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Food for the Future

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IAEA

The International Atomic Energy Agency serves as the world's foremost intergovernmental forum for scientific and technical cooperation in the peaceful use of nuclear technology. Established as an autonomous organization under the United Nations in 1957, the IAEA carries out programmes to maximize the useful contribution of nuclear technology to society while verifying its peaceful use.

The IAEA helps its Member States pursue their developmental goals by supporting the responsible planning and use of nuclear science and technology. The IAEA facilitates the transfer of the knowledge and technology needed by developing Member States to utilize these technologies peacefully.

By developing nuclear safety standards, the IAEA promotes the achievement and maintenance of high levels of safety in nuclear energy applications, as well as protecting human health and the environment against ionizing radiation.

The IAEA also verifies through its inspection system that Member States comply with their commitments under the Non-Proliferation Treaty and other non-proliferation agreements to use nuclear material and facilities only for peaceful purposes.

The work is multi-faceted and engages a wide variety of partners at the national, regional and international levels. IAEA programmes and budgets are set through decisions of its policymaking bodies — the 35-member Board of Governors and the General Conference of all Member States.

The IAEA is headquartered at the Vienna International Centre. Field and liaison offices are located in Geneva, New York, Tokyo and Toronto. The IAEA operates scientific laboratories in Monaco, Seibersdorf and Vienna. In addition, the IAEA supports and provides funding to the Abdus Salam International Centre for Theoretical Physics, in Trieste, Italy.

Photo: Louise Potterton, Division of Public Information

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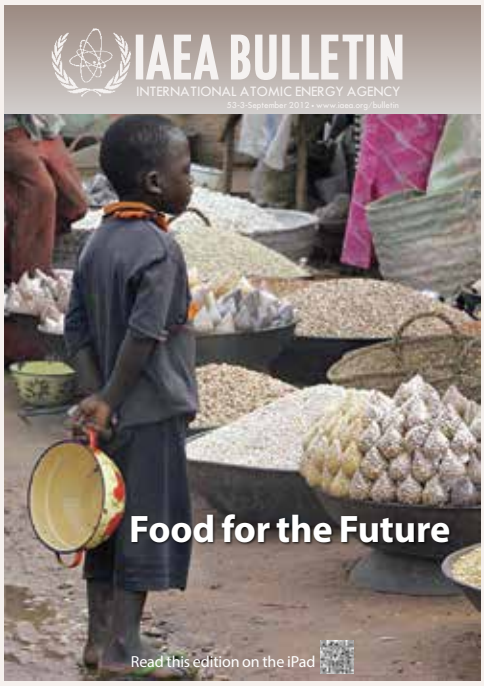

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Cover Photo:
A young boy waits with an empty pot at a market in Niger.
(Issouf Sanogo /AFP/Getty Images)

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FOOD FOR THE FUTURE

The population of the world is expected to grow by a third to nine billion by 2050. In order to feed this growing population, global food production will have to increase significantly.

It is vitally important to make optimal use of the latest modern technology to help farmers to produce more food, to protect animals and crops against diseases and pests and to ensure that food is safe and wholesome.

It is vitally important to make optimal use of the latest modern technology to help farmers to produce more food, to protect animals and crops against diseases and pests and to ensure that food is safe and wholesome.

Nuclear techniques can help to achieve all three of these goals. The International Atomic Energy Agency, working closely with the Food and Agriculture Organization of the United Nations, makes these techniques available to farmers and food producers in developing countries.

This special issue of the *IAEA Bulletin* has been produced on the occasion of the *2012 IAEA Scientific Forum*, which brings together experts and policy-makers from all over the world to consider how best to use nuclear techniques to increase food production, to control animal and plant diseases that threaten food supplies and to guard against food contamination.

A key goal of this two-day meeting is to make Member States more aware of the important contribution that nuclear applications, made available through the IAEA technical cooperation programme, can make in this area and to help countries to improve food security for their people.

You can read about nuclear techniques developed and applied by the IAEA, such as plant mutation breeding, that are effective in increasing the quantity and quality of food and feed crops, as well as radio-isotopic technologies that help countries to make optimal use of water and soil resources.

Other nuclear techniques help to eliminate pests such as the tsetse fly, thereby reducing cattle deaths, and the fruit fly, enabling countries to increase production and exports of fruits such as oranges and lemons.

The IAEA played an important part in eradicating the deadly cattle disease rinderpest. Nuclear techniques also help to reduce the need for pesticides and drugs in food production.

Exposure to chemicals and pathogens in the food supply represents a serious threat to the health of millions of people, particularly in developing countries. We will also show how food irradiation is a proven and effective treatment to improve food safety. It reduces bacterial contamination, extends the shelf-life of foodstuffs and controls insect pests.

These are just a few examples of the work being carried out by the IAEA through hundreds of projects throughout the world. I warmly welcome all participants to the 2012 IAEA Scientific Forum and the readers of this Bulletin. I am confident that nuclear techniques will make an important contribution to improving world food security in the coming decades.

Yukiya Amano, Director General, International Atomic Energy Agency

IMPROVING CROPS WITH NUCLEAR SCIENCE

increasing yields for smallholder farmers in the Peruvian Andes

Two of the most successful barley types were developed using a nuclear technique known as 'radiation induced mutation'.
(Photo: Louise Potterton/IAEA)

On his second voyage to the "New World," Genoese explorer, Christopher Columbus, sent a ship back to Spain carrying a letter to Ferdinand and Isabella, his sponsors and the Spanish King and Queen, dated January 30, 1494. He was asking for provisions for his men. Among the items on his list was "barley" and so the nutritious cereal was introduced to the Americas.

In the 1500s, barley came to the Peruvian Andes, where over centuries it has managed to adapt to extreme conditions and has become an important source of food and income for the seven million people who live there. It is one of only a few plant species that can thrive at altitudes of around 4,000 metres above sea level where soil is poor, water scarce and the winters harsh.

Up until the 1970s, the barley yields were meagre and the grain was low in quality. As a result, farmers used it primarily for animal feed and no effort was made by Peru's agricultural research centres to improve varieties. This changed in 1968, when Professor Marino Romero joined the National Agrarian University La Molina in Lima and founded the Cereals Research Programme.

Romero grew up in the Andes. He was the son of a teacher who was also a farmer, so he was aware of the importance of barley to the mountain communities. He set out on a mission to develop new varieties of barley that would thrive above 3,000 metres and would improve the diet, health and economy of the Andean population.

With the support of the IAEA's joint division with the UN's Food and Agriculture Organization, he managed to develop nine improved varieties of barley over the course of forty years that now account for over 90% of the barley cultivated in Peru.

Marino Romero died in 2005, but his work was continued by his wife, Professor Luz Gomez Pando, who since 1998 has led the Cereal Research Programme at La Molina University. "Before the intervention of my late husband, barley was largely ignored by plant breeders and researchers since it was associated mainly with beer and animal feed," she says. "They didn't realise that after potatoes it was the second most important source of food for poor communities."

By cultivating the higher-yielding, improved varieties, farmers have seen an increase from 800 kilos of grain per hectare to 3,000 kilos and a two-fold increase in protein content from 7 to 14%. Two of the most successful barley types were developed using a nuclear technique known as 'radiation induced mutation'. With

this method, breeders expose seeds to radiation to induce changes in plants. This speeds up a process that would normally take place under naturally occurring radiation.

