Country Impacts

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Improving agricultural water management through low-cost small-scale irrigation technologies in Kenya

The Challenge

Agriculture is the second largest contributor to Kenya's gross domestic product and accounts for about 24% of GDP and 50% of revenue from exports. About half of Kenya's total agricultural output is subsistence production and farming provides employment to about 70% of the population. Approximately 80% of Kenyan farmland is classified as arid and semi-arid, with low and erratic rainfall, and food production is low with frequent crop failures. In order to ensure food security and sustainable farmer livelihoods there is an urgent need to improve agricultural water management practices that ensure optimal water use efficiency. A promising option is the use of low-cost small-scale irrigation technologies that are affordable for resource poor farmers.

The Project

Small-scale drip irrigation in farmer's field

Through an IAEA technical cooperation project[1], the Kenya Agricultural Research Institute (KARI) has developed low-cost small-scale irrigation technologies to improve water- and nutrient-use efficiencies of high-value crops, including cucumber, tomato, kale and lettuce. Yields of these crops were compared under rain-fed conditions, with irrigation using traditional hand-watering method and small-scale drip irrigation. Using the soil moisture neutron probe to determine the soil water content at any time during the growing season and the optimal timing and amount of water to be applied, KARI devised and employed small-scale low-cost drip irrigation technologies and compared yields under a variety of water management applications. Using these technologies, tomato yields of 9.7 t/ha were obtained under rain-fed conditions (with 221 mm of rainfall), 13.0 t/ha with traditional hand watering of 927 mm and 32 t/ha when applying 510 mm of water using small-scale drip irrigation, hence increasing the yield by 3.3 and 2.5 times, compared to rain-fed and hand watering, respectively. In the latter case, this yield increase was obtained despite a 45% reduction in the amount of water applied to the crop.

Results also showed that a total of 580 t/ha of tomatoes can be obtained under the more optimal water and nutrient conditions provided in locally constructed greenhouses, where the ^{15}N stable isotopic tracer was used to determine the fate of nitrogen (N) fertilisers in soils and tomato plants. Information obtained indicates that as much as 50% of the applied nitrogen can be saved when applied through drip irrigation while at the same time tomato yield could be maintained.

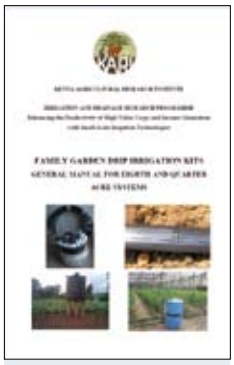
A training manual for extension workers on the use of these drip irrigation systems has been developed, and training and dissemination of these technologies have been conducted through farmers' field days and discussion groups.

The Technology

Drip irrigation 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 below 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 fertilisers, such as nitrogen.

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. It is also widely used to calibrate other moisture sensors for direct use in farmers' fields.



User manual on small-scale drip irrigation kits

Nitrogen is a major nutrient for plant growth. Labelling fertilisers with ^{15}N stable isotope tracers can help to determine the fate of applied nitrogen from fertilisers in soils, plants and water and is therefore useful in determining the nitrogen use efficiency of crops.

The Impact

Small-scale drip irrigation of kale by Maasai farmers at Namanga

Water use efficiency: A dramatic improvement in water use efficiency obtained with a range of high-value crops through better irrigation scheduling and the use of small-scale drip irrigation technologies highlights the potential to reduce the overall water requirements of field vegetables by up to 45%. This will be of tremendous importance in Kenya's endeavours to ensure the most efficient use of its scarce water resources in arid and semi-arid regions. This improvement also brought about a substantial saving (50%) in nitrogen fertiliser applications hence reducing farmers' fertiliser expenditure.

Food security: Combined with the substantial increases in yields achieved, the technologies and expertise developed through this project are generating substantial impacts on Kenyan farming both in terms of additional crop yields and in improved and more sustainable farmer incomes. This will be of tremendous importance in Kenya's drive towards food security for its population.

Farmer acceptance: The drip irrigation expertise and technologies perfected by KARI are currently being transferred to resource-poor smallholder farmers to improve agricultural water management and crop productivity. An example is the Maasai farmers at Namanga on the Tanzanian border through collaboration with the Green Belt Movement and the African Medical and Research Foundation (AMREF).

Small-scale drip irrigation for greenhouse tomato

Greenhouse farming: KARI is transferring drip irrigation technologies also for use in greenhouses, which are becoming widespread (covering more than 3000 hectares) due to the high quality, high yields and excellent resource use recovery obtained. As low-cost greenhouses are increasingly being constructed, they are becoming affordable to ordinary Kenyan farmers.

Local expertise: KARI is providing technical assistance and know-how to 23 African countries aiming to improve agricultural water management under rain-fed and irrigated agriculture. It assists the Agency in capacity building by: (i) training more than twenty IAEA fellowship holders, scientists and technicians from other African regions, (ii) backstopping IAEA projects in Africa and (iii) providing laboratory facilities for the analyses of field samples.

For further information, please visit:

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[1] RAF5058 on "Enhancing the Productivity of High Value Crops and Income Generation with Small-Scale Irrigation Technologies", 2009-2013.