OREGON'S AGRICULTURAL
PROGRESS
Winter 1990

RAIN FOREST BURNING AND GLOBAL WARMING DROVE OSU'S BOONE KAUFFMAN

UP THE AMAZON

(PAGE 6)

Agricultural Experiment Station • Oregon State University

THE EDITOR'S NOTE

The other day I heard a story about professor who is the head of one of he departments in OSU's College of Agricultural Sciences.

Year after year, this person looks ike he just left boot camp. His coiffure would send chills down Vidal Sassoon's spine. So imagine he abuse, good-natured or otherwise, e must have endured during the decades when long manes were the ampus rage.

Now, imagine Bill Krueger's musement a while back when a colleague told him a young student had een admiring Krueger's hipness, his new wave" haircut.

Trends can make us laugh or cry. n this issue, we examine several.

With the help of agricultural conomists, writer Tom Gentle looks ack at surprising developments in Oregon agriculture during the 1980s nd asks what they might tell us bout the decade we just started.

You may wonder what the subject as to do with your life, if you don't vork in agriculture. Quite a bit, robably. It goes beyond influence on he state economy. For example, ever onsidered how the agricultural boom n the Willamette Valley is affecting and use, including in the Portland metropolitan area?

Elsewhere in the issue you may feel the urge to glance up, rather than backwards or forwards. Ashlyn Barnard takes us into a curious corner of Oregon agricultural research involving "eyes in the sky," the application of satellites to farming and ranching.

Carol Savonen examines range scientist Boone Kauffman's work on a world-wide issue, burning in the Amazon. A number of scientists say the clearing of the rain forest for purposes such as subsistence farming is contributing to a heating up of the earth's atmosphere, the so-called Greenhouse Effect, and to other ecological problems. Yet the poor in the Amazon Basin have few options.

Last, I call your attention to a short piece in the "Update" section. It notes that the Agricultural Experiment Station may do cooperative research with a Russian institute. This is linked to a trend mind boggling to many of us—the rapid political and economic evolution, if not revolution, that seems to be underway in the Soviet Union.

Enjoy.

Andy Duncan

Bill Krueger as a high school senior in 1960, and today.

OREGON'S AGRICULTURAL
PROGRESS

Winter 1990, Vol. 36, No. 3

Andy Duncan
Editor

Tom Weeks
Designer

Dave King
Photographer

Oregon's Agricultural Progress is published by the Oregon Agricultural Experiment Station (Thayne Dutson, director). Send comments or questions to the editor, Agricultural Communications, OSU, Administrative Services A422, Corvallis, OR 97331-2119. Written material may be reprinted provided no endorsement of a commercial product is stated or implied. Please credit *Oregon's Agricultural Progress*, Oregon State University. To simplify technical terminology, trade names of products or equipment sometimes are used. No endorsement of products is intended nor is criticism implied of products not mentioned.

Free

There is no charge for *Oregon's Agricultural Progress*. It is a report to taxpayers, who help fund Oregon Agricultural Experiment Station research. For a subscription, write: Editor, *Oregon's Agricultural Progress*, Agricultural Communications, OSU, Administrative Services A422, Corvallis, OR 97331-2119.

Cover:
OSU fire ecologist Boone Kauffman could only reach some of his research sites on the banks of the Rio Negro, part of the headwaters of the Amazon, by boat. See story, page 6.
(Photo by Boone Kauffman)

Private funds, provided by the Agricultural Research Foundation, are used to pay for color reproduction in *Oregon's Agricultural Progress*.

TO RUSSIA WITH LOVE?

"I'm cautiously excited," said Thayne Dutson. "This seems to be the first step in increasing cooperative research for the mutual benefit of Oregon and Soviet agriculture."

The director of the Agricultural Experiment Station was talking about the outcome of a trip to Russia he made recently with Oregon business leaders and directors of the state's agriculture and economic development departments.

The Experiment Station and a Russian research institute are exploring the possibility of exchanging scientists, sharing information and genetic materials, and conducting joint studies of production and marketing.

Dutson is working with the head of the Far-Eastern Branch of the Lenin All-Union Academy of Agricultural Sciences in Khabarovsk, Portland's sister city. If you want to check your atlas, Khabarovsk is in the far southeastern corner of the Soviet Union. The city of 625,000, about 300 miles north of Vladivostok, is only 25 miles from the Chinese border.

"They provide research support to the entire Soviet Far East," said Dutson. "The area produces dairy and beef cattle, forages, vegetables and cereal grains, although that's limited by the short growing seasons.

"One example of the possibilities I see is our entomologists and their entomologists studying the type of insect predators that might be useful in pest management."

He cited precedents. Oregon has imported natural enemies of the Russian wheat aphid from that part of the world since the pest showed up in state fields in 1987. Also, the last 15 years OSU wheat breeder Warren Kronstad and scientists in the Ukraine, a major wheat-growing area in the western Soviet Union, have shared information and some genetic material.

Crop varieties and primitive, native plants in the Soviet Far East contain "pools" of genetic material that may be have desirable traits such as drought tolerance and resistance to cold weather and diseases, explained Dutson.

"We've also agreed to investigate doing collaborative research to define the agricultural output and marketing potential of the Soviet Far East," he said. "One goal of that is to identify joint agricultural trade ventures on the Pacific Rim that Oregon and the Soviet Far East can participate in."

For many years, Russian agriculturalists have been using conservation-related low-input agricultural practices that might provide useful data to OSU scientists, Dutson added.

"There are things we can give them and things they can give us in ways that enhance both systems," he said.

TOM GENTLE

Thayne Dutson

FARM LABOR VIEW FUZZY

Experiment Station researcher Robert Mason says the state could have a shortage of farm labor if it isn't careful.

The reason is that the number of foreign workers allowed into the country, which will be based on U.S. Department of Labor estimates for agricultural workers needed in 1990, may not fit some of Oregon's special demands.

"Commodity groups will need to rely on their own statistics to justify additional supplies of farm workers should shortages occur," warned Mason.

The professor with OSU's Survey Research Center recently completed a survey of the labor demand for six of the state's hand-picked fruit and vegetable crops. The study focused on 1988 demand in the strawberry, caneberry, sweet cherry, cucumber, hop and wine industries.

DAVE KING

The state Department of Agriculture, Immigration Coordinating Commission and commissions representing growers of the six crops, which funded Mason's survey, hope the data will help the agriculture industry cope with the impact of the federal Immigration Reform and Control Act of 1986 and related programs.

"The 1990 harvest season is the first year the full machinery of the act will be in place to regulate the supply of alien workers," noted Mason.

Mason has a limited number of copies of "Farm Labor Demand for Six Oregon Crops," a publication that reports the survey's results. You can contact him through OSU's Department of Statistics.

SPUD CRUD

Ever picked up a french fry and noticed, while it was headed to your mouth, that one end looked pretty strange?

The culprit may have been potato dark-end, once the unpredictable scourge of Malheur County's multi-million dollar potato industry, and of potato growers in other parts of the Treasure Valley and Columbia Basin. Dark-end is less of a threat these days. The reasons have to do with alternative irrigation and crop rotation methods developed cooperatively by

the potato industry and OSU researchers.

But there are still unknowns, and study of the disorder continues at OSU's Malheur Agricultural Experiment Station at Ontario and on the campus in Corvallis.

Water and heat stress cause dark-end syndrome, according to Clint Shock, superintendent of the Malheur research station. Field trials have shown mid-season water stress is most likely to cause dark-end.

The main problem is that potatoes with dark-end are unacceptable to food marketers, who want uniformity in the products they sell, says Zoe Ann Holmes, OSU foods and nutrition researcher.

"They won't accept french fries that cook light brown at one end and dark brown at the other. Color is the first issue, then taste," said Holmes.

Because of the uniformity issue, food processors in eastern Oregon and western Idaho have included uniform color requirements in their production contracts with growers. Potatoes with a high incidence of dark-end may be rejected for processing.

"Attempts to solve the problem from a field management standpoint will undoubtedly help, but that won't provide the whole answer," said Holmes. "We know that dark-end happens when sugars in the potatoes concentrate at the stem-end of the tuber.

"What we don't know is how that concentration happens," she continued. "It could be caused by an enzyme reaction or inhibition brought on by high temperatures or a chemical response. There's a possibility that calcium may play a role in dark-end.

"When we find out how dark-end occurs, we may be able to develop a means of controlling it in the field or when the potatoes are in storage," Holmes said. "The control method might be temperature- or chemical-related, or a matter of activating or deactivating an enzyme reaction, or a combination of these."

Potato dark-end syndrome isn't new or isolated to a specific area. Columbia Basin potato growers suffered a severe dark-end year in 1971. It was a serious problem for Malheur County growers in 1984 and 1985, but has been of little consequence in other years.

