cess power over what the theory predicts," says Anthony Readhead, leader of the CBI team. "If it's real, then we think it's a very exciting result." Readhead says that the unexpected excess might be due to the so-called Sunyaev-Zel'dovich effect, in which photons from the early universe scatter off electrons in hot gas in clusters of galaxies closer to Earth, distorting the cosmic background radiation.

If the observations hold up, a more detailed analysis of the excess "volume" at small scales might enable cosmologists to map the formation of galaxies and galaxy clusters in the early universe. "These are really signposts of the structural evolution of the universe," says Carlstrom.

CBI's fine-grained photos should also complement data taken from galaxy surveys. "Traditionally, microwave background has been on superlarge scales, while surveys of galaxy clusters have dealt with very small scales," says Tegmark. But with big galaxy surveys, such as the Sloan Digital Sky Survey, and small angular-scale measurements of the microwave background, the measurements are beginning to overlap, allowing scientists to compare them directly. "This will be particularly fun," Tegmark says.

–CHARLES SEIFE

AGRICULTURE

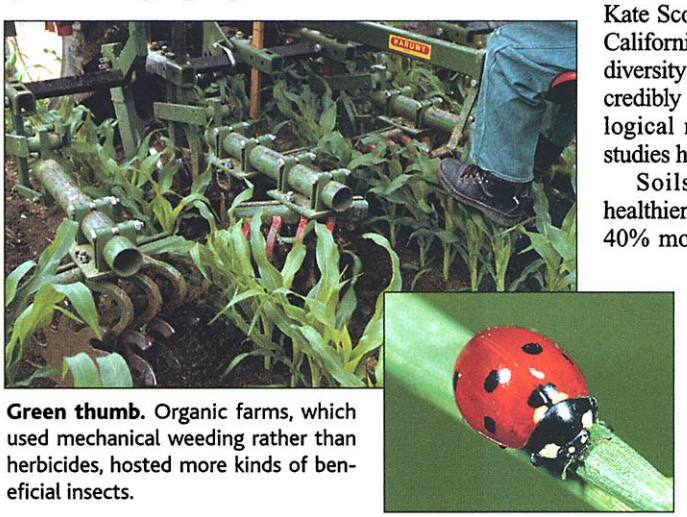
Organic Farms Reap Many Benefits

The bountiful crop yields of the green revolution have fed millions, yet they pose an environmental tradeoff: rich harvests in exchange for polluting pesticides and fertilizers. Organic farmers have long touted their methods as a more benign way to nourish the world. But few rigorous studies have looked at the long-term yields and environmental effects of organic farming. Outside of Europe, organic farms remain a niche operation relying on premium prices to survive.

Now a report on page 1694 brings encouraging news for organic fans. A team led by agronomists Paul Mäder of the Research Institute of Organic Agriculture in Frick, Switzerland, and David Dubois of the Swiss Federal Research Station for Agroecology and Agriculture in Zürich reports the results of the longest and most comprehensive study to date comparing organic and conventional farming, measuring many aspects of crops and soil over 21 years. The bottom line: Organic farms can be nearly as productive as regular farms for some crops, and they leave soils healthier. The study also conclusively demonstrates that for most crops, organic plots are more energy efficient per unit crop.

"This study is as complete a picture as we have from anywhere," says Phil Robertson, an agricultural ecologist at Michigan State University, East Lansing. Agrees soil scientist John Reganold of Washington State University, Pullman: "This gives more credibility to organic systems."

The 1.5-hectare trial, started in 1978 near Basel, Switzerland, compares four farming systems. One group of plots mimics conventional farming, treated with chemical pesticides and herbicides and soluble nitrogen for fertilizer. Another models an "integrated" approach that includes manure with conventional techniques. The organic plots use only manure and mechanical weeding, along with plant extracts to control pests. The fourth system is a much less common practice called biodynamic farming that adds unique treatments, such as a variety of herbs added to compost manure.



Green thumb. Organic farms, which used mechanical weeding rather than herbicides, hosted more kinds of beneficial insects.

