Settling Doubts About Livestock Stress

When scientists talk about animal stress, they're weighing the possibility of real pain and fear—even death—which not only violates animal care ethics, but also costs producers millions of dollars each year. Happy, healthy animals appear most likely to thrive, with the least intervention and fewest food safety problems. So the point of studying animal stress is to find out how livestock view the farm world.

A team of scientists is doing exactly that as part of an Agricultural Research Service national program to see whether current production practices are severely stressing animals—and, if so, to find objective measures to indicate those levels. Such measures could then be used to evaluate new practices that might alleviate pain and suffering. The measures might be behavioral, such as fighting, or physiological, including everything from elevated temperature, heartbeats, and hormone levels to low weight and nerve damage.

The team includes research leader Donald C. Lay, animal scientists Jeremy Marchant-Forde and Ruth Marchant-Forde, animal immunologist Susan Eicher, and neuroscientist Heng-wei Cheng, all with ARS's Livestock Behavior Research Unit, and ethologist Ed Pajor, with Purdue University at West Lafayette, Indiana.

Begin at the Beginning

Lay is a pioneer in the study of how pregnant livestock can transfer stress to their offspring. He is working with a group in Holland that's one of three others in the world researching prenatal stress in livestock. Lay and colleagues have found that if a pregnant pig or cow, for example, is stressed, profound changes occur in the offspring's physiology and behavior that can affect farmers' income. These include higher levels of the hormone cortisol, which indicate stress, and slow wound healing.

When Lay transferred from Iowa State University, where he was a professor and researcher, he brought this research to ARS. USDA recognized the significance of his findings on neonatal stress by awarding him a competitive USDA National Research Initiative (NRI) grant of $200,000 to continue his work.

Lay's expertise in stress physiology has allowed for an exciting breakthrough by working with Tom Stabel at the

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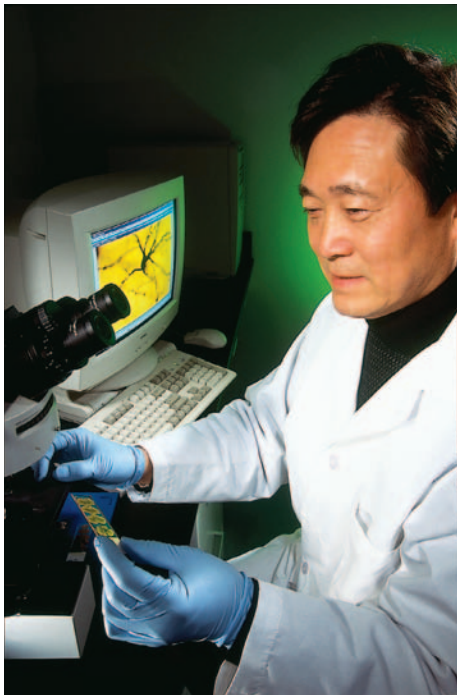

Neuroscientist Heng-wei Cheng examines stress-induced neuronal changes in brain tissue of selected gentler chickens.

ARS National Animal Disease Center to identify characteristics of *Salmonella* that allow them to more effectively infect their host. Doctoral candidate Mike Toscano found the first instances of bacteria "monitoring" their swine hosts.

"*Salmonella* respond to higher concentrations of norepinephrine, another hormone that indicates stress," says Lay. The phenomenon had been found in rodents, but not in swine. With the help of an additional 3-year, $300,000 NRI grant, Lay and Scott Willard, a professor at Mississippi State University, will use a new technology called biophotonics to study how *Salmonella* infect their host.

In this project, the bacteria are engineered to emit light. With a sensitive, photon-sensing camera, Lay and Willard will be able to watch *Salmonella* as they progress through a living swine. This technology will answer many questions, such as where *Salmonella* hide in their host and how they manage to travel so quickly once they infect a pig."This work suggests the possibility of using a blood test for stress-related hormones to spot at-risk animals and isolate them during transport," Lay says. "It also suggests that if farmers used practices to reduce stresses associated with mixing animals from different herds and transporting them in trucks, they could lower norepinephrine levels and reduce *Salmonella's* ability to infect swine."

