# INSIDE
## TECHNICAL COOPERATION


September 1995

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# Ready for partnership

When Lyndon Baines Johnson spoke of the need to "open the doors of opportunity" for people, he was quick to add that they must also be equipped "to walk through those doors". From its inception in 1957, some years before LBJ became president of the USA, the International Atomic Energy Agency took on the twin task of making nuclear technologies available to member countries and of enabling recipients to use them safely. For decades the focus of its **technical assistance** activities was dominated by building capacity to utilize nuclear technologies in scientific and research applications.

As other UN agencies were busy designing and delivering development projects, IAEA technical assistance built basic infrastructure—national institutions, research units, expertise and skills at all levels, interaction with other countries—so that each country would have the capacity to absorb and apply nuclear techniques to resolve local problems. The option, you could say, was thrust upon the Agency. Unlike other development sectors, it was clear that few countries had even a semblance of the required capacity. But beyond that, the IAEA reasoned, there was not a strong justification for transferring technologies that recipients would be forever dependent on foreign experts to use.

"Anybody who is involved in economic development anywhere in the world ... knows how critical human and institutional capacity is to the development effort and the chances of success," Edward V. K. Jaycox, World Bank Vice President for the Africa Region, said in a 1993

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*Marine research: deploying a sediment trap*

# UN family ties

A three-week cruise on the Caspian Sea this summer may sound enjoyable but would misconstrue what is happening on the Azerbaijan research vessel Alif Gadgiev rented by the IAEA. This is all work and no play. As the ship moves slowly from the shallow northern to the deeper middle and then the very deep basin in the south, the passengers are using sophisticated equipment to gather water samples at various depths and doing a number of measurements and experiments.

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# More dried fish not DDT ...

*Dried fish is an important source of protein*

Bangladesh scientists recently made a frightening find. Dried fish sold across the country contained DDT. Some samples analyzed at the Agency-established Pesticide Residue Laboratory of the Bangladesh Atomic Energy Commission (BAEC) had 100 times what was the permissible level before DDT use was internationally banned, including in Bangladesh, some 20 years ago. By then, DDT—the oldest synthetic organic pesticide and the most widely used worldwide—had got into virtually everything alive, from the eggs of soaring eagles to fish several kilometers down in the oceans. It was reported that by the early 1970s the milk of most mothers in the United States had so much DDT that, under US commercial regulations, it could be prevented from crossing from one state to another.

The DDT in the dried fish, Bangladesh's main source of animal protein, did not get there by chance from a residual. It was put there, by traders, to kill insect larvae that normally infest the sun dried fish and reduce them to bones in a few weeks. Dipping in (or spraying) DDT could extend the shelflife of the commodity to several months. Where they get the pesticide from has not been established. Despite its long name, *dichlorodiphenyl trichloroethane*, DDT is based on a simple compound found in natural gas and can be produced in a backyard laboratory. The damage it can do to human health is considerable. But what to do, beyond policing and cracking down on the use of the already banned substance?

Happily Bangladesh does have the means to preserve dried fish for many months, without using DDT: a demonstration and partly commercial multi-purpose (food and medical supplies) irradiation facility. The 80 000 curie Russian-built plant, paid for from TC funds, began operating in March 1993. Sited in Chittagong, in the heart of the fishing region, it could treat all the dried fish the country produces. Irradiation after packaging would keep the food undamaged by larvae and cleansed of pathogens as well. The government's emerging strategy to ensure that DDT is not used includes both compelling the traders to use the facility—and enabling them to do so. In fact it embraces other foods which are treated with other toxic substances after harvest.

Bangladesh is a least developed country (LDC) as defined by the UN, but in nuclear terms it is more advanced than many in the developing category. The key reason is governmental commitment to invest in the atom. Apart from the irradiation facility, it operates a research reactor, a linear accelerator and a neutron generator. The build-up of capacity to absorb nuclear technical help began when an atomic energy centre was set up in Dhaka in 1965, when the country was still East Pakistan.

