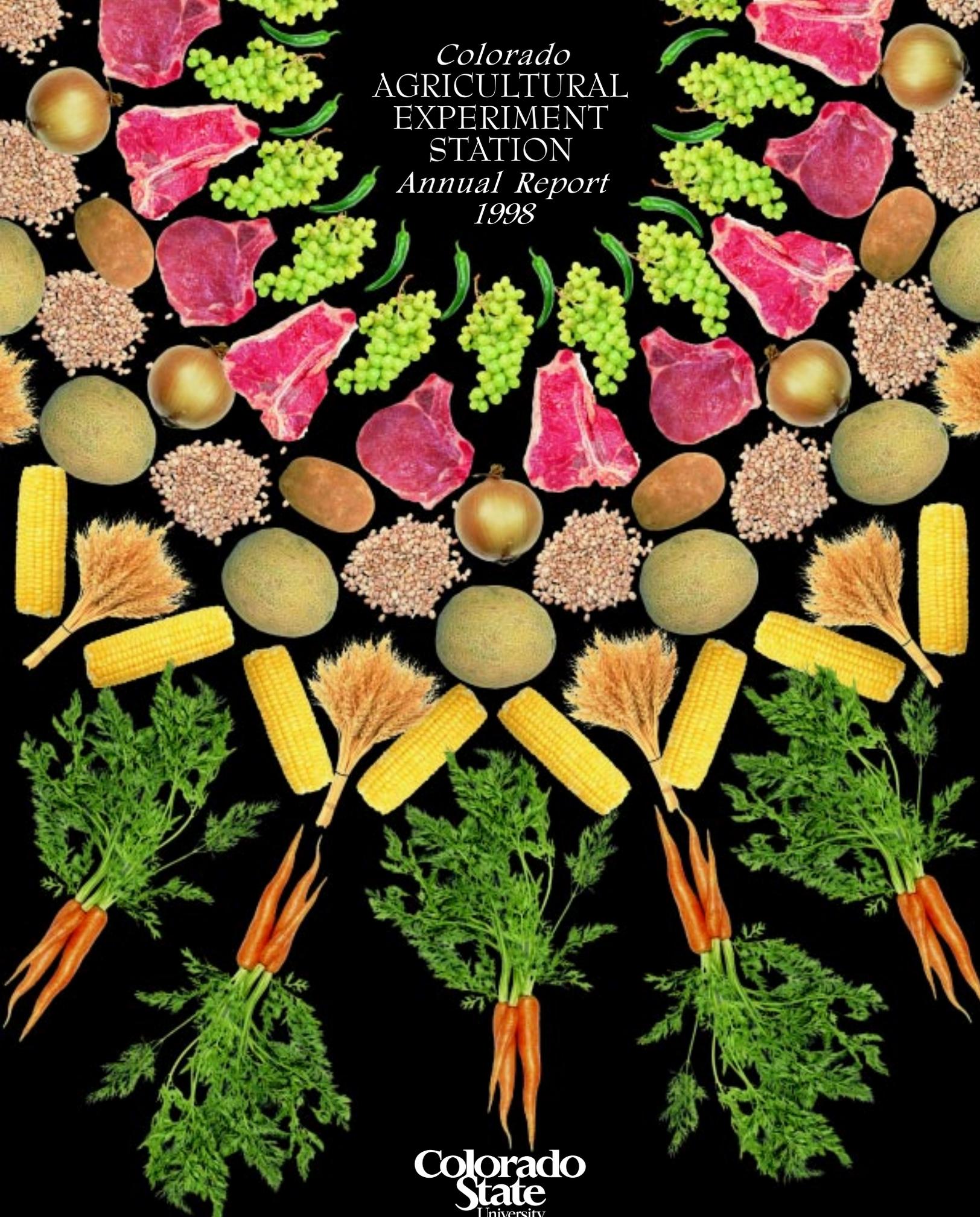


Colorado
AGRICULTURAL
EXPERIMENT
STATION
Annual Report
1998



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The Agricultural Experiment Station at Colorado State University developed this annual report to summarize the results obtained by a selection of our ongoing research projects. As an integral part of