As part of her studies on the effects of farm practices on the immune systems of livestock, Eicher has devised a milk formula supplement that helps dairy calves fight *Salmonella* and other infections, especially during stressful times.

She and colleagues—including Jeremy Marchant-Forde—take calves on 6- to 8-hour trips weekly, as new calves are born. They've found that calves are particularly vulnerable to transport stress when 4 days old. They do better before and after that age, just as farmers reported to a once-skeptical Eicher.

She wonders if it might have to do with the fact that on day 4, the calves make a transition from drinking colostrum (mother's first milk)—which boosts their immune systems—to drinking milk. To measure stress-induced weakened immunity, Eicher tests the reaction of cells taken from calves and exposed to infection. Calves shipped at 4 days of age show a much lower immune response and ability to fight pathogens.

Eicher uses her formula supplement—containing electrolytes, beta-glucan (a yeast supplement), and ascorbic acid—to boost calves' and piglets' immune systems. She checks for effects, including

looking at immune system cells under a microscope to see where beta-glucan is accumulating.

"Transporting farm animals is one of the most stressful practices for dairy calves," Eicher says. Her formula restores the calves' immunological systems, gives them back their appetites, and allows them to resume normal growth.

It even reduced stress in Holstein dairy calves taken from their mothers within 4 to 12 hours after birth. They were more active and had higher daily weight gains and levels of immunoglobulin (IgG)—an ingredient in colostrum that's an indicator of a good immune system—and lower levels of a liver protein that indicates stress.

Working with colleagues at the University of Florida-Gainesville, Eicher found that mixing formula-treated beef calves with those from other herds wasn't nearly as stressful as weaning and transporting. As indicators, they used behaviors and blood levels of cortisol, liver proteins and other proteins, and immune system indicators like IgG.

Eicher is also finding that acquainting young, pregnant cows with milking parlors and milking before their first births reduces stress when they're milked after their calves are weaned. She completed two studies with cows in Purdue's herd of 200 confined dairy cattle. She also worked with colleagues at Mississippi State University who did a similar experiment with a grazing herd.

According to Eicher, "There was lowered stress—as measured by increased milk production, less nervous weight shifting in milking stalls, and a quicker return to normal levels of heptaglobin, a protein that cleans up hemoglobin after tissue damage or other stresses—in the cows in all three experiments. But the benefits were clearer in the confined herd."

The Last Thing Over the Fence

Eicher has been working with Cheng for the past 8 years to see whether removing

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How livestock view the world is the focus of the work of ARS animal behavior scientists. They hope to identify and reduce excessive animal stress on the farm to improve health and productivity.

dairy cows' tails by constrictive banding causes them chronic pain. She is the first U.S. researcher to study the practice, called "tail docking." It's commonly done by dairy farmers for sanitary reasons and is growing in popularity, moving from adults to calves at ever-younger ages.

Eicher and Cheng have found both behavioral and physiological signs indicating that animals may suffer chronic pain from tail docking. Not only do calves pay attention to the stump, they also show physiological and neurological signs usually associated with "phantom limb" pain in people. The data showed that young calves actually respond to the pain more than adult cows do, a finding that doesn't support the normal practice of conducting painful procedures on young animals rather than older ones. Researchers observed an increase in blood temperature in the area around the tail and formation of neuromas—bundles of nerves occurring at their damaged ends—which can transmit pain spontaneously. The fact that Eicher's behavioral observations match up with Cheng's discovery of neuromas makes a stronger case for the likelihood of chronic pain.

Cheng uses a careful procedure to search for neuromas and other possible nerve damage that could cause chronic pain or hypersensitivity to temperature or touch. This includes an elaborate procedure for staining nerve tissue for electron microscopy study.

