provided by the Central Services Facility at the Isotope Laboratory in the Department of Agriculture. This laboratory, which also served as project head office, was fitted with modern analytical equipment, which included mass spectrometers for N-15 analyses.

Other services were provided by the In-vitro and Mutation Breeding Service Laboratory at the Department of Agriculture. Irradiation, mutation induction and tissue culture techniques were the specialities of this laboratory, which had also enjoyed support under a separate IAEA project.

Over 60 Thai scientists were trained under fellowships and scientific study tours abroad. Yearly seminars and national training courses were held with participants actively engaged in the project as counterparts in the 54 individual research activities. Besides the 15 Technical Reports produced by project experts and the various project progress reports from the project management, scientific publications in scientific international and Thai journals included 15 in plant breeding, 24 in soil science and 17 in animal science.

Among the outstanding achievements can be mentioned the rust tolerant Doi Kham Soybean mutant variety and a Cow Pea mutant resistant to Bacterial Blight and also to Root Rot, recommendations on the legume varieties with the most efficient *Rhizobium* strain to be used as inocculant with minimum use of nitrogen fertilizer, or the results from 67 villages with 1704 buffalo cows which could show an increase in pregnancy from 30% to 78% as a result of project activities.

The project ended in 1990, but a small IAEA project: "To Develop In-vitro Culture Techniques for obtaining Cultivars of Economically Important Crops with Greater Resistance to Fungal and Bacterial Diseases" continued the support of the in-vitro laboratory at the Plant Pathology and Microbiology Division of the Department of Agriculture.

China (1987-92)

A multidisciplinary five year UNDP project was approved in 1987 with a UNDP contribution of 413,000 dollars. The project was located at the Southwestern Agricultural University (SAU) i Sichuan to support the upgrading of undergraduate and graduate education in the application of isotope and radiation techniques in soil fertility and plant nutrition, crop breeding and food irradiation, - and to initiate development research projects in these fields. Björn Sigurbjörnsson, Director of the Joint Division, coordinated the project on behalf of FAO/IAEA.

Besides fellowship training, national training courses were arranged, and experts gave seminars on the application of isotopes in agricultural research, as well as on the use of radiation and chemicals in mutation breeding with emphasis on in-vitro cultures and genetic engineering.

As one result of the project besides the many trained scien-tists, the original laboratory at SAU was upgraded to become the Laboratory of Atomic Energy Applications in Agricultural Sciences.

REGIONAL COOPERATION

Many IAEA technical assistance field projects are regional with similar objectives and activities in countries of the region. These projects are listed under acronyms such as RAF (Africa), RAS (Asia), RLA (Latin America) or RER (Middle East and Europe). (Projects identified as INT are interregional, such as e.g. training courses offered to candidates from all Member States).

Countries participating in a regional project can often be serviced with advantage by the same "regionel" expert, in which case the incumbent's duty station may be the HQ's or the Seibersdorf Laboratory with frequent travels to the region. There are and have been several such experts attached to the Joint Division or the Agriculture Laboratory, as can be seen in Chapter 4.

Another type of regional cooperation has been formalized under agreements or arrangements. In order of chronology they are known under the following acronyms:

RCA Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology in Asia and the Pacific, established 1972.

ARCAL Regional Cooperative Arrangements for the Promotion of Nuclear Science and Technology in Latin America, established 1985.

AFRA African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology, established 1990.

The main difference between the regional projects (RAF, RAS, RLA, RER) and the regional cooperation (RCA, ARCAL, AFRA) is, that in the projects the IAEA initiates and decides on project details, whereas in the regional cooperation IAEA is not party to the agreement or arrangment but offers technical, administ-rative and sometimes economic backstopping and advice. In the case of RCA and AFRA agreements were signed by the partici-pating Governments, while in ARCAL signatories were the National Institutes involved.

Project activities agreed to during regular Working Group meetings among representatives of the participating countries make use of the mechanisms of IAEA technical assistance and cooperation, as well as research coordination and scientific meetings. The training component is usually very strong. The Working Groups also plan project activities for future years.

Funds for the regional cooperation activities consist of contributions from member countries, the IAEA TACF and research contract funds, UNDP and extrabudgetary donations, particularly from countries already participating in the cooperation.

RCA

RCA was established in 1972 "to promote and coordinate cooperative research, development and training projects in nuclear science and technology through appropriate institutions". It is an intergovernmental agreement designed to facilitate cooperative activities.

The agreement was extended several times, each for a period of five years, and the latest extension took place in 1992. The following 14 countries are parties to the agreement: Australia, Bangladesh, China, India, Indonesia, Japan, Republic of Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Thailand and Viet Nam.

RCA activities in food and agriculture include mutation breeding and related biotechnology for crop improvement, efforts to maximize biological nitrogen fixation in grain legumes, food preservation by irradiation and the improvement of buffalo nutrition, reproduction and health.

New proposals in 1993/94 include the use of the sterile insect technique to protect fruit and vegetables from destruction by tropical fruit flies, the amelioration of environmental pollution by use of F-1 sterility for controlling caterpillar pests, the establishment of a regional rinderpest sero-monitoring network, and the improvement of banana through integration of mutation and related technologies into conventional breeding.

ARCAL

ARCAL was first discussed by five countries of the Andean sub-region, who in 1983 requested IAEA to assist them in coordinating their efforts to promote nuclear techniques in a number of fields. The first technical planning meeting was held in 1984. It defined an ARCAL programme which became operational in 1985.

ARCAL has 15 participants: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela. The second five year arrangements were renewed in 1994.

ARCAL activities in food and agriculture have dealt with livestock reproduction of cattle, sheep and goats as well as indigenous llama, alpaca and vicuña and also introduced buffalo, through laboratory networks, food irradiation, breeding of improved cereals (rice, wheat and barley) through mutation induction and tissue culture techniques, and finally insect pest control (fruit flies). A new five year project is planned to start 1993. It is designed to improve fertilizer practices and also to optimize multiple cropping and rotating systems with regard to available water and nutrients.

AFRA

AFRA was established in 1990, and the following 16 Member States have acceded to the agreement: Algeria, Egypt, Cameroon, Ethiopia, Ghana, Kenya, Libyan Arab Jamahiriya, Madagascar, Mauritius, Morocco, Nigeria, South Africa, Sudan, Tanzania, Tunisia and Zaïre.

Ongoing AFRA projects in food and agriculture deal with food preservation by irradiation, improvement of livestock productivity by a combination of better feeding and reproductive management. A new planned project is entitled: "Nuclear Techniques in Plant Breeding and Biotechnology".

CHAPTER 7

FELLOWSHIPS AND SCIENTIFIC VISITS

FELLOWSHIPS AND SCIENTIFIC VISITS

A total of 3.286 applications were received from 89 Member States between 1958 and 1993. Of these applications 677 were withdrawn by the Governments or candidates or were rejected by the IAEA for technical reasons, while 2.609 (79%) were implemented.

The relative distribution of all implemented fellowships among the fields of nuclear techniques in agriculture was:

General Agriculture	2%
Soil Fertility, Irrigation and Crop Production	27%
Plant Breeding and Genetics	16%
Animal Production and Health	19%
Insect and Pest Control	13%
Agrochemicals and Residues	8%
Food Preservation	15%

Table 7 below shows the distribution of all applications and implemented fellowships (parenthesis) for each Member State.

It is evident that some Member States are represented with a relatively higher number of applications than others; - very often reflecting the fact that relevant large-scale projects funded by UNDP, SIDA or other extrabudgetary sources were executed by IAEA in Member States such as BGD, EGY, IND, INS, NIR, PAK, ROK, THA or YUG.

There has been a steady increase in the number of applications from year to year, thus e. g. only 17 in 1958 rising to 92 in 1974 and over 250 in 1992/93.

The number of agricultural fellowships related to specific TC projects has also been steadily increasing during the last ten years.

The costs of agricultural fellowships have increased over the years. As an illustration the total cost for 678 fellowship trainees (not related to a particular TC project) during 1981-93 exceeded 6 million dollars, or close to 9.000 dollars per fellowship (or some 2.000 dollars per m/m).

TABLE 7

AFG	5 (2)	EGY	157 (103)	LIB	28 (23)	SEN	15 (11)
ALB	12 (10)	ELS	11 (6)	LIR	1 (0)	SIL	9 (8)
ALG	26 (24)	ETH	24 (6)	MAG	10 (7)	SIN	1 (1)
ARG	14 (12)	FIN	1 (1)	MAL	64 (47)	SPA	8 (6)
AUS	3 (3)	FRA	1 (1)	MAR	10 (9)	SRL	88 (70)
BGD	91 (78)	GHA	115 (94)	MEX	36 (28)	STK	1 (1)
BOL	13 (12)	GRE	42 (32)	MLI	20 (15)	SUD	121 (70)
BRA	80 (67)	GUA	26 (16)	MON	20 (18)	SYR	43 (37)
BUL	98 (80)	HOK	1 (1)	MOR	20 (17)	THA	227 (193)
BUR	3 (2)	HUN	65 (57)	NER	10 (9)	TUN	5 (3)
CHA	61 (44)	ICE	17 (16)	NET	1 (1)	TUR	74 (53)
CHI	41 (34)	IND	140 (126)	NIC	2 (2)	UGA	34 (27)
CMR	9 (7)	INS	91 (77)	NIR	85 (58)	URT	41 (30)
COL	32 (27)	IRA	26 (17)	PAK	115 (90)	URU	25 (21)
COS	34 (27)	IRQ	42 (30)	PAN	10 (8)	VEN	43 (37)
CPR	50 (41)	ISR	11 (8)	PAR	3 (3)	VIE	42 (32)
CUB	28 (23)	ITA	5 (3)	PER	42 (36)	YUG	89 (82)
CYP	24 (18)	IVC	23 (20)	PHI	74 (62)	ZAI	42 (29)
CZE	13 (10)	JAM	1 (1)	POL	61 (52)	ZAM	56 (41)
DEN	1 (1)	JOR	9 (7)	POR	7 (6)	ZIM	7 (4)
DOM	5 (4)	JPN	7 (6)	ROK	106 (83)		
DRK	8 (4)	KEN	53 (37)	ROM	22 (20)		
ECU	51 (46)	LEB	18 (16)	SAU	3 (2)		

During the period 1962-93 a total of 380 fellowship trainees were hosted in the Agriculture Laboratory at Seibersdorf. This figure represents 15% of all fellowships in food and agri-culture implemented during the same period.

The 380 trainees in Seibersdorf spent a total of 2091 m/m in the laboratory. 21.6% of them were females. The distribution according to field of activity shows:

Soil Science:	130 trainees,	813 m/m,	34.2% of all,	26.9% females
Plant Breeding:	70 trainees,	426 m/m,	18.4% of all,	22.9% females
Animal Science:	53 trainees,	186 m/m.	13.9% of all,	24.5% females
Entomology:	109 trainees,	560 m/m,	28.7% of all,	7.3% females
Agrochemical:	18 trainees,	106 m/m,	4.7% of all,	55.6% females

The geographical distribution of the 380 trainees in Seibersdorf shows:

Africa:	163 trainees,	42.9% of all,	14.1% females
Asia:	101 trainees.	26.6% of all,	23.8% females
Latin America:	61 trainees,	16.0% of all,	39.3% females
Middle East & Europe:	55 trainees,	14.5% of all,	20.0% females

The average time spent by the trainees in the Agriculture Laboratory was 5.5 m/m varying between 1 and 55 months. The average time according to the field of activity shows:

Soil Science:	6.3 m/m
Plant Breeding:	6.1 m/m
Animal Science:	3.5 m/m
Entomology:	5.1 m/m
Agrochemicals:	5.9 m/m

The trend during later years has been to shorten the stay in the Laboratory to some 1-3 months.

Fellowships under the IFFIT programme of the Food Preservation Section are not included in the above figures.

CHAPTER 8

TRAINING COURSES AND STUDY TOURS

TRAINING COURSES AND STUDY TOURS

During the period 1959 - 1994 the Joint Division has been technically responsible for a total of:

116 interregional training courses,

6 interregional study tours, and from 1980

80 regional training courses.

In addition the Joint Division has assisted in the implementation of many national training courses in Member States.

INTERREGIONAL TRAINING

Table 8 shows the distribution of the interregional training events by year and subject, and the following conclusions can be drawn from the detailed records:

- There were close to 6.200 applicants for the 122 training events, with an average of 51 applicants per event.
- There were 2.200 participants in the 122 training events, with an average of 18 participants per event.
- 35 % of all applicants were selected to participate in the training.
- The number of training events per year varied between zero and eight.
- 25 % of all participants came from Africa.
- 27 % of all participants came from Asia
- 20 % of all participants came from Latin America.
- 28 % of all participants came from ME & E.

The trend over the last ten years is that there has been a steady increase in the percentage of participants coming from Africa and Latin America, a decrease in the case of ME & E and almost constant figures from Asia.

The Table does not include any of the IFFIT or ICGFI training courses in subjects of food irradiation. The subject heading "General" included during the first years items such as application of radio-isotopes in agricultural research, in forestry research, in horticultural research, in biochemistry and surveys of radio-nuclides in foods.

INTERREGIONAL TRAINING COURSES HELD IN THE AGRICULTURE LABORATORY

While the majority of training courses and study tours have been held in Member States, the Seibersdorf Laboratory has played an increasingly important role in hosting the training courses because of the availability of excellent facilities and trained staff.

A total of 33 interregional training courses were held in the laboratory since 1978. 635 students participated with the following distribution:

Soil Science

18 courses were held during 1978-93, 3 of which were devoted to Biological Nitrogen Fixation. A total of 342 students participated with 22.8% being females. 30.7% of the students came from Africa, 27.6% from Asia, 26.3% from Latin America and 14.3% from ME & E.

Plant Breeding

12 courses were held during 1982-93. A total of 232 students participated with 20.7% being females. 28.4% of the students came from Africa, 27.6% from Asia, 22.8% from Latin America and 21.2% from ME & E.

Animal Science

2 courses were held in 1987 and 1991. A total of 41 students participated with 26.8% being females. 29.2% of the students came from Africa, 31.7% from Asia, 22.0% from Latin America and 17.1% from ME & E.

Agrochemicals

1 course was held in 1993 with 20 students among whom 40.0% were females. 35.0% of the students came from Africa, 40.0% from Asia, 10.0% from Latin America and 15.0% from ME & E.

REGIONAL TRAINING

Regional training courses were initiated in 1980 with an average of some 5 courses every year. All the 80 courses were held in Member States with the following distribution:

26 courses, or 32.5%, were held in Africa

20 courses, or 25.0 %, were held in Asia

25 courses, or 31.3 %, were held in Latin America

9 courses, or 11.2 %, were held in ME & E.

Note: The figures include the tentative 1994 plans. Courses arranged under RCA, ARCAL or AFRA are not included.

TOTAL DISBURSEMENTS FOR AGRICULTURAL TRAINING COURSES

The total disbursements during the above period was 7.5 million dollars for 52 interregional and 29 regional training courses. This amounts to an average of 93.600 dollars for each of the 81 training courses held.

While the cost per training course was around 60.000 dollars in the early 1980´s, the figure has almost doubled during the last years. Thus the present average cost for one student in a training course is in the order of 7.500 dollars.

TABLE 8

Year	No.	General	Soil. Science	Plant Breeding	Animal Science	Insect and Pest Control	Agrochemicals and Residues	Food Preservation
				SUBJECT MATTER				
1959	1	1						
1960	0							
1961	2		2					
1962	2	1			1			
1963	3	1	1			1		
1964	1	1						
1965	5	3			1	1		
1966	1		1					
1967	2					1		1
1968	1	1						
1969	4		1	1		1		1
1970	4	1	1		2			
1971	5	1		1	1	1		1
1972	5	1	1	1		1	1	
1973	2				1	1		
1974	3	1	1	1				
1975	3				1	1		1
1976	1		1					
1977	5	1		1	1	1	1	
1978	5	2	2					1
1979	8		2	1	3	1		1
1980	3	1	1				1	
1981	6	1	3		1	1		
1982	4		2	1	1			
1983	5		2	2	1			
1984	4		2	1		1		
1985	5		3	1	1			
1986	5		2	1		1		1
1987	5		2	1	1		1	
1988	3		1	1		1		
1989	2		1	1				
1990	3		1	1	1			
1991	3		1	1	1			
1992	3		1	1		1		
1993	4		1	1	1	1		
1994	4			1	1	1	1	
TOTAL	**122**	**16**	**36**	**20**	**18**	**18**	**7**	**7**

(Figures from 1994 are tentative).

CHAPTER 9

SCIENTIFIC MEETINGS

SCIENTIFIC MEETINGS

One objective of the Joint FAO/IAEA Programme is the dissemination of relevant information through scientific meetings.

International Conferences and Symposia are important vehicles for reaching as many scientists in Member States as possible. These meeting categories require long-term planning, simultaneous interpretation and their proceedings have always been issued as IAEA priced publications.

Table 9 shows the distribution of Conferences (C) and Symposia (S) by subject and year. During the period, international Conferences were held in Cambridge, Mass. USA in 1959 and in Geneva in 1988, both dealing with food irradiation, and in Mexico City in 1961 on subjects relevant to animal science. Four Symposia were held jointly with two or three Sections of the Joint Division: 1967 (soil-plant-animal sciences), 1974 (soil and agrochemical sciences), 1976 (soil-plant-animal sciences) and 1979 (animal science and entomology).

The Table shows a total of 49 international Conferences and Symposia. Of those 24 were held in Vienna.

Other categories of scientific meetings include:

Seminars,
Panel of Experts,
Advisory Group Meetings, AGM,
Consultant Meetings,
Research Coordination Meetings, RCM.

The Seminars have mostly been regional. The Panels, AGM's and Consultants have been convened to advise FAO and IAEA on the planning and implementation of relevant research activities. Finally, the RCM's have been arranged within each Coordinated Research Programme at 12-18 months intervals, and thus about 3-5 meetings per programme. The objectives of these meetings are to review research obtained by the participants and often also by the Seibersdorf Laboratory and to plan in detail the joint, coordinated activities for the following years.

Very often reports of these meeting categories have been issued as priced or unpriced (TECDOC) IAEA publications.

On average some 10-15 meetings of all categories have been held yearly. In several cases meetings have been combined; - for example a Symposium together with Consultants and/or an RCM.

During the period 1981-94 the Joint Division arranged a total of 23 Seminars and 13 AGM's.

TABLE 9

Year	Soil. Science	Plant Breeding	Animal Science	Insect and Pest Control	Agrochemicals and Residues	Food Preservation
1958						
1959						C
1960		S		S		
1961			C			
1962	S					
1963				S		
1964			S			
1965	S				S	
1966	S					S
1967	S,S*	S*	S*			
1968	S					
1969		S				
1970		S		S		
1971	S					
1972			S			S
1973	S				S	
1974	S*			S	S*	
1975						
1976	S*	S*	S*			
1977		S				S
1978	S	S				
1979			S*	S*		
1980						S
1981		S	S a)	S		
1982				S		
1983	S					
1984						
1985		S				S
1986			S			
1987				S	S	
1988						C
1989				S		
1990	S	S				
1991			S			
1992				S		
1993						S
1994	S					
Total	14	10	9	8	6	8

* Indicates joint meetings between Sections

a) The Symposium was organized by the IAEA Division of Life Science in cooperation with the Joint Div.

CHAPTER 10

PUBLICATIONS

PUBLICATIONS

All publications generated by FAO and IAEA in the field of nuclear techniques in food and agriculture from 1960 till 1993 are summarized below and detailed in the following Tables.

In addition to the three categories of official publications the FAO/IAEA staff has always been encouraged to publish research findings in recognized scientific journals, and many such papers have appeared. Also, staff have published extensively in the proceedings of meetings held by national and other international organisations.

Each of the six Sections issues Newsletters at regular intervals. These are distributed free of charge to all collaborators and other interested scientists.

In several cases Proceedings from FAO/IAEA meetings have been published by outside publishers, and many monographs have appeared of specific scientific interest such as biological nitrogen fixation, mutation induction for plant improvement, insect control by SIT or pesticide residues.

PRICED IAEA PUBLICATIONS, 1960-93

Soil Fertility, Irrigation and Crop Production	32
Plant Breeding and Genetics	40
Animal Production and Health	38
Insect and Pest Control	28
Agrochemicals and Residues	18
Food Preservation	30
TOTAL	186

UNPRICED IAEA PUBLICATIONS, 1969-93

Soil Fertility, Irrigation and Crop Production	15
Plant Breeding and Genetics	18
Animal Production and Health	7
Insect and Pest Control	2
Agrochemicals and Residues	18
Food Preservation	21
TOTAL	81

FAO PUBLICATIONS

1969 Nuclear Techniques for Increased Food Production, Basic Study No. 22, (76pp).

1980 Maximizing the Efficiency of Fertilizer Use by Grain Crops, FAO Fertilizer Bulletin No. 3, (30pp).

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CHAPTER 11

THE SOIL FERTILITY, IRRIGATION AND CROP PRODUCTION SECTION

THE SOIL FERTILITY, IRRIGATION AND CROP PRODUCTION SECTION

From a gentle beginning towards the end of the nineteen fifties research activities in various fields of soil science took off under the inspired leadership of Maurice (Mac) Fried (1960-83) with Hans Broeshart (1961-83) providing the critical back-up in the laboratory. Their pioneering efforts and the Section's promotional activities would leave its mark on soil scientists all over the world.

Isotope labelling of a nutrient in a fertilizer or in the soil had already proved an invaluable and direct method to distinguish between the amount of the nutrient taken up in the plants that originated from either of the two sources.

