Relation to Population Growth

Under no circumstances should we consider that we have infinite capacity to increase either our total food or our protein supplies. All this makes sense only in view of concomitant strenuous efforts to control population growth so that eventually we may conceive of bringing food and population in balance.

Summary

Adequate protein nutrition is possible at lower cost without the undermining of man's satisfaction with his food. This potential requires the upgrading of the proteins of cereals by supplementation with amino acids and the development of new protein foods from low-cost sources such as the oilseeds; infant malnutrition can be eliminated by such means. The more sophisticated new foods such as protein beverages and textured products are proving acceptable to man and will supplement meager supplies of animal protein.

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The Promise of the International Atomic Energy Agency

Glenn T. Seaborg

Earlier than most men, scientists recognized that the successful occupancy of this tiny planet by man could best—or perhaps only—be accomplished through international cooperation. Indeed, I suspect that many scientists are inclined to believe that the very existence of the term "international cooperation" implies an artificial and unfortunate separation into arbitrary components of what is obviously a single, interdependent physical and biological system. Yet that separation exists, and it is to the credit of science and scientists that they have found ways to minimize its impact in their own affairs. Important as international scientific cooperation is in its own right, perhaps its most profound current significance is that it is showing the way increasingly to cooperation between nations in matters which can affect the well-being and even the life and death of millions of human beings. By the example of institutions such as the International Theoretical Physics Conference, by the active participation of scientists in the affairs of government, and in many other ways, scientific internationalism is transforming relationships between countries. It is doing this far more quickly and more profoundly than most of us, even those close to the scene, realize. We can only hope that it is working this transformation quickly enough.

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Formation of IAEA

What I have in mind is perhaps nowhere better illustrated than by the International Atomic Energy Agency. I believe its accomplishments and its prospects for the future hold deep significance for progress in international institutions, both scientific and otherwise. The IAEA was born out of a realization that the promise and the problems of the peaceful uses of nuclear energy recognize no national boundaries. The United States' proposal to create this agency in 1953 marked the turning point in the postwar evolution of nuclear energy from its preoccupation with military uses to an emphasis on peaceful uses open to all. In little more than 3 years, not an extended time for the formation of an international organization, the agency was established. It was established at a time when achieving international agreement in even the most minor matters was far more difficult than it is today. I believe it is possible to say that the creation of the agency was one of the early and significant demonstrations that a widely favored international objective can be achieved even in a climate of controversy between the major powers.

Today, the IAEA has achieved the status of a healthy youngster in the family of international organizations. It is 10 years old, with 97 members, and

still growing. With its professional staff of 300, it is participating—often taking the initiative—in a broad spectrum of international cooperation in peaceful uses of nuclear energy. In addition to these statistics, I would like to review its programs and some of the possibilities that I see for the agency in the future.

Like the Atomic Energy Commission of the United States and of a number of other of its members, the IAEA has two broad lines of activity. On the one hand, it actively promotes the peaceful uses of nuclear energy among its members. At the same time, it does all in its power to see that these applications are carried on without risk to world peace or to health. In all of its activities, the agency makes a special effort to meet the needs of its lesser developed members in the peaceful uses of nuclear energy, but it also provides services of great importance to even its most advanced members.

IAEA Programs

If we examine each of the major peaceful applications of nuclear energy, we find the agency actively at work helping its members to learn, evaluate, and take advantage of the benefits to be gained. Perhaps this is a good point for saying a word about the role of nuclear science and nuclear research centers in lesser developed nations. There are some who say that such nations are not ready for advanced scientific work or that they could use the required funds in a more productive way. On the basis of my observations in many developing countries, I cannot agree with this. I have found that nuclear research facilities are often the focal point of an entire country's best scientific activities. They provide a powerful influence for good, not only by advancing the scientific status of the country, but also by building a broad scientific base and by acting as a powerful force for the retention of scientists in their native lands.

