

Contributions to Global Food Security by the
Joint Division of the Food and Agriculture Organization
and the International Atomic Energy Agency



ATOMS FOR FOOD

a global partnership



IAEA

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Vietnam's rice production is benefitting through the FAO/IAEA partnership.



PARTNERS TO THE END

The FAO/IAEA “Atoms for Food” Partnership

The International Atomic Energy Agency (IAEA) and Food and Agriculture Organization of the United Nations (FAO) have been partners for nearly half a century, contributing to efforts toward shared goals of food security. Their mission — through a Joint Division headquartered at the IAEA in Austria — is to help countries effectively use nuclear science and related technologies for food and agricultural development.

Millions of people today look to a better future because of the foresight and longstanding investment of FAO and IAEA Member States in the “Atoms for Food” partnership. Worldwide, more than 100 countries are working together through the Joint Division to increase their harvests, combat animal and plant diseases and pests, and protect the lands, water resources, and environments on which food and agricultural production depend.

This century’s stark realities of hunger, poverty, climate change, and environmental degradation bring an unprecedented scale of challenges to the fields of food and agriculture. Action requires the research, expertise, and experience of the FAO/IAEA partnership — and other effective alliances worldwide — to help countries achieve and sustain higher levels of food security for their people.

The two organizations are well matched. FAO brings to the table its comprehensive knowledge and networks on food and agriculture. The IAEA, in turn, contributes technical know-how, specifically in agricultural and related applications of nuclear science and technology. The partnership’s potential builds on decades of experience.



“We are partners to the end,” emphasizes IAEA Director General Mohamed ElBaradei. “Much more investment is needed in food and agriculture. We’re committed to helping countries apply nuclear science and technology in ways that can help end hunger and achieve goals of food security.”

For a full report on the work and achievements of the FAO/IAEA Partnership, see “Contribution by the Joint FAO/IAEA Division to Food and Agriculture”, a report to the IAEA General Conference, September 2008, accessible on the IAEA web site at www.iaea.org. IAEA Member States at the General Conference strongly backed the work of the Joint Division in a resolution adopted 4 October 2008.

Countries in Latin America have realized economic benefits through the “Atoms for Food” partnership.

TIMELY ACTION

The Urgency of Global Food Security

FOOD SUPPLIES ARE INCREASING. But the world is headed toward what experts see as an unprecedented crisis of food security. How can this be?

In 1960, the world’s population stood at around 3 billion people. Average per capita food consumption was 2400 kcal a day. In developing countries, the average was 2050 kcal a day, and the proportion of undernourished people was 37%.

Today, more than 6 billion people live in the world. Cereal yields have doubled, meat production has quadrupled and milk output has tripled. The average person is much better fed (per capita food consumption is 2800 kcal/day; 2650 kcal/day in developing countries). People live longer and healthier than ever before. The proportion of undernourished people in developing countries has fallen to 17%.

What stands behind such achievements?

The main factors behind increased food variety and supply are:

- **Improved agricultural productivity.** It has come through new and better technologies and management practices.
- **Higher incomes.** They have boosted demand, especially for high value commodities.
- **Growth of trade and transport links.** They have helped bring food to where it is needed.

Yet millions of men, women and children do not have adequate food supplies.

More than 850 million people in developing countries are still undernourished and 1.4 billion people live in abject poverty, on less than US\$1.25 a day, according to the World Bank.



INVESTMENT IS NEEDED. Greater investment in agricultural technology and research will strengthen national infrastructures and competence, and help shape achievements toward goals of food security.

Action is urgently needed, and the way forward is known. Improving both the productivity and competitiveness of agriculture in developing countries must be at the heart of any strategy for hunger and poverty reduction. The Millennium Development Goals of the United Nations name the fight against hunger and poverty as the world's number one goal.

In April 2008, the Secretary General of the United Nations established a High Level Task Force on the Global Food Security Crisis. It produced a Comprehensive Framework for Action to deal with both urgent needs and sustainable longer-term food security. This was followed in June 2008 by a High-Level Conference on Food Security and the Challenges of Climate Change and Bio-energy convened by FAO.

