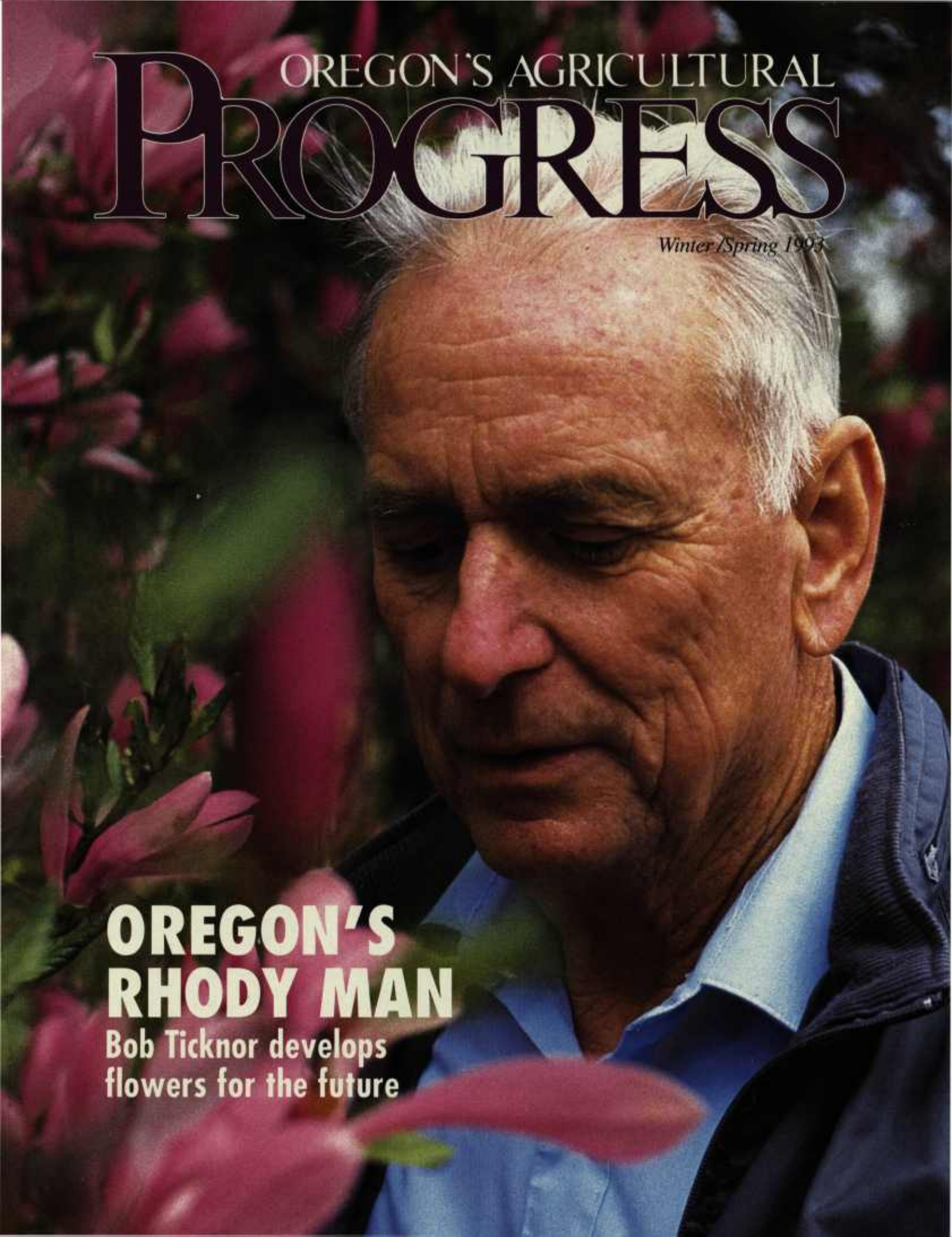

OREGON'S AGRICULTURAL

PROGRESS

Winter/Spring 1993

OREGON'S RHODY MAN

Bob Ticknor develops flowers for the future

THE EDITOR'S NOTE

Looking through the articles that follow makes me think of an incident involving a colleague who's had it tough on the auto front in recent weeks.

Luckily, the crashes weren't his doing and there were no injuries. But his spouse and children have reduced the family fleet from a beautiful and scratchless new car, an aged but perfectly serviceable truck and a "beater" (left by a son now off in the military) to a rental vehicle the size of a refrigerator.

"Hey Dad," she yelled, grinning devilishly, "just three more years."

The wretch, formerly good natured, was working in his front yard last weekend while one of his children, 12 years old, sat in the rental car, a Geo Metro, cranking the wheel from side to side.

As my acqaintance wallowed mentally in his plight, his only non-licensed offspring, the 12-year-old, popped her head out the window of the rental car. "Hey Dad," she yelled, grinning devilishly, "three more years."

After a lingering pause, he chuckled at the distraction and plunged back into the work at hand.

Why does this magazine issue make me think of that incident?

Even if you're only faintly familiar with Oregon, you've probably heard about Measure 5, the property tax limitation, and related debate on what are effective uses of public funds. I think the articles in this issue are good evidence that the scientists of the Agricultural Experiment Station, and the Extension specialists and county agents who work with them, have not let Measure 5-related distractions paralyze them.

Like my acqaintance, they're taking care of the work at hand.

Andy Duncan

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Andy Duncan
Editor

Tom Weeks
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Cover: OSU horticulturist Bob Ticknor develops products for Oregon $340-million-a-year nursery industry. Story on page 30. (Photo: Lynn Ketchum)

FISH EARS

Like a forester counting tree rings, OSU doctoral student Paulo Petry is counting rings on fish ear bones. The research could be important to the health of the Amazon River Basin—and provide useful information to researchers studying endangered fish in Oregon.

A citizen of Brazil, Petry is studying the survival of several kinds of important food fish, generally called pacus, in relation to the flooding cycles of the Amazon River. The flooding is somewhat similar to how Oregon rivers flooded before dams were built.

"If I eventually come to the conclusion that certain flood habitats are very important to producing a higher survival rate, I can say ... protect these areas, avoid any kind of development," said Petry.

Fish ear bones called otoliths, similar to the ear bones important to balance in humans, are the keys to the research. The bones are one of the first calcified structures that appear in a fish.

The bones grow at about the same rate the fish grows. A fish produces a new bone layer, or ring, about every 24 hours. To count the rings, Petry removes a section of the bone, mounts the section on a microscope slide, polishes the sample until it's paper thin and counts the rings with a microscope.

Once he's determined a fish's age, Petry measures the distance between the rings to help determine how fast it was growing at different stages of its life. That allows him to relate growth to events in the environment, such as a fluctuation in water level, or a major change in water temperature.

Petry recently returned from several months of field study in the Amazon River Basin, which experienced extreme flooding conditions this year. According to OSU fisheries professor Doug Markle, Petry's major professor, "the relevance of Paulo's work to Oregon is that normal flood cycles are still going on in the Amazon and he's finding out if his theory is correct—that young fish depend on them.

"Paulo's field data suggests that larvae [young fish] go into flooded areas where there is good food and vegetation that provides cover from predators. This year, researchers here in Oregon released salmon smolts in the Willamette River near Dexter Reservoir and found that they took a detour near Corvallis into some areas that flooded. What this all suggests is that a straight shot down the river may not be what is best for fish survival."

INPA, a Brazilian national fisheries research institute, is funding Petry's research.

LYNN KETCHUM

Doctoral student Paulo Petry, at OSU, injects a red-belly pacu with a chemical that helps him count rings in the fish's ear bones.

CLOTS & STROKES

Why might some recipients of artificial hearts or valves become more prone to blood clots and strokes? Why might some foods contain unacceptable levels of bacteria, even when processing equipment seems clean? Why are some therapeutic proteins and other pharmaceutical products so expensive?

These questions could be addressed more effectively if we had a better understanding of protein behavior on surfaces, according to Joe McGuire, a professor in OSU's Department of Bioresource Engineering.

McGuire says the way proteins behave on surfaces affects virtually every situation where a biofluid like blood or milk comes in contact with the surface of objects like human-made medical implants or stainless steel dairy tanks.

The OSU researcher is investigating the way certain proteins, whose structures are known, behave on well-characterized, uniform surfaces. He hopes these studies will help predict how other proteins will behave in complex medical and industrial situations.

"Currently, there is insufficient science to support economical manufacture of therapeutic or otherwise valuable proteins by biomedical and other industries," said McGuire. Industrial protein separation processes are quite inefficient, he said, which drives up the cost of many medicines.

TOM WEEKS

"This situation should change," he said, "as our understanding of molecular events governing these processes improves. If we could better predict the nature of competition of proteins in a mixture for sites at a surface, we could better predict protein separation. It is entirely realistic to think that we could improve process efficiency and so decrease costs by as much as a factor of 10."

TOES ARE TOOLS

You may have heard of people who gave their hearts to science, but their toenails?

Thanks to volunteers from the Corvallis area, two Agricultural Experiment Station researchers have developed a method of estimating the level of the trace element selenium in the body by analyzing toenails. The technique potentially could be expanded to become a non-invasive, diagnostic tool for physical exams.

"We got the idea from research that was done originally with lab rats," said agricultural chemist Philip Whanger. "We extended and applied this diagnostic tool while doing biochemical research with Chinese subjects, some of whom con-

sider blood sampling to be an unnatural practice."

Though toxic if you ingest too much, selenium is considered an integral part of the body's immune system. Research conducted by Whanger and senior research assistant Judy Butler, also of OSU's Department of Agricultural Chemistry, involved both selenium deficiency and selenium toxicity among rural populations in China.

"We completed our work in China last year," Whanger said. "As part of those studies we were able to gather some blood samples, as well as hair and nail samples from the same subjects. We were then able to establish an accurate correlation between all three sampling methods for selenium content.

"We've continued to analyze toenail clippings—in conjunction with blood sampling—as a part of some of our current selenium research projects.

"Other elements in the body could also be analyzed using this technique," Whanger said. "However, it's only been applied to selenium research, and, as far as I know, we're the only lab using this method."

According to Butler, analyzing fingernail clippings or hair trimmings for selenium content is not feasible in the United States because shampoos can contain selenium and fingernail polish remover can strip off part of the top nail layer. But toenails samples, because they are often *au naturel*, are more suitable.

"Our current studies," Butler said, "involve pregnant women and comparisons between the selenium levels in vegetarians and non-vegetarians. In these studies, we're not looking at nutritional extremes related to toxicity or deficiency, but whether stress and diet have more subtle effects on selenium levels in the body.

"Some people think low levels of selenium may be linked to certain diseases. If so, toenail analysis for selenium content could become an effective diagnostic tool," said Butler. "As an added benefit, toenail samples wouldn't have any special storage requirements, and non-medical staff could collect them."

TOM WEEKS

ANDY DUNCAN

Barley harvest near Pendleton. Stripe rust is headed toward Oregon.

FEAR OF FUNGUS

OSU Agricultural Experiment Station scientists are preparing for a potentially serious disease headed in this direction.

Barley stripe rust has reduced barley yields in Mexico and Texas as much as 70 percent, according to plant pathologist Chris Mundt. The wind-spread fungus that causes the disease arrived in South America in the 1970s and has moved north and south into barley growing regions of North, Central and South America. In 1991 it crossed the U.S. border into Texas. Last summer, growers found the fungus in the 8,000-foot-high San Luis Valley in Colorado. This year it showed up in Arizona, causing huge losses in commercial fields.

"If we do nothing, barley stripe rust will wipe us out," said Mundt, who is worried that the disease will thrive in the Northwest. "Look at the 70-percent yield losses in the South, where conditions are not conducive for stripe rust. The Pacific Northwest's damper climate is the most conducive place for stripe rust in the country."