"Radiation brings about changes," says Gomez Pando, adding: "These could be big or small, negative or positive. We're not adding anything to the plant, but in contrast to radiation, the natural process can take thousands or millions of years." After seeds have been irradiated they are planted at experimental sites and monitored carefully by the breeders.

The seeds of the promising plants are harvested and replanted and this selection process continues for up to seven years, to identify the best improved types in field and laboratory conditions. Once an improved line has been identified, tested and officially confirmed, it is released as a new variety.

In 2006, La Molina released its latest barley 'Centenario', which was developed using the irradiation breeding technique and is proving to be the best so far.

Professor Gomez Pando says: "It has more protein than other varieties and a higher yield. It's resistant to yellow rust, tolerant to frost and due to its inclinded head does not get damaged by hail." Thanks to Centenario, Andean farmers now produce enough grain to meet their personal needs and have a surplus to sell.

In the village of Conopa, farmer Erwin Ortega says: "Compared to all other types of barley, Centenario is the best, because it has more grains and they're heavier. It also tastes better and it's important for the development of our children."

Centenario fetches twice the price of other barley varieties. In fact, it is so popular and abundant that the farmers want to expand their markets. Erwin's brother, Armando, says: "We need to find new markets that will pay us the right price for this type of organic barley, perhaps in other parts of Peru or overseas. Now we sell barley to middlemen at a low price."

The work of Professor Gomez Pando is being supported by the Peruvian branch of the organisation Caritas. Together they distribute Centenario seeds to the farmers and help them find ways to sell their grain.

"When we started to support the farmers, by giving them the seeds and technical assistance, their production tripled," says Juan Pio Silva, head of Economic and Production Development at Caritas Peru.

"So there was a great supply of barley, but the market was not able to absorb it directly as grain. We then found the alternative of processing barley into flour and this opened new commercial channels for the farmers."

Caritas has set up a chain of small processing plants in the Andes where farmers can work in a collective initiative to process the barley into flour and other cereal products that are sold to outlets in Lima and other parts of Peru.

"In the rural areas, especially in the High Andes, poverty is higher than elsewhere in Peru," says Silva, "I think that the best way to support the people there is by developing the crops they've always harvested, such as barley."

Following the success of Centenario barley, the breeders at La Molina University turned their attention to another Andean plant, kiwicha, a kind of amaranth. Using radiation induced mutation, they have developed a variety, known as Centenario-Kiwicha, that has a higher yield than other varieties, and is more nutritious.

Kiwicha was a staple food in the diet of the Incas. It has 30% more protein than common cereals, such as rice and wheat, and is high in dietary fibre and minerals such as iron and magnesium. Kiwicha is not as common as barley in the Andes or as easy to grow, but it enjoys the export potential that barley currently lacks.

There is a high demand for exports of Centenario-Kiwicha to countries like Japan and the USA, since this is an organic, high-quality product. One of Peru's main exporters of Andean grains is Lima-based, Interamsa Agroindustrial. The company's General Manager, Gustavo Pereda, saw the potential of Centenario-Kiwicha and has developed a business strategy that is benefiting both the farmers and his company.

"In 2002, I started cooperating with Professor Gomez Pando. She gave me Centenario-Kiwicha seeds. I went to the farmers in the Andes and asked them to plant them with the promise that I would buy the grain at harvest time."

Impressed with the quality of the kiwicha, the cooperation progressed and now Interamsa Agroindustrial buys the seeds from La Molina and the farmers cultivate the kiwicha.

"I give the farmers the seeds, they do the work and when they harvest, I pay a fair market price for the grain."

He added that when the business deal goes well, he invests further in the farmers and provides them with new equipment.

"The market for kiwicha is growing every year. I sell it to the USA and Japan and am hoping to sell in Europe too," says Pereda.

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Plant Breeding

Around the world, the agricultural sector is facing many challenges, including climate change, droughts, floods, soil degradation, pests, and diseases. Sustainable crop improvement to increase yield, ensure food security and enhance farmers' incomes continues to be an important objective of agricultural policy in most countries. The use of new improved crop varieties with defences against these adverse environmental effects is an effective way of ensuring crop yields to meet the growing population demand.

Finding a Heat-Tolerant Tomato for Mauritius

Juanita Perez-Vargas/IAEA

Plant breeder Banamati Saraye was trained at the FAO/IAEA's Plant Breeding and Genetics Laboratory.

"Mauritius is a tropical country with temperatures exceeding 30 degrees, especially in summer. The tomato is a summer crop and it's very sensitive to high temperatures. At the IAEA, I worked on a project to find a heat-tolerant tomato variety, by using nuclear energy to induce changes in the fruit."

Greater Food Security by Improving Wheat and Barley in Jordan

Sasha Henriques/IAEA

Plant biotechnologist Faddel Ismail takes part in an FAO/IAEA project to create new varieties of grains.

"Jordan is expected to have an increase in temperature and reduction in rainfall. Breeding wheat and barley under such difficult conditions requires genetic variation. Inducing mutation by utilising nuclear techniques will accelerate the creation of plants, which have the required traits like resistance to certain pests, drought and salinity."

Growing Barley in the Peruvian Andes

Louise Potterton/IAEA

Farmer Erwin Ortega is growing and selling a variety of barley called "Centenario" that was developed using nuclear technology under an FAO/IAEA project.

"Centenario barley is very important here in the Andes. It has a better yield than other varieties, so it has improved my income considerably. It also tastes better and has more protein. We use barley for our own consumption. It's very nutritious and is especially important for the development of our children."

Text: Louise Potterton & Juanita Perez-Vargas, Division of Public Information

New Wheat & Barley

1 Wheat and barley are among the most important crops contributing to food security and sufficiency in Jordan and the Middle East.

2 Unleavened bread is enjoyed throughout the region, and has been a favourite for thousands of years.

3 But each year Jordan produces less than 3% of the wheat and barley needed to feed its population of 6.5 million.

4 That's mainly because wheat and barley crops are threatened by disease, saline soil and persistent drought.

for Arab Countries

5 Iraq, Jordan, Lebanon, Oman, Saudi Arabia, Syria and Yemen are using nuclear techniques to develop crop varieties that will produce more grain even under tough conditions.

6 The IAEA provides equipment and training to the scientists and irradiates wheat and barley seeds on their behalf at the IAEA laboratories in Seibersdorf, Austria.

7 Natural plant mutation occurs over millions of years and is caused by natural radiation and naturally-occurring DNA replication errors.

8 Irradiating the seeds/plant parts speeds up this process of change.

9 To develop a new variety, plant parts/seeds are exposed to gamma radiation or x-rays for about a minute.

10 This induces changes in the DNA, but doesn't make the plant radioactive.

11 Yahya Shakhatreh, Director of the Field Crops Research Directorate at Jordan's National Center for Agricultural Research and Extension (NCARE), says barley varieties more suited to dry conditions are in their final stages of development.

12 Even with the help of nuclear techniques, successfully breeding new wheat varieties will take many years.

13 Abdallah Alomary, a 46-year-old father of five, is excited about the latest barley varieties. Over the years he's planted four wheat and barley varieties from NCARE and has been pleased with the results.

14 This barley crop is the first batch developed using nuclear techniques. He's confident it'll be worth the effort on his 1.3 acre farm.

15 Abdallah is one of 21 Jordanian farmers helping scientists evaluate how the plants fare in real-world farming conditions.

16 42-year-old Khaldoon Karaki comes from a family of farmers and shares 40 hectares with his brother. His plot of land is just down the road from NCARE's testing facilities. Here Khaldoon tests the quality of the available barley varieties.

