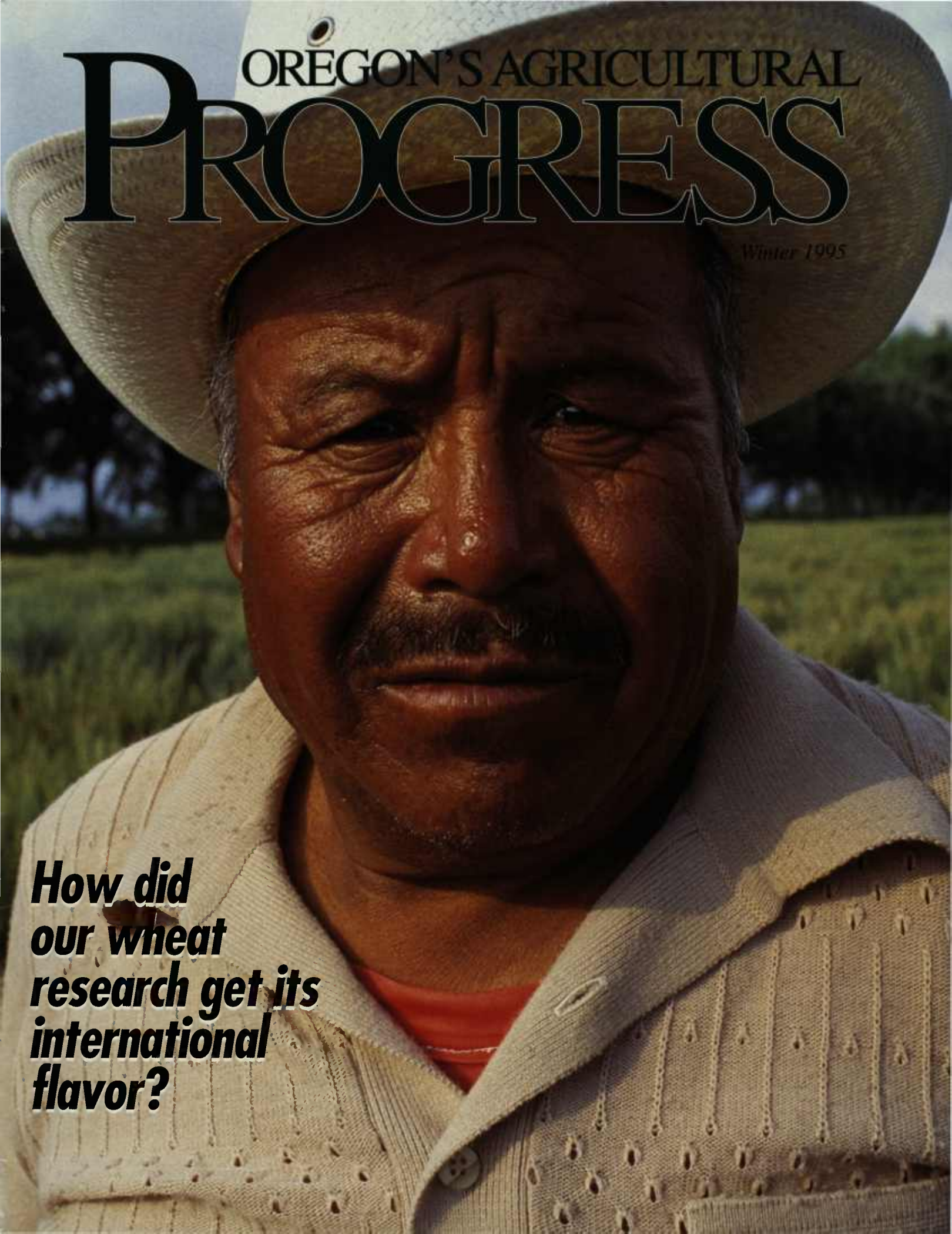

OREGON'S AGRICULTURAL PROGRESS

Winter 1995

How did our wheat research get its international flavor?

EDITOR'S NOTE

A while back the son of a friend of mine, an OSU student, was driving 65 miles an hour when the steering wheel in his older car came off in his hand. Doesn't that sound horrible?

But in scientific research, getting out of control, or at least what some might consider out of control, can be good. It tests the conventional wisdom in a world that, in many ways, is forever changing. It's how we learn.

The steering wheel came off in his hand.

If long-forgotten *Homo sapiens* hadn't challenged the conventional wisdom eons ago, we'd still be hunting and gathering roots and berries.

This issue of *Oregon's Agricultural Progress* made me think about the benefits of being "out of control."

"The Cooler King," on page 26, looks at the work of a horticulture professor who designed a different, sort of "space age" way of growing container plants. Jim Green did the work at the request of the nursery industry. Maybe parts of his system will prove themselves in the marketplace. Maybe the entire system will. Who knows where the concept will lead?

"High Plains Drifters," page 16, is about research with wild horses. One aim of Linda Coates-Markle's study is to move past "folk notions" and document more about how these controversial animals actually live—so we can do a better job of managing them and protecting the environment.

On page 8, "Wheat Dreams" examines the work of OSU cereals geneticist Warren Kronstad and a team of dedicated scientists, technicians and students he leads. Out of control isn't the right description, but since starting at OSU in 1959 Kronstad has never been content with the status quo. I suspect most Oregonians have no idea of the state and international impact of OSU's ambitious Cereals Breeding and Genetics Program.

Last, in case you're interested in the OSU student's predicament: Even going 65, he managed to stop without incident. He'd be the first to tell you it was scary. On the other hand, he certainly learned about different ways of controlling a car.

Andy Duncan

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Cover: This resident of the Toluca Valley west of Mexico City uses his whip to keep birds off experimental grain, including OSU material, at a field station of the CIMMYT international research center. Photo: Andy Duncan. Back cover photo: Bob Rost

UPDATE

NEW LAB TO GIVE SEAFOOD A BOOST

U.S. Sen. Mark Hatfield, U.S. Rep. Elizabeth Furse and other dignitaries converged on Astoria recently to attend the groundbreaking for a state-of-the-art seafood lab that's intended to give Oregon's seafood industry a boost.

"The lab is a product of an extraordinary level of cooperation by the community and several levels of government and education," said Thayne Dutson, dean of OSU's College of Agricultural Sciences and director of the Oregon Agricultural Experiment Station, which will operate the lab.

Funding for the $4 million lab includes about $2 million from the U.S. Department of Agriculture, $300,000 from the city of Astoria, $100,000 from the Oregon Department of Economic Development and $1.6 million from OSU.

The lab is phase one of a complex that will include the OSU Seafood Laboratory, a large conference facility to be called the Duncan Law Seafood Consumer Center, and a privately operated hotel.

The laboratory will be part of the Coastal Oregon Marine Experiment Station headquartered at Newport, one of 10 branches of the Agricultural Experiment Station.

The facility will replace an outdated lab where OSU conducts research, in cooperation with Oregon's seafood industry, on innovative seafood processing, development of value added products, seafood biochemistry and waste utilization.

The laboratory is expected to be ready for occupancy in the spring of 1996. Michael Morrissey, who began his duties as director of the Seafood Laboratory in 1990, will continue as director of the new laboratory.

The seafood complex was conceived by Duncan Law, a long-time OSU food technologist, now retired, who saw a need for a facility that promotes research, training, marketing and promotion of seafood.

Public and private organizations cooperating on construction and operation of the seafood complex include the Columbia River Maritime Museum, the city of Astoria, Clatsop Community College, OSU, Seafood Consumer Center, Inc., Northwest Conference Resorts, Inc., Clatsop County, the Port of Astoria and the Oregon Department of Economic Development.

Architect's drawing of the OSU seafood lab to be built at Astoria.

EARLY MATURING TOMATO RELEASED

A new early-maturing tomato called Siletz is available to home and market gardeners for the 1995 growing season. Siletz was developed by James R. Baggett, a vegetable breeder at OSU, who developed other favorites including the Oregon Spring and Santiam tomato varieties.

Siletz was jointly released by the OSU and University of Idaho Agricultural Experiment Stations and the Washington Agricultural Research Center.

BOB ROST

The new tomato is a full-sized, slicing tomato with flavor, according to Baggett. It matures at Corvallis, for example, in about 75 days after May 15 transplanting. That falls sometime between when the Oregon Spring and Santiam varieties mature.

Yield and fruit size of Siletz are much greater than those of Santiam and average fruit size is distinctly larger than that of Oregon Spring. Typical early fruits of Siletz may weigh 250–300 grams (a little more than one-half pound each). They are slightly flattened in shape and about three and a half inches in diameter.

If grown in a cooler climate such as western Oregon, as many as 60 to 75 percent of the fruits are seedless. Siletz plants are about 36 inches across and resistant to Verticillium wilt race 1.

Siletz tomato seeds are being sold through Territorial Seed Company, 20 Palmer Avenue, Cottage Grove, OR 97424 (send for free catalog) and wherever Territorial Seeds are sold.

Seeds for commercial trial or information on the availability of stock seed can be obtained from: J.R. Baggett, Department of Horticulture, OSU, Agricultural and Life Sciences Bldg. 4017, Corvallis, OR 97331-7304.

NEMATODE WOES HIT ONION FIELDS

Microscopic stubby root nematodes have become a pain in the roots for onion growers in the Hermiston area, says Phil Hamm, a plant pathologist with the OSU Extension Service in northeastern Oregon.

Hamm, Russ Ingham, a plant pathologist in OSU's Department of Botany and Plant Pathology, and George Clough, a researcher at the Hermiston Agricultural Research and Extension Center, are working together on the problem.

Onions, both fresh market and processing types, have become an increasingly important crop around Hermiston the last few years. This has caused many potato growers to start producing onions, which happen to be an ideal host plant for stubby root nematodes.

"These nematodes feed on onion roots, damaging them and the plant's ability to take up moisture and nutrients from the soil," said Hamm. "A healthy plant has long, white roots. A nematode-damaged plant has short brown roots, and the above-ground part of the plant becomes stunted, which causes production of small onions."

Nematodes are microscopic worms found in soils everywhere. As far as researchers are aware, stubby root nematodes have always been present in Hermiston area soils. They haven't been a problem in the past, said Hamm, because this particular type of nematode (there are thousands of kinds) doesn't damage potatoes unless it is carrying a disease called tobacco rattle virus.

"Two years ago, we began to see that stubby root nematodes could be a significant problem on onions in the area," said Hamm. "We are currently studying nematode populations to find the minimum concentration that will cause significant damage to onion plants. Studies are also underway to evaluate nematicides (chemical controls for nematodes) to determine the best application times for maximum effect."

Stubby root nematodes are highly mobile compared to other nematodes, Hamm said. They can move up to 3-4 feet through the soil, quite a long ways for a worm about the size of a pinpoint.

Growers in the Hermiston area are already using a nematicide that has proven very effective, based on the work of Hamm, Ingham and Clough. This particular treatment doesn't kill the nematodes, but stops them from feeding. Hamm, Ingham and Clough are continuing evaluations of this and other products to better understand their effects on the pests, plants and soil.

Onion acreage in the Hermiston area has grown dramatically in recent years as markets have increased for dehydrated onions, fresh processing onions and fresh market onions.

"There are 8,000 acres of dehydrated and fresh market onions in the Hermiston area now and that figure could double in the next few years," Hamm said. "Several major onion processing companies either are already in the Hermiston area, are growing onions here and shipping them to California processing plants, or may build additional facilities here soon."

According to Hamm, the processors like the quality and yield of onions from around Hermiston.

YEAST, BACTERIA PROTECT PEARS

David Sugar is studying strategies for keeping stored pears from rotting, including waking up freeze-dried yeast and bacteria and spraying them on the pears to protect nicks and wounds from fungi.

Sugar is a plant pathologist and horticulturist at OSU's Southern Oregon Agricultural Research and Extension Center at Medford. In his research with Bosc pears he applies freeze-dried yeast and bacteria to the fruit before putting it in cold storage.

