helping to expand scientific knowledge

Nuclear research has spread rapidly across practically all of the established sciences. It has been a dynamic and creative process in which the Agency has been able to play a constructive role. One of the methods has been the programme of research contracts. This has provided financial support for research involving some form of nuclear technology to physicists, chemists, medical doctors, hydrologists, entomologists, geneticists and scientists in many other disciplines. It is a system almost unique within the United Nations family, though the World Health Organization (WHO) also supports medical research under contract. An examination of the programme and its catalysing and co-ordinating effects in the expansion of scientific knowledge is made here by Clarence O'Neal, of the Division of Research and Laboratories.

Research Contracts

The Agency's statutory mandate "to encourage and assist research on, and the development and practical application of, atomic energy for peaceful uses throughout the world" was taken seriously; several contracts for research were awarded as early as 1959 and the programme became firmly established in its present form by the mid-1960's. In the same way as other research-support programmes, it has been designed to stimulate additions to scientific knowledge in selected fields of interest. Of particular importance also is the fact that the research subjects are highly oriented towards the special problems of the developing countries as well as the fact that the Agency, because of its international character, can effectively assist in the co-ordination of research between institutes located in different countries.

It is also the policy of the Agency to support projects at institutes located in the developing countries wherever such institutes are capable of carrying out research of high quality. As a result, nearly threequarters of research contract funds are awarded to institutes in these countries. The programme often serves as a stimulus to nuclear research there. Fig. 1 indicates the distribution of research contract funds in 1968 between developing and advanced countries for the three major categories of research supported.

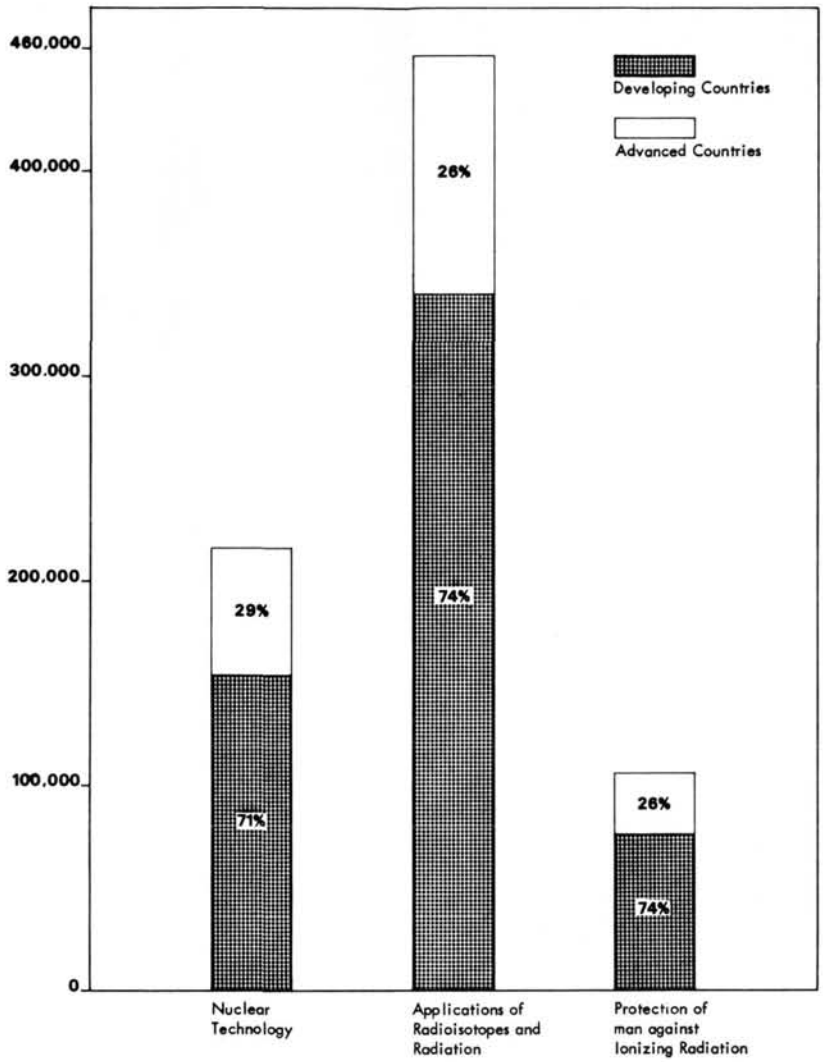


Fig. 1
Major categories of Research Contracts, 1968 (Values in U.S. Dolars)

