

# Sooty Air Cuts China's Crop Yields

China leads the world in grain production, harvesting more than 360 million tons each year. The growing affluence of its 1.2 billion inhabitants, however, has fostered a craving for more than China now grows. As a result, this nation imports grain. As China's population continues to swell, so will its demand for imports—leaving less for poorer grain-starved nations.

A new study finds that by cleaning its air, China might eliminate—at least in the near term—its need for imported grain.

Dust-size particles of soot and other pollutants have created a haze over much of China's grain belt. This pollution can significantly depress photosynthesis, reducing crop yields, the new study finds. In fact, its calculations suggest that the haze could be robbing farmers of more grain than China now imports.

Pollution analysts have viewed haze-causing particulates as a visibility-limiting nuisance and potential health threat. "This new paper looks at an impact that's never been considered," says study leader William L. Chameides of the Georgia Institute of Technology in Atlanta.

His international team put climate and pollution data into a computer model that simulates reactions between pollutants under local meteorological conditions. "From that," Chameides explains, "we get estimates of how much [haze] is in the atmosphere." Haze measurements collected throughout China invariably proved even larger than the estimated levels.

The model only accounts for pollution created by human activities, such as wood and coal burning, Chameides explains. It also ignores the role of particulates in gathering water into clouds.

The researchers put their computed values for haze into a crop-projection model that many governments use to predict harvests. To customize it for a given crop and region, scientists need some 10 years of meteorological and farm data. Such detailed information was only available for rural areas near Nanjing, about 200 miles west of Shanghai. Chameides' team then extrapolated its Nanjing findings to China's other farm regions.

Those harvest estimates, reported in the Nov. 23 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, show that haze may be depressing China's farm yields by 5 to 30 percent. The researchers project the biggest losses for the Sichuan Basin and Yangtze Delta, areas that have especially



Georgia Tech scientist measures haze in rural Zhejiang Province last month. The 5-mile visibility, typical there, represents almost three times the worst haziness in Tennessee's Smoky Mountains.

sooty air.

However, Chameides notes, because haze is a problem worldwide, it probably is diminishing crop yields in developing and industrial nations alike.

Though the new projections represent

"a good effort," they remain by necessity "a bit rudimentary," says Cynthia E. Rosenzweig of NASA's Goddard Institute for Space Studies in New York. The harvest models, for instance, employ overly simplified relationships between crop growth and sunlight. The new study also estimated yield losses from haze in the absence of any other problems. In fact, Rosenzweig notes, yields can be limited at least as much by pests, water shortages, or insufficient nutrients as by haze.

The good news is that China may have begun a transition away from the coal burning that contributes to its serious haze problems, notes agricultural economist Lester Brown of the Worldwatch Institute in Washington, D.C. Cutting coal subsidies has raised the price of this fuel and limited its use, he says.

Moreover, the nation recently activated its first wind farm. "China has enough usable wind to easily double its current national electricity generation," Brown notes. —J. Raloff

## One down: A human chromosome sequenced

It's not the biggest, or the smallest, or the one with the most genes. Still, chromosome 22 will go down in history as the first human chromosome to have almost its entire DNA sequence revealed to the world.

Scientists participating in the international effort to decipher the whole human genome announced this milestone in the Dec. 2 NATURE. The investigators report that they've determined more than 33 million bases—the chemical building blocks of DNA—of chromosome 22 and identified at least 545 genes.

"It's very exciting," says Bruce A. Roe of the University of Oklahoma in Norman, a leader of the sequencing project. "We've now got one book of the *Encyclopedia Britannica* of life. . . . We know all the words on its pages. We just have to go back to our dictionary and find out what all those words mean."

Twenty-two pairs of chromosomes, plus the X and Y chromosomes, carry almost all of a person's genes. Chromosome 22 ranks as the second smallest, holding just under 2 percent of all human DNA. It harbors many genes implicated in human disorders ranging from birth defects to cancers. Several studies have suggested that chromosome 22 may also contain a gene predisposing people to schizophrenia.

Four DNA-sequencing teams from Washington University School of Medicine

in St. Louis, the University of Oklahoma, the Sanger Centre in Cambridge, England, and Keio University School of Medicine in Tokyo led the chromosome-22 effort. While a private firm is sequencing the human genome using a so-called shotgun strategy (SN: 5/23/98, p. 334), these investigators pursued a more traditional approach. They took small pieces of DNA whose locations on chromosome-22 were known and identified which of four possible bases—adenine, cytosine, guanine, or thymine—exists at each point along the DNA.

The international human genome project aims for 99.99 percent accuracy. Claiming less than 1 mistake for every 50,000 bases, the chromosome-22 sequencers say they've beaten that benchmark. "Since this is the first chromosome being completed, we wanted to set the standard," says Roe.

He notes that chromosome-22 crossed the finish line first because scientists working on specific regions overcame their competitiveness and freely volunteered copies of their regions' DNA to the four sequencing centers. The centers made the resulting sequence data freely available worldwide. "The community really worked together," says Roe. "There was a tremendous spirit of cooperation."