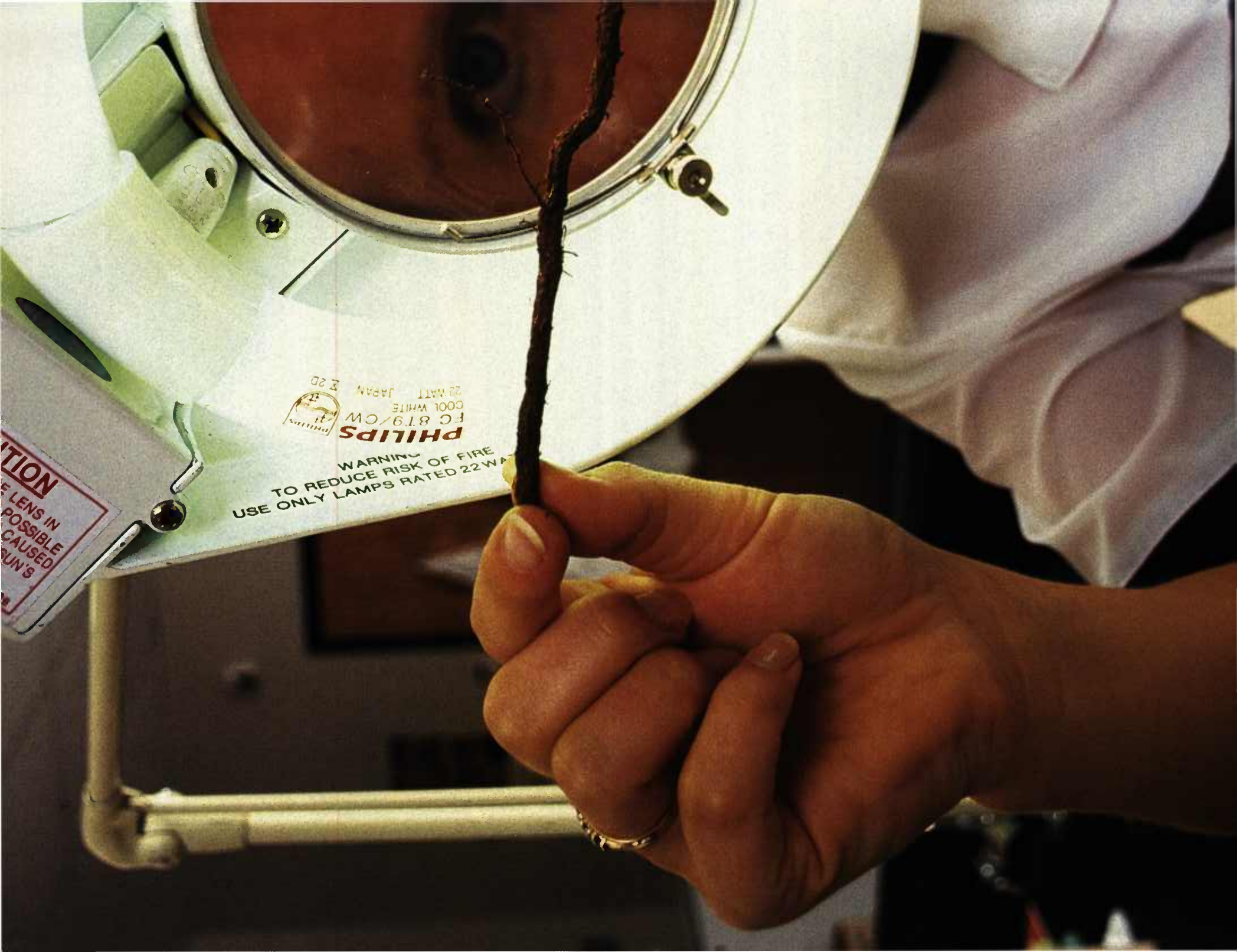
Mundt isn't as nervous as he might be because he and OSU crop scientist Pat Hayes found two resistance genes while participating in an international effort to map the genetic makeup of barley (called the barley genome).

Hayes, a geneticist, believes new genetic techniques that speed up the plant breeding process, will allow him to have a limited amount of resistant barley seed, adapted to the Northwest, available for growers quickly, perhaps by 1996.

Mundt is testing fungicides that might be effective in controlling the disease if it hits before the resistant barley is available.

"There's new compounds not yet registered, but close," he said. "I've been collecting data so I can go to EPA to request a registration permit to use them for barley stripe rust. When the time comes, we will have information on the best chemicals available.

"We've got the potential, if we play our cards right, not to lose anything ... But it is important that growers start thinking about the idea of growing resistant seed before the disease gets here."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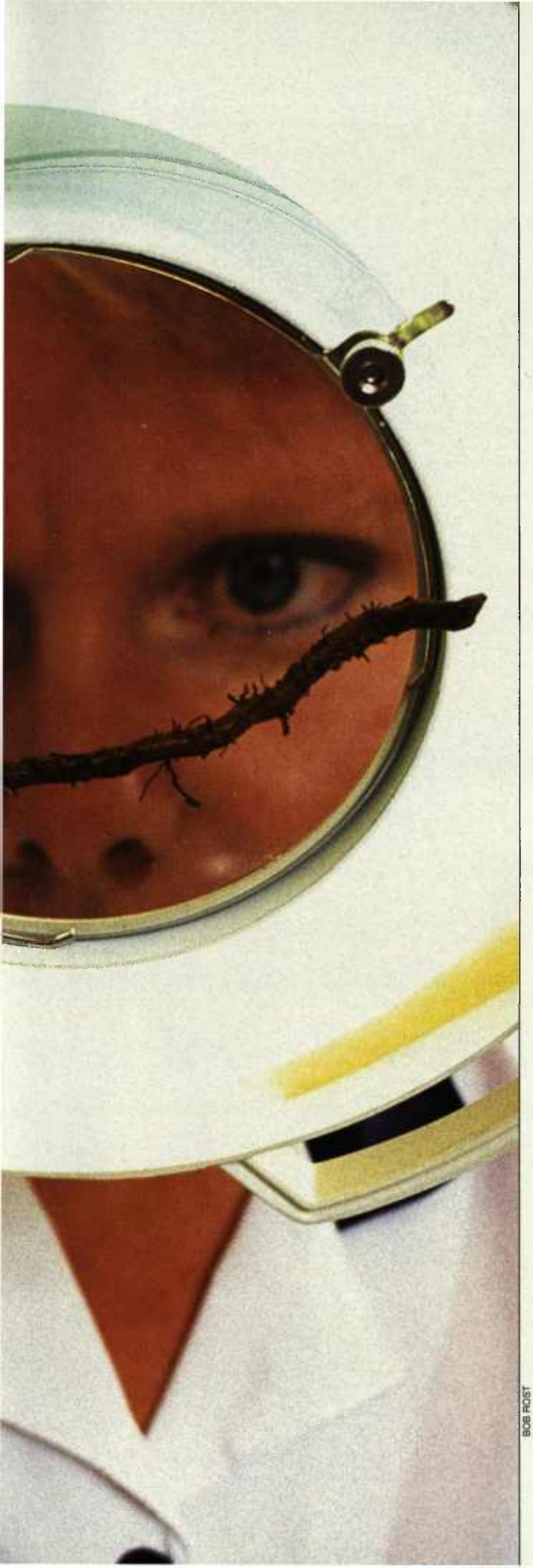


BOB ROST

THE BAD NEWS BUGS

BY BOB ROST

OSU researchers are studying a tiny creature that ravaged Europe more than a century ago and now threatens Oregon's young, $25 million wine industry

It was August 1990. A few of the vines began to die. The growers got nervous. A grower sent some samples into the lab, just to be on the safe side. Everybody's eyes—pardon the expression—bugged out when they found out it was phylloxera. Phylloxera wiped out the European wine grape industry back in the mid-1800s. How? Phylloxera was tough, see. Pesticide sprays? Soil fumigants? No way. Nothing could touch phylloxera.

Gary Parsons, Extension Service entomologist, made positive ID. It was phylloxera all right, probably from California, or maybe Washington. The growers got the bad news. They knew this bug was trouble. They knew it would cost them. They didn't want to believe it.

• • •

If this were a murder mystery, this is how the case of the wandering phylloxera would begin. The villain is an extremely destructive insect pest that may cost Oregon wine grape growers millions of dollars. You might call it protection money. It's what owners of phylloxera-infested vineyards will have to spend to replant grape vines resistant to phylloxera.

Left: OSU horticulturist Bernadine Strik uses an illuminated magnifier to look for phylloxera on a piece of winegrape root.

Currently, seven Oregon winegrape vineyards are infested with phylloxera. According to Bernadine Strik, a horticulture researcher with OSU's Agricultural Experiment Station and berry crops specialist with the OSU Extension Service, 97 percent of Oregon's vineyard acreage is susceptible to phylloxera infestation.

The farmgate value of Oregon wine grapes is $9 million.

Oregon's winegrape industry consists of 80 wineries and 350 growers with over 6,000 acres planted. The average vineyard size is 20 acres. The farmgate value of Oregon wine grapes is $9 million, but the grapes have a very high process value because of the wine. Total value of the industry is over $25 million when the value of the wine is included.

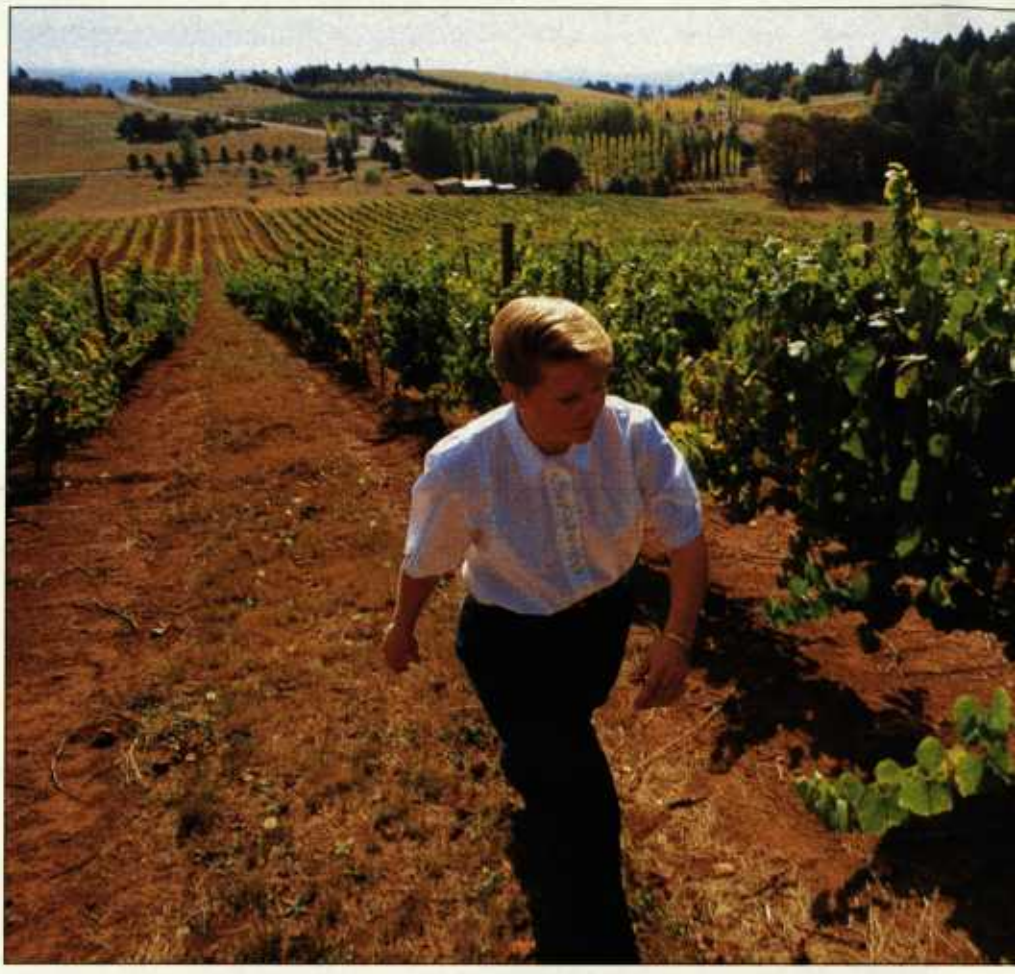
The industry is young, about 30 years old, and started slow, said Strik. She and Anne Connelly, graduate student in horticulture, are conducting research on phylloxera life cycle and how phylloxera infestations have spread in three infested Oregon vineyards.

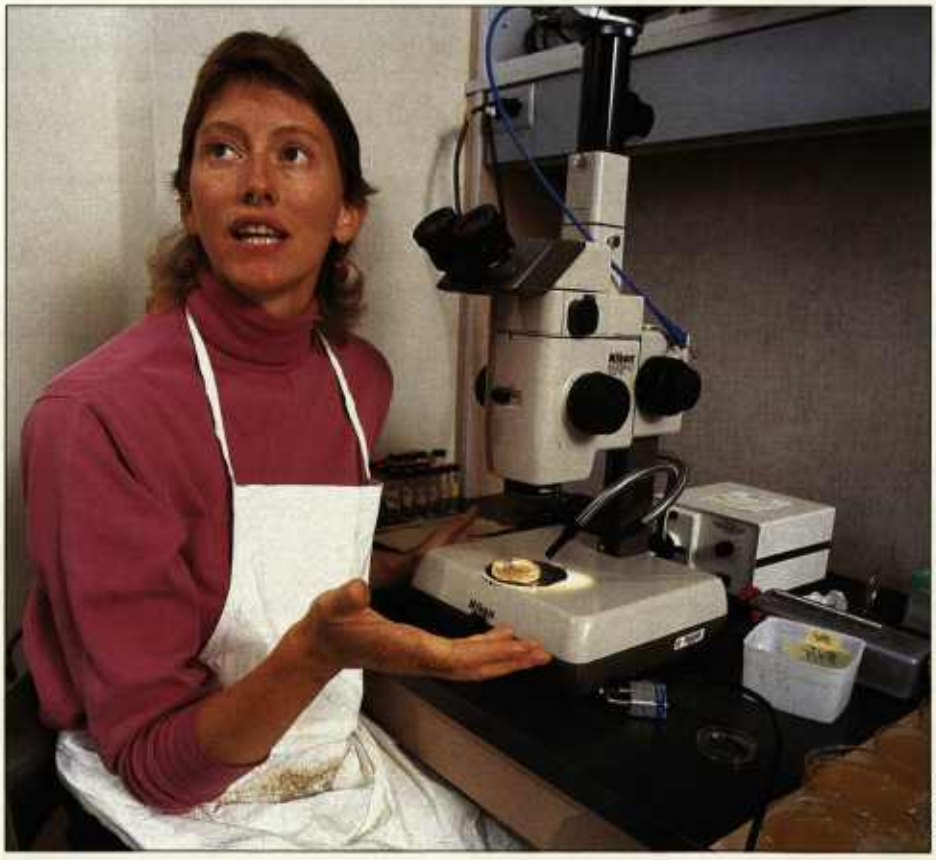
According to Strik, self-rooted vines were used almost exclusively to start up vineyards in the early years of the industry. Unfortunately, that's why phylloxera is a problem for wine grape growers now.

