The Challenge

Bangladesh is a deltaic country with a total area of 147,570 km², agriculture accounting for a major sector of the national economy. The coastal regions that occupy about 20% of the country’s land area are very fertile and are used primarily to grow rice. During the rice season from April to the harvest in August river water as well as monsoon rainwater, harvested in large ponds and natural depressions, is used to flood the rice. During the subsequent months of dry season the intrusion of tidal water from the coast causes the soil and water salinity to increase from around 1 ppt (parts of salt per thousand gram of soil or water) in August to 8 ppt or more in April. This natural salinization is a major threat to crop production, so that about 90% of these potentially arable lands remain unused during the dry season.

Key challenges to increasing the cropping intensity of these fertile lands are to use the collected pond water, consisting during the dry season of a mixture of rainwater and saline ground- and tidal waters, for crop irrigation without aggravating the natural soil and groundwater salinity, and to identify crops that will thrive in these saline conditions. In order to meet these challenges, irrigation must be applied at the right time and in the optimal amount for each type of crop so as to minimise the use of groundwater that would otherwise cause a further ingress of saline seawater and a resultant increase in soil salinity.

The Project

Through an IAEA technical cooperation project, the Bangladesh Institute of Nuclear Agriculture identified and assessed crop varieties for their tolerance to salinity and evaluated the use of water from ponds and natural depressions for drip irrigation during the fallow period from August to April at pilot sites in the Noakhali and Satkhira coastal regions. Saline-tolerant varieties of wheat, mung bean, mustard, sesame, chickpea, tomato and groundnuts were identified using the carbon isotope discrimination methodology and made available to participating farmers. Yields obtained by farmers with these varieties at both Noakhali and Satkhira ranged from 1 to 3 tons per hectare. Such a harvested yield, compared with nothing if land were left fallow, would provide a substantial increase in food crop production and a significant economic benefit to resource-poor farmers.

The soil moisture neutron probe (SMNP) was used to measure the soil content in order to ensure optimal irrigation scheduling. The soil salinity observed after the harvest of the crops in March/April averaged 1.5 ppt with drip irrigation, compared to 6.9 ppt on fallow land, hence showing that there is no adverse effect on soil salinity associated with the sustainable and productive use of these fallow lands for additional food production and income generation.
The Technology

Two isotopic techniques were used. The carbon isotope discrimination (CID) measures the extent to which plants assimilate carbon for photosynthesis using carbon isotope ($^{12}$C) compared to the heavier $^{13}$C carbon isotope. Using this measure as a surrogate marker of water use efficiency, drought and salt-tolerant varieties were deployed in conjunction with appropriate irrigation scheduling.

The soil moisture neutron probe (SMNP) is an instrument that measures soil water content for crop production. During the measuring process, the probe emits neutrons that collide with hydrogen atoms in soil water. This collision slows down the speed of the neutrons. The change in the speed of the neutrons is detected by the probe and provides a reading that corresponds to the soil water content. The SMNP is currently the most suitable instrument to accurately measure soil moisture under saline conditions.

Drip irrigation technology increases water use efficiency by applying water directly to the immediate vicinity of the plant roots through a network of pipes and water emitters. This results in a reduction both in soil water evaporation and in excess water draining away from the roots, so that much less irrigation water is needed. This technology can be easily adapted for use in large-scale fields allowing for automation of the irrigation process, or for small-scale plots using low-cost materials such as buckets, drum kits, etc. It can also be easily adapted for the simultaneous application of water-soluble nitrogen fertilisers, such as e.g. urea.

The Impact

Improved water management practices through drip irrigation, coupled with the identification of saline-tolerant crop varieties during this project, have enabled farmers in Bangladesh to introduce and harvest a second crop, in addition to the aman rice, on potentially up to 2.6 million hectares of highly fertile coastal lands that would otherwise lie fallow. Such a second harvest could potentially add an additional 4 million tonnes of, for example, wheat to the national bread basket of Bangladesh. At a current price on the international commodity market of US $348/t (February 2011), this would be equivalent to US $1.4 billion to the national economy. With high-value vegetables, the economic returns could be even higher.

Such a second crop would also provide a substantial additional income to local farmers and significantly increase food security in Bangladesh whilst also reducing the soil salinity of these fertile lands.

The saline-tolerant crop varieties have been quickly accepted by local farmers. In the 2010/11 season, these varieties were already grown on approximately 13,000 ha, generating additional incomes of about US $2000/ha/year to the farmers.

For further information, please visit:
The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture
International Atomic Energy Agency, Wagramer Strasse 5, PO Box 100, 1400 Vienna, Austria
www-naweb.iaea.org/nafa/swmn

1 BGD5026 on “Increasing Agricultural Production in the Coastal Area through Improved Crop, Water and Soil Management”, 2007-2010.