Both the High-Level Conference and the Comprehensive Framework called for urgent action to boost food production to meet immediate needs and to complement this with significantly increased investments in agricultural technology, research and infrastructure.

SEVEN CHALLENGES FOR FOOD SECURITY

1

Feeding More People. The world's population is predicted to increase by another 3 billion people by 2050, surpassing 9 billion.

2

Conserving Lands and Water. Opportunities for expanding the land area for growing crops or keeping productive livestock are becoming increasingly limited. So are the possibilities for tapping renewable fresh water resources. Widespread land degradation is causing further low and declining soil fertility.

3

Achieving Higher Yields and Productivity. Attempts to increase crop and livestock productivity in many developing countries is hampered by low and declining soil fertility caused by widespread land degradation. Additionally, harsh local conditions — such as drought, salinity, frost and flooding — underscore the need for expanding the availability of plant varieties that can be productively grown in such environments.

4

Protecting Animals and Crops. Animal and plant diseases — and pests that can ravage harvests — extract heavy tolls on productivity, trade and livelihoods. At the same time, the increased use of agrochemicals and numerous outbreaks of food-borne diseases raise concerns about both environmental and food safety.

5

Adapting to Climate Changes. The resilience of food production systems to climate change must be increased.

6

Balancing Food and Fuel Needs. The balance between crops grown for food and those used to produce biofuel requires better management.

7

Responding to Higher Costs. More attention is needed to deal with soaring prices of food and agricultural inputs which disproportionately affect the poor.

The FAO/IAEA partnership focuses on agricultural research and technology transfer to farmers.



ATOMS FOR FOOD AND AGRICULTURE. Applications of nuclear science and technology are essential components of work to improve crop and livestock production, and the quality and variety of foods.

When FAO and IAEA formed their Joint Division in 1964, nuclear applications in food and agriculture were in their infancy and restricted to industrialized countries. They involved the use of a few isotopes and X-rays in laboratories to conduct metabolic and genetic studies in plants, insects and animals.

Back then, applications of nuclear techniques in farmer fields and in developing countries in general were largely non-existent. Not so today.

Advances in technologies and methodologies have raised the bar enormously in terms of what can be achieved. Nuclear technologies today provide unique or substantial complementary value in addressing food security challenges.

As a result, the world's food and agricultural specialists have gained a vastly improved understanding of the processes that underpin the transformation of biophysical resources into food and the development of new and innovative technologies. Combined with modern biotechnologies, these have become essential in providing more efficient ways to improve food availability, accessibility and affordability.

The overall aim of the Joint FAO/IAEA Division is to help interested countries apply nuclear and related techniques that contribute to meeting the needs of their food and agricultural sectors. The techniques enable farmers, food processors and government agencies to provide people with more, better and safer food, while conserving soil and water resources and the biodiversity on which these products depend.

The work is underpinned by the determined pursuit of sound science, objectivity and balance, and the conviction that nuclear science, technology and research are key drivers of development. Nuclear applications are fostered only where they really add value (or have significant prospects of doing so), and have high applicability globally or regionally.

Nuclear techniques are proposed as adjuncts to — and not substitutes for — other techniques. They are most effective when used by people with knowledge in the relevant agricultural specialities. In some cases, nuclear applications provide the only solutions.

The focus is on coordination and support of research, practical application of techniques and exchanging scientific information. Research oriented towards sustainable development is supported through national and regional projects. A global scientific arm is the FAO/IAEA Agriculture and Biotechnology Laboratory in Seibersdorf, Austria, where research is conducted and scientists are trained.



Ghana's cocoa crops were protected from disease with the help of the FAO/IAEA partnership.

CONTRIBUTIONS TO FOOD SECURITY

Seeing Results of Development

LASTING IMPACTS. Through the FAO/IAEA partnership, countries have achieved important results — in farmlands, agricultural institutes, and research laboratories — contributing to food security.