"Over 95 percent of our industry is in self-rooted, or non-grafted, vines," said Strik. "Should a vineyard of self-rooted vines get an infestation it will eventually die. A grafted vine has a wine grape variety that is grafted onto a phylloxera-resistant rootstock. That's the only way to control phylloxera."

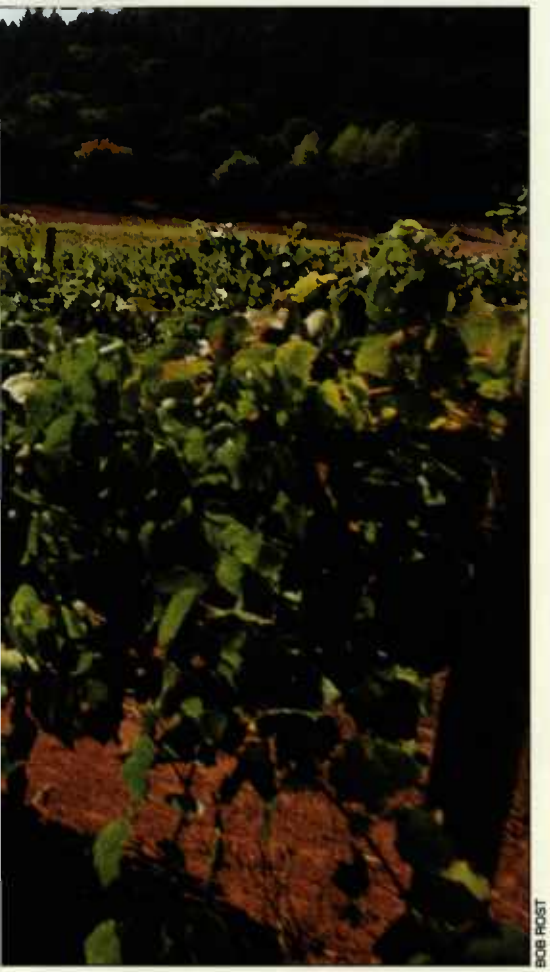
Grape phylloxera are tiny, aphid-like insects that feed below ground on juices from plant roots. This causes plants to become stunted, as if drought-stressed, and eventually die. It may take anywhere from two to five years before the effects of an infestation are apparent. Strik believes that spread of phylloxera in infested Oregon vineyards more than doubles every year.

"The early growers made a conscious decision to plant self-rooted vines," Strik explained. "They knew there was phylloxera in California. It is in almost every major wine-grape growing region





BOB ROST



BOB ROST

Above: Strik checks for signs of phylloxera in an Oregon vineyard. Left: At OSU, graduate research assistant Anne Connelly uses a microscope and camera to document types of phylloxera extracted from winegrape root samples.

around the world. But the growers chose self-rooted vines because they were cheaper and more available."

The growers knew they were taking a risk, Strik explained. But many growers felt—and still feel—that they can remain isolated from phylloxera.

"In Australia growers have tried to isolate infested winegrape vineyards without success," she said. "Ultimately, all Oregon vineyards will get an infestation. We just don't know how long it will take."

All root-feeding phylloxera are female and lay hundreds of eggs. Populations increase quickly. Most of their life cycle is below ground where they feed, which makes them difficult to control. Surface sprays are completely ineffective and soil fumigants don't penetrate far enough—3 to 4 feet—to reach the entire phylloxera population.

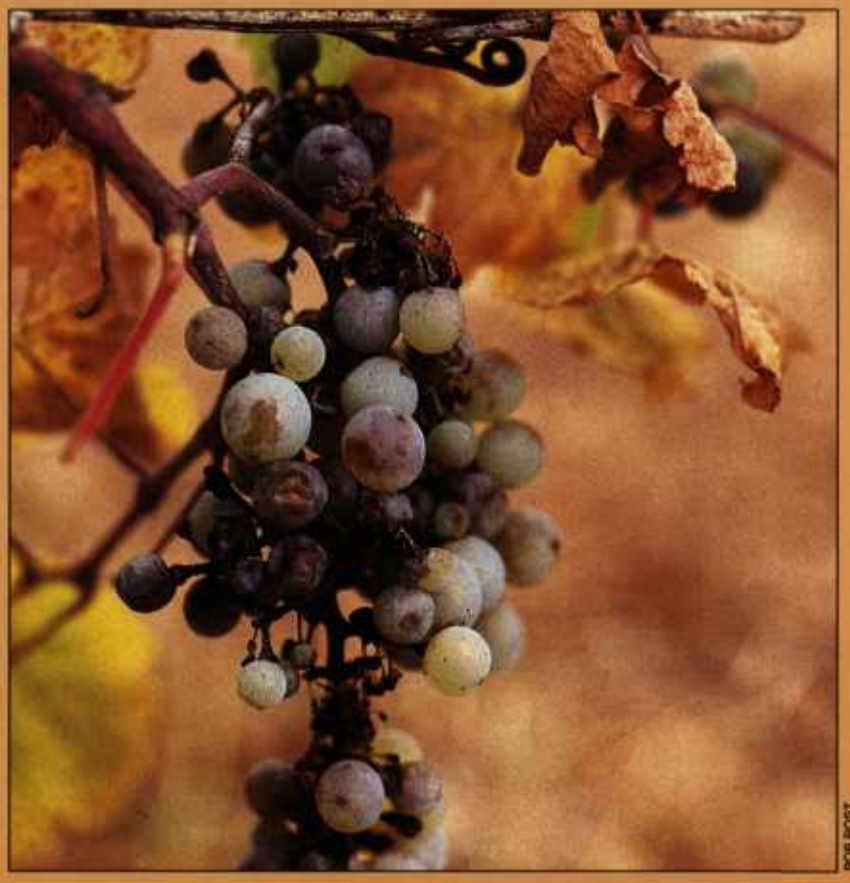
VINEYARD SAFETY

Phylloxera, tiny insects that feed below ground on juices from plant roots, are hard to detect. Guarding against their spread is critically important to slowing down further infestations in Oregon vineyards, according to OSU horticulturist Bernadine Strik.

Strik urges growers to be very conscious of sanitation practices in their vineyards. Phylloxera are spread easily when infested soil sticks to field equipment or the boots or other footwear of workers or visitors, she said. Phylloxera also are spread by infested plant material, such as planting stock, she added.

It's unfortunate that phylloxera populations peak in the late summer and fall, Strik said. That is harvest time, when workers and visitors are most likely to be in the vineyards. This year, many visitors to Oregon vineyards may see signs saying entry is prohibited. The reason is grower concern about getting a phylloxera infestation. Visitors will be doing growers a big favor by heeding those signs, Strik said.

Growers with infested vineyards also can combat the problem by stepping up irrigation and fertilization to improve the vigor of their vines, added Strik. But eventually the infestations will make the vineyards economically unproductive and growers will have to remove and destroy infested vines, she said.



BOB ROST

Root damage caused by phylloxera worsens the effect of stresses like drought and heat, which damaged these White Riesling grapes.

When phylloxera become active in the spring, they start feeding and laying eggs. These hatch into nymphs or crawlers that are mobile. Phylloxera populations peak in late summer to early fall.

"This is a very dangerous stage of the phylloxera life cycle for spread of infestations," Strik said. "They move through cracks in the soil, along roots, up the plant trunk and into the plant canopy where they can be blown by wind to other locations.

Phylloxera appear to be extremely resourceful in ensuring their own survival.

"How long phylloxera can survive above ground in a non-moist environment is unknown," Strik noted. "The nymphs mature into adults and the cycle is repeated." In Oregon, she added, research indicates that phylloxera have about three generations per year, hibernating during the winter.

Phylloxera appear to be extremely resourceful in ensuring their own survival.

"When populations increase and when environmental conditions are just right, phylloxera may emerge from the soil in a sexual stage," Strik said. "It is what we call the winged phylloxera."

Strik and Connelly found winged phylloxera for the first time in Oregon last year.

"A lot of aphid species, when their populations increase substantially, their food sources become depleted and day length decreases, reproduce in a winged form that is capable of searching for new food sources," Strik said.

"In the case of phylloxera, the winged form is a female without mouth parts so it can't live very long," she said. "However, it does have eyes unlike the below-ground form. These winged phylloxera emerge from the soil and fly onto the vineyard trellis or a plant trunk, then are usually carried off downwind to another location."

Upon landing, the winged phylloxera lay two eggs, one male and the other a

BOB ROST

Strik digs out around grapevine roots so she can cut root samples.

BOB ROST

Right: A researcher counts phylloxera adults, nymphs and eggs taken from a root sample.

BOB ROST

OSU's experimental Woodall III Vineyard near Alpine, Oregon, where researchers study winegrape varieties and growing practices. Eventually, predicts OSU's Bernadine Strik, phylloxera infestations are going to force all Oregon growers to replant their vineyards. That will be expensive but give them an opportunity to incorporate new techniques and materials, she says.

larger female egg. This is the only time a male phylloxera is present in the population, said Strik.

If they survive, the two mate and the female lays an egg that is almost as big as she is. This overwintering egg hatches into a nymph in the spring that is capable of feeding on leaves.

"As far as is known, phylloxera in the aerial stage of the life cycle can only survive on American or hybrid grape varieties like Concord, Niagara or Marechal Foch," Strik said. "It supposedly can't survive on European wine grape foliage. If this, in fact, is the case, then the presence of winged phylloxera will not greatly affect the rate of spread in Oregon vincyards."

Strik and Connelly will be doing research this year to determine whether the winged form of phylloxera can complete its life cycle on European wine grape varieties (the main varieties planted in Oregon vineyards). If it can, Strik said, then the rate of phylloxera spread in Oregon vineyards will increase dramatically throughout the state.

In the meantime, there are still Oregon wine grape growers planting self-rooted vines now, Strik reported. Looking at today's prices, she said, you can see why.

"If you want to plant an acre of wine grapes, self-rooted planting stock is more available and costs $.60 per plant," Strik said. "A grafted rootstock plant is less available and costs from $2.50 to $3.50 per plant. In addition, growers have to plan a year in advance to get grafted rootstocks because the nurseries producing them are swamped with orders.

I.A. RAMMER

An adult female phylloxera lays an egg on a grapevine root. The insects are 1/30 of an inch long.

"The bottom line is an increased cost of approximately $2,000 per acre to plant grafted rootstock," Strik said.

On the other hand, if the grower chooses to save some money and use self-rooted plants, he or she might lose that acreage to a phylloxera infestation in as early as 10 years, and if that happens the replanting costs will probably run as high as $11,000 per acre.

"I think when we look at the industry 10 to 20 years down the road we're going to see a tremendous number of vineyards that are infested in Oregon," Strik added. "And, our whole picture of viticulture—practices of raising wine grapes—is going to change because we're going to see many more vineyards planted on rootstocks that are resistant to phylloxera. This will likely bring concurrent changes in plant spacing, trellising and selection of clones. In the long term, these changes may improve wine quality."

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

THE CHEESE SQUEEZE

In Frank Kent's day, at least 30 dairies in western Oregon made cheese. Now there are three factories in the entire state. But the quality of our cheese has soared, some say

OREGON STATE UNIVERSITY ARCHIVES

Above: OSU dairy professor Frank Kent, right, and associates had just returned from a San Francisco-to-Corvallis bicycle trek when they posed for this 1896 photo. In 1899 Kent gathered data via a more common mode of transportation, horseback, about the state's many cheese factories. Page 13: "Blue cheese will always be made this way," says Steve O'Brien, stirring curds by hand to feel the texture of the batch. He's head cheesemaker at the Rogue River Valley Creamery at Central Point, the only blue-cheese maker left in the West.

BY CAROL SAVONEN

In 1899, Frank Kent, an assistant professor of agriculture and dairying at Oregon Agricultural College, set out on horseback to learn all he could about the cheese industry in western Oregon. Two years later, he published a report entitled "Creameries and Cheese Factories of Western Oregon" in a publication called *Oregon Agricultural Experiment Station Bulletin No. 65.*

At that time, western Oregon was a wild place. An occasional logging camp, or small settlements such as Tillamook, Elk City or Nestocan pierced the seemingly boundless forests and remote valleys. Paved roads, cars, even refrigeration were not yet part of the way of life. Each small town was relatively self-supporting. Most people grew crops and gardens, logged, fished, hunted, kept cows and sold their excess milk to local creameries for extra cash.

