Oregon's Agricultural
Spring-Summer 1984

PROGRESS

The Power of Biotech



Agricultural Experiment Station
Oregon State University

comment

Grab the ring . . . and hang on



John R. Davis
Director, Oregon Agricultural Experiment Station

Remember the TV commercial about the hazards of using magarine instead of butter? It ends with the scolding, "You can't fool Mother Nature."

Well, maybe we can't. But we can certainly put her to work for us or encourage her to smile more often on those who work with natural resources. There is no question about it—the future of agriculture will be directed by our ability to manipulate the biological world we live in, and that ability is changing rapidly.

Over the last few years, biologists have found that the genetic chemistry of all living things directs not only the characteristics of the offspring but also the ability of the living things to survive and to grow. Altering that chemistry, or transferring and recombining the chemistry of one plant or cell structure to another plant or structure, represents a tremendous potential for manipulating nature for the benefit of mankind. The research described in this issue of *Progress* illustrates some of the fantastic opportunities in what now is often called "biotechnology."

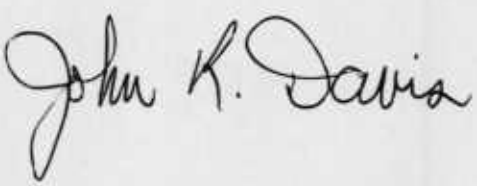
So, what does all this mean for Oregon's agriculture?

First, Oregon has already cashed in on some benefits of biotechnology. For example, we have developed some strategies for pest management utilizing biotechnology as simple as the introduction of the cinnabar moth and flea beetle for control of tansy ragwort. In a more complex program, the combined use of synthetic pheromones (imitations of insects' chemical sex attractants) and measuring both beneficial and harmful insects to evaluate the best balance of insect control has resulted in substantial savings in costs of chemical pest controls in the Medford Valley.

Second, we stand to gain substantially in the future: in the improvement of crop quality, reduction in costs of production, and stabilization of crop yields from year to year. (Just think of the advantages to Oregon if we could insert the necessary chemistry in wheat to increase disease resistance.)

All these opportunities make it imperative that the Agricultural Experiment Station invest more of it resources in biotechnology research ... if we are to serve Oregon's agriculture properly.

We may not be able to fool Mother Nature. Let's make sure we don't fool ourselves by watching the new technology of biological sciences pass us by. Let's grab the brass ring and hang on—the ride into the future of agriculture will be the thrill of a lifetime! □



Spring–Summer 1984

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Oregon's Agricultural Progress

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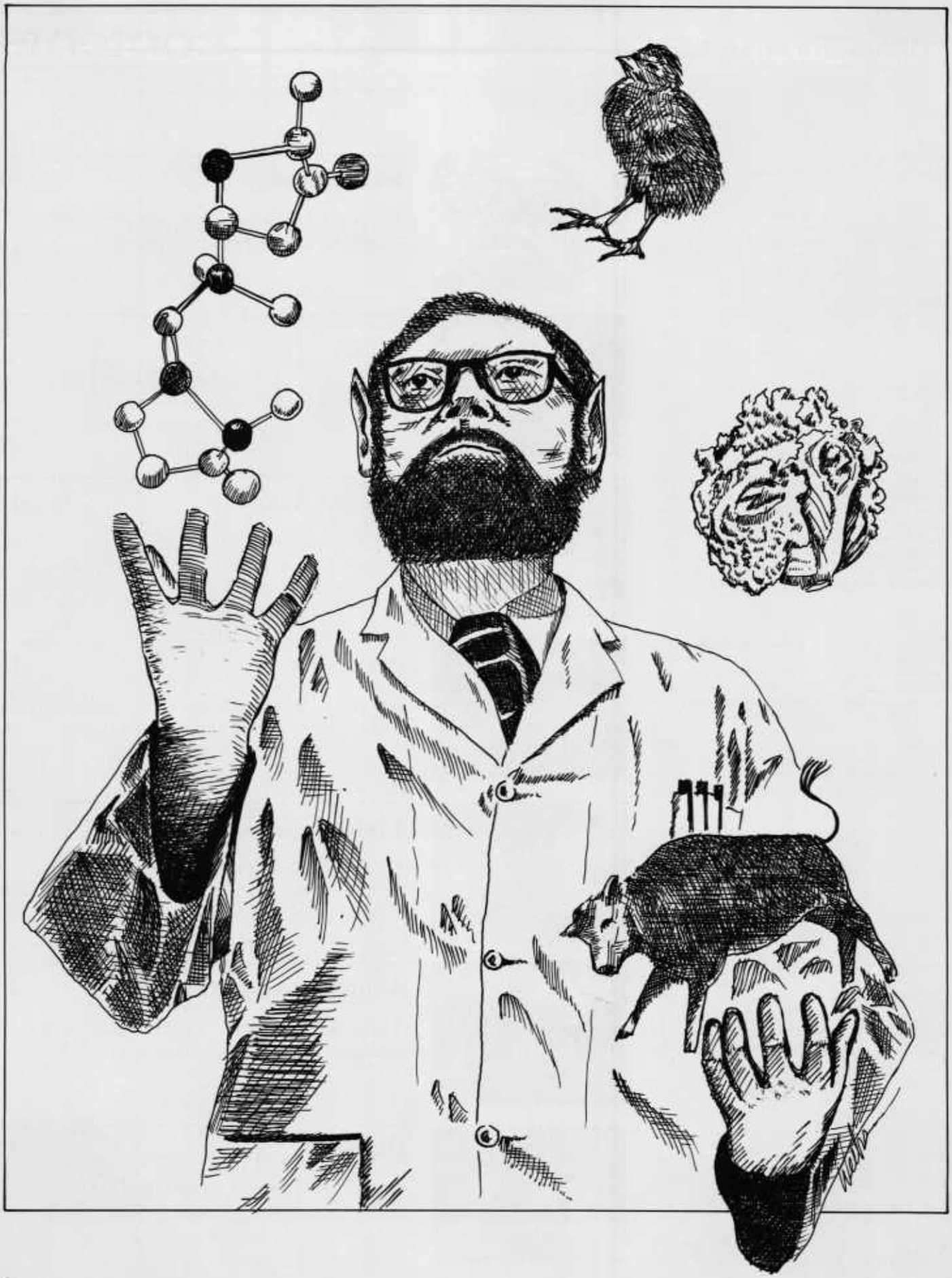
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Beam Me Down a Protoplast, Scotty

As biotech spills into their field, agricultural scientists are juggling new concepts and spouting some strange lingo

By Andy Duncan

It's too bad they stopped making "Star Trek," I thought, toying with the idea that the scientist a few feet from me could have been a big hit cast as a being from, oh, say a planet orbiting one of the stars in the Big Dipper.

He looked pretty normal standing by his blackboard talking a mile a minute, drawing diagrams and glancing over occasionally to make sure I was paying attention. It was what he was saying—the weird words.

He was one of the first of 18 scientists I interviewed while I was collecting information for an article about agricultural research at OSU involving biotechnology, which you've probably heard of or read about in connection with some exciting development in medical, industrial, agricultural or other research.

The rest of the women and men looked normal too (short, tall, bald, fuzzy-haired; wearing dresses, suits, blue jeans, white lab coats). But after we'd broken the ice chatting about basketball or the weather or campus politics, most of them shifted into the same alien language as the first fellow.

I got the message.

This biotechnology, which some predict eventually will give farmers and consumers some of the most incredible advances in the history of agriculture—from healthier and more nutritious plants to improved (and nearly identical) livestock—already has spawned a new vocabulary that is spilling into agriculture.

To write about the topic, I was going to have to explain concepts and terminology not usually tossed around by agricultural researchers.

Here goes:

In the first place, the word biotechnology is confusing. In one sense, it apparently refers to nothing more specific than using living things or their parts in processes intended to help humans. Big deal. Most traditional agricultural research fits that description. For example, plant breeding research, where two varieties of a plant can be combined, has produced better cereal grains, vegetables and other crops. Breeding research with animals has produced better livestock. Scientists have helped farmers harness "good bugs" that help keep insect pests in check. And I could go on.

> The very word biotechnology is confusing.

But there's another sense of the word.

What a lot of people are talking about when they speak of biotechnology is what I've seen described as "the new biotechnology." That's where the strange language has arisen. It has many parts. Its biggest influence has been molecular biology, the science of studying life's most basic construction unit, the molecule.

Since the 1950s, particularly in the last 10 years, scientists studying molecular biology have developed new means of using living things and their parts in processes that help humans. Much of the biotechnology spilling into agricultural research is coming from the medical research field, where considerable public and private funding has been available in recent years to molecular biologists trying to use biotechnology to fight human health problems. Notable results of that effort have been construction of bacteria strains that produce insulin for diabetics and interferon, a drug for cancer patients.

Despite the strange terminology, many of the processes the molecular biologists developed aren't terribly hard to use, I gathered from talking with OSU agricultural researchers. "You could compare it to using a Betty Crocker recipe to bake a cake. Putting together the recipe was the hard part," one told me. The sticky part of using the new biotechnology in agriculture seems to be that lots of information about individual plants, animals and microorganisms, at the molecular level, is going to have to be assembled to show where, and how, the processes can be employed.

With some fascinating exceptions, that seems to be what OSU scientists

involved with biotechnology and agriculture are doing: accumulating information they hope will allow them to use biotechnology to improve various types of plants, animals and microorganisms.

That also seems to be a fairly good description of what's happening nationally, although biotechnology has already made a few splashes in agriculture, including providing a much-needed vaccine for foot and mouth disease in livestock and a vaccine for Marek's Disease, which kills poultry.

"You could compare it to using a Betty Crocker recipe."



Curious about the new processes? Want to impress your friends by spouting the lingo? I'll assume you at least answered yes to the first question. Let's take a peek at some of the biotechnology researchers around the world are using, or hope to use, in agriculture. (First, though, a bit of advice—the most important step in biotechnology development was when molecular biologists figured out the system that guides the activities of the cells in all organisms. That allowed them to think of manipulating cells in new ways. If you got a A in high school biology and have kept up with all advances since, keep going. If not, I suggest you read the brief article on the next page about the cell, then continue.)

Recombinant DNA Technology and Gene Transfer

This is the biotechnology biggie. It hinges on scientists being able to identify genes' messages and figure out how the messages are switched on and off. It includes the "genetic engineering" that has been widely publicized.

In genetic engineering, a fragment of DNA (deoxyribonucleic acid) containing a gene can be isolated from surrounding DNA with "biological scissors" called restriction enzymes (thought to be produced by cells so they can slice up invaders like viruses). Once isolated, a gene can be transferred with chemical procedures to the cell of another organism. The transfer can involve putting the gene into the plasmid of a weakened disease bacterium that invades the cells of the organism you want to get the gene into—using the bacterium as a gene carrier, or "vector." If the gene is inserted into reproductive cells, like sperm or egg cells, it will be passed to future generations, altering the organism's natural evolution.

Of course, plant and animal breeding work has the same goal: to move desirable genes from plant to plant or animal to animal. But with breeding, bad genes as well as good ones can be transferred from parents to offspring. If perfected with plants and animals, as it has been with one-celled organisms like bacteria, the new process would be quicker, more precise, and, unlike plant and animal breeding, might allow researchers to move genes among differing creatures—across species and family lines.

Scientists have their eyes on exciting possibilities like transferring genes linked to salt tolerance (in plants), disease resistance, growth, and more efficient use of nutrients, to name just a few desirable characteristics. They also hope to learn to go into the DNA in a plant's or animal's cells and "turn off" genes causing problems.

But don't drop to your knees rejoicing yet. As I said, the successes so far have been with bacteria (for example, the bacteria medical researchers fitted with genes that make them produce insulin). Splicing genes into complex, multicelled organisms like plants and animals is a much bigger challenge. There have been promising experimental results, like transferring a growth hormone into mice from larger mammals, and transferring a gene that controls protein storage in bean cells into sunflower cells.

Protoplast Fusion

In this process, scientists use certain enzymes to "eat away" the walls of two cells, permitting the insides, or protoplasts, to combine. It is a direct method of combining genes and other materials from unrelated cells. Theoretically, these combined cells could be regenerated into a new crop variety (and, in fact, inventive researchers have created the "pomato," a tomato cell-potato cell combination, although they've found no commercial niche for it).

Tissue Culture

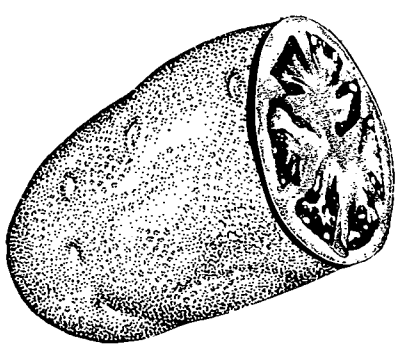
The procedure, already used commercially in some plant agriculture, involves growing tiny pieces of tissue in a test tube containing nutrients and other chemicals such as growth hormones. Scientists can screen the tissue for desirable traits, such as being free of various diseases or resistant to certain diseases, and then grow test-tube "plantlets" from the screened tissue.

The plantlets can be used as sources of tissue for growing additional plants, or they can be planted directly in the field. The later use of tissue culturing bypasses the planting of seeds, which is a gamble for farmers growing high-value crops like fruit trees where uniform genetic makeup is especially important (the genes in seeds can vary).

Some culturing has been done with single cells. An offshoot benefit of that has been labeled "somoclonal variation," which means same-body variation. Since cells from an organism have the same genes, you'd expect the cells to be identical. But scientists have found that some, when cultured into a plantlet, have different traits. Somoclonal variations may prove to be another source of desirable genes for the co-called "gene pool" plant breeders and genetic engineers will draw from to construct better crops. Tissue culturing techniques for animal cells are being studied, too.

Monoclonal Antibodies

When the immune system in animals, which fights disease, detects a foreign substance—called an antigen —it stimulates certain cells to produce protein molecules called antibodies that bind to the antigens and neutralize them. Animal antiserums that fight disease are made with antibodies obtained from immunized animals. But sometimes the antibodies are ineffective because they are impure.



Now scientists have discovered a way to produce pure antibodies in the lab. It's called the "hybridoma technique." They fuse fast-growing cancerous cells with antibody-producing cells from an immunized animal. The fused cells multiply rapidly, producing what are called monoclonal antibodies that can be isolated and injected into animals.

This technique may give scientists a new way of protecting livestock and poultry from diseases caused by viruses, bacteria and fungi. The technology also presents some interesting possibilities for diagnosing and preventing diseases in valuable plant crops like potatoes, fruit and wheat.

Embryo and Cell Transplantation

Beef and dairy farmers already transfer embryos from top-quality cows into surrogate mothers so the prized animals can produce more offspring. Scientists are learning to use certain hormones to trigger the production of as many as 25 eggs by a cow (as opposed to the regular one egg). When fertilized with semen from a top-quality bull, the eggs could be transferred to surrogate mothers for gestation, the researchers say. Scientists have demonstrated that they can inject genes into such fertilized eggs with a microscopic device, and they are studying the potential of that.

Ready to move on to how researchers in Oregon are using these techniques? I am, even though we probably haven't viewed all of the fledgling field of "agribiotechnology." The field is racing in many directions, so it's hard to capture a complete picture.

The articles that follow describe the program OSU has set up to promote the use of biotechnology, give some examples of how OSU scientists are applying biotech to agriculture, and discuss OSU researchers' hopes and reservations.

In my investigation, I found people who think the new approach will totally replace much traditional agricultural research, others who think agribiotechnology is being oversold, and still others who expect a melding of old and new will give farmers and others in agriculture new tools for coping with the challenges over the horizon.

I came away totally convinced of one thing—it is too bad they stopped making "Star Trek."□

The Cell: A Factory

What makes cells tick? Think of them as little factories.

In each one, the control centers are made up of molecules of a substance called DNA (deoxyribonucleic acid) that contain information in chemical coding—the "code of life," some call it. The DNA molecules form strands called genes. Each gene holds the plan, written in its sequence of molecules, for some activity in the cell.

In single-celled creatures like bacteria, genes have two locations. They are in little circular, free-floating DNA molecules called plasmids, and in large strands of DNA called chromosomes (chromosomes can contain all the genes necessary for an entire cell project). In higher organisms like plants and animals, most genes are only in chromosomes in a center section of the cell called the nucleus.

The messengers in cells are RNA (ribonucleic acid) molecules, which are mobile copies DNA makes of itself. RNA can pass from the genes into the manufacturing part of the cell, where raw materials are stored. There, in association with small particles called ribosomes, RNA aligns substances called amino acids for welding into proteins.

There are many types of proteins. Some of the most important are the enzymes, which serve as sort of "straw bosses," regulating functions throughout the cell, including the production of hormones. In plants and animals, hormones can move out of a cell to other regions and influence how cells in those areas behave.

All cells, no matter what kind of organism they are in, contain this machinery. The information in genes is what causes differences: leaf cells and liver cells. Although each gene carries a single message, genes do not act independently. They are affected by surrounding genes. So, to manipulate a cell, researchers must figure out how its genes interact.



How Do You Chew a Test-tube Plant?

Biotechnology will change life in Oregon; the question is how much

If you eat, it's going to affect you.

That's a simple way of saying that the worldwide biotechnology boom is echoing through the OSU campus, including agricultural laboratories.

The question is not if, but how much, biotechnology is going to change production of the home-grown food and fiber we Oregonians consume (and that we produce for export).

OSU researchers are using tiny pieces of plant tissue to grow virus-free "plantlets" in test tubes, improving crops like potatoes and strawberries; they're trying to genetically "engineer" better strains of bacteria that help crops like alfalfa, peas and clover fertilize



themselves; they're studying how cells release hormones that speed up and slow down growth in sheep and other livestock, wondering if they can manipulate the process.

And those are just examples of the work of Agricultural Experiment Station scientists.

Biotechnology, rooted mostly in a deepening understanding of genetics, knows no academic borders or textbook boundaries. What's discovered by a botanist studying the genes of an obscure fungus may help an agronomist trying to improve a valulable crop—and vice versa.

Scientists in OSU's Colleges of Agricultural Sciences, Science, Veterinary Medicine, Forestry and Pharmacy, and in other campus areas, are doing biotechnology-related research while

> Biotechnology knows no textbook boundaries.

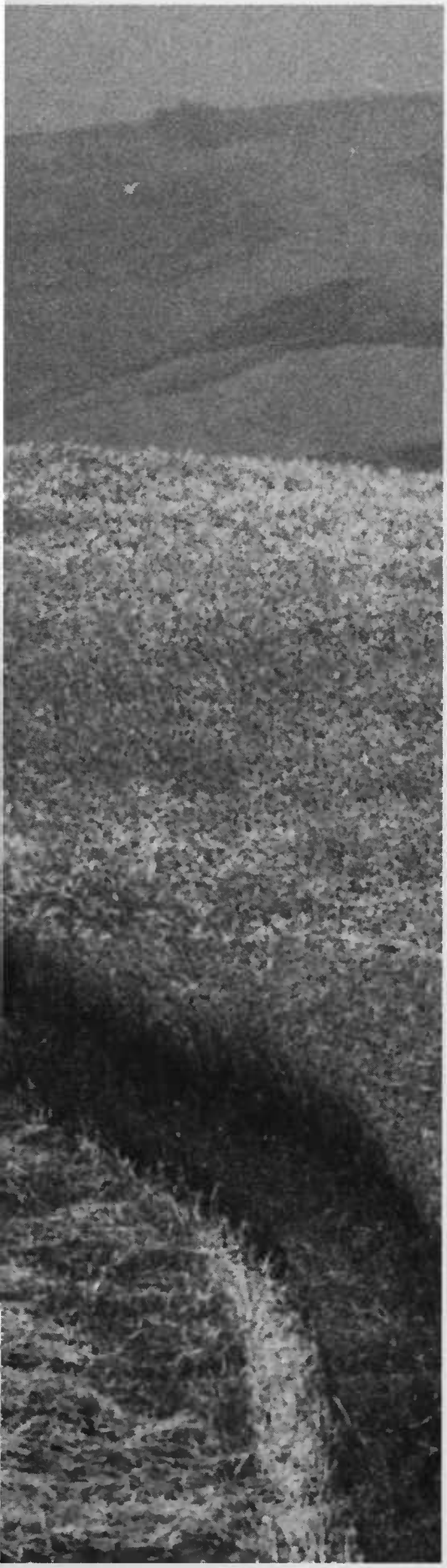
colleagues over the campus perk up their ears listening for spinoff information they might use.