Worldwide, the FAO/IAEA partnership has been instrumental in stimulating funding for and implementation of a number of initiatives having transnational impact for sustainable development and scientific research.

For example, isotopes and neutron moisture probes are part of almost all national research efforts to optimize plant fertilizer uptake, minimize soil erosion and water pollution and improve soil fertility and the efficient use of water for food production. Likewise, research supported through the partnership encourages plant breeding and genetics programmes to produce better varieties of food and industrial crops.

In animal production, the partnership's work transformed feed supplementation strategies for animals kept on low quality diets by small-holder farmers. The nuclear and nuclear-related serological platforms that FAO/IAEA experts helped to develop are now widely used by artificial insemination services for dairy farmers and by veterinary authorities to diagnose diseases and monitor the success of eradication or control efforts. Current advances in molecular technologies will follow suit.

Impacts of the FAO/IAEA partnership around the world include:

Greener farming methods. Huge savings in fertilizer applications are made possible by using isotopes. The tracer elements are used to more effectively determine optimal placement and timing of fertilizer use, or to determine how much nitrogen plants can capture from the atmosphere within a given cropping rotation. The economic benefit from fertilizer savings totals at least US \$6 billion per year.

Richer food harvests. Millions of hectares of crops that are higher yielding, more disease resistant and drought tolerant are grown all over the world from the use of mutation-assisted breeding. The economic benefit in terms of annual additional income to farmers totals billions of dollars per year.



Higher quality fruits and vegetables. Insect pests threatening high-value fruit and vegetable production are now being more widely controlled in more environmentally friendly ways. Areas free of fruit flies or with low pest prevalence have been established — in Mexico, Central America, Peru, Chile, the Patagonia and Mendoza Provinces of Argentina, the Arava Valley shared by Israel, Jordan and the Palestinian Authority, and the Hex River Valley in South Africa. Benefits of hundreds of millions of dollars per year are realized in terms of reduced production losses, increased exports and more jobs.

Healthier livestock. In North Africa, the screwworm fly attacking livestock in Libya was eradicated using the sterile insect technique (SIT), bringing estimated benefits of US \$280 million annually. Likewise, on the island of Zanzibar off Tanzania's coast, the removal of the tsetse fly increased the contribution of livestock up to 34% for the agricultural economy. The widespread use of immunoassay technology has provided the technological platform to monitor national vaccination programmes of the Pan African Rinderpest Eradication Campaign to save animals from the disease widely known as "cattle plague". The net annual economic benefit to the region is estimated at US \$920 million.

REALIZING RESULTS

10 FAR-REACHING ACHIEVEMENTS

The FAO/IAEA “Atoms for Food” partnership contributes to the world’s food and agriculture development in key ways.

Crop Production

- 1 Techniques using isotopes optimize the uptake of nutrients by plants.
- 2 Plant breeding methods using radiation produce varieties of crops that produce higher yields or that can thrive in harsh climates.

Agricultural Pest Control

- 3 Development and application of the sterile insect technique to suppress or eradicate major insect pests threatening crops and livestock. The technique especially targets pests that cause significant losses, affect international trade, or transmit human and animal diseases.
- 4 The sterile insect technique has proven especially effective against several fruit fly pests, including the Mediterranean fruit fly, various moth pests, and the tsetse and screwworm flies.

Animal Health and Productivity

- 5 Highly sensitive techniques have been developed that improve the efficiency of artificial insemination services provided to livestock keepers.
- 6 Other techniques identify diseases such as rinderpest, foot-and-mouth, brucellosis and Rift Valley fever that kill farm animals and can threaten the health of humans.

Environmental Protection

- 7 Techniques using isotopes minimize land degradation and water pollution, and improve soil fertility.
- 8 Applications using radionuclides advance understanding of factors causing soil erosion and identify cost-effective practices to reduce it.

Food Safety

- 9 Methods to understand and apply the optimal radiation doses for destroying bacteria, insects and other organisms that cause spoilage of food and human diseases.
- 10 Validated methods of sampling and analysis to determine and control radionuclide, pesticide, veterinary drug and mycotoxin contamination of foods.