The yeast and bacteria are compatible with a fungicide called Mertect that growers also use to protect the pears.

"When we use the biological agent spray [yeast and bacteria], we only need to apply Mertect at one tenth its recommended rate," said Sugar.

The researcher is also trying to give Bosc pears a helping hand before harvest. He's learned that reducing their nitrogen content, by fertilizing about three weeks before harvest instead of in the spring, meets the trees' needs and combats storage rot.

Sugar has also found that using calcium chloride sprays during the growing season increases fruit calcium content, which combats storage rot.

BALD EAGLE STILL FACING TROUBLE

Despite numerous reports about its comeback, the American bald eagle still has some problems, says a wildlife biologist stationed at OSU.

"Granted, the number of nesting bald eagles in Oregon has tripled in the last 15 years, but we still have only about 230 breeding pairs—a pretty small number when you look at what's happened to eagles' nesting sites and the amount of pollution in their environment," said Bob Anthony, acting leader of the Oregon Cooperative Wildlife Research Unit, part of the National Biological Survey.

Anthony said his biggest concern is the high percentage (about 35 percent) of bald eagle nest sites on private lands, where management of forests is regulated by the Oregon Forest Practices Act and the Endangered Species Act.

The scientist said he is recommending "progressive management—selective harvests and long rotations so there will always be some large trees to support the eagles' nests and winter roosting habits."

Anthony also is concerned about pollution. He and coworkers have documented high levels of DDE, an agricultural pesticide, and PCBs, an industrial pollutant, in eagles along the lower Columbia River.

"Efforts to understand and solve pollution problems in the Columbia River should focus on the entire river basin," he said. "Bald eagles and other wildlife species are not exposed to a single contaminant, but to a mixture of contaminants—DDE, PCBs, and dioxins—that are discharged or drained into the river basin."

Anthony said he would like to see more controls on the use and the disposition of PCBs. He has recommended that all transformers and circuit breakers on the hydroelectric dams and major waterways be checked and replaced if they contain PCBs.

ANDY DUNCAN

An immature bald eagle near Upper Klamath Lake.

UPDATE

NEW TEST HELPS FARMERS, WATER

Some western Oregon dairy farmers are thinking about more than milk these days.

OSU soil scientists and volunteer dairy farmers are learning how to more accurately balance the amount of manure applied to silage crops with the crops' nitrogen needs.

The goal is to use less fertilizer, save money and keep surface and groundwater cleaner.

The method the researchers and farmers are evaluating is called the "pre-sidedress soil nitrate test," or PSNT. Soil scientists John Hart and Neil Christensen have been testing and perfecting this new soil analysis method because soil testing methods developed for other parts of the country aren't accurate in western Oregon's wet and cold spring climate.

"We needed a test that would give an accurate picture of what nutrition will actually be available for the plant once the soil warms up and growing season gets underway," said Hart.

Two years of testing suggests that in many cases farmers do not need to add supplemental fertilizers to silage corn. Manure application may suffice, Hart said.

More than 80 percent of Oregon's dairy industry is in western Oregon. Most dairy farmers dispose of animal wastes by sprinkling their crops with liquid cow manure. In the spring they supplement, or "sidedress," corn silage crops with additional chemical nitrogen fertilizer.

The OSU Extension Service will publish new guidelines for dairy farmers on the nitrogen requirements of silage corn, said Hart. Mike Gangwer, an agent with the Marion County office of the OSU Extension Service, is the liaison with dairy farmers for the project.

CARE TO KNOW WHAT'S BELOW?

Healthy soil contains creatures some of us don't know much about.

But these microorganisms, visible with the help of a powerful microscope, play a significant role, according to OSU soil biologist Elaine Ingham.

Ingham and OSU colleagues are devising a way to help farmers, foresters, land managers and gardeners learn about the importance of soil microorganisms with a new "Soil Microbial Biomass Service" housed in OSU's Department of Botany and Plant Pathology.

BOB ROST

Growers and scientists from all over the world are sending soil samples to Ingham's laboratory, where she and associates test for bacterial and fungal activity and biomass, numbers of protozoa, number and type of nematodes, and other creatures.

While analyzing the samples, Ingham is learning more about soil microorganisms and developing reference information on them.

"Soil biology is understudied compared to over-ground biology," she said. "Yet it is important for the health of your garden, agriculture and forestry, as well as the whole ecosystem.

"Someday, we'll be able to tell you if your soil is healthy, and if it isn't ... we may know how to make it better," she added. "However, we have quite a way to go. Scientists don't even know the names of the vast majority of these creatures yet."

According to Ingham, a teaspoon of healthy agricultural soil is teeming with:

—100 million or so bacteria;

—150 to 500 feet of fungal strands;

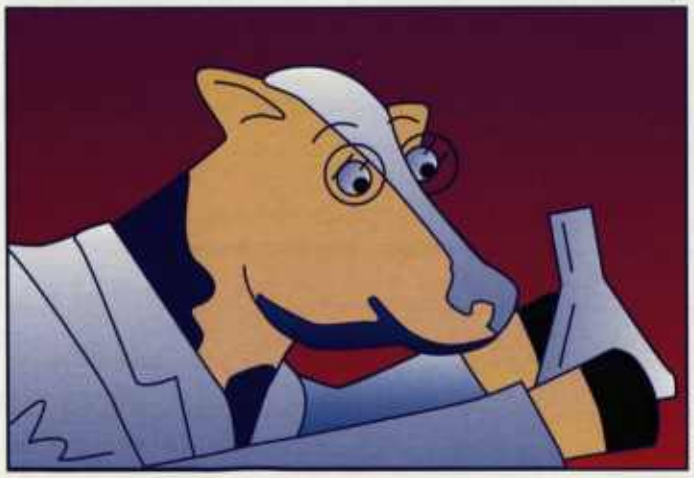
—10,000 to 100,000 protozoa (one-celled mobile organisms that feed on bacteria and each other);

—Five to 500 beneficial nematodes;

—A few to several hundred micro-arthropods such as springtails and mites.

"Just like the web of life that biologists study above ground, below-ground organisms form food webs," said Ingham. "But what most people don't realize is that the above-ground wouldn't exist without the below-ground system."

For more information about the Soil Microbial Biomass Service write Elaine Ingham, Department of Botany and Plant Pathology, Cordley Hall 2082, OSU, Corvallis, OR 97331-2902.



TOM WEEKS

POTATO VARIETY OFFERS BIG YIELDS

The Oregon Agricultural Experiment Station has officially released a new fresh-market potato called Century Russet. Researchers say it offers exceptionally high yields, which is good for both farmers and consumers.

Some growers have already experimented with the new potato. "It has been grown commercially in the Klamath Basin for several years," said Ken Rykbost, superintendent of OSU's Klamath Experiment Station at Klamath Falls and a member of the team that worked on development of the potato.

"It isn't just that Century Russet produces more potatoes per acre, it produces more that go in the high-value packs—

those that weigh 8 to 14 ounces," said Rykbost.

He added that more than 65 percent of Century Russet potatoes end up in high-value packs compared to about 40 percent or less with the standard potato variety sold to fresh markets, Russet Burbank.

The farm gate value of fresh-market potatoes in Oregon in 1994 was about $40 million, estimates Stanley Miles, an agricultural economist for the OSU Extension Service.

Most potatoes are grown in the Klamath Basin, the Columbia Basin, the Treasure Valley and central Oregon. But there also is commercial potato acreage in western Oregon counties such as Marion, Clackamas, Washington and Multnomah counties, according to Miles.

The new fresh-market variety, Century Russet, survived 20 years of scrutiny and testing, according to Al Mosley, an OSU crop scientist who coordinates Oregon's potato variety development program.

Century Russet was first developed in the early 1970's by Joe Pavek, potato breeder at the USDA Agricultural Research Service center in Aberdeen, Idaho. Oregon potato researchers selected it for further testing in 1975.

Century Russet is especially suited to fresh-market uses such as baking, boiling and mashing. "It's too high in sugar content to produce light-colored French fries," Rykbost said. "For acceptable fry quality, potatoes should have low sugar content and high dry matter. Century Russet falls a little short on both counts. Century Russet has a light skin and can be easily bruised, but its yield is superior to any russet released—so far."

The name Century Russet was chosen to commemorate the 100th anniversary of the Oregon Agricultural Experiment Station, celebrated in 1988.

Besides Mosley and Rykbost, the team of OSU campus and branch station researchers who helped develop the potato variety included Malcolm Johnson and Steve James of the Central Oregon Agricultural Research and Extension Center at Madras, Dan Hane of the Hermiston Agricultural Research and Extension Center, Chuck Stanger of the Malheur Agricultural Experiment Station at Ontario, and George Carter of the Klamath Agricultural Experiment Station.

Information on seed supplies of Century Russet and pending varieties is available from the Seed Certification Office at Oregon State University at (503) 737-4513, the Department of Crop and Soil Science at OSU at (503) 737-5835, the Klamath Experiment Station at (503) 883-4590 and the Central Oregon Agricultural Research and Extension Center at (503) 475-7107.

OF PIGS AND A BLANKET

The man who helped bring us odor-free kitty litter 20 years ago has tackled a stinkier problem.

His research may put hog farmers and their neighbors back on speaking terms, prevent some million-dollar lawsuits, and solve a problem that has plagued the swine industry for decades.

In the scientific language used by Ron Miner, an OSU professor of bioresource engineering, his newest invention is an odor-absorbent biodegradable barrier. In simpler terms, it's a blanket to cover pig poop. And it works great.

Anyone who has ever visited, driven by or lived downwind from a hog farm can appreciate the odoriferous problem.

"As more and more people who used to live in cities move into rural areas, we're hearing more complaints," Miner said. "Also, some of the big corporate operations are a hundred times bigger than hog lots used to be. Some people say it's like air pollution, or that it runs down property values."

Some people have an educated palate. Miner, who sometimes is an expert witness in court cases involving livestock smells, has an educated nose. His reputation as an odor expert goes way back. A chemical engineer, he's done extensive research in animal waste management and agricultural interactions with the environment.

BOB ROST

OSU bioresources engineer Ron Miner with a small prototype of the odor barrier he's designing for hog farms.

In the mid-1970s, he worked with private industry to help identify and develop products that could reduce the odor problem from kitty litter. One of the mineral compounds he tested, zeolite, had unusual capabilities for ion-exchange that help it absorb odor. It's now common as a litter additive and mined in several western states, including Oregon.

Taming the scent of the family cat is one thing. It's quite another to stifle the stench of a commercial hog operation.

"Most farm and larger commercial hog lots now use an anaerobic sewage lagoon to process their waste and hold it at least temporarily," Miner said. "The liquids are often applied to crop fields as fertilizer."

With research at the OSU Swine Center, Miner developed different types of barriers that can float over sewage lagoons. Rising gases such as ammonia and methane are absorbed into the moist mats, oxidized and deodorized.

"We're still working to perfect the product, make it naturally degradable and as inexpensive as possible," Miner said. "Ideally I'd like to create something that can sell for between 10 and 20 cents a square foot.

"About all we really need right now," he added, "is for a manufacturer to look at this and say, yes, it should be a money-making product. I'm convinced there's a market."

WHEAT DREAMS

This professor isn't locked in an Ivory Tower. He travels the world, and some estimate his team's work adds more than $6 million a year to Oregon's economy

BY ANDY DUNCAN

It's a nice June morning. Sunny. Insects and birds making noises you'd expect in this tropical spot thousands of miles from Oregon. Suddenly a pop that sounds like the mother of all firecrackers scatters the birds. They come back quickly to small trees that have been their staging areas for reconnaissance flights and daring raids on a target that's hard to resist. But a pop unnerves the birds again. The pops are from a whip in the skilled hand of a man in a straw hat, a human scarecrow guarding the field's ripening grain. His hand is dark from the ultraviolet light that radiates day after day through the high, thin air here in the mountains west of Mexico City.