Some of the work has been under way for years. But the first real signal that biotechnology would be part of a clearly defined team effort came last year when OSU President Robert MacVicar announced the university was setting up an interdepartmental program to coordinate and expand gene research and the use of biotechnology. An initial goal, since achieved, was to hire several new faculty members who had expertise in basic gene research and could augment the campus corps of scientists working with biotechnology.

The campus biotechnology boom is quieting somewhat. That is to say, the initial gush over the potential is giving way in many laboratories to the painstaking work necessary to apply biotechnology to researchers' fields of interest. □



OSU botany graduate researcher Barbara Ballo examines wheat grown for gene studies.



Never Say Never

From beans to bovines, the new technology is spreading to many OSU agricultural research areas

It would take an incredibly long article to describe all the ways OSU researchers are applying, or thinking of applying, biotechnology to agriculture. You won't get all that here. But the following rundowns should give you the flavor of what's happening in OSU agricultural research.

You may not be interested in all the work. If not, skip around. Some involves bacteria, some involves viruses, some involves plants, some involves animals, and some involves combinations— for example, several scientists are using bacteria as a tool for improving crops or livestock.

A good place to start is the OSU Laboratory for Nitrogen Fixation, directed by Harold J. Evans, professor of plant physiology. For several years, Evans and fellow researchers and graduate students have been using genetic engineering in their work.

Their goal is fairly simple. They want to improve the cozy — and economically important—relationship of bacteria called rhizobia and Oregon crops like alfalfa, peas and clover, called legumes. It's long been known that rhizobia attach to the roots of these plants, and other legumes like soybeans not grown much in Oregon, and live there in tiny nodules.

The bacteria get materials they need from the plants while collecting atmospheric nitrogen from the soil, converting it to a nutritious form, and providing it to their landlords.

The conversion process , called nitrogen fixation, is becoming more and more important because of the rising cost of nitrogen fertilizer. Some farmers "inoculate" their legume crops with rhizobia to try to ensure good nitrogen fixation, and many farmers rotate legume crops into their fields regularly to add "fixed" nitrogen to the soil and supplement store-bought fertilizer.

In Evans' lab, researchers Mac Cantrell, Rich Haugland, Joe Hanus, Sterling Russell and others have been trying to make nitrogen fixation more efficient. In one effort, they've focused on several strains of rhizobia that live on soybeans roots. The strains recycle hydrogen gas while fixing nitrogen, allowing them to use less energy than rhizobia that don't do the recycling.

The researchers have removed hydrogen uptake (or HUP) genes from soybean rhizobia and inserted the genes into strains of soybean rhizobia that do not have HUP genes. That converted them into more efficient nitrogen fixers. The researchers also have transferred HUP genes from soybean rhizobia into



Jo-Ann Leong, OSU microbiologist, is genetically constructing a vaccine to protect steelhead and salmon from IHN, a deadly virus.

rhizobia that live on alfalfa roots. But that hasn't produced the effect the researchers want, yet.

"Now Cantrell and Haugland have decided we need to isolate additional DNA that has the rest of the genes we need to turn on and turn off the recycling process," said Evans. "We want to transfer the whole banana."

The researchers expect to successfully move the HUP gene to rhizobia that live on alfalfa and other legumes, but they aren't sure how it will affect Oregon agriculture.

"Right now, in soybeans you're talking about a 10 percent maximum increase in nitrogen fixation efficiency in a controlled, lab environment where the plant has no access to nitrogen fertilizer residue (in the field, legumes use man-made fertilizer if they have a choice)," said Evans. "So you can see that it isn't going to revolutionize agriculture."

But it's important to try and take advantage of the process, not only for what it offers but because similar processes may be uncovered, Evans said.

Another scientist with rhizobia on his mind is microbiologist Lyle Brown.

"We want to transfer the whole banana."

Brown has the same goal as researchers in the Laboratory for Nitrogen Fixation. But he's trying to improve nitrogen fixation by studying "transcription" in rhizobia that live on alfalfa roots.

Transcription is when DNA uses a mobile copy of itself called RNA to deliver information within a cell, such as the information needed to manufacture important proteins.

"We know that in some mutants (genetically altered bacteria) we've created, where transcription was improved, nodulation was improved," said Brown.

The researcher also is culturing, or growing, tiny pieces of alfalfa tissue in test tubes and exposing them to rhizobia so he can learn more about how plant and bacteria communicate.

"Nobody knows anything about the signals that go back and forth," he said. "Does the plant tell the bacteria: 'O.K., nodulate me'?"

Cheese is what Bill Sandine, another OSU microbiologist, hopes to improve with genetic engineering.

"Does the plant tell the bacteria: 'O.K., nodulate me'?"

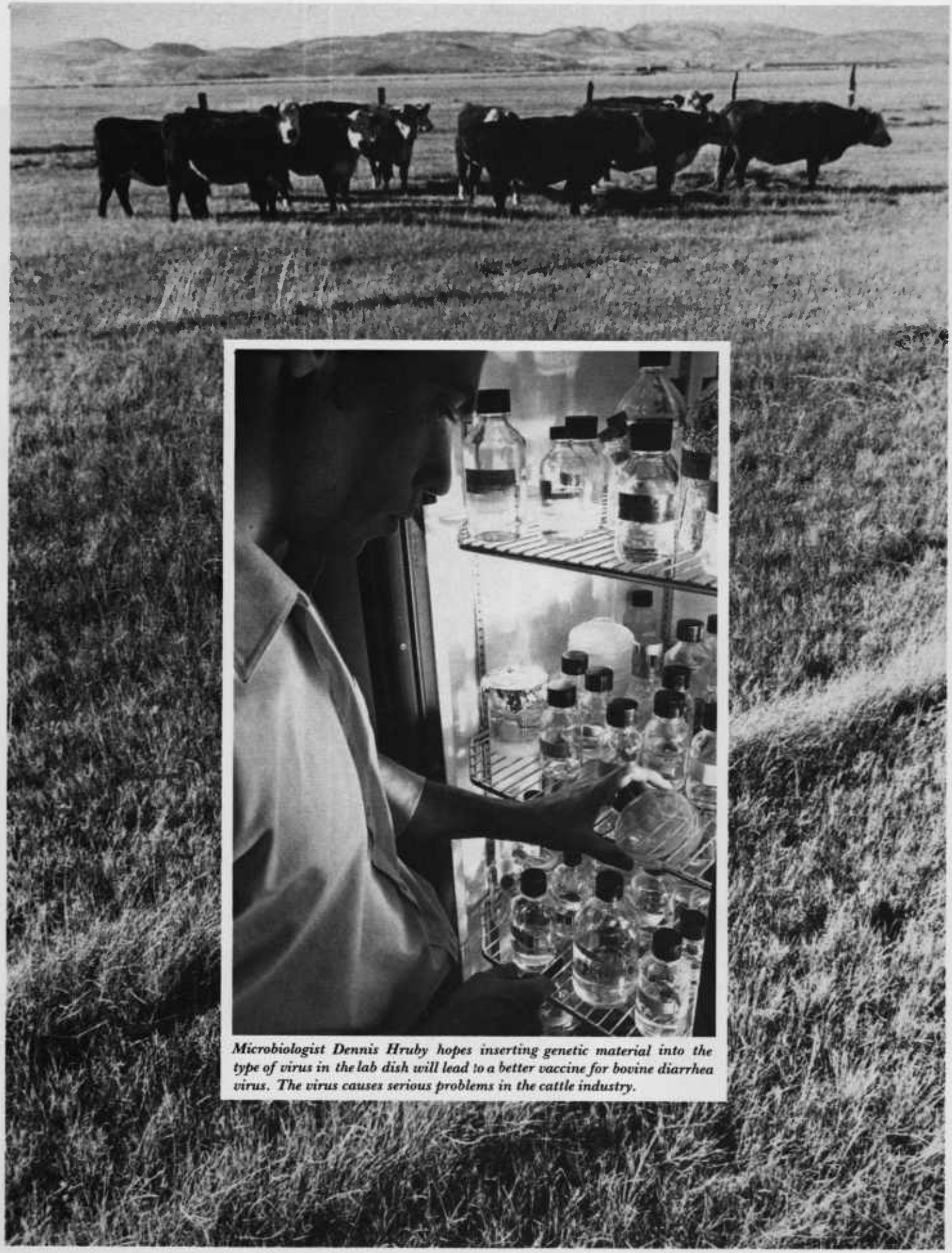
In recent years, Sandine and his graduate students have become popular around Oregon cheese plants by helping plant personnel save money by doing a better job of working with "starter bacteria." The bacteria cause milk to ferment in the first step of cheesemaking.

The Sandine group's contributions include finding and reproducing virus-resistant, fast-fermenting starter bacteria. The bacteria are eliminating a costly and cumbersome starter bacteria rotation system used in cheese plants so cheesemakers can keep ahead of viruses that attack the bacteria and spoil huge vats of milk. With the new system, starter bacteria need only be switched when a new or changed virus appears.

Now Sandine and graduate researcher Paul Orberg are studying the possibility of using genetic engineering to "build" even better starter bacteria.

Sandine would like to move a gene that controls milk sugar fermentation in starter bacterial cells from the plasmid, a circular piece of DNA in the outer portion of the cells, into the chromosomal DNA. That, he thinks, would make future generations of the fast-multiplying organisms more stable (uniformly able to trigger milk fermentation).

He also hopes to construct starter



Microbiologist Dennis Hruby hopes inserting genetic material into the type of virus in the lab dish will lead to a better vaccine for bovine diarrhea virus. The virus causes serious problems in the cattle industry.

bacteria that are permanently resistant to fast-changing viruses because the bacteria contain no "receptor sites" where the viruses can enter.

"Now, I think maybe we're light years away from doing that. But the first step is understanding those receptor sites," he said, "and that's what we're studying."

Dallice Mills, OSU professor of botany and plant pathology, is using biotechnology in three projects.

In one, Mills, graduate student Dirk Anderson and postdoctoral fellow Frank Niepold have identified genes responsible for virulence in bacteria that cause bean and fruit diseases, including "brown spot" and "halo blight" in several types of bush beans.

The researcher has learned how to transfer the virulence genes into bacteria that are free of virulence, giving those organisms the ability to cause the disease.

"What I'm interested in learning," he said, "is how these pathogens (disease-causing organisms) produce the chemical that actually damages the bean plants."



Researchers like Grant Lambert in OSU's nitrogen fixation lab are trying to genetically improve beneficial soil bacteria.

In another study, Mills is examining genes responsible for meiosis (cell division) in yeast cells. He hopes the work will produce clues for how to block reproduction in disease-causing organisms.

Mills also is using his knowledge of genetics to study similarities of TCK smut and common smut, two fungi that cause wheat disease. The mainland Chinese have refused to buy Northwest soft white wheat, claiming is it contaminated with TCK smut spores not present in their wheat. China does have common smut, however. Mills believes TCK smut is a genetic variant of common smut and not a separate species, as the Chinese contend.

> "If we could do that . . . it would be a tremendous breakthrough."

Dave Mok and Machteld Mok, a husband-wife research team in OSU's horticulture department, are studying genes linked to hormones that regulate cell division in beans and other vegetables. The work, they say, could provide useful information about how to make plants grow more quickly.

They also are studying new methods of producing hybrid plants, which are combinations of two varieties or species. Variety combinations often are high-yielding in vegetables like lettuce, carrots and corn.

One technique the Moks plan to experiment with is protoplast fusion, where the walls of cells from two varieties are removed so the contents can mix and form a hybrid.

The potential payoff is big, but so are the challenges, for several OSU researchers trying to use biotechnology in research with cereal grains like Oregon's high-value soft white wheat.

One group is directed by Ralph Quatrano, OSU botanist. Quatrano's doctoral students Barbara Ballo and John Williamson are using recombinant DNA technology and gene transfer to study how certain hormones influence genes expressed during wheat embryo development and subsequent germination. They hope the work will provide answers to questions about why a significant amount of Northwest wheat sprouts prematurely, ruining it.

Another member of Quatrano's group, postdoctoral researcher John Proffitt, is studying gliadin, a type of wheat protein. Proffitt and researchers working with him have identified and are studying DNA that contains a gliadin gene. The long-range hope in this type of research is to use gene splicing to alter the amount or type of protein in a kernel of wheat (protein content and quality are crucial factors in determining wheat's nutritional and economic value).

Such work interests Warren Kronstad, an OSU agronomist who directs one of the world's leading traditional wheat breeding programs.

While exchanging information with Quatrano's group, Kronstad's research team is experimenting with tissue culturing — generating wheat plant cells from small clusters of cells, or even single cells, in a laboratory dish containing nutrients and helpful chemicals (called growth media).

Kronstad sees several benefits if tissue culturing can be perfected in cereal grains. One would be the ability to subject cells to disease toxins and other sources of stress and identify, in a lab dish, cells with the resources to overcome the stress . The researchers then could regenerate those cells.

"If we could do that, it would be a tremendous breakthrough," he said, explaining that nowadays researchers have to screen for such desirable qualities by growing entire wheat plants in the field, an expensive and time-consuming process.

"This would be a tool to identify specific traits. Then we'd look at them in a conventional breeding program," said Kronstad, noting that he thinks it will be many years before gene splicing is a viable method of moving around desirable traits in the complicated wheat plant.

Tissue culturing could be a source of desirable genetic variation, the researcher added.

"Indications are that you get some variation from chromosomal breakage and DNA recombination, or maybe the growth media act as a mutagen (cause of genetic change)," he said. "We're always interested in getting variation and looking at new qualities."



Horticulturists Machteld and Dave Mok pose by a slide of leaf protoplasts (cells with their walls removed). The husband-wife team plans to mix vegetable protoplasts in hopes of producing high-yielding hybrid plants.

Te May Ching, one of Kronstad's colleagues in OSU's crop science department, is taking the molecular path to search for why kernels (actually the seeds) of some cereal grains shrivel, reducing their value.

The boom is reaching into fish and livestock research.

Ching and her graduate students are studying a starch-making enzyme called ADP-G Pyrophosphorykase, hoping that will lead them to an understanding of the interplay of genes and other factors that cause shriveling.

"It's very impressive to talk about gene splicing. But you'd better know what the genes and their neighbors are doing before you start," she said, pointing out that genetic engineering eventually could help her in trying to increase grain yields.

Agronomist Al Mosely and fellow potato researchers Tom Allen, Jeff McMorron and others are busy trying to improve one use of tissue culturing that has already proved its worth.

The researchers have set up a tissue culturing system that produces virus-free "plantlets," tiny potato plants in test tubes. Quite a few Oregon seed potato growers use the plantlets to produce potatoes that become the seed sources for their crops and eventually improve quality and yields for growers of regular potatoes.

The key to outmaneuvering the viruses is snipping off, and culturing, tissue from new-growth areas where viruses haven't spread. The researchers are experimenting with applying growth hormones to sprouted potato eyes to speed the growth of virus-free shoots they can use as culture tissue.

The work is going to allow OSU researchers to "clean up"—rid of viruses—experimental potato plants grown at Hermiston, Redmond and other locations in a program designed to develop better potatoes.

"In the past, we just discarded breeding lines infected with the more damaging viruses," Mosley said, adding that that was a waste of valuable genetic material.

"You could shoot a person up once and give resistance to four or five diseases."

OSU horticulturists and plant pathologists are doing similar tissue culture work with crops like lilies, strawberries and caneberries, ridding them of viruses.

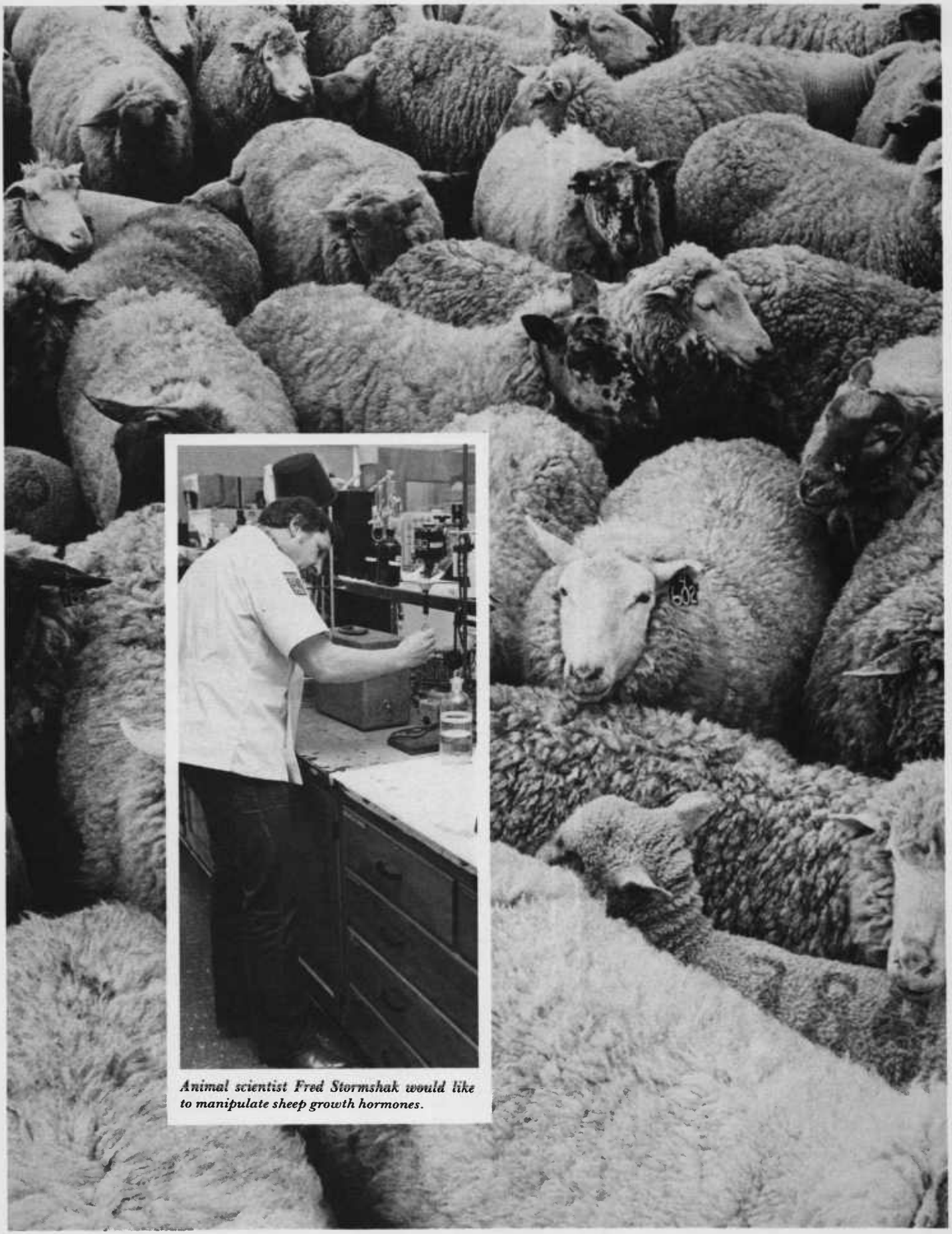
The new biotechnology is reaching into fish and livestock research, too.