SHARED EXPERTISE AND EXPERIENCE. The FAO/IAEA partnership helps countries develop the capacity to optimize the use of nuclear techniques for food and agricultural development.

30 countries are using methods for improved irrigation and crop production based on nuclear science. They are following the lead of Turkey, which has significantly boosted potato output through a system called drip irrigation-fertigation which involves adding water and fertilizer to the crop together. The system was developed through research using isotopes.

40 countries are using FAO/IAEA soil and water management guidelines to protect their farmlands. China successfully used nuclear tracer techniques to track soil movement, assess the extent of land degradation and soil erosion; and then implemented soil conservation measures to combat it. Similar success is reported by Chile, Morocco, Romania and Vietnam.

95 countries use isotopic and nuclear techniques to identify land and water management practices to improve nutrient and water use efficiency for crop productivity and environmental sustainability (up from 75 in 2000).

100 countries use radiation-based plant breeding techniques to improve food and industrial crops. They include Vietnam, which has developed better varieties of rice over the past 12 years. Three new rice varieties, known for both their high food quality and tolerance to salinity, have been released to farmers in the Mekong Delta. They have raised farmers' incomes by US \$350 million per year and one variety is among the country's top five export varieties. Worldwide, 2770 new varieties of crops have been officially developed and released by countries using mutation-assisted plant breeding techniques (up from 2250 in 2000).

64 countries use the carbon isotope discrimination technique to assess crop genotypes for tolerance to drought and salinity, and to evaluate the accumulation and storage of organic carbon in soils (up from 27 in 2000).

70 countries use disease diagnostic and monitoring tests developed or validated by the FAO/IAEA Joint Division to assist their animal disease prevention, control and eradication programmes. Diagnostic tests are in hand or under evaluation for contagious bovine pleuropneumonia, foot-and-mouth disease, avian influenza ("bird flu"), and Rift Valley fever through research supported by the Joint Division and subsequently approved for use by the World Organisation for Animal Health. In just one country for example, Botswana, the use of the pleuropneumonia test helped eliminate the disease in 2005 and protected beef exports to the European Union worth US \$90 million per year.

30 countries use the sterile insect technique against key insect pest species and are embarking on area-wide pest management approaches promulgated by the Joint Division (up from 15 in 2000). In 2008, Peru joined the list of successful countries, declaring the regions of Tacna and Moquegua free of Mediterranean and *Anastrepha* fruit flies. The achievement capped 20 years of effort by governments and institutions in Chile and Peru, the IAEA, FAO, the Inter-American Development Bank and others. More than 3.5 billion Mediterranean fruit flies are produced every week worldwide in special rearing facilities for crop protection (up from 1 billion Mediterranean fruit flies per week in 2000). Many countries employ the genetic sexing strain of the Mediterranean fruit fly developed by the FAO/IAEA Joint Division in their pest-control campaigns.

55

countries have approved the use of radiation instead of chemical or other methods to treat foodstuffs for safety and phytosanitary purposes. Collectively, there are 192 such food irradiation facilities worldwide (up from 32 in 2000). Work through the FAO/IAEA Joint Division has stimulated interest in applying the process commercially and developing international standards to regulate and promote its use.

INVESTMENT FOR DEVELOPMENT. Governments, private sector bodies and lending institutes are demonstrating commitments to invest in nuclear applications important to their national development.