A man in a baseball hat, a stout fellow about six feet tall with gray hair, pays no attention to the commotion. His hands are sunburned. There's a notebook in one and a pencil in the other. Working his way around plots of yellowish-green grain of different shapes and sizes, he eyes the plants like a drill instructor inspecting troops and stops often to write in the notebook.

This is the Toluca field station of the International Maize and Wheat Improvement Center, commonly known by the Spanish-language acronym CIMMYT. It's where Norman Borlaug, a CIMMYT agricultural scientist, was working in 1970 when reporters showed up and told him he'd won the Nobel Peace Prize. That was for work that contributed to the Green Revolution many credit with helping developing countries in their battle with hunger. The man in the baseball hat is in a battle himself, or at least confronting a challenge he takes very seriously.

Think of 63-year-old Warren Kronstad as an athlete trying to deliver in the clutch. That's why he's combing the field of experimental grain. He's looking for plants that will help him dazzle the growers back in Oregon one

PHOTO: BOB ROST

more time—and, perhaps, help CIMMYT help farmers in less prosperous countries. It's hard to predict how people will size up the career of a player, especially a prominent one. And Kronstad ought to be able to relate to that. These days there are many who think he's a modest, hard-working individual who's performed amazing feats for the state of Oregon in his 35 years as a wheat breeder at Oregon State University. But there are some who think he's as much politician as scientist, and too demanding with his students, employees and colleagues.

Warren E. (for Ervind, his father's first name) Kronstad was born on the third of March, 1932, on what he calls "a little stump farm" five miles east of Bellingham, Washington. He was the only child of working parents. His mother had a college degree in business and was a bookkeeper and his father, who had a degree in education, worked in a lumber mill because he could make more money doing that than teaching. The family got by just fine, but those were lean times for most Americans. "We didn't have a car until I was a senior in high school," he remembers.

Growing up, Kronstad enjoyed more success on the football and baseball fields than in the classroom. After high school he enrolled at Western Washington State College in Bellingham and "wasted a year or so" making A's in classes he liked and C's in those he didn't. Then, with the Korean War buildup, the Navy called his reserve unit to active duty. Instead of the Far East, the Navy shipped Kronstad to a Marine base in San Diego where he worked as a dental technician and played baseball.

He beams as if he'd cleaned Babe Ruth's uniform.

When he was released from active duty he tried college again, at Washington State University in Pullman. He'd married his high school sweetheart while in the Navy. "It was Kathy," he says, "who lit a fire under me to go to continue my education." This time he discovered he "wasn't so lazy after all" and received a bachelor's degree in agronomy, with honors.

There's pride when Kronstad remembers how he went on to earn a master's in plant genetics at WSU under Bob Nilan, "a top geneticist." And he beams, as if he cleaned Babe Ruth's uniform during the 60-homer season, talking about work he did as a research assistant for famed wheat breeder Orville Vogel, who died in 1991. At the time Vogel, a U.S. Agricultural Research Service scientist stationed at WSU, was developing a now-legendary Northwest wheat variety named Gaines.

Then came a watershed. In 1959 Kronstad headed south to Corvallis to be an instructor in what was then the farm crops department at Oregon State University, and to work on a doctorate in plant genetics. His major professor, Wilson Foote, was the leader of OSU's cereals breeding program. While continuing his scientific training, Kronstad learned other kinds of lessons.

"I've never seen anyone who could light up a room with a smile the way Wilson could," he remembers. "I learned a lot about people from him."

ANDY DUNCAN

Whips keep birds out of the experimental grain at Toluca. CIMMYT provides promising germplasm (wheat cells that are bearers of heredity) to developing countries for local evaluation and adaptation.

ANDY DUNCAN

Long-time collaborators: OSU wheat breeder Warren Kronstad, right, and Sanjaya Rajaram, head of wheat germplasm improvement at the CIMMYT international research center in Mexico, evaluate experimental plants at CIMMYT's Toluca field station west of Mexico City.

In increments, Foote moved into an administrative job as an associate director of the Oregon Agricultural Experiment Station, headquartered at OSU. Kronstad worked his way toward Foote's old job. By 1963 he had his Ph.D. and was OSU's project leader for cereals breeding and genetics (collaborating with Chuck Rhode, the OSU breeder at the Eastern Oregon Agricultural Research Center at Pendleton, operated by OSU and the USDA's Agricultural Research Service).

Wheat breeding is an endless relay race, with energetic new varieties entering farmers' fields to compete against an ever-changing complex of diseases, pests and other challengers. It often takes breeders 10 or 12 years to identify plants with desirable genes, cross them, refine the offspring and release a new variety. If the variety is strong, it gets out in front. But in a few years, three or four usually, diseases and pests catch up and growers need another variety.

CIMMYT INFORMATION OFFICE

Two generations of farmers: A mother (standing, left) and daughters in Ghana.

Yamhill, an outgrowth of his Ph.D. research, was Kronstad's first wheat variety. Since it was released in 1972, he and the scientists and technicians on the OSU campus and at branch research stations who have been part of the program team have produced a steady string of cereal grains adapted to growing conditions in Oregon and other Northwest states. These include varieties of oats and barley. But most have been soft white winter wheats. That's the kind used to make pastries and the primary cereal grain grown in the Northwest the last 30 years or so.

Several of the wheat varieties were popular with farmers in various areas for a few years, then diseases caught up. "That made us realize we had to pyramid, or breed more durable resistance, into our varieties," says Kronstad. In 1978 the OSU program had a dream season.

It started with the release of a variety named Stephens, named for an earlier OSU breeder named Dave Stephens. In wheat lingo, Stephens had good resistance to feared diseases with names like stripe rust and leaf rust, excellent yield potential, and performed well in a wide variety of locations and conditions. It became the most popular cereal grain in the Northwest, the one grown on the most acreage. Still, Stephens held a surprise. After a few years, when most varieties were wearing down, it was just getting started.

In the fall of the year, Kronstad and his co-workers could watch farmers planting seeds on hundreds of thousands of acres. In the spring they could see millions of green plants stretching across varied agricultural lands in Oregon, Washington and Idaho. In late July and August they could marvel as combines crisscrossed golden fields, grain elevators spilled over and barges filled with Stephens wallowed down the Columbia River to the Port of Portland, where ships were waiting to sail for foreign markets.

There were problem years. But it was the 1990s before diseases, particularly one called Cephalasporium stripe, really threatened to put Stephens out of the race. Many growers switched to Madsen, a newer wheat developed at Washington State University. Then in 1994, partially

CIMMYT INFORMATION OFFICE

Making "chapatis," a common flat bread, in Katmandu, Nepal. Wheat is a vital food in many developing countries. This unleavened bread will be baked in a clay oven.

because of the weather, Stephens surged again, giving farmers the highest yields. Today, 17 years after its release, it's still one of the Northwest's leading varieties.

The value to Oregonians? Such things are hard to pinpoint. But the OSU College of Agricultural Sciences has a database called Oregon Invests! that tracks the economic, environmental and social impact of the college's research. According to that database, since the 1970s the OSU breeding program has developed most of the major wheat varieties grown in Oregon. The average yield has risen from 48 bushels per acre in 1970 to about 65 bushels per acre in the 1990s.

These OSU-trained breeders earned the nickname "Oregon mafia."

Changes in farming practices have had a big influence on the Oregon wheat industry, whose farm gate value exceeds $250 million a year. But taking that into consideration, the database estimates the economic impact of the wheat breeding program to be about $6.5 million a year. This is based on yield, disease resistance that reduces the need for labor-intensive pesticide applications, and other factors. Stephens played a big role in all that. Also, the breeding work has helped the industry stay competitive by developing varieties targeted for new markets and uses.

It took about $500,000 a year to pay for the research. The story of where that money came from reveals a lot about why Kronstad and the program evolved the way they did.

The short answer is the money came from a wide variety of places, including the Oregon Wheat Commission, the National Institutes of Health, the National Aeronautics and Space Administration, the U.S. Department of Agriculture, Quaker Oats, Pendleton Flour Mills, Shell Chemical Company and other sources. But the largest portion, well over half, came from the U.S. Agency for International Development (AID) and the Rockefeller Foundation, which have an international focus.

"When I started here resources were scarce," says Kronstad. "Basically, I got into international work to build a critical mass of support we could use for the people of Oregon."

Another incentive to search for outside funds came in 1963 when OSU faced a financial crisis, he says. His department head called him and two colleagues into his office and told them to find some grants or the university wouldn't have a place for them.

Luck helped him do that.

In 1967 AID sent Orville Vogel, Kronstad's old boss at Washington State University, to Turkey to review wheat development work there. When Vogel returned he recommended that Kronstad and the late Tom Jackson, an OSU soil scientist, be given the job of introducing into Turkey winter wheat developed at the CIMMYT research center in Mexico.

The two constructed a program where 12 extension agents and farmers from Oregon and Washington went to Turkey for periods of three months to a year to work with farmers. "They did a really terrific job and they've never gotten all the credit they deserve," says Kronstad.

The Rockefeller Foundation, a key supporter of CIMMYT, then asked Kronstad to set up and direct a research center in Turkey specializing in winter wheat, which is planted in the fall, rather than the spring-planted wheat that is CIMMYT's main focus. He chose to stay at OSU but worked out a deal where Rockefeller would fund him to consult on winter wheat production in Turkey and to train Turkish scientists. (This quickly expanded, eventually including graduate students from 27 countries.)

Misfortune further changed the course of the OSU program.

A Rockefeller scientist named Joe Rupert had been working in Chile, cooperating with CIMMYT on crossing winter wheat with spring wheat to capture some of the desirable qualities of each. He returned to the United States, first to the University of California at Davis. Then in 1971 Rupert moved his program to OSU, partially because of the influence of a retired federal official named H. A. Rodenheiser who lived in Corvallis and partially because of Oregon's climate. Rupert died not long afterwards. Officials at CIMMYT arranged for Kronstad to carry on the

BOB ROST

Research asssistant Sonnia Rowe with OSU's cereals breeding project crosses wheat plants at Hyslop Farm near Corvallis. She's snipping spikes and removing anthers, which emasculates plants.

work, with Rockefeller Foundation funding, later replaced with AID funding.

By this time Kronstad had a ticket on a very fast plane. He was collaborating with Norman Borlaug, the Nobel Peace Prize-winning CIMMYT cereal breeder; Sanjaya Rajaram, an Indian cereal breeder Borlaug was grooming to be his successor; and other CIMMYT scientists—plus researchers in many parts of the developing world.

Besides U.S. graduate students, graduate students from South America, the Middle East, the Far East and elsewhere were coming to Oregon to study plant genetics and related topics, not only on the OSU campus but at branch experiment stations and in farmers' fields. The foreign students returned to their homelands to work on or lead breeding programs, or joined international research centers. In international wheat research circles these OSU-trained breeders eventually earned the nickname "Oregon mafia." The OSU breeding program stepped up the swapping of genetic material with foreign programs, eventually cooperating with more than 125 countries.

As the years rolled by, the work with CIMMYT changed in various ways. But the main thrust was refining breeding lines created by crosses of spring and winter wheat made at CIMMYT's Toluca field station near Mexico City, and making additional crosses with winter wheat at OSU. There was also collaborative research with grains such as barley and triticale, a wheat-rye cross.

Each year Kronstad would fly to Mexico, often with Oregon and Washington farmers and others in the wheat industry in tow, for whirlwind inspections of test plots along with Sanjaya Rajaram, who eventually replaced Borlaug as head of CIMMYT's genetic improvement program in wheat. The main goal was to identify promising plants for additional crosses and testing.

Each year Rajaram visited Oregon. He and Kronstad would look at how experimental plants from Mexico and other parts of the world responded to growing conditions at OSU's Hyslop Farm near Corvallis and at other sites in eastern and western Oregon.