OSU microbiologist Jo-Ann Leong is using genetic engineering to develop a vaccine to combat infections cause by IHN, a virus which has killed an estimated $109 million worth of steelhead and salmon in the Columbia River system since 1980.

Most virus vaccines for fish and animals work by introducing into the body either weakened live viruses or dead viruses that trigger the production of antibodies that provide immunity.

Leong and others in her lab are working to remove from an IHN virus the gene responsible for production of one of the virus's proteins. They plan to transfer the gene into *Escherichia coli*, a common bacteria, so the bacteria will manufacture the protein. The bacteria then can be killed and used in a vaccine for hatchery salmon.

The beauty of the process is that the vaccine will contain the virus protein and fool the fishes' bodies into producing antibodies, but there will be no need to grow large numbers of the miniscule viruses, which is expensive, or to release into the environment weakened viruses that could change back into a disease-causing form. Leong also is working on producing a vaccine for another salmon and steelhead disease caused by a virus (called IPN virus), and on constructing a "radioactive DNA probe" that would help catfish farmers check fish in their



Animal scientist Fred Stormshak would like to manipulate sheep growth hormones.

ponds for a disease-causing viruses. She's collaborating with Ron Hedrick, a University of California at Davis researcher, on that project.

Microbiology professor Dennis Hruby, hired recently through the university's expanded gene research and biotechnology program, is studying vaccines also—but for animals and humans.

Hruby's specialty is working with a form of Vaccinia, a harmless virus—although related to the small pox virus—whose size has attracted attention. Vaccinia is the largest and most complex of viruses. Scientists like Hruby are learning to remove large sections of Vaccinia DNA and replace them with foreign antigen material from disease viruses. That stimulates antibody production (the immune response) when the restructured Vaccinia is injected into an organism. Vaccinia has become a candidate for "multiple vaccine" duty.

"You can think of Vaccinia as a tape recorder and foreign antigens you put into it as cassettes," said Hruby. "Human medical researchers are thinking they can drop in DNA from herpes, influenza, Hepatitis B and other diseases. That multiple approach would be especially important in the Third World. You could shoot a person up once and give resistance to four or five diseases."

Hruby and Al Smith, director of research in OSU's College of Veterinary Medicine, hope to use Vaccinia to develop livestock vaccines, including an improved vaccine for bovine diarrhea virus, which weakens calves and makes them susceptible to other medical problems. An attractive feature of livestock vaccines made with Vaccinia is that they would not spoil easily, Hruby said. The benefits of a multiple vaccine, where one shot would make an animal resistant to several diseases, are obvious, he added.

Hruby also is studying the possibly of putting the genetic ability to produce antibodies directly into vaccines, rather than relying on using foreign antigen material to trigger the immune response.

In OSU's animal science department, scientists are aware of the possibilities for new, biotechnology-related research. "We will be hiring an embryo physiologist in the near future," said Steve Davis, department head. Some research under way may be laying valuable groundwork.

For example, animal scientist Fred Stormshak and his graduate students are studying the growth hormone in sheep and a hormone called somatostatin that acts as a brake on release of the growth hormone.

Piper Klinger, a master's student, has been searching for ways to stimulate release of extra growth hormone in lambs. Now, based on the finding of researchers in England, she and Stormshak are wondering about the possibility of using an antiserum to neutralize somatostatin, allowing the release of more growth hormone.

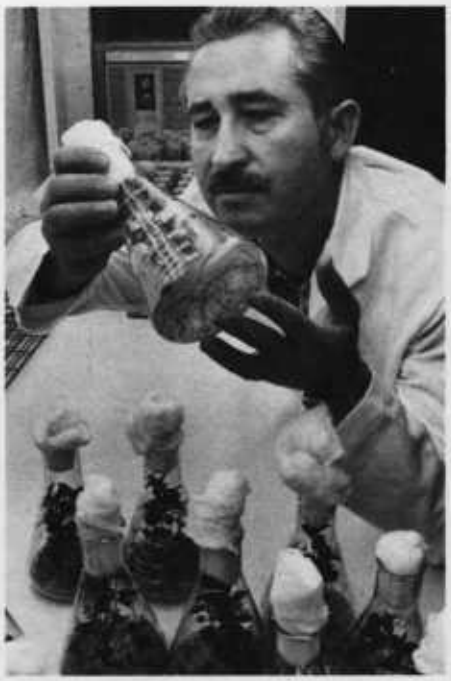
To lower costs, the antiserum, which seems to work over a long period of time, like a vaccine, probably could be manufactured by common laboratory bacteria outfitted with the proper gene, Stormshak speculates.

You see some fascinatingly different approaches to the use of genetic engineering. For instance, two OSU researchers are studying some species of agrobacteria, bacteria that cause crown gall disease, which produces unsightly tumors that can sap the strength of crops like fruit trees and ornamental bushes. But one researcher is trying to kill the bacteria, while the other sees them as a genetic resource.

> "Hypothetically, we may be able to give growers another .45-caliber revolver."

Several years ago, Larry Moore, plant pathologist, began working with a strain of bacteria called *A. radiobacter* K-84 that produces a chemical that kills some strains of the crown gall bacteria. Since then, commercial products containing K-84 have become the best control for crown gall disease. Now Moore has found several strains of bacteria called *Pseudomonas* that kill some agrobacteria strains that K-84 doesn't and also seem to be heartier than K-84.

His research group is trying to move the gene in K-84 responsible for production of the chemical that kills the disease-causing agrobacteria into a strain of *Pseudomonas* and construct a biological control agent that is heartier and toxic to more strains of agrobacteria.



Crop scientist Al Mosley eyes a "test-tube" potato plant grown from virus-free tissue.

"Hypothetically, we may be able to give growers another .45-caliber revolver to use against crown gall—at least we hope so," said Moore.

Roy Morris, agricultural chemist, views the agrobacteria in a more positive light.

The bacteria cause crown gall disease by invading injured plants at the wound site. When they find injured cells, they inject a circular piece of DNA called a Ti-plasmid through the cell's wall. The Ti-plasmid then inserts a small piece of itself, called the T-DNA, into the plant cell's chromosomes.

Once in the chromosomes, the T-DNA seizes control of the production of important growth hormones: cytokinins, which induce shoot growth, and auxins, which influence root growth. In a healthy plant, the hormones are released in a controlled way. But T-DNA switches on their production permanently in the wound area. A tumor develops.

Instead of wasting all that hormone production on tumors, Morris hopes to direct it toward normal plant growth.

"We're working on identifying exactly the gene (in agrobacteria) that controls cytokinin production," he said, noting that would be a big step toward learning to regulate plant growth with genetic engineering. □ ***—A.D.***

Some positive views of biotech's future

PRO

"You can just feel the excitement in the air. Here we are sitting on the edge of a technological breakthrough that could be as important as electricity, splitting the atom, or going back to the invention of the wheel or discovery of fire."

What famous scholar said that? An investment analyst for a prominent Wall Street securities firm. That was a couple of years ago and the analyst was talking about genetic engineering, the major cause of the biotechnology boom.OSU agricultural researchers are more subdued when discussing biotechnology's potential in their field. But what are the more enthusiastic of them saying? What's the "up" view? Some sample comments:

"The person who sees no major payoffs coming in agriculture is like the person who looked at the computer chip and said nothing will come of it," says Lyle Brown, OSU microbiology professor. "Some of the animal work is already there. With plants, micropropagation (tissue culturing) payoffs are going to come before payoffs from recombinant DNA work. They're already coming. But the potential is so great (in DNA work)."

"It's (the genetic engineering being used in agriculture) one of the exciting developments in science in our day," says Harold Evans, plant physiology professor. "The human species has sorted out the genetic code—that's a hell of an accomplishment. And much of it was done in the United States."

"People have things in the back of their minds they don't even dare talk about," says Dallice Mills, professor of botany and plant pathology. "Everybody has thought about the corn that fixes nitrogen. You don't see these biotech companies forming so people can waste their money."

"You don't see these biotech companies forming so people can waste their money."

Mills expects private companies to make many of the advances in applying genetic engineering to agriculture. One of the most important roles of universities will be teaching, he thinks.

"We have to be on the research forefront in our laboratories," he said, "so we can train the people private industry will need, and so our graduates can compete in the commercial world.

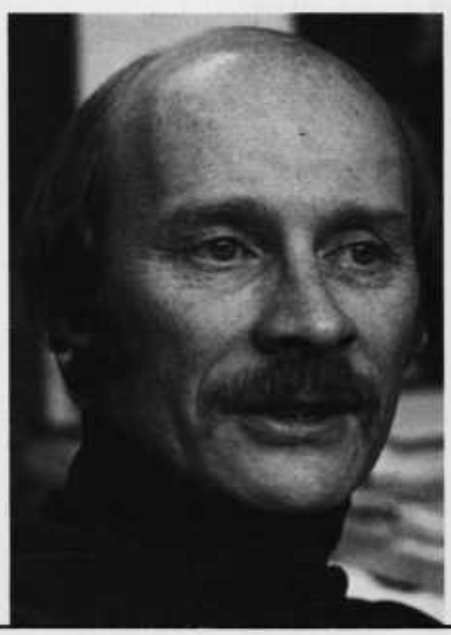
"Many of the techniques we're using in my lab today weren't even known four years ago. But, then, one of my major professors always told me that to work in science you have to be willing to change. I can't imagine doing science any other way."

Mills predicts barriers to using genetic engineering in agriculture will fall more quickly as more research is done—a "snowball effect" with the growing mass of information bowling over research obstacles.

Will the rush to biotechnology leave people who are doing traditional agricultural research feeling sort of lonesome, perhaps not "with it"?

Lyle Brown addressed that question in terms of plant research.

"The plant breeders and others will never be out in the cold. We have to interconnect. They know what's happening out in the field. They have specialized knowledge the gene-level people need. The challenge is to get everyone together. Then you'll have something very powerful." □





Left to right: Dallice Mills, botany and plant pathology professor; microbiologist Lyle Brown

CON

The critics cite two old problems

Is there a dark side to the force of the "agribiotechnology" movement?

Yes, some OSU researchers seem to think. It includes the old problems in science of creating false hopes and of limited funding.

"Wheat farmers grow varieties, not recombinant DNA," says Warren Kronstad, OSU wheat breeder. "Promising too much just cuts off your nose to spite your face. I think all of us in agriculture have to be excited about what we're seeing. The potential is quite great. But one has to ask that the story of gene research and biotechnology be told in proper perspective."

"My own feeling is that, with plants, we won't see many commercial payoffs in the next five to 10 years. We're a long way off. The work deserves support. But don't oversell. You're talking about additional tools, not and end-all. And let's not forget other valuable research. You can't turn that off and on."

Peter Bottomley, microbiology and soil science professor, agrees with Kronstad, at least in terms of research with his specialty, alfalfa.

"We've got people getting USDA research grants who a few years ago had all these aggie jokes up their sleeves. And that's great," he says. "They bring a new approach, new knowledge. But there's a certain naivete in some of them that bothers me. What they can say is that maybe they will hit upon something that will start the yield curve moving again. Anything beyond that is motormouthing, in my opinion."

> "A certain naïveté in some of them . . . bothers me."

Bottomley adds that his field studies of alfalfa production in Oregon, and his knowledge of the bacteria that fix nitrogen in alfalfa, suggest to him that pinpointing flaws in the way growers manage their crops has more potential for boosting yield than does using genetic engineering to improve nitrogen-fixing bacteria.

One problem facing agribiotechnology—controversy over the safety of genetic engineering and releasing altered organisms into the environment—is unfortunate, some OSU researchers contend.

Nationally, there has been an effort to block field testing of a type of bacteria researchers altered because they were reducing crops' resistance to cold weather.

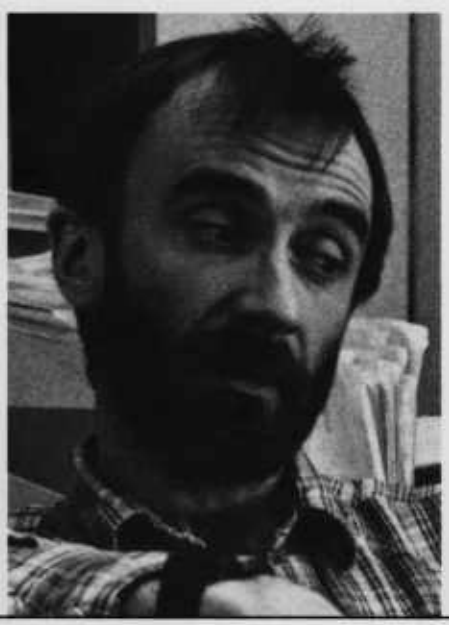
"But I think that comes from a misguided individual," says Roy Morris, an OSU agricultural chemist active in gene research. "All they've done is take bacteria that are already in the environment and delete one gene. I believe you would find similar, natural gene deletions if you looked for them in the environment."

Tightly controlled testing has shown that genes that might be dangerous—like genes from mammal tumor viruses—are not expressed when spliced into microorganisms like bacteria, says George Pearson, a biochemist who is head of OSU's biosafety committee.

Today, genetic engineering research at OSU is monitored by Pearson's committee, he points out, and researchers follow the procedure of first using high-containment testing to prove the safety of work they think might be dangerous.

"I think the safety question really is obsolete," he says.

But some researchers do not agree. They say the consequences of releasing altered organisms into the environment have yet to be determined scientifically—that the jury is still out. □





Left to right: Peter Bottomley, microbiologist; Warren Kronstad, crop scientist



Bob Spotts, Hood River experiment station plant pathologist, stands by his orchard computer.

The electronic orchard

There's a "real" apple computer in Hood River.

The device, the size of a large transistor radio, is in a little wooden stand in an orchard behind OSU's Mid-Columbia Agricultural Experiment Station just south of town.

"It's called an Apple Scab Predictor. The company back in Ohio that makes them gave it to me two years ago so I could test it under Hood River Valley growing conditions," said Bob Spotts, a plant pathologist at the facility.

Apple scab, the researcher explained, is a major disease of apples in the Hood River Valley. The fungus that causes it puts black, scabby spots on apple trees, leaves and fruit.

The Apple Scab Predictor is made up of a set of sensors and a microcomputer. The sensors monitor orchard conditions like temperature, relative humidity and wetness on leaves and fruit. A program in the computer is full of data about apple scab disease—including information about fungicides that can be used to combat the disease.

"You just quiz the thing by pushing buttons and it'll give you everything from the time to whether you're in an infection period and when the infection period started," Spotts said.

"The neat thing is spray options," said the researcher. "After giving the history of the current infection, when it started and what the conditions have been like and so on, it will give you the class of fungicides that will be effective."

The device, whose prototype was developed at Michigan State University, is used widely in apple-growing areas of the East such as in New York State but not in the generally arid West, according to the researcher. □



Near Burns, OSU range scientists are studying a new short-duration cattle grazing system.

Home, home on the paddocks

Scientists at OSU's Eastern Oregon Agricultural Research Center at Burns plan to divide the range into "cells" and "paddocks" this spring to study high-density, short-duration grazing.

"The concept was introduced to the United States by a ranch consultant from Rhodesia and really is a hot topic, especially in the South and Southwest. Proponents claim you can get higher carrying capacities on the land. But others say it requires a higher level of managerial skill," said Ray Angell, a range scientist at the facility, operated jointly by OSU and the U.S. Department of Agriculture's Agricultural Research Service.

The idea behind the system is that by dividing the range where you plan to graze a herd of cattle, referred to as the cell, into smaller units called paddocks, and rotating large numbers of cattle from paddock to paddock, you can get uniform grazing and give plants a rest periodically.

Angell, who works for USDA, and OSU range scientist Rick Miller hope to find out if the system could improve the grazing season in Eastern Oregon for crested wheatgrass, a popular forage.

"We're trying to devise a means of using crested wheatgrass earlier in the spring and later in the fall to reduce the amounts of hay ranchers have to feed in the winter, and we're wondering if short-duration grazing could help," said Angell.

More uniform grazing of crested wheatgrass, a hearty plant imported from Russia in the early 1900s, would reduce the number of so-called "wolf plants," ungrazed plants that enter the reproductive stage of development and become less palatable, said the researchers.

This spring, the scientists are dividing a 120-acre range into eight equal-sized paddocks. Using a portable electric fence, the researchers will let cattle herds of several densities graze in the paddocks.

"Our primary interest at the start will be how the crested wheatgrass responds to the increased grazing pressure. Later, we'll study how it affects the livestock, too," said Angell.

Several Oregon ranchers already are using short duration grazing but the system has not been employed enough to allow a useful evaluation of its worth, said the researcher, who has one reservation.

"I feel it carries the potential to do considerable damage to the land if not implemented properly. That's another reason we're going to study it," he said. □

Mongoose trappings

How many persons have trapped the wily mongoose?

Now there are two more, both wildlife scientists from OSU.

Bruce and Brenda Coblentz were asked by officials of the Virgin Islands National Park on St. John to study a mongoose problem. The ferret-sized mammals were eating an estimated 23 percent of the eggs and hatchlings of hawksbill turtles and causing other damage.

The mongooses had nearly driven the ground nesting quail dove to extinction and did wipe out a ground lizard in the Virgin Islands. The mongoose is from India. It feeds on, among other things, snakes and rats, and was introduced into the Caribbean in 1872 to control rats which were damaging sugar cane. Where mongooses have been introduced, native wildlife species have been effected.

"Seemingly, any vertebrate or invertebrate that can be captured and subdued by the mongoose is eaten," said Bruce Coblentz, an Agricultural Experiment Station researcher who was on sabbatical leave for the study.

The OSU scientists were asked to develop a control program after determining the population structure and seasonal patterns of reproduction and condition.

The husband-wife team trapped 1,009 mongooses from January through November 1983—871 adults and 138 juveniles. The animals, killed by asphyxiation or drowning, were studied for body fat, reproductive histories and other aspects.

Their recommendation for control was simple.

"The only total and lasting solution to mongoose predation is to completely eradicate them, a monumental task," said Bruce Coblentz. "As a second choice, we recommended a program of high-intensity, short duration trapping since the mongoose is one of the easiest of mammals to trap." □

1983 Publications Index

Oregon Agricultural Experiment Station scientists conduct a lot more research than *Oregon's Agricultural Progress* has the space to report. Most readers know that. But some of you may not know of other Experiment Station publications available to Oregonians. The scientists write reports—called Circulars of Information, Station Bulletins, Technical Bulletins and Special Reports—about their research findings. Also, the scientists have reprints—called Technical Papers—of articles they write for scientific journals and papers they present at scientific meetings. Usually, Oregonians can obtain single copies of the circulars, bulletins, reports and reprints free.

Following is an index of publications that were printed in 1983. They are categorized by the departments of the OSU College of Agricultural Sciences and by branch experiment stations. Copies of Circulars of Information, Technical Bulletins and Station Bulletins may be obtained by writing the OSU Bulletin Mailing Service, Industrial Building, OSU, Corvallis 97331. Copies of Special Reports and reprints may be obtained by contacting the scientists who wrote them through the scientists' campus departments or branch experiment stations. When requesting a publication, refer to the number preceding the title.