Therefore, at that time the backbone of the Section's work was assessment of the most efficient way to make use of a fertilizer and studies on plant nutrition through isotope techniques. This was reflected in the subjects of the very first individual research contracts awarded during 1959/60 and then the launching in 1962 of the first two CRP's on rice fertilization and plant nutrient supply, respectively. Further events during those first years were:

- a "Panel on the Uses of Radioisotopes in Soil-Plant Relations and Fertilization Studies" was held in Vienna in May 1961. The discussions concentrated on those uses which were expected to be of direct benefit to less developed areas with particular attention to tropical crops, especially rice.

- an "International Training Course on Radioisotope Techniques in Soil-Plant Aspects of Agricultural and Forestry Research". The Course was held jointly with FAO and in cooperation with the Government of the Netherlands in Wageningen during April/May 1961. This course was repeated during September/October of the same year, and provided the example for many similar courses to follow.

- an "International Symposium on the Use of Radioisotopes in Soil-Plant Nutrition Studies", organized jointly by FAO and IAEA during February/March 1962 in Bombay. Modern concepts of nutrient availability to plants were among the subjects highlighted.

It is interesting to note that the IAEA Scientific Advisory Committee, SAC, had recommended that special stress be laid on the agricultural programme (crop improvement, pest control and fertilizer uptake) and on the related subject of silviculture, including research on the use of isotopes to "expedite the growth of trees and thereby promote rapid afforestation".

Staff members in the Section during those first years were Peter Nye (1960); - Ed Engelbert (1962-64); - Robert A. Olson (1962-63); - and Carl G. Lamm (1962-64).

In the Agriculture Laboratory with Hans Broeshart as its Head, work related to soil science was also undertaken by Helmut Brunner (1961-64, when he was transferred to Unit of Plant Breeding) - Chai Moo Cho (1962-64); - Helga Axmann (1963-); - and Kigeshi Tensho (1963-64).

Work during these years centred on P-31 and P-32 determinations from the rice fertilization programme as well as pot experiments with P-32 labelled fertilizers in soil and plant samples received from the contractors.

With the establishment of the Joint Division Alfred Caldwell (1964-66) was appointed the first Section Head, and Frederich Howard (1964-65), Peter Vose (1964-68) and Yehia Barrada (1964-80) also joined the Section.

Studies conducted under the rice programme had indicated the most efficient way of phosphate fertilizer application. A similar CRP aiming at maize cultivation was started with Romania and a number of Latin American countries as participants, and with nitrogen as the important target fertilizer nutrient. In Romania Dr. Christian Hera, the Director of the National Agricultural Research Institute at Fundulea, outside Bucharest, played a key-role in this Programme. He interpreted and adapted the research results obtained into well-defined agricultural practices which were then applied on a country-wide scale to demonstrate the resulting significant increases in yields and the economic outputs of maize production in his country. In 1991 Dr. Hera became the head of the Section.

This was the first time that the stable isotope N-15 was mentioned in the FAO/IAEA programme as a candidate to isotopically labelling nitrogen fertilizers. Its potential use triggered a lot of research and development of methods and techniques, in which the Agriculture Laboratory would come to play a major role. Already during 1962/63 some N-15 analyses were carried out in plant samples.

In September 1963 FAO and IAEA held a technical meeting in Braunschweig, FRG, to discuss the potentials of using radio-isotopes for tracing organic matter in soils.

In 1964 Maurice Fried reported on his A-value concept at the 8th Congress of the International Soil Science Society, (ISSS), in Bucharest. Since that year the Section has contributed to and/or participated in many of the ISSS meetings such as the 9th Congress in Adelaide, 1968; the 10th Congress in Moscow, 1974: the 11th Congress in Edmonton 1978; the 12th Congress in New Delhi, 1982; the 13th Congress on Hamburg, 1986: and the 14th Congress in Kyoto, 1990. Participation is anticipated in the 15th Congress to be held in Mexico City. Symposia on special sessions on the use of isotopes in soil-plant relationship studies were arranged in the 11th and all the following Congresses.

During June/July 1965 an "International FAO/IAEA Symposium on the Use of Isotopes and Radiation in Soil-Plant Nutrition Studies" was held in Ankara. Contributions dealt with soil chemistry and physics, ion uptake and translocation as well as efficient fertilizer use.

John Hanway (1966-68) took over as Section Head in 1966, and the Soil Science Unit in the laboratory could welcome the following staff: Douglas Nethsinghe, (1966-70, when he was transferred to the Section); - Victor Middelboe, (1967-68); - and John Ketcheson, (1967-68) on sabbatical leave.

In September 1966 an "International FAO/IAEA Symposium on Plant Nutrition and Physiology", was arranged in Vienna. Besides soil chemistry and fertility the participants contributed to problems of ion absorption, accumulation and transport as well as genetical aspects of plant nutrition.

Already the following year, 1967, an "International FAO/IAEA Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies", was held in Istanbul. One issue at the symposium was the newly developed "Neutron Moisture Probe" for determination of water in the soil profile at any time and any depth without disturbing the growing crop. Other items for discussion were soil water movement and also the use of desalted water for agriculture.

In August/September of the same year, 1967, the Section cooperated with the Animal Production and Health Section as well as with the Plant Breeding and Genetics Section in arranging an "International FAO/IAEA/ICSU/ICAR Symposium on the Use of Isotopes in Studies of Nitrogen Metabolism in the Soil-Plant-Animal System", in Vienna.

The CRP´s on rice and maize fertilization were completed during 1967/68. The rice programme had shown i. a. that late application of nitrogen in a single dose results in the best utilization of the fertilizer, and also that nitrogen is best placed 5 cm below the surface, but phosphorus fertilizers on the surface. In the maize programme experiments showed that uptake of phosphate can be increased by mixing it with nitrogen fertilizer, and that application close to the time of tasseling resulted in much higher efficiency of nitrogen utilization than from application at planting.

A new CRP was started dealing with the rooting patterns and efficient fertilizer use in tree crops, such as coconut, oil palm, coffee, cocoa, olive and citrus.

A CRP on wheat fertilization was started in 1968, and another designed to study water use efficiency under different climatic conditions - now being in its third year - had emphasized maize and demonstrated the feasibility of using the Neutron Moisture Probe under practical field conditions. The Unit of Soil Science supported this work with methodological developement.

Donald A. Rennie (1968-70) became the next Section Head, and Douglas Nethsinghe (1970-77) joined the Section, until he was transferred to become Head of the Asia and Pacific Section of the IAEA Division of Technical Assistance and Cooperation.

An "International FAO/IAEA Symposium on the Use of Isotopes and Radiation in Soil Organic Matter Studies" was arranged in Vienna during July 1968. Studies presented at the meeting dealt with the chemical properties of soil organic compounds, nitrogen transformation using N-15, organic matter synthesis and decomposition and its effect on nutrient availability.

The then ongoing CRP on physico-chemical relationships of soils and plants kept providing basic data which were needed for the full interpretation of the fertilizer and water use efficiency programmes.

The laboratory activities continued to be closely linked with the various CRP´s both in relation to providing routine analytical services for P-32 and N-15 and carrying out supporting research and development of techniques.

One problem regarding the use of N-15 was its high cost, but investigations showed that reliable results could be achieved from field experiments using enrichments as low as 0.5 - 1.0 % atom excess. Also, N-15 analyses with the optical emission spectrometer (partly developed in the Seibersdorf Laboratory), which is a much cheaper instrument than a mass spectrometer, was found to yield adequate analytical results in samples from field experiments.

The increased demand for N-15 for the growing number of agricultural field experiments in the developing Member States eventually resulted in a significantly reduced price. All purchases were done by the IAEA, and the Unit of Soil Science prepared and labelled the many different fertilizer materials for subsequent distribution to the contractors.

A P-32 soil injection technique was developed by the Laboratory to study the distribution pattern of active roots in growing plants and trees. The double labelling with simultaneous injections of P-32 and P-33 also originated from the Unit of Soil Science.

The increasing interest in using N-15 labelling for the field measurements of the amount of atmospheric nitrogen symbiotically fixed by a legume triggered intensive discussions as well as laboratory and greenhouse studies.

Training through individual fellowships or training courses was - as still is - a major responsibility of the Unit of Soil Science (see Chapters 7 and 8).

Robert Soper (1970-73) became the next Section Head. During that period two sabbaticals worked in the Section: Walter Gardner (1971-72) and Ian Macrae (1973-74), and in the Unit of Soil Science: Kevin Tiller,(1970) on sabbatical leave; - David T. Canvin (1971-72) as consultant; - and Craig Atkins (1972-1974) as a staff member.

The CRP on water use efficiency was completed in 1970 after having provided valuable practical information on the water requirements of maize and other crops. The CRP on tree crops, aiming at establishing the most efficient placement of fertilizers through knowledge of the location of the active roots, was extended. A new CRP was started to develop efficient methods of applying fertilizers to grain legumes without reducing the plant´s ability to fix atmospheric nitrogen.

An "International FAO/IAEA Symposium on the Use of Isotopes and Radiation in Research on Soil-Plant Relationsships, Including Applications in Forestry", was held in Vienna during December 1971. Besides tree physiology, ecology and mineral cycling subjects presented dealt with soil-water regimes and nutrient availability.

Edward Halstead (1973-75) assumed the duties as Section Head, and during that period Donald Nielsen (1974-75) spent his sabbatical leave with the Section. R. B. Stryker (1974-75) was attached to the Unit of Soil Science.

Two symposia were arranged during those years, - both in Vienna. The "International FAO/IAEA Symposium on Isotopes and Radiation Techniques in Studies of Soil Physics, Irrigation and Drainage in Relation to Crop Production", was held in October 1973, to review the progress achieved through the use of nuclear techniques in soil physics and irrigation studies, and the "International FAO/IAEA Symposium on Isotope Ratios as Pollutant Source and Behaviour Indicators", was held in November 1974 in collaboration with the Agrochemicals and Residus Section. This symposium demonstrated the advantages of using stable isotopes in place of radioactive tracers in studying the fate of pollutants in the environment, because accurate measurements of isotopic ratios of a contaminant can indicate the source of the contaminant; - e. g. whether a carbonaceous contaminant has its source in oil or coal or in biological waste.

The CRP on nitrogen fertilization of wheat was completed, and a new programme was started aiming at studying the problems of micronutrient deficiencies, - particularly zinc. Simultaneously the CRP on nitrogen fertilizers in rice growing systems was completed, and emphasis was shifted to fertilization of grain legumes such as soybeans.

Yehia Barrada, who had been attached to the Section since 1964 became its Head (1975-80) until his retirement. Many scientists worked with the Section during this period: Arthur Edwards (1975-77); - Luis Mellado (1976-77); - Kekhushroo Mistry (1977-79); - Vadim Ladonin (1977-82); - Michael L´Annunziata (1977-80 when he transferred to the Fellowship Section of the IAEA Division of Technical Cooperation and Coordination); - Francis Broadbent (1977-78) and George Wagner (1979-80), both on sabbatical leave; - James Bole (1979 untill he became Section Head in 1980); - and Seth Danso (1980-). Robert J. Rennie (1976-78) and Felipe Zapata (1979-) became attached to the Unit of Soil Science, where Mohammad Shah (1978) worked as Cost-free Expert..

The Section cosponsored an "International FAO/IAEA Symposium on Nuclear Techniques in Animal Production and Health as related to the Soil-Plant System", in Vienna in 1976.

Significant progress was reported on elucidating efficient fertilizer application methods to various grain legumes without losing the benefits of their capacity to fix atmospheric nitrogen.

In cooperation with the "INPUTS" programme of the East-West Centre in Honolulu the Joint Division initiated a field programme in participating countries using N-15 to compare the use of slow-release nitrogen fertilizers - like urea - in rice and wheat.

Also, nuclear techniques proved effective in measuring the rate of movement of drainage water in the soil under different climatic conditions. Studies of this kind did contribute to a more satisfactory use of both limited water resources and nutrients. While this CRP was completed in 1978, another was started with the primary aim of improving soil water storage under dry, semi-arid farming conditions.

The radioactive isotope of zinc, Zn-65, provided the tool for finding the most efficient and economical method of applying zinc fertilizers. Zinc is the most important nutrient after the macronutrients N, P and K in paddy rice. The programme was completed in 1978/79.

An "International FAO/IAEA Symposium on the Use of Isotope and Radiation in Research on Soil-Plant Relationships" was held in Colombo in December 1978. Topics for discussions were development of new methods for studies of root systems, nutrient translocation and availability, diagnosis of micronutrient deficiency, ion and water movement, as well as effects of applying organic residues on soil properties and crop production.

New CRP´s were initiated in 1978 and 1979 dealing with: biological nitrogen fixation in legumes; - the efficient use of fertilizers in multiple cropping systems; - the effects of herbicides on nitrogen uptake in crops; - and the input of symbiotically fixed nitrogen into pastures. The Unit of Soil Science gave strong technical support to these programmes.

James Bole (1980-82) became Head of the Section. He was succeeded by Klaus Reichardt (1982-83, who was then transferred to Seibersdorf as Head of the Agricultural Laboratory). During this period Kir Kalinin (1982-86) joined the Section, and in the Unit of Soil Science Gudni Hardarson (1981-) and Saliya Kumarasinghe (1983-84 and 1986-87) as consultant. Felipe Zapata (1983-) assumed the responsibility as Head of the Unit.

An "International FAO/IAEA Symposium on Isotopes and Radiation Techniques in Soil Physics and Irrigation Studies" was held in Aix-en-Provence, France, in April 1983. The meeting concentrated on irrigation and crop-water studies as well as on crop production in saline soils.

Already during its second and third years the pasture management programme had shown that the potential for legumes for fixing atmospheric nitrogen is higher when they are grown together with grasses than when they are grown alone. A series of parallel field experiments carried out at Seibersdorf by the Unit of Soil Science confirmed this finding.

In 1983 a new CRP was launched to study nitrogen fixation by bacteria and blue-green algae in association with cereals and grasses through the help of N-15. Soon, experiments showed that the fixation of atmospheric nitrogen by the *Azolla - Anabaena symbiosis*, when used as a biofertilizer, was as efficient as urea in supplying the nitrogen needed for rice cultivation.

In Seibersdorf the Unit of Soil Science carried out field and greenhouse experiments using isotope labelling in order to study the availability to crops of nutrients released from natural sources; - not only nitrogen from *Azolla* and guano as biofertilizers but also phosphate from natural rock phosphates.

Craig Atkins (1984-85) took over the post as Head of the Section, and the same year David Eskew (1984-87) started working in the Unit of Soil Science.

During this period isotope techniques were used in field experiments to measure nutrient transfer from biofertilizers; - for example the transfer of nitrogen from different species of *Azolla* to paddy rice. Also, pot experiments in the laboratory and trials in FAO field experiments in Member States with the aid of P-32 enabled judgements as to the efficiency of rock-phosphates from local deposits to provide the crop with phosphate for its growth. Finally, portable Neutron Moisture Probes were used in studies of the dynamics of water movement in field soils under cropping conditions. This proved a fast and simple method of identifying those water conservation practices which enhance yield and ensure efficient fertilizer use.

A new CRP was started in 1985 to improve crop production in salt-affected soils. This programme emphasized biological nitrogen fixation as well as water and fertilizer use efficiency to promote plant growth on these damaged soils. A plant breeding component was also included in the selection of crop varieties tolerant to salinity with the help of mutation induction and in-vitro technology.

The next Section Head was Glynn Bowen (1986-91). During those years the following scientists were attached to the Section: David Eskew (1987-89, transferred from the Soils Unit in the laboratory); - Mohan Saxena (1987-88), sabbatical; - Cevat Kirda (1987-92); - Bogdan Astvatsatrian (1987-90) as visiting professor; - Saliya Kumarasinghe (1987-); - and Manase P. Salema (1990-) as regional expert.

Also the Unit of Soil Science could benefit from the following scientists: Hassan Sepetoglu (1987) as Cost-free Expert; Nteranya Sanginga (1987-89); Eric Crasswell (1987-88) as sabbatical; Anton Akkermans (1989); Wolfgang Nitschke (1989); John Davis (1990); Heinz Fischer (1990); Günther Meyer (1990); Katherine Wilson (1990); Ostwald Van Cleemput (1991): Carol E. Stone (1991) all as Consultants; Olufemi Awonaike (1990-); Kate Wilson (1990); J. Corbo (1990-91); Eva Holmgren (1991-92) and Naoto Kato (1992-93) on sabbatical leave.

Work continued in programmes dealing with *Azolla* as a biofertilizer and crop production in salt-affected soils. Two CRP´s were started on improvement of yield and nitrogen fixation in grain legumes, one mainly dealing with *Phaseolus vulgaris*, (field bean) in Latin America (1985), and the other in Asian tropics and subtropics (1986).

Further CRP´s were initiated with the following aims: to increase and stabilize plant productivity in low-phosphate and semi-arid and sub-humid soils in the tropics and subtropics (1989); - to improve water use in irrigation projects (1990); - to manage nitrogen fixation by trees for enhancing soil fertility and conservation in fragile tropical soils (1990); - and to explore the new area of molecular biology methods (including DNA probes) in microbial ecology (1990). In all these activities the technical support by the Unit of Soil Science was a 'sine qua non'.

An "International FAO/IAEA Symposium on the Use of Stable Isotopes in Plant Nutrition, Soil Fertility and Environmental Studies" was held in Vienna in 1990. The symposium addressed two problems: (a) how to increase or sustain productivity with minimum inputs, and (b) how to limit environmental damage due to inappropriate land management. Among the subjects discussed were N-15 use in studies on biological nitrogen fixation, transfer of fixed nitrogen to non-fixing crops and nitrogen oxide pollution. Other subjects were C-13 and C14 in studies on organic matter, photosynthesis, assimilate distribution, characterization of C2 and C3 plants for genotypic differences and climatic or atmospheric changes. Reports were given on O-18 use in studies of water transport in soils and S-34 to assess the sulphur balance and cycle.

Christian Hera (1991-) took over as Head of the Section, and Willem Marius Quist (1992-94) joined the Unit of Soil Science

Practical results were obtained in the soil salinity programme. Thus, salt tolerant crop genotypes, which have the additional benefit of ameliorating the soils were identified, such as of e. g. millet and sorghum in Nigeria. In Pakistan, where work had concentrated on Kellar grass, salt tolerant varieties of barley, rice, wheat and *Sesbania acyleta* were also identified. Physiological studies with Na-22 in barley varieties contributed to the understanding of the mechanism of salt tolerance.

The CRP on improving plant production in low phosphate and drought prone soils indicated significant genotype variation in the water and phosphate use efficiency of the crops, and elite cultivars could be selected.

Excess water application at farm level compounded with seepage water along irrigation networks are often the cause in a rise in the groundwater table, triggering soil salinity problems. The relevant CRP aimed at improving irrigation scheduling to increase the effective use of scarce water resources under irrigated agriculture.

The Unit of Soil Science contributed technically to these programmes. It had developed a sturdy apparatus for preparation of plant samples for N-15 analyses, and they are now in daily use in many developing Member States.

The Laboratory carried out some 12000 N-15 determinations yearly during the early 1990´s in plant and soil samples provided by the contractors. Research focussed on the adaptation of the N-15 methodology for assessing nitrogen fixation in trees. As a contribution to a Technical Cooperation project the laboratory has also worked with foliar fertilization using isotope labelling.

Pierre Moutonnet (1994-) joined the Section as a soil physicist.

Two new CRP´s were approved: "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in Particular Rock Phosphates", 1993, - and "The Use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Efficient Use of Fertilizers and Consequently Reduce Environmental Negative Impacts", 1993.

Main activities during 1993-94 emphasized the selection of a combination of microorganisms and plants capable of fixing atmospheric nitrogen so as to reduce the use of nitrogen fertilizer and lessen the environmental impact of such fertilizer additions. Furthermore, the aim was to identify plant cultivars with a good ability to grow in deleterious environments (such as saline and acid soils), drought conditions and soils deficient in plant nutrients. In addition, efforts were made to help increase the effective use of scarce water resources under irrigated agriculture.

An "FAO/IAEA International Symposium on Nuclear and Related Techniques in Soil/Plant Studies on Sustainable Agriculture and Environmental Preservation" will be held in October 1994 in Vienna.

CHAPTER 12

THE PLANT BREEDING AND GENETICS SECTION

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Ionizing radiation has proved invaluable for enhancing genetic variability in crop plants. Like chemical or physical mutagens irradiation induces both deleterious and beneficial mutations. A subsequent selection often permits plant breeders to utilize new genes and gene combinations to produce crop varieties with improved attributes such as higher yield, earlier ripening, better adaptation to local conditions and increased disease resistance.

One of the chief advantages of mutation breeding (a somewhat controversial term) is the often experienced ability to improve a single feature in a plant variety without significantly altering the otherwise desirable make-up of agronomic characters in the variety. For example, a well adapted and accepted local variety lacking in straw strength, can usually be shortened resulting in plants with a higher yield potential.

Mutation induction has also been used to remove certain defects or undesirable properties of high-yielding introduced varieties. For example, in India a Mexican wheat variety was made palatable to consumers by changing the red coloured grain to the preferred amber. Likewise, common bean varieties - constituting a staple food in Brazil - could be produced and marketed in white, brown or black colours to satisfy consumer tradition in different parts of the country.

The main advantage of mutation induction as a complementary tool for plant breeders is the ability to increase variability thus widening the base of selection. Of great significance is also the relatively short time it takes to breed a new variety by this technique. And finally, in vegetatively propagated crops - especially in asexual crops - mutation breeding represents the most efficient method available (often in combination with in-vitro techniques), since no hybridization can be carried out.

Mutagenesis has been known to scientists since about 1920, and was already applied in practical plant breeding from about 1940. A few pioneers like Stadler and Gustafsson have already been mentioned in Chapter 1.