Kent visited all 71 western Oregon creameries, from Ashland to Astoria, and found commercial cheese-making operations in 30 of the local dairy operations. Those included Corvallis, Logan, Scappoose, Marshfield, Myrtle Point, Gardiner, Goshen, Elk City, Scio, Laurance, Salem, Gresham, Cleone, Cloverdale, Tillamook, Nestocan,

Beaver, Oretown, Centerville, Forest Grove and Lafayette. Oregonians made about 1.5 million pounds of cheese in 1901. Commercial cheese makers made an average of $58.60 a month.

"When my family came to southern Oregon in 1935, there was a different economy."

As Oregon's population steadily grew, so did the number of cheese factories. Tillamook County had as many as 40 cheese factories at once, according to an early Experiment Station report.

"There were at least 30 cheese factories in southern Oregon in the '30s, scattered all over, " said Ignacio Vella, whose family has been making cheese in Oregon for more than 50 years. "Bandon, Langlois, that whole area was just scattered with cheese factories."

The Vella family owns one of the last small, non-automated cheese factories in Oregon, the Rogue River Valley Creamery in Central Point. Ignacio's father Thomas Vella, now aged 94, founded the small plant in 1935. Thomas still oversees the plant, famous for its "Oregon Blue" cheese, the only blue cheese made in the West.

"When my family came to southern Oregon in 1935, there was a different economy," said Vella. "It was what I would call a subsistence economy. A guy worked in a mill or forest in the summer and maybc had ten cows he was milking for extra income. Everybody in the family made a contribution. The idea was to get by. Now the small plants are almost all gone. The economic returns from milking cows is no longer important."

OSU ARCHIVES; PHOTO BY DRAKE BROTHERS STUDIO

Members of the Collidge and McClaine Calf Club of Silverton, Oregon, circa 1920. Many Oregonians abandoned the rural life after World War II. But people in some countries still make cheese at home to preserve milk for later.

OREGON STATE UNIVERSITY ARCHIVES

Early in the century Emile F. Pernot, OSU's first professor of bacteriology, helped cheese makers tackle the problem of wildly varying cheese quality.

Efficiency and economy have ushered in the era of the large, automated cheese plant. Now, only three cheese-making plants (excluding cottage cheese) remain in Oregon–in Tillamook and Bandon, and Vella's plant in Central Point. Together, these three plants produce more than 40 million pounds of cheese per year. The Tillamook County Creamery Association alone produces 36 million pounds. But Oregon cheese production is small peanuts compared to Wisconsin, the top cheese-producing state. With a surplus of milk, Wisconsin produced more than 1.9 billion pounds of cheese in 1991.

"Times changed," said Floyd Bodyfelt, a nationally renowned cheese expert and OSU Extension dairy specialist who conducts dairy research for the OSU Agricultural Experiment Station. "If I had to sum up why small local cheese plants disappeared in one phrase, I'd say 'economy of scale.'"

Transportation improvements had a profound effect on rural life and livelihoods. Vehicles became much faster and bigger. Refrigeration was developed. Milk could be trucked greater distances to larger, more centralized creameries without spoiling. Milk cans went the way of the horse and buggy. Tanker trucks were easier and cheaper to fill and kept milk cold until it was brought to market. After World War II, more and more folks

TOM GENTLE

Helen McCann wraps each wheel of blue cheese made at the small Rogue River Valley Creamery in Central Point by hand.

TOM GENTLE

abandoned the rural farming life and moved to urban areas.

Cheese making went from a hit-and-miss operation to a predictable and more productive process, explained William Sandine, professor of microbiology and Agricultural Experiment Station researcher at OSU.

"In the old days, cheese makers relied on the bacteria in the milk to make cheese," said Sandine. "They didn't add a starter culture like we do now. They would lose a significant number of cheese vats due to virus infection that would kill off the good bacteria."

OSU's first professor of bacteriology, E.F. Pernot, sums up the challenges of the early Oregon cheese industry in his 1904 report published in the OSU *Agricultural Experiment Station Bulletin*, No. 78.

Left: A computer helps Ed Yates monitor cheese making at the highly automated Tillamook County Creamery Association plant where he is production manager.

MILK'S GREAT LEAP

Cheese has been described as milk's great leap toward immortality, since an edible 600-year-old cheese was discovered in an Irish peat bog.

"Cheese making is basically a means of preserving milk," explained Floyd Bodyfelt, a dairy scientist with the OSU Extension Service. Since ancient times, people have pressed and dried the curd of sour milk to make the nutrients of milk last longer.

Today's commercial cheeses stem from an ancient recipe. Most cheeses are made by the same basic five steps:

- Adding lactic acid bacteria ("starter culture") to milk.
- Curdling the milk (with rennin, an animal enzyme, or another coagulant.
- Collecting and pressing the curd and draining off the whey, the watery part of milk.
- Salting.
- Ripening/Aging.

Each type of cheese is a variation of these five steps. Cottage cheese is a soft, unripened cheese. Cream cheeses have a smooth buttery consistency because of their high fat content. Cheddar cheese develops its sharp flavor from the aging process–a mild is aged for about three months; extra sharp cheddar can be as old as three or more years. Provolone and mozzarella have a "stringy" texture because they are kneaded in hot water after the curds are gathered. The holes in Swiss cheese are gas bubbles that form during ripening. Monterey Jack is mild because it is barely aged. Cheeses such as Blue, Stilton and Roquefort owe their strong ripe flavors to molds, inoculated into the cheeses during the ripening process. Limburger's intense aroma is due to the surface growth of a specific bacteria.

TOM GENTLE

Blue cheese is perforated to allow mold organisms to enter, giving the cheese its pungent flavor.

TOM GENTLE

One of the big steps in making cheese is getting milk to curdle. Here, the Rogue River Valley Creamery's Steve O'Brien adds a substance called rennet to heated milk. The substance, and fermentation bacteria, make the milk coagulate.

"The making of first class cheese of a standard flavor is attended with many difficulties and uncertainties, although made with material from the same source, under the same conditions," wrote Pernot. "As cheese is found on the market at present, there is a striking difference in flavor, consistency, and structure, varying from a tough, waxy, sour curd which is both unpalatable and indigestible, to a crumbling, pungent material bordering upon rankness.

"It is almost impossible to purchase two samples of cheese of the same character, and there is far more inferior cheese on the market than that which is first class," Pernot continued. "Many people cannot eat the ordinary cheese because of its indigestible qualities."

The problems of Pernot's era challenged cheese makers and researchers for decades. OSU Agricultural Experiment Station microbiologists and dairy researchers worked hand-in-hand with cheese makers to improve cheese starter cultures, combat harmful microorganisms and improve sanitation in cheese plants. Through the 1930s and 1940s, they improved methods for processing, handling and shipping cheese. At the same time, they made enormous advances in the understanding and control of microorganisms in the cheese making process. By 1949, cheese production in Oregon was at an annual all time high of 10 million pounds. But there were fewer factories than ever.

The most evasive problem with cheese production was, and still is, bacteriophage outbreaks–viral infections in bacterial

TOM GENTLE

As heated milk coagulates, O'Brien cuts the resulting curd. Later, he'll drain off the whey. This will be Monterey Jack cheese.

starter cultures. In the first step of making cheese, starter culture is added to milk to convert the milk sugar to lactic acid, which in turn helps the protein in milk (casein) coagulate into curd to be pressed into cheese. Bacteriophage outbreaks often stopped this process cold.

"We worked on quality, economy and spoilage problems of cheese," said Paul Elliker, dairy microbiologist at OSU from 1947 to 1976, chair of the microbiology department the last 25 years of his tenure at OSU, and still a consultant to the dairy industry around the world.

"Our two major thrusts were developing virus-resistant cultures and sanitation," said Elliker. "OSU set the standard for the entire country for dairy sanitation. We worked with germicides, detergents and solving bacterial contamination problems in cheese plants."

In 1954, Bill Sandine came to OSU to study dairy microbiology with Elliker, eventually joining the faculty in 1958. Sandine developed methods to select and identify better bacteria for cheese starter cultures. The bacteria were also resistant to bacteriophages. This "defined strain" culture approach revolutionized the way major cheese plants all over the world used starters.

"In the old days, no one knew what strains of lactic acid bacteria they had when they added their culture, so when there was a phage outbreak, they didn't know what bacterium was being attacked," said Sandine. "If you know what bacterial strain is being destroyed by the viruses, you can develop a virus-resistant culture."

"In the old days, no one knew what strains they had."

"Sandine's virus-resistant cultures have made as much of a difference to the Oregon cheese industry as $800,000 to $1,000,000 per year just in eliminating second grade cheese alone," said Bodyfelt. "And the process is so dependable that cheese makers can set their watches by it."

About 1980, Sandine also developed and patented a new way to help virus-resistant cheese cultures so they would grow faster, outpacing viruses and producing lactic acid more quickly. It was called "PHASE 4." A few years later, he came up with and patented a quicker and easier method for lactic culture suppliers to select and grow only fast-acting, acid-forming virus-resistant culture bacteria. That was called "Fast-Slow Differential Agar" (FSDA).

"The most exciting thing we learned over the years is about the dynamics of viruses," said Sandine. "We found that since viruses are always changing, the best approach to keeping cultures free of viruses is a dynamic approach, responsive to changing viruses."

By charging a nominal fee to cheese companies to participate in the product development, Sandine earned money to keep his research programs running. Most of the major cheese companies in the country, including Tillamook, became interested and eventually adopted his technology.

Three years ago, Sandine's advances in starter culture technology helped Tillamook double its production capacity and further automate its cheese making, explained Ed Yates, head cheese maker at Tillamook Cheese Company.

"I can't say enough about Bill Sandine's work," explained Yates, who has worked at Tillamook for 43 years. "Our cultures are not 'iffy' anymore. Our costs are also reduced substantially because we are more efficient."

TOM GENTLE

Finger-sized pieces of cheddar cheese curd are salted to stop acid build-up. A certain amount of acid is desirable for aging. Later, these curds will be pressed into hoops.

"When we went to the larger plant and more cheese-making hours within the day, we needed more control of our cultures," he said. "We had more eggs in one basket. Now we are able to monitor, identify and control the microbes, even for flavor and acidity. We couldn't do what we are doing now without Sandine's work."

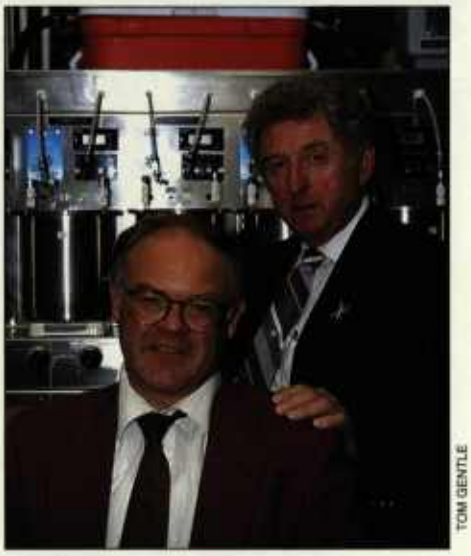
Other Agricultural Experiment Station scientists are currently conducting research on cheese. Mark Daeschel, OSU food microbiologist, and Joe McGuire, OSU bioresource engineer, are working with nisin, a protein naturally produced by lactic acid bacteria that will kill harmful or undesirable bacteria in cheese. These natural proteins have great potential as a natural, non-chemical food preservatives for both cheese and wine, said Daeschel. They are looking at coating cheese blocks, cheese wrapping or dairy processing equipment with nisin to prevent or slow down cheese spoilage. A patent is pending.

"Our nisin work is a marriage of microbiology and chemical engineering," said Daeschel. "Neither one of us could have done it alone." Mina McDaniel, OSU food scientist, analyzes the sensory qualities of foods and beverages, or the way the a consumer perceives a new product. McDaniel and Bodyfelt, dairy specialist, and Antonio Torres, another OSU food scientist, work together to develop products such as lower salt and low fat cheeses, analyze these products and test consumer reactions.

Will small cheese factories experience a resurgence, like gourmet coffee roasters or micro-breweries? Bodyfelt and Elliker don't think so.

TOM GENTLE

These 40-pound blocks of cheddar cheese on the assembly line at the Tillamook County Creamery Association will be aged from several months to two years. The longer they're aged, the sharper the flavor.



TOM GENTLE

OSU Extension dairy specialist Floyd Bodyfelt, seated, and microbiology researcher Bill Sandine.

"There've been several groups that tried to start up gourmet cheese factories in Oregon," said Elliker. "But they weren't willing to spend the money on the right equipment."

"The technology is too difficult to start up new factories," said Bodyfelt. "And there aren't enough people who know how to make cheese and make it well."

If F.L. Kent and his horse could wander through Oregon today, almost a century later, they would see that the small, local cheese plant has almost gone the way of the dinosaur. He might, however, be impressed by the new technology and the high quality of cheese produced today.