17 Zaki Muhammad Omari is a 52 year old retired Arabic language teacher. He's also keen to find out how the new barley varieties will benefit his three hectare farm.

18 Both plant breeders and farmers share the responsibility of selecting and evaluating the best plant varieties.

19 Before the IAEA project began seven years ago, more than half of the countries involved had no experience with this kind of nuclear science.

20 Bringing together people from countries with different levels of experience to train each other, exchange knowledge, and share the benefits of new wheat and barley varieties, is considered one of the plant breeding project's biggest achievements.

The Wheat and Barley project is under the Cooperative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA), and funded by the IAEA Department of Technical Cooperation. Text & Photos: Sasha Henriques/IAEA Division of Public Information.

Why Radiation Induced Mutation?

Pierre Lagoda, Head of the FAO/IAEA Plant Breeding and Genetics Section, explains why 'induced mutation breeding' is a practical, sustainable solution to the world's food crisis.

"We offer a very efficient tool to the global agricultural community to broaden the adaptability of crops in the face of climate change, rising prices, and soils that lack fertility or have other major problems," says Lagoda.

Induced mutation: half the time of traditional breeding methods. Routinely, plant breeding requires seven to 10 years of research to produce a promising new variety. A breeder looking for pest resistance, for example, might find the characteristic in a wild variety with poor quality and yield. This wild variety will be crossed with a plant that does have good quality and yield, and any offspring combining the desired traits will then be selected and propagated.

Induced mutation: more options from which breeders can choose. Hybrids, the product of crosses, are only as resilient and productive as the source parents. Over the past century, about 75% of crop biodiversity has been lost and monoculture has diminished plant variety in farmers' fields.

Both conditions limit researchers when crossing strains to create new plants. "This loss in plant genetic diversity endangers food security as resistance to yet latent biotypes of pests and diseases and extreme weather conditions may have become severely weakened," says Lagoda.

There is a solution: using radiation to artificially induce the variations that plant breeders need. Radiation-induced mutation produces millions of variants. Breeders then screen for the desired traits and crossbreed. "Induced mutation breeding is a safe and proven technology. The method does encounter resistance and the public is generally concerned by anything relating to radiation and mutation," Lagoda explains.

"In plant breeding we're not producing anything that's not produced by nature itself. There is no residual radiation left in a plant after mutation induction. Through its Technical Cooperation Programme, the IAEA provides the tool and the expertise, then national agricultural research systems and plant breeders must take the next step; selecting and cross-breeding plants to achieve the desired result," says Lagoda.

Pierre Lagoda, Head of the FAO/IAEA Plant Breeding and Genetics Section. E-mail: P.J.L.Lagoda@iaea.org

Genetic Commons Makes Critical Research Easier

For most of us, how scientists conduct their research isn't a big priority. And ways to make it more convenient for them to do that research are even less interesting.

However, while not all research may be scintillating, most of it makes an essential contribution to our daily lives.

For instance, the scientists developing salt-tolerant rice, disease resistant bananas or more nutritious potatoes will ultimately affect how much and what kinds of food are available in markets and on supermarket shelves. Their work will also affect how much nutrition our favourite foods are able to provide us.

The International Treaty on Plant Genetic Resources for Food and Agriculture, which is administered by the Food and Agriculture Organisation, is the key legal instrument helping scientists engage in beneficial food research.

Under the Treaty, 64 of the world's most important crops, which account for 80% of all human consumption, comprise a pool of genetic resources accessible to everyone (the 'genetic commons').

When countries ratify the Treaty they agree to make their nation's plant genetic diversity and related information about the crops stored in their gene banks available to everyone through the Multilateral System.

This gives scientific institutions and private sector plant breeders the opportunity to work with, and potentially to improve, the materials stored in gene banks or even crops growing in fields.

Plant Royalties

Those who access genetic materials through the Multilateral System agree that they will freely share any new developments with others for further research or, if they want to keep the developments to themselves, they agree to pay a percentage of any commercial benefits they derive from their research into a common fund to support conservation and further development of agriculture in the developing world.

"I value the Treaty as essential to undertake my work for the benefit and at the service of our 154 Member States," says Pierre Lagoda. "Anything, especially something this comprehensive, that makes critical food research easier, is something I wholeheartedly embrace."

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Food Security & Staple Crops

For health experts, food security is assured "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life", according to the WHO. Much of that security depends on a surprisingly small number of plants, called staple crops.

Of more than 50,000 edible plant species in the world, only a few hundred contribute significantly to our food supplies. Almost all of the world's food energy intake is satisfied by just a few crop plants. Rice, maize and wheat make up two-thirds of this already small group of foods.

These three grains are the staple foods for more than four billion people both as a source of nutrition and income. A staple crop, by definition, dominates the major part of our diet and supplies a major proportion of our energy and nutrient needs. If staple crops are threatened by drought, pests or nutrient-poor soils, hunger and poverty can rise dramatically.

Staple crops are commodities traded all over the world. If disease or difficult growing conditions limit their harvest then economic consequences are felt globally. When harvests are poor or when crops are used to make fuel, rather than food or fodder, then prices escalate, farmers face financial ruin, food becomes too expensive for the poor, national revenues are expended on food imports, adding to national and individual vulnerability.

A changing climate that triggers more crop-decimating droughts, floods, and storms, while increasing the temperature

range within which plant diseases can propagate, will increase food vulnerabilities in the future. The risk of crop failure and low yields, caused by drought, disease or rising salinity in irrigation water, can be reduced by breeding more robust crops that better withstand and flourish under harsher growing conditions.

To find tougher plants, the FAO/IAEA Joint Division of Nuclear Techniques in Food and Agriculture focuses on improving varieties of staple foods. It also supports Member States' efforts to improve their techniques in plant genetic mutation, speeding up the plant breeding process to develop new varieties to improve the disease-resistance and stress-tolerance of staple crops and help to identify better strains with superior nutrition and higher yields.

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Staple Food Around the World

Typically, people live on a diet based on one or more of the following staples: rice, wheat, corn, millet, sorghum, roots and tubers (such as potatoes, cassava, yams and taro), and animal products such as meat, milk, eggs, cheese and fish. Rice feeds almost half of humanity. Roots and tubers are important staples for over one billion people in the developing world, of which, approximately 40% are consumed by half the population of sub-Saharan Africa.

Meat and Milk

The Maasai of Kenya and Tanzania have traditionally relied on food for the majority of their diet that is provided by cattle: milk, meat, and blood. Today, grain has become a staple food of the Maasai, but they still drink one liter of milk per person/day. In some regions, diets are limited by the climate: fresh fruits and vegetables are scarce in the Arctic, where people rely heavily on meat and fish as food staples. For example, the Eskimo tribes of Alaska and northern Canada have traditionally eaten seal, walrus, and whale meat in addition to fish.

Tubers

Tubers are high in carbohydrates, calcium and vitamin C, but low in protein. However, per capita consumption of roots and tubers has decreased in many countries since the early 1970s, mainly because urban populations have found it cheaper and easier to buy imported cereals. Habits are changing and increasing global reliance on a handful of plants. For instance, rice consumption in the Pacific Islands has risen by 40% since 1970, while root and tuber consumption dropped by 8%. Although cereal grains and tubers make up the majority of food staples, they are not the only dominant foods in the world.