BAEC, formed in 1973, two years after separation from Pakistan, has set up many facilities (including an institute of nuclear medicine and 11 nuclear medicine centres, a radiation testing laboratory, and an atomic energy research facility) and guided an extensive research and development programme. It can now train scientists, engineers and technicians in nuclear physics, chemistry, electronics, medicine, radiation biology, isotope applications in agriculture and industry and other fields—for its own activities as well for others in the public and private sectors. IAEA **technical co-operation** assists in-country group training and funds fellowships abroad for top specialists

BAEC's institute of food and radiation biology began research on human tissue grafting in 1985, with IAEA **technical co-operation** help. Over the years items from its tissue bank—of bones, cartilage, embryonic tissue, ligaments, skin—sterilized by radiation, have been successfully used on more than 400 patients in Bangladesh hospitals. Tissue banking has developed over the past 40 years and today there are more than 100 banks worldwide. One of them is in this LDC.

# ...bigger harvests with less fertilizer

***Bangladeshi farmer and family at the edge of his lentil field.***

A major new drive by the Vienna-based Joint Division of the Food and Agriculture Organization (FAO) and the IAEA is to increase crop yields while using less chemical fertilizer which is both expensive and harmful to the environment. In Bangladesh the ultimate target crop is rice. But it has started on legumes, the principal protein source of the poor. Legumes have the natural ability to absorb nitrogen not only from the soil (and from fertilizers put there) but from the air. In fact this "fixing" of atmospheric nitrogen ($N^2$) is done by a bacterium called rhizobium in the soil. All legume plants seem to recognize rhizobia as alien, and form nodules around the bacteria at their roots. But the bacteria are benign and those in nodules go on fixing $N^2$ in forms usable by the plant.

The more nodules the better the plant thrives and the more protein it provides for humans and animals. The number of nodules is proportionate to the density of rhizobia in the soil. Since 1988 IAEA **technical co-operation** has aided the Bangladesh Institute of Nuclear Agriculture (BINA) in a project to improve its rhyzobiology capacity and take on the research and development to maximize this gift of nature. BINA has identified elite genotypes of grain legumes which, in combination with appropriate strains of rhizobia, can fix greater amounts of nitrogen than the traditionally used local cultivars, and shown that yields of chickpea, groundnut and lentil can be increased significantly.

Using a unique nitrogen-15 ($N^{15}$) technique developed by the FAO/IAEA Joint Division, the BINA studies have also shown that application of a **biofertilizer** of peat and the best strains of local rhizobia for lentils, chickpea and groundnut can add 70-100 kilograms per hectare of atmospheric nitrogen to the soil through biological fixation. This is about what 150-200 kg/ha of urea would provide. Urea costs US$20-25 per hectare, the biofertilizer $3-4. And the biofertilizer has none of the environmentally harmful effects of commercial nitrogen fertilizer. Lentils, chickpea and groundnut are grown on 357,000 hectares in Bangladesh (roughly half the area covered by all pulses). The amount of biofertilizer (rhizobia plus peat) needed, if chemicals are replaced in the total area, is estimated to be 750 tonnes a year.

Until the introduction of Model Projects (see "A Model Vehicle", page 3), such experimental findings might have remained in the institute, waiting for someone to come along and use them. In this case a model project called *biofertilizers for increased legume production* was launched this year. With seed money and some technical help from TC in the first three years, it is expected to generate its own funds through a contract mechanism with the private sector to sustain its future activities.

The idea is for BINA, the Ministry of Agriculture and private companies to collaborate and steadily build-up both the farmers' capacity to use the biofertilizers (different mixes for different legume crops) as well as the country's capacity to produce them. Both will require successive and widespread field trials to evaluate what is best for where. On the production side, BINA already has a pilot-scale factory with three small (100 litre) fermenters needed for rhizobia production, each able to produce 5-8 tonnes a year of bacteria-plus-carrier which would be sufficient for the early trials. Decisions on large scale production of biofertilizer and a large scale programme for sustainable legume production will not be taken until all the findings of the first two years (1995 and 1996) are in. But the government is committed to introduce a biofertilizer industry in Bangladesh. It is hoped to attract private investors in setting up a commercial scale plant with technical and scientific support from BINA.