In the field of nuclear power, the agency has for a number of years been the principal sponsor of the exchange of information on an international basis. Since 1959, 20 conferences and symposia on various fields of reactor science and technology have been held under agency auspices, not including the 1964 Third Geneva Conference on the Peaceful Uses of Atomic Energy, for which the IAEA had responsibility for technical organization. This year the agency's conferences on reactor topics will have included containment and siting of nuclear power plants, neutron thermalization and reactor spectra, physics and related safety problems of fast reactors, international extrapolation and comparison of nuclear power costs, heavy-water reactors, and the use of plutonium as a reactor fuel. It is hardly necessary to point out that this list goes to the heart of many of the most active and pressing problems of reactor technology today. International scientists know that no price tag can be placed on the benefits gained from the timely exchange of scientific results and the stimulation of direct contact with fellow researchers which conferences such as these afford. The Secretary General of the United Nations has asked his Scientific Advisory Committee to advise him on the question of a possible Fourth Geneva Conference in 1969 or 1970. I personally feel that there would be considerable merit in holding such a conference, with the IAEA once again providing the technical leadership.

The agency's technical meetings are not limited to conferences and symposia held primarily for the exchange of information. The IAEA has made effective use of a tool which might be more extensively used by other international scientific organizations—panel meetings at which small groups of experts meet to discuss and prepare recommendations on how specific technical problems might be attacked. Recent or scheduled panel meetings in the reactor field cover topics such as lattice constants of mixed systems, long-term reactivity and burn-up predictions, and long-term reactivity control. The recommendations of these panels provide useful guidance to the agency and its members in scheduling future research work, and often avoid costly duplication of effort.

Desalting of Seawater

There is one area related to nuclear power in which the agency's efforts to encourage international exchange and understanding have been of paramount importance. This is the field of large-scale desalting of seawater. I know of no more exciting prospect for the future—a future which I believe is not distant—than that of nuclear reactors producing unprecedented amounts of energy for the production of electric power and the desalting of water in some of the earth's most arid regions. This is not a futuristic dream. A decision has already been made to proceed with the first such plant, one which will produce 1.8 million kilowatts of electric power and ultimately 150 million gallons of fresh water per day for the Los Angeles area.

Since 1963, the IAEA has served as the principal forum for the international exchange of information on the technology and requirements for large-scale nuclear desalting. Through eight meetings of its Panel on Nuclear Desalting, it has brought together and established invaluable continuing contacts between both the technical leaders and the policy officials from all parts of the world who are concerned with the life-and-death subject of water. But its activities in this field go far beyond this exchange. Right now, a tripartite study under IAEA sponsorship and chairmanship is being made of the technical and economic feasibility of a large-scale dual-purpose nuclear power and desalting plant to serve the arid regions of Mexico and the United States surrounding the Gulf of California. This plant, which might produce as much as 1 billion gallons of water per day, could be the largest international project in history and could point the way to closer international cooperation in many fields.

We may find nuclear desalting playing a vital role in promoting international cooperation and the solution of international disputes earlier than many had thought likely. On 19 June, President Johnson, speaking on the Middle East, said: "We here will do our share, and do more, to see that the peaceful promise of nuclear energy is applied to the critical problem of desalting water and helping to make the deserts bloom." Other U.S. leaders have expressed their support for this solution of some of the obstinate problems of the Middle East. If this concept is to be implemented, the IAEA will undoubtedly play an important role.

The participation of the agency in the current study of nuclear desalting for the Gulf of California, as well as in earlier desalting surveys or studies in Israel, Chile, the United Arab Republic, and Peru, illustrates a vital role of the

IAEA in the field of nuclear power. Many nations considering the possible application of nuclear power in their economies find it invaluable to have the objective advice and assistance of an international organization of which they are themselves members and which has nothing to sell. The agency has undertaken nuclear power studies or surveys in more than ten countries including Peru, Korea, Turkey, Thailand, the Philippines, Finland, Tunisia, Chile, Pakistan, and El Salvador. Last year in cooperation with the United Nations Special Fund, it completed a detailed preinvestment feasibility study of nuclear power for Luzon in the Philippines. The agency's studies have been characterized by an informed and objective approach, which ensures that they will be of genuine value not only to the country concerned but also to international financial institutions and other interested countries.

These agency studies of nuclear power feasibility are paralleled by other services to countries undertaking reactor construction, such as assistance in evaluation of both proposals and the safety problems of proposed reactors. I believe it is hard to overestimate the importance of having services of this type available for nations whose size or current stage of development makes it impractical for them to maintain their own capability in these fields, or who feel the need for objective and expert independent advice.

