

# Sweet Smell of Science

## Fresno State professor's manure research holds answers for dairies and dirty air.

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Laser beams dance across a murky lagoon filled with the pasty green waste streaming from California State University, Fresno, dairy stalls where 180 cows produce more than just milk.

Through the gases rising from this liquefied gunk pit in northeast Fresno, lasers pulse 64 times per second. The laser information goes through a maze of cable to a nearby computer that determines how much pollution wafts into the air.

"I frankly had trouble believing it would work at first," says professor Charles Krauter, the Fresno State agriculture scientist who leads this study.

But the laser technology is well-established in the scientific community. It has been used mostly to measure pollution coming from smokestacks at power plants and factories.

Now it's at a dairy, where nobody expected to find a laser measuring air pollution.

And, in a little air-conditioned trailer next to this lagoon, a national spotlight shines on Krauter and his lasers. His work could become research bedrock for dairy industry officials, environmentalists, academics and government regulators.

It will no doubt be reviewed and cited from California to North Carolina in years to come.

Forget smokestacks and tailpipes. Krauter and the smoggy San Joaquin Valley, with its \$4.5 billion dairy industry, are at ground zero on the nation's newest frontier for air pollution investigation.

The logical question: Why would anyone care about air pollution coming from a Holstein? Because at one point last year, state and local estimates showed Valley cows would produce as much smog-making pollution -- called reactive organic gas -- as cars by 2005.

Cows passing cars. It sounded like a Jay Leno punchline.

In defense of the estimates, it was commonly known that gases vent from the Valley's prodigious stockpiles of livestock waste. Officials also knew that dairies with thousands of animals were replacing old-fashioned operations, which might have had 80 cows.

The Valley's dairy herds had swelled to total more than 1.1 million cows. With each animal daily expelling 20 times more waste than a human, environmentalists filed lawsuits from Madera to Bakersfield, claiming air pollution from dairies was too dangerous to allow continued expansion.

Trouble was, nobody really knew how much pollution was coming from cow waste. The government based its estimates on research published the year that casting was finished for "Gone With the Wind" -- 1938. Regulators admitted it was old and way off the mark.

For the Valley, which ranks among the nation's three dirtiest air basins and where respiratory disease afflicts 300,000 people, officials agreed the 65-year-old research should be updated.

The California Air Resources Board, the watchdog of the state's air quality, launched a campaign last year with a grant of more than \$100,000 to Fresno State.

Krauter's first results came from monitoring last fall at a Hanford-area dairy.

Three days of monitoring showed the old research grossly overestimated reactive organic gases. But it was only one dairy and one three-day period.

"We are planning more work," Krauter says. "But the emissions looked like they were far less than half of the current estimates."

Krauter will go to three Valley dairies over the next year to sample emissions in October, late winter and summer. His work at the Fresno State dairy is focusing on methane, which is not a regulated gas, but it may have some connection to the smog-making gases.

Based on lasers, computers and special equipment such as a gas chromatograph that helps identify the gases, the estimates should make a huge leap forward, he believes:

"There's a big difference between 1938 and 2003."

The dairy industry is pleased but cautious about Krauter's results from last year.

"The early results are very encouraging," says J.P. Cativiela, representing Community Alliance for Responsible Environmental Stewardship, a dairy advocacy group. "But more work needs to be done. We don't want to replace the old science with equally shaky numbers."

The old science was based on a methane study, which cited sources dating back to 1890. Additional research has taken place since 1938, but nothing has been definitive enough to replace the old work.

The 1938 study, found in a publication called "Nutritional Physiology of the Ruminant" from the Carnegie Institute, has remained the basis for dairy smog projections on environmental impact reports for decades.

The study indicates that cows emit about 160 pounds of methane annually. Methane, however, is not a smog-making gas.

Nobody measured the more reactive gases that make smog or ozone, a lung-corroding summertime pollutant. It is believed that the smog-creating gases account for about 8% of cow emissions.