Those trips continue, and Kronstad has developed a deep respect for Rajaram, and vice versa.

"I work with many U.S. universities," says Rajaram. "Warren is one of a few top breeders in the United States who are in the field at the right time. Some aren't. They send their technicians. And he is one of a few agricultural scientists in the United States with a vision of developing countries."

The Indian scientist is clearly excited about spring and winter wheat breeding lines coming out of the Toluca-Oregon shuttle, as he calls it. He's anxious to see that genetic material delivered to national breeding programs and predicts an impact will be felt in farmers' fields in developing countries in 10 years. "But, all in all," he adds, "Warren's biggest contribution is the graduate training program." More than 80 master's and Ph.D. students, plus visiting scientists, have trained at OSU.


BOB ROST

Bags keep windborne pollen away from emasculated plants until researchers return to pollinate them. The goal: a new plant with desirable qualities.

Kronstad believes this international collaboration has given the OSU program and the state of Oregon access to valuable genetic material and information. "For example," he says, "some of Turkey is like a lot of the wheat country in eastern Oregon. A lot of the important genes in our wheat came from that part of the world originally."

But most Oregon wheat is sold overseas. Sharing genetic material, and training breeders from other countries, hasn't always been popular with farmers.

"I hear comments like, 'why ruin our markets,'" says Larry Kaseberg, a friend of Kronstad's who, with his wife Sherry, grows wheat in Sherman County near the town of Wasco. "In some cases it may be generations before those people can even eat well. And in a lot of cases we used their genetic resources to get started. I look at it as a two-way thing."

"I remember Warren saying hungry people are not happy campers. They tend to be in wars," says Sherry Kaseberg. "People with a good economy tend to buy other things. Criticizing work with other countries is pretty short-sighted."

But even Kronstad points out a dark underbelly of his international work.

"If I have one regret it's that I didn't spend more time with my family," he says. "My first wife Kathy, who passed away in 1988, did a fantastic job. She raised four great kids. There was a time when I was teaching several very


BOB ROST

An international team: OSU's Kronstad, right, gives early-morning harvest instructions for test plots in a wheat field near Pendleton, Oregon. Left to right: Maria Mendosa, a Ph.D. student from Peru; visiting Egyptian cereal breeder Mustafa Mustafa; and Ottoni Filho, a Brazilian doctoral student. The crew included many other U.S. and foreign students.

demanding courses, plus the research program. I'd be at the university from 6 in the morning until 10:30 at night. Then there's the time I spent in distant places and in wheat fields in the Willamette Valley and eastern Oregon. I missed my oldest daughter's high school graduation because of a crisis in Turkey. The wheat we introduced wheat from Mexico was thought to be poisonous. We had to go assure them it wasn't. You think you'll be young forever, but you can't go back. You can't recapture those things."

Wheat breeding is different. "It's like being a football coach."

Then there's the time spent searching for funding. Some have criticized Kronstad for expending too much energy cultivating influential people. "It's a sad commentary about the system that you have to spend so much time politicking," he says. "But I tell my students from developing countries that they're not apt to have much support as individuals without a clientele supporting them."

He recalls an incident years ago when an OSU administrator who felt he was being too demanding slapped his fist on his desk and asked "just what do you want here?"

"I just want a first-class program," Kronstad replied. "I'm not ashamed I want to be on the first team."

He is known for pushing graduate students and employees, at times.

"Warren likes people who work hard. He will give a very hard time to those who don't," confides Mustafa Mustafa in heavily enunciated English. The 40-year-old Egyptian cereal breeder came to OSU for a year to work with Kronstad before returning to his job as director of a research center in his country.

"It's a boot camp sort of thing," says Pat Hayes, an OSU barley breeder who did his master's studies in plant genetics under Kronstad. "I think he likes being out in a wheat field sweating, even if you're too tired to see anything. But it's not a bad lesson for students. Later in their careers they may use that work ethic to bang their heads against the wall in other areas, in other ways."

There are those who feel Kronstad isn't taking full advantage of new biotechnology techniques. The state of the art is such that that isn't feasible, he contends. "The end product is a new wheat variety in the field. We use biotechnology techniques that seem appropriate. It's a very important tool. But at the moment it makes no economic sense for us to use our resources to do sophisticated gene cloning with the wheat plant. We'll adapt as soon as it's realistically and economically feasible."

With an eye on the future, he makes sure his graduate students work with Bill Dougherty, Dallice Mills and other OSU scientists who specialize in molecular biology, he says.

If you close your eyes and concentrate you can hear the warm wind hissing lightly through the wheat. Before long, the crack of a bullwhip and squawking birds crowd that out.

Kronstad is still inspecting plots. He's been at it all morning except for a 10-minute break in the shade of the trees at the edge of the field. A short man in his middle 50s is working with him. He is Nick Saulescu, a Romanian cereal breeder who's studying at OSU for a year. Like Kronstad, Saulescu is a victim of the altitude at the Toluca research station, "home of the 30-minute sunburn."

The day before, at CIMMYT's headquarters about 90 miles away, Saulescu gave a talk on cereal breeding. His audience included a tall Indian in a red turban, a young woman from China, a young man from Africa—all trainees at CIMMYT. Saulescu described plant breeding as science, art, gambling, industry ... and a terrifying challenge. You can spend your life at it, he told the trainees, and not develop one variety that is successful—that is grown on a significant amount of land.

Kronstad respects Saulescu, and not just because of the hardships he faced for many years doing research under a repressive political regime. "Nick works hard, and he's very talented," he says. "He really understands."

Long before Saulescu's seminar, just after daybreak in a small CIMMYT cafeteria, Kronstad ran into another cereal breeder he thinks is talented. Norman Borlaug lives in Texas, but he still has an office at CIMMYT and shows up regularly. While eating breakfast, Kronstad and Borlaug circled the globe gossiping about people and situations in various countries. With a parental tone Borlaug, still energetic in his 80s, asked Kronstad if he was going to be able to "put in a good day's work" eating only cereal rather than bacon and eggs, like him.


BOB ROST

Threshing experimental wheat varieties. Kronstad is proud of the many college and Oregon high school students who've gotten real-world experience through the years working on his project's summer crews.

THE GREEN REVOLUTION


DICK FLOYD

Nobel Prize-winning wheat breeder Norman Borlaug (left); the late Orville Vogel (center), a USDA breeder at Washington State University; and Kronstad in 1971 at the Eastern Oregon Agricultural Research Center. Vogel revolutionized Northwest wheat production with dwarf genes from Japanese wheat. Borlaug used those same genes in genetic work that led to the Green Revolution in agriculture.

Five days after he touched down in Mexico City Kronstad is back at the airport for the return to Oregon. On the plane there are two little girls behind him, coloring. They could be his granddaughters. Once in the air, he reviews a student's thesis, then puts on radio headphones and takes out a Robert Ludlum novel. But soon his head is down, arms folded across his chest as he catches up on sleep he missed rising before daylight each day to zip around CIMMYT headquarters and Toluca's mountain plots.

Much later, in his office in the OSU crop science building, he turns introspective answering questions about his career.

"I admit one thing I can't stand is someone who's very capable but lazy. When I was little my mom stood in line to get me into this special grade school at Western Washington State College in Bellingham. A lot of the kids were the children of professors, doctors, lawyers, people like that. I guess I was sort of from the wrong side of the tracks. I learned a lot from my mother about what it takes to keep up in life.

"And I learned very early from my father that you have to work hard to earn your pay. I've got an inner drive, and I think it may go back to those early days. I'm aggressive and competitive. I know that. I always tell my students, if someone puts the hard, fast one down the middle of the plate you swing as hard as you can. Preparation makes you lucky."

He's proud of his team's traditional academic contributions. He mentions papers on "biometric modeling" in grains. And he notes that a study he and Wilson Foote did of the inheritance of complex traits in wheat is included in *Plant Breeding*, a symposium proceedings that cites the most significant work in the field in the last 100 years.

But wheat breeding is different from most scholarly work, he says. "It has always been an area that brings a lot of attention. It's not like writing a glossy academic paper only a few people might read. When you're talking about 700,000 acres of your material ... it's like being a football coach, where you put your wares on display every Saturday.

BOB ROST

A Romanian student totes experimental wheat saved from a plot in eastern Oregon.

"The key to the success of the program," he says, "has been the dedicated people who've stayed in it and worked hard—the secretaries and the Nan Scotts and Mary Verhovens and Matt Koldings and Randy Knights [Scott is a computer specialist and Verhoven, Kolding and Knight are breeders], plus the graduate students and many others. I've never accepted an award without acknowledging the team. I didn't do the politicking to promote myself to be a dean or an administrator. I've turned down those kinds of opportunities. I'd be a disaster. No patience.

"I'm only one in 10,000 years of wheat breeders. They all made contributions," he continues. "We worked in different times, under different conditions. But it seems to be hard for people to understand that when they look at how we operated." And, he notes, even in recent times many didn't fall under the public's eye. "Clarence Peterson at WSU never got the recognition he deserved. He followed Vogel. Matt Kolding did a great job with MacVicar [a wheat variety], but I'm not sure how many people understand that."

The wheat industry in the Northwest is changing. Since about 1960, states like Oregon have sold mostly one wheat, soft white. Now, to compete overseas the industry may need several different types of wheat—soft white, club, hard white, wheat with specific milling and baking characteristics and other qualities. Oregon's wheat industry has put a lot of support behind Kronstad, including helping raise a million dollars to endow a plant breeding chair in his honor. Farmers expect a lot from him. Is there another Stephens in one of the test plots in Oregon or Mexico?

"I'm not sure we'll see anything as big as Gaines and Stephens again," he says. "We're at a high yield level. There may be more small improvements. If we can just get some more useful, better-quality wheat and get back part of the Japanese noodle market before I retire, I'll feel satisfied. The overall challenge I had when I came to OSU was to build a program. When I close up and walk out of here I want the next person to have a well-established program and good genetic material. That's all. I don't have to hit a home run or make a touchdown before I retire.

"But," he adds, "you always hope for that."

BOB ROST

Old friends: Kronstad and eastern Oregon wheat farmer Frank Tubbs size up an OSU variety, Gene, growing in one of Tubb's fields. "Warren has the knack and the tack to find the funds and get the research done," says Tubbs. "I wish he could clone himself."

HIGH PLAINS DRIFTERS

BY CAROL SAVONEN

Learning more about the lives of wild horses can help with public land issues, and it is changing how an OSU graduate student looks at domestic horses

Sitting on the edge of the dimly lit porch of a rickety store, we waited. We were in Benson, California, 4½ hours south and east of Reno, Nevada. Benson is your basic one-store, two-house town—it was our rendezvous point with a wild horse researcher from OSU. The sun was hours gone, and a million stars pierced the velvet black night. The heat generated by a July day in the high desert was still radiating from the gravel, like an oven door left ajar.

We had covered many miles since Oregon, flying to Reno, then driving a rented four-wheel drive vehicle to Benson. The last miles before sunset, we had passed by volcanic cinder cones, alkali lakes and out onto high desert. A long day was beginning to feel like it was to be yet a longer night. We waited—our researcher was late. A dog barked in the distance. A June bug buzzed into the rusty screen door. My soda pop was warm.

Headlights. BIG headlights. With a roar and a screech, an old green camouflaged monster four-wheel drive headed straight for the porch, full throttle. Oh, oh. Some local color. I hopped up, not wanting to be run over. Blinded by the after image of those gargantuan headlights, I heard the slam of a 100-pound truck door. Someone small and fast came around the front of

the rig into the porch light. It was Linda Coates-Markle.

Sunburned and wind blown, she had rushed out to meet us after a long day organizing gear for another 10-day trip into the back country to follow the wild horses. Her research was in remote and rugged country—the Montgomery Pass Wild Horse Territory, on the California-Nevada border, north of Death Valley. Earlier in the spring, she had offered to take us to her study site and show us how she investigated the social ranking, behavior and feeding habits of several bands of wild, or "feral" horses, her Ph.D. project in the Department of Animal Sciences at OSU.