Fruits and Legumes

People in tropical climates rely on starchy fruits such as plantains and breadfruit. In parts of Africa and Asia, especially India, legumes such as beans, lentils, and chickpeas are staple foods. Economic development, increase in income and free trade are contributing factors as to why many countries have shifted away from traditional foods. Despite this trend, there is growing recognition of the importance of traditional staple crops in nutrition.

www.fao.org/docrep/u8480e/u8480e07.htm

Cassava: Feeding Peop

1 The cassava feeds 500 million people in the developing world. With lots of starch, calcium, phosphorous, protein and Vitamin C, it doesn't need much rain, rich soil or fertilizer to grow.

2 In Ghana for instance, cassava provides the population with one-third of the carbohydrates their bodies need to survive each day. For the average Ghanaian, at least one meal, each day, contains cassava.

3 But like other important crops, cassava yields are threatened by the uncertainties of climate change and disease such as white fly infestation (seen on this African cassava), or Cassava Mosaic Diseases.

4 Scientists at the IAEA and the University of Ghana's School of Nuclear and Allied Sciences (like Kenneth Danso) have been using nuclear techniques to boost yields, help plants resist disease, and produce more starch.

le Today and Tomorrow

5 The scientists use radiation to speed up the natural process of mutation that plants undergo on a daily basis. The mutations that produce desirable traits would have needed thousands of years, using just the sun's radiation and natural DNA replication errors.

6 Cassava plantlets developed through radiation mutation have different traits. Researchers are constantly testing and screening plants in the field to see what, if any, changes they have undergone.

7 They might have traits like the ones Godwin Amenorpe is developing, which are tolerant to Cassava Mosaic Diseases. They might have very high starch content or be more nutritious. You never know until you experiment.

8 New cassava varieties developed during these projects haven't been released yet. But when they are, they will benefit farmers and consumers not just in Africa, but across the world.

Special thanks to the staff of the University of Ghana's School of Nuclear and Allied Sciences, whose work on mutation plant breeding is partially funded by the IAEA. Text & Photos: Sasha Henriques/IAEA Division of Public Information.

Small Yams, Big Deal

Yams are a big deal to tens of millions in dozens of countries. Available year-round, it's a reliable food source, especially for the poor in tropical regions.

Yams are rich in vitamin C, potassium, vitamin B6, manganese, starch and dietary fibre, and contain little saturated fat and sodium, therefore protecting against osteoporosis and heart disease. 90% of the world's yams are produced in West and Central Africa. There are more than 150 different types of yam, which have different textures, starch quality, colours and sizes.

The *Dioscorea esculenta*, or Chinese Yam as it's called in Ghana, is one of the smallest varieties still in existence. The Chinese Yam is quite tasty and slightly sweet. But it's becoming extinct in Ghana, having fallen out of favour with farmers who have chosen to plant high yielding nonindigenous crops. It's also being affected by the destruction of natural ecosystems, as well as socio-economic changes.

There are more than 150 different types of yam, which have different textures, starch quality, colours and sizes.

(Photo: S.Henriques/IAEA)

But with 150 yam varieties, I asked the Ghanaian researchers why they are trying to save this undersized yam from extinction? The answer: crops farmed large scale for profit (commercial agriculture) are all similar because they need to conform to the needs of the market; flowering at the right time of year, growing to a certain height and yielding a predictable amount.

That conformity ensures profitability: if plants develop at different times of the year or are too short for mechanical harvesting or yield too little, farming becomes inefficient and too cost-intensive.

Since commercial crops are so similar genetically, a disease that decimates one variety is likely to destroy all the others as well. Wild varieties on the other hand, like the Chinese yam, contain a wealth of genetic diversity, about 95% more diversity than high yielding commercially farmed varieties.

So when the agricultural sector is faced with diseases or pests that threaten the survival of their high yielding crops, researchers can sift through wild/less commercial varieties to find genes that can be incorporated into farmed varieties to give them the necessary disease resistance.

While modern commercial agriculture has many advantages, its spread threatens the survival of many wild or original plant genetic resources like Chinese Yams that are vital for present and future agricultural development. But, I asked, if the wild varieties are so robust and versatile, why try to alter Chinese Yams?

Scientists believe that if there were fewer, but larger tubers on each root (the size of sweet potatoes for example), Chinese Yams would be more attractive to consumers in Ghana and in neighbouring African countries.

That's what researchers like Kenneth Danso at the University of Ghana are using radiation to achieve. "We're exploring radiation-induced mutation because it has the potential to add traits of interest without changing the entire genome of the plant, while marginally increasing the tuber sizes and decreasing the number of tubers per vine," says Danso.

But, I wanted to know, how will Danso and his colleagues convince smallholder farmers and consumers to become interested in Chinese Yams again?

"I hope that farmers will start planting Chinese Yams again if we can make them bigger and therefore more profitable," says Danso. "There are still many years of research to undertake before we can tackle that problem. First we have to figure out how to improve the yams, then we can work on marketing."

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Soil Isn't Just Dirt

"Improving soil quality is a long term issue. But if we don't start working now, there won't be any good soil left in the future. And where will our food come from then?" asks IAEA/FAO Soil Scientist Gerd Dercon.

40% of the world´s land is used for agriculture. That land is increasingly threatened by desertification, salinity, and loss of nutritional content. Soil in many African and Asian countries is so damaged, farmers must struggle to eke out a living.

Soil loss and damage threatens the food security of tens of millions of people.

Conservation agriculture and nuclear science are two of the tools being used to address this problem: improving food security by making soil more fertile.

Conservation Agriculture and Soil Fertility

"There are a number of things you can do to make soil more fertile," says IAEA Soil Scientist Gerd Dercon. "The first thing is to significantly reduce how much farmers till the soil while sowing, because digging it up and turning it over makes the soil drier.

"Also, crop rotation, usually between cereals and legumes, is encouraged. This ensures that the soil isn't depleted of any one type of nutrient because the same crop is farmed over and over. And finally, using crop residues—stalks and leaves that would otherwise have been discarded—as ground cover.

"This serves two purposes. It provides a layer of protection for the soil so moisture doesn't

Conservation agriculture and nuclear science are two of the tools being used to improve food security by making soil more fertile.

(Christian Resch/IAEA)

escape easily. And when these residues decay completely, they'll become part of the soil's organic matter, matter that is essential for healthy, vibrant plant growth," explains Dercon, who works in the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture in Vienna, Austria.

While these conservation agriculture practices are being promoted by numerous organisations around the world, the Joint Division is conducting experiments to understand just how carbon moves from the atmosphere, into plants, then the soil.

Their ultimate goal is to improve soil quality so farmers can produce better, more nutritious food.

40% of the world´s land is used for agriculture. That land is increasingly threatened by desertification, salinity, and loss of nutritional content.

What does the movement of carbon have to do with better quality food?

Rich, fertile, soil has a lot of carbon. And food quality is determined by soil quality. "If you have poor soil, you won't be able to produce as much food, or food that's as nutritious as it could be," says Dercon.

The Joint Division is tracking carbon through the plant cycle to see which plants retain the most carbon from the atmosphere.

"If smallholder farmers in particular can plant these crops, while practicing conservation agriculture—no tillage, crop rotation and using crop residues—then globally we can become infinitely more optimistic about our prospects for continued food security," says Dercon.

Planting crops that absorb more carbon from the atmosphere can significantly contribute to the reduction of greenhouse gases like carbon dioxide, lessening the impact of climate change, a process that's driven by the release of these gases.