Through field trials researchers found that reduction of dark-end begins with crop rotation. The silt loam soils of eastern Oregon compact easily, which reduces water infiltration. This creates water stress for potato crops.

The water stress contributes to heat stress because potatoes release heat through moisture, said Shock.

One solution, researchers say, is a four-year crop rotation with crops such as alfalfa, wheat and corn following potatoes. After harvest these crops leave considerable plant material in the field that can be mixed into the soil to reduce its density and improve water filtration.

Researchers also found that sprinkler irrigation, unlike the furrow irrigation used in most Malheur County potato fields, helps reduce the incidence of dark-end syndrome. Other strategies for avoiding the problem include fall, rather than spring, bedding of potato fields, and delaying irrigation until late spring.

BOB ROST

Most Oregonians have seen what dark-end syndrome does to french fries.

BOUQUET OF OREGON OAK

Aging is good for wine. For some wines, Pinot Noir and Chardonnay for example, it's even better if it happens in an oak barrel. It can make them smell and taste better.

The question on the minds of OSU food scientists Mina McDaniel and Barney Watson: Can storage barrels made from oak grown in Oregon's Willamette Valley replace the French oak barrels traditionally used by the state's wine producers?

They plan to find out. McDaniel studies how foods and beverages affect the senses, such as taste and smell, and Watson studies winemaking. They are experimenting with Oregon oak and French oak wine barrels at six wineries in the state.

DAVE KING

French oak barrels

"We'll monitor two vintages of wines from the trial Oregon barrels and standard French barrels for a year," said Watson. "We will sample the wines at three-month intervals and compare them on the basis of sensory evaluations [taste tests] and aroma-flavor chemistry work."

The researchers are cooperating with the Oregon wine industry on the project. Oregon oak barrels appeal to the state's wine producers for three reasons, according to Watson.

"Oregon wine aged in Oregon oak is something that would be a marketing advantage a lot of Oregon wine industry people are interested in," he said. "Also, the flavor Oregon oak gives to various wines will probably be different than that of French oak. But if Oregon oak gives comparable quality and unique taste, it will help make good wines even better."

The third element is economics. "Victor Kreimeyer, co-owner of the Hyland Vineyard in Sheridan, estimates Oregon oak wine barrels may cost 25 to 30 percent less than imported French oak, 60-gallon wine barrels, which cost up to $400 each," said Watson.

Oregon Pinor Noirs and Chardonnays are aged six to 18 months to enhance their subtle, delicate flavors. Oregon oak is sent to northern California where coopers (barrel makers) make barrels for the research.

ASHES IN THE AMAZON

OSU's Boone Kauffman is studying the impact of fire in the rain forests of South America

"Imagine the forests of the Cascades of Oregon and Washington, the Siskiyous, the Coast Range and the Olympics all burning in one year. That's roughly equivalent to the amount of land that burned in only one year in the Brazilian Amazon," said J. Boone Kauffman, a fire ecologist in the rangeland resources department at OSU.

"Recent studies of photos taken from satellites are showing us that each year, an area of cut-over tropical forest 80 percent the size of Oregon burns in the Brazilian Amazon alone," said Kauffman, one of the few fire ecologists looking at the effects of fire in the tropical forests.

At the current rate of deforestation, tropical forests will be gone by the middle of the next century, he said.

Deforestation has become a global issue. Large-scale loss of tropical forests by logging, slashing and burning may be changing our planet's entire atmosphere, climate and ecology.

Yet little is known about the effects of fire on tropical forests. Did tropical rain forests naturally burn? What happens when large tracts of land are cut and burned? How likely are areas to burn after selective logging? Will the forest regenerate? Which plant species tolerate fire? Which can't? What can be done to help restore the health of the land while supporting the expanding human population?

BY CAROL SAVONEN

Page 7: A slash fire in Brazil set to clear rain forest for subsistence farming.

BOONE KAUFFMAN

Questions like these drive Kauffman and fellow researchers deep into forests of the Amazon Basin. The last three years they have made three forays to the wet tropical forests of southern Venezuela and northeastern Brazil and into the drier forests of far eastern Brazil.

Amazon rain forests have always been subject to sporadic and patchy natural disturbances, explained Kauffman. Floods, windstorms and fires have swept through the Amazon Basin for millions of years. And for several thousand years, humans have cleared small areas and set fires to prepare land for hunting and slash-and-burn subsistence agriculture.

"The understory environment changes."

Today, in most of the forested tropical regions of the world, population pressures and poverty drive people into remote wilder areas to eke out a subsistence living, Kauffman said. They clear and burn a few acres at a time and plant crops, keep a few cattle, and cut the wood still standing for cooking and heating. After a few years, the land loses its agricultural productivity. The people move on.

The major cause of deforestation is conversion to cattle pastures, according to Kauffman. Simple timber harvest also causes problems, because once a forest canopy is opened, the understory environment changes and the forest can no longer sustain itself.

Never has so much of the world's tropical forest been disturbed on such a large scale as in the last 30 years, said Kauffman.

"We are witnessing a grand experiment in Amazonia," he said, "forcing us to ask 'how much disruption can the ecosystem take before things are irreparably damaged?'"

In 1986, Kauffman, OSU assistant researcher Dian Cummings, and Chris Uhl, an ecologist from Pennsylvania State University, traveled to one of the wettest regions of the Amazon Basin. It is in southern Venezuela near the small village of San Carlos de Rio Negro. They looked at and compared the forest dynamics of intact rain forest and tracts of forest cut and cleared by humans.

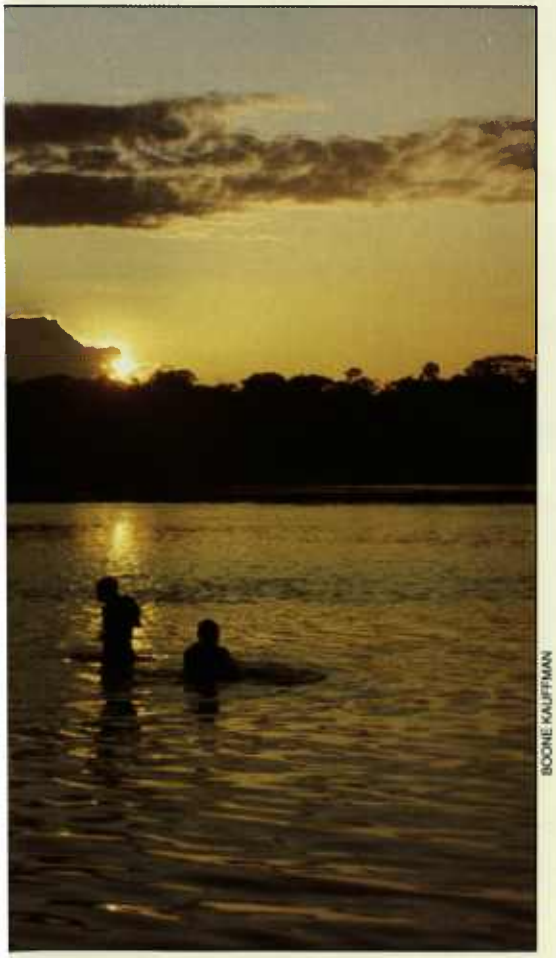
"One of our questions was, 'Can fire occur in intact wet tropical rain forest?'"

CHRIS UHL

OSU fire ecologist Boone Kauffman ignites a test site in southern Venezuela. Kauffman and associates covered the area with plastic to keep out moisture, trying to duplicate the conditions when the rain forest canopy is disturbed by logging.

BOONE KAUFFMAN

A Brazilian technician with a para para tree, a valuable hardwood Kauffman says is in danger of extinction because of rain forest burning.



BOONE KAUFFMAN

explained Kauffman. "In fact, we found that it's almost impossible."

To better understand the environmental conditions necessary for forest fires to occur, Kauffman and the others measured rainfall, temperature and humidity under plastic rain-free shelters they constructed in three types of forest—tall, closed canopy, short, closed canopy, and disturbed areas where the forest was felled. Each day, they also measured the amount, moisture content and chemical composition of the flammable debris on the forest floor.

Then they tried to set fire to these areas. They found it virtually impossible for the tall, closed canopy forest to burn, even when shielded from rain for more than a month with a plastic tent. In disturbed areas like tree-fall gaps and abandoned, cleared farms, they found conditions where fires could occur.

"We also developed models for predicting the likelihood of fires in different types of forest," said Kauffman.

People have so altered the environmental conditions in deforested areas of the Amazon, Kauffman said, the ecosystems are "unraveling" and irrevocably changing.