The ongoing public release of the se-

quencing data has already resulted in several published studies on newly identified chromosome-22 genes. Still, picking out all the genes remains a formidable task. A computer analysis of the sequence predicted the presence of more than 800 genes, but the software produces many false positives, warn the scientists. Using more stringent criteria, they count 545 genes.

"The real issue is how you find a gene if you know nothing about it. The problem is that genes don't come with little flags saying, 'I'm a gene,'" notes Peter Little of Imperial College in London, who wrote a commentary in the same issue of *NATURE*.

From their tally of genes on chromosome 22, the scientists who sequenced it predict that the human genome contains at least 45,000 genes. Finding all those

genes isn't the ultimate goal, however.

"Even when you can identify the genes, there's a lot more to be done on what does a gene do, what does its protein do, and how is it expressed in different tissues," notes Ian Dunham of the Sanger Centre.

To address some of those questions, biologists must also study the noncoding DNA that surrounds genes and regulates their activity. "Because we have the entire [chromosome-22] sequence, we should have all the elements used to control the expression of its genes," says Dunham.

Beyond these genes and regulatory regions, about 40 percent of the chromosome-22 sequence turns out to consist of seemingly useless, repetitive stretches of DNA, often labeled junk DNA.

"We don't know what [those sequences] do, if they do anything at all. They may just

be relics of the evolution of the genome," says Dunham.

The investigators haven't sequenced every base on chromosome 22. They've largely ignored one of its two arms, the much shorter one, because past research showed that it doesn't contain genes that encode proteins. Like the short arms of a few other chromosomes, it has many copies of genes that code for the RNA component of ribosomes, the protein-making factories in cells.

Even the DNA sequence for the long arm of chromosome 22 has 11 gaps, ranging from a few thousand bases to 150,000. Scientists expect to fill in some of those gaps, especially one thought to contain a gene involved in breast cancer, but a few may prove very difficult to sequence. —J. Travis

## The best Leonid show is yet to come?

The streaks of light came fast and furious. Some raced across the sky in nearly parallel tracks, leaving behind hazy trails. A few seemed to dive into the moon.

If last month's Leonid meteor shower proved disappointing in the United States, it took Europe and the Middle East by storm. And if the predictions of two astronomers continue to hold true, Earth will be in for a *really* big show in 2001 and another in 2002.

At the shower's peak, on Nov. 17, some observers saw between 3,000 and 5,000 shooting stars, or meteors, in a single hour. Activity reached a crescendo at 9:05 p.m. EST—just 3 minutes earlier than predicted by David J. Asher of Armagh Observatory in Northern Ireland and Rob McNaught of the Australian National University in Weston.

This is the first accurate prediction of a meteor storm, says Brian G. Marsden of the Smithsonian Astrophysical Observatory in Cambridge, Mass.

The Leonid meteor shower happens every November, when Earth passes through a stream of dusty debris, or meteoroids, expelled by Comet 55P/Tempel-Tuttle. Dust grains slam into Earth's atmosphere and burn, creating the streaks of light known as meteors. About every 33

years, when the comet passes near, Earth encounters a large amount of debris, resulting in a heavy shower or storm.

Exactly which years the Leonid dust particles will generate a storm has been difficult to predict. That's because astronomers hadn't realized that the debris stream is composed of distinct, narrow strands of dust, each expelled by the comet during a different passage by the sun, notes Asher. It's a matter of hit or miss: If Earth plows through the center of a dense strand, a storm will occur.

By simulating the motion of strands in the solar system, Asher and McNaught conclude that the dust strand Earth traveled through last month was shed by the comet in 1899. Although that's the same material the planet traveled through during the spectacular storm of 1966, last month's event wasn't as dazzling because Earth crossed the strand's edge rather than its center, Asher says.

Donald K. Yeomans of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., says he agrees with the pair's explanation for the 1999 event. "I do take their future predictions more seriously now," he adds.

Next year, McNaught and Asher calculate, Earth will pass for the first time

through the edge of a band of dust cast off by the comet in 1866, yielding a puny shower. In 2001, however, Earth will plow sequentially through no less than three trails—debris expelled in 1767, 1699, and 1866—and the light show should prove more stunning than last month's. In 2002, when Earth again encounters material from 1866, as well as from 1933, the Leonids should also put on a great show, McNaught and Asher say.

Their findings may shed light on a puzzling feature seen just hours after the Leonid shower reached its 1999 peak. Observers saw flashes of light near the moon, as if meteoroids had crashed on its surface. Researchers reported the phenomenon in a Nov. 26 circular of the International Astronomical Union.

The brilliance of these flashes requires that the meteoroids have as much mass as a bowling ball—a rare but not extraordinary occurrence, estimates Alan W. Harris of JPL. Moreover, Asher and McNaught calculate that the moon intercepted a denser part of the 1899 stream than Earth did and thus encountered a greater number of large meteoroids at the time the flashes occurred. However, cautions Paul R. Weissman of JPL, the flashes could merely have been sunlight glinting off satellites or space debris. —R. Cowen

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Scenes from the 1999 Leonid shower: Meteor's fireball and its fading light seen for more than 20 minutes over the Italian Alps.