"For a commercially successful cheese, you need to have predictable, consistent, uniform quality," explained Bodyfelt. "People are amazed that cheese quality may be better from today's automated plants than from the hands-on cheese-making process of the old days, because they associate old-fashioned hand craftsmanship with quality. The Tillamook experience has proven that hand craftsmanship doesn't necessarily equal high quality. Their quality is unbeatable day after day."

"It used to be said in the old days when you got a good cheese, there couldn't be anything better," said Bodyfelt. "But you didn't get good quality that often. The quality level bounced around. Every cheese was a surprise. Now, it is 'boringly' all the same—high quality."

Science writer Carol Savonen works in OSU's Department of Agricultural Communications.

SKY KING

By Gail Gallessich

Day after day, George Taylor and associates study the heavens, building a down-to-earth database important to a dizzying array of Oregonians

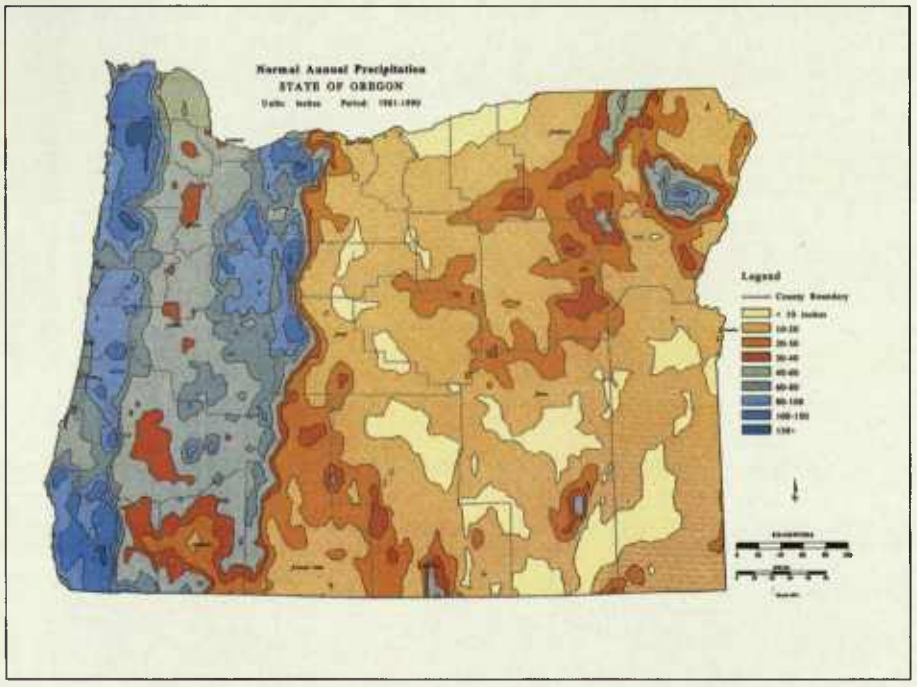
Rain or shine, hot or cold, the weather fascinates George Taylor. That's good, because it's his job. He's Oregon's official state climatologist.

Every day Taylor receives information from 400 weather stations in Oregon and surrounding states. With a small staff he compiles volumes of data and puts them into pictures that make sense to other meteorologists and, he hopes, to lay people. Taylor's office, the Oregon Climate Service, is based in OSU's Department of Oceanography and Atmospheric Sciences.

"Over time weather becomes climate," he explains. "Every drop of rain that is recorded by an Extension agent or a weather service employee gets added to an archive of data about Oregon's weather." The numbers contribute to current facts and databases. They add to long-term projections about the consequence of weather: climate.

George Taylor, state climatologist

Weather trivia is not trivial to Taylor. Recently, with OSU doctoral student Chris Daly, he took rainfall measurements from hundreds of stations and configured them into a new map that shows how much rain falls in Oregon and where. It's the state's first new precipitation map in 30 years, and it's causing a sensation. His office received hundreds of requests for the map the first two weeks following the public announcement of its availability. Farmers, ranchers, stream flow scientists, the Bureau of Land Management, ecologists, teachers, flood planners and the general public placed orders before it was in final form.



George Taylor and associates produced this up-to-date picture of Oregon's precipitation. You can buy color and black and white copies, in several sizes, from the Oregon Climate Service at 326 Strand Hall, OSU. For information call 1-737-5705.


BOB ROST

Gerry DeKam, research technician at OSU's Hyslop Crop Science Field Research Laboratory, just north of Corvallis, records weather data daily and feeds it to George Taylor, state climatologist, on the OSU campus. Several branch agricultural experiment stations and county Extension offices are among the 400 stations in Oregon and surrounding states that collect weather information for Taylor.

A computer model Daly developed is the basis of the new map, which replaces a hand-drawn map printed in 1964. Federal agencies such as the U.S. Soil Conservation Service are asking to have similar maps produced for all 50 states. Taylor has already received a green light to generate maps for Nevada, Idaho and Utah.

Taylor is used to the attention and welcomes it. His office logs more than 3,000 calls per year on weather-related issues. Public education is a major part of his mission as state climatologist.

"One quarter of my job is to educate our citizens about the weather," he says. "It's fun because everyone is affected by weather. People enjoy talking about it and learning more about why things happen as they do."

Steens Mountains and the Wallowa Mountains wring out the final drops.

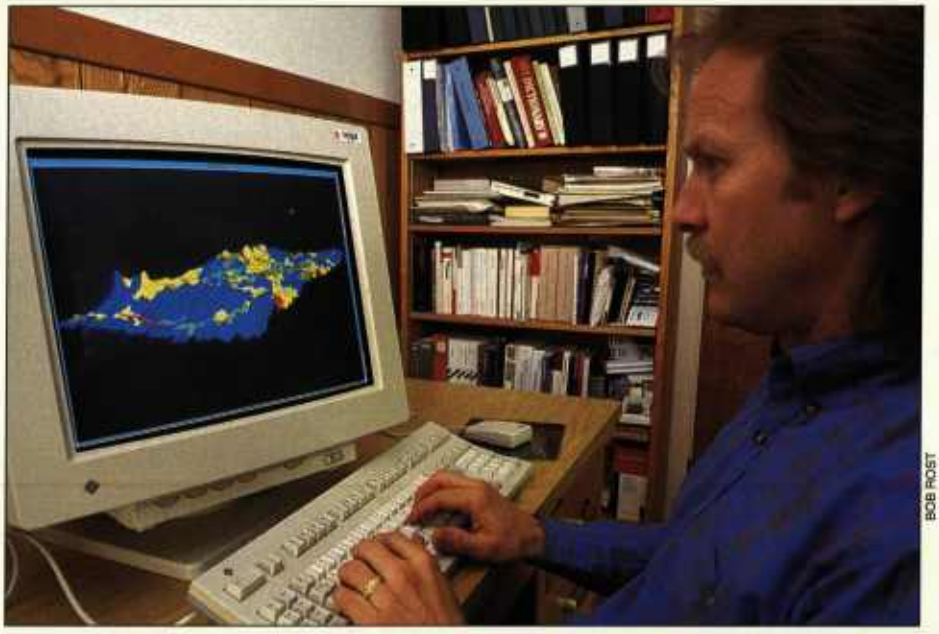
Taylor talks weather with everyone from school kids to fellow meteorologists at professional meetings. He gives presentations several times a month and is popular with farming groups like the Oregon Horticultural Society.

When he visits elementary schools, Taylor brings his official weather bucket and a large sponge. He shows how clouds, illustrated by the sponge, absorb moisture from the ocean, and then lose it in the form of rain as they cool off and shrink when rising to cross high terrain.

Wringing out the sponge, he shows the children how condensation results as clouds get cooler and unable to hold as much moisture. Using a map he shows how in Oregon the Coast Range initially draws rain out of the clouds, causing the heaviest concentration of rain to fall in the western part of the state.

By the time the clouds, now illustrated by a nearly dry sponge, reach eastern Oregon they have less rain inside. The higher elevations in the east, especially Steens Mountain in the southeastern desert and the Wallowa Mountains in the north, wring out the final drops of rain.

In any given area, higher elevations get more rainfall. For example, the peak of Mount Hood gets more than the lower slopes. But that doesn't always apply to



BOB ROST

large geographic areas. For example, the eastern movement of the clouds through the Coast Range creates an interesting anomaly: the driest place in the state is higher than the wettest. The Alvord Desert in southeastern Oregon, at an elevation of about 4,000 feet, receives only five inches of rain a year. The northeast corner of Tillamook County in the Coast Range, which is about 3,000 feet, receives the most rain, about 200 inches a year.

Precipitation is the hardest weather variable to map, according to Taylor. Yet it is the most important. He explains that with the old hand-drawn map there was a certain amount of guesswork involved.

Left: Wayne Gibson, research assistant in the Oregon Climate Service office, studies a computer climate chart. Doctoral student Chris Daly developed the model Oregon's new precipitation map was based on.

FROM HOLLYWOOD TO ALGAE BUILD-UP

Even George Taylor is amazed by all the ways that weather affects the economy of Oregon. As Oregon's official state climatologist, he receives a constant stream of calls for weather data ranging from the glamorous to the mundane. His answers often help attract or save money for the state.

The Oregon Film Council checks in with Taylor on a regular basis. "We're competing with British Columbia, Montana, Colorado, California and a host of other beautiful areas," said the Council's Karen Runkel. "Weather information can be a deciding factor."

For producers of the Kevin Costner film, "The Bodyguard," Runkel asked Taylor to find a small scenic town in Oregon with a mountain backdrop and snow during the month of April. "At first I thought there wasn't anywhere to fit the description," said Taylor, "but then I found Odell Lake. It's not high but it's a snow magnet. That year they got 15 inches of snow in late March."

To help with the threatening problem of soil erosion, Taylor works with the Soil Conservation Service in eastern Oregon."Strategies for the preservation of topsoil depend on good precipitation data," said Taylor. "If you have excessive runoff then gulleys form and wash away the topsoil." Wheat growers in Pendleton, The Dalles, Bend and Burns depend on Taylor for information.

The Oregon Department of Environmental Quality (DEQ) also calls on Taylor for help. He worked on a DEQ study of water quality in the Tualatin River. "Phosphorous loading from fertilizers is a tricky problem," said Taylor. "Plants require phosphorous to grow, it's one of three key ingredients, so the question becomes, how much can farmers reduce the application of phosphorous to their crops and still maximize the benefit to the plant. Timing and amounts of precipitation are key factors."

"Rainfall can greatly improve the water quality of the river, depending on the timing," said Taylor. "Phosphorous causes algae build-up. As the river gets more sun during the summer the combination of algae and dry weather cause river stagnation." He's working with DEQ to develop strategies for releasing water into the Tualatin River which will keep stream flow high in the summer.

Allen Holstein of Dundee Vineyards in Washington County consulted Taylor about his grapes. "He called me during the mild winter of 1991 wondering what type of spring and summer weather to expect," said Taylor. "My predictions encouraged him to thin his crop, which resulted in one of his best yields ever."

Weather data was essential for the development of a storm drain in Eugene that could handlc an extreme storm. An engineering firm called on Taylor for assistance in their contract with the city of Eugene. "They needed a drain that was just big enough to handle the most extreme storm event likely to occur in a 25 year period," said Taylor,"but no bigger. A larger drain would have been more expensive than necessary and would have had diminishing returns for the city's money."

Do you have a weather question?

Taylor has answers.

OREGON CONTRAST

At the top is Munson Creek Falls in Tillamook County. The northeastern part of the county is the state's wettest area. It gets more than 200 inches of precipitation a year. Below the falls is Oregon's driest spot, the Alvord Desert in Harney County, with Mickey Butte in the background. The Alvord Desert gets about five inches of precipitation a year.

"Because rainfall relates directly to elevation," he says, "we depended on the map makers' knowledge of particular slopes and areas of the state. Where their knowledge was greatest the map was most accurate. Now we've come up with a formula for elevation and rainfall that interpolates the areas between monitoring stations with complete objectivity. It takes the guesswork out of mapping. Now the distribution of precipitation is the same every time."

Rainfall data were collected from the nearly 400 recording stations within Oregon and in nearby states, developing averages based on 30 years of measurements. According to Taylor, the map is far more accurate, consistent and objective. In addition to the new method for drawing the lines, an increase in reporting stations helped fill out the picture and make the map more accurate.

Significant differences from the old map show up. For example, the northeast part of Tillamook County, the state's wettest area, gets drenched more than previously thought (nearly 200 inches of rain a year, compared to about 140 on old map).

The branch experiment stations collect the most complete and best data.

Currently Oregon's official recording stations are housed at the branches around the state of OSU's Agricultural Experiment Station, at weather offices, airports, public agencies, businesses and even private homes. "Some people just enjoy taking weather measurements for the state," says Taylor. "They do it as a service and because it's fun. Day in and day out they collect the information that forms the statewide picture. We couldn't do this with out them."

The branch experiment stations collect the most complete and best data, he notes. In addition to temperature and precipitation they monitor evaporation, soil temperature and solar radiation. "The information eventually returns to them," says Taylor, "as a component of the map and as publications describing the different climate zones of Oregon."