Once the forest has been even partially cleared or logged, conditions change dramatically. Cutting exposes the forest floor to sun and leaves large accumulations of woody debris on the forest floor. Temperatures soar, causing fuels to dry and become extremely flammable.

The ultimate result of most timber harvests is a quick change from a closed canopy, diverse forest that never burns to a weedy, flammable pasture that may burn repeatedly, Kauffman explained.

An intact rain forest creates its own climate—scientists estimate about one half of all the rainfall originates from the moisture given off by the forest itself. When large tracts of land are deforested, local and overall climatic patterns may change. Once the forest is gone, drought may occur, intensifying the probability of fire and decreasing the probability the forest will ever return.

"Once an area has been disturbed by even partial timber harvest, it's not a matter of will the area burn, but rather when will it burn," said Kauffman. "It is inevitable."

Left: A bath in the Rio Negro River, part of the Amazon's headwaters. Poverty is driving people into the remote areas of the Amazon Basin, where they clear the forest and try to eke out a living farming.

In 1987, in Para, Brazil, in the northeastern Amazon Basin, Kauffman and his colleagues compared microclimate (temperature, relative humidity, wind and sun) and potential for fires in a mosaic of intact rain forest, partially logged forests, pasture and abandoned farm fields. They also studied how tropical hardwood trees respond to burning.

There is nothing left but ash.

"We found average daily temperatures in deforested areas there to be 10 to 15 degrees higher than in adjacent intact forest. We measured declines in relative humidity of up to 21 percent in cleared areas," Kauffman explained.

"When an area is cleared for logging or agriculture, we are changing it from an ecosystem which is essentially fire-immune to where fires are extremely common and likely to occur."

Tall tropical rain forests can catch fire an average of only one day each 11 years, according to Kauffman's predictive models. Cleared and pastured areas become flammable after only one rainless day, and partially logged areas can burn after an average of only six rainless days.

"Given that fire is such a commonly used tool for pasture conversion, weed control and slash-and-burn agriculture, escapes of fire into adjacent disturbed forest are very common. It's just a matter of time until a disturbed area burns," said Kauffman.

There is nothing so dramatic as seeing the results of a tropical forest fire, he said.

"Many times, there's nothing left but ash and charred black stumps."

Very few Amazon plant species are adapted to fire, noted Kauffman. Because fires were extremely infrequent through the ages, most Amazon plants never developed strategies for dealing with the severe environmental stress of a fire and the post-burn environment.

In Para, Kauffman and his colleagues studied which plant species survived after being burned. By seeing which are the most and least tolerant to fire, they will be able to determine what kinds of land use activities are sustainable and how damaged ecosystems might be restored.

"We got dramatic losses of species in these burned areas," he said. In their

BOONE KAUFFMAN

A cane field burning in northeastern Brazil on a plantation where tropical rain forest once stood. In the Amazon Basin, sparks from burning fields often ignite wild fires in nearby rain forest.

NASA

BOONE KAUFFMAN

Brazilian study, they found that eight months after fires in partially cut rain forest, 36 to 69 percent of all trees died.

The species that survive fire often grow back by sprouting out of the cremated remains of the former forest. They are also species that can tolerate the hot, dry soil conditions of a burned forest.

Last year, Kauffman, Cummings and Robert L. Sanford of the Natural Resource Ecology Laboratory in Colorado traveled to Pernambuco, in northeastern Brazil, to look at tropical dry forests and the effects of fire on nutrients in the soil, forest and atmosphere.

"It's the hottest, most miserable work."

Pernambuco is on the trans-Amazon highway. It is densely populated, impoverished, and more environmentally degraded than the areas they studied in their two previous research trips.

They measured how much living material was on a site before and after a burn. They also found burned soils to be nutrient poor—nutrients including carbon, nitrogen and phosphorus literally go up in smoke.

"It's the hottest, most miserable work anybody could possibly do," said Kauffman about his work in South America. "The temperatures in clearcuts get up to 112 to 115 degrees. And the insects are unbearable. You are constantly climbing through slash or areas that literally look like moonscapes—nothing but gray ash and charred trunks.

"But what we are doing down there is helping to understand a very important global system. Everything is connected. We have a tremendous obligation to help impoverished people of the world to try and save valuable ecosystems and save our planet."

Estimates vary widely about the rate of deforestation and burning of the world's tropical forests, but one thing is clear—species are being lost at an alarming rate. Some scientists estimate up to 100 species per day may be going extinct in the tropics.

Far left: A satellite photo of a smoke cloud rising from a hugh fire in the Amazon Basin. Left: Rain forest with its dense canopy opened by logging. Wild fires often follow.

Whole communities of unique plants and animals are disappearing within a few decades, less than the lifespan of many of the forests' human inhabitants.

"We have certainly learned that all is not well in the Amazon," he said.

In Brazil and many other debt-ridden tropical countries, the rain forest is succumbing to additional pressures. The Brazilian government, swamped with a $70 billion foreign debt, has made the Amazon Basin a development priority. Cattle ranching, logging, mining and road building through virgin forests are subsidized with government tax breaks, grants, credits and homesteader-type programs. Once cleared, the land often is bought and sold on speculation by business people in faraway cities.

To save what remains of the world's tropical forests, scientists realize that successful strategies will have to consider more than simple preservation.

"It is very obvious that rampant deforestation is not a biological problem. It's merely a reflection of social problems with multiple causes," said Kauffman.

Robert Buckman, a professor of forest resources management at OSU, expands on that.

"If we have to address environmental problems and topics, we must concurrently address social and economic needs," said Buckman, who is in his fourth year as president of the International Union of Forestry Research Organizations, consisting of 600 research institutions in 100 countries.

"A combination of acute poverty, population explosions, serious health problems, a legacy of colonialism and lack of infrastructure in government, endemic and epidemic corruption, a history of absolute government and a lack of training and education are all causal," said Buckman.

Kauffman and Buckman agree there is no quick fix for the overwhelmingly complex problem of tropical deforestation.

"Most of the ecologists who do research down in the Amazon are not optimistic," said Kauffman.

"It's the policy people who are coming up with the answers—for example, economists are finding that a tropical forest is worth more standing than logged. Brazil nuts, rubber, wildlife and other food products coming from one acre of forest are worth much more than the lumber or pasture value of the same land, over the long term."

Other suggested strategies include population control through education, and renegotiation of foreign debts to allow debtor nations to swap intact forest land for debt (see sidebar). Moving toward a market economy might also provide incentive to leave the forest standing, said Buckman.

There are more tangible approaches as well.

Agroforestry, the practice of growing food-producing trees and shrubs in crop fields on deforested lands, has shown potential for increasing the productivity of cleared land.

"Some of the most successful agriculture we have seen is with agroforestry systems where the patterns of natural plant succession are closely mimicked," said Kauffman.

During the first year of an agroforestry system, an annual crop is planted, like corn or rice.

DAVE KING

Kauffman, in his OSU office, also studies the impact of fire and fire supression on eastern Oregon's rangelands.

Then in the second or third year, short-lived perennials like papayas are grown. After a few more years, long-lived trees such as rubber, Brazil nuts, mangos and cacao are put in. Eventually, a 50- to 60-year rotation may result.

"All these solutions are important," said Kauffman. "But we also need to remember that what affects these people also will affect us here in Oregon."

Scientists are now saying global warming will occur, or may be already occurring, because of the losses of tropical and temperate forests, a major source of carbon storage, explained Kauffman.

Oregon could experience problems including decreases in agricultural productivity, less annual precipitation, decreased water supplies, a significant sea level rise and loss of plant and animal species, according to some scientists' projections.

"Global warming will likely mean changes in everyone's lives," said Kauffman. "The writing is on the wall for us, too."

Carol Savonen is a writer in the OSU Office of Agricultural Communications.

WHY AMAZON BURNING MAKES HOLLAND SWEAT

What does tropical deforestation in the Amazon Basin have to do with the sea level in the Netherlands? Maybe more than we now know.

Trees can take up and store carbon dioxide. An estimated 45 percent of a tree, by weight, consists of carbon, most of it stored as cellulose, a major component of wood. Scientists have calculated that an acre of trees might store up to eight tons of carbon.

When vast forest tracts are logged and burned, the carbon turns into carbon dioxide, which is released, increasing the potential for heat storage in the atmosphere. Deforestation and its associated fires contribute to global warming or the "greenhouse effect," a 3 to 10 degree Fahrenheit temperature rise that may already be starting around the world.

Some scientists say global warming ultimately will lead to sea level rise, climate change, crop failures and perhaps other related problems such as world hunger and political upheaval.