It was indeed the eminent Swedish plant breeder Åke Gustafsson who stressed that the Green Revolution - i. e. the growing of new, higher yielding cereal varieties to fulfill the food requirements of growing populations - only marked a beginning, - a technological breakthrough: "What we are really concerned with is a Green Revolution maintained by agricultural research and technology, and accompanied by economic, social and political adjustments". These words amply put mutation induction as a complementary tool in plant breeding in perspective.

The first action to be taken by an international organization to discuss mutation induction by irradiation was an "International Symposium on the Effects of Ionizing Radiation on Seeds and their Significance for Crop Improvement", held in Karlsruhe, FRG, in August 1960.

With Björn Sigurbjörnsson (1963-69) in charge of plant breeding the IAEA Unit of Agriculture took a number of steps to assist scientists in developing countries in their efforts to induce definite gene mutations and chromosome changes by use of different kinds of ionizing radiation as well as chemical mutagens. Together with Åke Gustafsson, who visited Vienna as consultant, the two of them drafted the technical programme to be pursued in plant breeding.

Already, a number of released crop varieties (peas in Michigan, barley in Sweden) had demonstrated that beneficial changes could be induced by irradiation - some of which could not have been obtained with conventional methods - and since it was deemed important that individual plant breeders should know how to make use of this additional technique, the IAEA started the preparation of a "Manual of Mutation Breeding".

The first individual research contracts in plant breeding were awarded by the IAEA to scientists in FRG, Italy, Japan, USA and Yugoslavia during 1959/60.

Progress in plant pathology using isotopes and radiation had been slow during the 1950s. The IAEA therefore convened a Panel of Experts in September 1963 to study this particular problem. Training and relevant research assistance were the resulting recommendations of the Panel.

In May 1964 the FAO organized a "Technical Meeting on the Use of Induced Mutations in Plant Breeding" in Rome with IAEA as cosponsor. The meeting showed that the use of mutations chiefly induced by radiation had become an accepted means of breeding in a number of crop species, and that the main problem was to apply this technique effectively to major crops.

This gave hope that some serious problems of rice production could be solved by using mutation breeding methods and the very first CRP entitled: "Use of Induced Mutations for Rice Improvement" was started in 1964. The programme was initially carried out in five Member States in South-East Asia, and was reviewed at an RCM in Bangkok in February 1965 by, among others, Gustafsson, Gaul, Swaminathan and Kihara.

This meeting became the first occasion for Asian rice breeders to meet and discuss common problems of production. Here, the idea was born to establish a professional organization to further cooperation among plant breeders in Asia.

The organization was eventually founded in 1968 and became known as SABRAO; - a name contributed by Björn Sigurbjörnsson.

Björn Sigurbjömsson became the Head of the Section when the Joint Division was established in 1964. He was joined by Calvin Konzak (1965-66) on sabbatical leave, and in the Laboratory the Plant Breeding Unit (which had existed as a sub-unit in "Agronomy" since 1961) welcomed Helmut Brunner (1965-) and Knut Mikaelsen (1965-73) who had worked in the FAO Atomic Energy Branch (1961-65).

A number of developing countries had already at that time acquired research reactors. These represented an important source of neutron irradiation for plant breeding purposes. A device called SNIF (Standard Neutron Irradiation Facility) was therefore developed and constructed by the Plant Breeding Unit together with Robert Skjöldebrand of the IAEA Division of Nuclear Power and A. Burtscher of the Austrian Studiengesellschaft für Atomenergie in Seibersdorf to standardize the way of exposing seeds to fast neutrons, and also to establish adequate dosimetry procedures.

A CRP with nearly all of the world's most active mutation workers was started in 1965 in support of a more general research programme on methods of producing and inducing mutations in various major crop species: "Methods of Production and Use of Induced Mutations in Plant Breeding", and already during the following year a CRP on the "Use of Neutrons in Seed Irradiation" was launched with SNIF as the major research tool.

A programme to test the field performance of Italian mutant varieties of durum wheat was organized in 1965 jointly with the Field Crops Branch of FAO as part of an FAO Near-East Wheat and Barley Improvement and Production Project. Nine countries participated and the Plant Breeding Unit assisted with research on radiation-induced resistance to important diseases in wheat. Some of the wheat mutants included in the trials out-yielded both local and common control varieties.

The Joint Division also cooperated with FAO and the International Biological Programme in establishing standard formats for computerized recording of mutant and other germsource data in preparation for world records of germplasm collections. This work was initiated by Calvin Konzak and carried on by Thomas Bogyo.

Gunnar Ahnström (1967) and Thomas Osborne (1967-68) both joined the Section on sabbatical leave.

The Section cooperated with the Soil Fertility, Irrigation and Crop Production Section as well as with the Animal Production and Health Section in arranging an "International FAO/IAEA/ICSU/ICAR Symposium on the Use of Isotopes in Studies of Nitrogen Metabolism in the Soil-Plant-Animal System", in August/September 1967 in Vienna. Plant physiology, plant breeding and protein quality were among the subjects discussed of direct relevance to the Section.

The Section intensified its work with the addition of the following staff: Hernan Gacitua (1968-70), Bob Luse (1968-73) and Thomas Bogyo (1968-69), - the latter scientist on sabbatical leave.

In response to the growing and world-wide interest in new and better protein sources a CRP on "Nuclear Techniques for Seed Protein Improvement" supported by FRG was launched in 1968 following a landmark technical meeting in Röstånga, Sweden, also held in 1968.

The earlier rice programme could now report successes with one mutant containing almost twice as much protein as its mother variety and reaching maturity 60 days earlier. A new high-yielding rice variety produced by gamma irradiation was released in 1968 for use by farmers in Japan.

Three of the Italian mutant varieties of durum wheat were found superior in the Near-East field trials, not only in regard to yields but also shorter straw and better standability, and they were subsequently released to farmers in Italy.

Alexander Micke (1969-91) took over as Section Head, and Sung Ching Hsieh (1970-73) also started working in the Section. In the laboratory three scientists on sabbatical leave joined the Plant Breeding Unit: L. V. Vaidyanathan (1969-70), Om P. Kamra (1969-70) and Ron McKenzie (1970-71).

An "FAO/IAEA International Symposium on the Nature, Induction and Utilization of Mutations in Plants" was held in July 1969 in Pullman, Washington. The meeting reviewed the present status of mutation breeding, and a report by the Section showed that at least 77 new improved varieties of agricultural and horticultural crops had so far been produced by mutation induction.

The year 1969 saw the first FAO/IAEA Interregional Training Course in mutation plant breeding entitled "Use of Radiation and Mutagen Treatments for Crop Improvement". The course was held in Italy with 15 participants.

A CRP on "Effects of Low Doses of Radiation on Crop Plants" was initiated in 1970. As the results showed no stimulation it became the Section´s only contribution to this debatable subject of "radiation stimulation".

Two new CRP´s were started in 1971: one entitled "Use of Induced Mutations in Rice Breeding and Production" as a follow-up of the earlier rice programme, and another on "the Use of Induced Mutations for Disease Resistance in Crop Plants". This latter programme was the result of the recommendations made by an FAO/IAEA Panel of Experts convened in Vienna in October 1970.

SIDA financially supported the above CRP and also sponsored an Interregional training course which was held in Sweden and Denmark in June 1971. The following years would demonstrate SIDA´s continued generous support in the Section´s and also many of the Joint Division´s other activities.

Efforts to improve the quantity and quality of seed protein in major food crops were the subjects of an "FAO/IAEA International Symposium on Plant Protein Resources: Their Improvement through the Application of Nuclear Techniques", held in Vienna in June 1970. The meeting not only emphasized the role of mutation breeding for improved protein in cereal as well as non-cereal crops but also mass screening techniques of protein and amino acids, the nutritional value of plant protein, the effects of the environment on plant protein production and physiological and biochemical aspects of plant protein production.

Gunnar Jansson (1971-75) joined the Section, and two new CRP´s were started in 1972: "Improvement of Mutation Breeding Techniques", and "Improvement of Vegetatively Propagated Crops and Tree Crops through Radiation Induced Mutations".

The "Mutation Breeding Newsletter" started in 1972 as a means of communication among institutes actively working in plant mutagenesis. Over 1000 copies are presently distributed to interested plant breeders twice a year and free of charge.

Another publication series: "Mutation Breeding Review" was issued some years later to summarize information on procedures and results of mutation breeding for particular crops or groups of crops.

Sung Ching Hsieh (1973-74) transferred to the Laboratory to become Head of the Plant Breeding Unit, and Robert Rabson (1973-76) became staff member in the Section, while Calvin Konzak (1973-74) again spent a sabbatical year there.

As a direct result of the coordinated research performed with rice four improved mutant varieties were grown during 1973/74 in Bangladesh and the Philippines, and another one was to be released in Hungary.

Remarkable increases in the content of lysine in barley were reported in the seed protein programme by a Danish cooperator following mutation induction in seeds. Lysine is a nutritionally essential amino acid, and the mutant line was subsequently tested in many cooperating countries.

Chittranjan Bhatia (1974-76) came to the Section as did also Knut Mikaelsen (1975-80) having transferred from the Laboratory and a year as Project Manager in Brazil. Thorsten Hermelin (1975-85) took over as Head of the Plant Breeding Unit.

A CRP entitled "Use of Aneuploids for Wheat Protein Improvement" was started in 1975. One objective was the quest for high lysine wheat varieties that also had satisfactory agronomic characteristics in other respects.

R. D. Brock (1976-79) joined the Section, and the same year Alberto Brunori (1976-79) was contracted to work in the Plant Breeding Unit together with Bernd Georgi (1978) as consultant.

The Section cooperated with the Soil Fertility, Irrigation and Crop Production Section as well as with the Animal Production and Health Section in the arrangement of an "FAO/IAEA International Symposium on Nuclear Techniques in Animal Production and Health as Related to the Soil-Plant System" in February 1976 in Vienna. As was the case with a similar joint symposium in 1967, the Section's contribution centered around plant protein quality and quantity.

The mutant rice variety resulting from cooperative research with Hungarian plant breeders - mentioned above - was grown on large commercial scale collective farms under the name "Nucleoryza". An IAEA/FAO/UNDP technical assistance project in Pakistan resulted in the release of a mutant rice variety "Kashmir Basmati" for cultivation in the northern provinces of Pakistan.

Other positive results with the use of mutation induction were: a pearl millet variety in India resistant to downy mildew; - improved rice and jute varieties released in Burma; - and promising mutants in such vegetatively propagated plants as compact fruit trees as well as disease resistant varieties of turf, forage grasses and sugar cane.

Genetically determined resistance of crop plants to diseases caused by pathogenic organisms were the topic of an "FAO/IAEA International Symposium on the Use of Induced Mutations for Improved Disease Resistance in Crop Plants" held in Vienna in January/February 1977. Discussions and lectures emphasized: germ-plasm sources for improving disease resistance to plants; - host/pathogen interactions and concepts for breeding for resistance; - resistance to fungal and bacterial diseases in rice; - disease resistance in vegetatively propagated plant and woody perennials, legumes and vegetables, barley and wheat; - and cytogenetics and disease resistance.

The development of a better resistance of crop plants to insect pests was the subject of an Advisory Group Meeting in Dakar in 1977. The meeting concluded that only in few limited cases could mutation induction in plants be utilized with advantage for this purpose.

Eight years of work in cooperation with the GSF in the FRG on seed protein improvement culminated in an "FAO/IAEA/GSF International Symposium on Seed Protein Improvement in Cereals and Grain Legumes" at Neuherberg, FRG, in September 1978. Promising nutritionally improved genotypes of wheat, maize, rice, barley, sorghum, millet and a number of legume species were reported. Various subjects such as: the world protein and nutritional situation; - the need for and variability in protein characteristics; - genetics, biochemistry and physiology of seed storage protein; - natural and induced variability; - as well as analytical and nutritional techniques were all reviewed during the symposium.

Two CRP´s were initiated during 1978: "Use of Induced Mutations for Improvement of Grain Legume Production in South-East Asia", - an RCA activity - , and "Induced Mutations for Disease Resistance in Grain Legumes" as a follow-up of the earlier CRP on disease resistance from 1971.

Takeshi Kawai (1979-83) was attached to the Section followed by Basilio Donini (1980-85) and also Björn Sigurbjörnsson (1980-81) who returned on a sabbatical leave. In the laboratory Stefan Daskalov (1980-86) joined the Plant Breeding Unit as did Amram Ashri (1980) as consultant and Hirokazu Nakai (1981-82) on sabbatical leave.

The "Use of Nuclear Techniques for Cereal Grain Protein Improvement", and "Evaluation of Semi-dwarf Cereal Mutants for Crossbreeding" were the titles of two CRP´s started in 1979 and 1980, respectively. The following year, 1981, saw three new regional CRP´s: "Improvement of Leguminous Food Crops in Africa and the Near-East through Induced Mutations", "Improvement of Leguminous and Oil Seed Crops in Latin America through Induced Mutations", and "Semi-dwarf Mutants for Rice Improvement in Asia and the Pacific Region (RCA)".

The potential for using induced mutations in various fields of plant research was reviewed by an "FAO/IAEA International Symposium on Induced Mutations as a Tool for Crop Plant Improvement", held in Vienna in March 1981. A major part of the discussions was devoted to the role played by induced mutation research in providing insight into gene action and interaction; - the organization of genes in plant chromosomes from the viewpoint of homology and homoeology; - the evolutionary role of gene duplication and polyploidy; - the relevance of gene blocks; - the possibilities for chromosome engineering; - the functioning of cytoplasmic inheritance; - and the genetic dynamics of populations.

The "Mutation Breeding Newsletter" reported that in 1981 more than 450 mutant varieties of seed propagated and vegetatively propagated crops (including ornamentals) had been officially released in Member States.

Throughout the years the Plant Breeding Unit assisted the Section´s activities through research on e. g. methods for routine analyses of proteins and amino-acids, or on elucidating the radiosensitivity of seeds for mutation induction purposes. Also, a laboratory was fitted out for work with chemical mutagens. The Unit further provided services such as gamma or neutron irradiation of plant material submitted by collaborators. Treated seeds were then returned to the country for testing through field experiments and mutant selection. Furthermore, chemical mass screening was carried out in large numbers of samples submitted from field experiments under the various CRP´s. Finally, laboratory and field training in combination with lectures for individual trainees under the fellowship programme or in training courses held at Seibersdorf became increasingly prominent in the Unit´s activities, and for that purpose mutant stocks were created as demonstration material.

Miroslaw Maluszynski (1983-) joined the Section and Frantisek Novak (1983-93) arrived in the Plant Breeding Unit initially on a two years sabbatical leave. Sergio Lucretti (1984) served as cost-free Expert in the Plant Breeding Unit, and returned (1991)as a consultant.

Two new CRP´s were initiated in 1983: one on the "Improvement of Root and Tuber Crops and Similar

Vegetatively Propagated Crop Plants in Tropical Countries by Induced Mutations", and another entitled "In-vitro Technology for Mutation Breeding", the primary aim of which was to provide better crops through improvements in mutation induction and selection achieved using in-vitro techniques.

New facilities were also established at the Seibersdorf laboratory in 1984 for developing in-vitro culture techniques for use with mutation breeding. Bananas and cassava were among the first crops worked on in the laboratory, (which in 1984 was referred to as the "FAO/IAEA Agricultural Biotechnology Laboratory").

In its work the Plant Breeding Unit also emphasized improvement of seed protein in wheat, and the transfer of single traits into a recipient cultivar was achieved by fertilization with irradiated pollen.

Frantisek Novak (1985-93) took over as Head of the Plant Breeding Unit until his untimely death, and Amram Ashri (1985-86) came to the Section on his sabbatical leave.

A CRP entitled "Tissue Culture Applications through Mutation Breeding to Increase Resistance in Rice against Adverse Soil Factors" was launched in 1985 followed by two CRP's initiated in 1986: "Improvement of Rice and Other Cereals through Mutation Breeding in Latin America - (ARCAL)", and "Use of Induced Mutations in Connection with Haploids and Heterosis in Cereals".

An "FAO/IAEA International Symposium on Nuclear Techniques and In-Vitro Culture for Plant Improvement" was held in Vienna in August 1985. The symposium examined the usefulness, for plant breeding purposes, of somaclonal variation, i. e. the occurrence of mutations during in-vitro culture with or without the application of ionizing radiation or other mutagens. Also, methods to propagate virus free clones of economically important plants were discussed.

The laboratory work focussed on development of an in-vitro methodology for the mutation breeding of crops such as banana, plantain, sunflower, cocoa, cassava and yam. In 1986 plant re- generation in-vitro from maize leaf segments was achieved. The Unit also continued its services to plant breeding institutes in Member States and three video films were produced for training purposes.

Nobuo Murata (1986-89) became attached to the Section and B. V. Conger (1986-87) spent his sabbatical year with the Plant Breeding Unit.

The world-wide interest in tissue culture applications triggered a new CRP in 1987: "Use of Induced Mutations and In-vitro Culture Techniques for Improving Crop Plant Resistance to Diseases".

Radiation induced genetic variability and somaclonal variation in tissue culture were studied in maize by the Plant Breeding Unit for the purpose of assessing their nature and their possible contribution to plant breeding. Mutation breeding technology was investigated for nine different cultivars of banana and plantain. Considerable phenotypical variation was observed among in-vitro generated banana plants after mutagenic irradiation. The clonal offspring of a mutant plant was prepared for field testing under tropical conditions. Somatic embryogenesis and plant regeneration were induced in cell suspensions, whereby new possibilities for exploring somatic cell mutation in banana and plantain breeding were opened up. Induced mutagenesis was applied to the *Azolla-Anabaena* symbiotic system, and variants tolerant to high salinity and toxic levels of aluminium were selected.

Etsuo Amano (1989-94) and Richard Jefferson (1989-91) joined the staff of the Section as did also Amram Ashri (1989-90) on sabbatical leave. Marina Sacchi (1990-92), JPO, as well as Riccardo Morpurgo (1989-) worked in the Plant Breeding Unit.

Three new CRP's were initiated in 1988: "In-vitro Mutation Breeding of Bananas and Plantain"; - "Mutation Breeding of Oil Seed Crops"; - and "Improvement of Root and Tuber Crops in Tropical Countries of Asia by Induced Mutations".

In 1989 another regional CRP supported by Italy was started under the title: "Improvement of Basic

Food Crops in Africa through Plant Breeding Including the Use of Induced Mutations".

An "FAO/IAEA International Symposium on Plant Mutation Breeding for Crop Improvement" was held in Vienna in June 1990. The meeting gathered plant breeders from 46 countries to assess the contribution of plant mutation to crop improvement over the past 25 years. In 1964 only 49 cultivars were known to have arisen with the help of experimental mutation induction. This number reached nearly 1.500 by 1990, distributed among at least 90 different cultivated plant species, including ornamentals.

The symposium could thus amply demonstrate that mutation induction had been applied in Member States with considerable success. Some technological problems identified concerned primarily vegetatively propagated crops and also logistic difficulties in identifying desirable mutants in large mutagenized populations.

Miroslaw Maluszynski (1991-) took over as Head of the Section, to which two new staff members became attached: Lesley Sitch (1991-92) and Om P. Kamra (1991) on his second sabbatical with the Joint Division. Rajeev K. Upadhyay (1991-92) spent his sabbatical leave in the Plant Breeding Unit, where also Jaroslaw Dolezel (1992) served as a consultant.

Recent developments in plant molecular genetics had shown that radiation techniques were becoming a powerful tool in gene identification and mapping and the investigation of gene expression in crop plants. It was becoming evident that these techniques could be used to create new molecular markers for use as selection tools to improve the efficiency of plant breeding programmes.

These findings were reflected in the launching in 1992 of a CRP on "Application of DNA Based Marker Mutations for Improvement of Cereals and other Sexually Reproduced Crop Species" as well as another CRP entitled "Use of Novel DNA Fingerprinting Techniques for the Detection and Characterization of Genetic Variation in Vegetatively Propagated Crop Plants", which started 1993.

A new trend in the Section's technical cooperation projects was the upgrading or establishment of in-vitro facilities in developing Member States, in parallel with an intensive training programme.

Progress was reported during 1991 in the use of radiation in combination with in-vitro and doubled haploid technology for the genetic improvement of crops. Results of importance for the breeding of hybrid rice were obtained in China.

The FAO/IAEA Mutant Varieties Data Bank, which was started in 1964 by Björn Sigurbjörnsson and Calvin Konzak and then continued by the succeeding Section Heads Alexander Micke and Miroslaw Maluszynski, presented a status report in the December 1991 issue of the Mutation Breeding Newsletter. The very detailed material covering seed propagated food crops shows that the number of officially released mutant varieties of 80 different plant species in 51 countries reached 1.019 and over 1.700 in 1993.

New staff in the Section included Leonard van Zanten (1992-) as APO and Beant S. Ahloowalia (1993-). Nicolas Roux (1993-) joined the Plant Breeding Unit together with David J. Flanders (1993) and Qiufang Chen (1993-94), both as consultants.

Four new CRP's were approved during 1993/94: "Induced Mutations for Sesame Improvement"; - "Induced Mutations in Connection with Other Biotechnology for Crop Improvement in Latin America (ARCAL)"; - "In-Vitro Techniques for Selection of Radiation-Induced Mutants Adapted to Adverse Environmental Conditions"; - and "Radiation-Induced Mutations and Other Advanced Technologies for the Production of Seed Crop Mutants Suitable for Environmentally Sustainable Agriculture".

During the years 1993-94 the largest area of activity was the promotion of the application of biotechnology, including molecular biology methods, for the genetic improvement of various crops, in particular crops suitable for harsh agricultural conditions.

CHAPTER 13

THE ANIMAL PRODUCTION AND HEALTH SECTION

THE ANIMAL PRODUCTION AND HEALTH SECTION

In many regions of the world livestock production is limited by poor health and growth, poor reproductive performance and low quality fodder and feed. This in turn limits the availability of animal products for use by man.