IAEA technical co-operation will provide expert services to support the production of high quality biofertilizer, as well as some equipment and supplies, mainly inoculum fermenters and $N^{15}$ labelled fertilizer for field testing. Its total contribution over three years, including fellowships and scientific visits, is budgeted at $151,650. For Bangladesh, which will invest much more in various ways, increasing legume production by about 25% through the use of biofertilizer could lead to savings of about $25 million on imported legumes and about $6 million on chemical fertilizers. The returns in terms of a new industry, employment opportunities, and environment friendly sustainable legume cultivation, are more difficult to quantify.

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speech. Providers of development assistance, he said, "tend to use expatriate resident technical assistance to solve all kinds of problems. Not only do these problems not get solved, but I would contend that this is a systematic destructive force which is undermining the development of capacity ..."

Fewer than one quarter of the Agency's members have a nuclear energy programme and most of those are developed countries. But among the rest there is a clear interest to apply nuclear technologies for economic development.

The applications are now quite numerous, reaching ordinary people almost everywhere and everyday. These technologies range from treating cancer in humans to diagnosing diseases in animals, from improving crop productivity to producing disease-resistant plants, from controlling pests and eradicating pathogen carriers to measuring water resources, soil fertility and fertilizer regimes, from industrial applications such as measuring the thickness of paper and the integrity of oil or gas pipelines to those that affect us as individuals such as the quality of the food on our plates. These and many other nuclear technology applications can produce significant social and economic benefit for developing countries.

Under the Agency's traditional approach, each country, once it had developed its capacity, would be in a position to identify the problems that nuclear technology could best resolve; handling the research and preparing projects for implementation. A government could ask for international assistance when it had established what it wanted to accomplish.

In contrast, as Mr. Jaycox of the World Bank observed, much technical assistance "is imposed, it is not welcome and there is no demand for it really." For example, the World Bank Group lends US $4 billion a year in sub-Saharan Africa. In 1993 it had US $14 billion outstanding. The commitments were there, but no drawdown. Why? "It's an issue of capacity," Jaycox said.

Of the 88 countries which now benefit from IAEA **technical assistance**, the most advanced in nuclear science are those, unsurprisingly, whose governments have committed themselves to the task. Ghana (see Ghana, page 6) is one of the best examples in Sub-Saharan Africa, the region least advanced in application of nuclear techniques. Similarly, Bangladesh, a least developed country (LDC), is much more advanced in the nuclear field than some developing countries (see Bangladesh, pages 2,3).

IAEA support for nuclear based development activities to these two countries has amounted to some US $18million over the years. These are paltry sums compared with total development assistance, but Ghana and Bangladesh are now able to apply nuclear means to achieve nationally important ends, and have already done so, due in part to the Agency's concentration on capacity.

Now, after three decades of intensive focus on building infrastructure—typically through felloships abroad, training within the country, research contracts, expert assistance, and provision of laboratory equipment and facilities—Agency **technical assistance** is ready for a new partnership in **technical co-operation**.

For the TC Department, the reasoning is straightforward:

*"Adequate infrastructure including trained people in the field has been successfully established in many countries. The next step is adequate national capacity to take nuclear techniques into the development arena. With strong government commitment and the support of other partners nuclear technology can reach the end users and effect significant social and economic impact. We can no longer just transfer technology and hope somebody uses it. Its application must be part of a programme to address major problems and achieve lasting results."*

# A model vehicle

Having taken the step to enter the wider arena of development, utilizing its expertise and the capacities of its counterpart national nuclear bodies in a new partnership in development, the **Technical Co-operation (TC) Department** realized it needed a new vehicle. The road was clear. While many other development agencies continued to complain of lack of national capacity, many of the TC Department's national counterparts already had the skills and infrastructure to apply nuclear techniques, especially in the priority areas of human health and agriculture.