People's views on wild horses vary. To many, mustangs (as some call them) signify freedom and the Old West—the vestige of a vanishing era. Wild horse lovers say that the animals have a right to exist, because many generations have survived on their own and have become naturalized.

Ecological purists consider feral horses to be non-native "weed" animals, because they weren't found here before Spaniards first brought them to North America in the 1500s.

BOB ROST

Pages 16, 17: Wild horses grazing. In the background is 13,000-foot Boundary Peak in western Nevada's White Mountains. The horses live in the federal Montgomery Pass Wild Horse Territory (photo: Bob Rost). Above: With no harems, these stallions run together.

BOB ROST

OSU graduate student Linda Coates-Markle is studying Montgomery Pass's wild horses because there are no roundups to control population, as with Oregon's herds. Some days she follows the animals more than 20 miles, on foot. Her data will be useful in Oregon.

"Many statements are based on old cowboy stories."

Some biologists say wild horses damage natural ecosystems and compete with native wildlife for food and water. And that not all populations have a long history running free on the landscape—many are descendants of work horses, turned loose during the Depression and after World War II when tractor sales flourished.

Segments of the cattle industry consider feral horses to be competitors with their cattle for rangeland forage on public lands.

Love them or not, some 40,000 wild horses now roam in many remote parts of the West, mostly on public lands, explained Coates-Markle. And they are protected on federal lands by law.

In 1971, Congress passed the Wild Horse and Burro Protection Act, requiring federal land management agencies to protect and manage wild horses. The Act put an end to "mustanging," the rounding up of horses by private individuals for horse stock. There were no more captures off public land for European meat markets and pet food companies. With few natural predators such as cougars remaining in many of the wild horse areas, feral horses have thrived to the point of overpopulation, increasing 20-some percent per year in most areas.

"Wild horses breed like rabbits," said Coates-Markle. "They are amazingly successful. In most areas, they have a much higher reproductive rate in the wild than in domestic breeding programs."

The reproductive success of wild horses is an expensive challenge for the BLM, the federal agency with major responsibility for wild horse management, explained Ron Harding, manager of the BLM Wild Horse Program in Burns, Oregon. Most of the annual federal wild horse management budget (more than $14 million per year) is spent on roundups, holding and adoption programs. And there are many more horses rounded up than can be adopted.

"The Wild Horse Act of 1971 said to destroy unadopted horses in the most humane way possible," said Harding. "But the public didn't want that, so nine years ago, a moratorium was put on the humane destruction of surplus wild horses after government roundups."

Unadopted animals have to be turned back loose, or cared for in some way, Harding said. This surplus of animals is

motivating land managers and scientists to look at other ways to manage wild horses. Contraception, or birth control for horses, and ecologically-based management are frequently mentioned alternatives to expensive roundup and adoption programs.

"A contraceptive program for wild horses would cost one-eighth as much as roundups and adoption programs," said John Turner, professor of reproductive biology at the Medical College of Ohio in Toledo.

Turner, an advisor on Coates-Markle's project, is just finishing up contraception studies on a wild horses range near Ely, Nevada. So far, he says, contraceptive vaccine he administered to wild mares has proven about 95 percent effective.

"Wild horse roundups and adoptions are here to stay, but I think contraception programs could decrease the frequency at which roundups are being done, making wild horse programs more cost effective," said Turner, who has studied the reproductive biology of wild horses since the mid-1980s.

Most troubling to scientists like Coates-Markle and Turner is that many decisions about wild horse management are based on outdated and superficial information.

"A lot of decisions are made in a vacuum," said Turner. "Many of the statements about what horses do are based on unproven old cowboy stories. There's very little data out there. We have relatively little idea about what the horses are eating, what they prefer, or how horse feeding patterns overlap with cattle grazing. Studies as detailed as Coates-Markle's are few and far between."

Linda Coates-Markle

A natural balance: Each year predators—cougars—thin the Montgomery pass herds. They kill up to 70 percent of the foals.

CENTER GIVES STUDENTS EXPERIENCE WITH HORSES

When she is not off in the remote reaches of the Great Basin researching wild horses, Linda Coates-Markle directs the OSU Horse Center. She oversees the instruction of more than 250 students each academic quarter at the 200-acre facility, a mile west of the campus in Corvallis.

Some students take riding, jumping and dressage (horse ballet) classes for credit or recreation. Others are enrolled in OSU's undergraduate equine science option, offered within a four-year degree program in the animal sciences department. Prospects for careers are varied and many. Graduates go on to veterinary school, manage boarding stables, work as race and industry trainers, breeders or stable managers. Some even end up in the movie industry.

The equine science option at OSU offers more hands-on experience than most programs. About 45 students are hired part-time each quarter. They can earn wage or credit or volunteer for a number of duties, from feeding horses and cleaning stalls to teaching riding lessons (after completing a certified coaching program) or administering the day-to-day operations of the center.

The center was underfunded and understaffed before Coates-Markle was hired in 1986.

"At first, I had no idea what to do," she said. "This place was in dismal shape when I showed up. So I organized the students. After developing a curriculum in coaching, training, marketing and stable management, I got them going teaching others. I've certified more than 100 instructors."

BOB ROST

Students at OSU's Horse Center learn to wrap an injured horse's leg to prevent injury during exercise.

Coates-Markle also went to the horse industry and asked what kind of graduates were needed. In turn, the industry donates horses, guest speaker appearances and facilities for student internships.

"I also got the students involved in training, marketing both home-grown and donated horses. Education is not regurgitation. That's not my approach. The students do it all—they are the reason this program is such a success."

However, others are quick to give Coates-Markle credit.

"Linda took over the program when it was in trouble, and built it up from a negative to a successful and strong program," said Kelvin Koong, associate dean of the OSU College of Agricultural Sciences.

After the eight years under Coates-Markle's directorship, the equine program is so successful that it is one of the most popular options within the Department of Animal Sciences. And the center is about 90 percent self-sufficient financially because trained students run many of the operations, generating income.

"We are one of only two programs in the country that offer extensive hands-on experience for students, through employment at the Horse Center," said Coates-Markle. "We may be a small program, but we have lots of opportunity."

"The program is a prime example of learning by doing," said Koong. "By the time they graduate from the program many [students] already have teaching experience—credentials in the real world."

Coates-Markle hopes her studies will help answer questions that no one has examined in detail—How many horses might an area support? What determines when and where feral horses are found? Do they make decisions regarding forage use? What food is most palatable and how does this change with the season? And most importantly, how does the social structure of a herd influence this habitat and forage use, and ultimately, how does it affect reproductive success?

"How can we manage wild horses if we don't know much about them?" asked Coates-Markle.

For the past two field seasons, Coates-Markle and her research assistant, Katia Engelhardt, have studied the social organization, behavior patterns and nutrition of feral horses within 60 square kilometers of Montgomery Pass Territory. Coates-Markle chose this area because of a unique balance between the horses and cougars—unlike most other wild horse populations, Montgomery Pass horses are controlled by cougars, who prey on about 70 percent of the young horse foals. No roundups are necessary to keep the wild horse numbers in check. There are few human disruptions, making it an excellent study site.

BOB ROST

Researchers Katia Engelhardt, left, and Linda Coates-Markle bag wild horse manure. After the samples are dried in the sun, they are shipped to the OSU campus and analyzed to find out how much nutrition Montgomery Pass wild horses receive from plants they eat.

"It is the lead mare that makes the major decisions."

Coates-Markle and Engelhardt combed canyons, valleys and rimrock to find and intensively study 13 groups comprising more than 68 wild horses. Sometimes out for 10 days at a stretch, the researchers would walk more than 25 miles in a day, through rough country, 5,000 to 9,000 feet above sea level.

"We traveled light, with about 25 pounds of gear on our backs," said Coates-Markle. "We learned the lay of the land. Some days we'd look for the horses all day. We'd walk and track for half the day and we'd turn around and find them back where we started. Often we would scramble 15 miles in three hours to find a band of horses, then have to sit for eight hours and observe. We'd go from hot and sweaty and winded to cold and stiff. And we'd come back tired, filthy and full of ticks. But it's worth it just seeing the animals so wild and free, and doing what comes naturally!"

BOB ROST

"Whimbley," a stallion, once had a harem of mares. But he lost it. He's scarred from years of fighting with other wild stallions.

Through weeks of hot sun, cold wind, black flies and freak rain storms, Coates-Markle and Engelhardt patiently figured out individual identities and determined the basic social structure of each group. Looking through spotting scopes and binoculars, they noted individual scars, behavior, lameness, body condition, mane lay, color, age, sex and facial and leg markings. They named each horse—"Chesty," "Buck Mama," "Skinny Tail," and "Broken Ear" were among the favorites. They also recorded horse body language and social posturing—where each animal was relative to another in a group. And they recorded aggressive acts such as kicking and biting.

Once each horse' individuality and social rank were established, Coates-Markle looked for links between social rank and forage use.

"I want to know if dominant animals have more access to better food and if they share that knowledge with other members of their social group," she said.

Observing individual horse activity such as eating, lounging, sparring, defecating or playing during set sample times, Engelhardt and Coates-Markle noted when the horses changed activity and which one in the group initiated the change, calling out all activities they saw in a group of horses.

"Duke standing, Buck Mama standing, Bay-yearling standing, Mustard lying down, Chesty eating..." they recorded minute by minute, for 30-minute blocks over eight-hour shifts.

They determined forage use by comparing plant composition in the manure of individual horses with plant composition on the home range. A comparison of forage quality (protein) with manure composition will help determine nutritional fitness in each horse in the group.

"Wild horses are highly social animals, sometimes harem bands of mares and a lead stallion can form a kind of extended family, with as many as 45 or more individuals," she said. "What I'm finding is that it is the lead mare that makes the major decisions—when to eat, seek shade, sleep or migrate. Every

individual in a group mimics the lead mare. This flies in the face of predominant beliefs. Most people who study wild horses often believe that the lead stallion does most of the decision making. My work indicates its the lead mare who is the true leader 90 percent of the time."

Coates-Markle also is finding that horses exhibit "behavioral wisdom." Manure analysis is showing that dominant animals are eating higher quality food than younger, more inexperienced horses. The older, more knowledgeable horses are choosing plants of higher nutritional value—they are showing what biologists call "selectivity in foraging," she said. Obvious as it may seem, no one has shown that wild horses learn to choose more nutritious plants over time.

"What is also interesting is that the group's leader, the lead mare, develops a preference for certain plants and actively searches for these plants as she roams the range," she said. "The rest of the group follows her in her pursuit."

What does all this have to do with wild horse management and Oregon, with 21 herds of 3,000 wild horses?

"Linda's work will help teach others to make a lot more intelligent assessments of the impact that horses have on the environment," said John Turner, reproductive biologist. "Her work will help us know what ranges are good for horses, and which are not. We will know more about what they are eating and how efficient they are at processing the food, so we can better assess the carrying capacity of the land.

"And we now know a lot more about monitoring wild horse activity," Turner continued. "To really get to know what's going on, you have to go out and live with the animals for extended periods of time. You can't just go out for short visits, like many programs do.

"Plus, Linda's work has demonstrated that wild horse gathering programs would be disruptive to social structure and family units of horses," said Turner. "By showing that the lead mare is the key animal, we know that roundups break up social structure. When animals are gathered they ought to pay a lot more attention to social structure."

"Wild horses are part of our ecosystem in Oregon," said Kelvin Koong, associate dean of the College of Agricultural Sciences and associate director of the Agricultural Experiment Station at OSU and Coates-Markle's academic advisor for the horse project. "Knowledge on behavior could really help with public lands issues. Ranchers and other of our clientele need our research perspective. It might help BLM to make better decisions."