Animal production is a consequence of interactions between the genetic makeup, physiological state and the environment to which animals are exposed. Improvements depend on identifying the most suitable type of animal for a particular environment, altering the environment to make it less challenging, improving nutrition or some combination of these factors.

The important environmental components which require some modifications are nutrition, reproduction as well as control of viral, bacterial and parasitic infections. Isotope and radiation techniques are ideally suited as tools in the study of, and solutions to, these problems.

International efforts in this field got off to a slow start in the early sixties with some research in the areas of animal physiology and disease as well as in milk and meat production.

An "International FAO/IAEA/WHO Conference on the Use of Radioisotopes in Animal Biology and the Medical Sciences" was held in Mexico City November/December 1961. It dealt primarily with problems of mineral metabolism, lactation, ruminant metabolism and general animal physiology.

One year later an international training course on the "Use of Radioisotopes and Radiation in the Animal Sciences" was held at Cornell University, USA, and during the same year detailed preparations were made to assist - through a UNDP(SF) project executed by the IAEA - the development of an agricultural nuclear research institute, INEP, which would include veterinary sciences and animal nutrition in addition to soil science and plant breeding, in Zemun outside Belgrade, Yugoslavia.

In 1963 a panel of experts met in Vienna to consider the production and utilization of radiation attenuated vaccines against helminthic diseases. The panel's recommendations led to the development of widespread research in the practicality of such vaccines and the results were demonstrated in Yugoslavia and several years later in an IAEA/UNDP/SIDA large scale project aiming - *inter alia* - at the control and eradication of the lung-worm (*Dictyocaulus spp.*) disease in sheep in the mountains of Kashmir.

The early development of international cooperation in the promotion of appropriate nuclear applications was, however, hampered by the lack of an animal scientist on the staff of the IAEA Unit of Agriculture. The first activities were guided by Lars-Eric Ericson (1962-64), whose primary responsibility was food irradiation. In those years the professional guidance came primarily from Johannes Moustgaard, Denmark, who from the outset (and never as a staff member) took part in and advised on appropriate uses of isotopes and radiation as research tools in various fields of animal science.

With the establishment of the Joint Division in 1964 the Animal Production and Health Section was set up with Per-Göran Knutsson (1965-68) as its Head. He was soon assisted by drs. L. A. Black (1965) and Frederick W. Lengemann (1966-67), both on sabbatical leave. During these years the interaction with Johannes Moustgaard continued with his active participation in various technical meetings, coordinated research, training courses and technical assistance field projects. In effect since 1963 Johannes Moustgaard undertook more than thirty scientific and technical missions including to large scale-projects in Yugoslavia, India and Brazil. It was Johannes Moustgaard who proposed an FAO/IAEA symposium to focus on animal sciences in the context of the soil-plant-animal relationship; - a symposium which would become a reality in 1976 (see below).

An "International FAO/IAEA Symposium on the Use of Radioisotopes in Animal Nutrition and Physiology" was held in Prague in November 1964. It gave special attention to studies of milk secretion, the role of trace elements in certain metabolic processes and the influence of environmental factors in animals.

The success of the Cornell training course in 1962 prompted a repetition in the summer of 1965, and for that occasion a laboratory training manual was prepared by the Section and published. In 1966 there was a Vienna Symposium on radioisotopes and production in dairy science and technology.

The first individual research contracts were awarded during the mid sixties, and the first CRP dealing with the pathogenic effects and control of parasitic diseases in domestic animals was launched in 1966. It was based on the attenuation of the virulence of helminthic larvae by irradiation as a means of producing a vaccine against worm infections that presented a serious health problem in animals and man, particularly in developing areas of the world.

An "International FAO/IAEA/ICSU/JCAR Symposium on the Use of Isotopes in Studies of Nitrogen Metabolism in the Soil-Plant-Animal System" was arranged jointly with the Soil Fertility, Irrigation and Crop Production Section as well as with the Plant Breeding and Genetics Section, in August/September 1967 in Vienna. The meeting reviewed the importance of nitrogen with discussions on animal physiology and nutrition, soil science and plant physiology, as well as on plant breeding and protein quality.

A CRP focussing on trace element metabolism and disease in animals of agricultural importance was started 1968, and led to new approaches in the study of diseases caused by trace mineral deficiencies.

Gerald Ward (1968-70) and later Hugo Höller (1970-72) were appointed the next Heads of the Section.

It was during this time that the advantage of using N-15 in studies of non-protein nitrogen (e. g. urea) as a supplementary ruminant feed became a reality, and a CRP was established 1972 on this subject. Another CRP launched in 1973 dealt with animal parasitology and immunology. Its objective was to study the effect on various livestock of the parasites of bilharzia (Schistosomiasis), sleeping sickness (trypanosomiasis), East Coast Fever and other gastro-intestinal parasites.

An "International FAO/IAEA Symposium on the Use of Isotopes in Studies of the Physiology of Domestic Animals with Special Reference to Hot Climates" was held in Athens in March 1972. Factors of environmental adaptation and the interrelationship between the producing animal and its ecosystem were the main themes of the meeting.

John E. Vercoe (1972-74) took over as Section Head, and Hans Hamel (1974-77) joined the staff. Leon Hopkins (1975-78) followed as Section Head, and Frederick W. Lengemann (1976-77) again assisted the Section while on sabbatical leave.

A CRP entitled "Water Requirements of Tropical Herbivores Based on Measurements with Tritiated Water" was started in 1975. Its aim was to assess the water requirements and metabolism of livestock living in different climates and ecologies, especially in the drier parts of tropical Africa. Another CRP established 1977 dealt with the approaches to control the spread of ticks and tick-borne diseases.

An "International FAO/IAEA Symposium on Nuclear Techniques in Animal Production and Health as Related to the Soil-Plant-Animal System" was held in Vienna in 1976 in response to the earlier suggestion by Johannes Moustgaard, who also played a leading role in its implementation.

The symposium was arranged jointly with the Soil Fertility, Irrigation and Crop Production Section as well as with the Plant Breeding and Genetics Section. The meeting dealt with methods used to increase efficiency of animal production and to combat parasitic diseases. Papers were devoted to the soil-plant-animal relations in animal nutrition, to trace elements in animal nutrition, to Ca, P and Mg metabolism, to protein metabolism in ruminants and non-ruminants, to the control of parasitic infections and to the subject of animal endocrinology with special emphasis on radioimmuno-assays, RIA.

Three new CRP´s were started in 1978 entitled: "Use of Radioimmunoassay and Related Procedures to Improve Reproductive Performance of Domestic Animals" (aiming at small and large ruminants with a view to identifying the endocrinological factors associated with low reproductive efficiency), - "Use of Isotopes to Diagnose Moderate Mineral Imbalances in Farm Animals" (emphasizing selenium, copper, zinc and phosphorus. Simple methods for diagnosing selenium and copper deficiency at an early stage were developed); - and "Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia". This programme, which was multi-disciplinary involving studies of nutrition, reproductive efficiency and parasitic diseases, was part of the RCA (Regional Cooperative Agreement for Research, Developement and Training related to Nuclear Science and Technology). This CRP was implemented in two phases, with Phase II being initiated five years later in 1983.

John E. Vercoe (1978-80) returned to become Section Head for a second time. He was assisted by James Dargie (1978-80) and two scientists on sabbatical leave, Francis Kallfelz (1977-78) and Pavel Giacintov (1978-79).

An "International FAO/IAEA Symposium on Isotopes and Radiation Research on Animal Diseases and Their Vectors" was held 1979 in Vienna jointly with the Insect and Pest Control Section. The meeting discussed i. a. immune responses, pathophysiology, parasite viability and host-pathogen relationships as applied to babesiosis, anaplasmosis, trypanosomiasis and leishmaniasis.

Bruce Young (1980-82) took over the leadership of the Section, and was later followed by James Dargie (1982-).

An "International FAO/IAEA Symposium on Nuclear Techniques in the Study and Control of Parasitic Diseases of Man and Animals" was held in Vienna in June-July 1981. The symposium was organized by the IAEA Division of Life Sciences and cosponsored by the Joint Division and UNEP. It provided a forum to review the nuclear techniques available for the study of parasitic infections of man and economically important livestock, and to evaluate the progress that had been made in the application of these techniques to chemotherapy, diagnosis, epidemiology, immunology and pathology of such infections. Special attention was paid to major diseases such as schistosomiasis, malaria, trypanosomiasis, filariasis and leishmaniasis.

During this period the Section continued assisting developing Member States to use nuclear techniques in research on means to increasing milk and meat production, improving the performance of draught animals, enhancing reproduction and minimizing losses due to diseases.

In 1982 three isotope-aided CRP´s were begun aiming at: the optimization of grazing animal productivity in the mediterranean and North African regions; - improving the productivity of sheep and goats in Africa and the Middle East; - and improving the reproductive efficiency and productivity through the application of RIA. Furthermore, the second phase of the RCA programme on the productivity of domestic buffalo in Asia was initiated.

Lars Eric Edqvist (1983-87) joined the staff as did Julian Czerkawski (1983-84) on sabbatical leave. The following year Marshall N. Jayasuriya (1984-88) started his assignment; - first as a sabbatical.

Within the framework of the newly established IAEA regional programme in Latin America, ARCAL, a CRP was launched 1983 for improving the reproductive management of meat and milk producing livestock (cattle, sheep and cameloids) making optimal use of RIA. This programme was to continue through several phases.

The year 1984 was important for the Section because the Animal Production Unit started operations in the Agriculture Laboratory at Seibersdorf. Thus, facilities were established for assessing the nutritive value in-vitro of forage and agroindustrial byproducts (e. g. bagasse) from developing countries. An apparatus to simulate the rumen, RUSITEC, was constructed and used to study microbial degradation of feeds using isotope labelling and with emphasis on fibrous components. A "fibrous residues data bank" was also established in this context, which could store and evaluate the analytical results in samples from animal feeds sent by Member States.

The Animal Production Unit also initiated research to test and develop radio- and enzyme-immunoassays (RIA and EIA or ELISA = enzyme-linked immunosorbent assay) for measuring reproductive hormone levels, and for providing standardized reagents to monitor livestock reproductive efficiency and diagnose diseases.

One immediate result was the development of a simple solid-phase RIA technique for progesterone analyses in samples of blood and milk. Cheap, robust and reliable solid-phase RIA kits were developed and eventually supplied to counterparts in technical cooperation and research contract programmes.

Raymond Nachreiner (1985-86) spent his sabbatical leave in the Animal Production Unit, where Stefan Oschmann (1985-87) and John I. Richards (1985-86) were also working as APO and Regional Expert, respectively. Raymond Nachreiner was later to return as consultant in 1987 and 1990.

During the period 1984/85 the Section also investigated the potential of nuclear techniques as tools to assess and improve indigenous pig productivity, and assistance to Member States continued through some 131 research contracts and 26 technical cooperation field projects.

An "International FAO/IAEA Symposium on the Use of Nuclear Techniques in Studies of Animal Production and Health in Different Environments" was held in Vienna during March 1986. The meeting provided a forum for reviewing such subjects as animal adaptation, digestion and utilization of poor quality feedstuffs, reproductive efficiency and resistance to diseases and other forms of stress as well as use of ELISA tests for disease diagnosis and monitoring control programmes.

John I. Richards (1986-89) transferred from the Laboratory to the Section and was joined by Martyn Jeggo (1986-91) as Regional Expert.

In 1986 time was ripe to establish a disease diagnostics laboratory in the Animal Production Unit to complement the existing facilities for animal nutrition and reproduction studies. The laboratory would focus on developing immunoassay kits for use in diagnosis and epidemiological studies of viral, bacterial and parasitic infections. An early result was the development of ELISA tests for disease diagnosis and monitoring control programmes.

Over 700 progesterone RIA-kits were supplied to collaborators all over the world. A regional network for animal disease diagnosis using immunoassay and labelled DNA probe techniques was initiated in Latin America in 1986 as a CRP.

Hermann Unger (1987-89) joined the Unit as an APO, where Hamish Robertson (1987-88) and Edward Mather (1987-88) worked as sabbaticals. Camille Ooijen (1987-92) and Jan Plaizier (1987-92) joined the Section to assist in the implementation of two CRP's in Africa supported by funds made available by the Government of the Netherlands.

Three CRP's were initiated in 1987, entitled: "Sero-surveillance of Rinderpest and Other Diseases in Africa Using Immunoassay Techniques"; - "Improving the Productivity of Indigenous African Livestock Using RIA and Related Techniques"; - and "Development of Feeding Strategies for Improving Ruminant Productivity in Areas of Fluctuating Nutrient Supply Through the Use of Nuclear and Related Techniques".

During 1987 the Animal Production Unit obtained laboratory facilities at Seibersdorf for further development of enzyme assays and isotopically labelled DNA probes in support of the disease diagnostic work.

In 1988 a further three CRP's were started: "Strengthening Animal Reproduction Research in Asia Through the Application of Immunoassay Techniques"; - "Strengthening Animal Disease Diagnosis in Asia Through the Application of Immunoassay Techniques"; - and "Improving the Diagnosis and Control of Trypanosomiasis and other Vector-borne Diseases of African Livestock (cattle and camels) Using Immunoassay Methods".

Extrabudgetary funds, particularly those provided by the Swedish International Development Authority (SIDA) and the Technical Assistance Department of the Netherlands Ministry of Foreign Affairs made it possible to implement several of the new CRP's during these years.

New staffmembers in the Section were Oswin B. M. Perera (1988-) as regional expert and Emyr Owen (1988-89) on sabbatical leave. Bruce Murphy (1988) joined the Animal Production Unit as a sabbatical.

By 1989 the disease diagnosis group in the Animal Production Unit had outgrown the nutrition and reproduction groups. It developed, produced and distributed almost 100 ELISA kits to FAO/IAEA counterparts intended for diagnosing the following diseases counterparts: rinderpest; - brucellosis; - babesiosis; - trypanosomiasis (tsetse and non-tsetse transmitted); - enzootic bovine leukosis; - Aujeszky's disease; - as well as foot-and-mouth disease.

In the field of reproduction the Unit kits were developed, produced and distributed for progesterone assays by RIA to monitor reproductive status in agriculturally important species such as cattle, sheep, goats, buffalo, camelides, and yaks. During the course of the year some 2000 kits were sent to 70 laboratories in 50 developing Member States.

Further development and monitoring of the effects of the field use of the kits had also become an important laboratory activity. Thus, methods were developed for assessing thyroid function as well as oestrus and placental well-being during pregnancy; - development of ELISA kits for progesterone; - tissue culture facilities were established for production of monoclonal antibodies against progesterone (for vial coating purposes); - kits were produced for sero-diagnosis of additional diseases such as bovine coronavirus and rotavirus, Rift Valley fever and Newcastle disease; - and microcomputer software was developed to assist data interpretation.

Field validation was achieved through the establishment of an external quality control system with a number of key participating laboratories.

The Nutrition laboratory within the Unit continued its feed evaluation and formulation testing programmes, and data covering over 25 residue materials from participating Member States were compiled, evaluated and published.

Training of counterparts in immunoassay techniques continued and intensified during 1989 with 12 trainees from 10 developing countries. Also, the training course and workshop programmes were intensified.

Kassu Yilala (1989-90) worked in the Section as sabbatical, and in the Laboratory the following scientists joined the staff: Francesco Castrignano (1987-90) as JPO; - Daniel Sharp (1989-90) on sabbatical leave; - Giovanni Re (1989-91) as JPO; - Mark Eisler (1989-90) as APO; - and Aly Fadly (1989) and Anne-Marie Adachi (1989) as consultants.

The Section and the Unit were by now assisting over 210 research groups involved in 12 CRP's as well as 52 technical cooperation field projects.

The Joint Division collaborated with the OAU/Inter-African Bureau for Animal Research in the primarily EEC funded Pan African Rinderpest Campaign. The programme which involved a total of 34 countries had been operational for five years and by 1989 achieved eradication of the disease from some 15 countries. This result had been assisted by the establishment of a network of laboratories in the region capable of conducting rinderpest sero-monitoring using the ELISA based FAO/IAEA kits.

Similar tests for trypanosomiasis were developed in collaboration with ILRAD (International Laboratory for Research on Animal Diseases) and used to support national and regional control and eradication programmes in Africa and Asia. The research had clearly demonstrated that the tests were about five times more sensitive than the then currently available diagnostic tests, paving the road for much more precise monitoring of tsetse and trypanosomiasis control campaigns. FAO/IAEA immunoassay tests were validated for the diagnosis of brucellosis and bluetongue and approved for use by WHO and the International Office of Epizootics, respectively. Similar tests for other diseases, such as foot-and-mouth, babesiosis and Newcastle´s disease are presently under validation.

Peter Wright (1990-), who had already served in the Laboratory as consultant (1987), became the Head of the Animal Production Unit, which had previously been under the direction of John I. Richards. Further staff in the Unit were Gene van Rooij (1990-94) as APO; - Ernst Nilsson (1991-) and Dierk Rebeski (1991-) as APO´s; - and Martha Barmasch (1992-) as Cost-free Expert. They were joined by Walter Kelly (1991) and Klaus Nielsen (1993) as consultants.

In the Section, staff additions were Mario Garcia (1990-); - Roland Geiger (1990-) as APO; - Carlos Galina (1990) as consultant; - Vittorio Cagnolati (1990-91) as APO; - Michael Bryant (1990-91) as sabbatical and Jorge Moreno Lopez (1990-) as Regional Expert. Marshall Jayasuria (1993-) returned to the Section as Regional Expert.

CRP´s started in 1989 and later included the following titles: "Development of Feed Supplementation Strategies for Improving Ruminant Productivity on Small-holder Farms in Latin America Through the Use of Immunoassay Techniques (ARCAL) - Phase II"; - "Inter-regional Research Network for Improving the Productivity of Camelids" (1990); - "Immunoassay Methods for the Diagnosis and Epidemiology of Animal Diseases in Latin America (ARCAL)" (1991); - "Sero-surveillance of Rinderpest and other Diseases in Africa Using Immunoassay Techniques - Phase II" (1991); - and "Development of Supplementation Strategies for Milk-producing Animals in Tropical and Subtropical Environments Through the Use of Nuclear and Related Techniques" (1992).

An "International FAO/IAEA Symposium on Isotope and Related Techniques in Animal Production and Health" was held in Vienna, 1991. The meeting reviewed the use of isotopic methods in animal nutrition for developing optimal diets and feeding strategies. Considerable emphasis was also given to the role of hormone measurements by RIA for improving the reproductive efficiency, and the role of enzyme immunoassay, ELISA, methods for diagnosing animal diseases and monitoring disease control programmes. Several reviews dealt with isotopic methods in molecular biology, particularly their role in diagnosis and development of new vaccines.

New CRP´s were: "Development of Feed Supplementation Strategies for Improving the Productivity of Dairy Cattle on Smallholder Farms in Africa", 1993; - "Establishment of a Unified Approach to the Diagnosis of Animal Diseases in Mediterranean, Middle East and North African Countries Through the Use of Nuclear and Related Techniques", 1993; - and "Use of Immunoassay Methods for Improved Diagnosis of Trypanosomiasis and Monitoring Tsetse and Trypanosomiasis Control Programmes", 1993.

In 1993 FAO and IAEA jointly established a Central Laboratory for advancing the use of ELISA and molecular techniques in the diagnosis of animal diseases. The Central Laboratory operates within the existing Animal Production Unit in Seibersdorf and will develop and distribute diagnostic kits in support of FAO and IAEA programmes assisting veterinary services in developing countries. It will work in close cooperation with the WHO and the International Office of Epizootics to develop and apply accepted standards for conducting these assays and for assuring the validity of the results. By acting as the focal point for the development of international standards and the transfer of diagnostic methods based on biotechnology, the FAO/IAEA Central Laboratory is expected to play a key role in assisting developing countries to reduce the impact of animal diseases and the cost of their control.

CHAPTER 14

THE INSECT AND PEST CONTROL SECTION

THE INSECT AND PEST CONTROL SECTION

Insects cause losses estimated at between 8% and 20% of the total world production of crops and livestock. These losses - either through direct damage or cost of control - is in the billions of dollars per year on a world-wide basis.

The major method of insect control is with the use of insecticides applied directly to the crop affected. Being environmentally undesirable insecticides will, however, still continue to be used in the foreseeable future. Although future chemicals will be more selective in their toxicity and will break down more readily, they will be more expensive and require more frequent applications.

Alternative non-insecticide methods of insect control - among which some are popularly called bio-dynamic methods - have been developed and applied for many years. These techniques include crop rotation and use of insect pathogens and biological control including inundative releases of parasites and predators, hormones, attractants, pheromones, host-plant resistance and various forms of insect sterility, of which the sterile male technique or sterile insect technique, SIT, is the most important.

SIT represents a species specific and environmentally friendly approach which was conceived in 1937 to control or eliminate insect pests. It relies on the principle that when a sterile male mates with a fertile female, viable eggs are not produced. Thus, the SIT can be described as a form of birth control among insects.

The use of isotopes and radiation in entomology has a history of more than 60 years. Isotopes have been used in various studies including insect ecology, physiology, toxicology etc. Ionizing radiation has been utilized to induce sterility or to induce genetic changes, which may result in different mutant strains of the same species of insects, as well as to kill insects present in various food commodities.

The insect and pest control programme of the Joint Division has almost exclusively been limited to the use of radiation to sterilize insects for the application of the SIT. The reason for this decision is that SIT represents an insect control method which can have an immediate beneficial impact in the developing countries with minimal damage to the environment.

The SIT utilizes radiation induced reproductive sterility to bring about the eradication of an insect species without molesting other species in the environment. In effect, the SIT combines two of the strongest forces in nature: sex and atomic energy, with the result that the target species breeds itself out of existence.