The vehicle for applying nuclear technologies in social-economic development is what the TC Department calls its **Model Project**. In the past two years 23 Model Projects have been launched. The inauguration on 1 June this year of China's first industrial scale irradiation plant to be used for disinfestation of foodstuffs, mainly rice, reflects the success of one. Like all Model Projects, it has immediate practical benefit to the national economy. It is sustainable with national expertise and the technology has comparative advantage over conventional approaches.

The Chinese Government's strategy is to expand food irradiation applications once this pioneer project has demonstrated that the technology is economical and effective. Growing demand for quality foods has led to increasing restrictions on conventional methods of disinfestation (insecticides and chemical fumigation) which are harmful to human and environmental health. Irradiation offers a safe and effective means of achieving greater crop utility and value. For the IAEA the Model Project is the next stage in the evolution of its technical co-operation programme, from the transfer of technology to a partnership in national development. The MP concept, still being fine tuned, takes the results of nuclear science all the way to end users such as farmers, health services, industries.

For example, research by Mali scientists has produced mutations of native rice and sorghum that give higher yields than those now cultivated and are of a quality that is more attractive to consumers and more valuable to farmers. The TC Department provided expertise, equipment and training to accomplish this breakthrough. If the new seeds prove vigorous and can be widely distributed, farmers would earn more and the country's imports would be reduced. How to demonstrate the viability of the mutant seeds for the farmer? This is the thrust of a Model Project started this year, in which the government, particularly the Agriculture Ministry, is the primary motivator. The key prerequisites of all Model Projects are that they receive strong national commitment, respond to national development plans and be of practical value to specified end users.

Model projects are based on national capacities and designed to address national priority needs. The TC Department proposes application of nuclear techniques only where they are clearly advantageous or at least cost-effective compared to other means to ends that achieve results. The government must fully commit to the Model Projects objectives: construct building and facilities, provide national project personnel and even contribute in cash. China put in a massive US$1,015,500 of a total cost of $1,331,300 for the irradiation plant. The share in cash may vary, but all governments must provide substantial contributions. Additionally, Model Projects are designed to be completed in a few years, therefore governments must be prepared to sustain the activity after support from the Agency is discontinued, and also be able to do so with minimal international funds and expertise.

While the IAEA can develop basic national infrastructure and initiate projects that demonstrate the effectiveness of a particular nuclear technique to achieve national objectives, its resources are not sufficient to reach all end-users and situations in which the technologies are demonstrably useful. Many funding agencies have the opposite problem: finding good and clearly implementable projects which the government has the capacity to absorb. The Model Project concept provides a framework and opportunity for donors and development agencies to become partners in IAEA TC activities. Recent experience and discussions with top funding agencies have indicated that significant amounts of bilateral and multilateral assistance, already made available but unutilized by some IAEA Member Countries, could be redirected into IAEA **technical co-operation** projects that could be absorbed with significant socio-economic impact. The IAEA's Technical Co-operation Department has developed the tools to bring the benefit of nuclear technology to the doorstep of developmental objectives in food security, environmental quality, health, industry and poverty alleviation. The only thing missing is the opportunity to develop the full potential of this important contribution to human development.

# Home improvement

As it prepared for the transition from basic technology transfer to developmental partnership, the IAEA's Technical Co-operation Department also looked *inward*. Peer review was an important com- ponent for improving efficiency and enhancing the relevance of Agency TC activities.

The Model Projects initiative has established a new standard for the Agency's technical co-operation activities based on national priorities and providing end-users with new and powerful technical solutions. They have also served to orientate Agency staff to seeing nuclear technology not as an end in itself, but as a means to achieve improvements in the human condition.

The Department's new strategy to spread the Model Project concept throughout the TC programme and involve additional Agency technical officers, national nuclear counterparts, and officials of recipient countries includes two initiatives—country programming and thematic planning. These initiatives will identify where nuclear technologies can be most effective and concentrate assistance on "fewer but better" projects in order to create significant national impacts through strengthened commitment to priority activities, better co-ordination with other UN organizations **at country level** and interacting more effectively with donors and funding agencies.