Research Subjects

The budget for the programme is modest, amounting only to some $ 800 000 for the current year. With this amount a limited number of projects are supported in nuclear science and technology, isotope applications, and research on the effects of ionizing radiation on man and his environment. These topics represent both statutory responsibilities, such as research on the protection of workers and the public from harmful effects of ionizing radiation, and other programmatic interests. Programme plans are developed internally by the Agency's staff aided by consultants who are experts in their particular subjects, revised as necessary, and are reviewed annually by the Agency's Scientific Advisory Committee before being approved by the Board of Governors and the General Conference. A more complete listing of the subjects in which research was supported in 1968, in relation to the proportion of funds spent for each subject, is shown in Fig. 2. Nearly sixty per cent of the total budget was awarded for research involving isotope tracer

technology - the use of radioactive materials linked with other elements or compounds to carry out research by tracing what happens to them. A quarter was spent on projects in nuclear technology, and the balance on studies involving primarily the effects of radiation on living material.

From the earlier emphasis on a number of small reactor engineering and waste management studies, research supported in nuclear technology now encompasses reactor engineering and safety, reactor studies relating to desalination and other applications, and reactor economics as well as a limited number of fission studies, work in the field of neutron physics and hot atom chemistry, and the use of natural materials in the treatment and disposal of radioactive wastes.

Fifty projects are distributed between institutes in 24 different countries. In keeping with the general philosophy of the programme, most of the work is pragmatic in nature with but a small portion devoted to more basic studies of supporting nature.

Easing the Costs

Research involving isotopes, which is the heaviest programme component, affects such activities as agriculture, food irradiation, industry, medicine, and water resources development. Tracer technology, particularly for agriculture, medicine, and the use of water is especially applicable to problems common to nearly all of the developing countries. Research institutes in these countries can therefore, with a minimum of expense, play a leading role in carrying out research of high potential benefit to their own citizens. Projects involving isotope technology are currently being supported at some 234 institutes in 58 different countries.

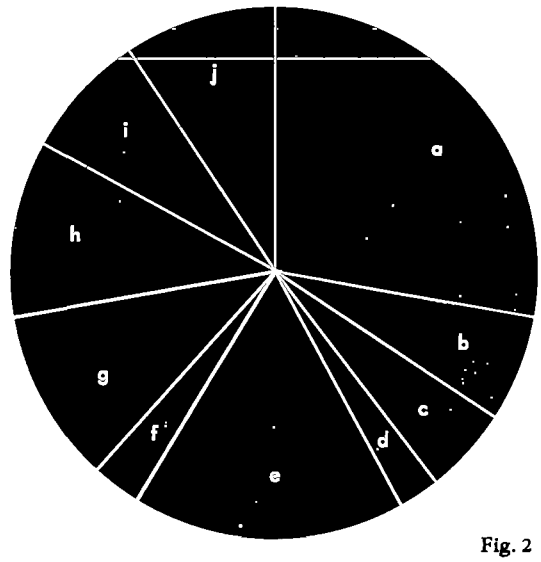


Fig. 2

Distribution of Research Contract Funds by subject.
a) Radioisotope and Radiation Applications - in agriculture 27.6%,
b) in food 6.5%, c) in water resources development 5.3%,
d) in industry 2.6%, e) in medicine 16.7%,
f) Protection of Man against Ionizing Radiation - health physics and radiation protection - 3.1%,
g) radiation biology 10.6%, h) Nuclear Technology - waste management 10,7%,
i) physics and chemistry 7.6%, j) nuclear power and reactors 9.3%.

In agriculture, studies have been expanded from a few plant metabolism and animal projects to several highly co-ordinated programmes involving plant breeding, fertilizer composition and placement in relation to important plant and tree food crops, plant nutrient supply and movement, water use efficiency, and the use of radiation to eliminate certain types of insects harmful to man and food crops. Research into food irradiation is concerned primarily with the most effective means of preservation by eliminating pathological microorganisms without, at the same time, significantly altering appearance, taste and wholesomeness. Work is concentrated at the present time on a limited number of citrus and tropical fruits.

After earlier emphasis on tropical medicine, during which time a number of the diseases common to the tropics were extensively studied, there is now more concentration on developing the isotope tracer techniques. They pertain to trace element and mineral metabolism in man, in vitro assay, communicable diseases and immunology, vectors and parasites of medical importance, and the measurement of radiation over the entire human body.