- 58 countries decided in 2007 to work with the FAO/IAEA Joint Division in 119 agricultural development projects run through the IAEA technical cooperation programme (up from 35 countries and 47 projects in 2003); a further 210 concepts for future projects have been submitted for the 2009 cycle of the programme.
- African Heads of State and Government in 2005 decided to establish the Pan African Tsetse and Trypanosomiasis Eradication Campaign. Subsequently, the African Development Bank invested US \$80 million in tsetse and trypanosomiasis control activities.
- In Central America, a multilateral approach reduced or eliminated the prevalence of fruit flies. The achievement led to investments in the production of fruit and vegetables of US \$150 million. All exports of tomato and bell pepper from Nicaragua, El Salvador and Guatemala now come from the newly established areas.
- Argentina, Brazil, China, Colombia, India, Ghana, Guatemala, Mexico, Nigeria, Sri Lanka, Thailand and the Philippines have plans for new or additional irradiation facilities for phytosanitary treatments of foodstuffs, especially fruits, which are being increasingly traded on the international market. The planned facilities represent investments ranging from US \$15–20 million for electron beam and US \$50–70 million for cobalt-60 sources by governments and the private sector.



SETTING STANDARDS. The FAO/IAEA partnership supports the setting of global standards for food safety, animal health and plant protection in support of agricultural trade and development.

In recent years, the international regulatory framework surrounding the protection of human, animal and plant life and health has become increasingly important in determining the conditions under which agricultural trade takes place.

The FAO/IAEA Joint Division has responded by providing scientific and technical information to the three international standard-setting bodies named in the World Trade Organization's Agreement on Sanitary and Phytosanitary Measures. These are: the FAO/WHO Codex Alimentarius Commission, the International Plant Protection Convention and the World Organisation for Animal Health (Office International des Épizooties, OIE).

Information from research and technical cooperation projects and expert group

meetings — coupled with the experience of the Joint Division's own technical staff — has contributed substantively to a number of international standards, and guidelines in food safety and animal and plant health.

Over the past five years, scientific knowledge has broadened significantly through the FAO/IAEA partnership. Results from research and technical cooperation projects, work at the FAO/IAEA Agriculture and Biotechnology Laboratory, and meetings and international symposia have led to the publication of several thousand peer-reviewed scientific papers, articles and numerous textbooks. In addition, a number of databases and decision-support systems are now run on specific agricultural topics. They are accessible on the Internet via the Nucleus scientific portal of the IAEA web site at nucleus.iaea.org.

Countries are seeing greener, more productive fields and healthier livestock with the help of the FAO/IAEA partnership.



FOOD SECURITY CHALLENGES

No Time to Wait

BIG CHANGES LOOM AHEAD. The challenges of food security demand substantial leaps in agricultural productivity and quality.

There is considerable scope for wider dissemination of techniques and approaches available today to deal with problems in food and agriculture. Adapted to local circumstances, these techniques and approaches will contribute relatively quickly to boosting productivity.

Farmers everywhere face new challenges. They include:

- ***the growing unpredictability of weather;***
- ***dramatic changes in land use related to deforestation and land degradation;***
- ***changing distributions of animal and plant pests and diseases.*** Fruit fly pests, for instance, are becoming established in previously inhospitable areas, while outbreaks of Rift Valley fever and other diseases, which also affect humans, are becoming more numerous.

Climate change may also affect food security and safety.

A growing number of pests and diseases could lead to higher levels of pesticides and veterinary drug residues in food, threatening human health and livelihoods. Changes in rainfall, temperature and humidity can lead to foods becoming more easily contaminated with fungi that produce potentially fatal mycotoxins.

Research is essential to identify ways of adapting agriculture to changing environmental conditions. It is equally essential for mitigating the contribution to climate change made by specific practices or systems (e.g. methane from cattle and nitrous

oxide from fertilizer use), while boosting and sustaining the productivity of smallholder farmers and enhancing agriculture's contribution to economic growth and poverty reduction.

Through the FAO/IAEA Joint Division, countries have banked on technical assistance for protecting their food and agricultural systems and the wider environment. They receive objective and science-based information on crop, livestock, soil and water management to help ensure that climate change dimensions are incorporated into national development plans for using nuclear technology.