The Nitty Gritty of Soil

Soil is made up of minerals and organic matter, as well as living organisms. Organic matter binds nutrients to the soil, improving the likelihood that crops will grow, using more and more carbon from the atmosphere, creating a cycle that is beneficial to the atmosphere and plant agriculture.

Organic matter maintains soil structure, which improves the soil´s ability to absorb and hold water. In addition, it speeds up the breakdown of pollutants and can bind these harmful substances to its particles, reducing the risk of run-off into rivers and streams where people could be affected.

Soil organic matter is essentially carbon. It's made up of dead plants, insects and animal remains that have decayed to the point of being unrecognizable. The bacteria, worms and insects that live in organic matter help in the decay process, thereby releasing nutrients that can be taken up by crops.

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Good Soil = Strong Agricultural Sector = Economic Development

"Roughly 2.5 billion people derive their livelihoods from agriculture. For many economies, especially those of developing countries, agriculture can be an engine of economic growth.

In many developing countries the agricultural sector contributes as much as 30% to the Gross Domestic Product (GDP) and is a source of employment for two-thirds of the labour force.

According to the World Bank, growth in the agricultural sector can be up to 3.2 times more effective at reducing US$1/day poverty than growth in other sectors.

Importantly, agriculture can provide a haven of resilience against global economic and financial turmoil, often more effectively than other sectors."

Food and Agriculture Organization of the United Nations Statistical Yearbook 2012 www.fao.org/docrep/015/i2490e/i2490e00.htm

Climate Smart Agriculture

©iStockphoto.com/Luca Tamboia

By 2050, the world population will increase to more than nine billion people, and many will live in developing countries that already confront a food crisis. Currently, around 870 million people in the world are "under-nourished," they do not have enough food. In the next 40 years, the world will have to harvest 70% more food to feed everyone adequately.

This is a tough challenge as the effects of climate change are expected to bring longer and more frequent droughts, more floods, and more destructive weather in general. This threatens food security and will severely cut agricultural yields. With two billion more people to feed in the next 40 years, there is an urgent need for countries to adapt to climate change.

In agriculture, water shortages are every farmer's nightmare. In dry conditions, every drop must reach the plant's roots to keep it thriving. It is the soil's ability to absorb and hold water that will determine whether the soil can keep plants alive. Soil retains water when it hosts vital microorganisms. If the soil loses these microorganisms, it loses its ability to absorb water.

When the rains do finally arrive, they can wash out these microorganisms and have devastating effects on the soil's fertility. As the soils dry again, they cannot retain moisture and the crops die, leading to food shortages.

With the help of nuclear techniques, the IAEA helps countries "keep the soil alive" and adapt to the devastating effects of climate change.

"The soil is alive", explains Nguyen Long, head of the Soil and Water Management and Crop Nutrition Section of the IAEA. "If it contains a large number of living organisms, it will retain water and nutrients and plants will grow. Soil that contains organic matter acts like a sponge

and absorbs the water. That reduces runoff and erosion during heavy rainfalls," he says.

With the help of nuclear techniques, the IAEA helps countries "keep the soil alive" and adapt to the devastating effects of climate change. Through these techniques, scientists have managed to not only help soil adapt to climate change, but also to help reduce the emissions that cause it.

Climate Change Adaptation

High temperatures due to climate change dry out the soil and lead to the rapid evaporation of water from the soil, destroying the crops. Farmers can adapt to these changes through better irrigation techniques and by reducing the loss of water through the soil.

"With isotopic and nuclear techniques, we can help to conserve the water in the soil. We can also enhance the soil's ability to store organic matter and determine the factors that lead to the decomposition of the organic matter," said Nguyen.

Through laser technology and with the help of soil moisture neutron probes, scientists are able to analyse how much water is lost through evaporation from the soil, and how much is lost through transpiration from the plant. These tools measure the oxygen in the water vapour released and determine whether it comes from the soil or from the plant.

More efficient irrigation systems save water and nutrients and increase the resilience of the crop against drought.

The difference between the vapours lies in the atom: because the isotopic composition of the oxygen isotopes evaporated from the soil differs from that transpired from the plants, the scientists can determine exactly how much water was lost through evaporation from the soil. "We want the soil to lose as little water as possible. It is best if a larger proportion of the water transpires from the plant, because that means that the plant is thriving," Nguyen explains.

"On-farm management practices can then be put in place to reduce soil evaporation through mulching and soil conservation tillage, or improving irrigation schedules to ensure that crops receive water when they most need it," explains Nguyen. But for this, scientists need to know how much water is lost.

Using laser technology, research in a Vietnam coffee plantation demonstrated that covering the soil surface with a 5 to 10 cm layer consisting of old branches and leaves, called a mulch layer, reduced soil evaporation from 17% to 5%. Since this happened during the critical phase of the plant's bud development, it enhanced the sprouting of new buds and stabilized soil structure.

More efficient irrigation systems save water and nutrients, while increasing the resilience of the crop against drought. For example, water that directly reaches a plant's roots through a technique called drip irrigation is one of the most efficient ways to save water and increase harvest at the same time. A neutron probe uses nuclear technology to measure the soil water and find out when and where the plant needs water.

Climate Change Mitigation

Scientists agree that climate change is caused by increasing greenhouse gas emissions. Nuclear techniques can help reduce the release of greenhouse gases from soil and thus mitigate climate change.

"Climate change is driven by the emission or release of greenhouse gases from farmlands in the atmosphere. Nitrous oxide and carbon dioxide are two of the main greenhouse gases released from the soil. We try to manage the soil to reduce the level of release of that greenhouse gas into our environment," Nguyen says.

Plants absorb carbon dioxide for photosynthesis. By storing more carbon dioxide and nitrous oxide in the soil, the microorganisms in the soil thrive. The FAO/ IAEA Joint Division trains farmers in conservation agriculture to reduce the release of greenhouse gases. Through this practice, they retain crop residues on the soil surface and cultivate different crops every season through a procedure called crop rotation.

These practices reduce the runoff and soil erosion, because the soil can retain more water and nutrients. This technique also permits the soil to incorporate more carbon and to reduce carbon emissions from soils. With the help of nuclear

techniques, scientists analyse the carbon and oxygen isotopes released. The results give them an indication of how to lock as much carbon in the soil, which helps to keep the soil "alive".

While carbon dioxide is the most well-known greenhouse gas, experts say nitrous oxide is also damaging. The gas is produced and released naturally in the soil and is contained in many fertilizers. With the help of a soil moisture neutron probe, scientists can determine how much nitrogen the plant can absorb naturally.

This data allows them to provide the plant exactly the amount of nitrogen it needs and minimize nitrogen's release into the atmosphere. "Some plants can pick up the nitrogen from the air and use it as a fertilizer. If you know how much they can absorb, you don't have to use that much fertilizer," explains Nguyen. Through a technical cooperation project, the IAEA helped Slovenia improve its water and fertilizer use efficiency for commercial vegetables, hops and maize.

By using the techniques described above, scientists managed to increase nitrogen absorption by the plant from 45% to as much as 75% and prevented its unnecessary release into the atmosphere. They also managed to obtain the same crop yields with less than one third water.

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Helping Farmers Back Home

Growing Healthy Crops in Drought-Prone Kenya

Maasai farmer Mary Kashu is benefiting from an FAO/IAEA project that uses nuclear-enhanced drip irrigation technology to grow crops with very little water.

"Drip irrigation is a new technology for us, and since it's been introduced here we can plant our own vegetables and don't have to depend on livestock alone. We can improve our children's nutrition and raise some income. We can use the money to pay school fees and to maintain the pump to get more water from the borehole."