Research on water resources development represents another field where isotope technology has proven of value and studies are supported primarily on groundwater tracing, measurement of river flows, sedimentation, and the age and geological significance of important isotopes of carbon, oxygen and hydrogen (14-carbon, 18-oxygen and tritium).

Support of research on industrial applications of isotopes has been limited to those fields where industry has been slow to adopt such techniques and where particular benefits are likely to result for the developing countries. An example is the use of radiation to produce usable, hard building materials from chemically impregnated and irradiated soft materials such as bamboo or bagasse, or the testing under identical conditions of a variety of radiation detectors in order to determine which physical principles and engineering techniques are best suited for further development.

Research concerned with the effects of ionizing radiation on man and his environment also displays a number of different facets. Fundamental studies are supported in relation to factors determining radiation sensitivity and resistance in biological objects, in radiation genetics in order to understand the genetical basis of radiation sensitivity, and to the application of radiation for the sterilization of medical products and biological tissues. Studies of a practical nature are also assisted in relation to the development of procedures and equipment for the protection of persons; problems of measurement of radiation absorption by various organs and the whole body; and research methods of, and instruments for, monitoring radiation. Increasing attention is also being given to the problem of the movement of radioactive substances in the marine environment and their uptake by marine organisms. There are 82 projects concerned with these studies in 36 countries.

Administration Simplified

Administration is kept as simple as possible. A small office handles all arrangements in connection with development and implementation, including contract procedure. More importantly, the function of scientific review is placed in the hands of a single scientist through use of the Project Officer system. In each case a scientist, whose training and

experience qualify him for the task, is responsible for the technical guidance and evaluation of the project. In so doing, he obtains additional professional opinion, as required, and co-ordinates as well with other Agency programmes and, to the extent required, with similar activities of other international or national bodies. An interdepartmental reviewing committee, composed of scientists, meets every two month to assist the Director General in screening and selecting projects.

Proposals may be initiated either by the Agency, or by any research institute. In developing a contract, the Agency deals directly with the scientific institute and the Agency's Project Officer communicates directly with its Chief Scientific Investigator on all technical matters. This procedure not only eliminates possible confusion, but also enables projects to be developed and carried out rapidly. From the time of the first contact between an institute and the Agency, a project is often underway within the ensuing three or four months.

Each contract is awarded on a cost-sharing basis; the institute itself is expected to bear the major portion of the cost. The amount awarded is seldom large, averaging some $4 000 per contract year. In keeping with this philosophy, contracts are normally awarded for a period of one year and are renewable up to a total project period of three years. The Agency's contribution thus takes the form of "seed money" designed to initiate worthwhile projects which, if successful, are expected then to be carried forward by the institute.

Although a contract is signed on behalf of a particular institute, each is entered into on the clear understanding that a specific individual - who is named in the document - will serve as its Chief Scientific Investigator; should his services no longer be available, the contract is then re-assessed and its continuation depends upon the availability of a qualified replacement. The primary emphasis is thus placed on the skill and competence of the individual who will guide the work on the project.

Unrestricted Information

It is also an important condition that no restriction whatsoever may be placed on any of the information developed under contract and the research findings must be made freely available throughout the world. Towards this end, publication of results obtained is strongly encouraged. A report of progress is required each six months and a final, comprehensive technical report at the end of the period of the project. Each payment beyond the first is made contingent upon the receipt and approval of a report, and renewal of contract is in each case subject to a thorough review of progress to date. The Agency also publishes a yearly review of final reports for distribution to the Atomic Energy Commissions of all Member States.

As many of the contracts are awarded to institutes located in the developing countries, the Agency is also prepared to arrange the purchase and shipment of any items of equipment or expendable supplies required under contract. By acting on behalf of the contractor, the Agency can avoid unnecessary delays in the importation of vitally necessary items which might arise from import or currency restrictions.

Although the programme is not large - some 350 contracts and agreements are active at the present time - the demand for various compilations of information relating to the programme are often extensive.

For this reason, as well as for simplified administrative control, all records concerning project proposals, contracts and agreements are kept on the Agency's IBM 360 computer.

Research Agreements

An important and unusual feature is that a sizeable number of projects are supported by means of a Research Agreement, under which no financial remuneration is provided. In return for carrying out a project and providing an annual technical report, the institute receives formal acknowledgement of the work by the Agency and participates in the exchange of information between all other institutes participating in the programme. Except for the fact that the reporting requirements are somewhat less stringent, research agreements are evaluated, awarded and reviewed in the same manner as research contracts.