The latest map brought to light some unique features in Oregon's weather. What appears to be the most rapid transition in the United States from high precipitation in an alpine setting to low desert rainfall

BOB ROST

Taylor in his campus office. As part of his duties as state climatologist, he maintains weather information that goes back to 1850.

occurs in western Deschutes and Jefferson counties. The extreme disparity in rainfall between the 100 plus inches at the crest of the Cascades and the paltry 15 inches measured at the eastern slope of the range is called the "rain shadow" effect.

The map also identifies some of Oregon's driest land. For example, says Taylor, "portions of Deschutes, Crook and Jefferson counties, including an area between Prineville Reservoir and Brothers, and from Redmond north to the Warm Springs Indian Reservation, receive very little precipitation–less than 10 inches per year."

As part of his duties as state climatologist, Taylor maintains weather data as far back as 1850. He stores most of the information in digitalized form for easy retrieval. With this and other weather data from around the world, he researches trends to see how Oregon is being affected by climate patterns. The El Niño event, where ocean currents affect world weather, is one such climate pattern of great interest to the state's farmers and ranchers.

Taylor also responds to public inquiries by solving weather-related problems and providing data. For example, he has been asked to provide farmers with information about the meteorological requirements for growing certain crops, and then to determine where, if at all, such crops can be grown in the state.

Naturally, farmers are interested in drought trends. Taylor and Daly likely will produce some maps that compare drought years to wet years. In recent years, lots of people called to check on Oregon's eight-year drought. In spite of heavy winter precipitation, and the lifting of emergency drought status, Taylor still worries that the years of low precipitation will cause problems this summer and in the years to come.

"The impression that the drought is over is not true, although we may be on the road to recovery," he says. "One wet year can't compensate for eight dry ones. We will probably have water shortages in some areas this summer.

"A key factor is when the snow or rain falls. Precipitation, stream flow, snowpack, reservoir storage, ground water and fire danger contribute to the total picture. As a cumulative effect the deficit in water is a critical factor, not just what happens in a single year."

Timing is everything. "What happens," says Taylor, "is that the precipitation falls at the wrong time of the year for water supply purposes. Water demand is much higher in the summer. That's why snow is like money in the bank. It delays the arrival of water until later in the year."

Oregonians might not have a crystal ball for weather predictions. But George Taylor is the next best thing. Day in and day out he plots the points that make up Oregon's total weather picture. He's always ready for weather questions, as school children, scientists, farmers and just plain folks are finding out.

CLIMATE DATA

A series of publications chronicling Oregon's weather soon will be published by OSU's Agricultural Experiment Station.

There will be nine publications, each including data for one of Oregon's nine climate zones, as designated by the National Weather Service, and a comprehensive booklet that covers all nine climate zones. State Climatologist George Taylor developed the publications.

To order, write or call: the Oregon Climate Service, Strand Hall 326, Oregon State University, Corvallis, OR, 97331, telephone (503) 737-5705.

Gail Gallessich is a writer in OSU's Office of News and Communications Services.

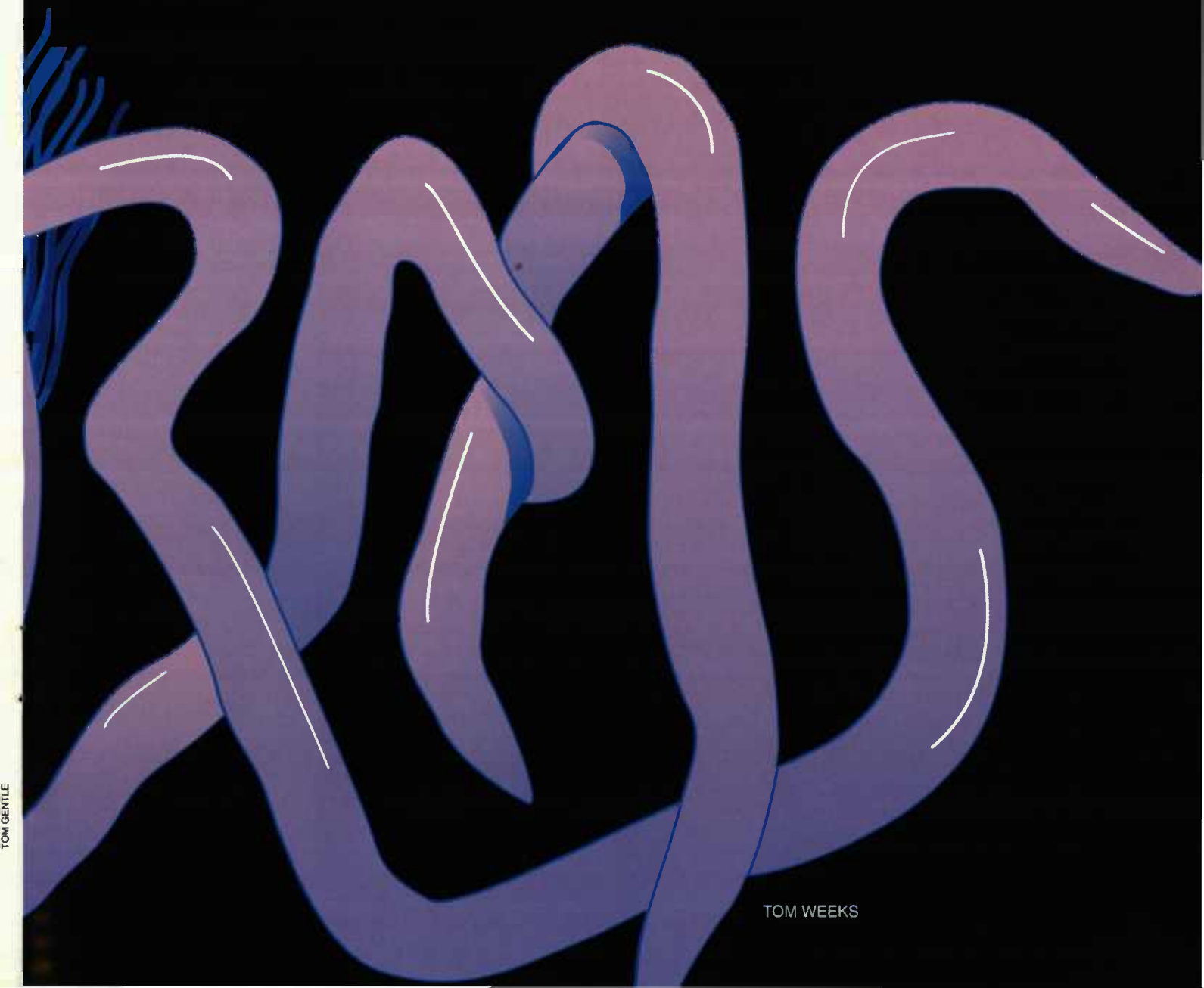
Oregon's diverse climate and rich soils yield a cornucopia worth an estimated $1.86 billion in annual agricultural crop sales ($2.6 billion including livestock sales). However, microscopic roundworms known as nematodes also feed on these crops and have the potential to drastically reduce yields. OSU nematologist Russ Ingham helps farmers keep the upper hand

BY AUGUST BAUNACH

Driving from Corvallis to Klamath Falls and back one day, then from Corvallis to Hermiston and back the next, might seem like a lot of traveling. But OSU Agricultural Experiment Station plant pathologist Russ Ingham covers that much ground—and often more—in an average week.

Ingham not only *covers* a lot of ground, he *uncovers* a lot of ground as he researches methods for controlling the most abundant multicellular organism on earth: the nematode. His services are in demand over the width and breadth of Oregon. Ingham is one of only a handful of nematologists in Oregon, and he is the only nematologist in the state with an academic research program.

"Essentially, nematodes are worms," Ingham explained, in his OSU lab between field trips. "There are many species of nematodes in the world. Many of them are beneficial and are necessary for recycling nutrients found in healthy soil.



TOM GENTLE

TOM WEEKS

"But my current research focuses on those that are crop plant parasites. In this lab, and in the nematology lab in the OSU Plant Clinic, we process plant and soil samples from around the state to determine nematode count and species.

One, found in a sperm whale, can reach 27 feet in length.

"More than 20 species are typically found in Oregon, but my research involves the five most common species, which also cause the most damage economically. These particular nematodes are a millimeter or less in length," Ingham said, "just at the edge of visual detection.

"If you had a pure solution of them suspended in water and held them up to the light, they would look something like dust motes in a sunbeam. So, to be accurate, all of our enumeration and identification have to be done in the lab under a microscope."

According to Ingham, most of the approximately 15,000 known species of nematodes are microscopic, although one species, found in the placenta of a sperm whale, can reach 27 feet in length.

Nematodes, generally, are non-segmented roundworms with complete sensory, digestive, excretory and reproductive systems. They are found in every kind of climate and soil, every kind of plant, in insects, in domesticated and wild animals, and in humans.

Nematodes cause diseases such as elephantiasis and hookworm in humans, and can cause anemia in all mammals. And the nematodes found in pigs, for example, are the reason that pork should never be undercooked. If consumed by humans these *Trichinella* nematodes can cause muscle pain and even death.

Plant-parasitic nematodes, or nematodes that feed on plants, affect the plant in a variety of ways, depending on whether they attack the roots, stems, leaves or seeds. Some nematodes also transmit plant viruses.

The plant destruction caused by nematodes can also increase when combined with plant diseases caused by fungi and bacteria. For example, when nematodes interact with verticillium fungus and cause peppermint plants to wither away, crop losses are substantially

BOB ROST

Research assistant Kathy Merrifield looks for nematode damage on experimental mint grown in an OSU lab. Many nematodes are beneficial. But some feed on plants. Others cause or promote diseases in plants and animals.

KATHY MERRIFIELD

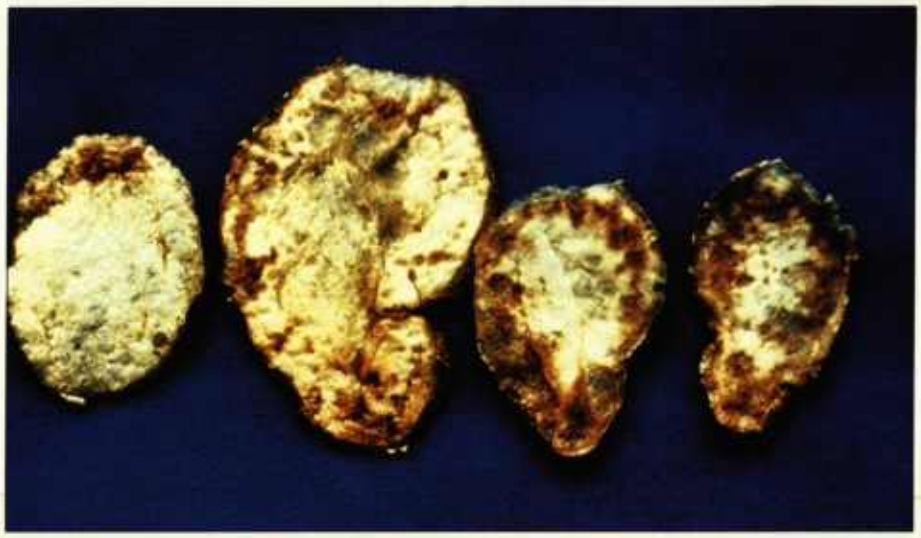
A microscopic nematode suspended in water. There are about 15,000 known species of the roundworms. Most are tiny but one, found in the placenta of sperm whales, reaches 27 feet in length. Nematodes live in all animals, including humans.

higher than with either nematodes or the fungus alone.

"It's estimated that plant-parasitic nematodes are responsible for more than $6 billion in crop losses in the United States each year," Ingham said. "I'm currently working with a farmer in the Columbia Basin who had two 160-acre plots of potatoes rejected last year because of nematode-transmitted diseases. That cost him about half a million dollars."

According to Ingham, no place in North America is better suited for growing potatoes than Oregon's Columbia Basin, which records even larger yields per acre than Idaho's famed Treasure Valley growing region. But crop losses can also be spectacular.

The potato best suited for conditions in the Columbia Basin—and in the four other potato growing regions in Oregon—is the Russet Burbank, a tuber with a rough, opaque brown surface. But the Russet's opaque surface can mask internal defects caused by nematodes, as well as those defects caused by corky ring spot disease, net necrosis and other diseases.



The dark spots on these potato chips were caused by root knot nematodes.

Nematodes cause elephantiasis and hookworm in humans.

"When harvesting and processing," Ingham said, "you can't cull out the bad tubers just on the basis of their appearance. You usually have to cut the tuber in half to be sure there are no defects.

"The Food and Drug Administration has stipulated a zero tolerance for animal products in processed potatoes. So if nematodes, which are animals, are found in even a small portion of your tubers, the potato processing inspector can reject the whole lot. If a random sampling of your crop produces from 5 to 15 percent culls, it can either be devalued or completely rejected by the processor.

"Because nematode populations can be so damaging to a crop," Ingham said, "farmers and growers need research results that are immediately applicable. Accordingly, most of my projects are field oriented, rather than lab or greenhouse oriented."