However, labelling of insects - whether with radioisotopes or dyes or activable tracers - serves important functions, which have also been utilized in the Section's programme. Thus, by releasing known numbers of labelled insects and recovering a sample of both the labelled and the normal specimen, the rate of dispersal, the maximum distance dispersed, the number of insects and their longevity under field conditions can be determined. The resting places of the insects can be located, and the mode of action of insecticides can be assessed.

Pioneers in the development and application of the SIT during the early 1950's were E. F. Knipling, R. C. Bushland and A. W. Lindquist. Several countries had already begun practical research on the use of the SIT against tropical fruit flies during the mid-fifties such as in Hawaii and Mexico with the assistance of the Agricultural Research Service of the US Department of Agriculture.

The first field trials and operational programmes involving SIT against tropical fruit flies were the suppression of *Ceratitis capitata* during 1959-60 on Hawaii, suppression of *Dacus dorsalis* and *cucurbitae* on the Rota island in 1960-62, suppression of *Dacus tryoni* in Northeastern New South Wales in Australia 1961-62, a small test with releases in 1959 of *Dacus oleae* in Italy, and suppression of *Anastrepha ludens* during 1960-62 in Santa Rosa and San Carlos in Mexico.

On the international scene the IAEA arranged its first scientific meeting in Asia as an "International Symposium on Radioisotopes and Radiation in Entomology". The meeting was held in Bombay during December 1960. The proceedings appeared as an IAEA STI/PUB/38 publication in 1962 with reviews on the use of nuclear based methods in controlling insect pests.

Claude Schmidt (1962-64) was attached to the IAEA Unit of Agriculture and became in charge of the insect and pest control programme. He was joined by Jack Keller (1963-65), who assumed the responsibility as Head of the Section when it was established in 1964. The arrival of John Monroe (1963-67) signalled the start of the entomology laboratory in Seibersdorf.

Already in October 1962 the IAEA had assembled a Panel of Experts in Vienna on "Insect Control by the Sterile Male Technique". The Panel reviewed the available information on the SIT and recommended research which resulted in the Section´s first CRP entitled: "Insect Control Using Radiation" that could start 1962/63. The main target insects were fruit flies, tsetse flies and the olive fly.

An "International FAO/IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests" was held in April 1963 in Athens. Subjects reviewed during the meeting included: tracer application in insect ecology; - labelled insecticides for studies of toxicology, residues and metabolism; - and the SIT.

The first interregional FAO/IAEA training course on "Use of Radiation and Isotopes in Entomology" was held in October 1963 in Gainesville, Florida. The success of the course and the generous US support has made it possible to repeat the course at Gainesville every second year for the last thirty years.

Maurice D. Proverbs (1965-66) joined the Section and Larry K. Cutcomp (1965-67) took over as Section Head.

A three year, 1.3 million dollar UNDP-SF project on eradication of the Mediterranean fruit fly (or Medfly for short) from parts of Central America was started in 1965 with IAEA as executing agency. The objective was to demonstrate that eradication based on SIT was scientifically and economically feasible on a large scale (60,000 acres). The project was carried out together with OIRSA, Organismo Internacional Regional de Sanidad Agropecuaria - whose laboratory in Costa Rica served as the project´s headquarters - and the Inter-American Institute of Agricultural Sciences. The Entomology Unit had developed techniques for producing several million sterile flies a week, and for releasing and dispersing them, and this work was turned to good use in the project.

The laboratory was also involved in research on the rearing of olive and tsetse flies. Practical difficulties were numerous, and an unconfirmed tale has it that in order to keep the precious tsetse colony alive one devoted entomologist offered his arm to the flies as a supplemental source of blood to the daily diet of rabbits, goats or guinea pigs.

Howard Erdman (1966-68) joined the Section and the following year Donald A. Lindquist (1967-69) assumed the responsibility as Head of the Section; - a post he was to hold with few interruptions until 1994.

New staff in the laboratory included Peter Langley (1967-69) as Head of the Entomology Unit, as well as David Nadel (1967-82) and Minos Tzanakakis (1967-68) on sabbatical leave.

Two new CRP´s were initiated in 1967 on: "Rice Stem Borer Control or Eradication", and "Fruit Fly Eradication and Control by the Sterile Insect Technique".

An "International FAO/IAEA Symposium on the Use of Isotopes and Radiation in Entomology" was convened in Vienna in December 1967. With the same title as the 1960 symposium in Bombay it was also designed to review recent development in this fast growing field with lectures and discussions on insect ecology, physiology and biochemistry, chemosterilants, SIT, as well as genetic and non-genetic effects of radiation.

Promising results had now been obtained in the Central American project and new small scale field operations were started in cooperation with the Italian Government to eliminate the Medfly initially from the Isle of Capri and later extended to the nearby island of Procida. A small project in Spain was also undertaken.

Dieter Enkerlin (1968-70) came to the Section, and Gordon Hooper (1968-70) joined the Entomology Unit.

Two new CRP's were launched: "Ecology and Behaviour of the *Heliothis* Complex as Related to the Sterile Insect Technique" in 1969, and "Use of the Sterile Insect Technique for Control of Lepidopterous Insects Attacking Fruit and Forest Trees".

Leo LaChance (1969-71) took over as Head of the Section, and the same year Milton Ouye (1969-70) and Alastair Mews (1969-73) joined the Entomology Unit.

The following few years saw several staff changes. Milton Ouye (1970-72) transferred to the Section in HQ's, and John Monro (1970-72) became Head of the Entomology Unit.

Donald A. Lindquist (1971-75) again took over the post as Head of the Section where Isaac Moore (1972-77) joined him. The laboratory could welcome Evans Offori (1971-74), Mainuddin Ahmed (1970-72) and Bill A. Butt (1972-74) Head of the Entomology Unit.

An "International FAO/IAEA Symposium on the Sterility Principle for Insect Control or Eradication" was held in Athens in September 1970. Being the fourth of its kind the meeting reviewed the potential effectiveness of induced sterility in insect control and eradication based on studies during the past ten years with hundreds of insect species. The symposium illustrated the potential effectiveness of the method in control campaigns against many harmful insect pests and the need to carry out large field tests to apply the results already obtained in the laboratory or small-scale field trials.

A Panel of Experts convened 1971 in Paris recommended that field trials be conducted in a tsetse fly affected area in Africa to demonstrate the effectiveness of the sterility principle for tsetse fly suppression.

The Entomology Unit could receive two new staff members: Hartmut Wetzel (1973-81) and Behrouz Malekghassemi (1973-76).

While the laboratory provided support in terms of training, research and services for the field experiments it also continued to carry out radiation sterilization studies on the tsetse fly, codling moth and Medfly. A real breakthrough was reported in 1970 with the rearing of tsetse flies on artificial membranes instead of the animal hosts. Methods for the mechanization of mass rearing of Medflies and olive flies were also developed in the laboratory during the early 1970's.

Pilot SIT field projects besides those already mentioned included one on the Hvar island in Yugoslavia to control the Gypsy moth during 1968-70, Medfly control in Israel 1972-73 and also in Argentina. SIT was one of the methods used on a larger scale by the United States to eradicate a Medfly infestation in South California.

Time was now considered ripe for larger campaigns, and the first one became entitled "Integration of Insect Sterility and Insecticides to Control the Tsetse Fly Species *Glossina morsitans*". This project started in 1972 in Tanga, Tanzania and would last for eight years.

The Entomology Unit received several new staff members: John George (1974-75) on sabbatical leave, Burkhard Bauer (1974-76) and André Van der Vloedt (1974-87). Patrick Vail (1975) arrived the following year as Head of the Unit, but was later transferred to the post as Section Head (1975-78).

A CRP on "Tsetse Fly Control or Eradication by the Sterile Insect Technique" was started in 1974. The programme would utilize the results obtained in the laboratory on mass rearing and sterilization, and a large-scale demonstration trial was subsequently negotiated with the Government of Nigeria.

An "International FAO/IAEA Symposium on the Sterility Principle for Insect Control" was held in July 1974 in Innsbruck, Austria. It was designed to review the practical application of the SIT and the economics that might thus be achieved. In addition laboratory aspects of mass rearing, sterilization and release of the target insect as well as aspects concerning the fitness of released sterile insects were subjects discussed.

John N. Kaplanis (1976-77) came to the Entomology Unit as its Head and was joined by Richard Gingrich (1976-77) on sabbatical leave, Michael Weiss (1977-80) and Willem Takken (1977-80), both JPO's involved in tsetse fly research, and Carrol Calkins (1977-80), who became the next Unit Head. Constantinos Serghiou (1977-79) became attached to the Section.

The plans for a large-scale campaign on tsetse fly control in Nigeria materialized during 1976/77. Several Member States agreed to contribute funds to the multilateral project, the objectives of which were to investigate the advantages, efficacy and economics of the SIT on a large scale in controlling or eradicating a riverine species of the tsetse fly, *Glossina palpalis*, from a 1500 sqkm area. The project document was signed in 1977 and the project became operational two years later in Vom, Nigeria, under the name BICOT (Biological Control of the Tsetse Fly by SIT). The project was active until 1987.

The threat of invasion of Medflies from Guatemala into Mexico also resulted in a major SIT based campaign. An agreement was concluded between the Mexican Government and USDA-APHIS (the Animal and Plant Health Inspection Service of the USDA) and the Seibersdorf laboratory agreed to supply 35 million irradiated Medfly pupae every week. In addition, mass rearing facilities that make use of the techniques developed at the Entomology Unit were constructed at Tapachula in Mexico and made operational in 1979 with the impressive average production of 500 million sterile Medfly pupae each week.

Germain LaBrecque (1978-82) took over the post as Section Head, and Lawrence Gringorten (1978-82), Thomas Jaenson (1979-81) and Jürgen Greiling (1979) joined the Entomology Unit.

A CRP - not based on insect sterility - entitled "Use of Isotopes in Pest Managment with Emphasis on Rice Insects" was launched in 1979.

An "International FAO/IAEA Symposium on the Use of Isotopes for Research and Control of Vectors of Animal Diseases, Host-Pathogen Relationships and the Environmental Impact of Control Procedures" was held in May 1979 in Vienna jointly with the Animal Production and Health Section. Parasite viability and host-pathogen interactions were discussed along with the application of SIT to tsetse flies and other insects of veterinary importance.

Apart from the production and shipment of sterile Medfly pupae to the Mexican project at Tapachula and the maintenance of a back-up colony of tsetse flies for the BICOT project, the Entomology Unit became increasingly entrusted with training, particularly of employees from these two projects.

Evans Offori (1980-88) returned to Vienna to become a member of the staff of the Section, and Richard Gingrich (1980-92) likewise came back to take over the post as Head of the Entomology Unit where also Udo Feldmann (1980-84) started working as JPO. In 1984 he was transferred to the BICOT project in Nigeria, which by now enjoyed financial support by Belgium, FRG, Italy, Sweden and the UK.

Further staff changes in the Entomology Unit were the arrivals of John Deloach (1981) on sabbatical leave, Geoffrey Kapatsa (1981-82), Jürgen H. Hamann (1981-82), who subsequently transferred to the BICOT project and then returned to the Laboratory (1984-85), and Paul Kaiser (1981-83) as expert for the Medfly projects in Mexico and Egypt.

An "International FAO/IAEA Symposium on the Sterile Insect Technique and the Use of Radiation in Genetic Insect Control" was held in Neuherberg, FRG, in June/July 1981. Besides reviewing the ´status quo´ of the SIT the meeting emphasized the use of nuclear techniques in the development of genetic sexing mechanisms as well as the quality control of mass reared insect.

Two new CRP´s were started in 1981: "Using Radiation and Isotopes to Develop Diets for Mass Rearing Haematophagous Insects for Sterile Insect Releases and to Study Disease Transmission by these Vectors", and "Development of Sexing Mechanisms in Fruit Flies through Manipulation of Radiation Induced Conditional Lethals and Other Genetic Measures".

Donald D. Lindquist (1982-90) returned as Head of the Section, and the Entomology Unit could welcome John Kabayo (1982-89), Erik Busch-Petersen (1982-89) and Gordon Hooper (1982-84) who also came back for a second term.

An agreement was concluded in 1982 between the IAEA and Egypt on the use of an integrated pest managment programme involving SIT as the principal suppression component for the eradication of the Medfly. The project (named MISR-MED) was originally estimated at a total cost of nearly 20 million dollars. which included contributions from Austria, Italy and the USSR to start up the project and aimed at eradicating the insect from the Nile Valley. However, owing to unforseen circumstances the project could not be implemented beyond its initial phase and it was cancelled at the Egyptian Government´s request.

The IAEA´s assistance to the Medfly project in Mexico was terminated in 1982. It was a total success; - all objectives having been achieved. The pest had so far been eradicated from some 15,000 sqkm. in Southern Mexico and Northern Guatemala. The experiences of and the technology used in the project were to be transferred to the project in Egypt through a TCDC (Technical Cooperation between Developing Countries) project between the two countries.

In addition, preliminary work was completed in 1982 aiming at a Medfly control project in Peru. The project known as MOSCAMED was to be supported by Italy and two large and three small isolated fruit-growing valleys in the South were selected as sites for the trials.

Germain LaBrecque (1983-84) continued in the Section as consultant for the project in Egypt until his untimely death. Willem Takken (1983) returned to the Entomology Unit to work for the BICOT project, and Harry Fay (1983-84) spent his sabbatical leave with the Unit.

In the laboratory research continued on tsetse fly rearing, including on artificial diets for mass rearing through membranes. Furthermore, work emphasized finding a method for genetically separating female from male Medflies in order to make the production of male flies more efficient and less expensive and also to avoid the release of female fruit-damaging Medflies concurrently with the sterilized males.

Construction work in Seibersdorf started on a pilot plant in which factory-scale procedures, diets and the rearing system to be used in the MISR-MED project would be developed and tested. The factory was completed in 1984, entirely financed by the Austrian Government.

A CRP was initiated in 1984: "Development of Methodologies for the Application of the Sterile Insect Technique for Tsetse Eradication and Control".

Leo LaChance (1985) returned to the Section as consultant for MISR-MED along with Danel G. Haile (1984-85) on sabbatical leave, and Domenico Bruzzone (1984-87) joinded the Entomology Unit as an APO with the project in Egypt.

During 1984 eight Egyptian entomologists underwent training in Tapachula while five field stations were established in Egypt.

A. P. Economopoulus (1985-90), Harold E. Mabry (1987) and Talal El-Abbasi (1985-87) all joined the

Entomology Unit.

The BICOT project had made good progress and by the end of 1985 almost 60% (and in 1986 85%) of the project area had been cleared of the target tsetse fly through weekly realeses of sterile male pupae combined with intensive trapping and the use of insecticide-impregnated screens.

The mass-rearing of Medflies in the La Molina laboratory for the MOSCAMED project in Peru proceeded as planned.

Work in the Seibersdorf laboratory during 1986/87 continued on developing genetic means for eliminating females from the mass rearing process of Medflies. Likewise, back-up support for the BICOT project continued with the production and shipment to Nigeria of 600,000 puparia and freeze dried blood corresponding to 1,500 litres.

Two new CRP's were launched in 1986: "Radiation-Induced F-1 Sterility in *Lepidoptera* for Area-Wide Control", and "Standardization of Medfly Trapping for Use in Sterile Insect Technique Programmes".

André Van der Vloedt (1987-91) was transferred from the Entomology Unit to join the Section until his untimely death. Bill A. Butt (1988-90) returned to the Section during his sabbatical leave. In the laboratory Rachel Galun (1987-88) spent her sabbatical leave with the Entomology Unit along with Riccardo Anouchinsky (1987-89) and Marc Vreysen (1987-90) both as APO's, and Philippe Kerremans (1987-), who served as APO until 1992 and then as consultant..

An "International FAO/IAEA Symposium on Modern Insect Control: Nuclear Techniques and Biotechnology" was held in Vienna in November 1987. The meeting addressed the general problem that insects become increasingly resistant to insecticides. As fewer insecticides are available and as environmental concerns limit their use, genetic control of insect pests offers practical solutions to some of these problems. Discussions centered on the recent development of F-1 (delayed) sterility, which would provide a potentially effective control method for many serious *Lepidoptera* pests.

The BICOT project was successfully concluded in June 1987 with the eradication of the target tsetse fly from the project area. However, fly monitoring continued as a precautionary measure in case the area was reinvaded, and - at the request of the Nigerian Government - plans were initiated for extending the project to cover an additional 10,000 sqkm.

The laboratory was able to isolate a genetically sexed strain of the Medfly on the basis of pupal colour. Furthermore, a compound produced by the bacterium *Bacillus thuringiensis*, which is pathogenic for adult Medflies, was identified.

Bill Butt (1988-90) spent his sabbatical leave with the Section, and Udo Feldmann (1988-93) returned to the Entomology Unit, which could also welcome Edward Lambremont (1988-89) as a sabbatical and Adigone Zacharopoulou (1988) as consultant.

Three CRP's were launched in 1988: "Laboratory and Field Evaluation of Genetically Altered Medflies for use in Sterile Insect Technique Programmes", "Genetic Engineering Technology for the Improvement of the Sterile Insect Technique" and "Development of Practices for Area-Wide Tsetse Eradication or Control with Emphasis on the Sterile Insect Technique".

In 1988 it became evident that the New World Screwworm, *Cochliomyia hominivorax* (which literally means "devourer of man", and has also ben referred to as the "fleshdevouring insect monster" or the "worm of death") had established itself in the Libyan Arab Jamahiriya. This insect attacks not only man, but also all warm bloodied animals, particularly livestock and wildlife, and could be devastating for Africa and the Mediterranean Basin just as it had been in North and South America. The discovery triggered very intensive national and international emergency actions.

The IAEA joined FAO in developing plans for eradicating this pest using SIT; - a method which had proved efficient in Southern United States and Mexico. Eradication strategies were developed and a training course was held for entomologists in North African countries.

The North African strain of the insect was found sexually compatible with the strain that had been reared for years at Tuxtla Gutiérrez in Mexico. Therefore plans elaborated included the shipping of sterile flies from the factory in Mexico.

Gerald Franz (1989-) joined the Entomology Unit as did also Harry Fay (1990), who returned as consultant, Elvira Riva (1989), Wayne Wolf (1989) as consultants and James Carpenter (1990) on sabbatical leave. Waldemar Klassen (1990-92) took over as Head of the Section when Donald A. Lindquist undertook an assignment as field project director in Tripoli, Libya, for the screwworm project.

The Entomology Unit reported the development of a new method for removing female Medflies based on the differential temperature sensitivity of male and female embryos. The differential temperature sensitive gene was induced by a "radiomimetic agent" and subsequently had to be linked to the sex-determining chromosome via a radiation induced chromosome translocation. This proved a very difficult and timeconsuming task.

Back-up colonies of six species of tsetse flies were maintained at levels ranging from 1000 to 150,000 females to provide insects for sterilization and release in test sites in Africa. Techniques were developed to transport up to 70,000 viable pupae per month to field trials in Africa, and improvement were achieved in determining the quality of the diets and the radio-sensitivity of newly colonized species.

Screwworm studies were also initiated in the laboratory: - particularly regarding the long distance shipment from Mexico and the storage of the insects. The response of adult screwworms to various attractant baits were investigated in order to develop efficient bait stations, and training was intensified.

Also in North Africa a project known as MAGHREBMED evaluated the feasibility of Medfly eradication from four countries: Algeria, the Libyan Arab Jamahiriya, Morocco and Tunisia. The project was to be implemented in three phases; - the first phase in 1991 being an assessment of the economic and environmental burden of the pest. It was found that the direct costs to the agricultural economies from the Medfly were in excess of 30 million dollars per year.

Jorge Hendrichs (1991-) joined the Entomology Unit for which he became the Acting Head in 1992. The Unit also hosted Andrew Parker (1991), Ute Willhoeft (1993-) as JPO, Aligui Djiteye (1993) and Slawomir Lux (1993) as consultants.

A CRP on the "Evaluation of Insect Population Suppression by Irradiated *Lepidoptera* and their Progeny" was started in 1992. Caterpillars belong to the order of *Lepidoptera* and constitute a very destructive pest of many crops. The pest has proved difficult to control by means of SIT, however, its radiation resistance is being used to good advantage in the F-1, or inherited sterility, technique.

Medfly field campaigns now also included Guatemala, Israel, Pakistan, the Philippines and Thailand, and tsetse fly pilot programmes were being pursued in Ghana, Nigeria, on Zanzibar in Tanzania, Uganda and Zambia. Mali and Burkina Faso also added to the list of countries, where a series of tests were completed.

An "International FAO/IAEA Symposium on Managment of Insect Pests: Nuclear and Related Molecular and Genetic Techniques" was held in Vienna in October 1992. The meeting highlighted the significant progress that had been made in the past decade in overcoming many of the difficulties of biologically based methods of pest management. Particularly emphasized were the advances made in the field of molecular technology and biotechnology. Subjects discussed included advances and trends in insect control and eradication, genetic engineering and molecular biology, insect genetics, operational programmes, sterility and behaviour, biocontrol and quarantine.

Donald A. Lindquist (1992-94) again took charge of the Section as its Head. Jan Chirico (1992-93) transferred from the Libyan project to the Section, and Udo Feldmann (1993-) came to the HQ´s from the laboratory.

Three new CRP´s were approved during 1993: "Enhancement of the Sterile Insect Technique through Genetic Transformation Using Nuclear Techniques"; - "Genetic Applications to Improve the SIT for Tsetse Control/Eradication Including Genetic Sexing"; - and "Automation in Tsetse Fly Mass-Rearing for Use in Sterile Insect Technique Programmes".