In the field of reactors the agency's activities are not confined to nuclear power and desalting. In small but significant ways the agency is helping to advance reactor technology through the direct support of research on a regional or international basis. For example, it is making a valuable contribution to the collection of reactor-physics constants through its sponsorship of the NORA project, a cooperative undertaking in Norway to develop the fundamental parameters of light- and heavy-water reactor lattices.

Radioisotopes and Radiation

In another field that has already achieved greater practical impact, the applications of radioisotopes and radiation, the agency also has a strong program. These versatile tools are used extensively in research, industry, agriculture, and medicine for a multitude of very valuable purposes. Many of the agency's programs involving radioisotopes and radiation are devoted directly or indirectly to increasing man's food supply, and no more critical need than this exists in the world today. Such projects as determining the most efficient use of fertilizers and irrigation water, eradicating insects such as the Mediterranean fruit fly by radiation sterilization, and breeding improved plant varieties through radiation are already yielding practical results, and rapid progress is being made toward much greater and wider application. Much of the agency's work in the field of agricultural applications of radioisotopes is conducted through an office operated jointly with the Food and Agriculture Organization, another member of the United Nations' family. This cooperative endeavor between the two international organizations is in itself a valuable demonstration of effective international administration.

In a more indirect way, the IAEA is contributing to the alleviation of hunger through its hydrological studies, for, in much of the world, water is often the missing vital ingredient for agricultural productivity. Measurement of tritium and other isotopes in naturally occurring water constitutes one of the most powerful tools ever devised for the understanding and measurement of the water cycle. For more than 6 years the agency has supported, jointly with the World Meteorological Association, a worldwide program of isotope-concentration measurements in rainfall, which provides basic input data for the extensive studies of water movement now going on as part of the International Hydrological Decade.

The agency has supported studies of groundwater movement, employing isotope concentrations in river basins in Austria and Czechoslovakia and in springs and lakes in Turkey and Kenya. It has also supported studies of snow hydrology in Czechoslovakia. Much of the experimental and analytical support for these projects is undertaken in the agency's own laboratory at Seibersdorf, near Vienna, an institution of growing importance and service to the agency's membership.

Medical Research and Services

The agency's program in the medical uses of radioisotopes reflects the increasingly vital contribution which these substances are making to modern medical research and practice. In the past 6 years, as part of its technical assistance program the IAEA has provided experts and consultants to 37 countries concerned with the medical applications of nuclear energy, conducted 12 training courses in the applications of radioisotopes, and provided $300,000 worth of equipment for use in this field. Its work in the field of standardization has been significant in such projects as the international calibration of measurements of uptake of thyroid radioiodine. Also it has been active in the field of the sensitivity of biological material to radiation, one of the most important areas of radiobiological research. This field is directly related to fascinating developments in use of radiation to facilitate the transplantation of organs between genetically dissimilar people by suppression of the immune reaction. Radiation is already being used to suppress the immune reaction in kidney transplants, and this application may be extended to the transplantation of other organs. Various aspects of this subject will be treated in the agency's panel and conference program this year and next.

One of the most important of the IAEA services to its members in the field of medical applications is that of providing adequate numbers of trained personnel. A training program, which includes fellowships, regional training courses, and advanced research assignments, is responsible for a major proportion of the qualified personnel working in the field of nuclear medicine in the developing countries.

As I have observed firsthand in my own visits to a number of these countries, medicine and related biological sciences are normally the first scientific pursuits undertaken in a developing country. Thus, aside from its obvious humanitarian importance, medicine plays a major role in the formation of a country's scientific structure. The large role being assumed by nuclear medicine in developing nations, with the assistance of the IAEA, is helping to ensure that medicine constitutes a sound foundation for future scientific progress in these countries.

Basic Research Contributions

Understandably, much of the IAEA's scientific program is directed toward applied work, but the agency recognizes that basic and applied science are indi-

visible and that the sound development of its members requires effort in both areas. There is no better example of the IAEA's contribution to basic research than its International Center for Theoretical Physics at Trieste, Italy. Inspired and directed by Professor Salam, Trieste has quickly assumed a place among the foremost theoretical physics institutes in being today. More importantly, it has filled a gap in theoretical physics that perhaps could be filled only by an institution operated under the aegis of an international organization such as the IAEA. For the first time, it affords a place where the growing number of theoretical physicists from the less advanced countries can work as a matter of right, keeping abreast of developments in the mainstream of physics and profiting from the guidance and stimulation of their colleagues from more established centers.