Although Ingham works directly with farmers and fieldmen, much of his preliminary research necessarily takes place on small plots on the OSU branch agricultural experiment stations near Klamath Falls, Corvallis, Aurora, Madras, Hermiston and Pendleton; these projects are closely coordinated joint efforts with the station staffs.

KATHY MERRIFIELD

Russ Ingham, OSU botany and plant pathology researcher, digs a soil sample from a popcorn stand in the Columbia Basin. In one of his experiments, nematodes migrated five feet up through the soil to feed. That's like "humans climbing Mt. Everest without even a snack," he says.

Ingham's collaborations include wheat research with Columbia Basin (Pendleton) station superintendent Dick Smiley; potato and crop rotation experiments with Hermiston station superintendent Gary Reed; peppermint research with Central Oregon (Madras) station superintendent Fred Crowe; small fruits research with district Extension agent Diane Kaufman of the North Willamette Research and Extension Center near Aurora; potato research with Klamath Falls station superintendent Ken Rykbost; and the evaluation of new potato varieties for nematode resistance with OSU crop scientist Al Mosely.

Funding for Ingham's research comes primarily from the growers themselves, through organizations such as the Oregon Potato Commission and the Oregon Mint Commissions. He's also able to garner funds from various chemical companies that need research data to register potential nematicides with the Environmental Protection Agency.

During the final stages, many of Ingham's research projects are conducted in the growers' fields. But often the initial stages of these experiments take place at a branch experiment station. Ingham considers the experiment station system a crucial aspect of his work.

"Experiment stations are the best option for trials involving integrated pest management," Ingham said. "Initial field tests can often involve a lot of unorthodox procedures, such as crop rotations, biocontrol studies or unregistered nematicide trials. And growers usually don't have the time, the equipment or the land to donate toward these efforts.

"And sometimes we have to selectively infest test plots with plant-parasitic nematodes. No one in his or her right mind would volunteer for that. Not only do you have to follow a precise procedure to prevent more widespread infestation, but it's also backbreaking work."

Ingham describes nematology as a labor-intensive science, and can rattle off stories regarding the planting of thousands

of tomatoes and potatoes and putting a spoonful of nematodes down each hole to deliberately infest the ground.

One experiment in 1991–92 measured how far nematodes are capable of migrating during a five-month growing season. The results surprised Ingham.

"We chose a field that had never been used to grow potatoes and had no Columbia root knot nematode, which can devastate a potato crop faster than any other nematode species," he said. "We used a fence post augur to dig holes 4 feet, 3 feet, 2 feet and 1 foot deep.

RUSSELL INGHAM

OSU entomology doctoral student Mark Morris, kneeling, cuts peppermint near Monroe, Oregon. Research technician Gene Newcomb fills the sack. Later the mint will be checked for parasitic nematodes at the OSU Plant Clinic.

KATHY MERRIFIELD

Carrots grown in the Willamette Valley, near Eugene. Northern root knot nematodes caused the damage.

"We put Columbia root knot nematodes at the bottom of these holes, covered them with nematode-free soil and then planted potatoes on the surface. We wanted to be sure that if any of the potatoes were infested by nematodes that it would be from the ones we'd poured down the hole.

"We then let the potatoes grow all season and dug them up at the end. Sure enough, the nematodes had migrated up from a depth of 4 feet to infest the potatoes. We did a variation of this same experiment at a site in Washington and found that Columbia root knot nematodes can migrate up even from a depth of 5 feet to infest potato roots.

"No one in his or her right mind would volunteer for that."

"The nematodes can't eat until they reach the potato plant. Inch for inch, this microscopic nematode's journey of 5 feet is roughly equivalent to a human climbing Mt. Everest without even a snack. Pretty incredible when you think about it. These results demonstrate just how thorough both field sampling and control measures involving nematicides have to be."

Ingham estimates that growers in Oregon spend more than $10 million annually on nematicides and soil fumigants to control nematodes and other pests. He feels more should be spent on integrated pest management research at the branch experiment stations—especially in light of recent changes in the EPA's regulation of pesticides, nematicides and soil fumigants.

"The EPA has recently redefined its rules for registering and testing these products," Ingham said. "These rules fit generally under what is known as GLP, or good laboratory practice, which uniformly establishes testing criteria. Not only are the old pesticide, nematicide and soil fumigant products now being closely scrutinized under the new re-registration guidelines, but also new pesticides have become more costly to test and register. In the future, growers may have fewer of these products to chose from. The net effect of these changes, however, has been to increase the importance of research in the area of integrated pest management.

"Two other developments are also making pest management research more critical. Two years ago, one of the preferred registered pesticides for potatoes,

KATHY MERRIFIELD

Ingham collects soil samples from a snap bean field near Salem so he can check for nematode infestation.

BOB ROST

Ingham checks Columbia Basin potatoes for damage. Control of nematodes is expensive for potato growers and for consumers. Ingham is searching for alternative methods.

Temik, was suspended because residue traces were found in harvested potatoes. This may have been due to improper handling procedures, but nobody is taking any chances.

"We still don't have a product to replace Temik, and it played a major role in controlling both Colorado potato beetle and virus diseases transported by insects and nematodes.

Methyl bromide depletes the upper atmospheric ozone layer.

"On the average, potato crops are part of a three-year rotation cycle, and in 1993 the majority of the potato crops will be part of a post-Temik suspension cycle. So, nematode infestation problems now have the potential to be very serious.

"Also," Ingham said, "it's been determined that one of the best soil fumigants we have, methyl bromide, interacts with and depletes the upper atmospheric ozone layer. We may see the end of methyl bromide as a soil fumigant by 1995."

That means Ingham and the scientists and farmers he works with are going to be very busy in the years ahead.

"Alternative nematicide treatments will have to be developed. In addition to potato crop rotation experiments that include, for example, lima beans and popcorn, we've also been doing experiments with what are called green manures—plowing under rapeseed and sudangrass cover crops to create natural nematicides. But these methods are certainly not equivalent to methyl bromide, which controls not only nematodes, but also weeds, fungi and insects.

"So, if Oregon is going to maintain its current level of agricultural production," Ingham said, "research breakthroughs will have to be made on several fronts: developing naturally resistant plants, working green manures and crops that aren't hosts for nematodes into the rotation cycles, and developing environmentally safe pesticides. And ag experiment station trials will play a critical role in these research projects."

Freelance writer August Baunach lives in Corvallis, Oregon.

HONEY, I CROSSED THE

RHODODENDRONS

Bob Ticknor's passion is developing plants that delight ordinary people, and Oregon's nursery industry

BY JOAN DRAKE

Rhodies? I'm a newcomer to Oregon and a novice gardener, so it took me a minute to realize we weren't talking about Rhodes scholars, but about members of a plant variety Bob Ticknor has worked with for more than 30 years. (Later I found out anyone in this state with even an iota of gardening knowledge is familiar with the nickname.)

Ticknor had been giving me a tour of Oregon State University's North Willamette Research and Extension Center in Aurora, where he conducts research on rhododendrons and other ornamental nursery crops. This branch of the Oregon Agricultural Experiment Station at Corvallis sits in the heart of the state's nursery production area, which last year generated $341 million in sales.

I learned the location wasn't a chance selection. It enables experts like Ticknor, a horticulturist, to direct on-the-spot studies that solve nursery industry problems dealing with the area's distinctive soil, climate and other characteristics. Established in 1958 on 52 acres of land provided by Clackamas County, the station was later expanded to 158 acres. Numerous projects on ornamental and nursery production, as well as small fruit and vegetable production, are carried out simultaneously at the facility.

BOB ROST

Above: Experimenting with variety development, horticulture researcher Bob Ticknor pulls anthers, which produce pollen, from a self-pollinating rhododendron. He'll add pollen from another plant. Left: Ticknor with experimental azaleas growing at OSU's North Willamette Agricultural Research and Extension Center near Portland, where he works.

Some of Ticknor's research has involved cross-breeding rhododendrons and he is credited with introducing three new varieties, including one with green flowers called "Shamrock." Having lived for five years near Boston, Mass., he was familiar with the big way that area celebrates St. Patrick's Day. When he was able to get the new plant variety to bloom in March, "it seemed like a very good tie-in," said Ticknor. Potted "Shamrock" rhodies make ideal gifts for this holiday.

As much as 90 percent of Oregon's nursery and greenhouse production is shipped out of state. "So there are growers that are very interested in plants that they can sell in other parts of the country," explained Ticknor. Offering new plants also helps to keep Oregon's 2,741 licensed nursery, greenhouse and Christmas tree growers competitive with other nursery production areas.

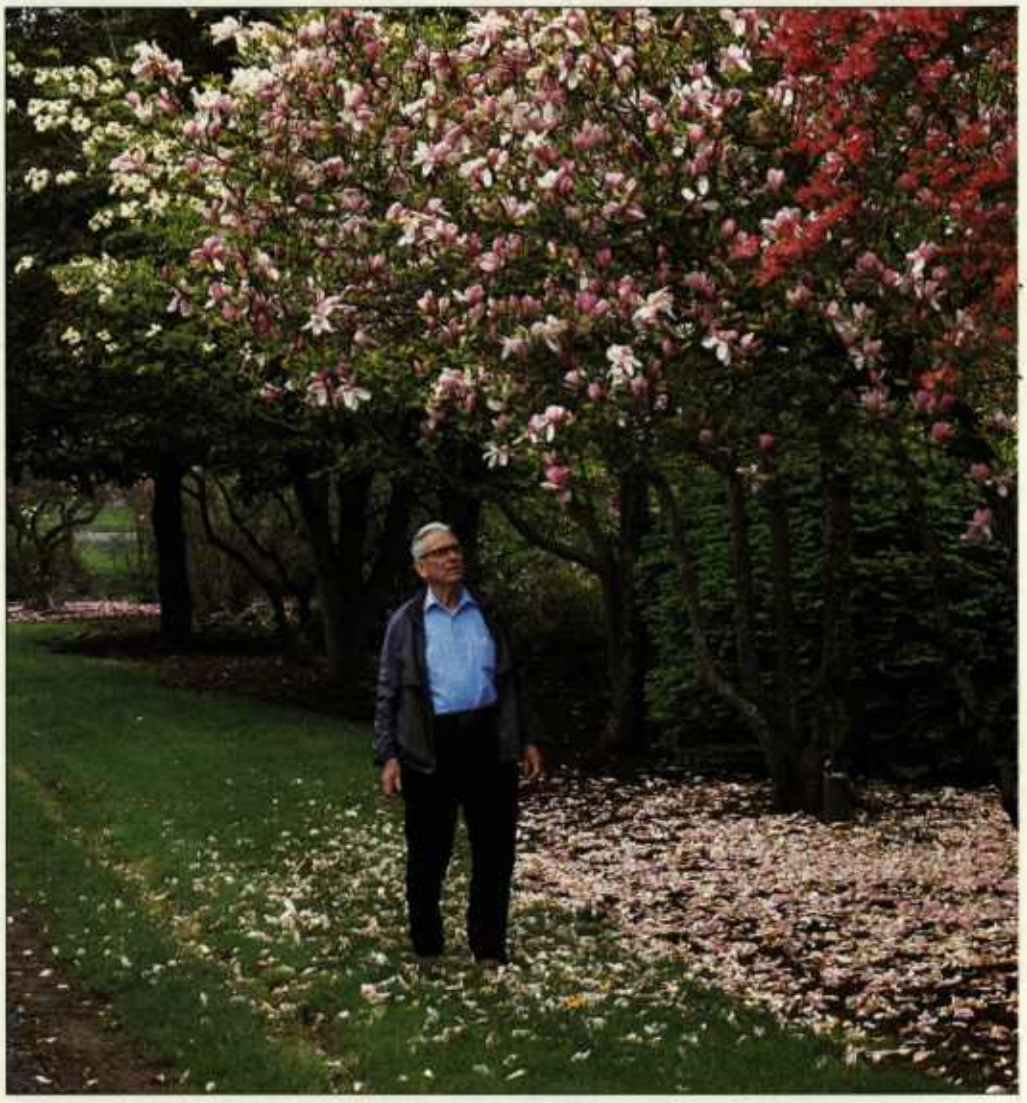
As much as 90 percent of Oregon's nursery and greenhouse production is shipped out of state.

Ticknor also has bred three cultivars of Pieris, an evergreen shrub related to rhododendron and azaleas. "Valley Fire" has clusters of white, urn-shaped flowers, but the tiny blossoms on "Valley Rose" and "Valley Valentine" are pink. All are now widely distributed in climatically suitable areas of the United States and Europe. Sales of rhododendron varieties yielded over $800,000 for Oregon in the past year.

Other breeding experiments involve modifying the shape of this shrub. Typically Pieris plants grow upright, but Ticknor worked to produce lower, spreading plants. "You use a lot more spreading plants in landscapes than you do uprights," he explained.