Thanks to the very fast and efficient reactions the SIT programme in the Libyan Arab Jamahiriya was successful in eradicating the screwworm fly from North Africa. In 1991 the last case found of infested animals was in April 1991. Intensive surveillance of animals in the country continued throughout 1992 and no additional cases of screwworm infested animals were found.

The MAGHREBMED Project entered its phase II involving one or more pilot eradication projects and other activities in preparation for the implementation of an overall eradication campaign.

CHAPTER 15

THE AGROCHEMICALS AND RESIDUES SECTION

THE AGROCHEMICALS AND RESIDUES SECTION

The protection of Man and his environment from pollution has long been of prime national and international concern. Among the reasons are the release of radioisotopes through nuclear explosions, and an uncritical over-use af agricultural chemicals for the purpose of increasing food production.

While radioisotopes certainly represented the villain in the first case, they became Man´s ally in his attempts to minimize pollution by pesticides or fertilizers. This was because radioisotope labelling not only assists in the very accurate analyses of minute amounts of residues, but also provides the means for establishing metabolic pathways and the fate of these compounds in nature. Such techniques are also invaluable in work to improve the efficacy of pesticides.

From its beginning the FAO Atomic Energy Branch dealt with the effects of radioactive fall-out on agriculture and in 1959 started to publish the Atomic Energy Series, which became a basic reference in this field. It is therefore understandable that upon the establishment of the Joint Division one of its Sections became responsible for the application of nuclear techniques to solve problems of environmental and food protection, arising from both the use of agricultural chemicals and as a result of radioactive fall-out.

UNSCEAR, the United Nations Scientific Committee on the Effects of Atomic Radiation, was created in 1954 in the wake of the many atomic test explosions which released large amounts of radioactive fall-out products in the environment. Naturally, close collaboration was soon established between UNSCEAR and the IAEA aiming at a full and continuing exchange of information on work dealing with environmental protection from the fall-out, including the provision of services to UNSCEAR in the IAEA Laboratory.

As early as 1958 an FAO/IAEA/WHO meeting was held to review methods of radioisotope analyses, and during a second meeting of the same organizations in 1964 particular attention was paid to methods to assess the extent of radionuclide contamination of food by fall-out. FAO published data collected during 1961/63 on such food contamination were published and in order to further UNSCEAR´s studies of radioactivity in man the FAO/IAEA agreed to extend the review to cover also contamination of soil and herbage.

Following the ban on atmospheric testing of nuclear explosives, interest in fall-out studies faded and more emphasis was placed on other types of potential pollution, particularly from the use of pesticides.

At the same time radioisotopes also became essential in studies of environmental behaviour and fate of agrochemicals, studies which have relevance both to problems of pollution and to the improvement of their performance in protecting crops. Radio-isotope studies of pesticides in stored products were among the earliest such investigations. The pioneering work of Peter Winteringham and his colleagues in the 1950´s had demonstrated the types of residue, which resulted from the use of halogenated hydrocarbon fumigants and their effects on wheat flour quality. The use of C-14 labelled compounds spread through a wide range of studies which had become necessary with the rapidly growing use of insecticides, herbicides and fungicides throughout the world.

This growth of pesticide use was accompanied by anxiety, not least because of the possibility that biological effects could be produced by residues at levels which at that time, were very difficult to detect or to analyse. In this situation an FAO/IAEA panel, which met in Vienna in 1965, could but confirm the unique value of radioisotope procedures for studies of residues concentrations in the parts per billion range.

Initially, the Joint Division´s Section involved was given the name "the Chemical Residues and Pollution Section", but some twenty years later the Section was renamed: "the Agrochemicals and Residues Section" to reflect its changing emphasis.

Gordon Wortley (1964-69) transferred from the Atomic Energy Branch, FAO, to become the first Section Head.

An "International FAO/IAEA Symposium on the Use of Isotopes in Weed Research", was held in October 1965 in Vienna. Together with WHO the FAO/IAEA also arranged an international training course in November/December 1965 at the Seibersdorf laboratory on survey techniques for radionuclides in food and agriculture.

Although the levels of fission products had been declining in human diet they were still appreciable, and therefore FAO/IAEA continued to collect information on the amount of radioactivity from fall-out found in soil, vegetation and food, reporting the data to UNSCEAR.

The cost of development of new pesticides escalated rapidly and by the end of the 1970's was of the order of 10 - 20 million dollars per compound. Therefore the interests of the chemical industry narrowed to compounds with a use in one of the 6 or 7 major crops in the world in countries where farmers can afford to buy them. This means that pesticide use in minor crops and in poor countries depends heavily on data generated in Government or University research. Much of the energy of the Section therefore became devoted to supporting such investigations and in 1970 the Section started its first two CRP's dealing with isotopic tracer-aided studies on the behaviour and fate of xenobiotic chemical residues; - one in the agricultural environment and the other in food. These programmes both aimed at investigating the nature, magnitude and significance of pesticide residues and other chemical contaminants, such as mercury derived from fungicides.

Work on the effects of radioactive fall-out residues continued together with UNSCEAR. Furthermore, collaboration was established between FAO/IAEA, WHO, ILO, UNIDO and IUPAC in order to improve the reliability of analyses of trace compounds in various biological samples. Finally, a "Joint FAO/IAEA/WHO Seminar on Agricultural and Public Health Aspects of Environmental Contamination by Radioactive Materials" was held in March 1969 in Vienna to review the situation.

Peter Winteringham (1969-80) transferred from the FAO Plant Production and Protection Division in Rome to take over as Head of the Section. He was assisted by Herwig Marchart (1970-74) and Jawas Al-Badri (1971-72) on sabbatical leave.

The first international FAO/IAEA training course on pesticide contamination entitled: "Use of Isotope Tracer Techniques for Study of Pesticide Problems" was held at the Seibersdorf Laboratory in 1972.

By 1973 the work on chemical residues and pollution problems had expanded to include two new CRP's; - one on "Isotopic Tracer-aided Studies of the Biological Side-effect of Foreign Chemical Residues in Food and Agriculture"; - and another entitled "Agricultural Nitrogen Residues with Particular Reference to Their Conservation as Fertilizers and Behaviour as Potential Pollutants", (jointly with the Soil Fertility, Irrigation and Crop Production Section). This programme aimed at the control of the possible nitrate pollution by fertilizer nitrogen residues in food, feed or water, and their conservation as useful plant nutrients.

The same year an "International FAO/IAEA/WHO Symposium on Nuclear Techniques in Comparative Studies of Food and Environmental Contamination" was arranged in Otaniemi, Finland, in August 1973. The symposium showed that it is essential to take into account the complex nature of environmental contamination and the possible synergistic action of two or more contaminants on organisms. The many lectures presented included aspects of general ecochemistry; - aquatic systems; - soil, plant and food; - metabolism and toxicology; -as well as radioactive and non-radioactive contamination.

Ryszard A. Leski (1974-76) joined the Section.

An "International FAO/IAEA Symposium on Isotope Ratios as Pollutant Source and Behaviour Indicators" was held in Vienna in November 1974. The Symposium was arranged jointly with the Soil Fertility, Irrigation and Crop Production Section. The meeting pointed to the advantages of using ratios of stable isotopes in studies of pollutant residues. This technique later also proved to be of use in the assessment of biological nitrogen fixation in plants.

New CRP´s based on isotopic tracer-aided studies were: "Chemical Residues in Cotton Seed, Feed, Oil and Related Products, (by employing radiolabelled pesticides it was possible to compare the efficiency of various processes for removing pesticide residues from the raw oil.), 1974; - "Agricultural Residue - (micro)biological Interactions", 1977; - and "Atmospheric Pollutant - Plant Interactions" (to study interactions between atmospheric sulphur pollutants and sensitive crops), 1978.

Two new staffmembers joined the Section: Aladin A. Hassan (1977-) and Robert Kokke (1977-81).

The work continued on the use of nuclear techniques in protecting food and the environment against chemical and also radioactive (fall-out) contaminants, and three new CRP´s were initiated: on improving the utilization of agricultural residues, 1979; - on the problems created by un-extractable or "bound" pesticide residues, 1980; - and on the use of herbicides and related chemicals in achieving the best use of the nitrogen in the soil, 1981 (together with the Soil Fertility, Irrigation and Crop Production Section).

The issue of "bound" pesticide residues would not have been recognized without radioisotope tracers. A substantial fraction of pesticide derived residues in soils and plants cannot be extracted by conventional analytical solvents and therefore would escape detection except by radioisotope labelling. However, the unextractable fraction may still be biologically available and constitute a hazard for man and animals ingesting the plant. The purpose of the CRP was to identify and quantify the unextractable fractions in soil and plants and to assess their possible significance to plants, animals and man.

Upon Peter Winteringham´s retirement Donald A. Lindquist (1980-82) took over as Head of the Section.

Several new CRP´s were started during this period: "Development of Improved Rural Methane Production from Biomass (with the residual slurry being used as fertilizer material) Utilizing Nuclear Techniques", 1980; - Studies of Agricultural Chemical Residues (of pesticides used in cattle dips or spraying) in Meat, Milk and Related Products of Livestock with the Aid of Nuclear Techniques", 1981; - "The Fate of Persistent Pesticides in the Tropics Using Isotopic Techniques", 1982; - "Isotopic Tracer-aided Studies of Pesticide Residues in Stored Products", 1982; - and "Research to Develop and Evaluate Controlled Release Formulations of Pesticides to Reduce Residues and Increase Efficacy, Utilizing Radioisotopes", 1982.

1982 became an important year with the inauguration of laboratory facilities at Seibersdorf for agrochemical work. Lajos Vollner (1982-87) was the first Head of the Agrochemicals Unit with Helmut Perschke (1982-), Maria Pasti (1982-86) as regional expert and Carlo Pascucci (1982-84), APO, on the staff.

The laboratory initially emphasized the development of techniques for studying the fate of pesticides in agricultural systems, beginning with research on the persistence of a controlled release formulation of endosulfan, an insecticide used in cotton fields and against tsetse flies.

The rationale of this research is that pesticides often are applied in excessive amounts to compensate for their environmental dissipation and degradation. In a controlled release formulation the active ingredient is discharged slowly to the environment at predetermined rates. This method of application will therefore diminish environmental hazards, because smaller amounts of the pesticide are needed, and also save costs.

An "International FAO/IAEA Symposium on Agrochemicals: Fate in Food and the Environment Using Isotope Techniques" was held in Rome in June 1982 in cooperation with the Italian National Atomic Energy Commission. The meeting reviewed advances made in the development and application of nuclear techniques in studying the fate of pesticides in plants, food and farm animals in both terrestrial and aquatic ecosystems. Particular attention was paid to the persistent pesticides in the tropics.

Jack Plimmer (1983-87) took over as Head of the Section after Dr. Lindquist's appointment to Head the Insect and Pest Control Section. In the laboratory Maria Laura Belli (1983-84) joined the staff of the Agrochemicals Unit.

During 1983 work in the Agrochemicals Unit in the laboratory started to identify microorganisms present in African termites, which had an enzyme capable of degrading lignin. This was an attempt to develop cultures capable of bioconverting agricultural wastes to animal feeds. The laboratory also studied methods for analyzing drugs used for treating cattle infected with trypanosomiasis. These activities were in support of two technical cooperation field projects in Kenya.

Work also aimed at developing and testing of a new controlled-release formulation of endosulfan with alginate as the carrier. In the field of analytical chemistry the laboratory developed new sensitive methods for determination of three trypanocidal drugs in bovine serum.

Two new CRP's were established: "Use of Isotopes in Studies of Pesticide Residues in Rice-Fish Ecosystems", 1983; - and "Radiotracer Studies of Fungicide Residues in Food Plants", 1984.

The Agrochemicals Unit welcomed two regional experts: Rudolf Kratzer (1984) and Angelo Peruffo (1985-86).

Jens Christian Tjell (1987-90) became Head of the Section, which had attracted two scientists on sabbatical leave: Andrew Daugulis (1986-87) and Douglas Eveleigh (1987).

In the laboratory Manzoor Hussain (1987-) took over as Head of the Agrochemicals Unit.

A CRP entitled "Biological Activity and Bioavailability of "Bound" Pesticide Residues Using Nuclear Techniques" was started 1986 as a follow-up of the earlier CRP on the subject, with emphasis on the bioavailability and toxicological potential of "unextractable" residues on non-target organisms.

An "International FAO/IAEA Symposium on Changing Perspectives in Agrochemicals: Isotopic Techniques for the Study of Food and Environmental Implications" was held in November 1987 in Neuherberg, FRG, in cooperation with the GSF (Gesellschaft für Strahlen- und Umweltforschung). The meeting concentrated on environmental contamination, pesticide residues and alternative methods for pest control. The search for safer and more specific pesticides and studies of the fate of applied pesticides in various regions of the world were the main themes of the Symposium.

Four CRP's were started in 1988: "Radiotracer Studies to Reduce or Eliminate Pesticide Residues During Food Processing"; - Development of Controlled Release Formulations of Pesticides Utilizing Nuclear Techniques"; - Use of Isotopes in Studies of Pesticide Residues in Rice-Fish Ecosystems - Phase II"; - and Radiotracer Studies of the Behaviour of DDT in Tropical Environments". The latter programme was to show that DDT dissipates many times faster in tropical regions than in temperate parts of the world. This is potentially a very important discovery since it means that in tropical environments DDT may - under certain conditions - be used as an economical, readily available and safe aid to agriculture.

The Agrochemicals Unit continued its work in Seibersdorf in support of technical cooperation field projects. In addition, new analytical methods for determining trypanocidal drugs in milk, faeces and animal tissues were developed together with improved pesticide formulations - particularly of carbofuran for use in rice paddies - and the quality control of radioisotope-labelled pesticides. A new activity was the development of non-sophisticated, simple radioanalytical methods. On-the-bench training of scientists from developing Member States became an increasingly important activity.

The Chernobyl nuclear reactor accident in 1986 revived the earlier international concern about the contamination of the environment with radionuclides. The Section and the Agrochemicals Unit became deeply involved through surveys and discussions with FAO and WHO on measures to minimize the damages to agriculture, and Peter Winteringham was called upon as the experienced consultant to advise the FAO and IAEA on how they could contribute. His report "Radioactive Fallout in Soils, Crops and Food" was published both by FAO (FAO Soils Bulletin Nr. 61, 1989) and by IAEA (TECDOC 494, 1989).

Prompted by the incident, an "International FAO/IAEA/UNEP/WHO Symposium on Environmental Effects Following a Major Nuclear Accident" was held in October 1989 in Vienna. The objective of the symposium was to review the extent and magnitude of environmental contamination that would arise after a large injection of radioactive materials and the methods employed in monitoring, assessing and limiting the short and long term effects on the environment, agriculture and human health.

Among the main points relating to possible future activities that resulted from the Symposium were: the need for international harmonization in the definition and use of terms, units and accident terminology; - problems associated withpost-accident intervention criteria; - the need for improved guidelines and economic provisions to assist countries affected by a transboundary release; - and the revival of research into possible countermeasures to restrict the entry of radionuclides in the food chains.

Staffan Wiktelius (1990-1994) and Vladimir A. Vetrov (1990-92) as consultants joined the staff. Jointly with the IAEA Division of Nuclear Safety, V. Vetrov started preparation of "guidelines for agricultural countermeasures that can be taken following an accidental release of radionuclides ", which will be published in 1994.

Research and development in the laboratory continued to support the various research programmes and field projects, in particular environmentally stable controlled release formulations of insecticides (against tsetse flies) and herbicides (against weeds in rice paddies). Furthermore, the Agrochemicals Unit provided technical support to the screw worm eradication project in North Africa (ref. the Insect and Pest Control Section) by developing a combined insecticide and bait system.

New CRP´s initiated during the period were: "Adverse Effects on Flora and Fauna from the Use of Organochlorine Pesticides on the African Continent", 1990; - Development of Procedures to Stabilize Acaricides in Livestock Dips and of Simplified Methods to Measure Their Concentrations", 1993; - "The Use of Nuclear and Immunochemical Methods for Pesticide Analysis", 1992; - The Use of Isotopic Tracers in Studies of Herbicide Performance on Grasses and Sedges", 1992.

Raymond J. Hance (1991-) became Head of the Section.

During the years 1993-94 two new projects involving the use of nuclear techniques for environmental protection gained support from SIDA. One project is "The distribution, fate and effects of pesticides on biota in the tropical marine environment". It will be operated in collaboration the IAEA´s Marine Environment Laboratory in Monaco.

The second project concerns "The agroecological effects resulting from the use of persistent pesticides in Central America".

Finally, a new proposal was drawn up in collaboration with FAO for the establishment of a Training Centre and Reference Service for Food Quality and Pesticide Control at the Seibersdorf Laboratory. It would include an international analytical quality assurance programme for pesticides which would provide quality assurance support for FAO, UNEP and WHO activities relating to the control of the use of pesticides.

Two new CRP´s were approved: "Development of Improved Insecticide Formulations for Targets Used in Tsetse Control in Africa Using Nuclear Techniques", 1993; - and "Impact of Long-Term Pesticide Usage on Soil Properties Using Radiotracer Techniques", 1994.

CHAPTER 16

THE FOOD PRESERVATION SECTION

THE FOOD PRESERVATION SECTION

Research carried out since the early 1950's had demonstrated the technical feasibility of using ionizing radiation to preserve food by destroying insects or harmful microorganisms. By the mid-sixties foodstuffs preserved by radiation had been authorized for public consumption in Canada, the Soviet Union and the USA and later in many other countries, and - eventually - irradiated food constituted the diet for astronauts in space to protect them against food borne infections.

It was therefore logical that the possibilities and potentials of preserving food by treatment with ionizing radiation became one of the earliest research subjects of the IAEA Unit of Agriculture as well as the FAO Atomic Energy Branch. IAEA also cosponsored an "International Conference on Preservation of Foods by Ionizing Radiation" with the Massachusetts Institute of Technology, which had initiated the Conference. It was held at Cambridge, USA, in July 1959.

During 1960/61 the IAEA cooperated with an European Nuclear Energy Agency, ENEA, Study Group on a detailed evaluation of specific applications of food irradiation. One proposal being considered at that time was to set up a permanent panel to consider questions relating to the health and safety of irradiated foods, and in October 1961 at a meeting in Brussels IAEA joined FAO and WHO in sponsoring a Technical Meeting on the Evaluation of the Wholesomeness of Irradiated Foods. The meeting recommended the establishment of an international protocol to promote work on the subject with animal tests.

This became the forerunner of the International Project in the Field of Food Irradiation, IFIP, which came into being some ten years later, - on 14 October 1970, for an initial period of 5 years.

In 1961 a small group of consultants met in Vienna to advise the IAEA in its preliminary study on disinfesting grain by radiation. This study had been contemplated based on the estimate that the amount of stored grain consumed or spoiled by insects would be sufficient to feed more than one hundred million people, particularly in the tropics and subtropics.

The European Information Centre for Food Irradiation located in Saclay, France, published a Quarterly International News Letter sponsored by EPA, and IAEA staff contributed on a regular basis.

Lars Erik Ericson (1962-64) was in charge of the food irradiation work until his untimely death. Karoly Vas (1964-66) became the first Head of the Food Preservation Section. Other staff members during the period were Harry Goresline (1963-66) as consultant coming from the FAO Atomic Energy Branch, and Fred Howard (1964).

Following up on the efforts to reduce storage losses by irradiation, comprehensive studies were made towards the end of 1963 to control insect pests in stored grains in a field experiment in Pakistan and a year later in Turkey.

The first (individual) Research Contracts were awarded to scientists in the Netherlands and Thailand emphasizing disinfestation of grain and control of Salmonellae. Further individual contracts went to institutes in Belgium, Greece, India, Japan and UK, mainly dealing with factors influencing the radiosensitivity of food spoilage microorganisms.

In April of 1964 the FAO, IAEA and WHO convened an "Expert Committee on the Technical Basis for Legislation on Irradiated Food" in Rome. Later, a panel on "Microbiological Specifications and Testing Methods for Irradiated Foods" held in Vienna in June 1965 carried this work further with the hope that the recommendations of these meetings would encourage Governments to adopt a similar legislation, thereby fostering the commercial development of food irradiation and - eventually - international trade in irradiated food.

In June 1965 the UNDP Special Fund agreed to provide funds to construct a pilot plant in Turkey using a Co-60 source to disinfest stored grain. The plant should be used for demonstration and training, being the then first facility at which technical and economical evaluations could be carried out with sufficient precision and reliability to demonstrate the industrial potential of this technique in other developing countries. Unfortunately, local politics eventually prevented the project to come to fruition.

The Austrian Atomic Energy Society, the ENEA and the FAO/IAEA embarked on a joint project in 1965 entitled the "International Programme on Irradiation of Fruit and Fruit Juices", with research carried in Seibersdorf.

An "International FAO/IAEA Symposium on Food Irradiation" was held in June 1966 in Karlsruhe, FRG. It demonstrated that a wide variety of foodstuffs existed with which irradiation could be used for three different purposes: to produce ´indefinitely´ stable products; - to rid food of organisms that constitute health hazards; - and to extend the shelf or market life of perishable food products. Papers presented dealt with radiation sources and dosimetry, chemical and physical effects of ionizing radiation, microbiology, virology and quarantine problems as well as with economics and legislation of food irradiation.

Maurice de Proost (1966-71) became the next Head of the Section, and further staff were W. Bednarczyk (1966-68) and Ian Clarke (1967-69) on sabbatical leave.

Three CRP´s were launched during 1966/67: one on microbiological aspects of food preservation by irradiation , such as radiosensitization, elimination of food pathogens, microbiological standards, testing methods and effects of ionizing radiation on food tissue; - another on general food irradiation; - and the third on tissue physiology and entomological aspects of food preservation by irradiation.

An eight-week "International FAO/IAEA Training Course on Food Irradiation Technology and Techniques" was held 1967 in Michigan, USA, and it represented the very first of its kind.

