RESEARCH *of* CHAMPIONS

WHETHER IT'S WHEAT, CORN OR LIVESTOCK, MU RESEARCHERS BUILD A CROP OF KNOWLEDGE THAT FUELS MISSOURI.

BY JOHN BEAHLER • PHOTOS BY NANCY O'CONNOR

ERNIE SEARS' LAB coat is still hanging on the wall of his Curtis Hall laboratory. For six decades Sears spent long hours absorbed in his research here, right up to the day he died in 1991 at the age of 80. His colleagues hold occasional meetings here, but the lab is almost like a museum to the quiet MU researcher who helped revolutionize our understanding of genetics.

WHEAT GENETICIST ERNIE SEARS WORE THIS TATTERED LAB SMOCK WHILE HE POTTED THOUSANDS OF WHEAT PLANTS IN THE GREENHOUSE ATTACHED TO CURTIS HALL.

In Sears' day, boxes of wheat seed were stacked nearly to the ceiling. They're gone now, although not much else has changed. Two battered metal desks are pushed together, facing each other in the middle of the room. That's where Sears and his wife, fellow scientist Lotti, shared their research and their lives. Two microscopes, sheathed in dusty plastic sleeves, sit on an empty lab bench.

There's nothing special about Sears' lab coat. It's a faded gray smock with frayed cuffs and worn-out sleeves. The rips are patched with denim, stitched meticulously together.

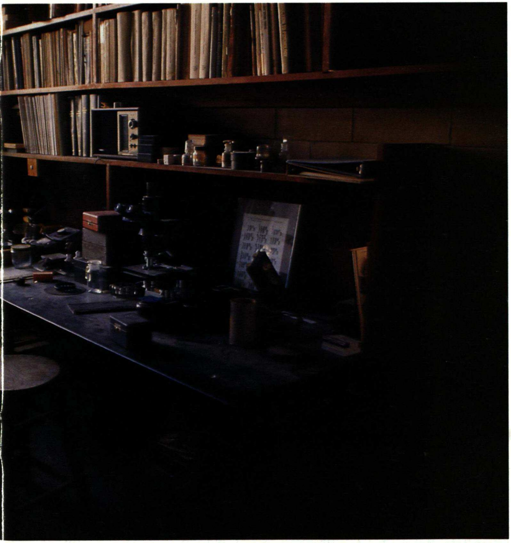
Sears was equally precise as a researcher. He was the first scientist to stitch chromosomes from a wild grass onto domesticated wheat. That first cross with a wild grass produced a wheat strain able to withstand an epidemic of rust disease that was devastating wheat fields around the world in the mid-'50s. His discovery saved farmers back then hundreds of millions of dollars a year.

That breakthrough was just one of Sears' many contributions to plant genetics. He pioneered the use of X-rays and ultraviolet light to trigger genetic mutations in plants. The technology helped him develop a series of more than 100 genetic stocks of wheat that researchers still use today.

Each plant is missing one of the 21 pairs of chromosomes in wheat, part of a chromosome, or has an extra chromosome. That lets scientists link plant characteristics—such as early flowering or high protein content—to specific chromosomes. Using Sears' genetic stocks, researchers and plant breeders can manipulate genetic material in wheat almost like shuffling a deck of cards.

"The impact of his research is still felt everywhere in the world," says Perry Gustafson, a USDA scientist and MU agronomy professor who worked with Sears. "What Ernie did with wheat, scientists haven't been able to do with any other plant or animal. Every wheat geneticist in the world uses his stocks. And it was his groundwork that really started this kind of research in animals and humans."

Gustafson and other MU researchers continue to manipulate the genes in



SCIENTISTS TODAY USE POWERFUL MOLECULAR BIOLOGY TECHNIQUES TO STUDY THE CHEMISTRY THAT REGULATES PLANT GROWTH. SEARS USED A MICROSCOPE, NEEDLES AND TWEEZERS TO MANIPULATE GENETIC MATERIAL. HIS WORK HELPS PLANT BREEDERS DESIGN BETTER WHEAT TO FEED A GROWING WORLD.

wheat. They ship seeds and genetic material from Sears' original stocks and from their own research efforts to hundreds of scientists around the world. Sears' plants are still grown in a small greenhouse behind Curtis Hall, as well as at seed repositories in England, France, Canada, Australia and the United States.

In his Curtis Hall laboratory, Sears used a needle and a pair of tweezers to manipulate genetic material between plants. Researchers today use powerful molecular biology techniques to tear those plant cells apart and study the chemistry that regulates plant growth. These techniques not only engineer bumper crops, but also build in natural resistance to insect pests and increase the yield of economically important by-products, such as protein and lysine.