Co-ordination between TC and other IAEA Departments (such as Research & Isotopes or Nuclear Safety) is also being enhanced, especially with those Divisions and Sections having a role in implementing TC projects. Each project has a project officer from the Technical Co-operation Department and a technical officer who could be from any one of the technical divisions of another Department. Regular meetings between technical and programme staff have speeded up the project implementation process significantly as witnessed by the rate of financial implementation for Technical Co-operation Fund (TCF) resources of almost 72%.

The Department was concerned about the large number of projects not implemented on schedule and the annual carry-over of unutilized resources. There was an unacceptable gap between project approval and implementation caused by delays in getting the prerequisites for the first six months of projects—expert job descriptions, specifications for equipment procurement, workplans, fellowship applications and the like. Improved technical liaison has cut those delays. In 1994, project prerequisites were sought and received for a substantial number of proposed projects between 3-6 months earlier than in previous years, yielding an important "head start" in project implementation of the 1995-96 Programme.

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On board are experts from the Agency and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and participants from the five countries that surround the sea (Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan) who are doing the sample taking and receiving hands-on training to do precise oceanographic measurements and acquire the skills necessary for follow-up activities. Such sampling, especially at great depths, needs special equipment and skills. Training in management and collaboration among the disciplines involved—chemistry, oceanography, isotope technology and marine biology—is also included in the on-board course.


*Loading sterilized flies for aerial release.*

The mystery of the Caspian's dramatic sea level rise since the late 1970s remains to be solved. It has risen an estimated 2.5 metres in the past 15 years and is still rising at about 15 centimeters per year. The devastating consequences to the people of this basin include flooding of harbours and coastal facilities, changing groundwater flow of adjacent aquifers, cholera outbreaks caused by stagnating sewage which cannot flow towards the sea, pollutant build up from refining oil and salt water intrusion into adjacent groundwater and agricultural soils. The increase in pollutants is affecting fisheries and caviar production due to declining sturgeon numbers. The cruise, which is also expected to provide valuable new data on the Caspian Sea, is a small but important input in a massive programme being knitted together by members of the UN family.

An international meeting called by the UN Environment Programme (UNEP) in Geneva early this year concluded that a multidisciplinary, multisectoral and intergovernmental approach is needed to cope with a situation that is getting worse. The comprehensive programme which is being finalized will be coordinated by UNEP and involve many other UN agencies which have visited the riparian states in order to establish government commitment and active participation.

The World Meteorological Organization (WMO) is preparing to re-establish and upgrade the hydro-meteorolocal monitoring stations in the region, especially in the Caspian's catchment area, that have fallen into disuse or neglect since the break up of the former USSR. UNESCO (the UN Educational, Scientific and Cultural Organization) and the World Health Organization (WHO) are also deeply involved because of the threat to national heritage and human health.

The IAEA has a key role in establishing the *cause* of the sea level rise, without which preventive, mitigative or curative actions cannot be planned. The "cruise" project, an Agency initiative in which the IOC is taking part, will provide initial baseline data from isotopic analyses of the samples it gathers. The **Technical Co-operation Department of IAEA** has a second-phase project designed to produce detailed data on this phenomenon and contribute significantly to the remediation activities planned by UNEP.

Joining forces with other agencies is crucial to the effectiveness of **technical co-operation** in efforts to apply nuclear science in the social and economic growth of Member States of the Agency. Because the technologies are applicable in so many areas, the Agency can seldom take the lead. Instead it sees itself as a valuable "partner in development" in support of many areas of activity by UN specialised agencies. Collaboration, with governments and development agencies, has become an important component of Agency TC. Its Model Project concept provides a mechanism for realizing the socio-economic benefits of nuclear technology.

The IAEA and FAO (the Rome-based Food and Agriculture Organization of the UN) established a Joint Division in Vienna more than 30 years ago. The recent FAO initiative (with UNDP financial support) on global food security, has led to even greater co-operation with FAO in Rome. The TC Department, however, wants to go beyond just transferring nuclear techniques in agriculture; it seeks to carry their application through to end users, using FAO connections with national agriculture extension services. Collaboration with WHO is expanding as well. One noteworthy programme is directed against cancer. Cancer is increasing worldwide and the greatest increase is in the developing world. By 2010 approximately two-thirds of new cases will be in developing countries.