Over 2 decades, the average crop yield was about 20% lower in both kinds of organic fields, a finding on par with previous studies. The best-performing organic crop was winter wheat, which stacked up at about 90% of the conventional harvest. Potatoes fared the worst with about 38% lower yields, mainly due to potato blight and potassium deficiency. The yields are all the more impressive given that the organic plants received less than half the nutrients given to conventional plots. "To add that much less fertilizer and still get 80% of the conventional yields is outstanding," says Reganold.

Because no synthetic fertilizer had to be produced or applied, growing organic crops also required less energy than conventional crops—up to 56% less energy per unit yield. The team also found evidence that nutrient-cycling microbes are more plentiful and efficient in organic soil, making more nutrients available to plants. According to a microbial diversity assay (which measures the range of bacterial metabolites as a proxy), biodynamic soil ranked higher than organic, which in turn outranked soils in conventional fields.

More microbes are known to improve soil structure, and Mäder's team found another benefit: higher yields in organic plots with maximum microbes. But Robertson questions whether the greater microbial diversity is simply a product of more diverse organic materials in the soil, for example, from the added manure. And microbiologist Kate Scow of the University of California, Davis, notes that the diversity assay looks at an "incredibly narrow" range of ecological niches and that other studies have been contradictory.

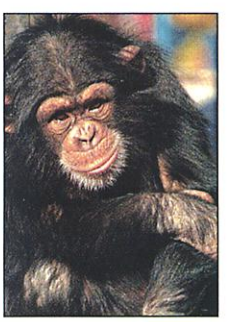
Soils did appear to be healthier in organic plots, with 40% more roots colonized by fungi that assist with plant nutrition. Earthworms were up to three times more abundant, and there were twice as many spiders and other pest-eating arthropods. Mäder thinks that these environmental benefits and higher energy efficiency help justify the existing government subsidies for organic farmers in Europe: "I think our research could stimulate governments to encourage this by showing long-term benefits."

But the study doesn't address other concerns about organic farming, Robertson adds, for example, whether organic farms can be economically viable on a large scale or in other economic conditions, such as in the United States, where such farms are not subsidized. Also uncertain are questions of groundwater pollution and atmospheric emissions of nitrogen forms. But if such concerns can be addressed, as indicated by a few other large trials, then perhaps the next revolution might be a bit greener.

–ERIK STOKSTAD

SEQUENCING

Chimps and Fungi Make Genome "Top Six"

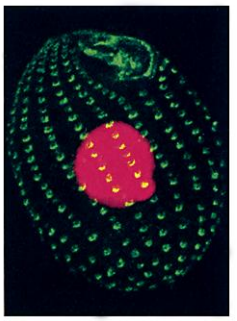


Although the relevance of honey bees, chickens, and sea urchins to biomedicine might seem a stretch, the National Human Genome Research Institute (NHGRI) announced last week that deciphering the genomes of these species is a top priority. These organisms, in addition to the chimp, a protozoan called *Tetrahymena thermophila*, and several fungi, will be next in

CREDITS: (TOP TO BOTTOM) P. MÄDER; ERIC WYSS/FIBL; P. POWERS AND C. SCHAFER/PHOTODISC

line at the big sequencing centers that are now scrambling to decipher the genetic code of humans, mice, and rats, says NHGRI director Francis Collins.

The list is intended to bring order out of chaos. In the past couple of years, various researchers have lobbied the big sequencing labs—including those at Washington University, Baylor College of Medicine, and the Whitehead Institute for Biomedical Research—which now have excess capacity, to sequence their pet organism. Some succeeded: The Whitehead Institute recently deciphered the genomes of a fungus and a tunicate.