For the first time, developed nations are linking their political decisions to global environmental issues. Recently, the Netherlands proposed that Brazil leave large tracts of rain forest intact in lieu of paying back foreign debts.

Why? According to the British newspaper *The Guardian*, the Netherlands proposed the debt-for-tropical rain forest swap as insurance against the ominous threat of global sea level rise which would dramatically affect this low-lying country.

THE RIGHT STUFF

Remote sensing with satellites and airplanes is flying high in agriculture

Oregon Indians, pioneers and farmers have glanced heaven ward and wondered what the seasons would bring.

Today, OSU researchers also are looking to the skies for answers. How many acres of potatoes will there be this year? How much water should be used to irrigate a certain area? Will there be another corn earworm infestation?

These researchers aren't waiting for divine revelations; they're using a process called remote sensing.

Satellites or aircraft are equipped with sensors, which record the patterns of light waves reflected from the earth's landscape. Infrared and microwave signals are often used in remote sensing. Microwaves could be especially useful in Oregon's often uncooperative climate, because their longer wavelengths can penetrate clouds, fog and rain.

In a $1 million research program partially funded by the National Aeronautics and Space Administration (NASA), OSU researchers are using remote sensing to measure the land area potato crops cover. They have surveyed potato growth models around the world, working with colleagues at Washington State University, Cornell University and in Israel. The acreage estimates are about 98 percent accurate.

BY ASHLYN BARNARD

Right: A computer-enhanced infrared image of the Hermiston area from SPOT, a French satellite. The Columbia River is black; red circles are irrigated agricultural fields.

"We're now trying to go one step further and estimate the yield," says Marshall English, a professor of agricultural engineering at OSU. "It's more difficult than just estimating acreage."

Yields are estimated using satellite measurements of the greenness of the crop to determine how well that crop is progressing. The rate of crop development then is entered into a crop production model that estimates yield. The models are being calibrated and tested with 15,000 ground measurements each season.

"We're now trying to go one step further."

The remote sensing project ultimately will be used in a commercial venture in coordination with Frank Lamb of Cropix, Inc., an eastern Oregon remote sensing and consulting company, and NASA's Ames Research Center in Mountain View, California. Cropix has been in the business of selling information from satellites to potato growers and processors for about five years.

Knowing the total acreage of potatoes in an area, and the likely yield, helps growers judge whether potatoes will be scarce or abundant and allows them determine a fair contract price. Processors can better judge how many potatoes they'll be handling.

"This will eliminate a lot of uncertainty and risk," English says of the program. "It would stabilize prices."

The three-year research project started more than a year ago. Frank Lamb, who operates a 10,000-acre farm near Hermiston, started buying satellite data and contacted OSU for cooperation. English and graduate student Chaur-Fong Chen started working on the project. NASA soon heard of it and encouraged Lamb to apply for a grant.

The project uses data from two LANDSAT satellites, the French SPOT satellite and an ER-2 plane (a converted U-2), which flies twice as high as a regular plane. Several images put together form a large map of potato acreage in the Columbia basin. The SPOT satellite's images are received in a week; LANDSAT's can take from two weeks to six weeks. The LANDSAT satellites aren't fully operational anymore, but English expects five new satellites in the '90s.

"Satellites age just like people," he says. "When they're launched, it's like a baby. You watch every second. Then you forget about them for a while, and then one day they start breaking down a little at a time."

Two of the new satellites will be American, two more will be European, and one is Japanese. Additional satellites could solve one of the researchers' biggest problems: Oregon weather. The more satellites available, the more days' images. For instance, LANDSAT takes one image of the study area about every 16 days, and if that day is cloudy—no data. (To make up for the losses, English's colleagues recently gave him a rainy-day "remote sensing" cardboard

tube with an eyehole and a picture of potatoes pasted inside at the end.)

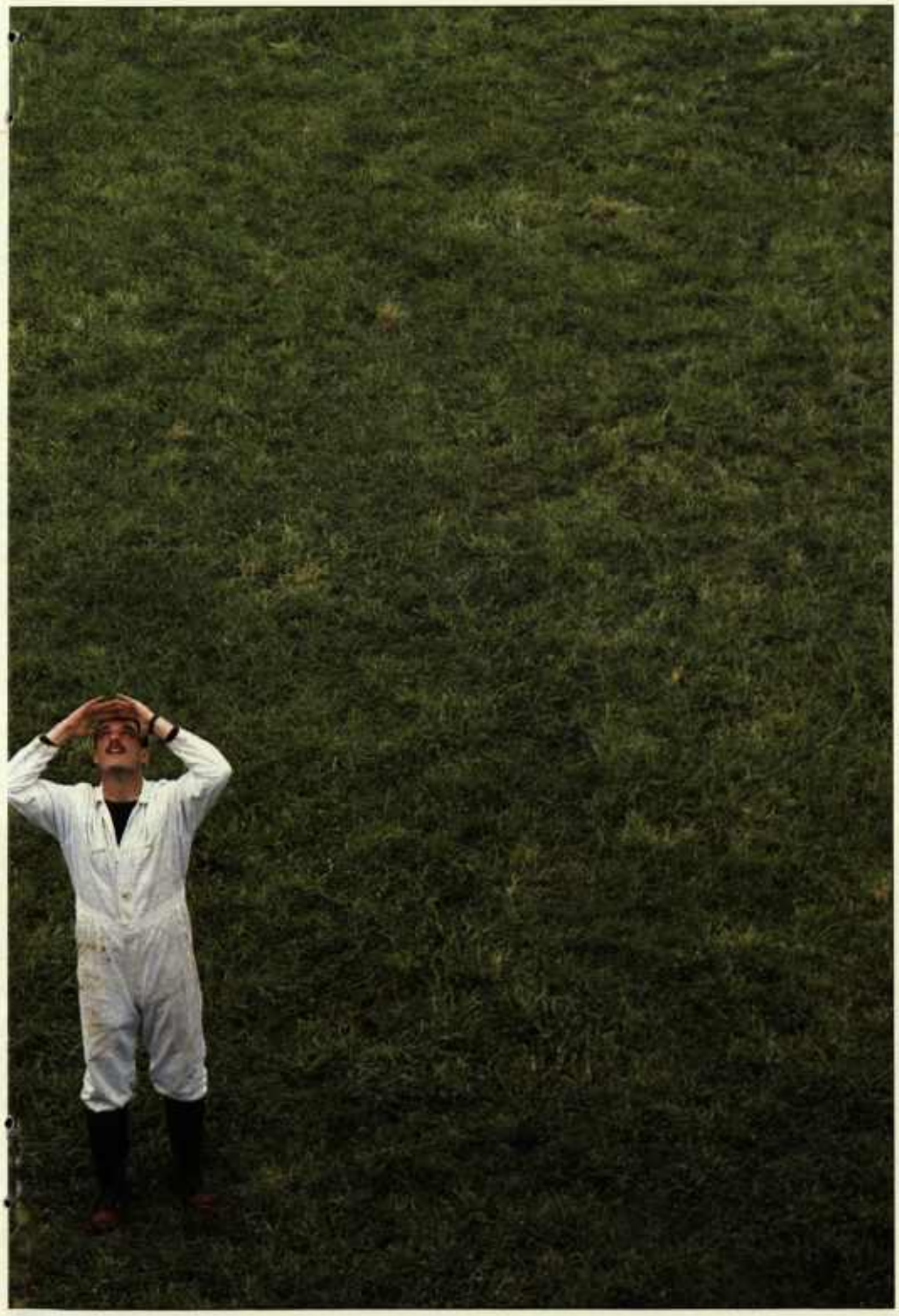
OSU's ERSAL, or Environmental Remote Sensing Applications Laboratory, has contributed equipment and data to the potato project and to other OSU studies.

Researchers are developing technology to recognize other crops besides potatoes. Corn, alfalfa and wheat have been added to the satellite's repertoire. Another project may measure irrigated acreage in parts of Oregon.

Richard Cuenca, an OSU professor of agricultural engineering, uses remote sensing to track the movement of water and energy for his irrigation research. He looks at infrared and microwaved images that have been coded so greener areas indicate plants higher in moisture and red areas are drier. With field equipment and remote sensing he measures the factors of an equation: net radiation (solar radiation minus earth's radiation) equals soil heat, energy to drive water off plants, and heat in the air.

Cuenca has mapped the water use by grass, month by month, for the entire state of Oregon. He also has a table of crops and regions that shows the water requirement of a crop, the irrigation requirement and expected rainfall.

"It's used both to determine how much water is needed for an irrigation project and to conserve water," says Cuenca.



DAVE KING

One of the...biggest problems: Oregon weather.

