thestar.com

World looks to science to solve food crisis

Drought-resistant wheat, cloning, even growing crops on Mars. No, this is not science fiction.

July 05, 2008

STUART LAIDLAW
STAFF REPORTER

ILLUSTRATION BY RAFFI ANDERIAN/TORONTO STAR
As we face an "unprecedented world food crisis," former UN secretary general Koffi Annan called for a Green Revolution for Africa much like the one in Mexico and India in the 1950s and '60s that saved millions there from starvation.

Over and over in the past 100 years, science has pulled the world back from the brink of starvation.

As the human population more than quadrupled – from an estimated 1.65 billion in 1900 to more than 6.7 billion today – technology brought farmers new crops, machinery, irrigation systems and chemical fertilizers and pesticides to keep people fed.

And as we stand at the edge of the precipice of hunger once more, the world is again asking the men and women of the labs to perform their miracle.

From traditional plant breeding, to genetic modification, to cloning, to projects to put crops on Mars, there is no shortage of scientific advances being made that will one day help boost food production and feed a growing world. As well, scientists are revisiting traditional techniques once considered too primitive to be of any use, trying to figure out how they work and how they can be improved and adapted to modern needs.

And still others are looking for ways to make food delivery and processing more efficient, to get more from what we already grow.

The need is urgent.

At a recent United Nations summit on food and the environment in Rome, former UN secretary general Koffi Annan called for a Green Revolution for Africa much like the one in Mexico and India in the 1950s and '60s that saved millions there from starvation.

"The world is facing an unprecedented world food crisis and nowhere is this crisis more serious and acute than in Africa," Annan said. "We hope to spur a Green Revolution in Africa which respects biodiversity and the continent's distinct regions."

FOOD SERIES

June 28: Is the world food system fixable?

June 29: Feeding a family – on $2 a day.

JULY 5: How science can help solve the crisis.

JULY 6: Europe's role.

JULY 7: Canada's challenge.

Scientists like Thijs Tollenaar take such statements as their marching orders, confident the successes of the past can be repeated in the future.

"We did it before, we can do it again," says Tollenaar, a corn breeder at the University of Guelph.

Tollenaar's work focuses on improving corn's ability to deal with stress, which for corn can mean anything from a lack of water to too much water due to global warming, or soil made salty by too much irrigation.

Hundreds, perhaps thousands, of researchers around the world are trying to do the same thing, with virtually every crop grown:

In Guelph, Tollenaar is joined by other scientists such as Hugh Earl and Manish Raizada to use traditional plant breeding techniques (crossing same-species plants with one another) to boost crop yields;

Biotechnology giants Monsanto and BASF have joined forces in Kenya, Tanzania, Uganda and South Africa to develop genetically modified drought-tolerant corn, using $47 million (U.S.) in funding from the Bill and Melinda Gates Foundation;

The two companies have also formed a $1.5-billion partnership to develop GM corn, soybeans, cotton and canola varieties that can grow in adverse environments, including drought;

Switzerland's Syngenta is researching ways to make corn resistant to colder temperatures or salt in the soil;

Dupont is researching genetic sequencing as a way to make such crops as grains, soybeans, sunflowers, cotton and canola resistant to cold and drought;

Trans Ova, a leading U.S. animal cloning research firm, hopes to use cloning to develop "elite breeding" that would one day lead to faster-growing, disease-resistant farm animals;

The Australian Centre for Plant Functional Genomics is partnering with scientists from the Italian region of Puglia to develop a drought-tolerant strain of durum wheat, used to make pasta;

Mike Dixon at the University of Guelph is using space program money to figure out how to grow crops on Mars in self-sustaining containers – sort of high-tech greenhouses – using methods that could one day make Earth-bound hothouses more efficient and environmentally friendly.

Biotechnology companies such as Monsanto and BASF, bruised by battles with consumers and activists in the 1990s over the first generation of genetically modified crops, see opportunity in the current crisis to push the technology.

In a shift from the past, however, scientists in developing countries are also investigating techniques used for centuries by farmers to coax crops from their often challenging environments.

Nathalie Beaulieu, a Canadian researcher working in Africa, laments that for too long Western scientists have disdained traditional knowledge in favour of their own discoveries. It's important to remember that these farmers grew crops for centuries before Western scientists showed up, she says.