Events during 1968 in connection with the above mentioned pilot plant project in Turkey had underlined the importance of obtaining clearance by public health authorities so that individual radiation preserved foods may be released for human consumption. To this end the FAO/IAEA together with WHO expanded its clearing house functions on legislation and wholesomeness.

A CRP dealing with the preservation of fishery products by irradiation was started in 1969, and the shelf life extension of irradiated fruits and vegetables was the subject of another coordinated study launched in 1970.

Kevin Shea (1969-71) and Mohamed-T Fawi Abdu (1970-74) joined the Section.

A meeting was held in April 1970 at the OECD HQ´s in Paris between several government representatives. Here, agreement was reached to establish a new international project on food irradiation under joint FAO/IAEA/ENEA auspices. The project would mainly operate by awarding research contracts to cooperating laboratories to perform wholesomeness studies on selected food items, and the first priority was to be given to additional wholesomeness testing of potatoes, wheat and wheat products. This had become a necessary and urgent objective following the provisional 5 years clearance of wheat, wheat products and potatoes recommended by the "Joint FAO/IAEA/WHO Expert Committee on Food Irradiation", (JECFI), in April 1969. This was the second JECFI - the first being held in 1964 - and the third was scheduled for 1976.

The Section coordinated the activities and publication of data collected through IFIP concerning wholesomeness of irradiated food.

Roy Hickman (1971-74) became the first Project Leader for this "International Project in the Field of Food Irradiation" or IFIP, located in Karlsruhe, FRG. The project was initially set up for a period of five years.

Karoly Vas (1972-78) again took over as Section Head.

An "International FAO/IAEA Symposium on Radiation Preservation of Food" dealing with questions of wholesomeness, legislation and specific techniques was held in Bombay in 1972.

Also in Asia, a regional project under the IAEA sponsored RCA focussed on the technical and economic feasibility of fish irradiation. This was important because fish protein could not reach in-land areas for the lack of efficient preservation methods. Initially, seven countries participated: Bangladesh, India, Indonesia, the Republic of Korea, Pakistan, the Philippines and Thailand.

David Clegg (1974-76) was appointed the second Project Leader for IFIP, in which the number of participating countries had risen to 23.

Under the IFIP project the additional work was completed on wheat, wheat products and potatoes, and emphasis was shifted to the study of the wholesomeness - including toxicology, nutritional value and microbiology - of other selected irradiated foods.

The results of the investigations were presented at the third JECFI in 1976. The Committee resolved that five irradiated foodstuffs: potatoes, wheat, chicken, papaya and strawberries were accepted as unconditionally safe for human consumption, and three further food items: rice, fish and onions were given provisional approval.

The Committee also laid down new principles for the safety evaluation of irradiated foods, emphasizing the growing importance of the chemical approach in toxicological evaluation (to complement the conventional feeding tests), and - most important - envisaging the eventual generalization of the acceptance of groups of irradiated foods or of the process itself.

The IFIP was again renewed for another three years until 1978, and the number of irradiated food items that Member States had accepted for limited or unrestricted clearance had reached some 28 in 20 countries.

Paisan Loaharanu (1974-) joined the Section at this crucial period, and two years later Ryuji Matsunaga (1976-78) also became a staff member. At IFIP, Peter S. Elias (1976-78) took over as Project Leader.

A meeting of experts was convened in Vienna in December 1976 to draw up proposals for a ´standard´ for food irradiation and a ´code of practice´ on process control to be submitted for acceptance by the Codex Alimentarius Commission of the Joint FAO/WHO Food Standards Programme, - and for ultimate approval by its 114 Member States.

Three new CRP´s were started in 1975 on: technological and economic feasibility of food irradiation; - radiation preservation of Asian fish and fishery products; - and wholesomeness of the process of food irradiation.

An "International FAO/IAEA/WHO Symposium of Food Irradiation" was held in Wageningen, the Netherlands, in 1977. The meeting reviewed post-harvest conservation of foodstuffs as well as the chemical, biological, microbiological, toxicological, engineering, economic, public health and regulatory aspects of food irradiation.

Wageningen was also to become the site for the "International Facility for Food Irradiation", or IFFIT. Following intense negotiations during the second half of the seventies final agreement had been reached between FAO, IAEA and the Netherlands Government to set up IFFIT as a centre for training, development and research in the fields of the technology, economics and commercialization of food irradiation. Further objectives under the agreement were to assist national and international agencies in their assessment of the feasibility of irradiation as a means of food preservation mainly of products from developing Member States, and to develop and facilitate the dissemination of relevant information.

IFFIT was officially inaugurated in 1978 at Wageningen, where facilities were available for the training, research and pilot-scale studies on different aspects of food irradiation.

During the same year Jan van Kooij (1978-85) became the Head of the Section.

A draft general 'standard' for irradiated foods and also a draft 'code of practice' for the operation of radiation facilities used for treatment of foods were accepted for elaboration of Codex Standards by the Codex Alimentarius Commission in April 1978, and finally adopted during the following year.

The fourth JECFI in 1980 represented an important breakthrough for the general use of irradiation as a food preservation technique by reaching the conclusion that no toxicological hazard is caused by irradiating any food up to an overall average dose of 10 kGy (1 Mrad). Hence, foodstuffs treated in this way no longer have to be tested for toxicity; - the dose range normally used for food preservation purposes normally being 0.05 - 10 kGy.

Having now reached its objectives, the IFIP terminated itself, and in the light of the latest JECFI conclusions FAO/IAEA/WHO prepared amendments to the Recommended International General Standard for Irradiated Food, which were subsequently adopted in 1983 by the Codex Alimentarius Commission, these represented by some 130 countries..

Josef Farkas (1980-85) became the Project Leader of IFFIT, where training courses on aspects of the food irradiation technology were being held at regular intervals, as well as individual long-term training for scientists from developing Member States.

An "International FAO/IAEA Symposium on Combination Processes in Food Irradiation" was held in Colombo, Sri Lanka, in 1980. The purpose of this meeting was to review the progress in the field of food preservation by irradiation combined with the effects of other physical or chemical agents.

Three new CRP's were initiated: an Asian Regional Cooperative (RCA) project on Food Irradiation, in 1978; - Pre-commercial Scale Radiation Treatment of Food, in 1980; - and Factors Influencing the Utilization of the Food Irradiation Process, also in 1980.

At the request of the Board of Management of the former IFIP a proposal for continued international cooperation in food irradiation was distributed Member States of FAO, IAEA and WHO during 1982. Already the following year agreement was reached in principle for the establishment of an "International Consultative Group on Food Irradiation", or ICGFI, during a meeting in Vienna with representatives of 19 Member States and of WHO, FAO and IAEA.

The functions of ICGFI would be to:

- evaluate global developments in the field of food irradiation;
- provide a focal point of advice on the application of food irradiation to Member States and the Organizations; and
- furnish information as required to the JECFI and to the Codex Alimentarius Commission.

ICGFI was officially inaugurated in May 1984 by 15 Governments for an initial period of 5 years with the objectives of furthering the development and possible commercialization of food irradiation, and also assisting Member States in the promotion of wholesome supplies and proper nutrition on the basis of irradiated food items. The Food Preservation Section would act as the Secretariat for the Group.

A CRP was started 1981 to study insect disinfestation of food and agricultural products by irradiation, and in 1984 to investigate the use of irradiation as a quarantine treatment of food and agricultural commodities.

1985 and the following few years saw several changes in the staff. Paisan Loaharanu (1985-) became Head of the Section, W. Oesterheert (1985) and Jan van Kooij (1985-88) Project Leaders of IFFIT, Alexander Dollar (1986) and Walter Urbain (1986) served as consultants, Mordeca Lapidot (1986-87) on sabbatical leave, Christopher Rigney (1986-89) and Mainuddin Ahmed (1987-) joined the staff.

The IFFIT project was extended in 1985 for another two years. The number of countries now participating had ICGFI increased to 26 with activities focussing on the promotion of international trade in irradiated foods, training, feasibility studies and public education. Guidelines were prepared by the ICGFI on the use of irradiation as a quarantine measure and as a method for ensuring hygienic quality of foods, and marketing and public relations strategies were also developed.

The regional technical cooperation activities in Asia under RCA (RPFI, now in Phase II) and ARCAL in Latin America were intensified through two CRP´s, regional training courses and workshops, and a video film was prepared under the aegis of ICGFI to inform the general public about the safety and efficacy of food irradiation. Finally, a CRP was established in 1987 to use irradiation to control infectivity of food borne parasites.

The regionalization of the Section´s activities were carried further through two CRP´s started in 1988; - one emphazising food irradiation applications in Africa and another in Middle East and Europe, (FIPMEE).

Towards the end of 1988 the number of countries in which one or more food items had been approved for human consumption was 35, and 30 commercial or demonstration irradiators were in operations for treating food in 21 countries.

In 1988 the membership of ICGFI had grown to 28 Governments, and its mandate was extended for another five years until May 1994. Among its many activities "Eight Codes of Good Irradiation Practice" for specific applications of food irradiation (e. g. sprout inhibition of roots and tubers, control of pathogens in poultry and meat, insect disinfestation of grains, dried fish and fresh fruits) were elaborated (and subsequently adopted in 1990), and a Food Irradiation Process Control School, (FIPCOS) for training operators and food control officials was established.

The agreement for establishing IFFIT was extended until the end of 1990, and Ari Brynjolfsson (1988-90) took over as its Project Leader.

A major "International Conference on the Acceptance, Control of and Trade in Irradiated Food" was held 1988 in Geneva sponsored by FAO/IAEA/WHO and ITC-UNCTAD/GATT. The Conference was prompted by the lack of acceptance by some Governments, which did not see a need for the use of food irradiation in their countries, and as a consequence might hamper its application in other countries, where food irradiation could significantly improve consumer health and nutrition. The Conference adopted a set of principles for the acceptance of irradiated food in trade under strict control by competent national authorities.

Lesley Ladomery (1989-94) joined the Section (coming from ESN of FAO, Rome) and also Henry Delincee (1989) as consultant.

That same year the number of countries having approved irradiation of one or more food items had grown to 37, and the Asian Regional Cooperative Project on Food Irradiation under the RCA entered its third phase (RPFI Phase III) with a new CRP emphasizing food irradiation process control and acceptance. This phase of RPFI was sponsored by UNDP from 1989 to 1993.

An often repeated argument against the general introduction of irradiated food has usually been the lack of precise methods for ascertaining whether a food item has been irradiated and - not the least - at which dose. Therefore, a CRP was launched in 1989 under the title: "Analytical Detection Methods for Irradiation Treatment of Food, or ADMIT".

In 1990 ICGFI had reached a membership of 37 Governments, and established a "Network for Training on Food Irradiation", or INTFI. The purpose of the network was to arrange collaboration between various suitably equipped institutions in the member countries and to contribute towards joint training programmes.

Two new CRP's were initiated: "Irradiation in Combination with Other Processes for Improving Food Quality", 1990; - and "Irradiation as a Quarantine Treatment of Mites, Nematodes and Insects other than Fruit Flies", 1992. This latter CRP followed the CRP conducted between 1984-90 which had aimed at overcoming quarantine restrictions in the trade in fresh agricultural produce against the fruit fly. This work was begun in view of the needs of the food industries and regulatory agencies after the prohibition of the use of ethylene dibromide as a fumigant for the purpose of quarantine. Initial research had shown that a minimum dose as low as 0.15 kGy can be effective for disinfesting any species of fruit fly without adversely affecting the quality of the fruits.

During 1991 two workshops were arranged in Bangkok and Karlsruhe, respectively, to inform media in the respective regions and the public on the safety, benefits and limitations of irradiated food.

George Giddings (1991-92) became a staff member of the Section as an inter-regional expert. Ari Brynjolfsson (1991-92) also joined the Section and became in charge of training activities on food irradiation.

By the end of 1991 the total number of irradiation facilities available for food processing had reached 50.

An "International FAO/IAEA/WHO Symposium of Cost Benefit Aspects of Food Irradiation" was held in March 1993 in Aix-en-Provence, France. The meeting was convened to evaluate the cost/benefits of irradiation for treating various food items either based on its own merit or in combination with other processes. Illustrated by a number of case studies the symposium included discussions on the economic benefits of irradiation to control a number of food-borne diseases, especially those originating from consumption of food of animal origin as well as the potential economic benefit as a quarantine treatment of fresh fruit and vegetables.

The IAEA General Conference in 1992 passed a resolution requesting the Director General to prepare a detailed project proposal for introducing practical utilization of food irradiation in developing countries.

As a result, the June Board of IAEA Governors in 1993 approved an Action Plan, which initially foresaw introducing commercial-scale food irradiation programmes in Chile, China, Mexico and Morocco in collaboration with FAO, WHO and ITC (International Trade Centre).

An IAEA General Conference resolution in 1993 also endorsed this plan, requesting that particular attention be given to technical, legislative, public acceptance and financial aspects in the implementation of the plan.

Two CRP's were initiated: Irradiation as a Public Health Intervention Measure to Control Food-Borne Diseases (cysticercosis/taeniasis and vibrio infection) in Latin America and the Caribbean", 1993, (co-sponsored by the Pan American Health Organization) and "Standardized Methods to Verify Absobed Dose of Irradiated Fresh and Dried Fruits and Tree Nuts in Trade", 1994.

A Seminar was jointly organized by ICGFI and the International Organization of Consumers Unions, (IOCU), in the Netherlands in September 1993. The objective of the meeting was to exchange views on the effectiveness and acceptance of food irradiation and to discuss consumers interest and concerns. The Seminar represented a major achievement in terms of a better understanding among consumers of food irradiation and its technology. It was clear from the conclusions of the meeting that IOCU now no longer opposes the use of food irradiation, but expressed some reservations as to the need of the method. They would prefer that food be produced without contamination, so that disinfestation/decontamination treatments including irradiation will not be required.

The 10th Annual Meeting of ICGFI held in Geneva in November 1993 decided to extend its mandate for another five years, i.e. until May 1999.

CHAPTER 17

PAST, PRESENT AND THE FUTURE

by

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THE JOINT FAO/IAEA DIVISION

PAST, PRESENT AND THE FUTURE

Björn Sigurbjörnsson

THE PAST

The discoveries of ionizing radiation and radioactive isotopes opened up a new world of scientific tools unlike any that existed before. The exactness of measurements went up by orders of magnitude and one could compress eons of genetic evolution into a few generations by multiplying the rate at which mutations occur. With the development of nuclear reactor technology these tools became widely available to scientists, medical doctors and industrialists. The fascination with nuclear technology in agriculture also derived from the concept of man's most advanced technology being harnessed to improve man's most basic need for daily food. Nevertheless, as with all new technology, the novelty wore off with time. In fact, there was a backlash. Hardly had the new Joint FAO/IAEA Division taken its first upright steps when the critics started preaching against using "sophisticated" technology in developing countries.

The fashionable word became "appropriate" technology. In a book on development aid published in the early seventies the establishment of two agricultural institutes based on nuclear technology in Pakistan was used as an example of this folly. This led the Chairman of the Pakistan Atomic Energy Commission to ask if he should advise PIA to get rid of its jets and go back to propeller planes. On the 25th anniversary of one of the institutes, NIAB, the author of that book would have wished he had not made these comments. The success of applying nuclear technology by the institutes, particularly in mutation breeding, had been nothing short of spectacular. The economic returns each year to farmers and Pakistan society as a whole from the release of only one of these mutant varieties (in cotton) were higher than the total costs of the construction and operation of the institutes (then three) from the time of their establishment. In fact, that one variety was considered to have contributed more to economic growth in Pakistan than any other single factor.

In the beginning the Joint Division did not have smooth sailing only - indeed at times it was quite rough! The two agencies had somewhat different attitudes, different styles, different emphasis, and different ways of doing things. This included a yearly budget and programme cycle in the IAEA and a biennial cycle in the FAO. Many smaller things required harmonization - the programme style differed between the agencies, different types of meetings were held, different fellowship programmes and different publishing policies existed. Also, the different philosophies existing in the two staffs, combined to form the Joint Division, did not make for easy relationships at the start. All this required ironing out, which in time was done successfully.

THE PRESENT

The critics have not been stifled entirely. But now it is more difficult to criticize a methodology which, over the last 30 years has produced some of the leading varieties of rice, barley and durum wheat, improved the efficiency of fertilizer application, saved the African continent from the screwworm, cleaned Mexico of Medflies, improved productivity of livestock and even saved toothpaste from permanently loosing its peppermint flavor - to mention just a few examples. As a result we gathered an astonishingly large fan club all over the world.

One sometimes hears that nuclear techniques have outlived their usefulness and have in any case been replaced with new, simpler, safer and more efficient technologies. This does not reflect the facts. Sometimes one hears that "biotechnology" will certainly replace nuclear technology. A simple look at the nature of nuclear techniques and even a cursory glance at the nature of some biotechnologies -

even a walk through a biotech lab reveals something else: the fact that without radioactive markers there would be very little left of biotechnology/molecular biology. Walking through a biotech lab one is struck with the frequency of labels warning of radioactivity (I have not seen so many labels in our own Seibersdorf laboratory!). Nuclear technology depends on the very basis of our physical universe, the atom, its nucleus and its electrons and their properties. One cannot go much beyond those fundamentals of nature. The characteristics of the atom enable identification and quantitative determination of such accuracy and such sensitivity that it is hardly conceivable that these techniques can ever be replaced. The penetrating power of ionizing radiation through most packaging materials is unsurpassed. Thus there is no way nuclear techniques can ever become obsolete.

One must also look at the present situation of the Joint Division within FAO and IAEA in order to contemplate the future. Within FAO the Joint Division is the only truly "research" division, the only one operating an effective research contract system and the only one assisted by an active, major in-house research and training laboratory. As such the Division is not only unique within FAO but probably also within the UN system. The Division operates across nearly all fields of agriculture, employing nuclear and related techniques to solve priority agricultural problems as approved by FAO Governing Bodies (as well as those of IAEA of course) and most often in close cooperation with sister Divisions in Rome.

The place the Joint Division fills within IAEA is somewhat different. Perhaps due to the demonstrated success of nuclear techniques in agriculture, the Division and the Laboratory grew rapidly in size (until the onset of zero real growth) until it now represents one of the largest activities in the IAEA with regard to manpower and budget. Its successes are often cited as a showcase of peaceful uses of atomic energy. Nevertheless the owners, or more accurately, the major contributors, often seem to view all peaceful applications of atomic energy as a necessary burden to justify to developing countries the emphasis put on the safeguards activities of the IAEA. However it has been agreed that there should be a balance between the regulatory and the peaceful application activities of the IAEA. As long as that policy is maintained, the Joint Division will be able to continue to spread the benefits of nuclear technology to the economic benefit of developing countries.

The Division's activities are examined by the two parent organizations in quite different ways.

FAO's Committee on Agriculture, its Programme Committee and Commission 11 of the Conference asks questions and comments on the content of the programme and sets agricultural priorities. The IAEA Board and the A and B Committee usually ask questions and comment on form, budget transparencies and harmonies with programmes, if there should be a sunset clause for activities or why plant breeding activities seem to go on for ever, or on substance if large irradiation sources are involved. (Fortunately there are notable exceptions). This is understandable considering the background and interests of the respective Governing Bodies. Nevertheless the IAEA takes pride in the completion of successful projects as, irrespective of the growing attention to safeguards, the promotion of peaceful applications of "atomic energy"is one of the cornerstones of the Agency's Statutes drawn up in 1957 and has contributed to the overall favourable and respected position the IAEA has earned over the years.

Both FAO and IAEA derive some satisfaction out of operating a joint division. Firstly, for both it is arguably the best example in the whole UN system of inter-agency collaboration that not only functions smoothly and without complications, but is also quite successful, earning considerable amount of goodwill in Member States for both agencies. Secondly, the relatively small financial contribution from FAO (depending on how one calculates it, anywhere from 8 - 17%, earns FAO the co-title to all IAEA funded programmes in food and agriculture, as, according to the agreement, all activities under the technical responsibility of the Joint Division are carried out in the name of both organizations.

Thirdly, FAO's involvement in and approval of the joint programme gives IAEA the license to operate in food and agriculture. IAEA by itself could not go out into the world with its isotopes and radiation and try to increase food supplies on its own. It would not be taken seriously. However, with the scrutiny of FAO's Committee of Agriculture and the de facto approval of the world's Ministers of Agriculture, the IAEA's activities are welcomed as an important contribution to - and within - the over-all effort to improve food and agricultural production and its protection.

In short, everyone gains from the joint approach. Two independent programmes make even less sense now than in 1964.

THE FUTURE

Having reviewed the past and contemplated the present, we can attempt to peek into the future, first in a general manner and then on a subject matter basis.

As there is a general desire, frequently expressed by the Board, that the IAEA should work more closely with other UN organizations (a sentiment less often heard at the FAO Council) and as it does not look like nuclear techniques are going out of style anytime soon, one can safely predict that the Division will continue to exist to the satisfaction of both parents for a long long time to come, perhaps as long as both parent agencies exist. Although there are continuous attempts to find non-nuclear substitutes for what we do, the trend seems to be to the contrary: with ever increasing sophistication in scientific approaches and in technology, further advances in crop and livestock production and protection are depending more and more on the deft employment of isotopes and radiation. Thus the rationale behind the Joint Division is likely to be even stronger in the future: contributing to the effectiveness of science and technology in solving the food and agricultural problems of the future.

There are many ways to contemplate the outlook in the various sectors. It depends on so many factors, breakthroughs in other disciplines, new technique developments and agricultural policy decisions to be established.