About ten years ago, he installed the first automated weather station in Oregon, part of a Spanish-American cooperative project funded by the U.S. Department of Agriculture. In addition to measurements taken near the ground by this system and other field equipment 10 miles north of Corvallis, Cuenca now has planes with sensors fly over the field to take images. In the second phase of research, he'll use the planes' data and LANDSAT images together.

"This is the way global resources are going to be mapped in the future," Cuenca says of remote sensing, explaining that problems such as water distribution and erosion in large areas can be picked up easily by satellite.

Planes that are part of the OSU forest science department's Oregon Transect Program, which has forest sites for measuring various weather factors and the response of vegetation, also take images of Cuenca's site. He's worked on projects with equipment similar to the Corvallis site in France and Spain.

Cuenca foresees that his research could have practical applications for Oregon agriculture as well as improving models for climate and meteorological conditions. His data could be used for

Left: Ten years from now Oregon farmers may routinely use data about crop yield, irrigation and pest control collected by satellites and airplanes, Experiment Station scientists say.

predicting weather and climatic change in a small area, though probably not for farmers' individual fields.

Remote sensing with infrared can tell when a field's too dry and where, and infrared or microwave could show what areas have poor drainage. The irrigation tables could help farmers determine their water needs and save water. Remote sensing could even be used to estimate movement of contamination in groundwater.

"With some of what we're doing, the payoff's today," Cuenca says. "Other things are three or four years down the road. You don't know the answers when you start."

"This will eliminate a lot of uncertainty."

Satellites also play an important role in the battle with agricultural pests.

Brian Croft has a remote sensing project in the works that could give farmers some important answers to a question they ask about pest control: "To spray or not to spray?"

Croft, an OSU entomology professor, is working with graduate students Tianhe Zheng and Ray Drapek on computer systems that would use satellite and ground data to determine the risk of damage that corn earworms could wreak on sweet corn crops in the Willamette Valley.

"We could help growers estimate the risk, or tell them how much loss they'll have," Croft says. "We could help them decide whether they should spray with pesticides."

It works like this: the researchers will use a satellite, maybe LANDSAT, to identify corn crops by their color, or particular wavelength of light, then determine the crops' stage of development. The plant is at greatest risk of an earworm attack when the corn silk is out.

NASA

Then earworm moths are caught in traps using pheromone, a sex attractant. Looking at the number of moths in a field and the stage of the corn crop, the researchers could estimate the risk of damage in dollars per acre.

Using a satellite's "big picture" of many fields helps calculate the risk to an individual field. A field in good condition is likely to attract earworms when the surrounding fields offer less for them to munch on.

"We now have the ability to tell from moth traps whether it will be a good or bad year," Croft says. "It's a protection against crop loss, advanced warning to head it off."

In 1985, a corn earworm infestation caused serious problems for Oregon canneries. Damage decreased in the following years, but Drapek says 1988 was the worst infestation year since 1985 for late-season corn. Though 1989 was relatively trouble-free that doesn't mean the pesky earworm is on permanent vacation, Croft cautions.

"Farmers haven't forgotten the corn earworm yet," he says. "There'll be some bad years. There are some indications that the corn earworm is increasing as a problem in the Willamette Valley, although it's worse in the Columbia Basin."

Croft and his fellow researchers are devising an "expert" computer system, soon to be available through Extension Service offices, that will use a question and answer program to help farmers decide whether to use pesticides or other ways of dealing with pests. The system uses information about a farmer's corn crop and field location to offer advice. Drapek says the Extension Service also will distribute flyers about the corn earworm for farmers' use in decision-making.

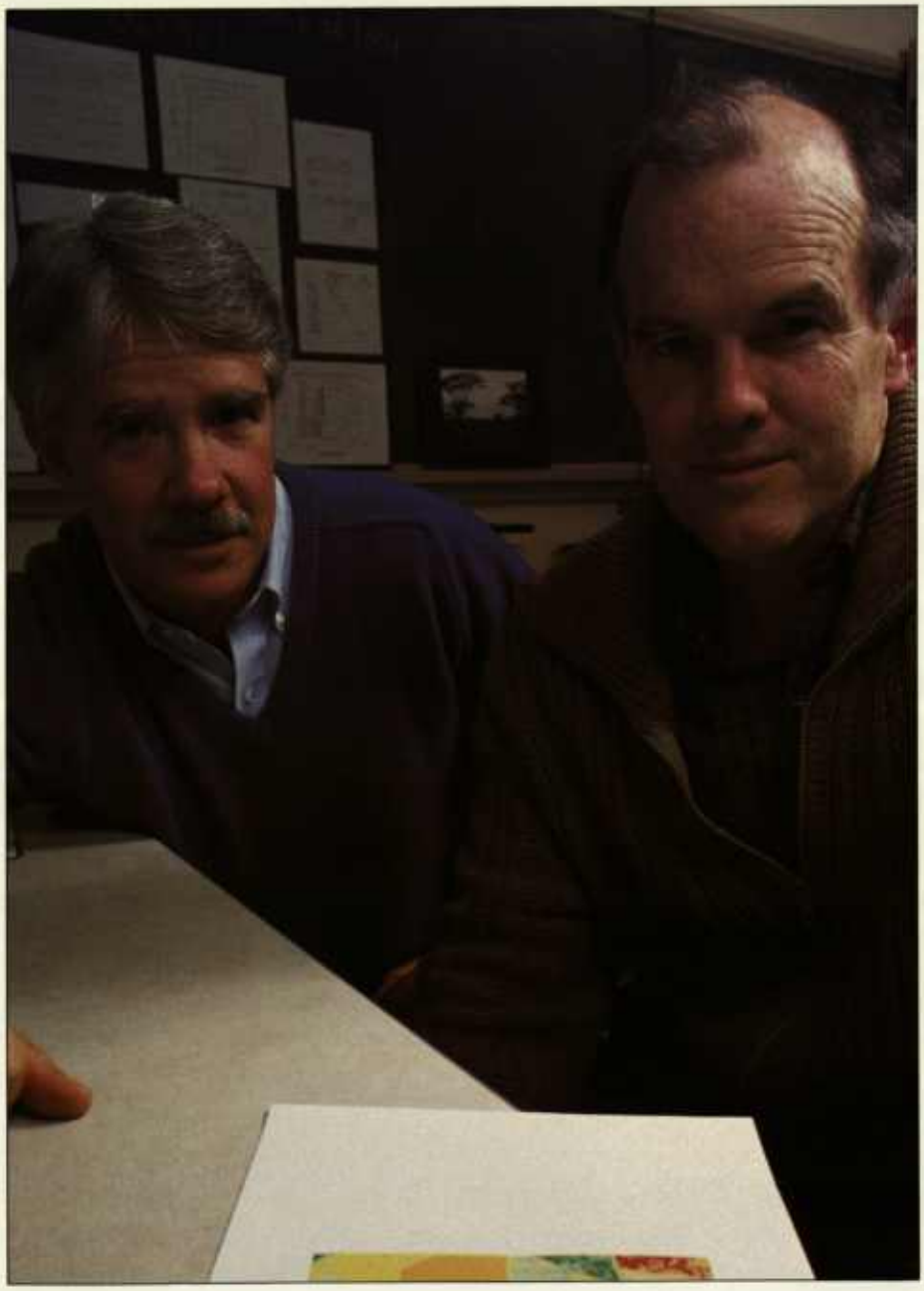
"Satellites age just like people."

The expert program is geared more toward farmers growing for canneries. Fresh corn growers in the Willamette Valley spray, as a rule; canneries can cut off the bad tip of a corn ear, but roadside stand buyers are less willing. Drapek says the program could tell fresh corn growers when not to spray.

Meanwhile, the researchers are beginning the remote sensing project by working on a GIS (Geographical Information System), which keeps track of the needed data on a large scale. A variety of information is overlaid: satellite images, moth traps, a field's stages, and perhaps wind and soil data.

"Ten years from now you'll see many different resource managers using common 'layers' of information," Croft predicts.