In one project, Beaulieu is researching a landscaping system used by farmers in Senegal to conserve water. The fields are tiered slightly, preventing rainwater from running off too quickly. The water can then seep slowly in the soil, replenishing the water table so it can be taken up by crops during dry spells.

"You've got these ancestral techniques that are becoming very useful," says Beaulieu, a director with the International Development Research Centre, a Canadian Crown corporation.

But many of the techniques are labour intensive, a problem as HIV/AIDS sweeps through Africa, claiming the young men who are the backbone of farm labour. Beaulieu is looking for ways to adapt the old ways so they can be used by those left behind.

"Sometimes all that's left is children and old women," she says.

The AIDS crisis that is wiping out farm labour is also claiming those who hold the traditional knowledge of farming on the continent before they can pass it on to the next generation, she says. If today's scientists don't capture that ancient knowledge, she warns, it could be lost forever.

"We're finding that a lot of these options are indigenous techniques that have been forgotten."

Returns from techniques such as plant breeding, genetic modification, cloning or farming on Mars, are years, even decades, away. Other solutions will be needed in the shorter term.

That's where researchers like Don Mercer come in.

"A quarter to a third of food is lost in developing countries because of waste between the farmer and the consumer," says Mercer, a food science professor at the University of Guelph's Kemptville campus, south of Ottawa. "It's a terrible waste."

This summer, Mercer will spend three weeks of his vacation in Malawi working with food processors and farmers to cut down on food waste.

When food is cheap, he says, there is little economic motivation for improving storage, transportation or packaging systems to eliminate waste. But as prices rise, investing in more efficient systems begins to make more sense.

"And just by improving the efficiency of the system, we can increase the amount of food that's available," he says.

Alfons Weersink, an agricultural economics professor at Guelph, credits rising prices for the boost in food research, but says there is a long way to go before the funding levels of a generation ago are matched.

In the 1980s, up to 12 per cent of overseas development aid to Third World countries was dedicated to agriculture. Today, it's just 2.9 per cent.

Weersink says that after the Green Revolution, a complacency developed that more food research was not really needed.

As well, Western companies began outsourcing their work to developing countries, and Third World governments realized there was more money to be made attracting industry than in researching agriculture.

"With food prices low, there was no incentive to invest in agriculture," says Weersink.

Weersink wants to see more public investment – both by developing countries and in the form of foreign aid by countries such as Canada – saying private research will always be geared to areas where companies can make the most money.

To solve world hunger, Weersink says, research is needed into crops and farming methods that poor farmers can afford. Corporate-backed research, he says, tends not to look at this sector.

"It's not amenable to private funding," he says, choosing his words carefully.

Rene Van Acker, head of plant science at Guelph, says perhaps the most important scientific breakthrough in recent years has been the realization that good science must be backed by policies on poverty and the environment that ensure advances are both sustainable and affordable for the poor.

In short, a holistic approach to science is needed to defeat hunger.

"It's not this or that," Van Acker says. "It's this *and* that."

An ecosystem in a can

If it'll work on Mars, it'll work on Earth. For a starving and parched planet, at least, that's the hope.

For more than a decade, Mike , right, has been using his labs at the University of Guelph to figure out a way to grow food and sustain life during an extended trip to Mars.

His plan is to build a system of self-contained greenhouses that need no outside inputs to grow all the food space travellers will need. That's important, because in a place like Mars, there are *no* outside inputs.

The idea is simple, even if the execution is taking years of research and millions of U.S., European and Canadian space agency dollars: build chambers that take the carbon and waste produced by humans and use it to feed the plants. The plants will then produce food and oxygen, and the cycle will continue. It's like an ecosystem in a can.

"In space, nothing can be wasted," Dixon says.

But the real prize is in the bigger project. Ontario already has a major greenhouse industry. Dixon says technologies being developed in his labs could help make those greenhouses more self-sufficient, and so more environmentally friendly. The greenhouse industryhas come under some fire for using a lot of water and pesticides. Dixon's research could help reduce that.

But the prize could be even bigger.

