feed the hungry today and tomorrow

by Qu Liang and Katherine Long

Through the Joint FAO/IAEA Division, nuclear technology and related biotechnologies contributed to food security for over 40 years.

Soaring global food prices, their effects on the world's economy and the widespread social unrest that followed, have brought to the fore the issue of poor investments made in agriculture and food production over the last three decades.

As a result of decreasing investments, farmers are not only subject to rising costs of inputs, but also to high transportation costs and poor infrastructure. At the same time, natural resources such as soil, water and plants are coming increasingly under pressure from conflicting demands from agriculture, population growth and other sectors of the economy.

Dwindling food stocks combined with low crop productivity and the increase in costs for inputs such as fertilizer and seeds, has led to an overall decrease in food availability and a consequent rise in prices. The Food and Agriculture Organization (FAO) Food Price Index rose, on average, by an annual 12 per cent in 2006, and further accelerated to 24 per cent in 2007. According to FAO, the price of food commodities, currently 30 per cent above 2007 levels, will continue to increase through 2017. The impact of rising food and fuel prices is having dramatic consequences, especially for those living in developing countries where food security is already precarious.

Other factors contributing to the current global food crisis include climate change, the increase in transboundary pests and diseases (e.g., UG99, also known as 'wheat rust') and the change in land use and water distribution.

Increased demand for biofuel is also putting pressure on agriculture and will continue to do so in coming decades due to rising fossil energy prices.

Another factor related to rising food prices is the increasing number of people moving away from starchy foods towards meat and dairy products, a trend that is intensifying demand for feed grains.

Our Work

The IAEA has been working together with other UN and international organizations to find solutions to the problems set before us by the global food crisis. The strategies adopted have been necessarily divided into short, medium and long term.

In the short term, the World Food Programme (WFP) has sought to dramatically increase food aid with additional funding of US$755 million, while FAO has been distributing seeds, fertilizer, animal feed and

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A Partnership for Food Security

On 1 October 1964, FAO and its partner in the UN system, the IAEA created the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. The aim of setting up the Joint Division was to use the talents and resources of both organizations for broadening cooperation between their Member Countries in applying nuclear technology and related biotechnologies for developing improved strategies for sustainable food security.*

Its uniqueness stems from the nature of the technology itself and the fact that all its activities are conceived, planned and executed only after the scrutiny and approval of the IAEA and FAO Governing Bodies.

The Joint Division is a successful example of inter-agency cooperation and coordination in the UN and a precursor for UN-wide reforms being undertaken. The UN and the governments of its Member States continually stress the need for more cooperation among UN agencies, for less overlapping and duplication and for more harmony in their approach towards building a prosperous and peaceful world.

Earlier this year, IAEA Director General Mohamed ElBaradei cited plans by the FAO to end the partnership as part of its reform process. "I believe that termination of the current arrangements would have significantly negative consequences for developing Member States in areas such as animal disease and insect pest eradication, land and water management, plant breeding, food safety and trade," Dr. ElBaradei said. He urged countries to maintain the partnership.

** Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.*

other farming tools and supplies to smallholder farmers through its Initiative on Soaring Food Prices (ISFP). The IAEA, through its Joint FAO/IAEA Programme, is active with an integrated medium and long term approach to the global food security crisis. The sustainable intensification of agricultural production, including enhanced food quality and safety, and the integrated use of nuclear technologies and related biotechnologies is its field of action. This falls under three categories: monitoring; adoption of appropriate technology; and intervention.

Monitoring

Monitoring refers to the selection and assessment of options for the prevention or mitigation of problems. In this sense, a typical monitoring effort is the tracking of land degradation and pollutants in soil through the use of stable isotopes that pose no environmental threat and do not change the chemistry or biology of the target organism or system.

Soil monitoring through the use of isotopes

Agricultural production may be improved through the development and use of integrated land and water management. Isotopic and nuclear techniques play an important role in identifying the source of pollutants from different land use practices and farming activities.

Both stable isotopes and fallout radionuclides (FRN) in soil, water or sediment samples can help to accurately pinpoint the sources of these agricultural pollutants. FRN such as caesium-137, lead-210 and beryllium-7, airborne radioactive debris originating from man-made activities such as nuclear weapon testing and nuclear power plant accidents as well as from the natural collision of cosmic rays, are attached to soil particles and can therefore be used as fingerprints to track their movement.