Circulars of Information

Southern Oregon Experiment Station

- CI 694, Alfalfa Production Practices and Variety Performance in Southern Oregon.

Station Bulletins

Agricultural and Resource Economics

- SB 660, Design and Selection of Cooperative Market Pools.

Eastern Oregon Agricultural Research Center

- SB 659, Adjusting and Forecasting Herhage Yields in the Intermountain Big Sagebrush Region of the Steppe Province.

Special Reports

Agricultural and Resource Economics

- SR 693, Estimating Oregon's Private Nonfarm Gross State Product: A Review of Literature and Methodological Extension.

Animal Science

- SR 677, OSU Annual Swine Day.

Columbia Basin Agricultural Research Center

- SR 680, Columhia Basin Agricultural Research Center Research Report.
- SR 684, Irrigated Crop Research in Oregon's Columbia Basin.

Crop Science

- SR 668, Tunisia Cereal Breeding and Production Symposium.
- SR 675, Results of the Ninth International Winter x Spring Wheat Screening Nursery (1981-82).
- SR 681, Wheat Cultivar Ahhreviations.

Eastern Oregon Agricultural Research Center-Squaw Butte

- SR 678, 1983 Progress Report, Research in Beef Cattle Nutrition and Management.

Malheur Experiment Station

- SR 683, Malheur Agricultural Experiment Station Research.

North Willamette Experiment Station

- SR 679, Vegetable Research at the North Willamette Agricultural Experiment Station, 1981-82.

Rangeland Resources

- SR 682, Research in Rangeland Management, 1983.

Soil Science

- SR 686, Statistical Analysis of Climatological Data to Characterize Erosion Potential: 1. Precipitation Events in Western Oregon.
- SR 687, Statistical Analysis of Climatological Data to Characterize Erosion Potential: 2. Precipitation Events in Eastern Oregon and Eastern Washington.
- SR 688, Statistical Analysis of Climatological Data to Characterize Erosion Potential: 3. Freezing Events in Western Oregon.
- SR 694, Results of Some Northeast Oregon Potato Soil Fertility Studies.

Technical Bulletins

Crop Science

- TB 145, Quantified Evaluation for Decisions.
- TB 146, Fallow-Cropping Systems in the Pacific Northwest.

Technical Paper Reprints

Agricultural Chemistry

- 5563, "Heavy Metals in Estuarine Shellfish from Oregon," R.S. Caldwell and D.R. Buhler, Archives of Environmental Contamination and Toxicology, Volume 12, pages 15-23, 1983.
- 5644, "Effect of Temperature on the Chemical Composition of Pink Salmon (*Oncorhynchus gorbuscha*) Muscle," B.M. Kepshire, Jr., I.J. Tinsley and R.R. Lowry, Aquaculture, Volume 32, pages 295-301, 1983.
- 5778, "Incorporation of Selenium-75 into Semen and Reproductive Tissues of Bulls and Rams," F.R. Pond, M.J. Tripp, A.S.H. Wu, P.D. Whanger and J.A. Schmitz, Journal of Reproduction and Fertility, Volume 69, pages 411-418, 1983.
- 5879, "Protective Role of Dietary Butylated Hydroxyanisol Against Chemical-Induced Acute Liver Damage in Mice," C.L. Miranda, M.C Henderson, J.A. Schmitz and D.R. Buhler, Toxicology and Applied Pharmacology, Volume 69, pages 73-80, 1983.
- 6139, "Secretion of *Trans*-Zeatin hy *Agrobacterium tumefaciens*: A Function Determined hy the Nopaline Ti Plasmid," D.A. Regier and R.O. Morris, Biochemical and Biophysical Research Communications, Volume 104, pages 1560-1566, 1982.
- 6168, "Effect of Phenoharhital on Toxicity of Pyrrolizidine (*Senecio*) Alkaloids in Sheep," R.A. Swick, C.L. Miranda, P.R. Cheeke and D.R. Buhler, Journal of Animal Science, Volume 56, pages 887-894, 1983.
- 6169, "Effect of Sheep Rumen Fermentation and Methane Inhihition on the Toxicity of *Senecio jacobaea*," R.A. Swick, P.R. Cheeke, H.S. Ramsdell and D.R. Buhler, Journal of Animal Science, Volume 56, pages 645-651, 1983.
- 6191, "Bromine Levels in Tissue Lipids of Rats Fed Brominated Fatty Acids," B.A. Jones, I.J. Tinsley and R.R. Lowry, Lipids, Volume 18, pages 319-326, 1983.
- 6273, "Inducihility and Amounts of Metallothionein as Influenced hy Cadmium and Zinc in the Developing Rat," J.W. Ridlington, D.E. Goeger, D.C. Chapman and P.D. Whanger, Biological Trace Element Research, Volume 5, pages 175-187, 1983.
- 6277, "Predictions of Evaporative Loss Rates of Solutes in Stagnant and Turbulent Waters in Relation to Rates of Reference Materials," C.T. Chiou, R.L. Kohnert, V.H. Freed and R.G. Tonkyn, Environment International, Volume 9, pages 13-17, 1983.
- 6305, "Comparison of the Toxicities of *Senecio jacobaea, Senecio vulgaris* and *Senecio glabellus* in Rats," D.E. Goeger, P.R. Cheeke, H.S. Ramsdell, S.S. Nicholson and D.R. Buhler, Toxicology Letters, Volume 15, pages 19-23, 1983.
- 6309, "Effects of Dietary Mercury Level and Cadmium on Rat Tissue Metallothionein:

Mercury Binding and Influences on Zinc," P.D. Whanger and J.T. Deagen, Environmental Research, Volume 30, pages 372-380, 1983.

• 6338, "Comparative Properties of Purified Cytocbrome P-448 from β-Napbtboflavone Treated Rats and Rainbow Trout," D.E. Williams and D.R. Buhler, Comparative Biocbemistry and Physiology, Volume 75C, pages 25-32, 1983.

• 6384, "Size Determination of *Orgyia pseudotsugata* Cytoplasmic Polybedrosis Virus Genomic RNA," M.S. Galinski, K-C. Chow, G.F. Rohrmann, G.D. Pearson and G.S. Beaudreau, Virology, Volume 123, pages 328-335, 1982.

• 6399, "An Evaluation of Acetone Extracts from Six Plants in the Ames Mutagenicity Test," R.D. White, P.H. Krumperman, P.R. Cbeeke and D.R. Buhler, Toxicology Letters, Volume 15, pages 25-31, 1983.

• 6401, "Toxicology of Brominated Fatty Acids: Metabolite Concentration and Heart and Liver Cbanges," B.A. Jones, I.J. Tinsley, G.L. Wilson and R.R. Lowry, Lipids, Volume 18, pages 327-334, 1983.

• 6406 "Determination of Carbofuran and 3-Hydroxycarbofuran Residues in Peppermint Hay and Peppermint Oil," R.D. Inman, U. Kiigemagi and M.L. Deinzer, Journal of Agricultural and Food Cbemistry, Volume 31, pages 918-919, 1983.

• 6409, "Differential Induction of Hepatic Drug Metabolizing Enzymes in Japanese Quail by 1,2,4-Trichlorobenzene," C.R. Miranda, J-L. Wang, M.C. Henderson, H.M. Carpenter, H.S. Nakaue and D.R. Buhler, Toxicology, Volume 28, pages 75-82, 1983.

• 6439, "Bioavailability to Rats of Selenium in Various Tuna and Wheat Products," A.R. Alexander, P.D. Whanger and L.T. Miller, Journal of Nutrition, Volume 113, pages 196-204, 1983.

• 6480, "Partition Equilibria of Nonionic Organic Compounds Between Soil Organic Matter and Water," C.T. Cbiou, P.E. Porter and D.W. Scbmedding, Environmental Science and Technology, Volume 17, pages 227-231, 1983.

• 6494, "Determination of the Phenolic Metabolites of Carbofuran in Peppermint Hay and Peppermint Oil by Multiple Ion Detection Mass Spectrometry," R.D. Inman, U. Kiigemagi, D.A. Griffin and M.L. Deinzer, Journal of Agricultural and Food Chemistry, Volume 31, pages 722-726, 1983.

• 6514, "Cytokini Auxin Balance in Crown Gall Tumors Is Regulated by Specific Loci in the T-DNA," D.E. Akiyoahi, R.O. Morris, R. Hinz, B.S. Mischke, T. Kosuge, D.J. Garfinkel, M.P. Gordon and E.W. Nester, Proceedings, National Academy of Science, USA, Volume 80, pages 407-411, 1983.

• 6530, "Separation of Fatty Acid Methyl Esters on tbe Basis of tbe Number of Double Bonds Using Alumina Plates," R.R. Lowry and I.J. Tinsley, Journal of the American Oil Cbemists Society, Volume 60, pages 792-794, 1983.

• 6582, "Pyrrolizidine Alkaloid-Induced Alterations in Benzo[α]pyrene Metabolites to Deoxyribonucleic Acid," D.E. Williams, C.L. Miranda and D.R. Buhler, Biocbemical Pharmacology, Volume 32, pages 2443-2447, 1983.

• 6591, "Purification and Comparative Properties of NADPH-Cytochrome P-450 Reductase from Rat and Rainbow Trout: Differences in Temperature Optima Between Reconstituted and Microsomal Trout Enzymes," D.E. Williams, R.R. Becker, D.W. Potter, F.P. Guengericb and D.R. Buhler, Arcbives of Biocbemistry and Biophysics, Volume 225, pages 55-65, 1983.

• 6656, "Purified Form of Cytochrome P-450 from Rainbow Trout witb Higb Activity toward Conversion of Aflatoxin B_1 to Aflatoxin B_1-2,3-epoxide," D.E. Williams and D.R. Buhler, Cancer Research, Volume 43, pages 4752-4756, 1983.

• 6663, "The Acute Toxicity of Penta-, Hexa-, and Heptachlorohydroxydiphenyl Esters in Mice," T.L. Miller, D.J. Lorusso, M.L. Walsb and M.L. Deinzer, Journal of Toxicology and Environmental Health, Volume 12, pages 245-253, 1983.

• 6677, "Catalase Activity of C_3 and C_4 Species and Its Relationship to Mercury Vapor Uptake," S-H. Du and S.C. Fang, Environmental and Experimental Botany, Volume 23, pages 347-353, 1983.

• 6679, "Dietary Effects on Lipid and Fatty Acid Composition of *Clistoronia magnifica* (Trichoptera: Limnepbilidae)," B.J. Hanson, K.W. Cummins, A.S. Cargill, and R.R. Lowry, Freshwater Invertebrate Biology, Volume 2, pages 2-15, 1983.

• 6721, "Fatty Acid Composition of Liver Lipids in Rats Fed Brominated Fatty Acids," G.R. Wilson, I.J. Tinsley and R.R. Lowry, Lipids, Volume 18, pages 661-663, 1983.

• 6759, "Distribution of Selenium and Glutatbione Peroxidase in Blood Fractions from Humans, Rhesus and Squirrel Monkeys, Rats and Sbeep," M.A. Beilstein and P.D. Whanger, Journal of Nutrition, Volume 113, pages 2138-2146, 1983.

• 6786, "Differential Uptake of Mercury Vapor by Gramineous C_3 and C_4 Plants," C.L. Browne and S.C. Fang, Plant Pbysiology, Volume 72, pages 1040-1042, 1983.

• 6800, "Comparison of Sequence Diversity in Several Cytoplasmic Polybedrosis Viruses," M.S. Galinski, V.H. Stanik, G.F. Rohrmann and G.S. Beaudreau, Virology, Volume 130, pages 372-380, 1983.

• 6892, "Metabolic Activation of 1,2,4-Trichlorobenzene by Avian Liver Microsomes *in vitro*," C.L. Miranda, M.C. Henderson, D.E. Williams and D.R. Buhler, in *Developments in the Science and Practice of Toxicology*, Elsevier Science Publisbers B.V., 1983.

Agricultural Engineering

• 6662, "A Proposed Severity Index for Seed Handling," N.R. Brandenburg, Journal of Applied Seed Production, Volume 1, Number 1, pages 8-11, 1983.

• 6736, "Clarification of Pear Juice by Hollow Fiber Ultrafiltration," Dale E. Kirk, Morris W. Montgomery and Marjan G. Kortekaas, Journal of Food Science, Volume 48, Number 6, pages 1663-1666, Nov.-Dec. 1983.

• 6741, "Criteria for Selecting Manure Handling and Land Application Systems," James A. Moore and R.K. White, Second National Dairy Housing Conference Proceedings, pages 36-44, March 14-16, 1983.

b 6856, "Application of Regionalized Variable Analysis to Climatic Data," Kodjo Y. Amegee and Richard H. Cuenca, Second International Meeting on Statistical Climatology, pages 1-8, Sept. 1983.

Agricultural and Resource Economics

• 6258, "A Distributed Lag Approach to Forecasting Wilderness Use," R.A. Oliveira, Louise M. Arthur and A.C. Papastavrou, Journal of Leisure Research, Volume 15, pages 52-65, First Quarter 1983.

• 6458, "Using Individual Observations to Estimate Recreation Demand Functions: A Caution," William G. Brown, Colin Sorhus, Bih-lian Chou-Yang and Jack A. Ricbards, American Journal of Agricultural Economics, Volume 65, pages 154-157, February 1983.

• 6470, "A Note on the Functional Form of Travel Cost Models with Zones of Unequal Populations," Elizabetb J. Strong, Land Economics, Volume 59, Number 3, pages 342-349, August 1983.

• 6603, "Opportunities for tbe More Intensive Use of Input-Output Analysis in Public Rangeland Decision-Making," Frederick W. Obermiller, Intermountain Forest and Range Experiment Station, General Technical Report INT-149, pages 100-109, July 1983.

• 6632, "Pricing Policies for Antlerless Elk Hunting Permits," Ronald A. Sandrey, Steven T. Buccola and William G. Brown, Land Economics, Volume 59, pages 432-443, November 1983.

• 6634, "Risk Preferences and Sbort Run Pricing Efficiency," Steven T. Buccola, American Journal of Agricultural Economics, Volume 65, pages 587-591, August 1983.

• 6640, "Estimating Residential Flood Control Benefits Using Implicit Price Equations," Mark E. Thompson and Herbert H. Stoevener, Water Resources Bulletin, Volume 16, pages 889-895, December 1983.

• 6823, "Goal Programming Via Multidimensional Scaling Applied to Senegalese Subsistence Farming: Reply," Bruce A. McCarl and Brian F. Blake, American Journal of Agricultural Economics, Volume 65, pages 832-833, November 1983.

Animal Science

• 5710, "Effect of Ammoniation Treatment of Wheat Straw on *in vitro* and *in vivo* Digestibility," R. Herrera-Saldana, D.C. Church and R.O. Kellems, Journal of Animal Science, Volume 56, pages 938-942, 1983.

• 5775, "Estimation of Repeatability, Heritability and Breed Differences for Lamb Production," Stephen E. Clarke and William D. Hobenboken, Journal of Animal Science, Volume 56, Number 2, pages 309-315, 1983.

• 5778, "Incorporation of Se-75 into Semen and Reproductive Tissues of Bulls and Rams," F.R. Pond, M.J. Tripp, A.S.H. Wu, P.D. Whanger and J.A. Schmitz, Journal of Reproduction and Fertility, Volume 69, pages 411-418, 1983.

• 5873, "Relationship of Dietary Crude Protein to Composition of Uterine Secretions and Blood in Higb-Producing Postpartum Dairy Cows," E.R. Jordan, T.E. Chapman, D.W. Holtan and L.V. Swanson, Journal of Dairy Science, Volume 66, pages 1854-1862, 1983.

• 5881, "Suckling Activity and Calf Growtb in a Group of Crossbred Cows Eacb Rearing Two Foster Calves," J.G. Rosecrans and W.D. Hobenboken, Applied Animal Etbology, pages 131-140, 1982-83.

• 5931, "Feather and Hair Meals for Ruminants. I. Effect of Degree of Processing on Utilization of Feather Meal," A.O. Aderibigbe and D.C. Cburch, Journal of Animal Science, Volume 56, pages 1198-1207, 1983.

• 5932, "Feather and Hair Meals for Ruminants. II. Comparative Evaluation of Feather and Hair Meals as Protein Supplements," A.O. Aderibigbe and D.C. Church, Journal of Animal Science, Volume 57, pages 473-482, 1983.

