Improving Farming with Nuclear Techniques

by Sasha Henriques

Soil erosion, land degradation, the excessive or inappropriate use of fertilisers in agriculture and poor water quality are threats to the environment and hamper development.

IAEA projects apply nuclear technology to evaluate these risks and find ways to make better use of water and soil resources. Many countries have benefited from this programme, including Qatar, Chile, Kenya, Turkey, Vietnam and Bangladesh.

Qatar is one of the 10 most water-scarce countries in the world and all its arable land is irrigated with groundwater. But, more than half of the water being used doesn't reach the crops, evaporating from the soil to the atmosphere. As more groundwater was used for irrigation, and levels fell, seawater and saline water from deeper aquifers intruded on the supply of fresh groundwater.

Isotopic techniques were used to determine the most efficient way to use saline groundwater and treated sewage water through drip irrigation.

Drip irrigation reduced the amount of water needed by up to 30%, compared to sprinkler irrigation.

There are now plans to use 100 million m^3 of saline groundwater with 60 million m^3 of treated sewage water annually, which will effectively increase agricultural acreage eleven fold.

Nearly 60% of arable land in Chile is affected by erosion, and in Central Chile, a shortage of flat land has increasingly compelled wine growers to plant vineyards on hillsides which eventually pollutes water downstream. Three consecutive IAEA technical cooperation projects were undertaken in Chile to investigate this problem. A fallout radionuclide was used to determine the extent of soil erosion and resulting water pollution. The research showed that current vineyard management practices are untenable.

So there are now plans to investigate the use of permanent ground cover between vines to effectively minimise soil erosion and water runoff on slopes and hence improve downstream water quality. Emilio Sanchez from the La Roblería vineyard in Apalta says, "The vineyard associations have been open to embrace nuclear research techniques as it has been a win-win relationship for the farmers of the region."

In Kenya, agriculture is the second largest contributor to gross domestic product, with 70% of the population working in the sector. Yet the majority of farmland is arid or semi-arid, with low and erratic rainfall. And food production is low with frequent crop failures. The IAEA worked with the local scientists to develop small-scale, low-cost drip irrigation technologies for poor farmers.

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These technologies, perfected by the Kenya Agricultural Research Institute (KARI), are currently being transferred to smallholder farmers for use with high-value crops like cucumber, tomato, kale and lettuce. An example is a project that provides Maasai farmers at Namanga on the Tanzanian border hands-on training in drip-irrigation techniques (see page 23). KARI now provides technical expertise and know-how on agricultural water management to 23 African countries.

Turkey is the world's 5th largest potato exporter. The main challenge farmers encounter is to use water and fertilisers more efficiently by applying irrigation water mixed with fertilisers, also known as fertigation, to the right place, at the right time and in the appropriate amount. Using drip irrigation significantly reduced the amount of water and fertilisers that were needed. This is having

a major impact on Turkey's potato production, yielding substantial savings for farmers.

Vietnam has also been affected by erosion, loss of soil nutrients, as well as water and fertilizer use efficiency problems. They sought the IAEA's help. Compound-specific stable isotope techniques were used to identify areas of land degradation. The findings of the project have been used to raise farmers' awareness and to help them adopt strategies to mitigate the impact of typhoons on agriculture in north-western Vietnam.

Soil salinization is a major threat to crop production in Bangladesh; such that about 90% of potentially arable lands in the coastal area remain unused during the dry season. Improved water management practices through drip irrigation, coupled with the identification of saline-tolerant crop varieties during the project, have enabled farmers to introduce and harvest a second crop, in addition to aman (paddy) rice, on potentially up to 2.6 million hectares of highly fertile coastal lands. This could, for example, possibly add an additional 4 million tonnes of wheat to the national bread basket.

Abdul Aziz, who is a farmer from Noakhali, Bangladesh, says, "I used to leave my family in the village and go to Dhaka in search of a job because I could not grow any crop from August to April due to the high salt content in the soil. Now, I earn about US $2000 per hectare each year from the cultivation of newly introduced groundnuts and wheat."

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Making the Most of It by Peter Kaiser

Radiation technology cleans polluted water for re-use

Today, cities host rapidly growing populations and expanding industries. The flow and severity of the pollution that transforms freshwater into wastewater is increasing as a result. Common chemical contaminants in water include persistent organic pollutants, petrochemicals, pesticides, dyes, heavy metal ions, as well as excreted pharmaceuticals. These complex compounds are difficult, often impossible, to remove or degrade using conventional means, and remain in the water to pose new and worsening health risks. Neutralizing these risks makes wastewater management challenging and more expensive. Cities and industries need cost-competitive solutions to treat water to be able to reuse it responsibly.

Frequently, cities face a water shortage, which they hope to alleviate by treating wastewater so that it can be utilized for tasks such as fire fighting, street cleaning, urban park and horticultural irrigation, industrial cooling and laundry, and boiler water for heating that do not require drinking-water quality. This "reuse water" can be produced through a variety of means, including treatment with energy delivered by an electron accelerator. Electron energy leads to the formation of highly reactive free radicals that inactivate toxic microorganisms, parasites and also decomposes the complex pollutants into less harmful and more easily treatable substance, which other means and agents cannot. Radiation treatment using electrons, causing no lingering radioactive contamination due to the low energy of the electrons.

At an industrial textile dyeing complex in Daegu, Korea, the first electron beam waste water treatment plant has been working successfully since 2006 The treatment plant handles 10 000 cubic meters of textile wastewater daily, or approximately the volume of four Olympic swimming pools.

The Daegu plant has demonstrated that "the process is safe and effective" said Bumsoo S. Han, an international expert on electron beam wastewater treatment. Han compared the performance of the existing technologies and concluded that "the electron beam technology produces the desired quality of effluent water at lower cost, without additives. It is a win for the environment and a win for the industry."

Together with its international partners, UNIDO and national institutions, the IAEA supports research and expert collaboration in the field and is pursuing wastewater treatment projects in Hungary, Iran, Morocco, Portugal, Republic of Korea, Romania, Sri Lanka, and Turkey.

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