For the most part, such agreements are only awarded in relation to a highly co-ordinated programme, under which a number of institutes collaborate in research based on a central, well-defined research topic. Co-ordinating meetings are also normally held periodically, to which each Chief Scientific Investigator is invited at Agency expense, to review progress and discuss future activities. Under some programmes a mixed group of contractors and agreement holders engage in a collaborative research effort. This enables arrangements to be made for part of the research expenditure to be reimbursed to those unable to pay.

Although no funds are provided (except, perhaps, for the Chief Investigator to attend a co-ordinating meeting) the opportunity to participate in a co-ordinated programme and, in some cases, the prestige of Agency sponsorship, has been sufficient to induce a number of institutes to participate. Following their introduction some three years ago, there are now some 110 research agreements in force at institutes in 30 different Member States.

Evaluation

This hacienda on the El Azaraque estate in Spain is the Headquarters of an additional experiment to demonstrate the sterile male method of of controlling the Mediterranean fruit fly. The research is being carried out under a cost-free research contract.

However laudable may be the aims of a programme of research support, the question must ultimately be raised as to its true value. This is not a simple question to answer in view of the divergent nature of the various fields involved and the often multiple goals. Basic science may contribute towards the extension of the scientific horizon, but it is harder to see how it concerns the more practical and immediate requirements of society. Where the application of well-understood technology is aimed at specific problems under varying environmental conditions the economic or social relationship is more apparent, though it is not so certain that the scientific disciplines represented have been equally affected.

Nevertheless several statements of a general nature may be made, indicative of the considerable impact of the programme. As a first, rough measure of productivity, it can be noted that to date the Agency has been informed of the publication of more than 1100 articles, in reputable scientific journals, which report on work carried out under contract. This compares with some 750 contracts and agreements awarded to date, and in considerable measure reflects a careful selection procedure and a high standard of evaluation.

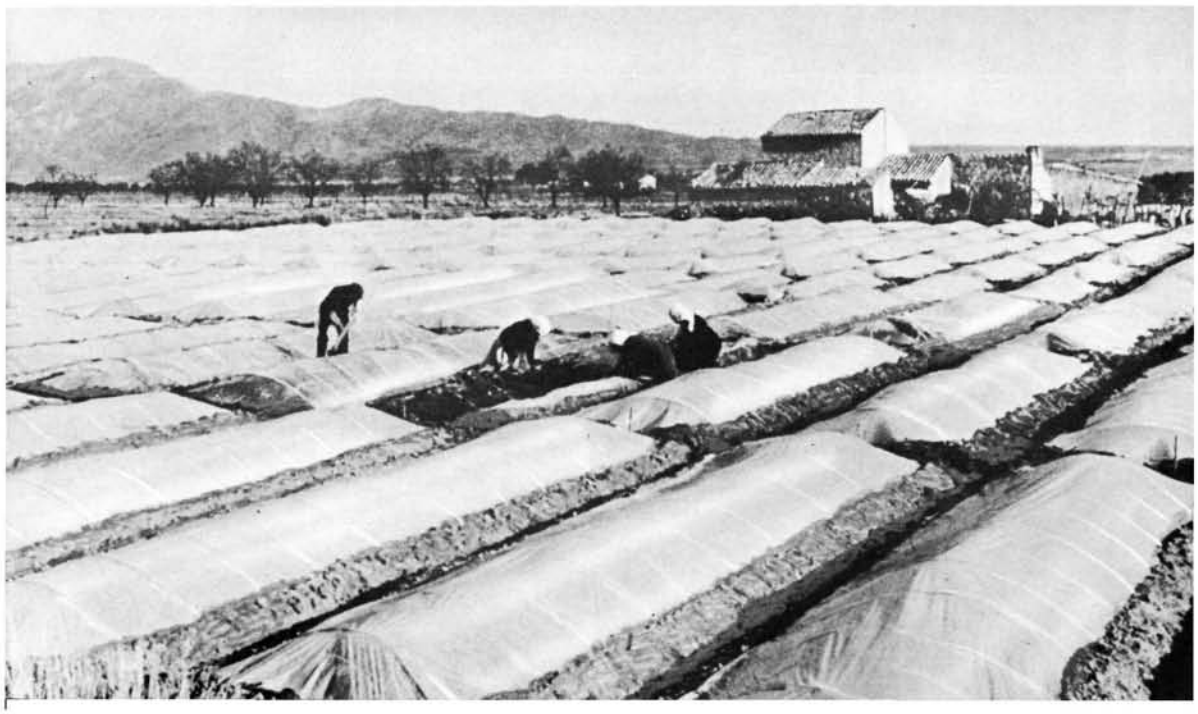
Secondly, it is obvious that Agency awards, because of their costsharing nature, have a total impact considerably in excess of the actual amount awarded. It is also no exaggeration to say that, in some developing countries, such awards can mean the difference between the presence or absence of a particular type of research, as it is only through the prestige of Agency support that local funds are made available for research. In a number of cases, also, support is provided for young scientists not yet fully established at home, and this provides an excellent means of reducing the so-called "brain drain".