Soil Fertility, Irrigation and Crop Production

FAO's goal is to double food production in the next 30 years. Thus there are two major challenges up front: One is to increase dramatically crop production in food deficient areas which calls for stepping up the use of fertilizers and water. The other is to counteract the possible adverse impacts of the inputs needed for doubling production on soil, water and air resources and on the non-agricultural environment. With increasing pressure on soil and water resources, soil erosion and inadequate water supplies may become the most serious problem of the next century. The calculated half life of the world's soil resources (using estimated current rates of erosion) is 100 years! This situation calls for attention being paid to measuring the rate of erosion, fertilizer and water use efficiency and the use of biological fertilizers, all areas where isotope and radiation technology plays an indispensable and often a unique role. One can thus expect increasing demands on the Division's services and expertise in this field. Also of concern is the production of greenhouse gases from agricultural fields including oxides of nitrogen and methane.

Plant Breeding and Genetics

Contrary to earlier forecasts, genetic engineering is not replacing mutation breeding. In fact, induced mutations coupled with a variety of new biotechnology/molecular biology approaches are opening up new exciting opportunities. Due to the difficulty and high costs of getting clearance for the release of genetically engineered varieties, there is a surge in the use of induced mutations for improving important agronomic characters. Many biotech companies have resorted to mutation breeding to ensure a flow to the market of income earning varieties. Simultaneously the track record of mutation breeding world-wide - the release to growers of nearly 2000 mutant varieties in nearly all crop and horticultural species - is now registering with many breeders who have run into blind alleys with "conventional" breeding and are impatient for biotechnology to deliver the goods. Furthermore, it is becoming more difficult to find desired characters in existing gene banks and germ plasm collections; perhaps the genes we desire were never selected and fixed during natural evolution when there was no need for them. No amount of searching and selection will succeed if the gene does not exist. One can thus safely predict that there will be increasing demand for induced genetic variability - and demands for our seed treatment services and expertise, even to the extent that the use of induced mutations will become a method of choice as a supplemental tool for most plant breeders.

Animal Production and Health

The last 3O years showed a steep growth in demands for this programme. The development of the Center for ELISA and Molecular Methods of Disease Diagnosis has firmly anchored this programme in the international effort. One can thus predict that the Division will become a pivotal center for international livestock disease control by providing the crucial central services for diagnosis. The near term emphasis is on rinderpest and trypanosomiasis and will extend to other important livestock diseases.

There will be increasing demand to improve the efficiency of animal feeds. Increased competition between croplands and pastures will result in diminishing areas for good animal grazing lands. The use of nuclear techniques to improve feed supplementation will thus increase. So far the animal programme has only dealt with ruminants and lately restricted to dairy cows. At the same time there is increasing demand for improvement in productivity of monogastric animals, including aquacultured fish. Pigs and poultry represent some of the most important sources of protein food throughout the world. Fish farming already constitutes over 10% of world fish harvests. As nuclear techniques are equally applicable to improve reproduction, nutrition and health of these types of livestock one can expect the Division to expand in this direction in the future.

Insect and Pest Control

No one questions the elegance of the SIT or the proven success of its application for insect eradication or how kind it is to the environment. The total eradication of one of the two tsetse species from 1500 km^2 in Nigeria was splendid proof of its success. For some reason that success did not impress people, possibly because the concurrent political instability and declining economy of the country prevented any meaningful follow-up. The eradication of Medfly from Mexico was another concrete example where our involvement, even if minor, was crucial. The impact story that went around the world was the victory of SIT over the screwworm in Libya. Of the many FAO units involved with this campaign, the credit goes increasingly to the Joint FAO/IAEA Division for its technical guidance, professional planning and lending Don Lindquist to direct the field operations to such a spectacular success.

One would have thought that donors would be waiting at the door to offer money for more such programmes. That has not been the case, the reason possibly being that SIT programmes, even reasonably small ones, are enormously expensive; never mind that the return on the money is estimated at 5 - 10 to 1 !

Nevertheless, the happy days of indiscriminately spraying pesticides are numbered and there is an increasing call for alternative methods. Integrated Pest Control is certainly one of the chief answers and SIT is easily integrated into an integrated package of area-wide measures for control of many insects. The genetic sexing breakthrough for Medfly achieved by Seibersdorf is without any question going to change attitudes towards SIT and make it **the** method of Medfly control. One can expect the genetic sexing strain to be used for control/eradication in the whole Mediterranean area, all of Central America and in large parts of South America. One wonders if the Medfly will not join polio and smallpox and start worrying about its existence. We now have the tools to get rid of this pest for good and the Division will of course continue to lead that crusade.

The future for SIT tsetse control is not (yet) so rosy. Our mass rearing and sexing methods are archaic to say the least. The hand separation of the sexes makes one wonder why radiation is needed for sterilization! I predict that both mass rearing technology, feeding of tsetse and the sexing procedure will be streamlined in the near future - but only if the Division and Seibersdorf do the necessary research: outside of Africa nobody seems to be really interested in tsetse. Unless there is a breakthrough, the going will be slow. With improved technology, I am sure SIT, in integrated campaigns (pour-ons, screens and traps), will become the method of choice.

If staff, space and funds permit, there should be more emphasis on F_1 - sterility for Lepidoptera. If only because of the enormous damage caused by moths and their larvae to the world's major crops. There is likely to be a gradual increase in the application of this technology in the fight against these crop insects.

One thing this Section has going for it at the present time: new, young and enthusiastic staff members taking over from the old guard. A bright future seems all but guarantied.

Agrochemicals and Residues

There was a time not so long ago that the IAEA administration decided that this activity did not deserve attention and should be phased out. In fact it disappeared from the first draft of the Agency's former Medium Term Plan. The IAEA had not seen the writing on the wall. This was pre Rio. All of a sudden sustainable development became fashionable and peppered all over UN studies and papers. Pesticides and their residues could be harmful to the environment and one of the most effective methods of learning of their behavior and fate in the environment is of course the use of isotopically labelled materials. But still, it was only after Swedish SIDA insisted on giving us abundant money for studies of agrochemicals that the IAEA finally woke up and reconsidered its priorities. From now on the future is full of wind in the sails. The call for doubling of crop yields in the coming 20 - 30 years will call for greater use of pesticides and mineral fertilizers. The effect of these agrochemicals and their residues on the environment must be carefully monitored - where isotopic tracers will have an important role. They will also be used to evaluate the efficiency of new formulations of pesticides, designed to increase the effect of the active ingredient and reduce the side effects which may be harmful to the non-target fauna and flora, both terrestical and aquatic. These activities come within the framework of the FAO International Code of Conduct on the Distribution and Use of Pesticides which, among other things, aims to ensure that developing countries have suitable legislation. Effective pesticide laws require reliable analytical laboratories and the Agrochemicals Unit at Seibersdorf is uniquely placed to provide the quality assurance services that will be increasingly necessary.

And finally, the resources are there, should there be another Chernobyl!

Food Preservation

In 1965 food irradiation was on the verge of a breakthrough into wide-spread commercial applications. Then our Turkish project for grain disinfestation collapsed under a choir of critical voices accusing the UN of using developing countries as guinea pigs for a potentially dangerous technology. It was a long lasting blow. Then came the recognition by CODEX ALIMENTARIUS of the safety of the process in 1983 and the advice by WHO to use irradiated food for safety wherever it was available, leading to rising expectations until 1986 when the Chernobyl reactor explosion took the wind out of our sails. But again we are in an upswing. It is hard to admit it, but to many former adversaries, we are the lesser of many evils. Fortunately for food irradiation, one after the other of the standard chemical fumigants used for disinfestation have been identified as carcinogens or adding to the ozone problem and have been banned or their use restricted. World trade in fruits, vegetables and grains could grind to a halt due to quarantine regulations unless a method such as irradiation is permitted to overcome these constraints. The GATT sanitary and phytosanitary agreement, the EU and NAFTA are also conducive to the spread of food irradiation technology. Also the alarming increase in food borne diseases - notably Salmonella and related pathogens - and the absence of effective means of ensuring hygienic quality of food, especially of animal origin has propelled the use of irradiation as a treatment of choice. Even the International Organization of Consumer Unions (IOCU), once a sworn enemy, now realizes that the perceived dangers of food irradiation are minimal as compared to those in a world without the possibility of prudent irradiation treatment.

It is not an exaggeration to say that IOCU has become (perhaps reluctantly) our working partner. Largely due to the work of the Division, many of the technological problems of food irradiation have been solved. In retrospect the creation of ICGFI was a masterpiece. Since 1984 the IAEA is not seen as a promoter of food irradiation. IAEA, together with FAO and WHO, only serves the will of ICGFI

Members Governments. This has worked extremely well.

For the third time one can hope for a rosy future for food irradiation. Perhaps this time the hope will come true.

CONCLUSION

Looking on the subject matter areas of the six Sections and the five laboratory Units and their present programmes and activities, the Division has possibly never been in a stronger position as now: a real partner of both FAO and IAEA with a 30 year proven track record of significant contributions to the advance of food and agriculture in developing countries and also the world community at large, and no shortage of extrabudgetary support from our many generous donors.

Our shortcomings are less in what we do than in what we neglect. We have been slack in forestry and fisheries, pigs and poultry, shrimps and trout. It has been said that zero real growth budget is better than no growth at all, but it's been hard to live with it so long. Either we break through this barrier or entice our donors to open up their purse strings. One way or another the Division should go into these new fields where nuclear techniques promise to unravel many of the production constraints, health problems and other limitations to productivity in these branches of agriculture. At the same time our present programmes all deal with areas in food and agriculture with a high priority in the foreseeable future and should be followed through.

If the Joint Division continues to attract as qualified, competent and cooperative staff as in the past, its future will be secure and bright.

APPENDIX

ARRANGEMENTS FOR THE JOINT FAO/IAEA DIVISION

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

INTERNATIONAL ATOMIC ENERGY AGENCY

NOTE

This text reproduces the original document defining the "Arrangements" for Joint FAO/IAEA activities.

ARRANGEMENTS BETWEEN THE DIRECTORS GENERAL OF THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE JOINT FAO/IAEA DIVISION OF ATOMIC ENERGY IN FOOD AND AGRICULTURE

INTRODUCTION

(a) In order further to implement the purposes and objectives set forth in the agreement between the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations signed respectively on 9 March 1960 and 29 February 1960, and the arrangements set forth in the exchange of letters on 28 August 1964 and 3 September 1964 between the Directors General of the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations, the Directors General established the Joint FAO/IAEA Division of Atomic Energy in Agriculture with effect from 1 October 1964.

(b) In the light of the experience gained the arrangements were reviewed and the Directors General of the Joint Division have agreed, as outlined below, on the continuance of the Joint FAO/IAEA Division which will hereafter be entitled "Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture".

1. Basic Principles

(a) The aim of the Joint Division is to ensure that the technical services of both organizations are brought fully into the joint operations. To this end the Joint Division, in consultation and co-operation as appropriate with other divisions of the two agencies, shall be concerned with the overall planning, programming and co-ordination of all activities concerned with atomic energy in food and agriculture, irrespective of the division through which particular projects in the approved programme may be carried out.

(b) The Joint Division shall have main operational responsibility for all scientific and technical meetings (conferences, symposia, seminars, panels and committees), special missions, training courses and publications concerned wholly or mainly with atomic energy in food and agriculture.

(c) In addition, the Joint Division shall have scientific and technical responsibility for all technical co-operation, preinvestment and other field projects of either agency concerned with atomic energy in food and agriculture, as well as for projects in programmes such as the research contracts programme and the programme of the Seibersdorf Laboratory of the IAEA.

(d) In activities of general concern in either agency in which atomic energy in food and agriculture is only partly involved, the Joint Division shall be associated through appropriate consultation.

(e) All activities under the new arrangement which are wholly or mainly concerned with atomic energy in food and agriculture and which involve the joint participation of the two agencies shall be carried out and given recognition in the name of both agencies.

(f) Recognizing that the purpose of establishing a Joint Division is to develop a single joint programme for atomic energy in food and agriculture on behalf of both agencies, it is considered desirable that all work in this field should be built around the Joint Division and such a position is the ultimate goal to be achieved as soon as circumstances permit.

2. Administration

(a) The Joint Division will be headed by a Director who will be assisted by a Deputy Director. The FAO will be responsible for the employment of a Director agreeable to both agencies; the IAEA will be responsible for the employment of a Deputy Director who is agreeable to both agencies. The remaining staff of the Joint Division will also be staff members of one or the other of the parent agencies.

(b) The Deputy Director and the remaining staff of the Joint Division will perform their work under the direction of the Director and will be responsible, through him, in accordance with normal channels, jointly to the executive heads of both agencies. For the purpose of preserving and protecting his rights and status as an international civil servant, each member of the staff of the Joint Division will retain his employment status in and accrued rights with the parent agency.

(c) The Joint Division will be located in Vienna and the IAEA will provide office accommodation, supplies and other office facilities, and general operation services.

(d) The Deputy Director General for Administration of IAEA and the Assistant Director General (Administration and Finance) of FAO will arrange jointly for other necessary administrative, fiscal and house-keeping operations to ensure proper and effective servicing.

(e) The policies to be followed by the Division will be worked out jointly and mutually agreed by the two agencies.

(f) In carrying out the mutually agreed policies, the Joint Division will be established within the Department of Research and Isotopes of IAEA, and the activities of the Division will be reported on by the Director to both agencies: in the case of FAO through the Assistant Director General (Technical Department) and in the case of IAEA through the Deputy Director General of Research and Isotopes.

(g) The Joint Division will maintain direct contacts with other technical divisions in IAEA and FAO.

3. Technical Fields of Responsibility

The work of the Joint Division will pertain to the impact of atomic energy and the application of isotopes and radiation in the following technical fields:*

(a) Soil science (including soil chemistry, soil physics, soil microbiology, soil water and soil fertility);

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* This list is not exhaustive and may be revised from time to time through mutual agreement.

** Refers to fisheries projects in general and not to administration and operation of the Monaco Laboratory.

(b) Water used for irrigation;
(c) Plant and animal production (including nutrition and physiology, breeding, protection and entomology);
(d) Fisheries;
(e) Forestry;
(f) Food preservation and processing (including disinfection);
(g) Radiation protection in food and agriculture, without prejudice to the responsibilities of the Division of Health, Safety and Waste Disposal of the IAEA.

4. Programme and Finance

(a) The two agencies will operate a single integrated programme of work in the field of atomic energy in food and agriculture in terms of the Basic Principles. The programme will be drawn up in consultation between the two agencies, taking into account the general policies and principles governing the overall programme of each agency at the time that the Joint Division's programme is drawn up. Taking into account the different budgetary and programming period of each agency, the agreed programme will be submitted for approval to the competent organs of the appropriate agency in accordance with the established practice of that agency.

Procedures for reaching agreement on the content of the programme and for consultations regarding its presentation, as well as any subsequent adjustments needed in the approved programme, will be mutually developed by the two agencies.

(b) The integrated programme of work will be financed from the following sources:
- (i) The assessed budgets voted by the competent organs of both agencies;
- (ii) The General Fund, financed by voluntary contributions of the IAEA;
- (iii) Activities and projects assigned by the United Nations Development Programme to either agency;
- (iv) Trust funds and other relevant outside sources of support of work in this field.

(c) The Directors General of both agencies agree that they shall recommend to the respective competent bodies of each agency that the costs shall be borne equally by each agency for any future programme expansions, over and above the 1966 approved budgetary level, being approved for the Joint Division, which are to be funded under the assessed budgets voted by the competent organs of both agencies, as distinct from expansions under other possible sources of funds.

5. Field and Technical Co-operation Activities

Pursuant to paragraph 1(c) each agency will ensure that the Joint Division is effectively associated in the planning, programming and execution of all technical co-operation activities for which the Division has scientific and technical responsibility, including such activities financed from the assessed budgets and regular technical assistance programmes of both agencies, projects carried out by either agency on behalf of the United Nations Development Programme, and to this end:
- (i) This Joint Division will be apprised at the early planning stage of all projects of either agency in which there may be a potential application of atomic energy in food or agriculture. Appropriate procedures for this purpose will be

established between the Division and the concerned offices in both agencies;

(ii) The Joint Division will be represented on any bodies of the secretariat of either agency responsible for the planning, programming and execution of technical co-operation activities;

(iii) The Joint Division will associated to an appropriate extent with respect to its terms of reference, with missions of either agency which are sent out to identify or follow up technical co-operation projects.

(iv) The FAO regional and county offices and field experts, and IAEA regional officers and field experts will assist the Joint Division in the same manner as they assist other Divisions of their respective agencies.

6. Applicability

These arrangements will come into force with retroactive effect in part from 1 October 1964 and in full from 1 January 1966, upon the conclusion of an exchange of letters between the Directors General of the two agencies. The current and future arrangements for and operations of the Joint Division are subject to a further review by the two executive heads before 31 December 1967, and to additional reviews whenever either agency so requests.

Vienna
8 November 1966

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ABBREVIATIONS

ABBREVIATIONS

AA	Administrative Assistant
ADG	Assistant Director General
AFRA	African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology.
AGE	Joint FAO/IAEA Division (used in FAO)
AGM	Advisory Group Meeting
APHIS	Animal and Plant Health Inspection Services (of USDA)
APO	Associate Professional Officer
ARCAL	Regional Cooperative Arrangements for the Promotion of Nuclear Science and Technology in Latin America
BARC	Bangladesh Agricultural Research Council
BARC	Bhaba Atomic Research Centre, Trombay, Bombay, (India)
BATAN	National Atomic Energy Agency, (Indonesia)
BICOT	Biological Control of the Tsetse Fly by SIT, (Nigeria)
BINA	Bangladesh Institute of Nuclear Agriculture
CAIR	Centre for the Application of Isotopes and Radiation, (Indonesia)
CEC	Commission of the European Communities
CENA	Centre for Nuclear Energy in Agriculture, (Brazil)
CINAGRI	Centre for Nuclear Agricultural Investigations, (Venezuela)
CNEN	National Atomic Energy Commission, (Brazil)
COAG	Committee on Agriculture, (FAO)
CRP	Coordinated Research Programme
DANIDA	Danish International Development Authority
DDG	Deputy Director General
DG	Director General
ECOSOC	United Nations Economic and Social Council
EEC	European Economic Community
EU	European Union

ELISA	Enzyme-Linked Immunosorbent Assay
EMBRAPA	the Brazilian Agricultural Research Council
ENEA	European Nuclear Energy Agency, (OEEC)
EPA	Environmental Protection Agency, (USA)
EPTA	United Nations Expanded Programme of Technical Assistance
ESNA	European Society of Nuclear Techniques in Agriculture
FAO	Food and Agriculture Organization of the United Nations
FIPCOS	Food Irradiation Process Control School
FIPMEE	Regional CRP on Food Irradiation in Middle East and Europe
GATT	General Agreement on Tariffs and Trade
GSF	Gesellschaft für Strahlen- und Umweltforschung, (FRG)
IAEA	International Atomic Energy Agency
IANEC	Inter-American Nuclear Energy Commission of OAS
IARI	Indian Agricultural Research Institute, (New Delhi)
ICAR	Joint Commission on Applied Radioactivity
ICGFI	International Consultative Group on Food Irradiation
ICRP	International Committee for Radiological Protection
ICRU	International Commission on Radiological Units and Measurements
IFFIT	International Facility for Food Irradiation Technology, (the Netherlands)
IFIP	International Project in the Field of Food Irradiation
ILRAD	International Laboratory for Research on Animal Diseases, (Kenya)
ILO	International Labour Organization
INA	Institute of Nuclear Agriculture, (Bangladesh)
INPA	National Institute for Research in the Amazonas, (Brazil)
IOCU	International Organization for Consumers Unions
ISNA	Indian Society of Nuclear Techniques in Agriculture
ISSS	International Soil Science Society
IUPAC	International Union of Pure and Applied Chemistry

IVRI	Indian Veterinary Research Institute, (Izatnagar)
JECFI	Joint FAO/IAEA/WHO Expert Committee on Food Irradiation
JPO	Junior Professional Officer
KAERI	Korean Advanced Energy Research Institute
MAGHREBMED	A North African Technical Assistance Project to eradicate the Medfly by SIT
MEDFLY	Mediterranean Fruit Fly
MISR-MED	A Large-Scale Technical Assistance Project to Eradicate the Medfly from the Nile Valley, (Egypt)
MOSCAMED	Mediterranean Fruit Fly (Mosca de Mediteranea) Eradication Programme, (Peru)
NAFTA	North American Free Trade Agreement
NDRI	National Dairy Research Institute, Karnal, (India)
NRL	Nuclear Research Laboratory, at IARI, (India)
OAEP	Office of Atomic Energy for Peace, (Thailand)
OAS	Organization of American States
OECD	Organization for Economic Cooperation and Development
OEEC	Organization for European Economic Cooperation
PPAB	Programme and Policy Advisory Board, (FAO)
RCA	Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology in Asia and the Pacific
RCM	Research Coordination Meeting
RIA	Radio Immuno Assay
RIFA	Joint FAO/IAEA DIvision, (used in IAEA)
RPFI	CRP on Food Irradiation within the RCA
SABRAO	Society for the Advancement of Breeding Research in Asia and Oceania
SAC	Scientific Advisory Committee, (IAEA)
SAREC	Swedish Agency for Research Cooperation with Developing Countries
SIDA	Swedish International Development Authority
SIT	Sterile Insect Technique
SNIF	Standard Neutron Irradiation Facility

TACF	Technical Assistance and Cooperation Fund, (IAEA)
TCDC	Technical Cooperation Among Developing Countries
TECDOC	IAEA unpriced publications
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNDP/SF	United Nations Development Programme/Special Fund Component
UNEP	United Nations Environmental Programme
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
USDA	United States Department of Agriculture
USP	University of São Paulo, (Brazil)
VIC	Vienna International Centre
WARDA	West African Rice Development Association
WHO	World Health Organization