Given their different mandates, WHO and IAEA have played different but significant roles in the fight against cancer. WHO has concentrated on diagnosis and treatment while transfer of technology and equipment for radiological methods such as teletherapy and brachytherapy has been left exclusively to the IAEA.

Early diagnosis is vital for successful treatment. For example cervical cancer is decreasing in the developed world because of early diagnosis. Many cases that come to cancer treatment centres in developing countries are too far advanced to permit treatment. A new WHO/IAEA collaboration is planned to develop national diagnostics and radiotherapy systems for health maintenance programmes in several developing countries.

Collaboration with others organizations of the UN family has not been easy, but many new projects have been launched recently or are being developed. One such initiative with the UN Industrial Development Organization (UNIDO) seeks to set up a pilot facility to produce sterile male tsetse flies in Africa. Tsetse flies infest 36 countries and a total area of 10 million square kilometres in Africa.

Throughout this area the disease transmitted by the tsetse fly has a devastating effect on huge numbers of livestock. The sterile insect technique (SIT), which involves releasing sterilized males to challenge the fertile wild ones as mates, has the potential to eradicate the pest in significant portions of Africa where tsetse infestation is seriously affecting human and animal health, and economic productivity. IAEA has the ability to transfer technology to breed and sterilise the flies on a massive scale to combat this devastating pest, while UNIDO is assessing the capacity to industrialize this process as a *national* activity which is essential for sustainability. UNDP has the field network to organize the activity on a regional and sub-regional level.

Several projects have sought to control tsetse fly populations, but not as yet eradicate them over truly large areas. Eradication will bring highly desirable consequences to African social and economic development and also for the environment which would be spared of chemical control effects. Much remains to be done in conjunction with planning, organization, infrastructure development relating to fly rearing, release, monitoring and maintenance. However, the success of FAO and other international partners such as the European Union in controlling tsetse fly species creates a favorable situation for full eradication, especially with the strong commitment of governments, national counterparts and extension services.

# Ghana sees big benefits from "mini" research reactor

In March this year Ghana started-up its first research reactor, 32 years after a grand design to install a much larger one from the then Soviet Union was aborted. The new Chinese-built reactor is truly 'mini', with a capacity of only 30 kilowatts. Commonly research reactors have megawatt-plus capacity. But Ghana has made enormous strides in nuclear science in recent years and has the capacity to make maximum use of it. An important activity for the national economy would be neutron activation analysis (NAA) techniques, using neutrons produced by this research reactor to assay rocks, sands, soils, and help identify mineral resources such as bauxite and manganese which are very important to the Ghanaian economy.

NAA techniques will also be applied to assess the quality of the environment, water, and food supplies, both imported and locally produced. NAA can determine minuscule particles of elemental and other impurities in a sample very rapidly and accurately, far beyond the capability of conventional chemical methods. Using the research reactor Ghanaian scientists are now able to perform these analyses. The procedure includes spectral analysis to find out what elements are present and in what concentration in the whole sample. But this requires computer software. Shortly after the reactor was started up, Ghanaian technicians adapted a software that the agency had developed for spectral analysis. Since then a dedicated software package specially designed by the Chinese for NAA in this reactor type has been installed.

The other key activity for the reactor is radioisotope production. Many radioactive isotopes are routinely used in agriculture, health care, hydrology and other fields. They are commonly produced in nuclear research reactors with a minimum flux density of neutrons. Although it is small the reactor in Ghana has the flux density to produce certain specific radioisotopes, though not on a commercial scale. Most importantly the mini reactor will be used for research and training, increasing Ghana's skilled manpower and upgrading expertise.