Louise Potterton/IAEA

Improving Agriculture in Sierra Leone

Soil Scientist Samuel Soki Harding was trained by the FAO/IAEA at the Kenya Agricultural Research Institute.

"I'm trying to acquire knowledge and skills in water management by using drip irrigation and the neutron probe, which measures soil moisture levels. In some parts of my country we have little rainfall and soil moisture shortage. So the farmers are getting poor harvests. The knowledge gained here will be shared with my institute at the Ministry of Agriculture."

Louise Potterton/IAEA

Training Scientists to Increase Harvests in Afghanistan

Soil expert Shahnawaz Rohani is being trained at the FAO/IAEA's Soil and Water Management and Crop Nutrition Laboratory.

"I'm here with five colleagues. We want to learn about the use of nuclear technology in soil and water management and crop nutrition. Back home, we will share this information with other people at the Ministry of Agriculture where we work. Isotope techniques will assist us in dealing with soil degradation through erosion, limited rainfall and drought."

Juanita Perez-Vargas/IAEA

Text: Louise Potterton & Juanita Perez-Vargas, Division of Public Information

Global Challenges in Animal Diseases

Livestock is the economic backbone for many farmers in poor countries. However, nearly 25% of the world's livestock is lost to animal disease. These losses cause hardship for three-quarters of the world's rural poor and one-third of the urban poor, who depend solely on their livestock for survival.

The livestock's loss threatens poor families' food security and their livelihoods. At the same time, since poor smallholders often live in close proximity to their animals, disease threatens these families' health as well.

Livestock are vulnerable to a number of highly infectious animal and transboundary animal diseases (TADs) such as foot-and-mouth disease (FMD), African swine fever (ASF), contagious bovine pleuropneumonia (CBPP) and peste des petits ruminants (PPR is an acute respiratory ailment affecting goats and sheep). Avian influenza (H5N1), 'Swine Flu' (H1N1) and other "zoonotic" diseases are transmissible between animals and people.

Given the risks that animal diseases, especially transboundary animal diseases, represent, national early disease detection, diagnosis and reporting is essential when coordinating early warning and quarantines in the affected region.

Combating animal diseases requires animal health strategies that can effectively combine local, regional and international action with coordinated research to share comparable diagnosis and surveillance data between countries.

Swift diagnosis is a crucial factor in controlling animal diseases. Yet, in many developing countries, the available veterinary services are not sufficient to adequately track and control animal disease outbreaks.

To eradicate rinderpest, a highly contagious viral disease that caused immense livestock losses and devastating economic damage throughout history, a long-term collaborative partnership between the the African Union, the Food and Agriculture Organization, the IAEA, the World Organisation for Animal Health (OIE), as well as national governments was established. Scientists and researchers developed, evaluated, validated and distributed immunological and nuclear technologies to diagnose and control rinderpest.

The Joint FAO-IAEA Division's veterinary laboratory network enables laboratories in developing countries to undertake animal disease diagnosis with the use of immunological and molecular biological platforms utilizing nuclear and nuclear related technologies. It also provides know-how, guidelines and expert support to help build the diagnostic capacities of veterinary laboratories in its Member States, as well as training, and the coordinated delivery of needed equipment.

In 2011, after several years of coordinated effort, the world was officially declared free from rinderpest.

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Taking the Lab into the Field

nuclear applications rapidly diagnose animal disease

The vets get to work. In just a few minutes, they set up a small table and unload a range of sophisticated sampling equipment.
(Photo: P.Pavlicek/IAEA)

After a four-hour drive over dusty, potholed roads, the vets finally reach their first destination — Yagoua in northern Cameroon.

The team consults with the staff of the local animal health services and heads further north towards the Chad border to a village where goats have reportedly been dying.

Off the main roads, driving becomes more difficult. With no lighting or signposts, navigation in rural Cameroon is not easy.

Finally, the team reaches Gabarey Waka, the scene of the reported disease outbreak. It is five o'clock — one hour until sunset when the village will be enveloped in darkness.

Inquisitive children greet the visitors. Two little boys, accompanied by their father, are holding baby goats. The animals, like many in the herd, are sick.

The goats have diarrhoea, infected eyes and sores in their mouths. The farmer is worried. Many of his goats have already died. They are his family's main source of food and its only source of income.

The vets, from LANAVET, Cameroon's National Veterinary Service, get to work. In just a few minutes, they set up a small table with chairs and unload a range of sophisticated sampling equipment from the back of their vehicle. They also change into their protective veterinary gear: rubber gloves, brown coats and boots.

By now, the whole village has gathered to observe the unfolding spectacle. After clinical inspections, the vets take blood samples from the animals, process them and place them into a small device, bearing the IAEA logo, which is linked to a laptop and powered from the car battery.

The system is capable of performing rapid and highly accurate diagnostic tests, on-site, in under an hour. (Photo: P.Pavlicek/IAEA)

After just 45 minutes, they have a diagnosis: PPR, or peste des petits ruminants, a highly contagious virus that kills goats and sheep.

The farmer, Galgava Oumarou, is distraught: "I'm a poor farmer. I've no other source of revenue apart from these animals. Nearly all of them have died from disease," he says.

"I used to sell them to get money to take care of my family. Now that these goats are no more, I do not know what to do. Poverty has stepped into my house and I don't know how I will feed my family."

The technique the vets are using is known as "LAMP PCR"- Loop-Mediated Isothermal Amplification, based on real-time Polymerase Chain Reaction.

It sounds complex and it is. But scientists from the Joint Division of the IAEA and the UN´s Food and Agriculture Organization (FAO) have been able to condense four years of research using isotope technology and nuclear-related techniques into one small, portable kit.

The system is capable of performing rapid and highly accurate diagnostic tests, on-site, in under an hour. In the past, several days were needed to perform the same diagnosis in a well-equipped laboratory.

Senior LANAVET vet Abel Wade says, "This technique has revolutionised traditional diagnostic procedures. In the past, I had to take samples, then return to my lab or wait for samples to arrive from the field. It could take weeks, even a month, before we actually got round to testing the samples and confirming an outbreak of a disease.

"Now, with this portable lab, we can run tests at the farms, in the bush. It's easy-to-use, quick, and works in high temperatures. We can give immediate advice to the farmer to prevent further losses and to limit the spread of the disease."

Animal diseases are a major problem in many African countries, including Cameroon, where the majority of people depend on agriculture and livestock for food and income.

According to estimates from the Interafrican Bureau for Animal Resources Office, around 300 million people in Africa depend on livestock for their livelihoods.

But 25 % of these animals die annually from preventable diseases. For example, whole flocks of poultry infected with Newcastle Disease are sometimes killed.

"I've seen people crying because of outbreaks of diseases like foot and mouth disease, which can kill more than 100 cows — that's 50% of one herd," says Wade. "Cattle are especially important here because you can use cows for their milk, meat and for farming. If you need some money for hospital fees or a scholarship, then you sell cows at the market."

The project, which led to the development of the portable diagnostic platform, was originally launched in 2008 as a direct response to the needs of many countries for the rapid diagnosis of avian influenza, in rural settings and outside of a conventional laboratory.

FAO/IAEA animal disease expert Hermann Unger says, "The rapid diagnosis and confirmation of an infectious disease, best at an early stage, is the prerequisite for its cost-effective control and to curb its spread."

