

IT'S ALL ABOUT GREEN

“We Need a Second Green Revolution”

Safeguarding food for a growing world population

Defying climate change

Our numbers are growing! By 2012, the world population is forecast to top the seven billion mark. In 2025, the number of people is even set to hit eight billion, with this rapid population growth taking place almost exclusively in developing countries, where over 80 percent of all people already live. And it is precisely these countries that are already hit by food shortages. The World Bank estimates that the number of hungry people in the world could shoot up quite soon from 850 million at present to 950 million. United Nations forecasts, meanwhile, show that only 30 percent of the land that was available for growing food in 1950 will be available per capita for safeguarding the supply of food in 2050.

On top of this, worldwide food reserves have now dropped to their lowest level for 30 years. The main problem is that there is hardly any potential left for expanding the growing areas for wheat, rice, or millet. In many parts of Asia, every last hill which can possibly be used has already been covered with fields and rice terraces. In many regions of Africa, it is likewise almost impossible to expand the amount of arable land. This is partly because the soils are simply not suitable, and partly because intensive farming would lead to desertification.

Extreme weather phenomena threaten harvests

Another problem is that meteorologists worldwide are registering extreme weather events with increasing frequency—the absence or displacement of tropical rainfall as well as abnormal ocean current phenomena. One well known example is El Niño: every three to six years, torrential rains devastate whole tracts of land in South America, while at the same time extreme weather leads to droughts in South East Africa, Indonesia, and Australia, and frost in Florida, causing enormous harvest losses for farmers.

But it is not just natural catastrophes that cause billions of dollars' worth of agricultural damage each year: persistently unfavorable farming conditions such as water shortages, increasing salination of arable soils and extreme heat and cold are prime causes of enormous harvest losses. Corn, rice, and wheat are no longer able to withstand the extreme environmental effects. Climate change is adding to the stresses to which plants are subjected, with grave effects; even with the best of care for their fields, farmers regularly lose 30-70 percent of their harvests.

Stop the self-destruction program in cereals

“There is an urgent need for us not only to make agricultural production more efficient, but also to do it in a way which is sustainable,” says Friedrich Berschauer, Chairman of the Board of Bayer CropScience. A key objective of the crop protection scientists is to increase corn, rice, and wheat yields and make the plants more resistant to severe heat, cold, drought, or intense sunlight. These factors put plants under enormous stress, triggering a process which can even lead to self-destruction: the plant increases its energy consumption and can therefore no longer



Bayer CropScience research scientists assess enhanced stress tolerance characteristics in a new generation of hybrid rice. Copyright Bayer CropScience AG.

produce certain energy transport molecules, which are however needed by the cells to survive. The supply gap has dramatic consequences for the plant, which can no longer supply leaves, fruit or stems properly with energy. Individual cells gradually die, followed ultimately by the whole plant.

Stress-tolerant plants are considerably better at coping with climate fluctuations

Researchers at Bayer Crop Science are using a trick to protect rice plants, for example, against a number of stress factors. They have put the plants on a fitness program. “Our idea was to get crops into shape,” says Michael Metzloff of the Bayer CropScience Innovation Center for Plant Biotechnology in Ghent, Belgium. To achieve this, his team is pursuing two strategies: firstly, the scientists incorporate genes into the plants which should help them deal with excessive stress caused by dry and wet conditions. Secondly, they quite specifically deactivate individual genes which trigger excessive stress reactions in normal plants and lower the yield. “Our goal is to enable plants to produce high, stable yields over the longer term in spite of fluctuating environmental conditions,” Metzloff says.

A “second green revolution” is needed

For Berschauer, biotechnology is a vital tool to safeguard the supply of food for the world population in the future. “We need a second green revolution. If we use plant biotechnology in combination with crop protection solutions in a targeted manner, we can achieve significant advances in productivity,” comments Bayer CropScience’s CEO. Other experts share this view: according to the estimates of the Consultative Group on International Agricultural Research, only with biotechnology can harvests be increased by around 25 percent.

Antifungal agents help wheat plants to grow

In Canada, Bayer CropScience researchers are already using advances in seed breeding to increase canola oil yields by up to 30 percent compared with conventional varieties. In addition to plant biotechnology, new crop protection agents can also increase harvest yields. The latest example is the active ingredient trifloxystrobin. Farmers all over the world have been using this agent for years to protect cereal, vegetable, and fruit crops against harmful fungal diseases. But trifloxystrobin, an antifungal agent belonging to the strobilurin group of active ingredients, can do more: it also increases the ability of plants to withstand stress. “Field trials show that crops in which strobilurins are used produce better harvests than those protected with other types of antifungal agent,” says Dirk Ebbinghaus, a Bayer CropScience research scientist. Crops protected with trifloxystrobin also do much better than untreated plants under conditions of drought. “Our active ingredient clearly triggers a number of different positive effects in the plant which result in an above-average increase in yield,” says Ebbinghaus. The latest research results have also shown that certain active ingredients, i.e. the Bayer CropScience insecticide Gaucho®, can even make rice plants more resistant to fluctuations in the salt content of water.