• 5933, "Feather and Hair Meals for Ruminants. III. Relationship Between Enzymatic or *in vitro* Rumen Digestibility and *in vivo* Digestibility of Diets Containing Feather and Hair Meals," A.O. Aderibigbe and D.C. Church, Journal of Animal Science, Volume 57, pages 483-494, 1983.
• 5999, "Feather and Hair Meals for Ruminants. IV. Effects of Chemical Treatment of Feathers and Processing Time on Digestibility," R.J. Steiner, R.O. Kellems and D.C. Church, Journal of Animal Science, Volume 57, pages 495-502, 1983.
• 6165, "Suhcellular Distrihution of Hepatic Copper, Zinc and Iron and Serum Ceruloplasmin in Rats Intoxicated by Oral Pyrrolizdine (*Senecio*) Alkaloids," R.A. Swick, P.R. Cheeke and D.R. Buhler, Journal of Animal Science, Volume 55, Numher 6, pages 1425-1430, 1983.
• 6166, "Effect of Dietary *Senecio* Alkaloids and Monocrotaline on Guinea Pigs," R.A. Swick, P.R. Cheeke, D.E. Goeger and D.R Buhler, Journal of Animal Science, Volume 55, Numher 6, pages 1411-1416, 1983.
• 6167, "Absorption and Excretion of Pyrrolizidine (*Senecio*) Alkaloids and Their Effects on Mineral Metaholism in Rahhits," R.A. Swick, P.R. Cheeke, N.M. Patton and D.R. Buhler, Journal of Animal Science, Volume 55, Number 6, pages 1417-1424, 1983.
• 6168, "Effect of Phenobarhital on Toxicity of Pyrrolizidine (Senecio) Alkaloids in Sheep," R.A. Swick, Cristohal L. Miranda, Peter R. Cheeke and Donald R. Buhler, Journal of Animal Science, Volume 56, pages 887-894, 1983.
• 6169, "Effect of Sheep Rumen Fermentation and Methane Inhihition on the Toxicity of *Senecio jacobaea*," R.A. Swick, P.R. Cheeke, H.S. Ramsdell and D.R. Buhler, Journal of Animal Science, Volume 56, Numher 3, pages 645-651, 1983.
• 6274, "The Effect of Exogenous Follicle Stimulating Hormone Treatment on Anterior Pituitary and Testicular Function in the Prepubertal Bull," S.A. Meyers and L.V. Swanson, Journal of Andrology, Volume 4, pages 371-377, Nov.-Dec. 1983.
• 6301, "Prolactin Binding Sites in the Uterus of the Mink," Jack Rose, Fredrick Stormshak, John Adair and James E. Oldfield, Molecular and Cellular Endocrinology, Volume 31, pages 131-139, 1983.
• 6399, "An Evaluation of Acetone Extracts from Six Plants in the Ames Mutagenicity Test," Randy D. White, Paul H. Krumperman, Peter R. Cheeke, and Donald R. Buhler, Toxicology Letters, Volume 15, pages 25-31, 1983.
• 6405, "Canola Meal as a Protein Supplement in Dairy Rations," J.M. Sanchez and D.W. Claypool, Journal of Dairy Science, Volume 66, pages 80-85, 1983.
• 6543, "Effect of Prerigor Pressurization on the Retail Characteristics of Beef," M. Koohmaraie, W.H. Kennick, E.A. Elgasim, R.L. Dickson and W.E. Sandine, Journal of Food Science, Volume 48, pages 998-999, 1983.
• 6547, "Meadowfoam (*Limnanthes alba*) Meal as a Feedstuff for Dairy Goats and Toxicologic Activity of the Milk," R.D. White and P.R. Cheeke, Canadian Journal of Animal Science, Volume 63, pages 391-398, 1983.
• 6609, "Doe Reproduction and Preweaning Litter Performance of Straightbred and Crossbred Rahhits," Steven Lukefahr, W.D. Hohenboken, P.R. Cheeke and N.M. Patton, Journal of Animal Science. Volume 57, Number 5, pages 1090-1099, 1983.
• 6610, "Characterization of Straighthred and Crosshred Rabhits for Milk Production and Associative Traits," Steven Lukefahr, W.D. Hohenhoken, P.R. Cheeke and N.M. Patton, Journal of Animal Science, Volume 57, Numher 5, pages 1100-1107, 1983.
• 6611, "Breed, Heterotic and Diet Effects on Postweaning Litter Growth and Mortality in Rahhits," Steven Lukefahr, W.D. Hohenhoken, P.R. Cheeke and N.M. Patton, Journal of Animal Science, Volume 57, Numher 5, pages 1108-1116, 1983.
• 6612, "Appraisal of Nine Genetic Groups of Rahhits for Carcass and Lean Yield Traits," Steven Lukefahr, W.D. Hohenhoken, P.R. Cheeke and N.M. Patton, Journal of Animal Science, Volume 57, Numher 4, pages 899-907, 1983.
• 6688, "Effect of Prerigor Pressurization on Bovine Lysosomal Enzyme Activity," E.A. Elgasim, W.H. Kennick, A.F. Anglemier, M. Koohmaraie, E.A. El-Khalifa, Journal of Food Microstructure, Volume 2, pages 91-97, 1983.
• 6697, "Feeding Value of Dried Liquefied Pacific Whiting Product for Broilers," H.S. Nakaue, R.O. Kellems and G.H. Arscott, Nutrition Reports International, Volume 27, Numher 6, pages 1163-1168, 1983.
• 6735, "Feed Preference Responses of Several Avian Species Fed Alfalfa Meal, High and Low Saponin Alfalfa, and Quinine Sulfate," P.R. Cheeke, J.S. Powley, H.S. Nakaue and G.H. Arscott, Canadian Journal of Animal Science, Volume 63, pages 707-710, 1983.
• 6756, "Storage and Case-Life Characteristics of Beef as Affected hy Prerigor Pressurization," Mohammad Koohmaraie, Walter H. Kennick, E.A. Elgasim and Rohert L. Dickson, Journal of Food Protection, Volume 46, pages 878-882, 1983.
• 6773, "The Effects of Sodium Bentonite on Performance and Feed Preference of Weanling Rahhits," M.A. Grohner, P.R. Cheeke and N.M. Patton, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 133-137, 1983.
• 6780, "Toxicity of *Senecio jacobaea* and Pyrrolizidine Alkaloids in Various Lahoratory Animals and Avian Species," P.R. Cheeke and M.L. Pierson-Goeger, Toxicology Letters, Volume 18, pages 343-349, 1983.
• 6781, "Phenotypic Relationships Between Ewe Lamh Traits and Lifetime Production Efficiency," Naheel B. Saoud and William D. Hohenhoken, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 21-24, 1983.
• 6782, "Inheritance of Maternal Immunoglohulin G1 Concentration hy the Bovine Neonate," Noelle E. Muggli, William Hohenhoken, L.V. Cundiff and Keith W. Kelley, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 260-262, 1983.
• 6783, "Effects of Dietary Supplementation with BHA, Cysteine and B Vitamins on Tansy Ragwort Toxicity in Horses," D.W. Holtan, B.J. Garrett and P.R. Cheeke, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 183-186, 1983.
• 6784, "Utilization of Raw and Heat-Treated Soyheans and Pinto Beans hy Weanling Rahhits, W.K. Sanchez, P.R. Cheeke and N.M. Patton, Proceedings, Western Section, Society of Animal Science, Volume 34, pages 150-153, 1983.
• 6787, "Evaluation of Liquefied Dover Sole Fillet Scraps as a Supplemental Protein Source for Swine," Y.C. Wu and R.O. Kellems, Proceedings, Western Section, American Society of Animal Science, Volume 43, pages 154-157, 1983.
• 6788, "Sheep Digestibility and Performance Evaluations of Feather Meals Treated with Sodium Hydroxide (1%, 2%, 4%) Before Steam Processing," J.C. Buckley and Richard O. Kellems, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 280-283, 1983.
• 6795, "Methods of Assessing Temperature Influence on Performance and Carcass Traits of Barrows Fed 11 or 14% Crude Protein Corn-Soy Rations," Paul T. Bellatty and David C. England, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 130-132, 1983.
• 6804, "Industrial Wastes as Soil Amendments for Orchardgrass as a Selenium Source for Grazing Livestock," Eve Finkelstein and J.E. Oldfield, Proceedings, Western Section, American Society of Animal Science, Volume 34, pages 176-178, 1983.

Botany and Plant Pathology

• 5795, "Pea Streak and Alfalfa Mosaic Viruses in Alfalfa: Viruses Infectious to *Pisum* Peas," R.O. Hampton and K.A. Weher, Plant Disease, Volume 67, pages 308-310, 1983.
• 6151, "Rose Powdery Mildew and Its Control in the Greenhouse and Field," D.L. Coyier, Plant Disease, Volume 67, pages 919-923, 1983.
• 6236, "Influence of *Meloidogyne hopla*, Chitwood, 1949 on the Development and Estahlishment of *Heterodera schachtii*, Schmidt, 1871 on *Beta vulgaris* L.," Parviz Jatala and Harold J. Jensen, Journal of Nematology, Volume 15, pages 564-566, 1983.
• 6242, "Systemic Nematicides Control the Mint Nematode in Estahlished Peppermint Plantings," J.N. Pinkerton and H.J. Jensen, Plant Disease, Volume 67, pages 201-203, 1983.
• 6248, "Control of Stuhhy Root Nematodes in Onions with Oxamyl," T.E. Nishimura, H.J. Jensen and J.N. Pinkerton, Plant Disease, Volume 67, pages 43-44, 1983.
• 6281, "Pea Streak Virus Transmission from Alfalfa to Peas: Virus-Aphid and Virus-Host Relationships," R.O. Hampton and K.A. Weher, Plant Disease, Volume 67, pages 305-307, 1983.
• 6351, "An Improved Buffer for Mechanical Transmission of Viruses from *Fragaria* and *Rubus*," R.R. Martin and R.H. Converse, Acta Horticulturae, Volume 129, pages 69-74, 1982.
• 6364, "Pathogenic Seedhorne *Fusarium oxysporum* from Douglas-fir," J.H. Graham and R.G. Linderman, Plant Disease, Volume 67, pages 323-325, 1983.
• 6393, "Association of Viral, Bacterial and Fungal Pathogens with Vascular Discoloration of Russet Burhank Potato Tubers," R.G. Clarke, M.L. Powelson and L. Beraha, American Potato Journal, Volume 60, pages 235-243, 1983.
• 6430, "Evaluation of Boehringer Mannheim ELISA Kits for the Detection of Potato Viruses," T.C. Allen and J.P. McMorran, American Potato Journal, Volume 60, pages 369-373, 1983.
• 6448, "Detection of 41 Isolates of Necrotic Ringspot, Apple Mosaic, and Prune Drawf Viruses in *Prunus* and *Malus* by Enzyme-Linked Immunosorbant Assay," J.P. McMorran and H.R. Cameron, Plant Disease, Volume 67, pages 536-538, 1983.

• 6463, "Crown Gall of Pecan: A Survey of *Agrobacterium* Strains and Potential for Biological Control in Georgia," H. Bouzar, L.W. Moore and N.W. Scbaad, Plant Disease, Volume 67, pages 310-312, 1983.
• 6464, "Analysis of Spore Dispersal Gradients of *Botrytis cinerea* and Gray Mold Disease Gradients in Snap Beans," K.B. Johnson and M.L. Powelson, Phytopathology, Volume 73, pages 741-746, 1983.
• 6491, "Bean Common Mosaic Virus Strains Associated witb Mosaic Epidemics in the Northwestern U.S.A.," R.O. Hampton, M.J. Silbernagel and D.W. Burke, Plant Disease, Volume 67, pages 658-661, 1983.
• 6492, "Recovery of Tomato Spotted Wilt Virus from Hydrangea and Four Weed Species," T.C. Allen, J.P. McMorran and E.A. Locatelli, Plant Disease, Volume 67, pages 429-431, 1983.
• 6539, "Effects of Application Rate and Cold Soaking Pretreatment of *Pisolithus* Spores on Effectiveness as Nursery Inoculum on Western Conifers," J.M. Trappe and I.F. Alvarez, Canadian Journal of Forest Research, Volume 13, pages 464-468, 1983.
• 6562, "Enzyme Activity in Dormant Spores of Two *Telletia* Species," S.-q. Yu and E.J. Trione, Phytopatbology, Volume 73, pages 1423-1428, 1983.
• 6567, "Effects of Ethylene and Fungicide Dips During Cold Storage on Root Regeneration and Survival of Western Conifers and Their Mycorrbizal Fungi," I.F. Alvarez and R.G. Linderman, Canadian Journal of Forest Research, Volume 13, pages 962-971, 1983.
• 6584, "Strategies for Detecting and Cbaracterizing Systems for Biological Control of Soilborne Plant Pathogens," R.G. Linderman, L.W. Moore, K.F. Baker and D.A. Cooksey, Plant Disease, Volume 67, pages 1058-1064, 1983.
• 6594, "Effect of Container Plant Growtb Medium and Fertilizer Pbospborus on Establishment and Host Growtb Response to Vesicular-Arbuscular Mycorrbizae," B. Biermann and R.G. Linderman, Journal of the American Society for Horticultural Science, Volume 108, pages 962-971, 1983.
• 6596, "Use of Vesicular-Arbuscular Mycorrhizal Roots, Intraradical Vesicles and Extraradical Vesicles as Inoculum," B. Biermann and R.G. Linderman, New Phytologist, Volume 95, pages 97-105, 1983.
• 6597, "Increased Geranium Growth Using Pre-transplant Inoculation witb Mycorrhizal Fungus," B. Biermann and R.G. Linderman, Journal of the American Society for Horticultural Science, Volume 108, pages 972-976, 1983.
• 6614, "Influence of Prebloom Disease Establishment by *Botrytis cinerea* and Environmental and Host Factors on Gray Mold Pod Rot of Snap Bean," K.B. Jobnson and M.L. Powelson, Plant Disease, Volume 67, pages 1198-1202, 1983.
• 6636, "Effect of Root Zone Temperature on VA and Ectomycorrbiza Formation in Disturbed and Undisturbed Forest Soils of Southwest Oregon," J.L. Parke, R.G. Linderman and J.M. Trappe, Canadian Journal of Forest Researcb, Volume 13, pages 657-665, 1983.
• 6638, "The Role of Ectomycorrhizae in Drougbt Tolerance of Douglas-fir Seedlings," J.L. Parke, R.G. Linderman and C.H. Black, New Phytologist, Volume 95, pages 83-95, 1983.
• 6639, "Effects of Forest Litter and Humus on Mycorrbiza Development and Growtb of Douglas-fir and Western Red Cedar Seedlings," J.L. Parke, R.G. Linderman and J.M. Trappe, Canadian Journal of Forest Researcb, Volume 13, pages 666-671, 1983.
• 6696, "The Occurrence of Viruses in Some Indexed Strawberry Clones," R.H. Converse, Proceedings, Horticultural Society, Volume 74, pages 148-150, 1983.
• 6714, "Virus-Tested Blueberry Cultivars Are on the Way," R.H. Converse, Proceedings, Nortb American Blueberry Council, Volume 18, pages 72-77, 1983.
• 6838, "Pea Leaf Roll in Nortbwestern U.S.A. Pea Seed Production Areas," R.O. Hampton, Plant Disease, Volume 67, pages 1306-1310, 1983.

Columbia Basin Agricultural Research Center

• 6009, "Effect of Grain Drill Opener on Wheat Emergence," D.E. Wilkins, G.A. Muilenburg, R.R. Allmaras and C.E. Johnson, Transactions, American Society of Agricultural Engineers, Volume 26, Number 3, pages 651-655 & 660, 1983.
• 6285, "Runoff and Soil Erosion on Frozen Soils in Northeastern Oregon," John F. Zuzel, R.R. Allmaras and R. Greenwalt, Journal of Soil and Water Conservation, Volume 37, Number 6, pages 351-354, November/December 1982.
• 6498, "Effects of Lodging on Yield and Quality of Soft White Wheat," F.V. Pumphrey and G.L. Rubentbaler, Cereal Cbemistry, Volume 60, Number 4, pages 268-270, 1983.

• 6678, "Time Distributions for Describing Appearance of Specific Culms of Winter Wheat," R.W. Rickman, B.L. Klepper and Curt M. Peterson, Agronomy Journal, Volume 75, pages 551-556, May/June, 1983.
• 6709, "Leaf and Tiller Identification of Wheat Plants," Betty Klepper, R.W. Rickman and R.K. Belford, Crop Science, Volume 23, pages 1002-1004, September/October, 1983.
• 6758, "Rain on Snow: Sballow, Transient Snowpacks with Frozen Soils," J.F. Zuzel, R.N. Greenwalt and R.R. Allmaras, Proceedings, Western Snow Conference, pages 67-75, April 19-21, 1983.

Crop Science

• 5645, "Cytological Examinations of Two Tall Fescue Genotypes and Tbeir Sterile Hybrids," P.R. Beuselinck, R.M. Vasquez, R.V. Frakes and D.O. Chilcote, Crop Science, Volume 23, pages 485-487, 1983.
• 6290, "Registration of Indore Rapeseed," Wheeler Calhoun, G.D. Jolliff and J.M. Crane, Crop Science, Volume 23, page 184, 1983.
• 6296, "A Comparison Between Glyphosate and Assimilate Translocation Patterns in Tall Morningglory (*Ipomoea purpurea*)," Steven A. Dewey and Arnold P. Appleby, Weed Science, Volume 31, pages 308-314, 1983.
• 6599, "Response of Wheat (*Triticum aestivum*) and Rotation Crops to Chlorsulfuron," Bill Brewster and Arnold P. Appleby, Weed Science, Volume 31, pages 861-865, 1983.
• 6625, "Genetic and Non-Genetic Effects on Hop Quality," Alfred Haunold, S. T. Likens, Gail B. Nickerson and R.O. Hampton, Proceedings, Scientific Commission of the International Hop Growers' Convention, pages 54-71, 1983.
• 6629, "An Interactive Computer Program for Plotting Bar and Line Graphs," David B. Hannaway, David Fuhrer and Henry A. Fribourg, Agronomy Journal, Volume 75, pages 844-845, 1983.
• 6669, "Starch Syntbesis in Shriveled and Plump Triticale Seeds," Te May Cbing, Chris J. Poklemba and Robert Metzger, Plant Pbysiology, Volume 73, pages 652-657, 1983.
• 6670, "Registration of USDA 63015M Male Hop Germplasm (Reg. No. GP 14)," Alfred Haunold, S.T. Likens, G.B. Nickerson, C.E. Horner and R.O. Hampton, Crop Science, Volume 23, pages 600-601, 1983.
• 6684, "Yield and Quality Potential of Hop, *Humulus lupulus* L.," A. Haunold, G.B. Nickerson and S.T. Likens, American Society of Brewing Chemists, Volume 41, Number 2, pages 60-63, 1983.
• 6690, "Reduction of Hardseededness in Crownvetcb (*Coronilla varia* L.) Seed Lots," A.E. Garay and D.F. Grabe, Journal of Applied Seed Production, Volume 1, Number 1, pages 1-7, 1983.

Eastern Oregon Agricultural Research Center, Squaw Butte

• 6182, "Manipulation of Flood Meadow Vegetation and Observations on Small Mammal Populations," J.E. Cornely, C.M. Britton and F.A. Sneva, The Prairie Naturalist, Volume 15, Number 1, pages 16-22, Marcb 1983.
• 6288, "Nitrogen Fertilization Effects on the Essential Oils in Sagebrusb," Forrest A. Sneva, A. Winward and R. Kelsey, Northwest Science, Volume 57, Number 2, pages 143-146, 1983.
• 6537, "Big Sagebrusb Control with Tebuthiuron," C.M.Britton and F.A. Sneva, Journal of Range Management, Volume 36, Number 6, pages 707-708, November 1983.
• 6617, "Effects of Soil Moisture on Burned and Clipped Idaho Fescue," C.M. Britton, R.G. Clark and F.A. Sneva, Journal of Range Management, Volume 36, Number 6, pages 708-710, November 1983.
• 6685, "The Concentration and Composition of Big Sagebrusb Essential Oils from Oregon," Rick G. Kelsey, William E. Wright, Forrest Sneva, Al Winward and Carlton Britton, Biocbemical Systematics and Ecology, Volume 11, Number 4, pages 353-360, 1983.

Eastern Oregon Agricultural Research Center, Union Station

• 5715, "Drought Effects on Diet and Weight Gains of Yearling Heifers in Nortbeastern Oregon," J.L. Holechek, and M. Vavra, Journal of Range Management, Volume 36, pages 227-231, 1983.
• 5919, "Fistula Sample Numbers Required to Determine Cattle Diets on Forest and Grassland Ranges," J.L. Holecbek and M. Vavra, Journal of Range Management, Volume 36, pages 323-324, 1983.
• 6292, "A Comparison of Four Methods Used to Determine tbe Diets of Large Herbivores," M.L. McInnis, M. Vavra and W.C. Krueger, Journal of Range Management, Volume 36, pages 302-306, 1983.

Entomology

• 5409, "Three New Species of *Macrocheles* (Acari: Gamasida: Macrochelidae) Associated Witb 3-Toed Slotbs, *Bradypus* spp. (Edentata: Bradypodidae) in Brazil and Surinam," G.W. Krantz, Acarologia, Volume 24, pages 3-12, 1983.
• 6170, "Patbogenicity of *Ascosphaera* Species for Larvae of *Megachile rotundata*," J.D. Vandenberg and W.P. Stephen, Journal of Apicultural Research, Volume 22, pages 57-63, 1983.

• 6214, "Density of Fisb and Salamanders in Relation to Riparian Canopy and Pbysical Habitat in Streams of the Nortbwestern United States," C.P. Hawkins, M.L. Murpby, N.H. Anderson and M.A. Wilzbach, Canadian Journal of Fisheries and Aquatic Sciences, Volume 40, pages 1173-1185, 1983.

• 6221, "Monitoring tbe Filbertworm, *Melissopus latiferreanus* with Sex Attractant Traps. Effect of Trap Design, Elevation and Placement on Motb Catches," M.T. AliNiazee, Environmental Entomology, Volume 12, pages 141-147, 1983.

• 6222, "Effect of Summer Moisture Stress on tbe Capacity of Tansy Ragwort (*Senecio jacobaea*) to Compensate for Defoliation by Cinnabar Moth (*Tyria jacobaeae*)," C.S. Cox and P.B. McEvoy, Journal of Applied Ecology, Volume 20, pages 225-234, 1983.