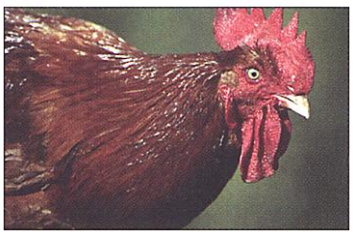
To make the process fairer, NHGRI last summer invited researchers to justify why their organism should jump to the front of the queue. Each proposal was peer reviewed and rated according to the organism's importance to medical research, basic biology, and evolutionary studies. The selection committee also considered how many researchers would benefit from the sequence and how amenable it was to study.

In setting sequencing priorities, NHGRI was also indirectly determining which model organisms biologists will be studying in the coming years. "The viability of your model system is really dependent in this day and age on having a genome sequence," says James Coffman, a developmental biologist at the Stowers Institute for Medical Research in Kansas City, Missouri.

The sea urchin made the cut after 75 biologists wrote effusive letters about its usefulness in developmental biology, cell biology, biochemistry, and studies of gene regulation.

Honey bee proponents, including entomologist Gene Robinson of the University of Illinois, Urbana-Champaign, swayed the committee by describing the insights the bee can offer into the genetics underlying complex behaviors.

Fungi made it for practical reasons—small genome size, big impact on crops and health—and its potential contribution to evolutionary biology. "With them, we can learn about a whole kingdom in one fell swoop," says Ralph Dean, a fungus expert at North Carolina State University in Raleigh (*Science*, 22 June 2001, p. 2273).



Lobbyists for the rhesus macaque got an assurance that it will be first in line once these six are done. But advocates of the cow and *Xenopus* will have to wait.

–ELIZABETH PENNISI

MEXICAN BIOTECHNOLOGY

New Law Could Turn Scientists Into Outlaws

Imprison your leading scientists for doing … research? That could be the effect of a sweeping new law that effectively bans most biotechnology in Mexico. So broad are its restrictions, in fact, that they could block researchers from working with any transgenic organisms, even in the lab. Although Parliament passed the law in February, many of the nation's molecular biologists are just now learning of it, and they are up in arms.

The law, perhaps the world's most sweeping biotech regulation, is part of a larger initiative to reform biosafety rules in Mexico. Most of the law deals with relatively uncontroversial matters: regulating the disposal of hazardous wastes, controlling toxic chemicals in urban areas, and blocking the introduction of exotic species. But the little-noted Article 420 of the new law imposes up to a 9-year prison sentence on anyone who, "in violation of the established applicable norms, imports, exports, traffics, transports, stores or releases into the environment any genetically modified organism that changes or can change negatively the components, structure, or function of natural ecosystems." According to Article 420, "genetically modified organism" means "any organism with a new combination of genetic material that has been created by the techniques of biotechnology, including those deriving from the techniques of genetic engineering."

The draconian ban might have been a legislative response to the controversial report that maize in southern Mexico, the center of diversity for that crop, contained genes apparently acquired from illegally planted transgenic stock (*Science*, 1 March, p. 1617; 12 April, p. 236). If so, scientists say, it is a ludicrous overreaction that seems at cross-purposes with government efforts to encourage home-grown biotech. Indeed, the government body intended to supervise these efforts, the Consultative Committee on Biotechnology, complained in a 26 April letter to Parliament that its members "could be threatened with prison by a simple claim that the transgenic organisms that we developed, stored or transported *could* have negative effects on the environment."

Although Article 420 is in effect, it is not yet being enforced, because the relevant "established applicable norms" do not exist. SEMARNAT, Mexico's environment ministry, has told researchers that it is developing the "norms," which will be published in draft form in the *Diario Oficial*, probably next month, for a 60-day comment period. Scientists inside and outside SEMARNAT are demanding that the norms be used to rein in the law.

Illegal action? A researcher obtains DNA at a maize research lab, CIMMYT, outside Mexico City.

But researchers in Mexico are far from complacent. "Nobody is sure how the law will affect them, nor how it will be enforced," *Science* was told by one geneticist in Mexico, who has asked for anonymity because of the "delicate" situation. "It is very difficult to envision that the Mexican government is going to send some of its best scientists to jail for following what were the laws before this latest act was passed." But that, this researcher said, might end up being the case.

–CHARLES C. MANN

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