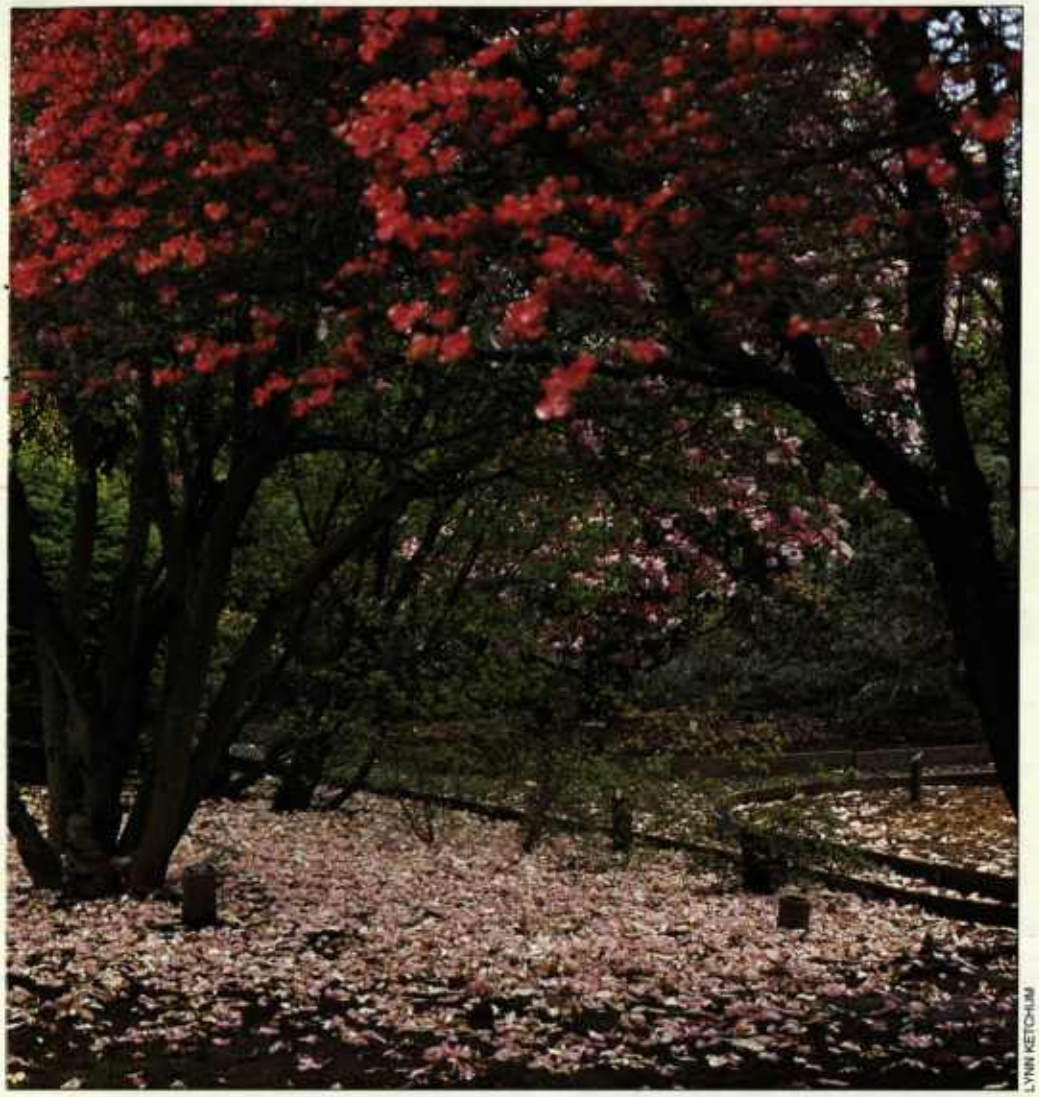
Through cross-breeding, Ticknor tries to transfer the best qualities of one plant to another. For example, say a Pieris has most of the characteristics he wants, but the florets on a different plant are a little larger. By transferring pollen from the second plant to the pistil of the first, he may be able to produce an even more desirable plant.

First the targeted plant must be raised in an insect-free environment to prevent any unwanted pollination. Then, from the



BOB ROST

Blaney's Blue, a rhododendron Ticknor named for Lawrence Blaney, one of his professors when he was a horticulture student at OSU. Before he died, Blaney made the crosses that led to development of the variety.



LYNN KETCHUM

Left: These dogwood trees went in at North Willamette in the 1960s. Ticknor is evaluating characteristics like growth and bloom time.

Of course, not every plant must be this versatile—some regional varieties are also desirable.

Plants that pass all the tests are then evaluated by the Agricultural Experiment Station scientists in Corvallis before being released to Oregon's nursery industry. Dave Adams, district Extension agent in ornamental crops, writes a monthly newsletter from the North Willamette station to keep nursery people updated on new plants developed by Ticknor and other researchers, and other industry concerns.

In the future it will be important for nurseries to use less water.

"We've done a lot more breeding, but haven't named nearly as many as we've grown. It's easy to get things that look good, but not as easy to get things we think are really better than those already out there," said Ticknor.

He also noted, with a little laugh, that with 300 to 400 new varieties being introduced each year, "the challenge, almost, is finding a name that hasn't been registered." The Horticultural Society in Great Britain handles the only official registration of rhododendron plants throughout the world and filing entails a considerable amount of time and paperwork.

After only a short time listening to Ticknor discuss studies he has been involved with over the years, I knew I was talking to a man who thoroughly enjoys his work. His enthusiasm was contagious—I couldn't wait to start planting rhodies in the yard of the house I just bought.

A current project that excites Ticknor involves sub-irrigation, a watering system used in England and Holland. It was a bit beyond my comprehension, but he patiently showed me how it worked and explained that in the future it will be important for nurseries to use less water, and this method may provide an alternative.

In another study, he monitors more than 50 types of English holly growing on the station grounds. The leaves differ in size and gloss and some varieties are

LYNN KETCHUM

Valley Fire is a variety of Pieris, an evergreen shrub related to rhododendrons and azaleas. Ticknor released the variety in the mid-1960s, along with varieties he named Valley Valentine and Valley Rose.

BOB TICKNOR

Ticknor developed this yellowish-green rhododendron, named Shamrock, for sale around St. Patrick's Day.

seeds it produces, Ticknor can raise new plants with larger flowers.

Once a satisfactory variety has been developed, Ticknor ships it to friends around the country. These nursery people and hobbyists try growing the plant to see if it is adaptable to their soil and climate.

LYNN KETCHUM

Oregon is the country's largest producer of shade trees. In a long-term study, Ticknor and associates at the North Willamette center are studying the performance of 300 kinds of trees. Nurseries will use the information to help people select the best trees for their yards.

BOB ROST

In this greenhouse at the North Willamette Research and Extension Center, Ticknor is studying azalea and rhododendron varieties' flowering performance and resistance to root rot, a disease many Oregon homeowners know about firsthand.

variegated (have several colors on the leaves). It takes seven years to get any yield, said Ticknor, so this is a long-term crop. Also, the variegated varieties that are becoming more popular with consumers yield fewer berries. This presents a problem for the nursery industry because holly is sold by the pound and berries increase weight.

Recently Mukhtar Ahmad, an OSU horticulture department graduate student working under Ticknor's supervision, studied a type of holly called September Gem that Ticknor believes could make a good holiday plant. In the experiment Ahmad and Ticknor examined whether they could consistently produce plants with plenty of red berries. The berries ripen in September and remain red long after Christmas, if birds don't eat them.

Muhktar just finished a year-long project on the use of slow-release fertilizer in the propagation of Forsythia, an ornamental shrub. He also mixed different levels of composted sewage sludge, yard debris compost and garbage compost into the propagating material.

The treatments affected both rooting and subsequent growth. His best results came from the highest rate of sewage sludge compost, which contains a higher percentage of nitrogen. Previous nutrition experiments with slow-release fertilizers resulted in the North Willamette Container Fertilizer, a product now produced by three Oregon formulators and marketed throughout the Pacific Northwest.

Oregon is the largest producer of shade trees in the United States.

Another experiment deals with keeping the roots of trees grown in containers from choking the trunk after the trees are planted in the landscape. By coating the inside of the pots with a paint containing copper, the root tips will branch back instead of spiraling around, which can kill the plant.

Oregon is the largest producer of shade trees in the United States, so a long-term project has been compiling data on 300 different kinds of these trees. "We didn't have good information on how they grew, especially once they were bigger," explained Ticknor. "What they really looked like was an open question."

For four years, Ticknor and associates documented how fast the trees grew, whether they had good fall color and when they dropped their leaves. Currently they are expanding their reporting to five- and 10-year growth patterns. Nurseries will be able to use this information to help people select the best trees for their yards. When I asked about his own yard, Ticknor said with a chuckle, "It's not that great. I spend most of the time fiddling with vegetables—trying out new varieties." Currently he's experimenting with asparagus, one of his wife's favorite vegetables.

What will he do after retiring next year? Well, there's a program where you can still work 600 hours without affecting your pension, until a successor is hired, explained Ticknor. So he plans to stick around the station. After talking with him for just two hours, I wasn't a bit surprised.

Joan Drake, formerly a reporter for the *Los Angeles Times*, is a free-lance writer in McMinnville, Oregon.

E-MAIL AT 5 A.M.

Thayne Dutson, the director of the Oregon Agricultural Experiment Station, is preoccupied with 20 words.

They make up the experiment station's mission statement: "To conduct research in the agricultural, biological, social and environmental sciences for the economic, social and environmental benefit of Oregon."

Over the last four years, Dutson and associates have set up a continually changing computer program called "Oregon Invests." It's a database filled with examples of what Agricultural Experiment Station scientists at branches around the state, and in departments on the OSU campus, are doing to fulfill this 20-word mission taxpayers have given them.

"We present the data to legislators, industry, civic, governmental and environmental organizations, the Oregon Business Council, all kinds of groups," says Dutson. "I got started first on the economic benefits of our scientists' research. The current version of Oregon Invests looks mostly at those. The other benefits—social and environmental—are harder to quantify. But we're working on them now."

A few examples of "dividends" to Oregonians last year: Controlling fire blight (a pear disease), $3 million; reducing fertilizer use (with nitrogen fixation, where certain microorganisms help certain plants make their own fertilizer), $3 million; developing improved wheat varieties, $5 million.

Total dividends from the Oregon Agricultural Experiment Station's research in 1992 exceeded $100 million, says Dutson. The impact of those dollars as they spread through the state economy may have exceeded $200 million, he says.

You don't have to be involved with natural resources to benefit, Dutson believes. "If our whole state gross product rose by 30 percent, everyone would benefit from that," he says.

Hearing Dutson tick off the accomplishments of Experiment Station scientists could give you the idea that directing the organization is easy. When pressed, he admits keeping the statewide research network moving in the right directions isn't.

"My day usually starts at 5 a.m. We have an automatic coffee maker that comes on," he says. "The first thing I do after having my morning coffee is look at my electronic mail—I'm hooked to the office by computer. After 5 I can also pick up the phone and begin my work in Washington, D.C., because of the time difference. Then I can gradually move back toward the West Coast with the phone work. That involves federal programs and projects, mostly. I have to put Oregon's priorities on the national agenda so they don't forget us.

"I get into the office around 7:30 or 8. My days are usually full of meetings—just managing the organization in the present and trying to stay poised so we can take advantage of developments and continue to be strong in the future.

"I usually have evening meetings or family commitments like our children's band concerts and basketball games and that sort of thing. There's too little time to manage the present and look to the future. What prevents this from being frustrating are the good people in the Experiment Station office, and including the department heads and branch experiment station superintendents, who help manage the present and look after our future."

TOM GENTLE

Thayne Dutson with the program that helps him monitor research impacts.

Many Oregonians don't realize what a valuable resource the Oregon Agricultural Experiment Station is, Dutson contends.

He says he left an administrative job at Michigan State University several years ago to direct Oregon's experiment station because he saw surprising quality in a research unit relatively small compared to the stations in some more populated states.

"The things that impressed me when I came here to interview are things I still get satisfaction out of—the quality of our faculty and staff and graduate students. I started trying to quantify that almost right away, after dealing some with budgetary matters like cutting expenditures in areas that weren't contributing to the mission, and looking for new sources of outside funding.

"The level of state financial support for our scientists is about 75 percent of the national average," says Dutson. "If you look at agricultural experiment stations at comparably sized institutions, our scientists receive about 80 percent of the state dollars those scientists do.

"You'll find top-quality people at every agricultural experiment station and probably every institution in higher education. But I think the national reputation of Oregon's experiment station scientists is truly exceptional. I've documented that using federal reviews and by looking at the grants and contracts our researchers are able to get nationally through USDA's competitive grants program.

"The main reason we initiated Oregon Invests [the database] was to document these quality factors and to find out more precisely what our contributions were to our mission so we could communicate that to others. Oregon Invests allows us to analyze what we are doing right and what we need to work on.

"Reviewers in the OSU Department of Agricultural and Resource Economics have developed a real commitment to making sure it is good data. There's also a commitment from faculty of the Agricultural Experiment Station to put their research in a format where it can be analyzed effectively for the taxpayers of Oregon.

"Some critics might ask why we're spending time and effort documenting what we're doing. I think the answer is simple. We won't be able to continue the work unless we show that the money is well spent."

Andy Duncan

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THE VINIFEROUS DETECTIVE

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