One school of thought in dealing with hunger and how to feed a growing world population is to find ways to grow food in urban settings. The problem, however, has always been that pavement and air pollution tend to thwart crop development. The Mars capsulescould solve that problem. If they can grow food in the uncompromising environment of the red planet, Dixon says, they can do it in the big city. He is quick to point out, however, that his labs are far from providing a miracle cure for world hunger.

Success is still years away, even on a very small scale, and bound to be expensive. From a relatively modest budget of $150,000 fourteen years ago, his expenditures have expanded to more than $8 million annually, plus $10 million in equipment.

And for that, he can grow the basic ingredients of a salad.

-Laidlaw

Green revolution gets a rethink

Monkombu Sambasivan Swaminathan, the father of that great scientific leap that saved India from starvation known as the Green Revolution, is having second thoughts.

"It looks like it was a one-time revolution," Swaminathan says on the phone from New Haven, Conn., where he was visiting friends recently on a break from the conference circuit.

The 82-year-old Swaminathan has long been a favourite speaker about how science saved his country. His work has been an inspiration for a generation of researchers around the world, and held out as proof that science can avert a Malthusian disaster of overpopulation and starvation.

And while his American counterpart, Norman Borlaug, was awarded the Nobel Peace Prize in 1970 for his work boosting crop yields and continues to speak about the great potential of science to feed the hungry, Swaminathan himself frets about "the fatigue of the Green Revolution."

The Green Revolution was an amalgam of new plant breeds, advances in fertilizers and pesticides, mechanization and irrigation in the 1950s and '60s that boosted crop yields and made food cheaper.

But the industrial farming and monocultures – one crop per field – that were the revolution's trademark has left his country's soil degraded and water tables low, Swaminathan says.

Growth in crop yields has slowed to only half of 1 per cent a year – a quarter of what's needed just to keep up with demand – leaving India hungrier with each passing year.

"There has been an over-exploitation of the land, and an over-exploitation of groundwater," he says.

Global warming will only add to the problem. The Peterson Institute for International Economics, a Washington-based think-tank, predicts that changes in temperature and rain patterns could cut agricultural output in India by 30 per cent by the 2080s.

With such studies in mind and his own observations of his Green Revolution's legacy, Swaminathan spends his days now promoting an "evergreen revolution" that combines science, economics and sociology to boost food production sustainably.

He wants to bring back to Indian farms some of the biodiversity destroyed by his Green Revolution. Before the Green Revolution, Indian farmers grew a wide mix of crops – often in the same field. The ancient technique helped keep the soil healthy and pests at bay, though yields were smaller.

Monocultures boosted yields, but are an ideal breeding ground for pests. That forced farmers to use more chemicals to keep the bugs and weeds to a minimum. Too many chemicals can degrade the soil, requiring farmers to invest in nitrogen fertilizers made from fossil fuels.

The cycle can soon lead to mounting debt, as farmers are forced to spend more and more money to get a good crop from their fields. India has seen a wave of farmer suicides in recent years as debt loads become untenable.

The favoured method of suicide is a cocktail of farm chemicals.

Today, Swaminathan says some sort of mix of old and new techniques is needed that allows farmers to take advantage of the advances of the Green Revolution, while drawing on traditional methods for enriching the soil and fighting pests. It also needs to be affordable for the poorest farmers.

David Hallman, a long-time campaigner with the World Council of Churches, likens the approach to an investment portfolio. No broker, he says, would advise clients to invest all their money in just one or two companies – and yet farmers with monocultures are doing just that.

"It's better to have a varied portfolio," says Hallman, a retired United Church minister.

While Hallman believes the current crisis demands that researchers continue to find new ways to boost crop yields – "We need the best that science has to offer," he says – he warns it is dangerous to put too much hope on answers coming from the lab.

"We are all ultimately responsible for one another," he says.

He wants people to think about how much they really need in life – as opposed to how much they want – and adjust their expectations accordingly. The Earth, he says, can't provide everyone with a North-American-styled life, and science can't change that.

Swaminathan says one adjustment people could make is the sort of food they eat – perhaps substituting rice for wheat. Rice, he says, is a more resilient crop, able to withstand weeks of flooding or dry conditions that would wipe out a field of wheat in similar conditions. Trying to breed such hardiness into grains would take years, he says, and might not even be possible.

-Laidlaw