In Morocco, the MIT team with local implementing partners at the International Center for Agricultural Research in the Dry Areas and the Institut National de la Recherche Agronomique stand with a local farmer who will host a phase one field pilot. Photo credit: MIT GEAR Lab

Reducing the Drip of Irrigation Energy Costs

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Throughout the Middle East and North Africa (MENA) region, fresh water is being consumed faster than it is being replenished. Irrigation accounts for most of this use. Unlike traditional flood-style or rain-fed irrigation, drip irrigation delivers controlled amounts of water directly to each plant through a series of tubes and emitters. This can reduce agricultural water consumption by 30 to 60 percent and increase crop yields by 20 to 50 percent, yet only 27 percent of the irrigated cropland in MENA countries uses the technology. For the small-scale farmers who make up the bulk of agricultural producers in the MENA region, the cost of a drip system and the cost to run it are often barriers to making the shift from traditional to drip irrigation.

A new USAID partnership is working to bring down these costs for farmers. Researchers at the Massachusetts Institute of Technology (MIT) have developed a more efficient design for emitters, the small components that actually release the water

in a drip system, which promises to dramatically cut the amount of energy needed to run a system. MIT researchers are now testing this new design in Morocco and Jordan.

"The objective of the project is to design and field-validate ultra-low pressure drip irrigation systems for the Middle East and North Africa region that will cut pumping energy by 50 percent, enable drip systems to run on low-pressure municipal water supplies, and facilitate the dissemination of low-cost, solar-powered drip irrigation solutions," explains USAID Activity Manager Kamal Ouda.

It is essential that the drip systems are powered with solar energy because millions of farms in arid regions around the world are not tied to electricity grids, or depend upon unreliable sources of electricity. "What makes it so challenging to get drip irrigation to those farmers," says MIT Assistant Professor of Mechanical Engineering, Amos Winter, "is that if you want to use an alternative means of power like solar power, that makes the system exorbitantly expensive. It costs about $3,000 per acre for a drip system, and we're trying to target farmers who make a few hundred dollars a year."

MIT Researcher, Susan Amrose says that finding a cheaper design started with a lot of math. "No one had ever written out the equations governing the flow of water through the drip emitters before," she explains. "After we found the equations, we were able to optimize the design in the lab."

"Now we have drippers that operate at about one-seventh the pressure of their competitors on the market," continues Winter, the principal investigator on the project. "Those drippers will cut the capital cost of an off-grid drip system in India, for example, by about 40 percent and cut the energy costs about in half." Much of the MIT team's initial research was focused on agriculture in India.

The MIT researchers are now working with Jain Irrigation Systems, the world's second largest micro-irrigation company, to fabricate the newly designed equipment. "They are the best company in the world to large-scale commercialize this technology for our target market of poor farmers," says Winter.

MIT and Jain Irrigation previously collaborated on solar-powered water desalination technology for small farmers (see sidebar), which won first place in the Desal Prize competition, an initiative of the Securing Water for Food Grand Challenge for Development, which is funded by USAID alongside Sweden, the Ministry of Foreign Affairs of the Kingdom of the Netherlands, and the South African Department of Science and Technology.

Jain's expertise in understanding the local manufacturing context of drip irrigation equipment (e.g., costs, subsidies, strengths, weaknesses) and designing off-grid drip systems is a critical part of the field testing of the drippers, which has just begun in Jordan and Morocco.

"Working with this manufacturer from the beginning has helped us not only understand the manufacturing, but also understand the market," says Amrose. Jain will also commercialize the results of this project and disseminate the resulting drip

technology.

The project is proceeding in two phases. In the first, Winter and his team are testing the newly developed ultra-low pressure on-line drip emitters, so called because they are installed on the outside of irrigation tubing. Phase two will focus on in-line emitters, which are molded directly on the inside of tubing and are still being designed.

Phase one field trials of the on-line drip emitters on tree crops such as fruit trees, almonds, olives, and figs began in April, targeting Moroccan farmers in regions that are good environmental candidates for drip irrigation under the government's Green Morocco Plan (e.g., Beni Mellal and Marrakech), and Jordanian regions where farmers are currently growing tree crops using standard on-line drippers (e.g., North Jordan Valley, Jordan Valley and its foothills, and Mafraq). Each country will host three to five field pilot locations, most of which are agricultural research stations, over multiple irrigation seasons.

"USAID has been investing in the water sector for decades, in Jordan for roughly 60 years," explains Ouda. "The pilots are connected to the bigger effort, in this case, water conservation in the agriculture sector. Regional programs like this complement mission programs in driving toward a common goal."

Two well-established NGOs in the region — the International Centre for Agricultural Research in the Dry Areas in Morocco, and Methods for Irrigation and Agriculture in Jordan — are connecting the researchers with local farmers and helping them understand the specific regional context of the existing system. They will also provide on-the-job training to farmers on the use and maintenance of new equipment (such as off-grid solar pumps), and help translate quantitative and qualitative results into design changes and upgrades.

In the meantime, design and lab testing of the ultra-low pressure in-line drip emitters, a more complex technology than on-line emitters, is underway. Phase two field trials will test these in-line emitters, which are used more for vegetable crops, on approximately 10 pilot locations in Morocco (moving to the Agadir region) and Jordan over one irrigation season. Complete off-grid solar systems will also be installed and tested in 9–10 pilot locations.

Winter says that he expects farmers around the world, both in developing and developed nations, will be interested in the dripper technology, and its reduced cost, which will be developed through this project. "If you can deliver satisfactory performance in the core features of that technology for a fraction of the price, any consumer in the world is going to like that," he explains. Farmers in Jordan, India, and California all want to reduce their costs. And these new drip irrigation systems may help them do just that.

Natasha Wright, who was interviewed for a Global Waters Radio podcast last year, recently was awarded a $15,000 Lemelson-MIT "Eat it!" prize for her technology-based inventions that can improve food and agriculture. Wright, a graduate student in MIT's Department of Mechanical Engineering, invented a solar-powered desalination system for off-grid water production in communities in India and Gaza that reduces the required amount of energy and the amount of wasted water. Wright was also part of a team that developed Smart

Spout, a small, inexpensive, low-energy consumption usage sensor that measures the long-term use of household water treatment and safe storage devices. The sensor collects large quantitative datasets, replacing less-reliable, self-reported survey data.

By Christine Chumbler

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Additional Resources:

- USAID Bureau for the Middle East
- Global Waters Radio: Natasha Wright on Solar-Powered Desalination in India

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