"As most of the diagnostic techniques used so far needed laboratory-based equipment, the development of the LAMP technique in a

portable, robust and simple kit format, which makes it possible to confirm disease in the field in less than an hour, is a major step forward."

With an early diagnosis, quick decisions can be made on how best to contain and control a disease — by quarantine, treatment or vaccination. Fast action can not only limit damage to the affected herds, but can also prevent the disease from spreading into neighbouring villages or even other countries.

The LAMP PCR device can run tests simultaneously for up to eight diseases, including foot and mouth disease, African swine fever and peste des petits ruminants, as well as for diseases such as avian influenza (H5N1), Rift Valley fever and bovine tuberculosis that affect both animals and humans.

"Of course, Africa is not the only place where we're contributing with this new technology," says Unger. The IAEA, through its Technical Cooperation Department, has already provided devices costing around € 4000 each to more than 30 countries in Africa and Asia.

"In Sri Lanka, for example, we're seeing good progress in applying the technology on leptospirosis, an animal disease that is also infecting rice farmers," Unger says.

Livestock supports the livelihoods and food security of almost a billion people worldwide. As populations increase, countries not only need to increase livestock production, but also need more efficient tools for the prevention, diagnosis and control of animal diseases.

Nuclear and nuclear-related technologies have an essential role to play in maintaining animal health and protecting vulnerable communities.

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Swift animal disease diagnosis reduce the risk of livestock loss in sub-Sahara Africa

Livestock is the economic backbone for many subsistence farmers in poor countries. Farmers look after their animals for meat and milk, draught power and for social and cultural reasons. However, livestock are vulnerable to a number of highly infectious transboundary animal diseases (TADs) that can spread to other countries. Swift diagnosis is therefore crucial.

In partnership with the FAO, the IAEA develops new technologies and strategies to combat major livestock diseases. Fellows and beneficiaries explain how they have benefitted.

Technician Eugene Arinaitwe (top photo) was trained at the FAO/IAEA's Animal Production and Health Laboratory.
"At the Agency's Seibersdorf laboratories, I've learnt new techniques for the rapid and highly accurate diagnosis of animal diseases. I'll use the experience I've acquired here to train my fellow technicians in my home country, Uganda. This way, I can use this training to improve the diagnostic capacity in the lab where I work."

Cattle farmer Amadou Ama Adama (middle photo) was assisted by the National Veterinary Laboratory through an FAO/IAEA project.
"Some of my cattle die every year from Foot-and-Mouth Disease and this is a great financial loss. But during a recent outbreak the vets came to my farm and collected samples from the sick animals for laboratory analysis. They advised me on how to avoid the further spread of the disease and they gave me drugs to help heal the wounds."

Molecular Biologist Abel Wade (bottom photo) coordinates FAO/IAEA projects at the National Veterinary Laboratory, LANAVET.
"The collaboration between LANAVET and the IAEA is excellent and very important for the farmers we assist. If we can diagnose a disease quickly with the techniques provided by the IAEA, we can stop it from spreading. If it wasn't for the IAEA, we would have never reached the stage where we are now in the analysis and control of animal diseases."

Text: Louise Potterton & Juanita Perez-Vargas, Division of Public Information

Food Safety: An Integral

Food safety can be compromised anywhere along the way from the 'farm to the fork'.

Food safety is a necessity for everyone. The food on our table needs to be produced, processed and marketed safely to protect the consumer.

Trade liberalization and globalization have opened not only our borders; they also have increased our exposure to insect pests and food safety hazards. Annually, the number of people suffering from food poisoning in industrialized countries increases by 30%.

Foodborne illness caused by ingesting contaminated foodstuffs which carry viruses, bacteria, protozoa, parasites or fungi, usually results in nausea, vomiting, diarrhoea or fever. Symptoms range from mild to severe, and tend to affect the more vulnerable consumers such as babies, pregnant women and the elderly.

Part Of Food Security

Many of the germs that cause foodborne illness also can be transmitted in contaminated fresh water. Infection usually occurs while preparing or eating contaminated food. Because water systems often serve large numbers of people, outbreaks of disease can affect large segments of the population.

According to the World Health Organization, foodborne and waterborne diarrhoeal diseases together kill approximately 2.2 million people annually, including 1.9 million children.

Foodborne illness can also be caused by chemical hazards such as pesticides, which can lead to chronic, life-threatening symptoms or immunological disorders, as well as cancer and death.

Food safety can be compromised anywhere along the way from the 'farm to the fork': farmers use agricultural chemicals, fertilizers, pesticides and veterinary drugs; processors and retailers can adulterate, improperly prepare or store the food, or fail to adhere to the best hygienic standards before the food reaches our kitchens.

Trade liberalisation and globalisation have opened not only our borders; it also has increased our exposure to insect pests and food safety hazards.

In recent years, many countries have developed integrated and harmonized food safety and quality control guidelines in accordance with national legislation and international standards to protect the health of consumers. But food safety standards alone are not enough. Radiation technology can complement and supplement existing technologies to ensure food security, safety and quality.

For instance, nuclear techniques are used to verify food safety, by tracing food or feed products through all stages of production, processing and distribution.

Nuclear techniques are also used to prove product authenticity, to combat fraudulent practices, which are important issues for economic, religious or cultural reasons. For instance, nuclear techniques can be used to authenticate the purity and origin of specific regional specialities such as oil, wines, and other commodities.

But food safety standards alone are not enough. Radiation technology can complement and supplement existing technologies to ensure food security, safety and quality.

Increasingly, food safety is also a vital factor in ensuring food security — the quantity, access and availability of safe food. Food irradiation can cut post-harvest food losses caused by insects, bacteria or mould by 25% to 40%.

In the irradiation process, food is exposed to electron beams, gamma rays or X-rays to destroy microorganisms and control spoilage. Food irradiation has several advantages over heat or chemical treatments, refrigeration or freezing since it does not significantly raise food temperatures so the food does not "cook".

The process does not affect the taste, smell or texture of the food, nor does it deposit any potentially harmful chemical residues. Since the radiation can pass through packaging, packed foods can be treated, protecting them from any subsequent microbial contamination or pest reinfestation.

The FAO/IAEA Joint Division provides technical assistance to Member States who wish to adopt irradiation technology to support their international trade in food commodities and to help ensure consumer safety.

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When Eggs Don't Hatch

The Benefits of the Sterile Insect Technique

Insect pests, such as the medfly, tsetse flies and carob moth can devastate crops and infect herds, causing severe economic hardship. To suppress the insect pest population and protect their livestock and crops, farmers usually use large quantities of pesticides. However, these pesticides are expensive, a risk to public health and cause environmental damage. Another technique, however, can reduce the insect pest population using natural means that do not require toxic chemicals: the sterile insect technique, or SIT.

When female insect pests mate with male partners that have been radiation sterilized, the insemination produces eggs that cannot hatch. Since mating does not produce offspring, the insect population decreases naturally. The pest population can be suppressed with little or no use of pesticides.

With the help of the IAEA, farmers have applied SIT successfully in over 20 countries on five continents, for over 15 insect species worldwide.

The Technique

Large numbers of insects are raised in specialized facilities, where the male insects are sterilized with gamma radiation. This radiation sterilization does not harm the males in any other way: they can fly, mate and transfer sperm to wild females. The sterile male insects are mass-released repeatedly in the regions affected by an insect pest outbreak. While the wild insect population decreases, the number of sterile male insects is replenished. Over time, the rate of decline of the insect population increases.