• 6254, "Evidence for Spider Mite (Acari: Tetranychidae) Injury-Induced Leaf Water Deficits and Osmotic Adjustment in Peppermint," J.D. DeAngelis, Ralpb E. Berry and G.W. Krantz, Environmental Entomology, Volume 12, pages 336-339, 1983.

• 6262, "Attractants for Several Genera and Species of Wireworms (Coleoptera: Elateridae)," J.A. Kamm, H.G. Davis and L.M. McDonough, Coleopterists Bulletin, Volume 27, pages 16-18, 1983.

• 6297, "Photosynthesis, Leaf Conductance, and Leaf Chloropbyll Content in Spider Mite-Injured Peppermint Leaves," J.D. DeAngelis, Ralph E. Berry and G.W. Krantz, Environmental Entomology, Volume 12, pages 345-348, 1983.

• 6310, "Tbe Pupa of the Elmid Beetle, *Lara avara* (Coleoptera: Dryopoidea: Elmidae)," Robert J. Steedman, Aquatic Insects, Volume 5, pages 17-19, 1983.

• 6327, "Response of the Alfalfa Seed Cbalcid, *Bruchophagus roddi*, to Alfalfa Volatiles," J.A. Kamm and R.G. Buttery, Entomologia Experimentalis et Applicata, Volume 33, pages 129-134, 1983.

• 6425, "Influence of Spider Mite (Acari: Tetranychidae) Injury on Essential Oil Metabolism in Peppermint," J.D. DeAngelis, Ralpb E. Berry, Anna Marin, and G.W. Krantz, Environmental Entomology, Volume 12, pages 522-527, 1983.

• 6440, "Cytochrome P-450 in Insects. 5. Monoterpene Induction of Cytochrome P-450 and Associated Monooxygenase Activities in the Larvae of the Variegated Cutworm *Peridroma sauca* (Hubner)," Alison F. Moldenke, Ralpb E. Berry and L.C. Terriere, Comparative Biochemistry and Physiology, Volume 74C, pages 365-371, 1983.

• 6453, "*Tropilaelaps clareae*: A Parasite of Honeybees in Southeast Asia," M. Burgett, P. Akratanakul and R.A. Morse, Bee World, Volume 64, pages 25-28, 1983.

• 6484, "The Types of Cercerine Wasps Described by Nathan Banks (Hymenoptera: Philanthidae)," G.R. Ferguson, Journal of New York Entomological Society, Volume 91, pages 223-234, 1983.

• 6499, "Polysubstrate Monooxygenases (Cytochrome P-450) in Larvae of Susceptihle and Resistant Strains of House Flies," R. Feyereisen, Pesticide Biocbemistry and Pbysiology, Volume 19, pages 262-269, 1983.

• 6518, "Developmental Biology of *Apanteles californica* hy *Apanteles yakutatensis* on Peppermint in Oregon," R. Madar and J.C. Miller, Annals of Entomological Society of America, Volume 76, pages 683-687, 1983.

• 6519, "Parasitism of *Autographa californica* by *Apanteles yakutatensis* on Peppermint in Oregon," R. Madar and J.C. Miller, Environmental Entomology, Volume 12, pages 1103-1106, 1983.

• 6555, "Bacterial Activity Associated witb tbe Decomposition of Woody Substrates in a Stream Sediment," J.H. Baker, R.Y. Morita and N.H. Anderson, Applied and Environmental Microbiology, Volume 45, pages 516-521, 1983.

• 6589, "Two New Species in the Genus *Philanthus* and a Key to the *Politus* Group (Hymenoptera: Philanthidae)," G.R. Ferguson, Pan-Pacific Entomologist, Volume 59, pages 55-63, 1983.

• 6613, "Ecological Relationships Among Parasites and the Practice of Biological Control," J.C. Miller, Environmental Entomology, Volume 12, pages 620-624, 1983.

• 6635, "Management Practices for Cranberry Girdler (Lepidoptera: Pyralidae) in Douglas-fir Nursery Stock," J.A. Kamm, P.D. Morgan, D.L. Overbulser, L.M. McDonougb, M. Triebwasser and L.N. Kline, Journal of Economic Entomology, Volume 76, pages 923-926, 1983.

• 6661, "Two New Species and Synonymy of Three Species of Nortb American *Cerceris* (Hymenoptera: Philanthidae)," G.R. Ferguson, Journal of New York Entomological Society, Volume 91, pages 235-241, 1983.

• 6668, "Evaluation of tbe PETE Pbenology Modeling System for IPM of Deciduous Tree Fruits," B.A. Croft and A.L. Knigbt, Bulletin of Entomological Society of America, Volume 29, pages 37-42, 1983.

• 6683, "Host-Related Alterations of Detoxification Enzymes in *Tetranychus urticae* (Acarina: Tetranychidae)," C.A. Mullin and B.A. Croft, Environmental Entomology, Volume 12, pages 1274-1277, 1983.

• 6700, "Differential Tolerance or Resistance to Insecticides in *Typhlodromus arboreus* and Associated Pbytoseiid Mites of Apple in tbe Willamette Valley, Oregon," B.A. Croft and M.T. AliNiazee, Environmental Entomology, Volume 12, pages 1420-1424, 1983.

• 6706, "Pest Status of Filbert Insects in Oregon Orchards: A Ten-Year Study," M.T. AliNiazee, Canadian Entomologist, Volume 115, pages 1155-1162, 1983.

• 6707, "Carbaryl Resistance in the Filbert Apbid," M.T. AliNiazee, Journal of Economic Entomology, Volume 76, pages 1002-1004, 1983.

• 6791, "Self-Catalyzed Destruction of Insect Cytochrome P-450," R. Feyereisen, K.C. Langry and P.R. Ortiz De Montellano, Insect Biocbemistry, Volume 14, pages 19-26, 1983.

Family Resource Management

• 6269, "Dwelling Energy Efficiency and Home Energy Conservation Policies: A Western U.S. Perspective," Lou A. Guthrie and Jeanette A. Brandt, Journal of Consumer Studies and Home Economics, Volume 7, pages 307-319, 1983.

• 6689, "The Effects of Homemakers' Employment Level and Age Level of the Youngest Child on Time Use in Two-Parent, Two-Child Families," Geraldine Olson, Proceedings, 22nd Annual Western Regional Home Management-Family Economic Educators Conference, November 1982.

• 6712, "Energy Directions: An Oregon Perspective," Susan Badenbop and M. Marganus, Proceedings, 1983 Agricultural Conference Days, March 1983.

Fisheries and Wildlife

• 5989, "Distribution and Productivity of Nesting Bald Eagles in Oregon, 1978-1982," F.B. Isaacs, R.G. Anthony and R.J. Anderson, The Murrelet, Volume 64, pages 33-38, 1983.

• 6201, "Notes on the Marine Life of tbe River Lamprey, *Lampetra ayresi*, in Yaquina Bay, Oregon, and tbe Columbia River Estuary," C.E. Bond and T.T. Kan, Fisbery Bulletin, Volume 81, Number 1, pages 165-167, 1983.

• 6260, "Survival of Mallard Broods in South-Central Nortb Dakota," L.G. Talent, R.L. Jarvis and G.L. Krapu, Condor, Volume 85, pages 74-78, 1983.

• 6279, "Observations of Nesting Townsend's Warblers in Northeastern Oregon," R.W. Mannan, B.S. Hale and M.L. Morrison, The Murrelet, Volume 64, Number 1, pages 23-25, 1983.

• 6381, "Effects of Steroids and Steroid Antagonists on Growtb, Gonadal Development, and RNA/DNA Ratios in Juvenile Steelhead Trout," S.A. Sower, C.B. Schreck and M. Evenson, Aquaculture, Volume 32, pages 243-254, 1983.

• 6412, "Habitat Use by Female Roosevelt Elk, Oregon Coast Range," G.W. Witmer and D.S. deCalesta, Journal of Wildlife Management, Volume 47, pages 933-939, 1983.

• 6510, "Status and Life History Notes on tbe Native Fisbes of tbe Alvord Basin, Oregon and Nevada," J.E. Williams and C.E. Bond, Great Basin Naturalist, Volume 43, Number 3, pages 409-420, 1983.

• 6653, "Influence of Ambient Salinity on Osmoregulation and Cortisol Concentration in Yearling Cobo Salmon During Stress," J.M. Redding and C.B. Schreck, Transactions, American Fisberies Society, Volume 112, pages 800-807, 1983.

• 6705, "Glucuronidation and Biliary Excretion of Pbenolphthalein in Temperature-Acclimated Steelhead Trout (*Salmo gairdneri*)," L.R. Curtis, Comparative Biochemistry and Pbysiology, Volume 76C, pages 107-111, 1983.

• 6737, "*Sylvilagus nuttallii*: a Semiarboreal Lagomorpb," B.J. Verts, S.D. Gebman and K.J. Hundertmark, Journal of Mammalogy, Volume 65, pages 131-135, 1983.

• 6842, "Snag Use by Birds in Douglas-fir Clear cuts," B.G. Marcot, pages 134-139 in J.W. Davis, G.A. Goodwin and R.A. Ockenfels, tecb. coords., Snag Habitat Management: Proceedings of tbe Symposium, USDA Forest Service General Technical Report RM-99, 229 pages.

• 6910, "Monitoring Wildlife Habitat and Validation of Wildlife-Habitat Relationships Models," B.G. Marcot, M.G. Rapbael and K.H. Berry, Nortb American Wildlife and Natural Resources Conference, Volume 48, pages 315-329, 1983.

Food Science and Technology

• 5375, "HPLC Analysis of Cyclopropenoid Fatty Acids," P.M. Loveland, N.E. Pawlowski, L.M. Libbey, G.S. Bailey and J.E. Nixon, Journal of the American Oil Chemists Society, Volume 60, Numher 10, pages 1786-1788, 1983.

• 6141/6193, "Effects of Processing on the Sodium-Potassium and Calcium-Pbosphorus Content in Foods," C.J. Wyatt and K. Ronan, Journal of Agricultural and Food Chemistry, Volume 31, Numher 2, pages 415-420, 1983.

• 6178, "Dietary Antioxidant Effects on the Hepatic Mixed-Function Oxidase System of Rainbow Trout (*Salmo gairdneri*)," T.A. Eisele, R.O. Sinnhuber and J.E. Nixon, Food and

Chemical Toxicology, Volume 21, Number 3, pages 273-277, 1983.

• 6361, "The Effect of High Protein and High Carhohydrate Diets on ^{125}I-Insulin Binding in Skeletal Muscle Plasma Memhranes and Isolated Hepatocytes of Rainbow Trout (*Salmo gairdneri*)," R.F. Ablett, M.J. Taylor and D.P. Selivonchick, British Journal of Nutrition, Volume 50, pages 129-139, 1983.

• 6370, "Histopathology of Four Spontaneous Neoplasms in Three Species of Salmonid Fishes," T.R. Meyers and J.D. Hendricks, Journal of Fish Diseases, Volume 6, pages 481-499, 1983.

• 6383, "A Summary of Tissue Lesions in Aquatic Animals Induced hy Controlled Exposures to Environmental Contaminants, Chemotherapeutic Agents, and Potential Carcinogens," T.R. Meyers and J.D. Hendricks, Marine Fisheries Review, Volume 44, Numher 12, pages 1-17, 1982.

• 6424, "Potassium Sorhate Inhihition of Microorganisms Isolated from Seafood," Y.M. Chung and J.S. Lee, Journal of Food Protection, Volume 45, Numher 14, pages 1310-1313, Decemher 1982.

• 6438, "Inhihitory Effect of Aroclor 1254 on Aflatoxin-Initiated Carcinogenesis in Rainbow Trout and Mutagenesis Using a *Salmonella*/Trout Hepatic Activation System," D.W. Shelton, R.A. Coulomhe, C.B.Pereira, J.L. Casteel and J.D. Hendricks, Aquatic Toxicology, Volume 3, pages 229-238, 1983.

• 6477, "Cysteine as an Inhihitor of Browning in Pear Juice Concentrate," M.W. Montgomery, Journal of Food Science, Volume 48, pages 951-952, 1983.

• 6507, "1-Methylcyclohex-2-en-1-ol as an Aggregation Pheromone of *Dendroctonus pseudotsugae*," L.M. Lihhey, L.C. Ryker and A.C. Oehlschlager, Journal of Chemical Ecology, Volume 9, pages 1533-1541, 1983.

• 6533, "Acceptahility of Reduced Sodium in Breads, Cottage Cheese, and Pickles," C.J. Wyatt, Journal of Food Science, Volume 48, Numher 4, pages 1300-1302, 1983.

• 6544, "Multiple Antihiotic Resistance Indexing of *Escherichia coli* to Identify High-Risk Sources of Fecal Contamination of Foods," P.H. Krumperman, Applied and Environmental Microbiology, Volume 46, Numher 1, pages 165-170, April 1983.

• 6549, "Identification and Mutagenicity of Aflatoxicol-M$_1$ Produced hy Metaholism and Aflatoxin B$_1$ and Aflatoxicol hy Liver Fractions from Rainhow Trout (*Salmo gairdneri*) Fed β-Naphthoflavone," P.M. Loveland, R. A. Coulombe, L.M. Libbey, N.E. Pawlowski, R.O. Sinnhuber, J.E. Nixon and G.S. Bailey, Food Chemical Toxicology, Volume 21, Number 5, pages 557-562, 1983.

• 6552, "Evaluation of a Modified AOAC Determination for Thiamin and Rihoflavin in Foods," D.E. MacBride and C.J. Wyatt, Journal of Food Science, Volume 48, Numher 3, pages 748-750, 1983.

• 6553, "Formation and Occurrence of Nitrosamines in Food," R.A. Scanlan, Cancer Research (suppl.), Volume 43, pages 2435s-2440s, May 1983.

• 6607, "Proteolytic Activity in the Sarcoplasmic Fluids of Parasitized Pacific Whiting (*Merluccius productus*) and Unparasitized True Cod (*Gadus macrocephalus*)," M.C. Erickson, D.T. Gordon and A.F. Anglemier, Journal of Food Science, Volume 48, pages 1315-1319, 1983.

• 6657, "Effect of Washing on the Nutritional and Quality Characteristics of Dried Minced Rockfish Flesh," G.A. Adu, J.K. Babbitt and D.L. Crawford, Journal of Food Science, Volume 48, pages 1053-1055, 1983.

• 6673, "Time- and Dose-Dependent Effects of Dietary Cyclopropenoid Fatty Acids on the Hepatic Microsomal Mixed Function Oxidase System of Rainbow Trout," T.A. Eisele, R.A. Coulombe, J.L. Williams, D.W. Shelton and J.E. Nixon, Aquatic Toxicology, Volume 4, pages 139-151, 1983.

• 6682, "The Isolation of Skeletal Muscle Plasma Membranes from Rainbow Trout (*Salmo gairdneri*)," R.F. Ablett and D.P. Selivonchick, Comparative Biochemistry and Physiology, Volume 76B, pages 107-111, 1983.

• 6688, "Effect of Prerigor Pressurization on Bovine Lysomal Enzyme Activity," E.A. Elgasim, W.H. Kennick, A.F. Anglemier, M. Koohmaraie and E.A. El-Khalifa, Journal of Food Microstructure, Volume 2, pages 91-97, 1983.

• 6736, "Clarification of Pear Juice by Hollow Fiber Ultrafiltration," D.E. Kirk, M.W. Montgomery and M.G. Kortekaas, Journal of Food Science, Volume 48, pages 1663-1666, 1983.

• 6746, "Wine Grape Maturity and Wine Quality Standards from Other Countries of Interest to Oregon," D.A. Heatherhell, Proceedings, Oregon Horticultural Society, Volume 74, pages 306-312, 1983.

• 6747, "Potential Application of New Technologies to Oregon Wineries," D.A. Heatherhell, Proceedings, Oregon Horticultural Society, Volume 74, page 298, 1983.

• 6748, "An Overview of Ripening of Several Wine Grape Varieties in Western Oregon," B.T. Watson, D.A. Heatherbell and P.B. Lombard, Proceedings, Oregon Horticultural Society, Volume 74, pages 298-305, 1983.

• 6749, "Update of Industry Trials with O.S.U. Malolactic Bacteria," B.T. Watson and D.A. Heatherhell, Proceedings, Oregon Horticultural Society, Volume 74, pages 292-297, 1983.

• 6771, "Functional Aspects of Sweeteners," R.E. Wrolstad, Proceedings, Symposium on Beverages: Today's Health Concerns, AES Technical Bulletin, May 17, 1983.

• 6821, "The Effect of Indole-3-Carbinol, an Aflatoxin B$_1$ Hepatocarcinoma Inhihitor, and Other Indole Analogs on the Rainhow Trout Hepatic Mixed Function Oxidase System," T.A. Eisele, G.S. Bailey and J.E. Nixon, Toxicology Letters, Volume 19, pages 133-138, 1983.

• 6851, "Use of Sugar, Acid and Pigment Profiles in Detecting Adulteration in Fruit Juice Concentrates," R.E. Wrolstad, Proceedings, Detection of Juice Adulteration, sponsored by Association of FDA Officials, 1983.

Foods and Nutrition

• 6015, "Selenium Status of Vegetarians, Nonvegetarians, and Hormone-Dependent Cancer Subjects," Terry D. Shultz and James E. Leklem, The American Journal of Clinical Nutrition, Volume 37, pages 114-118, 1983.

• 6144, "Dietary Status of Seventh-Day Adventists and Nonvegetarians," Terry D. Shultz and James E. Leklem, Journal of the American Dietetic Association, Volume 83, pages 27-33, 1983.

• 6434, "Enterotoxin C2 Production by *S. aureus* in Entree Salads," Toshiko N. Morita and Margy Woodburn, Journal of Food Science, Volume 48, pages 243-254, 1983.

• 6469, "The Composition and Nutritional Adequacy of Subject-Selected High Carbohydrate, Low Fat Diets in Insulin-Dependent Diabetes Mellitus," Claire B. Hollenbeck, James E. Leklem, Matthew C. Riddle and William E. Conner, The American Journal of Clinical Nutrition, Volume 38, pages 41-51, 1983.

• 6503, "Increased Plasma Pyridoxal 5'-Phosphate and Vitamin B6 in Male Adolescents After a 4500-Meter Run," James E. Leklem and Terry D. Shultz, The American Journal of Clinical Nutrition, Volume 38, pages 541-548, 1983.

• 6520, "Influence of Ascorhic Acid Supplementation on Copper Status in Young Adult Men," Elizaheth B. Finley and Florian L. Cerklewski, The American Journal of Clinical Nutrition, Volume 37, pages 553-556, 1983.

• 6540, "Characteristics of Prerigor Pressurized Versus Conventionally Processed Beef Cooked hy Microwaves and by Broiling," L.M. Riffero and Z.A. Holmes, Journal of Food Science, Volume 48, pages 346-350, 374, 1983.

• 6557, "Vitamin Retention, Color and Texture in Thermally Process Green Beans and Royal Ann Cherries Packed in Pouches and Cans," O.S. Ahou-Fadel and L.T. Miller, Journal of Food Science, Volume 48, pages 920-923, 1983.

• 6691, "Influence of Maternal Magnesium Deficiency on Tissue Lead Content of Rats," Florian L. Cerklewski, Journal of Nutrition, Volume 113, pages 1443-1447, 1983.

• 6711, "Vitamin B6 and Exercise," James E. Leklem, Proceedings, 1983 Agricultural Conference Days, Oregon State University, pages 131-138, 1983.

