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The seeds of aridity: Crops for a parched world

Scientists help farmers grow crops as water supplies grow scarce

By James Kanter

Six years ago, Jennifer Thomson, a molecular biologist in South Africa, trekked high into the Drakensberg mountain range seeking ways of cultivating food in an increasingly arid environment. After seven hours on the trail, she spotted an inhospitable-looking rock face dotted with green grassy tufts, a cluster of resurrection plants, so called for their ability to spring back to life after surviving periods of drought in a state of desiccated dormancy.

Thomson collected samples of the plant and began identifying its genes, with the aim of transferring them into a crop, corn, that plays a critical role in the African diet.

"We are trying to allow maize to survive under conditions when just a little bit of rain would make the difference," said Thomson, a professor at the University of Cape Town. "African farmers never know where the next water shortage will strike."

Her research is just one of many thousands of projects aimed at tackling one of the world's most pressing needs: helping farmers keep their crops growing as water supplies grow scarce.

That quest is taking on new urgency at a time when the global population is expanding by roughly 75 million people each year and creating ever-greater demand for water from cities and towns, even as farmers are growing more crops for food, grain-fed livestock and fuels.

The result is unprecedented pressure on natural resources, and on water in particular, at a time when extreme weather conditions linked to climate change are creating more severe droughts than in the past.

Scientists, companies and governments are responding with a variety of projects to lessen water demand, but they face a race against time.

Salts carried by groundwater used for irrigation are building up in soils, reducing productivity. In addition, many aquifers are being drained more quickly than management techniques are being implemented, sometimes leaving coastal farm land open to contamination by encroaching seawater.

Complicating the quest for water, some of the most ambitious projects may create other forms of environmental damage, lessening their appeal.

"We need to realize that we don't have a silver bullet to manage water," said Pasquale Steduto, chief of the water, development and management unit of the Food and Agriculture Organization, a United Nations agency based in Rome. "My view is that we're going to find ways of curbing overall demand."

Agriculture is the No. 1 user of water worldwide, accounting for about 70 percent of all freshwater withdrawn from lakes, rivers and aquifers around the world, according to the agency. That figure is closer to 90 percent in some developing countries.

Agriculture also is the top consumer of water in Southern Europe, where the amount of land under irrigation has increased in recent decades, even as water scarcity has increased.

In 2006, droughts resulted in the lowest corn production in 50 years in France and Spain. In Australia, where drought has been persistent since 2002, some wheat farmers failed that year to harvest a crop for the first time in four decades, while in the United States corn production fell 5 percent.

The trends are not just a concern for agriculture. Business leaders worry that intensified competition for water, driven by the boom in biofuel crop cultivation, could hurt other industries and trigger problems in manufacturing hubs like China.

"If there are water shortages going forward, then clearly there's a greater risk industry could be cut off," said Bjorn Stigson, president of the World Business Council for Sustainable Development. "If society doesn't have water, then you also have an overriding risk of instability."

In the past, governments undertook large-scale projects to relocate water for irrigation without worrying much about local opposition. Now, such projects are more vulnerable to attack by political, regional and international opponents.

In Spain, which has some of the most water-stressed regions in Europe, a conservative government in 2001 approved a vast project to divert water over hundreds of kilometers to support farmers in the south of the country.

But environmentalists fought the plan, saying that it would harm birds, destroy historic villages and cause damaging silting in depleted rivers. European Union officials also turned against the plan, largely because of fears that salt water from the Mediterranean Sea would seep inland to replace diverted fresh water, threatening fertile farmlands in the north.

When a Socialist government came to power in 2004, it canceled the project, replacing it with a different solution: the construction of 20 seawater desalination plants along the southern coast.

The desalination projects have been a boon for water treatment companies like Cadagua and Inima, which are based in Spain, and Veolia Environnement and Suez, which are based in France, as well as dozens of companies that make pumps, valves and filters.

Suez also operates Europe's largest wastewater recycling plant.

At a site in Milan, urban wastewater is used to irrigate thousands of hectares of fruit and vegetable farms. About 2 percent of wastewater is recycled worldwide; Suez says that volume could grow by more than 10 percent annually over the next decade.

Still, projects like these have their own problems, including questions over their sustainability. Most desalination plants consume large quantities of energy during the extraction, treatment, and transport of the water. Another concern is that desalination leaves large residues of concentrated brine that could alter marine life at sites where it is pumped back into to the sea.

Recycling may create problems too: Some European opponents cite a public health risk of food crop contamination by recycled wastewater.

With little likelihood that agricultural demand for water will ease, biotechnology supporters say they are developing one of the best solutions for managing increasingly tight supplies.

Plants like Xerophyta viscosa - the subject of Thomson's research in South Africa - grow on rocks at high altitudes because they can thrive in very shallow soils and survive extreme heat, retaining a tiny fraction of their normal water content and "resurrecting" after rainfall to regain full metabolic functions in three days.

With support from the Rockefeller Foundation and farming groups, Thomson hopes to engineer those traits into corn seeds ready for distribution within five years.

Eric Rey, chief executive of Arcadia Biosciences, based in California, said his company was aiming to insert traits in crops so they would tolerate salty soils, require fewer fertilizers - a significant source of greenhouse gases - and use two-thirds less water. Such seeds, he said, could be on the market within six or seven years and would be licensed for free in some developing countries.

"We're at the intersection between the goals of feeding people, taking care of the environment, and helping ensure that there's enough water for human needs," Rey said. "I think we really are moving into an age where technologies can address some these major issues."

But some environmentalists are skeptical.

Geert Ritsema, a campaigner for Greenpeace, warned that gene-altered crops could spread unpredictably, threatening other crops and animal life. Groups of farmers have complained about large biotechnology corporations charging high prices for seeds protected by patent.

Steduto, the UN agency official, also warned against relying on a single technology like genetic modification to come to the rescue of farmers.

Referring to biotechnology companies, he said: "They have been claiming they are getting close to obtaining drought-resistant crops for a few years. We still could be talking about drought-resistant crops 20 years from now."

Steduto said much of the answer to water scarcity could be addressed by greater emphasis on comparatively basic technologies and improved management.

Some strategies he recommended included putting more devices on farms that harvest rainfall and reducing waste in irrigation by fixing leaky pipes, replacing water ditches with pressurized taps and using so-called trickle irrigation systems, where feasible, to deliver small, steady amounts of water directly to the roots of plants.

In some cases, farmers have reduced water use by shifting into growing organic crops with lower yields that require less water but command premium prices. But when it comes to water, it seems that even the best intentioned policies can have unintended results.

Thomas Dworak of Ecologic, a private research institute in Berlin, cited cases in which Spanish farmers, who were charged higher prices for water to encourage conservation, had responded by introducing efficiencies like trickle technology to grow more water-demanding crops, like citrus fruit and olives. That action, Dworak said, canceled out water savings.

And Thomson, the molecular biologist, said she feared that large agricultural companies could use drought-resistant seed technologies to plant fuel crops in Africa to supply motorists in the rich world rather than feed more Africans.

"When lack of water means you don't have enough maize to eat, it's a whole different game, and that is what Africa is continually facing," she said. "These splendid genes should not be used to produce more biofuels."