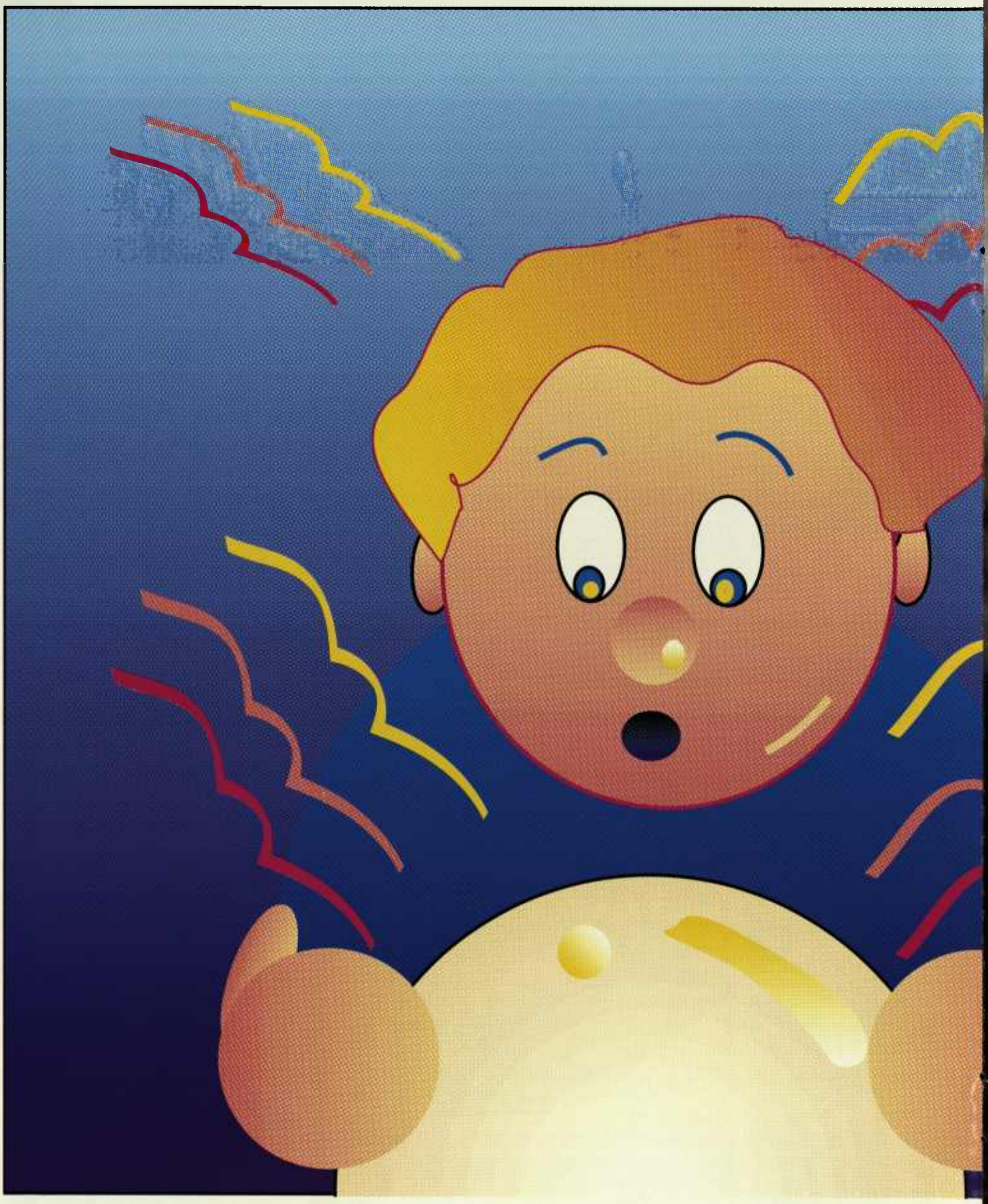
Ten years from now, Oregon farmers may be using remote sensing data on a routine basis to answer questions about crop yield, irrigation needs or pest invasions. The sky may indeed be the limit.

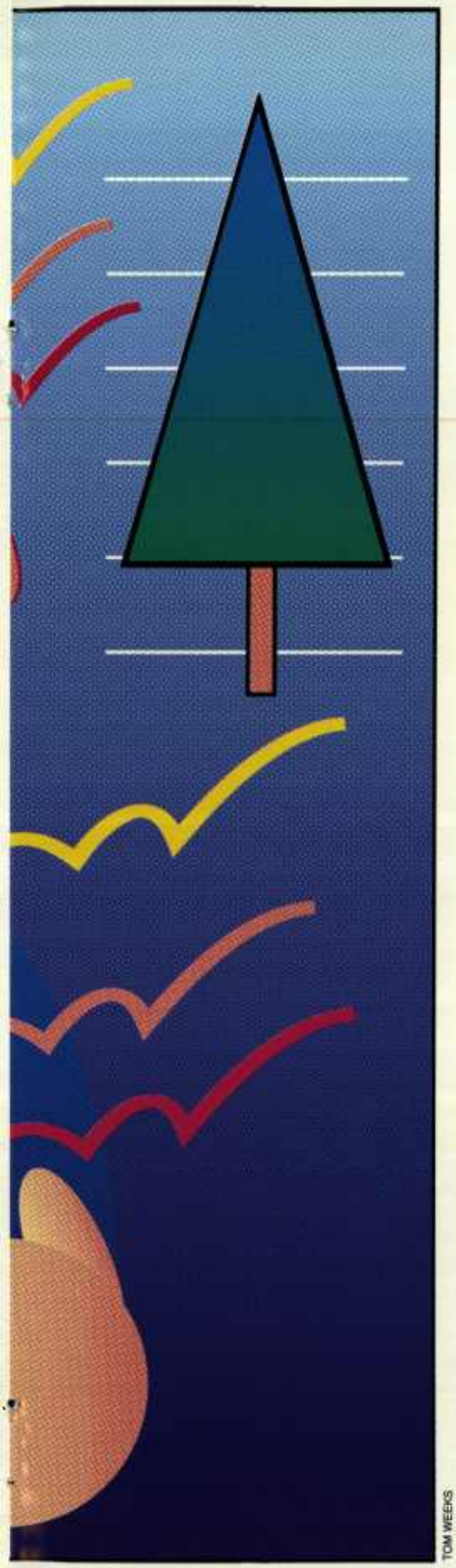


DAVE KING

Far Left: The Earth as seen by Apollo 13 astronauts in April 1970. The southwestern United States and northwestern Mexico (including the Baja Peninsula) are prominent. Clouds, like those obscuring Oregon, can be a problem in collecting remote sensing data for agricultural uses. Left: Agricultural engineer Dick Cuenca, left, is studying the use of remote sensing to improve irrigation; colleague Marshall English is doing the same with crop yield estimates.

Ashlyn Barnard, who grew up in Corvallis, Oregon, is a freelance writer in Virginia Beach, Virginia.





TOM WEEKS

WOODLOTS? NURSERIES? ARE YOU KIDDING?

OSU agricultural economists revisit the Eighties for clues to the Nineties

BY TOM GENTLE

For American agriculture, the 1980s began with high hopes. Farm exports were booming. America, some said, was going to feed the world. Farmers were urged to plant from fence row to fence row. But the giddy optimism was soon buried beneath a blizzard of images on the evening news: bewildered farmers forced off land that had been in their families for generations, public auctions of farms and equipment, shuttered storefronts lining the main street of rural towns. Then came drought and more crop failure and more farm foreclosures. In the Great Plains things got so bad that some experts recently suggested transforming the Dakotas into a gigantic buffalo preserve.

> The ... success story of the decade took many people by surprise.

Oregon didn't escape the agricultural debacles of the 1980s. But their effects were felt unevenly across the state. And in some cases, misfortune elsewhere actually spurred prices and sales for many Oregon commodities.

During the 1980s, the state's agricultural base expanded, driven primarily by the rapid growth of the nursery industry and high demand for logs from small, privately owned woodlots. The Willamette Valley gained economic clout relative to eastern Oregon in terms of total dollars generated by commodity sales. Financially, the state's farm sector suffered tough times during the first half of the decade before returning to relative prosperity as the 1980s drew to a close. And the mid-size, self-sustaining family farm continued to dwindle as the number of farms under 50 acres increased and large farms grew larger.

These trends emerge from a variety of statistics pertaining to Oregon agriculture. "Statistics help us identify long term changes or confirm trends that we think are occurring," said Stan Miles, an economist for the OSU Extension Service.

"Of course, the statistics also show how uncertain agriculture can be and how unexpected events can suddenly change things. Farmers can cash in on a crop one year and go broke the next."

"Farmers and ranchers are at a new crossroads."

The agricultural success story of the decade took many people by surprise. Imagine the snickers in 1980 if the smart money had predicted that logs—a product most of us don't even associate with farming—would be Oregon's hottest agricultural commodity by the end of the decade. And yet, gross sales of logs from small woodlots on farms and ranches soared from $55 million in 1980 to an estimated $235 million in 1989, an increase of 318 percent. The sales increase was the largest among the more than 100 agricultural commodities produced in Oregon during the decade.

The success of small woodlots is just one of the surprises revealed by the statistics on gross sales of agricultural products. Cash sales, the total dollars Oregon farmers and ranchers receive for the sale of raw commodities, were one of the bright spots for Oregon agriculture in the 1980s. Total cash sales rose steadily throughout the decade, from $1.7 billion in 1980 to $2.5 billion in 1989.