The spirit of Sears' work continues at Mizzou. Scientists here are international leaders in developing a genetic map of corn, one of Missouri's biggest cash crops. Ed Coe, a USDA research geneticist stationed at MU, has been working for six years with scientists around the world cataloging and listing corn genes on an electronic database that is available over the Internet. So far, nearly 2,000 of the estimated 50,000 genes in corn have been identified and mapped.

That work in genetics is only one example of a continuum of research in agriculture and the life sciences at Mizzou—from early pioneering studies to the latest groundbreaking innovations. There are similar examples from every corner of campus.

Tucked among the parking lots and residence halls near University Hospital, a small plot of land is staked off with a chain-link fence. This is where MU researchers conducted some of the first soil erosion studies that were ever done anywhere.

It started back in 1915, when agronomy professor M.F. Miller assigned a graduate student to set up an experimental plot to measure rainfall and runoff. Wooden boards around the test plot funneled rain runoff to an old oak vinegar barrel, where the water was sampled and measured.

But grad student F.L. Duley found that mud also collected in the barrel along with rainwater. By analyzing that mud, the researchers discovered that erosion removed more nutrients from soil than growing a crop did. For decades, Mizzou soil scientists continued their research at the test plots, and they uncovered volumes of information about soil conservation practices.

In fact, it was that Missouri research that helped convince Congress in 1928 to set up a network of soil erosion experiment stations around the country. Farming techniques developed at those experiment stations helped America's farmers weather the great drought that stirred up dust storms throughout the Midwest in the next decade and gave the era its well-earned nickname—the "Dirty Thirties."

By 1935, those early experiment stations had evolved into the U.S. Soil Conservation Service. The Duley-Miller plots still are used by researchers studying, among other things, ways to restore eroded farmland.

Most Missouri farmers were still plowing with teams of mules when that first soil erosion research got under way. Today, they're harnessing the power of giant combines and tractors that gobble up huge tracts of land in just hours. By studying a new farming technique called precision agriculture, Mizzou scientists are leading the way into the next generation of land-use research.

Precision agriculture teams up those giant machines with satellite positioning systems and on-board computers. The new technology lets farmers apply just the right amount of fertilizers and pesticides to specific spots in their fields. That keeps production costs down and, at the same time, keeps the runoff of those potentially harmful substances to a minimum.

The Show-Me State has long been known as an important livestock producer. With 4.6 million cows, Missouri is second only to Texas in the number of cattle it produces. Livestock sales add $2.24 billion to the state's economy each year. For more than a century, Mizzou animal scientists have been working to keep livestock healthy and Missouri farms prosperous.

In the late 1800s, Missouri cattle were dying in droves from Texas fever, a tick-borne disease they caught from herds of wild longhorns that Texas cowboys were driving to market. It was MU scientist John Connaway who discovered the connection between Texas fever and the cattle tick. His subsequent research helped eradicate the disease.

Hog cholera was the next disease Mizzou animal scientists tackled. Cholera was decimating swine herds all over the state at the turn of the century. Many researchers were working on cholera vaccines, but MU took it a step further. Mizzou animal scientists built a small factory to produce a serum that protected pigs from cholera. For more than 20 years, they distributed the low-cost medicine to Missouri farmers.

The battle against hog cholera was a long fight. Two decades later a new laboratory technique—called a fluorescent antibody test—allowed researchers to detect the cholera virus in a hog's body tissue. Testing at Mizzou went into full swing, with laboratories in the College of Veterinary Medicine working around the clock for months, testing swine herds from every corner of Missouri. That effort led to a national program that eventually eradicated hog cholera.

Although scientists can help livestock producers control the devastation of some diseases, one thing they never will be able to control is the weather. Especially Missouri weather, where scorching summers follow bone-chilling winters.

Those temperature extremes have a huge impact on livestock. Heat stress can keep cattle from putting on the extra pounds that mean more profit for producers. It can interfere with reproduction. High temperatures can even lead to death from toxins produced by a fungus that thrives in Missouri fescue pastures.

Mizzou animal researchers are doing more than just talking about the weather. They're using unique climate-controlled chambers to study how weather influences animals' health and growth. It's called the Brody Animal Climatology Lab. Scientists use it to simulate everything from desert conditions of as much as 110 degrees Fahrenheit all the way down to an arctic-like minus 26. There's nothing else like it anywhere in the world.

The lab is named for the late MU professor Sam Brody. Right after World War II he used military surplus equipment to build the first-ever climate chamber to study farm animals. Brody was an expert in what's called the "bioenergetics" of livestock, the study of an animal's metabolism—how it converts feed to meat, for instance, or the factors that control its production of body heat.

That original chamber was replaced in 1984 with a new high-tech version. The climatology lab has four chambers, each big enough to hold up to six dairy cows. Scientists can monitor the animals' food

and water intake. Video cameras record the animals' behavior. Computers track the animals' body temperature using sensors placed in the animals' abdomens.