Case Studies

The island of Unguja in Zanzibar has been affected by the disease spread by the tsetse fly for decades. The tsetse feeds on the blood of humans and animals transmitting a deadly disease called trypanosomosis. This disease has taken its toll on agriculture for centuries, causing countries significant economic damage. With the help of the FAO/IAEA Insect Pest Control Laboratory, which employed the SIT in the region, the tsetse fly was eradicated from Unguja.

The world's most economically devastating fruit fly pest is the "Mediterranean" fruit fly, also called the medfly. Yearly, these flies attack fruit and vegetable crops worldwide, making them unsuitable for export or local consumption. Countries such as Argentina, Chile, Guatemala, Mexico and Peru use the SIT to reduce the medfly population and protect their crops. They produced and released billions of sterilized male medflies leading to a significant decrease in the wild medfly population and ultimately in the medfly population as a whole.

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Better Diets for Weaker Systems

Making Food Safer in Indonesia

Sri Wahyuni sorts through yellow and silver foil packages: "This is beef, this is from soya beans, and this is a small fish, my favourite," she says with a smile.

These are not everyday food dishes; they are carefully prepared and specially vacuum-sealed meals that have been treated by irradiation.

Sri has breast cancer. She was diagnosed in December 2007 and six courses of chemotherapy have weakened her immune system. The 57-year-old research scientist is taking part in an IAEA project that is developing safe food for so-called "immuno-compromised" people using irradiation technology.

"This project is about improving the patient's nutritional status by eating sterile food," says Sri. "I need better antibodies to make my immune system stronger and I hope to achieve this by eating this nutritional food."

The project, which involves 17 countries, is being coordinated at the IAEA's Headquarters in Vienna, Austria, by Food Irradiation Specialist, Carl Blackburn, who works in the Joint FAO/IAEA Division. "Including irradiated food in a restricted diet can increase the range of safe foods that a patient is allowed to eat and in this way can help improve the nutrition in their diet," he says.

"Another benefit is that irradiated meals need less intense preparation methods, so it isn't necessary to 'overheat' the food to make sure it's safe to eat," he says.

People with impaired immune systems, such as those undergoing therapy for cancer, suffering from HIV/AIDS or recovering from an organ transplant, are more at risk from food-borne disease.

"These people can't usually eat fresh and healthy produce like salads, fruit and vegetables because of fear of infection. But if the food is irradiated, it's safe since this process has killed any potential bacteria or other harmful microorganisms," adds Blackburn.

Research conducted under an earlier IAEA project showed that despite food irradiation's potential to reduce the risk of food-borne diseases, there is little evidence of its wide-scale use to provide food for patients or other target groups who require this level of food safety.

According to Blackburn, the main aim of the project is to improve, and eventually increase, the variety and availability of nutritional food for people with special dietary needs, and to make hospital meals, which can be bland, more varied and appealing.

"Since starting this project, I've realised how important it can be to also provide a feel-good factor at meal times, especially for children," he says.

Including irradiated food in a restricted diet can increase the range of safe foods that a patient is allowed to eat and help improve the nutrition in their diet.
(Photo: L.Potterton/IAEA)

"This can be done by providing 'treats' like ice cream and local specialities, the dishes people would normally enjoy if they were not ill or hospitalised. So these kinds of food are also being developed under this project," he adds.

The IAEA project has brought together an international group of researchers, from North and South America, Africa, Europe and Asia, who are working together with medical professionals in their countries to develop the most appropriate types of safe foods.

In Indonesia, at the National Nuclear Energy Agency, BATAN, Zubaidah Irawati works as

a Food Irradiation Specialist and has been collaborating with the IAEA for over 30 years.

Irawati says: "I'm working with different groups of people, including scientists, regulatory bodies, government institutions, doctors and caterers. We're making tasty, ready-to-eat meals, based on traditional Indonesian dishes."

One of her research projects is in cooperation with the National Narcotics Board's Rehabilitation Centre in Sukabumi, west Java, where Irawati is working with former drug users who suffer from HIV/AIDS or hepatitis.

"We saw that by eating our irradiated food, the nutritional status of these people improved. I'm hoping to extend the project to include malnourished children in the future," she says.

Although this is a new project, Indonesia has been using irradiation to improve food safety and quality for over 40 years. It is one of 60 countries worldwide that are using the technique, which is approved by both the FAO and the World Health Organization (WHO).

"Food irradiation is of great importance here in Indonesia. It's a country with an abundance of spices, grains and fruits," says Irawati.

"But we have a hot, tropical climate with high humidity, so food can easily get contaminated with bacteria and insects and can spoil quickly."

Indonesia's commercial irradiation centre, Relion, in Jakarta operates seven days a week, 24 hours a day to accommodate the growing demand for food irradiation.

Some 150 products, including spices, grains and frozen and dried fish, are currently irradiated here for domestic and international markets.

The irradiation process applies energy from gamma rays, x rays or electrons to control insects and destroy harmful bacteria, which can cause food poisoning.

The process also extends the shelf life of food, since it destroys microorganisms, such as mould, that cause spoilage.

Food irradiation provides the same benefits as chemical treatment, heating, or refrigeration, but does not leave any harmful residues, raise the temperature or affect the taste and texture of food. It can also be used to treat packaged and frozen foods.

"For us, food irradiation means food safety, food security and food quality. It also enables producers to export more food so it's of economic importance too," says Irawati.

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Food irradiation provides the same benefits as chemical treatment, heating or refrigeration, but does not leave any harmful residues or affect the taste and texture of food.
(Photo: L.Potterton/IAEA)

What happened to my IAEA Bulletin?

In 2011, the IAEA Bulletin began its transition from print to an electronic publication. The move conserves natural resources, avoids carbon and cuts costs by over 80%, allowing the electronic IAEA Bulletin to be produced more frequently and reach many more readers than could affordably and sustainably be achieved with the print version.

A new Bulletin

After a half-century of continuous publication, changing a venerable journal like the IAEA Bulletin requires considerable care and thought. In fact, after nine months of experimentation and testing, the IAEA Bulletin's designer, Ritu Kenn, announced in June 2012 that the IAEA's first "App", the new Bulletin, was 'live'. Although initially designed for the iPad, Ritu plans to provide apps for many more mobile devices.

What's an App?

An "App" is an abbreviation for the term "Application", which is a small software package that can be downloaded to a mobile device. Apps offer the IAEA Bulletin-makers many new possibilities to deliver news, features and background about the IAEA and its mission.

Where do I get my IAEA Bulletin now that it's 'electronic'?

Just visit the Apple App Store and search for IAEA Bulletin. You will see our new App logo (left). Once you download the Bulletin App you will be able to read this and future editions on your iPad. In addition to articles you are used to reading in print, it incorporates videos, photo essays and other interactive features. It's fast, easy and free.

What is the black and white box?

The black and white box-like emblem you see is a Quick Response, or "QR" Code. It is the barcode's more advanced, 21st century cousin. A QR code stores over 1800 characters and it can link your mobile device to a website or an App without the need to remember and type long website addresses. The IAEA Bulletin's QR code (left) will instantly connect your iPad to the free App. Simply download and install a QR code reader App on your iPad. Using this App, point the iPad camera at the QR code and get linked to the IAEA Bulletin's free App.

Past editions are still available in the online archive at **www.iaea.org/bulletinarchive** in Arabic, Chinese, English, French, Russian and Spanish.

We would be very pleased to receive your comments on these developments and thank you for your loyal readership.

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