The First Thing Into the Feed Bin

Cheng also looks at neuromas to evaluate a similar practice in poultry production: beak-trimming. Farmers trim from a third to a half of the beaks off chickens, turkeys, and ducks to cut losses from poultry pecking each other.

"Poultry beaks are much more complex structures than cattle tails," Cheng says. "They're really intricate, so it's not hard to cause problems when cutting them. Sometimes the beaks are deformed as they heal, which interferes with eating or other instinctive behaviors, like preening."

One ARS study involves socializing piglets in hopes of preventing fighting among pigs as they get older.

SCOTT BAUER (K9455-9)

Cheng is tackling that problem from two angles: finding the most humane way to trim beaks and eliminating the need to trim them. He's first looking at infrared and laser techniques as alternatives to the knives currently used. He recently completed a study with Pajor on trimming the beaks of Muscovy and Pekin ducks. That data is currently being analyzed.

But Cheng thinks the need for trimming can be eliminated by breeding gentler poultry, so he's found a breeding line of such chickens. He and his colleague, Bill Muir, a professor at Purdue University, believe that breeders of many types of livestock have inadvertently bred more aggressive animals—with less maternal instinct and ability to cope with stress—as they've selected for traits such as productivity. USDA recognized the significance of their findings on the ability to reduce aggression through genetic selection by awarding them an NRI grant of $300,000 to continue their work.

A House Is Not a Home

Eicher and Pajor found that piglets born to sows housed individually in conventional stalls bore evidence of the stress the housing caused their mothers. Piglets from stall-housed mothers had lower growth rates and increased measures of stress—including more squealing—during an isolation test after weaning than piglets from group-housed sows. Jeremy Marchant-Forde also works with Eicher and Pajor on alternative housing for sows.

Confining pregnant sows in stalls is a major well-being issue. It curtails

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Technician Gary Nowling loads a calf onto a trailer during a study to determine the effects of transportation stress and its relation to calf age.

movement and social interaction and fails to provide dirt or hay to satisfy their instincts to use their snouts to root for food.

So Pajor is asking sows what they prefer. He's set up a way to let them choose either extra food or space and company. Each sow is in a typical gestation stall, but she is able to push a bar to open a door that lets her visit the sow on either side of her stall. Or she can push another bar and get a little extra food. The scientists rate a sow's motivation or priority level by the number of times she's willing to press a bar to get her reward.

To his surprise, so far the sows are choosing extra food. His first project was done with 16 sows, studying 4 at a time from Purdue's herd of 250 sows.

"Scientists have often compared sows in different housing situations," says Pajor. "What's new here is letting them choose the 'extras' to see what their priorities are.

The current setup is a typical, barren environment, with slatted cement floors. The next round of experiments will see whether the sow chooses different options in an enriched environment—where there's more to do, a soft floor, and straw to satisfy instincts like nesting or rooting.

Getting Along With Others

Lay is also working with Pajor on experiments to show the effects of an enriched environment on baby pigs, including the socializing effects of letting young from different litters play and interact at about 10 days of age.

"We want to see whether there is an age window for socialization," Pajor says. "Could early socialization help piglets cope better when mixed with different pigs later in life? Could it help them spot dominant pigs and get in fewer fights, for example? That would be good for both the pigs and the farmers.

"When a lot of these indicators—behavioral and physiological—come together and point to the same thing, you begin to feel that you've proven the animal is experiencing stress," Pajor says. That has already happened in several cases as ARS farm animal stress research begins its second decade, fulfilling its mandate to seek out objective measures of stress and ways to alleviate it.—By **Don Comis,** ARS.

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Purdue University graduate student Danielle Cary (left) and immunologist Susan Eicher feed a calf a fluorescently labeled supplement that will enable them to determine where the supplement acts to boost the immune system.

This research is part of Animal Well-Being and Stress-Control Systems, an ARS National Program (#105) described on the World Wide Web at www.nps.ars.usda.gov.

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