These figures need to be kept in perspective, Miles noted. Throughout the decade, inflation affected prices paid for commodities. And while prices rose, farm expenses also went up. Most importantly, the increase in total receipts was not reflected in net profits. Only after producers pay all their operating expenses from the money they receive from cash sales can they talk about profit.

During the 1980s, all agricultural commodities except grains showed gains in gross sales. Those that experienced the most dramatic growth in sales were: farm forestry (small woodlots), +318 percent; nursery and greenhouse, +142 percent; grass and legume seed, +110 percent; vegetable crops, +63 percent; cattle and calves, +41 percent.

The Willamette Valley nursery industry's strong performance should continue in the 1990s, say OSU economists.

How long the two top-ranked commodities, farm forestry and nursery crops, will enjoy their trends is difficult to predict. The long term prospects for the nursery industry appear stronger than those for logs. According to Dave Adams, an Extension agent at OSU's North Willamette Research and Extension Center, the Willamette Valley climate is uniquely suited to nursery production. Its long, cool summer days and relatively warm winters are unmatched anywhere in the United States. In addition, he explained, Oregon's land use laws have promoted the development of small nursery operations. Nurseries can meet the land use income requirements and the regulations allowing homes on small parcels of agricultural land.

In contrast, the log supply situation appears more tenuous, according to Keith Blatner, professor of natural resources at Washington State University. Writing in *The 1990 Pacific Northwest Agricultural Situation and Outlook*, he characterizes the prospects for forestry products as "positive but clouded." Concerns about log supplies, the old growth controversy,

Left: An agricultural boom may be slowing housing development in east Multnomah County, observers say.

mortgage interest rates, and housing starts could be subject to sudden change.

The commodity sales figures also highlight another trend of the 1980s, the shift of a relatively greater share of sales value to the Willamette Valley. Umatilla and Malheur counties, the traditional strongholds of commodity sales, have been replaced by Marion and Clackamas, with Washington and Linn close behind. Furthermore, where the Willamette Valley accounted for 40 percent of the state's commodity sales 20 years ago, in 1989 that figure had risen to almost 50 percent on the strength of $1.2 billion in sales.

This trend adds a new dimension to the land use issue in the Willamette Valley, where farmland is under increasing pressure from population growth and industrial, commercial and residential development. The crux of the problem, according to Dave Adams, is that the best agricultural land is also the most suitable for housing construction. As population growth creates demand for more housing, agriculture is slowly squeezed out.

"However, we may be seeing the reverse of that scenario," Adams said, citing reports of small parcels of land in east Multnomah County being purchased by agricultural interests and removed from the land available for housing development.

For those who grumble about the economy of the northern Willamette Valley growing at the expense of the rest of the state, the shift of sales value from east to west appears to add more fuel to the fire. But that isn't really the case, according to Jim Cornelius, an Extension economist and colleague of Miles. Cornelius, who is working on an Agricultural Experiment Station project intended to estimate the impact agriculture has on the Oregon economy, thinks the emergence of the nursery industry and the booming woodlot sector during the late 1980s overshadowed the bright performance of Oregon agriculture in general.

"Agriculture isn't declining in eastern Oregon, but the explosion of specialty crops has benefited western Oregon, especially the northern Willamette Valley, and taken the spotlight off the steady performance of agriculture in other parts of the state," Cornelius said.

Even wheat, the major crop in northeastern Oregon, could be getting a bad rap, he maintained. According to the sales statistics, the value of annual wheat sales dropped 26 percent between 1980 and 1989. During the same years, however, wheat production dropped 32 percent as farmers responded to federal farm programs intended to limit production.

TOM WEEKS

In the 1980s, the number of mid-sized, family farms in Oregon continued to sink.

"There's nothing inherently wrong with Oregon's wheat industry. Wheat growers intentionally reduced their plantings and the drop in sales value naturally followed. That decline in sales value actually began to reverse itself by the end of the 1980s as the international market once again turned to Northwest white wheat," Cornelius said.

The statewide value of the sale of crops continued to increase in comparison to livestock products during the 1980s, though at a much slower rate than in the previous 10 years. In 1971, crops accounted for 53 percent of total sales. In 1980, the figure was 67 percent, and by 1989 it had risen slightly to 69 percent.

"There were years when the gap narrowed, of course, but generally it has continued to expand," Miles said. The slower rate of increase during the 1980s reflects the recovery of the cattle industry in the latter part of the decade.

The dominance of crop sales is even greater in the Willamette Valley where, in 1989, crops accounted for 80 percent of gross sales, up from 72 percent in 1980. Once again, this underlines the influence of the burgeoning nursery industry as well as increased sales of grass seed and vegetables.

"Almost half of Oregon's annual gross farm sales come from the Willamette Valley, which has only 10 percent of the state's agricultural land," Miles said.

Unfortunately, the continuous growth of commodity sales did not necessarily translate into profits. While the state by and large escaped the severity of the recession that ravaged the farm economy elsewhere in the United States, bankruptcies, falling land values, commodity surpluses and drought still took their toll. Their impact is reflected in statistics on net farm income, production costs, and farm equity.

Net farm income, the amount of money remaining after farmers pay their production costs, dropped dramatically from $400 million in 1980 to $262 million in 1983. During this time, production costs and farm debt, already swollen by the runaway inflation of the 1970s, remained high.

"By 1982, the boom of the previous 10 years came to an end," Cornelius said. "Then through 1986 came recession, the collapse of land values, and lower commodity prices."

"The majority of the corporate farms are really family farms."

Production costs began to drop in the mid-1980s, influenced by widespread farm reorganization. "Farmers had to cut their costs or sell out to more efficient operators," Miles said. As a result, net farm income began to level out and then increase.

From about 1986 or 1987, relative prosperity began to return to Oregon's

farm sector. Net income eventually rose to an estimated $1 billion in 1989. Production costs increased, too, but more slowly than in the past, and farm equity rose in relation to debt.

The British and Canadians are the biggest foreign owners.

"The financial picture for Oregon agriculture improved by the end of the 1980s and farmers and ranchers are at a new crossroads," Cornelius said. "Can we maintain the present relative balance between supply and demand, or will agriculture begin to overproduce? In addition, we have a whole new set of concerns to deal with—food safety, liberalizing international trade, global warming, animal rights, ground water supply and quality. And the traditional concerns of weather, insects and disease never go away. So even though the financial situation has improved in the last few years, there's no guarantee it will continue."

Oregon is going against national trends in the number and size of farms, according to Farm Census statistics. Nationwide, the number of farms is dropping and the average farm size is growing larger. During the 1980s, Oregon farm numbers increased by 2,000 to a total of 37,000. And the average size of those farms shrank from 517 acres to 481 acres.

"The statistics mask the trend to some extent. What's actually happening is that farm size is becoming more polarized as the number of small farms increases and the large farms grow larger," Cornelius said. "The Jeffersonian concept of a family farm is disappearing from the landscape. You either get larger or you shrink and rely on an outside job for income."

The majority of Oregon farmers are part-time or hobby farmers, Miles noted, reinforcing the point that the self-sustained family farm is disappearing. The census figures indicate that more than half reported their principle occupation was outside of agriculture. Further, just 12 percent of Oregon's farms sold $100,000 or more each year. Those 12 percent accounted for 80 percent of the state's sales of agricultural products, while 63 percent of the farms had sales of less than $10,000.

"The trend toward smaller, part-time operations began long before the last decade, but during the 1980s it has become more dramatic," Miles said.

The popular perception that investor-owned corporations are taking over Oregon agriculture is not justified by the statistics, Miles noted. Only 5 percent of Oregon farms are owned by corporations.

"Based on the census and other studies, we know that the majority of the corporate farms are really family farms that have incorporated for easier transfer of ownership or other business reasons," he said.

Nor do the statistics indicate that foreign ownership of Oregon farms is increasing. The British and the Canadians are the biggest foreign owners and their holdings are concentrated in forest lands, according to Cornelius.

"Japanese investment is coming in, but it appears to be headed into the processing and marketing sector," Cornelius said. "There's probably too much volatility and too small a margin of profit in agricultural production for any investor-owned corporation, foreign or domestic, to get involved in farming. People are attracted to farming because it's a way of life, not because it's a source of quick, easy profits."

TOM WEEKS

The sale of logs from woodlots on farms and ranches soared 318 percent in the 1980s.

"Diversity" is the key word used to describe Oregon agriculture. The variety of the state's landforms, its differing climates and soils—all contribute to the more than 100 crop and livestock commodities produced in the state.