In addition, fertilizers, farmyard manure, pesticides and animal excreta deposited by grazing animals in an agricultural catchment carry distinct stable isotopic signatures — e.g., carbon-13 and nitrogen-15. Thus specific areas within a catchment may have distinctly different stable isotopic signatures (natural biomarkers) because of varying agricultural uses and animal grazing patterns. The different signatures offer a 'forensic tool' in environmental soil science to verify the origin of a range of pollutants such as nitrate, phosphate, and pesticides in waterways.

Soil studies using stable isotopic signatures also assist in the understanding of climate change. Isotopes such as carbon-13 and nitogen-15 can be used as fingerprints to investigate how soil acts as a sink for greenhouse gases. Changes in soil carbon and nitrogen isotopes are expected to reflect the shift in soil organic matter as influenced by variations in the levels of greenhouse gases in the atmosphere and land use activities.

Adoption of Appropriate Technology

Appropriate technology is identified and adopted to intensify production systems in a sustainable manner. The development of new plant varieties through mutation induction is one of the foremost examples of this process.

This technology goes beyond conventional plant breeding to address challenges such as the development of new traits, adaptability to harsh environments, climate change and enhancement of biomass productivity.

The UN Response to the Global Food Crisis

The timeliness of FAO's High Level Conference on World Food Security held in June 2008 in Rome, Italy, was widely acknowledged by participants and countries alike. During the conference, participants agreed that the issues of food, energy and climate change are all closely linked.

While many analyses were presented, there was general agreement on the fact that agriculture would once again play a prominent role in the international agenda, and that increased agricultural investment and enhanced agricultural productivity would be crucial for the future. Short, medium and long term responses were identified.

On 28 April, 2008, the UN Secretary-General, Mr. Ban-Ki Moon, established a Task Force on the Global Food Security Crisis composed of the heads of the UN specialized agencies, funds and programmes, Bretton Woods institutions and relevant parts of the UN Secretariat. The Task Force is chaired by the UN Secretary-General, with FAO Director-General Jacques Diouf as Vice-Chairman. The primary aim of the Task Force is to promote a unified response to the global food price challenge. The proposed framework for action is to:

1. address the current threats and opportunities resulting from food price rises;
2. create policy changes to avoid future food crises; and
3. contribute to country, regional and global food and nutritional security.

The Science of Plant Breeding

by Giovanni Verlini

Agriculture is synonymous to plant domestication and trait selection. However, scientific research applied to the screening, selection and development of plant varieties has grown immensely over the last few decades. But not all techniques used in this endeavor are the same.

Mutation breeding refers to the development of plant strains using mutagens, including the irradiation of seeds. Quite simply, through this procedure the natural process of evolution of the plant's DNA is speeded up. New varieties of crops can be chosen with characteristics tailored to a particular environment, such as grains with higher yield, better nutritional value, tolerance to salty soil or resistance to a specific disease.

Smart breeding, which makes use of marker assisted selection**,** refers to a process whereby a marker is used for indirect selection of a genetic trait of interest. This is a similar process to traditional breeding, although it involves a far more precise knowledge, i.e., at a genetic level, of species' traits.

Genetically modified plant varieties, on the other hand, have had their genetic material altered using genetic engineering techniques. With this technology, DNA from the original plant and other sources are combined into one molecule to create a new set of genes. This DNA is then transferred into the plant, causing it to acquire modified or novel traits.

Mutant barley varieties filling the food bowl in the Peruvian Andes

Planted in areas above 3,000 m of altitude, where adverse climatic conditions do not allow other crops to be grown, barley is the main food security component for the 3 million native Peruvians living off subsistence agriculture in the Peruvian Andes. In an effort initiated in the 1970s, the National Agrarian University of La Molina, together with the Joint Division and the Backus Foundation, developed nine improved varieties of barley through mutation induction and crosses that now cover 90% of the barley producing area in Peru. The last released mutant variety of barley has the potential to produce 5,500Kg/ha representing a six-fold increase in productivity of the original barley grown in 1978. Led by Prof. Luz Gomes Pando, the socio-economic impact of the improved barley varieties was awarded the 2006 Prize of Good Governmental Practices.

Intervention

Intervention refers to products and processes adopted to optimize efficiency, reduce vulnerability and improve the quality and safety of food.