Far more cooperative work is needed to:

- ***foster applications of techniques for emerging issues of food security.*** This includes, for example, dealing with a wider spectrum of animal and plant pests and diseases than at present.
- ***promote the international validation and acceptance of techniques supporting food and agricultural safety.*** They include a technique known as isotope ratio mass spectrometry, which is used for establishing the geographic origins, authenticity and traceability of agricultural resources, products, pests and disease agents and food contaminants.
- ***continue facilitating agricultural trade.*** This entails the provision of technical support for the development and harmonization of international sanitary and phytosanitary standards and their use by developing countries to facilitate their access to international markets and foreign exchange.



- **explore further cooperative opportunities.** Subject to greater international consensus on biofuel production, the Joint Division may join with public and private sector partners in using nuclear techniques for specific aims. One aim would be to develop plant varieties from non-food plant materials and inedible by-products that contribute to sustainable production of biofuels.

Studies point toward greater pressures in coming years on global food supplies and agricultural resources. Unfolding climate changes and an expanded demand for food, animal feed, and biofuels from a growing population are prime drivers of the challenges facing governments and the international community to achieve greater food security.

Countries will need to work together, through the partnerships and cooperative channels they form and sustain.

Progress already achieved illustrates how the FAO and IAEA have contributed to global food security. Today, in the face of 21st century challenges, the Atoms for Food partnership forged decades ago stands stronger than ever.

AT A GLANCE

Joint FAO/ IAEA Division of Nuclear Techniques in Food and Agriculture

ESTABLISHMENT: October 1964 by FAO and the IAEA. The organizations are well matched. FAO brings to the table its comprehensive knowledge and networks on food and agriculture. The IAEA contributes technical know-how, specifically in agricultural applications of nuclear science and technology.

LOCATION: Headquartered at the IAEA in Vienna, Austria. The Joint FAO/IAEA Agriculture and Biotechnology Laboratory is in Seibersdorf, Austria.

MANDATE: Applications of nuclear and isotopic techniques to contribute to solutions for global food security, through a coordinated global approach of research and technical cooperation.

STAFF: 71 IAEA positions, and 24 FAO positions.

BUDGET: €14 million per annum, of which approximately €2.2 million is provided by FAO. An additional €7–10 million is provided annually by the IAEA Department of Technical Cooperation for some 220 national and regional projects in food and agriculture. The Joint Division programme and budget are approved by the policymaking organs of FAO and the IAEA.

ACTIVITIES: About 50 training courses, workshops, and seminars are held annually involving more than 500 trainees. Additionally, about 40 research projects are coordinated, involving the participation of approximately 400 research institutions and experimental stations worldwide.

PARTNERSHIP ORGANIZATIONS: *These include:*

Arab Organization for Agriculture Development (AOAD),
African Union/Inter-African Bureau for Animal Resources (AU-IBAR),
Codex Alimentarius,
Consultative Group on International Agricultural Research (CGIAR),
International Centre for Research/Development on Livestock in the Sub-Humid zone (CIRDES),
European Food Safety Authority (EFSA),
International Relief & Development (IRD),
Abdus Salam International Centre for Theoretical Physics (ICTP),
International Center for Soil Fertility and Agricultural Development (IFDC),
Inter-American Institute for Cooperation on Agriculture (IICA),
International Plant Protection Convention (IPPC),
International Treaty on Plant Genetic Resources (ITPGR),
North American Plant Protection Organization (NAPPO),
Programme Against African Trypanosomiasis (PAAT),
Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC),
Technical Cooperation Network on Plant Biotechnology in Latin American and the Caribbean (REDBIO),
United Nations Trust Fund for Human Security (UNTFHS),
United Nations Fund for International Partnerships (UNFIP),
United States Agency for International Development (USAID),
United States Department of Agriculture (USDA),
World Health Organization (WHO),
World Organisation for Animal Health (OIE).

IAEA Division of Public Information:
L. Wedekind (Editor), A. Diesner-Kuepfer (Design)



Wagramer Strasse 5, P.O. Box 100,
A-1400 Vienna, Austria
Tel.: (+43 1) 2600 21270/21275
Fax: (+43 1) 2600 29610
E-Mail: info@iaea.org / www.iaea.org

Printed by the IAEA in Austria
October 2008
IAEA/PI/A.96 / 08-38391