Wild horses in a BLM corral at Burns, Oregon. "Wild horses breed like rabbits," says OSU researcher Linda Coates-Markle, but rounding them up disrupts the animals' social structure.

"My outlook on horses has changed a thousandfold."

And for Coates-Markle, there have been unforeseen benefits for her work at the OSU Horse Center.

"My whole outlook on horses has changed a thousandfold," she said. "After 30-some years of working with domestic horses, I realize now that I still didn't really know them. I now understand better that the decision-making process, so important in the wild, is all but extinct within our large domestic companions.

"Too often, I fear, we are dealing with empty shells that have been conditioned to respond to our every wish," she said. "I've also realized that although their personalities are suppressed, only a particular type of personality is truly capable of being a decision maker. This is why the majority of horses are 'happy' to mimic the human lead.

"However, in return, we treat them like prisoners, confining and isolating them, putting them in stalls, not allowing them to socialize with their buddies. Horses are gregarious and need to socialize. Yet we treat them like glass and wonder why they develop undesirable vices in response to our impositions and expectations.

"I'm gaining new-found respect for the horse's personality," she added. "It's helping me in my job. I'm learning not to be such a control freak. You have to let them make some of the decisions sometimes. The majority of horses would be better partners if they were treated as more of an 'equal' and if they participated by choice, not motivated by force or fear."

Carol Savonen is a science writer in OSU's Agricultural Communications department.

BOB ROST

GREEN ACRES

For some Oregon farmers putting up hay is an art. Which region does it best?

BY JOE MARKS

If you're like most of Oregon's three million residents you probably don't think much about hay. Oh, you may get a little annoyed if you're driving through the Cascades to go skiing or hiking and get trapped behind a big truck stacked with bales, or if allergies have you sneezing. But think about this: Hay affects the state economy, and so it affects your pocketbook. Last year it was Oregon's third leading agricultural commodity, behind cattle and calves and the nursery industry. It was big bucks—worth about $250 million, roughly, and that doesn't include the "multiplier effect" economists use to calculate the impact industries have on other parts of the economy.

Stan Miles, an economist with the Oregon State University Extension Service, explains that $250 million is the amount that hay grown in Oregon would have been worth if it had all been sold. But the farmers and ranchers who grew Oregon's 1994 crop used a lot of hay themselves, as feed for their animals.

Economists usually break hay into two categories, alfalfa and other types. "Other types," valued at about $85 million last year, include hay grown in meadows with irrigation (sometimes called native hay), grain hay such as oats, triticale, wheat and rye (which often includes the seed), clover hay, and improved grass hay such as orchardgrass and tall fescue.

BOB ROST

Alfalfa is the most expensive hay. It's grown on fewer acres, about 400,000 compared to about 600,000 for other types in 1994. But it has a higher protein content and was valued at about $165 million last year.

Many people think of the aftermath of the grass seed crops grown in the Willamette Valley, northeastern Oregon, central Oregon and elsewhere in the state as hay. But economists and farmers don't. They call that straw, as in grass straw. That had a farm gate value of $13.3 million in 1994, according to Miles, and twice that value by the time it was exported (most was compressed and shipped from Portland to Japan to be used as animal feed).

A significant amount of Oregon's hay and straw grows on land that either won't produce other agriculture crops, or won't produce them very well. But the land can produce these fibrous forages. If you were to sit down to a bale of alfalfa, you'd get pretty frustrated trying to digest the protein and other nutrients. But cows, equipped with four-compartment stomachs including the fermentation vat we call the rumen, easily convert hay into milk and meat.

Many parts of Oregon produce excellent hay. Among the spots often mentioned are the Hermiston-Pendleton area in the Columbia Basin, Christmas Valley in Lake County, the area around Klamath Falls and the "alfalfa country" in central Oregon.

Far left: Oregon farmers go to lengths to bale alfalfa with the right moisture, including working at night. Left: "To find out if it's dry enough, twist a handful. If it breaks, it is," says Hermiston grower Malcolm Skinner. Skinner also uses a "moisture meter" he sticks in bales.

What area deserves bragging rights for the best hay in the Beaver State?

The Columbia Basin lays claim to the highest yields and some pretty good hay quality. In fact, Jerry Christian, who farms near the Morrow-Umatilla county line, placed second in international hay contests at the World Dairy Expo in 1992 with hay that contained 27 percent protein. In 1993 Don Key, who lives near the same county line, won the area's "Hay King" contest with protein near that same level.

The plants used to make hay are like hair. You cut them and they grow back and you cut them again. Growers in the Columbia Basin normally are able to get four cuttings of alfalfa during a growing season, and some get five.

Bob Reuter, manager of the Hermiston Hay Marketing Cooperative, which has 38 grower members, says farmers in his area know what they're doing. "Some of the top managers in the Northwest are located here," says Reuter. "They're used to intensive management of crops and rotation, like potatoes and sweet corn, and they pass that good management on to their hay crops."

Some growers in the area average 10 tons or more of quality alfalfa hay a year. The average is 7.5 to 8 tons. Protein levels can range from 13 to 27 percent. "This is good hay-growing country," Reuter says. "But I still give credit to management. Sure, top quality hay can be raised anywhere on the eastern side of Oregon, but some real junk can be grown here too."

Reuter says the top hay in his area sells for $95 to $105 a ton, with a little

BOB ROST

Old meadow hay stacked near a winter pasture for beef cattle in eastern Oregon.

selling for $110 a ton. Lower grade hay runs $80 to $85, and rain damaged, weedy alfalfa goes for $60 to $70 at ton.

Reuter explains that the co-op samples hay and finds a market for it. The majority goes to dairy farms in western Oregon and western Washington, but some is shipped to Japan.

Christmas Valley is sure to be mentioned when there's talk of Oregon's best hay.

"We may not produce the most hay per acre, but we do have some of the best quality," says Willie Riggs, an OSU Extension Service agent in Lake County. Riggs says the county's meadow hay runs 3 to 9 percent protein, and the alfalfa runs 22 to 23 percent.

Most of the high-protein alfalfa is sold to dairies in Washington and California, but some is exported to Europe, Japan and Canada. The meadow hay is supplemented with a little molasses and protein and fed to beef cattle.

"Making good [alfalfa] hay is an art form," says Riggs.

The keys, he says: Irrigation and harvest time [before flowers have formed on the plants]. Take cuttings in late May, early June, mid-July and early September. "The soils here are high in pH (alkaline), so we use a lot of gypsum on the ground to make sure the alfalfa gets its sulfur requirements. We also rotate alfalfa with small grains in some places and sell those grain hays."

Last year, alfalfa produced in Lake County sold for $110 to $115 a ton ($85 a ton for hay that had been rained on after it was cut).

"About 90 percent of hay quality is management."

"Our biggest problem," Riggs says, "is cutworms. We also have some problems with the alfalfa weevil, and keeping grass out of the stands. Grass in the alfalfa reduces the forage quality and lowers the price. But it's still valuable. It just doesn't meet dairy standards."

Klamath County is a great a place to grow hay, says Randy Dovel, an agronomist at OSU's Klamath Experiment Station at Klamath Falls.

"We have good temperatures for growth during the day, cool nights, and rain is usually not a problem," says Dovel. With alfalfa, farmers in the area usually get three cuttings and could get four if they spaced them right, but that probably wouldn't "pencil out" because of labor costs and other factors, adds Dovel.

Getting "dairy quality" alfalfa with about 20 percent protein isn't a problem with the first and third cuttings, in the spring and fall. It can be more difficult, he says, in the summer when the days are long and plants are growing fast.

A good portion of the area's alfalfa is sold to dairy farmers in the Willamette Valley and California. Farmers also raise grass hay—with names like tall fescue, bluegrass, orchardgrass and meadow

BOB ROST

A worker cuts alfalfa in an irrigation circle in Lake County's high, dry Christmas Valley, one of Oregon's most well-known alflafa production areas.

foxtail—in pastures they irrigate and fertilize. Some produce native hay in meadows. Beef cattle eat the grass and native hay.

Dovel is studying alfalfa and grass varieties to find out which are best for his area. It's hard to detect differences in forage quality among varieties, he says, because growth stage is so important and it's almost impossible to sample plants when they are in exactly the same stage. "To get past that," he says, "we're starting research that samples at several points in the growth cycle."

Mylen Bohle, an OSU Extension agent in Crook County and reseacher at the Central Oregon Agricultural Research Center, says production has dipped in one part of Oregon long famous for high-quality hay.

"Alfalfa acreage in central Oregon is going down a little," says Bohle. In recent years, water shortages and other factors have encouraged growers to move toward higher value crops like mint and grass and vegetable seed, he explains. He notes that central Oregon still produces excellent, dairy quality alfalfa and other types of hay, including excellent grass hay sold locally.

"About 90 percent of hay quality is management—the time you cut it," says Bohle. He notes that the cutting schedule varies in central Oregon. Farmers in Deschutes and Crook Counties usually get three cuttings, in Jefferson County they can get four if water is available, and in higher elevation areas they only get two.

Along with Randy Dovel at Klamath Falls, Bohle is studying long-term weed control in alfalfa. The idea is to monitor several methods over several years, analyzing yield and quality to find out which method works best and what level of infestation makes weed control worth the expense. OSU forage specialist David Hannaway, and retired weed specialist Larry Burrill, are cooperating with them on the work.

Other research includes an "ecozone study" where he and Crook County Extension agent Tim Deboodt put 80 plant species and varieties in farmers' fields to find out if any could be grown commercially without irrigation.

Though some may not realize it, western Oregon's Willamette Valley produces good alfalfa.

"We may not have the reputation, but we can put up a pretty good crop of hay when the weather is right," says Gail Gingrich, an OSU Extension agent in Marion County. Alfalfa hay in Marion County contains 15 to 18 percent most years, he notes. But Gingrich says the biggest hay acreage category in his county is "other." Grass hay that people grow on pastures runs 7 to 12 percent protein.

This alfalfa from Christmas Valley will be compressed and shipped overseas as animal feed.

Cows need a lot of protein to make milk. A good portion of Oregon's high-quality alfalfa is sold to dairies in Oregon, Washington and California.

Much of the seed for grass hay is grown in the Willamette Valley. The Willamette Valley also produced about 250,000 tons of grass seed straw last year, Gingrich points out. The straw usually contains 4 to 7 percent protein. Although it isn't considered hay, it is a good source of fiber.

Malheur County on the Idaho border is Oregon's center for alfalfa seed production. More than 5,000 of the state's 6,000 acres of alfalfa seed are there. The area also produces alfalfa hay. Mike Barnum, a researcher at the Malheur Experiment Station, helps farmers identify the best varieties to grow. Agronomist Chuck Stanger studies weed control.