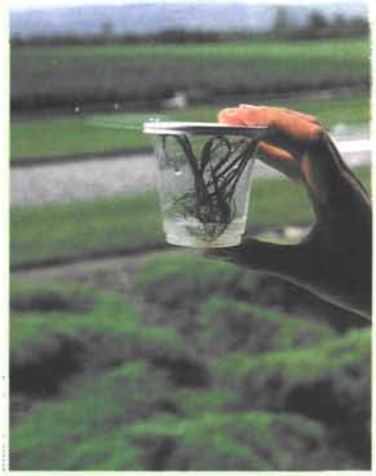
# Search for sleeping genes

The crops that feed us today evolved over millions of years. Their early ancestors often had to contend with extremely hostile conditions such as salinity, drought, frost, heat, and water-logging. Only those that had the right genetic make-up survived. Later, as climate conditions became more comfortable, there was less need for those hardy genes. But plant scientists believe they are not dead, just dormant, and that if crop plants are suitably challenged the appropriate genes would be aroused from slumber.

The need to awaken these "inducible" genes is becoming urgent. The burgeoning human population has to be fed. Demand for living space adds to the need for more crops to be grown on less land, in nutrient-depleted soils, in areas prone to increased flooding or drought, heat and cold. Already some 40 per cent of cropland worldwide suffers from salinity, another 20% from acidity.

In mid-1994, the Agency launched a coordinated research programme (CRP) to search for inducible genes in crops that either do not produce viable seeds or are propagated by seed but the progeny are very different from the parent. The aim is to identify the genes that enable each crop to tolerate one or other inhibiting condition—drought tolerance in potatoes is an example—isolate these genes, clone or transfer them to that variety, or accentuate their effect, so that the crop better meets the challenge. Another part of the programme is to induce mutations by irradiation and thereby produce new and possibly more productive varieties of crops.

**IAEA Coordinated Research Programmes, designed to promote international research in a thematic way, network agricultural research institutes of a number of countries with focus on a single subject to be researched in a way prescribed in detail. Typically they bring together institutes of developing countries and one organization that has done extensive research on the theme, normally from a developed country.**



**From lab to land: tissue culture is a key to improving vegetatively propagated plants. (credit: Beant Ahloowalia)**

The CRP on ***in-vitro* techniques for mutation induction and selection of desired genotypes** involves national agricultural research institutes of nine countries—Bangladesh, China, Colombia, Egypt, Ghana, India, Pakistan, Peru and Syria—with Ilga Winicov of the University of Nevada, Reno, USA, as agreement holder.

Crops being studied are cassava (Kenya), garlic (China, Syria), pineapple (Ghana), potato (Colombia, Egypt, India, Pakistan), sugarcane (Bangladesh, Pakistan) and sweet potato (Peru). The countries are seeking to find out how these plants can withstand specific stress in a particular environment. Peru, for instance, wants a sweet potato that can cope with high temperature and drought. Bangladesh wants a sugarcane that can grow in water-logged conditions, and one that does not flower because flowering stops growth and sugar recovery suffers.

Ilga Winicov has done pioneering work on alfalfa. By stressing alfalfa with high doses of sodium in the growing medium she has been able to select cell lines and regenerate plants (even seeds) that are much more tolerant than the parental variety; and can withstand 1% sodium chloride in the water. What's more, they exclude the salt rather than survive salt uptake. In much earlier experiments with sugarcane, in Hawaii and Cuba, scientists found plants that tolerated salt but took it up, so when crystallising sugar the salt was also crystallised. Winicov has also used molecular techniques to identify the messenger RNA in alfalfa, opening new avenues for that technique to be used.

The CRP is applying a combination of tissue culture and radiation mutation techniques, to induce desired genes or produce new ones. In the first, the planting medium is manipulated by adding salt or chemicals that produce the undesired effect in the plant, such as cell dessication which is what happens in drought, to simulate the stress conditions in a field. In the second, mutations can be induced in millions of plant cells or entire plants by a single radiation dose. Both provide the huge cell populations needed, to select the desired traits. In some cases, even selection can be done at the test tube culture stage. And once the required genetic changes have been identified the selected plants can be multiplied in tissue culture very quickly in the lab, for release to farmers—the ultimate target. Some CRP participants already have plants in field trials which were produced in the lab.

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Tel: + 43 1 2060 26005 Fax: + 43 1 2060 29633 e-mail: foucharp@tcpo1.iaea.or.at