Protecting biodiversity

Because the demand for high-quality food in adequate quantities and at affordable prices must not be allowed to jeopardize

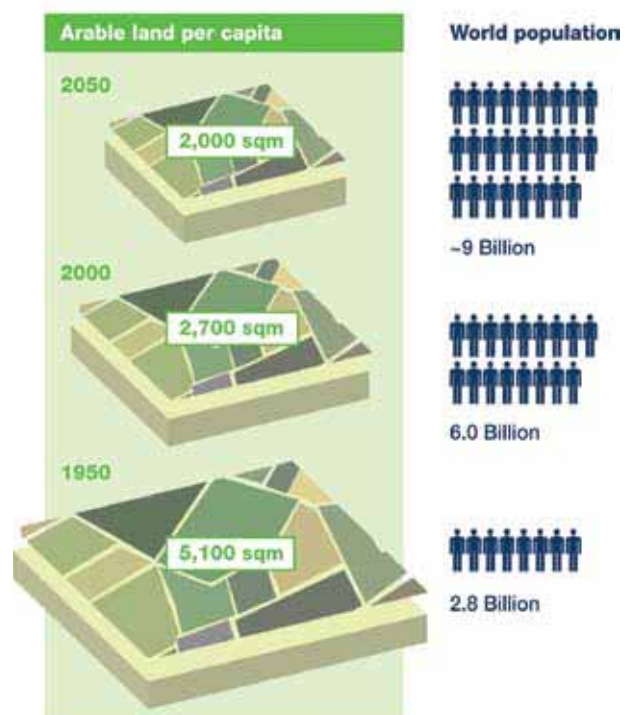
nature, Bayer Crop Science has committed itself to an important principle: using state-of-the-art technologies, the company wants to help both small and large-scale farmers achieve higher productivity on land already used for agriculture. This protects natural habitats from being converted into arable land.

Securing food with less land

Of the approximately 13 billion hectares of land covering the Earth’s surface, around 1.5 billion hectares are used for agriculture, with a further 3.5 billion hectares being used for meadowland and pasture. This area of land cannot be increased. Every year, around seven million hectares of agricultural land are lost as a result of building construction, erosion, desertification, and other causes. Without modern crop protection measures and fertilization, we would already need significantly more arable land, namely around four billion hectares. As a result of population growth, agricultural production must increase by around two percent per year in order to be able to safeguard the amount of food required to supply all people.

This figure does not yet take into account the increases in demand for meat. In China, for example, meat consumption has doubled in the last 15 years. For one kilogram of beef, it is necessary to produce well over seven kilograms of animal feed—this also drives up the demand for animal feed, which increases the competition for arable land for food production.

Globally arable land per capita is shrinking



Source: FAO. Copyright: Bayer CropScience

Chemical Waste Doesn't Have to Be Bad News in the Green Economy

Oxford University researchers have discovered a new way to produce the biofuel methanol from the industrial waste chemical glycerol.

Methanol is useful either as a fuel on its own or in biodiesel manufacture. It is also used widely in industrial chemistry. Currently, 90 percent of the world's methanol is produced from natural gas, but the new process bypasses the need for fossil fuels.

"Essentially, this is a way of getting methanol 'for free' from biomass," said Edman Tsang of Oxford's Department of Chemistry, the main inventor behind the new method. "Around 350,000 tons of glycerol are incinerated in the US each year, and converting this to methanol gives you a portable store of energy, and potentially an economically viable new biofuel business."

The big advantage of the process is that it's direct—cutting out costly processing steps—and it works at a low temperature and low pressure: a relatively mild 100 degrees Celsius at 20 bar of pressure.

"When we say the process is clean, we mean that the catalyst is very selective. The exclusive product is methanol, so little additional processing is required," Tsang explained. Earlier this year, his research in new catalytic materials identified a supported precious metal, which efficiently converts glycerol to methanol. Isis Innovation, the technology transfer company for Oxford University, has patented the technology.

Plan Set for 2008 Effluent Guidelines Program

The U.S. Environmental Protection Agency has published its final 2008 Effluent Guidelines Program Plan in the *Federal Register* on September 15 (<http://www.epa.gov/fedrgstr/EPA-WATER/2008/September/Day-15/w21484.pdf>).