• 6744, "Measurement of Glycosylated Vitamin B6 in Foods Treated with hetaglucosidase," Hossein Kabir, James E. Leklem and Lorraine T. Miller, Journal of Food Science, Volume 48, pages 1422-1435, 1983.

• 6837, "Relationship of the Glycosylated Vitamin B6 Content of Foods to Vitamin B6 Bioavailability in Humans," Hossein Kahir, James E. Leklem and Lorraine T. Miller, Nutrition Reports International, Volume 28, pages 709-716, 1983.

Horticulture

• 5388, "The Effect of Location and Plant Population on Carbohydrate Partitioning and Nitrogen Fixation of Two Bean (*Phaseolus vulgaris* L.) Cultivars in the Tropics," L. Waters, Jr., P.H. Graham, P.J. Breen, H.J. Mack and J.C. Rosas, Journal of Agricultural Science, Camhridge, Volume 100, pages 153-158, 1983.

• 5945, "Inoculation Methods for Corn Head Smut (*Spacelotheca reiliana*) Resistance Tests," J.R. Baggett and P.A. Koepsell, HortScience, Volume 18, pages 67-68, February 1983.

• 5960, "Responses of Excised Douglas-fir Shoots to Disorientation," C.J. Starbuck, W.M. Proehsting and A.N. Roherts, HortScience, Volume 18, pages 102-104, Fehruary 1983.

• 5995, "Compression Wood in Rooted Cuttings of Douglas-fir," C.J. Starhuck and A.N. Roberts, Physiologia Plantarum, Volume 57, pages 371-374, 1983.

• 6146, "Inheritance of a Leaf Distortion Tendency in Bush Lines of Beans, *Phaseolus vulgaris* L., of Blue Lake Background," A. Rahakoarihanta and J.R. Baggett, Journal of the American Society for Horticultural Science, Volume 108, pages 351-354, March 1983.

• 6231, "Effects of Pre- and Post-bloom Temperature Regimes on Development of

Lilium longiflorum Thunb.," A.N. Roberts, W.T. Wang and F.W. Moeller, Scientia Horticulturae, Volume 18, pages 363-379, 1982/83.

• 6255, "Modeling of Cold Hardiness of Red-osier Dogwood," K.D. Kohayashi, L.H. Fuchigami and C.J. Weiser, Journal of the American Society for Horticultural Science, Volume 108, pages 376-381, May 1983.

• 6282, "Modeling Temperature Effects in Breaking Rest in Red-osier Dogwood (*Cornus sericea* L.)," K.D. Kohayashi and L.H. Fuchigami, Annals of Botany, Volume 52, pages 205-215, 1983.

• 6329, "Modeling Bud Development During the Quiescent Phase in Red-osier Dogwood (*Cornus sericea* L.)," K.D. Kohayashi and L.H. Fuchigami, Agricultural Meteorology, Volume 28, pages 75-84, 1983.

• 6394, "Cluhroot Resistant Cabbage Breeding Lines Oregon 100, 123, 140, and 142," J.R. Baggett, HortScience, Volume 18, pages 112-114, February 1983.

• 6395, "Oregon 11 Early Parthenocarpic Tomato Breeding Line," J.R. Baggett and W.A. Frazier, HortScience, Volume 17, pages 984-985, December 1982.

• 6398, "High CO_2 Applied to Cuttings: Effects on Rooting and Suhsequent Growth in Ornamental Species," T.D. Davis and J.R. Potter, HortScience, Volume 18, pages 194-196, April 1983.

• 6400, "The Effect of Stratification and GA_3 on Germination of Filhert Seed as Influenced hy Dry Storage," E.S. Nussbaum and H.B. Lagerstedt, Proceedings, Nut Growers Society of Oregon, Washington and British Columbia, Volume 68, pages 86-92, 1983.

• 6459, "5-Methylthiorihose Kinase Activity in Plants," M.M. Kushad, D.G. Richardson and A.J. Ferro, Biochemical and Biophysical Research Communications, Volume 108, Number l, pages 167-173, 1982.

• 6462, "The Influence of Air and Soil Temperature on the Growth and Development of Easter Lily, *Lilium longiflorum*, During Different Growth Phases," Y.T. Wang and A.N. Roberts, Journal of the American Society for Horticultural Science, Volume 108, pages 810-815, September 1983.

• 6468, "Pear Rootstocks: Present and Future," M.N. Westwood and P.B. Lomhard, Fruit Varieties Journal, Volume 37, pages 24-28, January 1983.

• 6569, "Elemental Content of Douglas-fir Shoot Tips: Sampling and Variability," W.M. Proebsting and M.H. Chaplin, Communications in Soil Science and Plant Analysis, Volume 14, pages 353-362, May 1983.

• 6573, "Fertilizer and Plant Density Effects on Yield Performance and Leaf Nutrient Concentration of Bush Snap Beans," H.J. Mack, Journal of the American Society for Horticultural Science, Volume 108, pages 574-578, July 1983.

• 6579, "Interactive Effects of Ethylene Concentration and Storage Temperature on Bud Break and Viahility of Dormant 'Viva' Roses," S.E. Meadows and D.G. Richardson, HortScience, Volume 18, pages 453-454, August 1983.

• 6592, "Yield Response of Major Pod-Bearing Nodes in Bush Snap Beans to Irrigation and Plant Population," C.S. Mauk, P.J. Breen and H.J. Mack, Journal of the American Society for Horticultural Science, Volume 108, pages 935-939, November 1983.

• 6618, "Mechanical Harvest of Bramhles in Oregon," F.J. Lawrence and L.W. Martin, HortScience, Volume 18, page 136, April 1983.

• 6650, "Use of Canopy-Air Temperature Differentials as a Method for Scheduling Irrigations in Snap Beans," A.R. Bonnano and H.J. Mack, Journal of the American Society for Horticultural Science, Volume 108, pages 826-831, Septemher 1983.

• 6651, "Yield Components and Pod Quality of Snap Beans Grown Under Differential Irrigation," A.R. Bonnano and H.J. Mack, Journal of the American Society for Horticultural Science, Volume 108, pages 832-836, Septemher 1983.

• 6652, "Water Relations and Growth of Snap Beans as Influenced hy Differential Irrigation," A.R. Bonnano and H.J. Mack, Journal of the American Society for Horticultural Science, Volume 108, pages 837-844, Septemher 1983.

• 6729, "Reciprocal and Modifier Effects on Expression of the En Gene for Enation Mosaic Resistance," J.R. Baggett and R.O. Hampton, Pisum Genetics Newsletter, Volume 15, pages 3-6, 1983.

• 6739, "Intermediates in the Recycling of 5-Methylthiorihose to Methionine in Fruits," M.M. Kushad, D.G. Richardson and W.M. Proehsting, Plant Physiology, Volume 73, pages 257-261, 1983.

• 6740, "Transmissihle Factors Regulating Shoot Growth of *Cornus sericea* L.," W.M. Proebsting, Zeitschrift fur Pflanzenphysiologie, Volume 112, pages 191-198, Decemher 1983.

• 6809, "The Effects of Thidiazuron on Cytokinin Autonomy and the Metabolism of N^6-(Δ^2-isopentenyl) (8-^{14}C) Adenosine in Callus Tissues of *Phaseolus lunatus* L.," S.C. Capelle, D.W.S. Mok, S.C. Kirchner and M.C. Mok, Plant Physiology, Volume 73, pages 796-802, 1983.

• 6813, "Royal Ann Pollination in Western Oregon," P. Lomhard, V. Guerrero and M. Thompson, Annual Report, Oregon Horticultural Society, Volume 74, pages 121-124, 1983.

• 6814, "Some Ohservations on the Control and Measurement of Fruitfulness in Wine Grapes," R.C. Menary, P. Lombard and R. Kohnert, Annual Report, Oregon Horticultural Society, Volume 74, pages 260-267, 1983.

Malheur Experiment Station

• 6672, "Tillage and Cultural Management of Irrigated Potatoes," D.R. Burton and J.C. Zalewski, Agronomy Journal, Volume 75, pages 219-225, March/April 1983.

Microbiology

• 6133, "Antigenic Relationships of Selected Strains of Infectious Pancreatic Necrosis Virus and European Eel Virus," N. Okamoto, T. Sano, R.P. Hedrick and J.L. Fryer, Journal of Fish Diseases, Volume 6, pages 19-25, 1983.

• 6205, "Susceptibility of Chinook Salmon, *Oncorhynchus tashawytscha* (Walhaum), and Rainhow Trout, *Salmo gairdneri* Richardson, to Infection with *Vibrio anguillarum* Following Suhlethal Copper Exposure," R.J. Baker, M.D. Knittel and J.F. Fryer, Journal of Fish Diseases, Volume 6, pages 267-275, 1983.

• 6257, "Effect of Methotrexate, Kenalog and Cyclophosphamide on the Antihody Response of Steelheads of *Aeromonas salmonicida*," Martin F. Chen, J.S. Rohovec and J.L. Fryer, Transactions of the American Fisheries Society, Volume 112, Number 4, pages 561-564, 1983.

• 6331, "The Relationship Between the Antifungal Activities of Miconazole, Clortrimazole, and 15-azasterol and Their Inhibition of Sterol Biosynthesis," F.R.Taylor, R.J Rodriguez and L.W. Parks, Antimicrobial Agents Chemotherapy, Volume 23, pages 515-521, 1983.

• 6408, "Biochemical Characterization of Eel Virus European," R.P. Hedrick, N. Okamoto, T. Sano and J.L. Fryer, Journal of General Virology, Volume 64, Numher 6, pages 1421-1426, 1983.

• 6431, "Synthesis of the Structural Proteins of Infectious Hematopoietic Necrosis Virus," J.C. Leong, Y.L. Hsu and H.M. Engelking, *in* Molecular and Applied Approaches to the Study of Bacterial and Viral Diseases of Fish, edited hy J. Crosa, Washington Sea Grant Program WSG-WO 83-1, 1983.

• 6473, "Bacterial and Viral Diseases of Cultured Salmonids in the Pacific Northwest," James R. Winton, John S. Rohovec and John L. Fryer, reprinted from Bacterial and Viral Diseases of Fish: Molecular Studies, edited by Jorge H. Crosa, Oregon State University Sea Grant College Program ORESU-R-83-018, 1983.

• 6534, "*Legionella* Incidence and Density in Portable Drinking Water Supplies," D.L. Tison and R.J. Seidler, Applied and Environmental Microhiology, Volume 45, pages 337-339, 1983.

• 6542, "Relative Susceptihility of Four Strains of Summer Steelhead to Infection hy *Ceratomyxa shasta*," D.V. Buchanan, J.E. Sanders, J.L. Zinn and J.L. Fryer, Transactions, American Fisheries Society, Volume 112, Numher 4, pages 541-543, 1983.

• 6543, "Effect of Prerigor Pressurization on the Retail Characteristics of Beef," M. Koohmaraie, W.H. Kennick, E.A. Elgasim, R.L. Dickson and W.E. Sandine, Journal of Food Science, Volume 48, pages 998-999, 1983.

• 6548, "Medium-Dependent Production of Extracellular Enterotoxins hy Non 0-1 *Vibrio cholerae, Vibrio mimicus,* and *Vibrio fluvialis*," M. Nishihuchi and R.J. Seidler, Applied and Environmental Microhiology, Volume 45, pages 228-231, 1983.

• 6550, "Further Characterization of a New Reovirus of Poikilothermic Vertehrates," J.R. Winton, C.N. Lannan and J.L. Fryer, *in* *Double-Stranded RNA Viruses*, edited by Richard W. Compans and David H.L. Bishop, Elsevier Science Publishing Company, Inc., pages 231-236, 1983.

• 6555, "Bacterial Activity Associated with the Decomposition of Woody Substances in a Stream Sediment," J.H. Baker, R.Y. Morita and N.H. Anderson, Applied and Environmental Microbiology, Volume 45, pages 516-521, 1983.

• 6556, "Distrihution of Hydrocarhons and Microbial Populations Related to Sedimentation Processes in Cook Inlet and Norton Sound, Alaska," R.M. Atlas, M.I. Venkatesan, R.R. Kaplan, R.A. Feeley, R.P. Griffiths and R.Y. Morita, Arctic Journal, Volume 36, Numher 3, pages 251-261, 1983.

• 6565, "Methane Oxidation hy *Nitrosococcus oceanus* and *Nitrosomonas europaea*," R.D. Jones and R.Y. Morita, Applied and Environmental Microhiology, Volume 45, pages 401-410, 1983.

• 6566, "Effect of Crude Oil on Microbial Activities in a Stream Sediment," J.H. Baker and R.Y. Morita, Environmental Pollution, Volume 31, pages 149-157, 1983.

• 6568, "Current Fish Disease Control Policies Affecting the Columbia River Basin," J.S. Rohovec, Proceedings of a Workshop on Viral Diseases of Salmonid Fish in the Columhia River Basin, edited hy J.C. Leong and T.Y. Barila, Bonneville Power Administra-

tion Special Publication, pages 119-129, 1983.
• 6575, "Microbial Processes Related to Carbon Cycling in Southeastern Bering Sea Sediments," R.P. Griffiths, B.A. Caldwell, W.A. Broich and R.Y. Morita, Marine Ecology Progress Series, Volume 10, pages 265-275, 1983.
• 6577, "Isolation and Characterization of Fast Acid-Producing Antihiotic Resistant Mutants of Lactic Streptococci," J.J. Wulf and W.E. Sandine, Journal of Dairy Science, Volume 66, pages 1835-1842, 1983.
• 6578, "Examination of Strain Interaction in a Multiple Strain Lactic Starter Culture hy Streptomycin Resistant Mutants of Lactic Streptococci," J.J. Wulf, R.K. Thunell and W.E. Sandine, Journal of Dairy Science, Volume 66, pages 1436-1444, 1983.
• 6616, "Starvation-Survival Processes of a Marine Vibrio," P.S. Amy, C. Pauling and R.Y. Morita, Applied and Environmental Microhiology, Volume 45, pages 1041-1048, 1983.
• 6620, "Increased Occurrences of Infectious Hematopoietic Necrosis Virus in Fish at Columbia River Basin Hatcheries: 1980-1982," W.J. Groherg, Jr. and J.L. Fryer, Oregon State University Sea Grant College Program ORESU-T-83-002, 16 pages, 1983.
• 6644, "*Vibrio* Factors Cause Rapid Fluid Accumulation in Suckling Mice," M . Nishibuchi, R.J. Seidler, D.M. Rollins and S.W. Joseph, Infection and Immunity, Volume 40, pages 1083-1091, 1983.
• 6646, "Starvation-Survival Patterns of Sixteen Isolated Ocean Bacteria," P.S. Amy and R.Y. Morita, Applied and Environmental Microhiology, Volume 45, pages 1109-1115, 1983.
• 6667, "Starvation-Survival Physiological Studies in a Marine Pseudomonas sp.," G. Kurath and R.Y. Morita, Applied and Environmental Microbiology, Volume 45, pages 1206-1211, 1983.
• 6659, "Complementary Methodologies to Delineate the Composition of *R. trifolii* Populations in Root Nodules," M.H. Dughri and P.J. Bottomley, Soil Science Society of America Journal, Volume 47, Number 5, pages 939-945, 1983.
• 6692, "Recovery From Nutrient Starvation by a Marine Vibrio," P.S. Amy, C. Pauling and R.Y. Morita, Applied and Environmental Microhiology, Volume 45, pages 1685-1690, 1983.
• 6719, "Proceedings of a Workshop on Viral Diseases of Salmonid Fishes in the Columhia River Basin," edited hy J.C. Leong and T.Y. Barila, Bonneville Power Administration Special Puhlication, 173 pages, 1983.
• 6739, "Intermediates in the Recycling of 5-methylthiorihose to Methionine in Fruits," M. Kushad, D.G. Richardson and A.J. Ferro, Plant Physiology, Volume 73, pages 257-261, 1983.
• 6745, "Protein Patterns from Growing and Starved Cells of a Marine Vihrio sp.," P.S. Amy and R.Y. Morita, Applied and Environmental Microhiology, Volume 45, pages 1748-1752, 1983.
• 6756, "Storage and Display Life Characteristics of Beef as Affected hy Prerigor Pressurization," M. Koohmaraie, W.H. Kennick, E.A. Elgasim, R.L. Dickson and W.E. Sandine, Journal of Food Protection, Volume 46, pages 878-882, 1983.
• 6775, "Characteristics of Four Birnaviruses Isolated from Fish in Taiwan," R.P. Hedrick, J.L. Fryer, S.N. Chen and G.H. Kou, Fish Pathology, Volume 18, Number 2, pages 91-97, 1983.
• 6798, "Sterol Uptake in the Yeast, *Saccharomyces cerevisiae*," L.F. Salerno and L.W. Parks, Biochimica et Biophysica Acta, Volume 752, pages 240-243, 1983.
• 6818, "*Vibrio aestuarianus*: a New Species from Estuarine Waters and Shellfish," D.L. Tison and R.J. Seidler, International Journal of Systematic Bacteriology, Volume 33, pages 699-702, 1983.
• 6825, "Role of Sterol Structure in the Thermotrophic Behavior of Plasma Memhranes of *Saccharomyces cerevisiae*," C.D.K. Bottema, C.A. McLean-Bowen and L.W. Parks, Biochimica et Biophysica Acta, Volume 734, pages 235-248, 1983.
• 6826, "A Requirement for a Second Sterol Biosynthetic Mutation to Allow for Viahility of a Sterol C-14 Demethylation Defect in *Saccharomyces cerevisiae*," F.R. Taylor, R.J. Rodriguez and L.W. Parks, Journal of Bacteriology, Volume 155, pages 64-68, 1983.
• 6852, "Effect of Acidity on the Composition of an Indigenous Soil Population of *Rhizobium trifolii* Found in Nodules of *Trifolium subterraneum* L.," M.H. Dughri and P.J. Bottomley, Applied and Environmental Microbiology, Volume 46, pages 1207-1213, 1983.
• 6878, "Structural and Physiological Features of Sterols Necessary to Satisfy Bulk Memhrane and Sparking Requirements in Yeast Sterol Auxotrophs," R.J. Rodriguez and L.W. Parks, Archives of Biochemistry and Biophysics, Volume 225, pages 861-871, 1983.
• 6962, "Growth of a Sterol Auxotroph Derived from *Saccharomyces cerevisiae* on Chemically Synthesized Derivatives of Cholesterol Possessing Side Chain Modifications," R.J. Rodriguez, T.A. Arunchalam, L.W. Parks and E. Caspi, Lipids, Volume 18, pages 772-775, 1983.

Mid-Columbia Experiment Station

• 6392, "Relationship Between Fruit Weight, Firmness, and Leaf/Fruit Ratio in Lamhert and Bing Sweet Cherries," T.J. Facteau, N.E. Chestnut and K.E. Rowe, Canadian Journal Plant Science, Volume 63, pages 763-765, July 1983.
• 6583, "Changes in Ripening Behavior of 'd'Anjou' (*Pyrus communis* L.) After Cold Storage," P.M. Chen, W.M. Mellenthin and D.M. Borgic, Scientia Horticulturae, Volume 21, pages 137-146, February 1983.
• 6627, "Fruit Quality of 'Bosc' Pears (*Pyrus communis* L.) Stored in Air or One Percent Oxygen as Influenced hy Maturity," P.M. Chen, W.M. Mellenthin and S.B. Kelly, Scientia Horticulturae, Volume 21, pages 45-52, February 1983.
• 6733, "Effect of Pyrene and Fluoranthene on Pollen Tuhe Growth in Apricot and Sweet Cherry," T.J. Facteau and N.E. Chestnut, HortScience, Volume 18, pages 717-718, Octoher 1983.