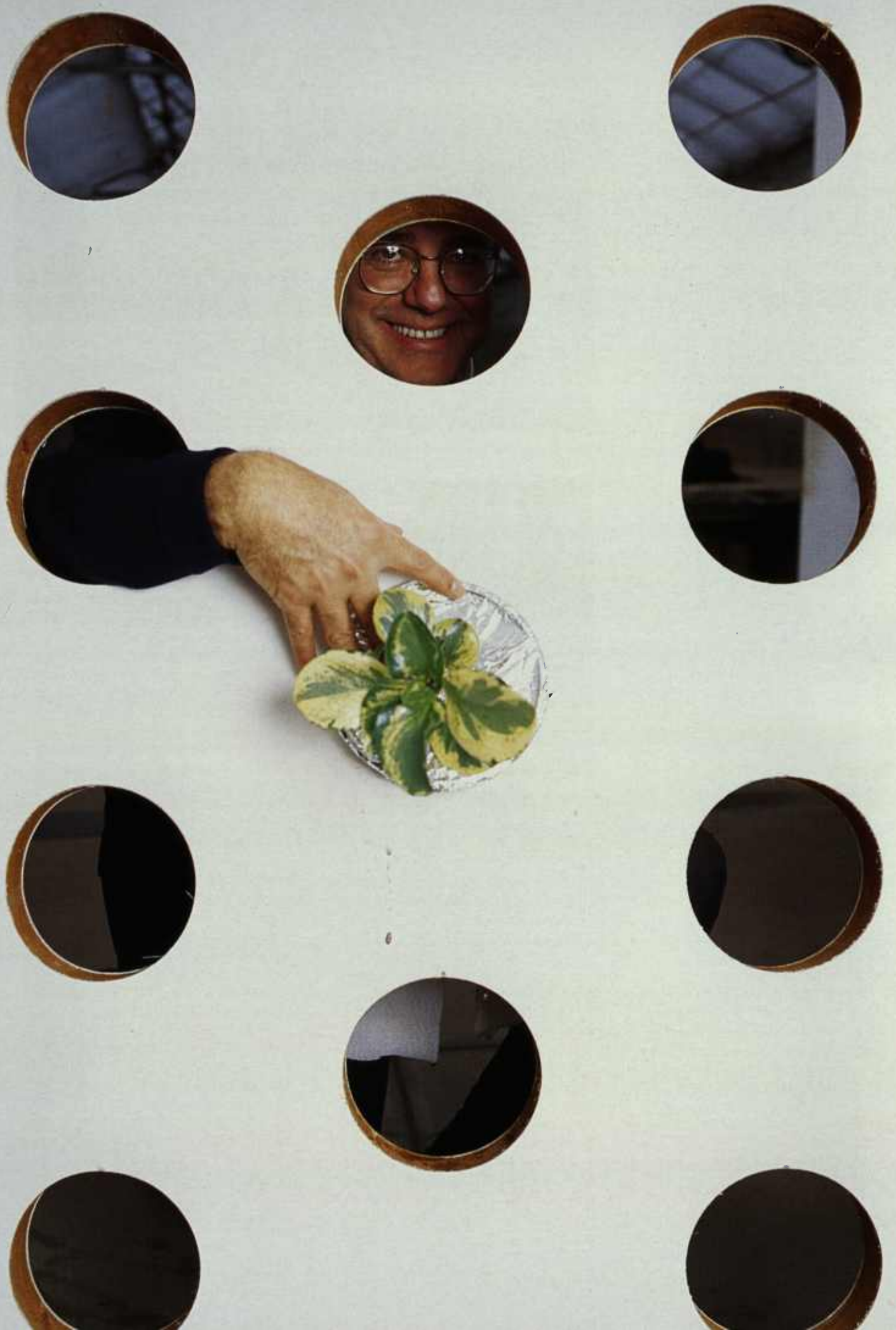
When you get right down to it, it is very hard to say where Oregon's best hay grows. And "best hay" is hard to define. The best hay for dairy cattle is usually alfalfa. For beef cattle, it is usually other types. But at any given time, economics and other factors can change the equation.

Researchers at OSU have figured out the best way to get the most protein punch: Harvest early. In the case of alfalfa, that's the pre-flower stage before the plants start putting energy into flowering and reproduction. Young, tender, leafy plants makes the best hay. The trick is to cut and bale before they get so dry they lose leaves (and their appeal to cows), but not when they are so wet they turn moldy.

Tim Del Curto, an OSU animal scientist with the Eastern Oregon Agricultural Research Center's Union station, studies the merits of hay as feed for beef cattle. He makes producing hay sound like winemaking.

"What you really want to have," says Del Curto, "is cool weather with some clouds and just enough sun and moisture. That gives you powerful feed. That's why 1993 was such a great year: record crops and good quality. Growers enjoyed some breaks—rainy days sprinkled in with some sunny ones. It was a vintage year."

Joe Marks is a science writer at the University of Missouri at Columbia. Andy Duncan contributed to this article.



THE COOLER KING

Jim Green thinks his new way of growing container plants in nurseries could cut costs while protecting Oregon's environment

Imagine for a moment that you're a small shrub living in a 5-gallon container. Well-meaning people devoted to your needs will do their best to take care of you, but in the process they may either dump so much water on you you'll almost drown, or they may forget to water you at all. And then they may put so much fertilizer on your soil you'll want to pull up your roots and run away.

Life for container plants would be much better, says Jim Green, if we let the plant satisfy its own needs for food and water. Think of it as the difference between being fed intravenously or dining at a buffet.

The buffet style illustrates the plant-driven method of horticulture, the principle upon which Green has based a new system of producing nursery container plants.

Nursery growers take the best possible care of their plants, but in a mass production operation it's difficult to grow large quantities of diverse plants in containers while supplying each one's needs for water and nutrition efficiently," said Green, an OSU Extension horticulture specialist who also conducts research through OSU's Agricultural Experiment Station. "Container plants usually get more than they need."

Page 26: The Cooler King peeks through his pallet. OSU horticulture professor Jim Green envisions huge pallet systems for growing plants in commercial nurseries. This contraption with holes is the top of a pilot version. At one point, he bought most of the ice chests— coolers—in Corvallis to demonstrate his concept. Photo: BOB ROST

BY BOB ROST

Green's new system is called the Closed Insulated Pallet System (CIPS). It is designed to make container plant production as efficient as possible by letting the plants take charge of satisfying their own needs for water and fertilizer nutrients. In the process, losses of water and fertilizer are eliminated.

The project began in response to requests from the industry.

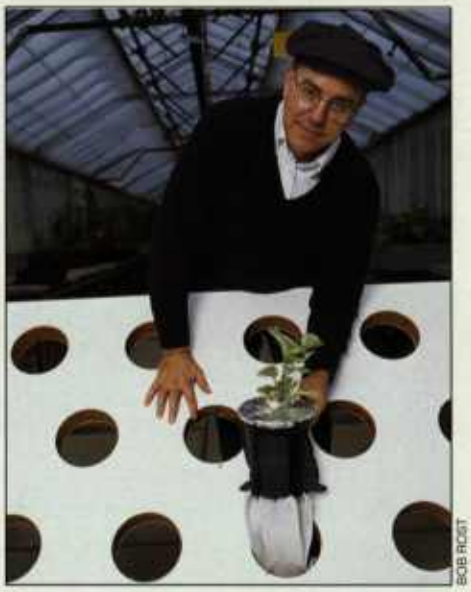
The traditional method of producing container plants in nurseries is to establish large numbers of transplants in plastic pots and group them by variety in lots on the nursery grounds. The groups of plants are then irrigated, usually with overhead sprinklers. Growers often apply fertilizer through irrigation water in a technique called fertigation.

As the Oregon nursery industry has grown throughout the 1980s and early 1990s, nursery operators have become increasingly heavy users of irrigation water. Water falls between containers during irrigation or drains out the bottom of pots, carrying with it fertilizer residues leached out of the planting media. This has created concerns about efficient water use and prevention of water pollution.

Adding urgency to the situation are 1991 Oregon regulations for nursery water management that stipulate there will be no water runoff from nursery operations between the months of May and September.

The usual response to these problems has been to refine currently used irrigation systems.

"A lot of work has been done on improving the design of overhead irrigation systems and some nursery operations have devoted resources to constructing systems that collect runoff so it can be recycled," said Green. "The problem with the first approach is that no matter how uniformly you apply overhead irrigation water, a sizable amount will fall in between the pots and will be lost. ... The problem with recycling is that the best systems collect only about half the applied water, and recycling uses a lot of energy to run pumps and water treatment systems."



BOB ROST

Plants in cloth pouches sit in these holes in the pallet's lid. There's a tub of water below.

BOB ROST

Green started the research in the late 1980s in response to industry requests to develop methods of using energy more efficiently and using smaller amounts of water, fertilizer and herbicides. An OSU team brainstormed ideas. Coolers like these helped him experiment.

The CIPS project began in the late 1980s in response to requests from the Oregon nursery industry to develop methods of dealing with water runoff from container plant irrigation.

Green formed a committee to study the broad range of issues related to water runoff and pollution. The group included a soil chemist, an entomologist, an agricultural economist, a bioresource engineer, a plant pathologist, county Extension agents and horticulturists and growers. After several meetings to discuss the problems, Green invited the group to submit proposals for solutions. Several were offered, including one written by Green for the CIPS, which represented an entirely new system that eliminated customary methods of irrigation and fertilization.

"After an intensive review of nursery water runoff problems it seemed to me that the traditional irrigation systems couldn't be modified enough to achieve the kind of water conservation growers wanted, so the CIPS proposal was a look in an entirely new direction," Green said.

As originally sketched five years ago, CIPS was intended to address, simultaneously, several issues in the production of nursery plants, but the foremost problem was water conservation.

Green wanted a system that would:

- conserve water and eliminate runoff;
- conserve chemical inputs such as fertilizers, herbicides and pesticides, which dissolve in water and are carried along with irrigation water runoff;
- be energy efficient—no use of electronic devices or electric pumps that consume large amounts of electrical energy and might fail;
- eliminate all waste discharge of resources mentioned above.

In addition, Green wanted the system to improve pest management by improving cultural conditions for the plants.

That means the system should offer an environment that favors the plant and beneficial organisms rather than the pests," Green said. "This gives the plant a better chance of survival than the pest."

Connected with that was Green's desire that the system should provide stable, viable root zone temperatures and moisture conditions, which would improve plant health and the effectiveness of biological pest controls.

BOB ROST

A typical nursery. Overhead sprinklers irrigate the plants in plastic containers on the ground.

Last, Green wanted a system that would improve labor efficiency.

Handling and moving plant containers, or pots, consumes more labor than any other activity in a typical nursery operation," said Green. "On average, from planting to shipping, one container plant is moved six times. Growers want nursery operations to be more efficient, especially now that the availability of hand labor is more limited than it used to be."

The first CIPS was a rectangular tub about the size of a child's swimming pool with a lid that fit snugly on top. The tub and lid were opaque, and Green insulated all interior surfaces except the bottom of the tub. This prevented temperature fluctuations inside the system but allowed heat gain through the bottom.

Technicians cut sixteen holes in the lid to hold plastic baskets. Green placed pouches, containing planting medium and the plants, in the plastic baskets. The pouches were made of a polypropylene material. The baskets were plastic planting containers with some of their sides cut out to allow moisture and air exchange through the sides of the container.

A strip of absorbent cloth called a wick dangled from the bottom of each pouch. The end of the wick extended down to the 4 or 5 inches of water in the bottom of the tub, allowing plants to "wick up" as much water as they needed.

Green put an impermeable plastic foam collar around the trunk of each plant where it emerged from the planting medium. This provided an upper seal for the plant, preventing moisture, insect pests and plant disease organisms from infiltrating the planting soil. The seal also kept weeds from becoming established.

BOB ROST

In Green's gravity-defying system this cloth wick sucks water up to the pouch, when needed. Plant roots grow up into a "diffusion zone" where there's fertilizer. OSU Ph.D. student Shaun Kelly is holding the plant.

In CIPS the part of the plant below the soil surface in the planting pouch is sealed off from the outside environment," said Green. "This promotes temperature stability for the sensitive root system of the plant while it absorbs water and nutrients at its own rate."

Initially, Green fertilized plants in the system by placing fertilizer around the inside edge of the pouch. Later he made a fertilizer container, called a conserver, out of a piece of plastic pipe. It was left open at the bottom to allow the fertilizer to slowly diffuse downward through the planting media in the pipe. The pipe was capped at the top to prevent water flow through the fertilizer. This stopped leaching of fertilizer and enhanced slow diffusion of the fertilizer downward within the tube where it could be intercepted by roots growing upward into the pipe (or, as Green calls it, the "protected diffusion zone"). At planting, one conserver, with a predetermined amount of fertilizer placed inside, was put in each pouch.

"The purpose of the conserver was to make fertilizer applied to each pouch last as long as possible and to prevent it from leaching away," said Green. "The easily removed cap on the top of the conserver also makes it easy to add additional fertilizer annually, if needed."

The planting pouch is sealed off from the outside environment.