The agency has many other activities in basic research, covering the whole range of its technical programs. It has actively assisted in ensuring the effective use of the research reactors located in several developing countries by conducting regional seminars in research reactor utilization, by providing expert advisers under its technical assistance program, and by research contracts. Its active programs include symposia, research contracts, and fellowships in such varied fields as the thermodynamics of nuclear materials, the effects of ionizing radiation on DNA, neutron diffraction studies, low-energy physics, and plasma physics, to name only a few.

Health and Safety Measures

In one field in particular, the agency's services are as directly valuable to its most advanced members as to its least developed ones. I refer to the critical problem of ensuring that nuclear energy activities do not endanger health or safety. By their very nature, these problems are international in scope. The consequences of a reactor incident or other potential release of radioactivity might well not be confined within the boundaries of the country in which it takes place. Efficient development of the peaceful uses of nuclear energy involves large-scale shipments of radioactive materials across national boundaries. The disposal or management of millions of curies of radioactive waste, some having a half-life of many years, is a problem of worldwide concern, not only to us but to future generations as well.

In most nations, the regulation of nuclear energy activities to ensure adequate health and safety precautions is a major governmental responsibility. The IAEA is in many respects fulfilling this function in relation to the international health and safety aspects of nuclear activities. Even though the agency lacks direct regulatory authority except in relation to its own projects, its advisory standards on radiation protection and transportation of radioactive materials have come into wide use and have helped to rationalize many international transfers of radioactive substances. The United States has adopted regulations very similar to the IAEA standards for the international shipment of several categories of radioactive materials, and is working to extend these regulations to additional categories within the next year or so.

Peaceful Uses of Nuclear Energy

The IAEA role in helping to ensure that peaceful nuclear activities do not endanger health and safety in the usual sense has a counterpart in another novel and indispensable program. This is its responsibility for ensuring that nuclear materials devoted to the peaceful uses of nuclear energy are not diverted to military purposes. No greater risk to public health and safety could occur, in the broad sense, than the unauthorized use of these materials for the development or production of nuclear explosives or other military purposes. The world's leaders are in agreement that one of the most urgent tasks facing us today is the conclusion of agreements—specifically a nonproliferation treaty—to avoid the acquisition of nuclear weapons by additional countries. The IAEA is already playing an important role in the accomplishment of this objective, and its responsibilities under a nonproliferation treaty could well be vastly increased. The agency's part in avoiding the further proliferation of nuclear weapons consists of the development and application of a system of safeguards, measures designed to detect the diversion of nuclear material to unauthorized uses. The development of these safeguards and their application by an international organization constitutes in itself an unprecedented step forward in international relations, a step which I believe has received far too little notice.

The agency's safeguards system includes actual on-site inspections by international civil servants, with broad powers of access and investigation, to detect any military use of nuclear materials committed to peaceful uses. Surely this constitutes a meaningful step toward the eventual world rule of law, which may someday ensure that international disputes are settled without recourse to hostilities between the parties.

Today IAEA safeguards are in effect in a growing number of activities for which a nation, voluntarily or in agreement with a supplier of nuclear assistance, has requested the agency to apply its safeguards. Agency safeguards are also applied whenever the agency itself has supplied nuclear material or other substantial assistance. Agency agreements involving the application of safeguards in 27 nations, covering more than 60 reactors, have been approved by the Board of Governors.

This is an impressive record, but a fundamental problem still persists. Even those nations which have requested the application of IAEA safeguards to some or all of their current nuclear programs remain free to undertake the development of nuclear explosives in the future if they desire.

Fortunately, most nations have recognized that their own self-interests are much better served by refraining from a costly program of development of nuclear weapons which could only serve to stimulate similar activities in other nations—with a consequent loss, rather than gain, in security for all. However, as long as there is no restraint on individual national action in this dangerous field, the decision of a few, or even of one more nation, to follow the path of independent capability in nuclear weapons could precipitate a widespread breakdown in the current consensus against proliferation of these instruments of mass destruction. I believe the ideal solution to this problem would be the widespread adoption of a treaty of nonproliferation, providing for effective international safeguards such as those I have described, which would be applied or verified by the IAEA. In this way, every nation can be assured that its neighbors, like itself, are not constructing nuclear explosives and that the peaceful nuclear programs of all can go forward without the risk that they will be turned to destructive ends.