The research is coming up with practical answers to questions that plague livestock producers. What's the most efficient way to use fans and misting systems to cool off dairy cows and keep up milk production? At what temperatures does the toxin found in fescue pastures do the most damage to cattle? Can a special feed ration reduce an animal's body heat on the hottest days of the year?

Over the years, MU scientists have had answers for farmers about another enemy of agriculture—crop-destroying insects. Right along with the weather, bugs have been a constant headache for agriculture ever since the first farmer scraped the ground with a digging stick.

All the way back in the 1860s, Mizzou professor and entomology pioneer C.V. Riley developed some of the first methods to control an invasion of Colorado potato beetles that was threatening Missouri crops. He later was credited with saving the French wine industry by introducing

SEARS DEVELOPED MORE THAN 100 OF THESE GENETICALLY ALTERED WHEAT PLANTS THAT RESEARCHERS STILL USE TODAY. HE WAS THE FIRST SCIENTIST TO CROSS WHEAT WITH A WILD GRASS, RESULTING IN A HYBRID PLANT THAT WAS RESISTANT TO A RUST DISEASE THAT COST WHEAT FARMERS WORLDWIDE HUNDREDS OF MILLIONS OF DOLLARS A YEAR IN THE 1950S.

Missouri-grown grape rootstock that was resistant to the phylloxera insect.

MU insect experts were in the forefront again when chinch bugs attacked in 1934, during the driest of the drought years in Missouri. Chinch bugs can decimate grain and grass crops by sucking out the plants' sap and nutrients. They move out of their wintering spots in tall grass along fence rows and march straight across a field.

Mizzou entomologists showed Missouri farmers what was then the most effective way to control chinch bugs: plow a trench around the threatened field and fill it with a foul-smelling compound called chinch bug oil. MU extension experts distributed nearly a million gallons of the oil around Missouri. That counterattack saved the hay crops that farmers relied on to keep their livestock alive.

In Riley's day, and even much later, insect-fighting weapons often were harsh, dangerous chemicals. Today at Mizzou, researchers are working on a new generation of more environmentally friendly insect-control mechanisms.

Some of the most promising developments include genetically engineered plants that have natural insecticides spliced into their genetic code. Other MU scientists are developing biological methods to control bug infestations, going after them with viruses and other disease organisms. And they're finding insect predators, such as parasitic wasps, that can be just as effective as chemical insecticides.

MU scientists also are exploring one of the biggest problems facing livestock producers by opening the door to some of the basic science behind animal reproduction. Only seven out of 10 pregnancies in farm animals are successful, and most of the losses occur during early pregnancy. This reproductive riddle costs farmers millions of dollars each year.

A Mizzou research group led by animal scientists Bill Day and Randy Prather last year produced the first all-female litters of piglets in collaboration with USDA scientists in Maryland. That research breakthrough one day could help swine producers develop breeding lines more efficiently. It's only one part of an internationally recognized research effort to explore animal reproduction.

Animal researchers working in Scotland grabbed global attention last year when they reported cloning an adult sheep for the first time. While the announcement made headlines around the world, MU researchers went quietly about their work. Day and Prather have spent years in the laboratory studying some of the basic science behind animal reproduction. What they're learning about cloning pigs could make the process more efficient.

Right now, it's anything but. The Scottish researchers had to repeat their cell transfer technique nearly 300 times before the experiment worked. One of the main difficulties, Prather says, is to mimic what happens naturally in the egg during fertilization.

"With natural fertility, a series of events is initiated," he says. "It's like dominos falling—one event leads to another which leads to another." Prather and his colleagues are making solid progress in understanding what happens in the pig egg during fertilization.

When sperm mixes with an egg, for instance, a burst of calcium is released in the egg. And not just once; the calcium level oscillates up and down. Prather is using precise electric shocks to trigger that release of calcium in the same up-and-down pattern that mirrors normal development.

Cloning can be a valuable tool in animal research. For instance, cloned animals could improve meat and milk production. Or, by adding new genes to cows and sheep, a herd of these cloned animals could be genetically programmed to manufacture pharmaceuticals in their own bodies.

"Right now," Prather says, "many of these pharmaceuticals are more expensive per ounce than gold."

Pigs aren't good candidates to be cloned into genetically altered drug factories. But because most of a pig's organs are similar to human organs, scientists one day might be able to use pigs as human organ donors. That's another research area that a team led by Prather and Day is working on, thanks to a $500,000 grant from the National Institutes of Health.

They're just a few of the MU scientists continuing a tradition forged by researchers like Ernie Sears, Sam Brody and C.V. Riley. They're pushing the boundaries of knowledge and providing scientific know-how that will keep the Show-Me State showing the way in science and agriculture. ❋