Instead of measuring those gases, regulators have just been figuring 8% of the 160 pounds of methane, or 12.8 pounds of smog-making gases per cow each year. In the 12.8 pounds, dozens of smog-making gases could be included, such as ethyl alcohol, ethyl amine, isopropyl alcohol, propyl acetate and trimethyl amine.

Nobody knows if the 12.8 pounds is right. Until the past few years, when dairy herds began expanding, nobody had any reason to figure it out.

Now environmentalists say regulators should impose rules on dairies to save the lungs of Valley residents. The regulations could be changed as science catches up, they say.

"Act now, apologize later," says Brent Newell, lawyer for the Center on Race, Poverty and the Environment, which has sued several dairies over air pollution.

The lawsuits have resulted in many delays and reviews of county standards, but many dairies are moving forward.

Dairy officials say they are willing to invest in emission controls, but there simply isn't enough science to guide them yet. Animal waste emissions are not understood well enough to devise a control strategy, they argue.

That's one argument they use in opposing state Sen. Dean Florez's legislation. Among Florez's eight air quality bills this summer is SB 707, which seeks buffers around new or expanding dairies to separate them from communities and schools.

Industry officials fear it might unfairly restrict dairies and cause unnecessary expense if it's enacted before the research is done.

"The National Academies of Science advised the federal government not to develop recommendations [about dairies] without sound science," says Michael Marsh, chief executive officer of Western United Dairymen, representing more than 1,000 dairies. "There's nothing to support the legislation from Florez."

It is a matter of time -- perhaps a year for Krauter's work -- before scientists understand enough to guide regulators.

But past research has provided much more information about ammonia. Scientists believe ammonia hangs in the Valley's thick, winter fog and combines with another chemical to make dangerous particles, called ammonium nitrate, that lodge in people's lungs. The state considers dairies the No. 1 source of ammonia, estimating more than 60,000 tons annually.

The San Joaquin Valley Air Pollution Control District is attempting to control ammonium nitrate by cutting down on nitrogen oxide, the chemical that combines with ammonia.

Nitrogen oxide comes from cars and other combustion sources such as boilers on steam generators. Stricter engine standards and more controls on other sources will help.

But the Fresno State research has something to say about ammonia, too.

Krauter is standing next to his portable weather station at the Fresno State trailer when dairy ammonia crosses his mind.

He and graduate student Matt Beene are discussing how the lasers will be placed downwind of dairies during their testing to see how far pollution travels.

Farmers often grow crops around their complex of stalls, buildings and lagoons. The crops appear to absorb ammonia, Krauter says.

"In our initial monitoring, we found excellent evidence that vegetation pulls the ammonia plume down to about 20% of its original size," he says. "Most of it is gone after [it moves] a short distance beyond the dairy."

But the possible equation for smog-making gases may not be so simple, Krauter says. Atmospheric chemistry and the sometimes-chaotic nature of weather complicate his work. And dairies differ in their construction and the way they manage waste.

To illustrate one difference, Krauter says he hopes to monitor a dairy with a biogas digester, a system to capture methane from cow waste and burn it to run an electricity generator. It is believed that digesters cut down air pollution but, again, no one knows.

"It might produce more reactive organic gases," Krauter says. "It might also burn them up."

If dairy pollution estimates were eventually lowered as a result of Krauter's work, it would raise a formidable challenge. Jerry Martin, spokesman for the state Air Resources Board, says regulators would have to cut back pollution from other sources.

He says dramatic efforts may be needed, such as focusing on better mass transit and cleaner-running vehicles. He cited the Los Angeles-area South Coast Air Basin, which has drastically cut down on diesel in truck and bus fleets by switching to natural-gas power.

"We know the ozone is there," he says. "The bottom line is, where do we get the reductions from?"

Back at Fresno State, Krauter watches as the dairy stalls flush into the 30-foot-deep lagoon. The lasers keep firing across the 138-by-378-foot pit.

He knows sweeping policy decisions, industry adjustments and public health are riding on what he finds. His findings will be under a microscope. State scientists wait to review the work, and his academic colleagues across the country will take a hard look.

"Really, there aren't that many facts to work with," he says. "It has taken us a year to get where we are. It may take another year to make it useful."

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