Effluent guidelines are industry-specific national regulations that control the discharge of pollutants to surface waters and to publicly owned treatment works. The plan announces that EPA will conduct focused detailed reviews in 2009 and 2010 for the steam electric power-generating industry; the coalbed methane extraction portion of the oil and gas extraction industry; and unused pharmaceutical disposal in the health services industry.

ARS, TEDCO Showcase Latest "Green" Technologies

By Jan Suszkiw

What do chicken feathers and soybean oil have in common? Both are bio-based resources for environmentally friendly products such as biodegradable flower pots and petroleum-free printing inks. These and other "green" technologies were on display at a showcase in Baltimore, Maryland, in late October co-hosted



Most soybean varieties have the Agricultural Research Service in their pedigree. Agency scientists have released 66 varieties and 280 breeding lines between 1980 and August 1994. Photo by Scott Bauer.

by the Agricultural Research Service (ARS) and the Maryland Technology Development Corporation (TEDCO).

ARS is a US Department of Agriculture (USDA) intramural scientific research agency that employs approximately 2,100 scientists at more than 100 research locations in the United States and abroad. TEDCO, headquartered in Columbia, Maryland, is an independent entity established by the Maryland General Assembly in 1998 to facilitate the creation of businesses throughout the state and foster their growth.

"ARS and TEDCO are working together to furnish small-business operators with access to the latest technologies and scientific expertise necessary to develop new and improved consumer products," said Assistant Administrator Rick Brenner, with the ARS Office of Technology Transfer in Beltsville.

"Today's showcase demonstrates ARS' and TEDCO's commitment to furthering and supporting technologies that better our environment and quality of life," said Renée Winsky, president and executive director of TEDCO.

As part of the showcase, ARS and TEDCO commemorated the one-year anniversary of a Partnership Intermediary Agreement (PIA) which established a formal mechanism by which ARS can leverage TEDCO's existing relationship with Maryland businesses to better ascertain their technology needs and notify them of opportunities to partner with ARS on development and commercialization of technologies. As part of the commemoration,

TEDCO presented ceremonial funding checks to two Maryland companies—Chesapeake Microproducts and CrispTek, LLC—to further their use of ARS-developed technologies.

TEDCO has hosted four technology showcases for ARS' Henry A. Wallace Beltsville (Md.) Agricultural Research Center since 2000. The October event was the first that TEDCO has hosted for ARS agency-wide. The program's agenda included an opening ceremony, keynote speakers, interactive demonstrations, and breakout sessions on biofuels, bio-based products, and sustainable agriculture.

Under the PIA, TEDCO is providing funding to Chesapeake Microproducts of Salisbury, Maryland, to produce biodegradable materials for horticultural pots made from chicken feathers, using technology developed by ARS scientists. The PIA has also enabled CrispTek, a new small business in Columbia, Maryland, to begin commercializing a gluten-free, rice-flour-based batter developed by ARS that reduces the oil uptake of fried foods. CrispTek was established to commercialize this technology, for which ARS granted them a license in April.

According to Brenner, ARS plans to establish similar PIAs with other US economic development organizations to further the use and development of ARS research and technology throughout the nation.

Water Reuse for Processing Facilities

Reclaimed wastewater from municipal treatment facilities may provide an alternative water source for agri-processing facilities, particularly where water resources are scarce.

The Agricultural Utilization Research Institute (AURI) in Waseca, Minnesota, has partnered with the Metropolitan Council Environmental Services to evaluate the feasibility of using reclaimed wastewater in agricultural processing applications where high-quality groundwater is not necessary or is in short supply. Municipalities may benefit by offering reclaimed water as an alternative water source to industries.

Municipal facilities in Minnesota treat about 425 million gallons of water a day. Much of that treated water is discharged into groundwater sources such as rivers. Water reuse could conserve resources and support industries and economic development.

“There are agri-processors that have looked at building in certain locations but can't because of a lack of groundwater resources,” says Jennifer Wagner-Lahr, AURI project development director. “This project will look at the feasibility of connecting municipal treatment facilities to processors because in the right circumstances, it could reduce groundwater depletion and provide a reliable and potentially lower cost water source for industry.”

The project will involve two case studies involving agricultural processing facilities. Once the findings are in, Wagner-Lahr says AURI will be holding industry forums to distribute the information to facilities that could benefit.

Several industries are already taking advantage of reclaimed wastewater including a North Dakota ethanol plant that is piping in treated water 27 miles from Fargo to its site.

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