Another very important aspect, which is impossible to quantify, is the fact that researchers in different countries are brought into contact with one another. The value of this contact, whether it be between scientists in developing countries who are thus made aware of their colleagues' handling of similar problems, or between a laboratory in a developing country and one in an advanced country, cannot be overestimated. It has proved to be one of the most powerful factors in stimulating research efforts. The role of the Agency as co-ordinator and catalyst is thus most important as it cuts through existing political, geographic, and language barriers.

In a great number of cases institutes have been able to obtain quickly through the Agency the equipment or supplies needed. This is another factor of often critical importance in countries which impose stringent exchange or import controls, irrespective of the geographical location or state of development of the country concerned. Without such assistance a number of projects would simply not have been carried out.

Finally, it is also true that several "breakthroughs" have been made, such as through the development of a new high-yield strain of rice under one of the agriculture programmes, or the successful efforts on the part of the Agency to develop new uses for — and thus lower the price of — Ca-47, an isotope of calcium, for medical purposes. Such advances are not considered to be a major criterion for evaluation, however.

While it appears evident that a number of benefits have been derived, allocation of financial resources, both as between subject headings and



different geographic areas may still be questioned. Inasmuch as demand for funds under nearly all subject headings appears to be potentially limitless, it is difficult to arrive at a "natural balance" between them. Nevertheless the distribution shown in Fig. 2 has been developed out of considerable experience and appears to represent a reasonable mixture and weighting of subjects in relation to the Agency's own capacities.

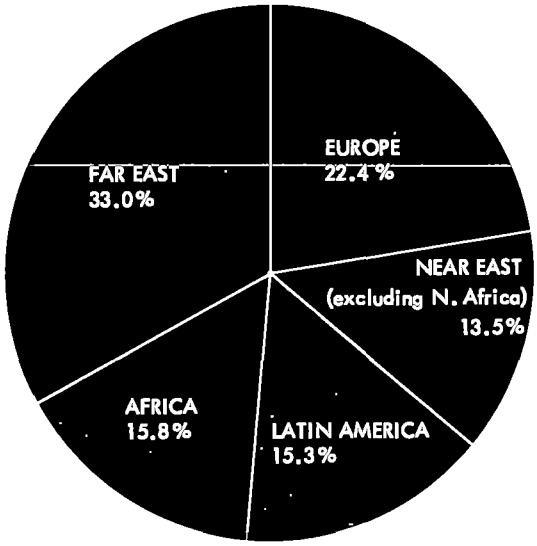


Fig. 3
Geographical Distribution of Research Contract Funds to Institutes in Developing countries, 1968.

The question of geographic distribution is perhaps equally as subtle in that the potential demand for funds also greatly exceeds the supply in nearly all geographic areas. Owing to the particular competence of a certain number of countries in soliciting research funds and employing them effectively, moreover, a sizeable portion of research contract funds have been awarded through the years to a rather limited number of countries. In recognition of this an effort has been made to limit awards to institutes in these countries if the work can be performed equally as well at an institute located in a country that has not been so liberally treated. This has resulted in a somewhat broader geographic distribution which has made possible a somewhat stronger subsidization of research in areas where such stimulation is definitely warranted. The distribution of funds in 1968 between the major regions of the world is shown in Fig. 3.

The money spent up to now on the programme has amounted to more than seven million dollars, a sum including money generously provided by the U.S. Atomic Energy Commission under an agreement with the Agency for joint funding of research. Taking into account all the factors which have been mentioned, it seems clear that this expenditure has been well worth while. Accepting this to be true, it is also evident that the Agency must continue to fulfil its role of catalyst and co-ordinator in the expansion of man's scientific knowledge through the use of nuclear techniques.