Nitrogen Fixation Laboratory

• 6496, "Aspects of Hydrogen Metaholism in Nitrogen-Fixing Legumes and Other Plant-Microbe Associations," G. Eishrenner and H.J. Evans, Annual Reviews of Plant Physiology, Volume 34, pages 105-137, 1983.
• 6531, "A Rapid Colony Screening Method for Identifying Hydrogenase Activity in *Rhizobium japonicum*," R.A. Haugland, F.J. Hanus, M.A. Cantrell and H.J. Evans, Applied and Environmental Microbiology, Volume 45, pages 892-897, 1983.
• 6541, "Construction of a *Rhizobium japonicum* Gene Bank and Use in the Isolation of a Hydrogen Uptake Gene," M.A. Cantrell, R.A. Haugland and H.J. Evans, Proceedings, National Academy of Science, Volume 80, pages 181-185, 1983.
• 6681, "Nickel: A Micronutrient Element for Hydrogen-Dependent Growth of *Rhizobium japonicum* and for Expression of Urease Activity in Soybean Leaves," R.V. Klucas, F.J. Hanus, S.A. Russell and H.J. Evans, Proceedings, National Academy of Science, Volume 80, pages 2253-2257, 198[2]

North Willamette Experiment Station

• 6280, "Tahle Beet Yield and Boron Deficiency as Influenced hy Lime, Nitrogen, and Boron," D.D. Hemphill, Jr., M.S. Weber and T.L. Jackson, Soil Science Society of America Journal, Volume 46, pages 1190-1192, 1982.
• 6442, "A Comparison of Five Pacific Northwest Strawherry Cultivars for Hand and Machine Harvest," Lloyd W. Martin and Peter J. Pelofske, Fruit Varieties Journal, Volume 37, Number 2, pages 37-41, 1983.
• 6618, "Ammonium Sulfate Fertilization of Blueberries on a Mineral Soil," Lloyd W. Martin and Peter J. Pelofske, Communications in Soil Science and Plant Analysis, Volume 14, Numher 2, pages 131-142, 1983.

Poultry Science

• 5825, "Restricted Water Time with Dwarf and Normal Size Single Comh White Leghorn Pullets," H.S. Nakaue, M.L. Pierson and G.H. Arscott, Poultry Science, Volume 62, pages 12-18, January 1983.
• 6188, "Influence of Physical Exercise on Plasma Creatine Kinase Activity in Healthy and Dystrophic Turkeys and Sheep," M.J. Tripp and J.A. Schmitz, American Journal of Veterinary Research, Volume 43, Number 12, pages 2220-2223, 1982.
• 6245, "Early Expression of Hereditary Deep Pectoral Myopathy in Turkeys Due to Forced Wing Exercise," J.A. Harper, P.E. Bernier and L.L. Thompson-Cowley, Poultry Science, Volume 62, pages 2303-2308, Decemher 1983.
• 6319, "Effect of Feed and Water Restriction in Dwarf and Normal-Size Single Comh White Leghorn Pullets," H.S. Nakaue, M.P. Goeger and G.H. Arscott, Poultry Science, Volume 62, pages 1473-1474, July 1983, Ahstract.
• 6339, "Effect of Low Salt, Sodium, and Chloride Levels in Poult Rations on Growth, Bone Development, and Related Factors," C.O. Egwautu, J.A. Harper, D.H. Helfer and G.H. Arscott, Poultry Science, Volume 62, pages 353-358, February 1983.
• 6355, "Effects of the Sex-Linked Dwarfing Gene (dw) on Growth and Reproduction in White Leghorn Hens," M. Sadjadi, F.H. Benoff, K.E. Rowe, J.A. Renden and J.A. Harper, Poultry Science, Volume 62, pages 1921-1930, Octoher 1983.
• 6356, "Effects of the Blue Egg Shell Allele (0) on Egg Quality and Other Economic Traits in the Chicken," M. Sadjadi, J.A. Renden, F.H. Benoff and J.A. Harper, Poultry Science, Volume 62, pages 1717-1720, September 1983.
• 6407, "Anticoccidial Drugs and Duckling Performance to Four Weeks of Age," D. Holderread, H.S. Nakaue and G.H. Arscott, Poultry Science, Volume 62, pages 1125-1127, June 1983.
• 6409, "Differential Induction of Hepatic Drug Metabolizing Enzymes in Japanese Quail hy 1,2,4 Trichlorobenzene," C.L. Miranda, J. Wang, M.C. Henderson, H.M. Carpenter, H.S. Nakaue and D.R. Buhler, Toxicology, Volume 28, pages 75-82, 1983.

• 6426, "Studies on tbe Porpbyrinogenic Action of 1,2,4 Trichlorobenzene in Birds," C.L. Miranda, J. Wang, M.C. Henderson, H.M. Carpenter, H.S. Nakaue and D.R. Buhler, Toxicology, Volume 28, pages 83-92, 1983.
• 6471, "Divergent Selection for Mature Body Weight in Dwarf White Leghorns, 1. Growth and Reproductive Responses to Selection," F.H. Benoff and J.A. Renden, Poultry Science, Volume 62, pages 1931-1937, October 1983.
• 6472, "Divergent Selection for Mature Body Weigbt in Dwarf White Legborns, 2. Maternal Determinants of Egg Size," F.H. Benoff and J.A. Renden, Poultry Science, Volume 62, pages 1938-1943, October 1983.
• 6558, "An Observation of Dermatitis in Caged Dwarf and Normal-Sized Single Comb White Legborn Laying Hens," W.B. Rousb and G.H. Arscott, Poultry Science, Volume 62, pages 2114-2116, October 1983.
• 6676, "True Metabolizable Energy of Two Fat Blends and Yellow Grease," M.P. Goeger and H.S. Nakaue, Nutrition Reports International, Volume 27, pages 977-981, 1983.
• 6697, "Feeding Value of Dried Liquefied Pacific Whiting Product for Broilers," H.S. Nakaue, R.O. Kellems and G.H. Arscott, Nutrition Reports International, Volume 27, Number 6, pages 1163-1168, 1983.
• 6738, "Feed Preference Responses of Several Avian Species Fed Alfalfa Meal, Higb and Low Saponin Alfalfa and Quinine Sulfate," P.R. Cbeeke, J.S. Powley, H.S. Nakaue and G.H. Arscott, Canadian Journal of Animal Science, Volume 63, pages 707-710, 1983.
• 6757, "HDL/LDL Lipoprotein Ratios in Deep Pectoral Myopathy of Turkeys," L.L. Thompson-Cowley, M.J. Tripp and J.A. Harper, Proceedings, 32nd Western Poultry Disease Conference, University of California at Davis, February 8-10, pages 42-44, 1983.
• 6762, "Tbe Influence of 16 and 17.5% Dietary Protein Levels and Supplementary Methionine on Reproduction of Caged Dwarf Broiler Brooder Hens," R.E. Buckner and T.F. Savage, Poultry Science, Volume 62, page 1393, July 1983, Abstract.
• 6763, "Effect of Nutrition and Management on Foot Pad Dermatitis in Dwarf- and Normal-Size Single Comb White Legborn Layers," R.A. Burger, Y.O. Atuahene, P.E. Bernier and G.H. Arscott, Poultry Science, Volume 62, page 1394, July 1983, Abstract.
• 6764, "Ring Letbal, an Autosomal Recessive Condition of Medium White Turkey Embryos," T.F. Savage and J.A. Harper, Poultry Science, Volume 62, page 1497, July 1983, Abstract.
• 6765, "The Effects of Mount St. Helens' Volcanic Ash and Sand on the Digestive Tracts of Broilers," M.C. Bland, M.P. Goeger, H.S. Nakaue, D.H. Helfer and E. Wallner-Pendleton, Poultry Science, Volume 62, page 1384, July 1983, Abstract.
• 6769, "Reproductive Performance of Caged Broiler Breeder Males on Low Protein Breeder Rations of 5, 7, and 9% Crude Protein," R.E. Buckner and T.F. Savage, Poultry Science, Volume 62, page 1393, July 1983, Abstract.
• 6770, "Effects of Feeding Level on Reproductive Performance of Caged Broiler Breeder Males," R.E. Buckner and J.A. Renden, Poultry Science, Volume 62, page 1392, July 1983, Abstract.
• 6780, "Toxicity of *Senecio jacobaea* and Pyrrolizidine Alkaloids in Various Laboratory Animals and Avian Species," P.R. Cbeeke and M.L. Pierson-Goeger, Toxicology Letters, Volume 18, pages 343-349, 1983.
• 6801, "Minority and Sex Distribution Profiles of Graduate Students and Academic Staff for Poultry Programs in the United States and Canada," G.H. Arscott and M.L. Sunde, Poultry Science, Volume 62, pages 2315-2320, December 1983.
• 6945, "Foot Pad Dermatitis in Dwarf and Normal Layers," G.H. Arscott, Proceedings, 18tb Pacific Nortbwest Animal Nutrition Conference, Oregon State University, November 2-3, pages 113-118, 1983.

Rangeland Resources

• 4743, "Optimizing tbe Use of Grazed Dryland Pasture in Western Oregon," Thomas E. Bedell, Proceedings, 14tb International Grassland Congress, Lexington, Kentucky, June 15-24, 1981, pages 793-795, 1983.
• 5884, "Infiltration Rates of Various Vegetative Communities Within tbe Blue Mountains of Oregon," R.E. Gaither and J.C. Buckbouse, Journal of Range Management, Volume 36, pages 58-60, January 1983.
• 6208, "A Comparison of Three Metbods for Estimating Forage Disappearance," S.H. Sharrow and I. Motazedian, Journal of Range Management, Volume 36, pages 469-471, July 1983.
• 6210, "Rotational vs. Continuous Grazing Affects Animal Performance on Annual Grass-Subclover Pastures," Steven H. Sbarrow, Journal of Range Management, Volume 36, pages 593-595, September 1983.
• 6243, "Forage Standing Crop and Animal Diets Under Rotational vs. Continuous Grazing," Steven H. Sbarrow, Journal of Range Management, Volume 36, pages 447-450, July 1983.
• 6292, "A Comparison of Four Metbods Used to Determine the Diets of Large Herbivores," M.L. McInnis, M. Vavra and W.C. Krueger, Journal of Range Management, Volume 36, pages 302-307, May 1983.
• 6600, "Impacts of Cattle on Streambanks in Nortbeastern Oregon," J. Boone Kauffman, W.C. Krueger and M. Vavra, Journal of Range Management, Volume 36, pages 683-685, November 1983.
• 6647, "Effects of Late Season Cattle Grazing on Riparian Plant Communities," J. Boone Kauffman, W.C. Krueger and M. Vavra, Journal of Range Management, Volume 36, pages 685-691, November 1983.

Soil Science

• 5788, "Sorption Processes in Soils as a Function of Pore Water Velocity: 1. Theory," S. Yingjajaval, L. Boersma and G.O. Klock, Soil Science, Volume 135, Number 5, pages 267-274, 1983.
• 5789, "Sorption Processes in Soils as a Function of Pore Water Velocity: 2. Experimental Results," S. Yingjajaval, L. Boersma and G.O. Klock, Soil Science, Volume 135, Number 6, pages 331-341, 1983.
• 6155, "Clay Mineralogy in Relation to Landscape Instability in tbe Coast Range of Oregon," J.D. Istok and M.E. Harward, Soil Science Society of America Journal, Volume 46, pages 1326-1331, 1982.
• 6411, "Soil Lime Level (pH) and VA-mycorrhiza Effects on Growth Responses of Sweetgum Seedlings," E. Anne Davis, J. Lowell Young and Robert Linderman, Soil Science Society of America Journal, Volume 47, pages 251-256, 1983.
• 6428, "Effects of Fertilization on Soil Solution pH and Mn and P Concentration," S.E. Petrie and T.L. Jackson, Proceedings of tbe 33rd and 34tb Annual Northwest Fertilizer Conferences at Boise, Idaho, July 11-13, 1982, and at Portland, Oregon, July 12-14, 1983, sponsored by the Soil Improvement Committee of tbe Nortbwest Plant Food Association in cooperation witb the State Universities of tbe Nortbwest, pages 93-102, 1983.
• 6429, "Effects of N Fertilization on Mn Concentration and Yield of Barley and Oats, S.E. Petrie and T.L. Jackson, Proceedings of tbe 33rd and 34tb Annual Nortbwest Fertilizer Conferences at Boise, Idaho, July 11-13, 1982, and at Portland, Oregon, July 12-14, 1983, sponsored by tbe Soil Improvement Committee of the Nortbwest Plant Food Association in cooperation witb tbe State Universities of tbe Northwest, pages 81-92, 1983.
• 6508, "Adsorption of Cd(II) and Cu(II) by Na-Montmorillonite at Low Surface Coverage," William P. Inskeep and John Baham, Soil Science Society of America Journal, Volume 47, pages 660-665, 1983.
• 6509, "Competitive Complexation of Cd(II) and Cu(II) by Na-Montmorillonite in the Presence of Water Soluble Organic Ligands," William P. Inskeep and John Babam, Soil Science Society of America Journal, Volume 47 (Nov./Dec.), 1983.
• 6523, "Effects of Subsurface Drainage on Runoff and Sediment Yield from an Agricultural Watersbed in Western Oregon," Jonathan Istok and Gerald F. Kling, Journal of Hydrology, Volume 65, pages 279-291, 1983.
• 6563, "Some Cbaracteristics of *R. meliloti* Isolates from Alfalfa Fields in Oregon," P.J. Bottomley and M.B. Jenkins, Soil Science Society of America Journal, Volume 47 (Nov./Dec.), 1983.
• 6602, "Chloride, Nitrogen Form, Lime, and Planting Date Effects on Take-All Root Rot of Winter Wheat," R.G. Taylor, T.L. Jackson, R.L. Powelson and N.W. Christensen, Plant Disease, Volume 67, pages 1116-1120, 1983.
• 6659, "Complementary Metbodologies to Delineate the Composition of *Rhizobium trifolii* Populations in Root Nodules," M.H. Dugbri and P.J. Bottomley, Soil Science Society of America Journal, Volume 47, pages 939-945, 1983.
• 6830, "Physical Properties of Coarse Fragments and Their Effect on Available Water in Skeletal Soils," Alan L. Flint and Stuart W. Childs, in Erosion and Productivity of Soils Containing Rock Fragments, ALA & SSSA Special Publication, 1983.
• 6852, "Effect of Acidity on tbe Composition of an Indigenous Soil Population of *Rhizobium trifolii* Found in Nodules of *Trifolium subterraneum* L.," M.H. Dughri and P.J. Bottomley, Journal of Applied and Environmental Microbiology, Volume 46, pages 1207-1213, 1983.
• 6898, "Microbial Respiration and Chemical Speciation in Metal-Amended Soils," Bruce Lighthart, John Baham and V.V. Volk, Journal of Environmental Quality, Volume 12, pages 543-548, 1983.
• 6915, "Microbial Decomposition of Wood in Streams: Distribution of tbe Microflora and Factors Affecting ^{14}C Lignocellulose Mineralization," N.G. Aunen, P.J. Bottomley, G.N. Ward and S.V. Gregory, Journal of Applied and Environmental Microbiology, Volume 46, pages 1409-1416, 1983.

Veterinary Medicine

• 6495, "Soluble Fractions of *Pasteurella multocida*: Their Protective Quality Against

Fowl Cholera in Turkeys," Masakazu Matsumoto, Avian Disease, Volume 27, Number 1, pages 283-291 January-March 1983.

- 6588, "Susceptibility of *Bacteroides nodosus*, Etiologic Agent of Sheep Foot Rot, to Various Antimicrobial Agents," J.L. Gradin and J.A. Schmitz, Journal of American Veterinary Medical Association, Volume 183, pages 434-437, 1983.
- 6601, "Preliminary Report on the Isolation and Pathogenicity of Two Ovine Adenoviruses," Nancy A. Ullrich, Donald E. Mattson and John A. Schmitz, 25th Annual Proceedings, American Association of Veterinary Laboratory Diagnosticians, pages 185-195, 1982.
- 6645, "Isolation and Partial Characterization of a Calicivirus from Calves," Alvin W. Smith, Donald E. Mattson, Douglas E. Skilling and John A. Schmitz, American Journal of Veterinary Research, Volume 44, pages 851-855, May 1983.
- 6703, "Coronavirus and Adenovirus Infections in Lambs," John A. Schmitz, Proceedings, 86th Annual Meeting of the United States Animal Health Association, page 477, 1982.
- 6772, "Abortion Due to Histoplasmosis in a Mare in Oregon," J.R. Saunders, R.J. Matthiesen and W. Kaplan, Journal of American Veterinary Medical Association, Volume 183, Number 10, pages 1097-1099, November 15, 1983.
- 6810, "Chronic Encephalomyelitis Caused by Canine Distemper Virus in a Bengal Tiger," L.L. Blythe, J.A. Schmitz, M. Roelke and S. Skinner, Journal of American Veterinary Medical Association, Volume 183, Number 11, pages 1159-1162, December 1, 1983.



profile

He's become a student again



Harold Evans

He's just "an incredibly hard-working scientist," says one colleague. "Everybody knows he's a workaholic," says another.

Whatever the reason, Harold J. Evans isn't resting on his laurels, although he could probably use them as a bed and most people wouldn't object.

Evans, the only OSU professor ever elected to membership in the prestigious National Academy of Sciences, is at that twilight stage of a productive career when more than a few scientists have been content to sit back, bestow occasional words of wisdom on students and young faculty members, and reel in the awards and praise.

Instead, the 63-year-old Evans is headed out to meet a new challenge—the fast-changing genetic engineering invading agricultural research.

"It's late in the game for me. I'm only two years from retirement. But I find it terribly exciting," says the plant physiologist, director of OSU's Laboratory for Nitrogen Fixation.

Evans points out that he wasn't trained as a geneticist. And the professor isn't ashamed to admit he's become something of a student again, "learning by osmosis" some of the fine points of gene splicing from the researchers and graduate students he brings in to work in his lab.

New technology is where the schooling stops, though. Evans is the master when it comes to overall knowledge of the object of research—rhizobia, bacteria that live on the roots of legume plants like peas, alfalfa, clover and soybeans and convert nitrogen in the soil into a form the plants can use.

Evans has studied rhizobia, discovered in 1888 by a Dutch scientist, through most of his career. Associate Joe Hanus and Evans showed the scientific world a few years ago that some strains of the bacteria not only can fix nitrogen but also carbon, an essential element of life.

"This means they have metabolic flexibility, an additional way of getting food," says Evans. "Nobody wanted to believe it. They'd been thinking another way for 100 years. But we proved it beyond any doubt."

And that was only one of several major contributions Evans—and colleagues, he consistently emphasizes—have made to scientific understanding of the biochemistry of how rhizobia fix nitrogen.

Now researchers in his lab are trying to use gene splicing to transfer the ability to fix nitrogen more efficiently, by recycling hydrogen during the process, from strains of rhizobia that can recycle hydrogen to strains that can't.

The work is a logical extension of the research Evans has done for many years. That means Evans has his foot in two worlds: classical agricultural research and genetic engineering. Which holds the greater potential?

"You don't want to dampen the enthusiasm of the new genetic researchers. Only enthusiastic people get things done. But the advances will be a blending of new and classical," predicts Evans, noting that in his opinion recruiting "the best minds" is the most important direction you can take in an agricultural research program.

"There's room for everybody," he adds. "Good work is good work, wherever it is." □

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