Trials have shown that plant roots will readily grow up through the open bottom of the conserver and feed directly from the fertilizer in the top of the tube. This development surprised Green and his colleagues. Previously, horticulturists believed that roots primarily grew downward and that fertilizer moved to the roots in the downward flowing water from surface application.

The first version of CIPS worked so well that Green decided to enlarge the experiment by attempting to grow many different types of ornamental plants in similar conditions. To accomplish that, he started his cooler collection.

" I created many mini-versions of the larger pallet by turning insulated plastic food and beverage coolers into small pallets capable of holding one to three plants," Green explained.

The result of this portion of the experiment was an odd-looking, self-contained garden of a broad variety of ornamental plants that appeared to be growing out of the tops of a bunch of ice chests. (In pursuing these variety trials

Green bought most of the portable coolers available in Corvallis.)

He converted the coolers to mini-pallets by simply cutting holes in the lid for planting baskets; placing plant pouches, with wicks, in the baskets; and adding water.

Green's favorite cooler plant is a *Ficus benjamina,* or weeping fig, that he raised from a two-leaf rooted cutting to a robust 4-foot-high shrub. He started the plant in 1992 and still keeps it in his office as a ready example of how well CIPS technology can work. He waters the plant about once a month and adds fertilizer annually. Green proudly says the plant has not dropped a leaf during the two years it has been in CIPS.

The first CIPS proved capable of maintaining many types of container plants in excellent health for periods of six months to a year with very little upkeep and no additional application of water or fertilizer beyond what was put in the system initially. However, that first pallet system was also a sleek, rather sterile-looking fiberglass box that drew a lot of murmurs about space-age technology from observers.

"That caused many to think that CIPS was going to be prohibitively expensive or that it simply was too far ahead of its time to be of any practical use to the nursery industry now or in the near future," Green said. "But CIPS doesn't have to be a 4- by 5-foot fiberglass box. It might take many forms, such as a plastic-lined trench covered with a basket-supporting lid made of wood.

"It's the concept of plant-driven fertilizer diffusion and capillary water flow within the protected root zone that is important," Green said. "It's an elegant concept that can be cheaply implemented."

Experimentally, CIPS has exceeded all expectations. In growing trials to date, plants grown in CIPS have done very well on a fraction of the water they are usually given in open container systems.

"The CIPS has proven a great test bed, which we continue to use and learn from, but further research is needed to detect unknown risks and to establish reliability," said Green.

"It's amazing what the plant can do on its own."

Bruce and Doris Briggs, owners of Briggs Nursery in Olympia, Washington, have worked closely with Green in field tests of the system. Both are strong supporters of Green's work, but they agree that industry adoption of the system is likely years away.

"There are a lot of pluses here but it's going to take time for the system to become accepted," said Bruce Briggs. "It's a large capital investment to get these CIPS pallets. Also it would require a lot of changes for the retailers in how they handle stock they receive from nurseries. Right now they get shipments of plants in pots. With CIPS they would receive pallets of plants in pouches.

"It's going to take a lot of education to get the industry used to CIPS," Briggs continued. "There may be parts of the system, such as the protected diffusion zone, that can be put into use by the industry right away, but use of the complete system is a ways off."

Whatever its future applications might be, Briggs noted that CIPS has proven a great learning tool. "CIPS proved that a plant can be its own guide in taking up food and water," he said. "It's amazing what the plant can do on its own. This system has shown us a way to let the plant govern itself."

We learned quite a bit about plants' water requirements, which was quite surprising," said Jeff Britt, plant pathologist at Briggs Nursery. "It didn't seem possible that plants could thrive so well on the relatively small amount of water used by CIPS.

"Once you have the system set up it's real low maintenance," he added. "And weeds aren't a problem in CIPS. The system cut the herbicide use to nil.

"Also, I thought CIPS would be more prone to root diseases," Britt said. "I thought that root rot might be a problem, but trials with the system proved that was not the case."

Green hopes to gain industry acceptance of CIPS through further research. In the meantime, interest in CIPS continues to percolate both in the United States and overseas. "Japanese horticulturists have visited the OSU campus to have a look at CIPS and Kuwait seems interested as well," he said.

Green feels the first application of the research may be the use of closed-container systems for the maintenance of indoor ornamental plants.

"Many businesses decorate their interiors with container plants, such as shopping malls," said Green. "The use of closed containers for these kinds of ornamental plants could eliminate a lot of maintenance costs while keeping the plant in excellent health.

"There is also commercial potential for CIPS technology in the homeowner market," he said. "Imagine being able to purchase a self-contained house plant that will remain in excellent health for years with minimal watering and fertilizing. All you'll have to do is put it where you want it."

BOB ROST

A wide variety of plants will grow in his system. Here, Green inspects tomato plants in a small-scale pallet he developed with help from colleagues such as OSU bioresources engineer Bob Schnekenberger.

Bob Rost is an information representative in OSU's Department of Agricultural Communications.

PLEASE DON'T SEND HIM BODY PARTS

LYNN KETCHUM

OSU entomologist Jack DeAngelis inspects wood for carpenter ant damage.

Do you have ants in your kitchen or beetles in your floor joists? Are there lice in your kid's hair? Do you know someone who is irrationally afraid of bugs?

For the answers to creepy-crawly queries like these, people from all over the state call Jack DeAngelis, Oregon State University's urban entomologist.

In his work as a specialist for the OSU Extension Service, DeAngelis demystifies insects, spiders, mites and other invertebrates, especially in public health, structural and landscape situations. He brings the expertise of OSU's Department of Entomology to the people via phone consultation, insect identification, off-campus teaching, written materials, news stories and radio interviews.

One example is the Extension Service-sponsored "Insect Identification Clinic," where DeAngelis works with OSU colleagues Glenn Fisher and Gary Parsons, who are also entomologists.

"We work with homeowners, "aggies," field scouts and Extension agents; virtually anyone can bring in or mail samples of insects for identification," explained DeAngelis. "We will do our best to figure out what it is."

The Clinic is offered free of charge as a public service. For more information, contact your local county office of the OSU Extension Service.

DeAngelis's clientele come from many other occupations. Physicians and veterinarians often call him when they have to identify a patient's fleas, ticks, mites, lice. Some of these tiny creatures spread disease, including scabies, bubonic plague and Lyme disease.

Homeowners and small businesses call with questions ranging from carpenter ants and cockroach infestations to fabric pests and cluster fly problems.

DeAngelis speaks to garden clubs and Master Gardener groups around Oregon on subjects ranging from plant pests and beneficial insects to bug zappers and slugs.

And sometimes he appears in court as an expert witness in cases where insect-damaged wood is found in a building.

"When damage is found after the purchase of a house, people often want to know when pests came and did the damage," he said. "Did the pests attack at the lumberyard or after a house was sold or built? That's when they call me."

DeAngelis always tries to help his clients come up with a satisfactory solution. "If I sense that a client is not into strong chemical pesticides, I will make an alternate recommendation," he said. "It all depends on their preferences."

Occasionally, his job can be a little scary.

"I've had someone send me live poisonous spiders in a film can," said DeAngelis. "That's dangerous. You are supposed to freeze them first."

Or the day can get somewhat gross.

"Once someone sent me pieces of skin where they had been bitten by something," he said. "What am I supposed to do with chunks of tissue in a vial of water? Don't send us body parts, please."

Each month DeAngelis publishes the "Home and Garden Newsletter" for all the county Extension agents around the state. He writes on a wide array of topics, ranging from yellow jacket and weevil control to food pests, house dust mites and "entomophobia," the irrational fear of insects. Often the information from these articles ends up in newspaper articles.

DeAngelis also conducts research for the OSU Agricultural Experiment Station. One of his projects involves using natural predators and parasites to control pests on Christmas tree farms. Another is a study of the conditions that lead to pest fly outbreaks in the commercial mushroom industry. And he is helping commercial greenhouse growers find solutions to their pest problems.

"I really enjoy the freedom I have in designing my own program and schedule," said DeAngelis. "I pick and choose what I'm best at and do more of that. Off-campus teaching is my favorite. I enjoy going out and working with small groups, helping them learn."

"And I enjoy writing for a popular audience," he added. "One of my biggest challenges is translating university research results into a form that the general public can not only understand, but use. This is what I strive for."

—Carol Savonen

Agricultural Experiment Station
OREGON STATE UNIVERSITY
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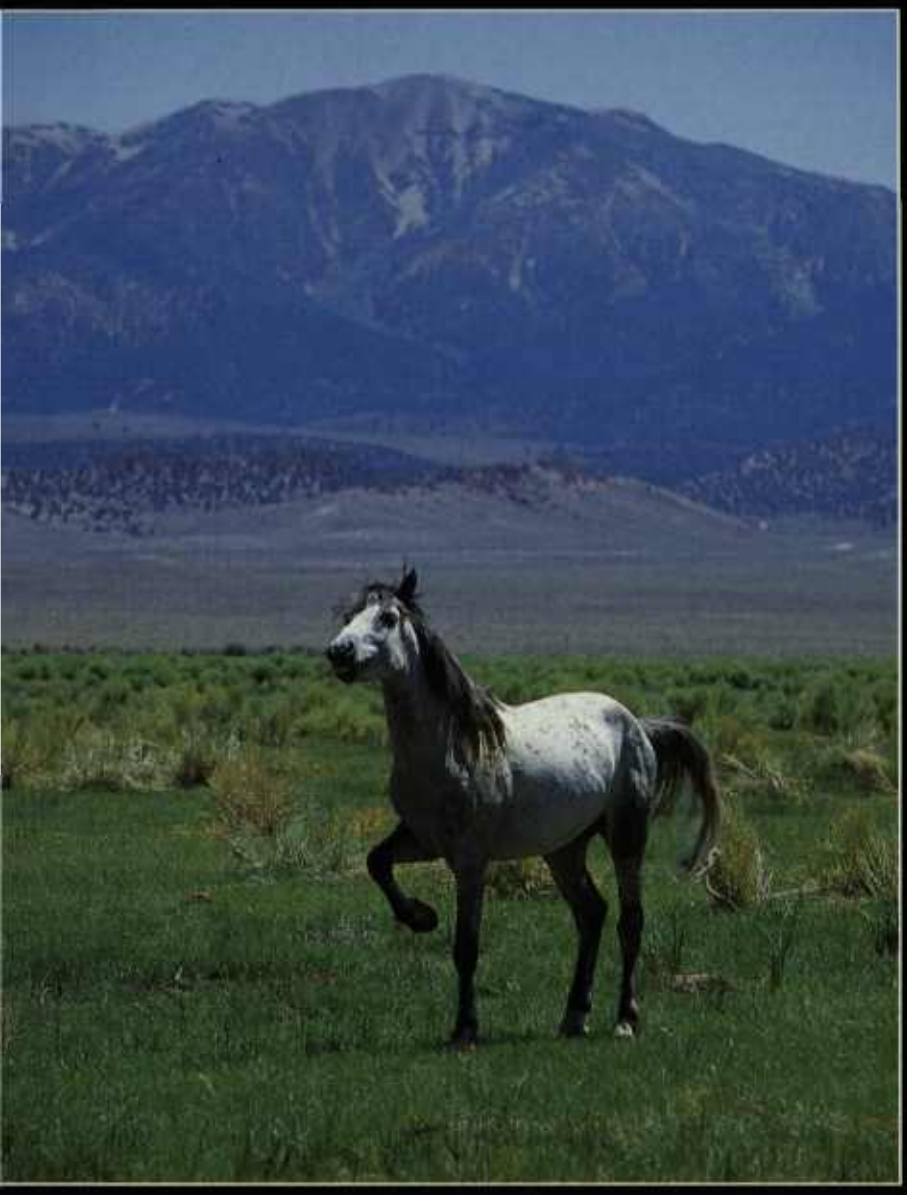
Thayne R. Dutson, Director
Oregon's Agricultural Progress



BORN FREE

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