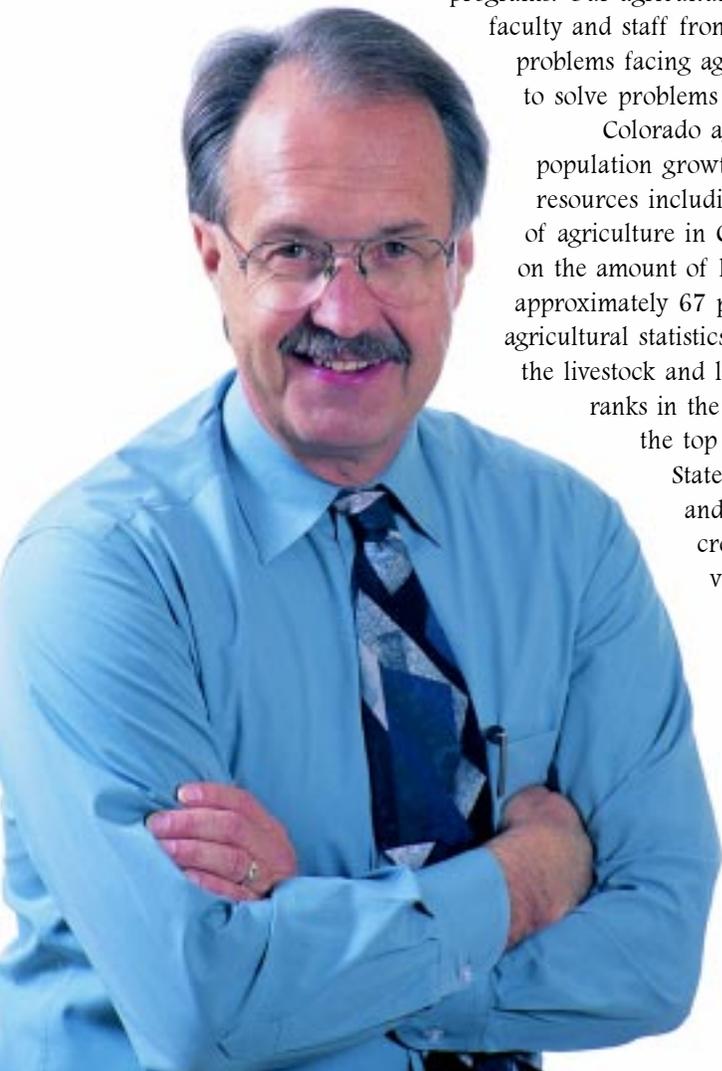
Colorado State University, the Agricultural Experiment Station is committed to implementing the land grant mission by conducting research on the agricultural and environmental needs of the people of Colorado, the region, and the nation. The mission of the Colorado Agricultural Experiment Station is to support research leading to an agriculture that is economically viable, environmentally sustainable, and socially acceptable. Areas of research emphasis for the Agricultural Experiment Station include: a) environmental quality – the interaction of agricultural and natural resource systems; b) improvement of plant and animal resources; c) integrated agricultural systems; d) alternative uses for agricultural commodities; e) foods – their quality and safety; and f) enhancing agricultural and rural economies. These areas of emphasis correspond closely with the priorities earlier established for agriculture and outreach programs at Colorado State University; they also mirror priorities set for national research

programs. Our agricultural research efforts extend across the entire campus involving faculty and staff from 22 academic departments in six colleges. To address the complex problems facing agriculture, it is essential that academic departments work in concert to solve problems through interdisciplinary effort.