This development, which I believe lies within our grasp, would surely place the IAEA in the forefront of institutions responsible for world peace and would constitute an impressive demonstration of the contribution which international scientific cooperation can make toward the maintenance of peace.

International Meeting Ground

A major accomplishment of the agency, which was foreseen by its founders as one of its principal purposes, is the function of serving as a constructive and cordial meeting ground of scientists and political leaders of East and West. On the basis of my own experience, the agency has been exceptionally successful and profoundly important in fulfilling this purpose. Its success cannot be measured simply in statistical terms by the numbers of meetings, conferences, and symposia attended by scientists from both East and West. Rather, its success must be viewed in terms of the quality of the contacts which have taken place and the relationships which have been established. I know of no other international organization in which there has been as much constructive cooperation between scientists of East and West, for such an extended period of time and on such a wide variety of topics, as in the IAEA.

I have personally valued the opportunities which my annual attendance at the General Conference of the IAEA has given me to meet and hold cordial discussions with my counterparts from many nations—both East and West. This experience is duplicated many times over in practically every conference and activity of the agency. Of equal if not greater importance are the lasting relationships which come out of these contacts. I am convinced that the strong scientific interchange between East and West in the peaceful uses of nuclear energy, which is so much in evidence today, would be much less intense were it not for the opportunity to meet and know each other which the agency has afforded to myself and my counterparts, our predecessors, and scientists in many different fields.

The IAEA represents, in an institutional sense, one of the most significant and promising developments in many years in international relations—the emergence of science and scientists as an important factor in the determination and execution of national policy. Scientists are by their very nature internationalists. They deal on a daily basis with laws and phenomena which are universal in their occurrence and application. They attack problems with a presumption that solutions are possible and that solutions will not be arbitrarily limited by political boundaries. Finally, they bring to the solution of problems the long history of scientific objectivity and rationalism that has served us so well in advancing the frontiers of knowledge. In short, there is an international language of science which, as a minimum, makes it possible for scientists to discuss with each other problems that often defy communications between people of other disciplines.

I do not suggest that science holds easy solutions to all or most of the profound problems which beset us. But I do suggest that through its capabilities for bettering the tragically inadequate conditions under which so much of the world's population lives today—through its methodology of problem-solving which has application to issues far beyond the normal realm of science and, perhaps above all, through the ability of scientists themselves to communicate with their fellow scientists of every nationality—science is one of the powerful forces that we can put to work to build a better world. The International Atomic Energy Agency is perhaps a test tube in which this hypothesis is being proved.

NEWS AND COMMENT

Money for Research: Prospects for Next Year Are Gloomy

Nikita Khrushchev probably spoke for all politicians who must deal with money-seeking scientists when some years ago he declared that scientists "always want more than they can get—they are never satisfied."

So, let us assume that dissatisfaction is the universal base line in science money matters, and then go on to register the following: Among the people in Washington who staff the fiscal and administrative command posts of research, next year's money prospects have caused dissatisfaction to be replaced by an unprecedented funereal gloom. Laboring in the innards of the federal budgetary process is, of course, not conducive to the development or retention of a sunny disposition. This is especially so in the science policy area, where the staff people, who frequently are talented and sought-after researchers or administrators, find themselves ground between insatiable professional colleagues and skeptical political bosses. To which must be added the cruel hours, the edibility gap in government cafeterias, and sleepless, 3 a.m. suspicions that, if their offices closed down forever, only the janitors might notice.

However, the principal source of gloom is the realization that, after several years of relatively tight financial rations, the national scientific enterprise now can at best look forward to still another year of the same, but is more probably moving from a phase of manageable scarcity into a period of disruptive privation. Relative to other segments of American society—let's face it—research is not, nor is it ever likely to be, badly off. Thus, if one is shedding tears for those who must tithe for the costs of the Vietnam war, the post-doc who lost a trip to a foreign conference might properly take a place behind the slum kid who had a Head Start program budgeted out from under him.

Nevertheless, taking the national research enterprise in terms of scientific and technical performance and potential, as well as the integral part it plays