When poor markets, bad weather or other disasters strike a particular commodity, the sheer variety of our production acts as a buffer against a widespread downturn in the farm sector. Diversity adds stability to our agricultural sector unlike, say, Iowa where a change in hog or corn prices can cause a dramatic change in sales.

On the other hand, because of the variety of its products Oregon ranks among the top national or world producers in only a few areas. And diversity resists our urge to generalize. "It's difficult to characterize agriculture in Oregon because there are exceptions to every statistical average or trend," said Cornelius.

Each year during the 1980s, for instance, some segments of agriculture in the state encountered difficulties while the others were thriving. Agricultural producers did not share equally in the good and bad times.

What trends are likely to continue into the 1990s?

"Farmers tend to be optimists," said Miles. "The situation looks good now, so I think most of them are approaching the future with a good attitude."

It appears agriculture in the Willamette Valley will continue to perform strongly, led by the nursery industry, and it appears the eastern part of the state will maintain its steady performance. But commodity sales are affected by a variety of national and international circumstances, many as unpredictable as the collapse of communism in eastern Europe.

The words of J. P. Morgan, the American financial tycoon, might be more apropos. A man stopped Morgan as he was leaving his Wall Street office and asked him for a prediction on what the market was going to do. "It will fluctuate," Morgan replied.

Tom Gentle is a communications specialist with the OSU Office of Agricultural Communications.

HIS WORK'S SORT OF DRY

For six years Fred Crowe's laboratory has been some high, often parched country just east of the Cascades—Deschutes, Crook and Jefferson counties. But his science career started to the south, in the shadow of other mountains.

"I sort of backed into agricultural research," says the superintendent of OSU's Central Oregon Agricultural Experiment Station, recalling his childhood in the little town of Dos Palos, California, about 60 miles west of Fresno.

"A science teacher got me interested in entomology. All through high school I used to wander up into the foothills of the Sierras collecting insects, mostly beetles and wasps."

Dos Palos is the size of Madras, Oregon. Crowe's father managed the telephone company. His mother taught English at the high school.

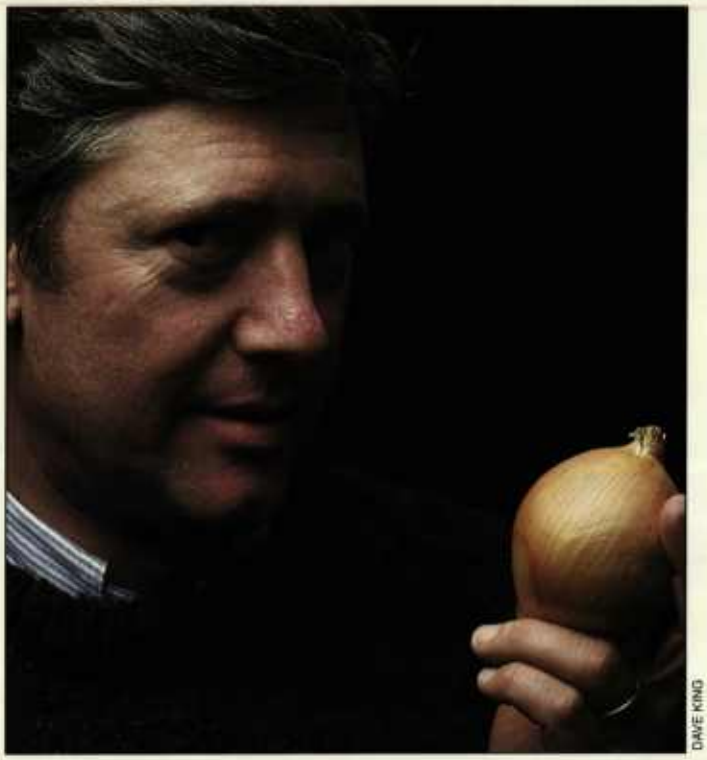
"But all my friends were farmers' kids," he says. "They raised cotton, alfalfa, dairy cattle. I think I was always heavily influenced by those people. Wanted to fit in."

A well-rounded student in a school system he describes as "not noteworthy," he applied to a variety of colleges and universities and was "a little overwhelmed" when Stanford accepted him. "I always thought they let me in because they wanted a cross-section of humanity," he says, grinning mischievously.

In 1971, he left Stanford with a bachelor's degree in biology, with an emphasis in microbiology, and entered a graduate study program in plant genetics at the University of California at Davis.

"I quickly made one of my early judgement calls. I decided there wasn't much of a future in plant molecular genetics and left," he says, chuckling at the thought. (Molecular genetics is the heart of today's biotechnology rage.)

Crowe was still fascinated with insects and he had a chance to work for a strawberry growers' cooperative headquartered near the northern California city of Salinas.



DAVE KING

Fred Crowe

"I didn't know much. It was on-the-job training in agriculture," he says. "I worked for all the growers checking their insect levels, fertility levels, diseases, production problems. "

After a couple of years he returned to UC Davis, thinking he wanted to study insects or microbes. It turned out to be microbes. By 1978, he had a Ph.D. in plant pathology, the study of plant diseases.

His first job out of graduate school was at Kansas State University, as an Extension Service specialist helping with diseases of the wheat-growing state's "minor" crops.

Crowe liked working with Kansas farmers but missed doing research. In 1984, he heard of an opening for a superintendent at OSU's central Oregon experiment station.

"The job sounded interesting, research and a little administration," he says.

Little did he know.

"It's the most demanding position I've ever had, a constant challenge," he says, reflecting on the last six years. "There's the short growing season but so many crops. And I've had to spend so much time acquiring equipment and raising funds for facilities and getting them constructed."

But the payoffs for that are coming soon, he points out.

The station is opening new potato research and office facilities at Powell Butte, east of Redmond, that will support a tri-state potato breeding program serving growers in Oregon, Washington and Idaho, as well as research with other central Oregon crops.

Also, later in the year the branch station's headquarters will move from Redmond to a new facility, yet to be built, at Madras.

Central Oregon produces a fourth of the nation's peppermint. That and grass seed are the area's biggest crops, although potatoes, wheat, livestock and many other crops are nearly as important.

Crowe may have backed into agriculture, but he doesn't seem to have time or the inclination to back out.

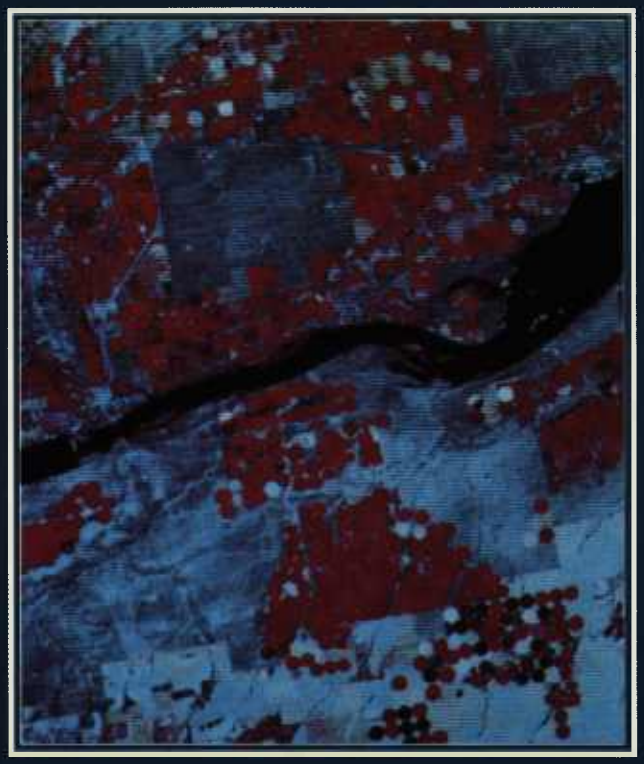
Besides working with farming groups and supervising the station, he's doing research with scientists in OSU's crop science department on alternatives to burning straw produced in central Oregon's grass seed fields. He's also studying verticillium wilt, a disease that afflicts peppermint; trying to clarify the role of weeds and range plants in the spread of potato viruses, and experimenting with a method of controlling white rot disease in onions. The last work has statewide, perhaps international, implications.

"I like what I'm doing," he says. "I like having my foot in both worlds—doing research and working with growers. Recently, things haven't been great from the research funding standpoint. But they have to get better if the public expects solutions to a lot of big problems facing agriculture, like water and food quality questions and pesticide and land use concerns."

—Andy Duncan

Agricultural Experiment Station
OREGON STATE UNIVERSITY
Corvallis, Oregon 97331
Thayne R. Dutson, Director
Oregon's Agricultural Progress

Bulk
U.S. Postage
PAID
Corvallis, OR 97331
Permit No. 200



SATELLITES AND YOUR FOOD
(See page 12)