Pre- and post- harvest problems account for 30-50 per cent of crops lost due to insects and adverse storage conditions. The Joint FAO/IAEA Division has been working to remove key constraints to agricultural production, not only to increase production, but also to improve food quality in relation to insect pests of plants and animals, animal diseases and food control measures.

Diagnosis: identify and characterize constraints and risks

The IAEA has been actively involved in the validation of kits to measure antibodies against non-structural proteins of foot and mouth disease virus (FMDV). The tests can distinguish between infected and vaccinated livestock and are of utmost importance in assessing countries as free from foot and mouth disease (FMD). The use of such assays in well planned serological surveys is vital to declaring countries or zones as free from FMD and therefore has huge trade implications.

Sterile insect technique to generate export markets

Fruit flies cause major losses, and their presence in a country can pose a significant barrier to trade in fresh fruits and vegetables. The sterile insect technique (SIT) has been used in many parts of the world against insect pests, such as the Mediterranean fruit fly in Chile, Mexico and California, and the New World screwworm in Libya, Central and North America.

The technique is a form of biological pest control, an alternative to pesticides which can have serious impacts on human health and the environment. It involves the mass breeding of huge quantities of target insects and the sterilization of the males by exposing them to low doses of radiation. These sterile male flies are then released by air over infested areas where they mate with wild females. As they produce no offspring, a gradual suppression or elimination of the pest is eventually achieved.

An example of this work is the eradication of Medflies from the Patagonia region of Argentina, which represents the culmination of ten years of technical support provided by the IAEA and FAO. Crucially, this achievement—which was officially recognized by the USA—will allow Patagonia to export fresh fruits and vegetables to the USA without any quarantine treatments, representing annual savings of millions of dollars.

Food Safety

Food and feed products (and the water used for their production, processing and preparation) are likely vectors of many microbiological, (bio) chemical and environmental hazards.

The Joint FAO/IAEA Division promotes the establishment of food control and quality assurance systems compatible with international standards, with a focus on Codex food standards and the reduction of the incidence of food trade detentions and rejections from contaminants and residue violations.

Conclusion

Nuclear and isotopic techniques can help address the issues of food security and safety facing the world today. They are economically sound and highly competitive in relation to non-nuclear technologies and can be used to achieve a better understanding of and adaptation to new challenges in agriculture.

The Joint FAO/IAEA Division provides an integrated approach to address these challenges throughout the food chain. At a time when soaring food prices, combined with population growth and continued stress on the environment due to climate change, is becoming a problem for millions of people in the world, it is time to make the necessary investments that will ensure the sustainable production of food for generations to come, so that crisis such as the present one will never happen again.

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Nuclear Partners

by Louise Potterton

James Butler, Deputy Director-General of the Food and Agriculture Organization (FAO), talks about the importance of nuclear techniques in agricultural and livestock production.

Question: When we look at the global food crisis, how important is the contribution from nuclear science?

James Butler: It is very important in the medium and long term. When we stabilise food production and we are able to move from the immediate needs to the next level, then we will see the impact. It could be the improved seed, or the plant that has been developed that has genetic resistance to insects or salt conditions. Or it could be techniques that allow animals to be utilised in production practices in Africa, for example – the tsetse fly has been reduced in number through sterilization technique, allowing animals to be utilised in previously hostile areas. There are many uses of nuclear technology that will have a medium and long term impact on agriculture and livestock production.

Q: I understand that you have applied these technologies in your field of work. Can you tell me about this experience?

JB: I am from the US and have spent most of my career in production agriculture. In my youth the screw worm was very prevalent in the US, Mexico and Central America. One of the earliest uses of technology was the sterilization of the fly. As I increased in age and went through the distribution of sterile flies, the cases of screw worms we were dealing with in our own ranching operation decreased significantly and then were removed all together.

This is a success model often cited as a proper use of technology in agriculture and livestock production.

Q: According to UN Secretary General Ban-Ki Moon, to meet global food demand production will have to increase by 50 per cent by 2030. Is this realistic?

JB: Yes it is. We have the crops; we can utilize some improved varieties, improve yields, and reduce losses during the production phase. If we increase production by 1-2 per cent a year we can raise production to meet this challenge.

Q: Do we need to invest more in science and technology?

JB: Yes. International financial institutions and individual country donors have stated that they are willing to invest in agriculture and many of the needs are medium and long term, and I do believe that this is where the collaboration with the IAEA applying nuclear techniques will have benefits into the future.

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