Colorado agriculture is diverse and faces numerous issues related to population growth, water quality and quantity, and management of natural resources including forests and grasslands that are held as public lands. A synopsis of agriculture in Colorado reveals that the state ranks 12th in the United States based on the amount of land in farms. Gross receipts are about \$4 billion with approximately 67 percent derived from livestock and 33 percent from crops. Colorado agricultural statistics indicate that the value of beef cattle comprise about 80 percent of the livestock and livestock products sold in the state. With respect to crops, the state ranks in the top 10 for 26 different commodities. Wheat, corn, and hay rank as the top three crop commodities in the state. Colorado leads the United States in production of summer potatoes and ranks second for carrots and market sheep and lambs. In addition to its diverse livestock and crop enterprises, Colorado has a range of soils, climates, and vegetation types. Irrigation is a key factor for two-thirds of crop value produced in the state. In summary, agriculture is an important component of Colorado's economy and makes significant contributions to our overall quality of life.

I hope you enjoy this report. Please contact us if you have any questions concerning our research programs at Colorado State University.

Lee E. Sommers, Director
Colorado Agricultural Experiment Station
at Colorado State University



THE PRODUCTIVITY PUZZLE

**Integrated
resource
management
program helps
ranchers piece
together
strategies
that work**



If you examine one piece of a 3,000-piece picture puzzle – or even three or four – it’s nearly impossible to see what the entire puzzle means. Running a business is often like trying to put a puzzle together. You have to understand how all the pieces fit together before you can see the big picture.

For a cattle rancher, the puzzle pieces include cows and bulls, pasture and water, finance and markets. They can be combined in many ways – some profitable, some not. Researchers at the Colorado Agricultural Experiment Station are helping ranchers fit those pieces together for optimum profit and production.

In 1981, Colorado State agricultural scientists started working with individual producers to identify successful management practices – and unsuccessful



ones. Then, in 1983, a national initiative called Integrated Reproduction Management was established to help deal with a growing nationwide trend: cattle ranchers who were in financial trouble.

Gordon Niswender, an animal reproduction and biotechnology researcher at Colorado State University, has been involved from the beginning. He remembers a common pattern in the puzzle. For many ranchers, things seemed to get out of hand just as they tried to get ahead. To make more money, they maximized their operations to deliver more beef to the marketplace. But even as they began producing more, they had to spend more and more money on cattle, grain, and other inputs. Debts grew and the entire operation was threatened.

Niswender and others began by looking for common denominators, some magic piece of the puzzle that would show up at the ranches that were having trouble. They soon found, however, that this approach was too simplistic.

“Every ranch has unique problems,” says Niswender. “After working with producers of all sizes from every part of the state, we didn’t find many common specific problems.” But, he goes on to say, “We did discover that some producers may not notice how one decision affected their entire operation – usually because they’re just too close to it.”

Suddenly, a new picture began to take shape. Niswender and the others realized building a successful

cattle operation took more than just finding the right pieces – it takes someone with the skill and knowledge to put them together.

“Integration is the key to success in agriculture,” he says. “It’s not just how the cows are fed, when the calves are weaned, or which bulls are used. It’s how all of those factors interact in a profitable big picture.”

Armed with that insight, Niswender and the others went on to create Integrated Resource Management (IRM), statewide program that helps individual ranchers, communities, students, and researchers better understand the puzzle that is agricultural management.

Often, when the team sat down to look at a ranch’s financial and production records, it also was the first time the costs and profits of each piece of the operation had been broken down in detail. “You can’t walk onto a place and predict the problem just by looking around,” Niswender warns. “You have to break it down and look at it piece by piece.”

Since 1983, IRM has developed programs and specific methods for building a successful big picture that are passed on through community workshops and field days. IRM has even changed the way agricultural management is taught in the classroom at Colorado State University.

“We now teach students to look at each scenario and see how it works within the operation, before adopting a new practice,” Niswender says. “In modern

*Gordon Niswender
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agriculture, you may have more possibilities and outcomes, but you also have more opportunities to mess things up. And you can’t just understand cattle nutrition and reproduction; you have to understand how those things interact with everything else and all of the potential outcomes.”

A GNAWING P

Food safety is a big concern for all consumers. Bacterial contamination in particular has

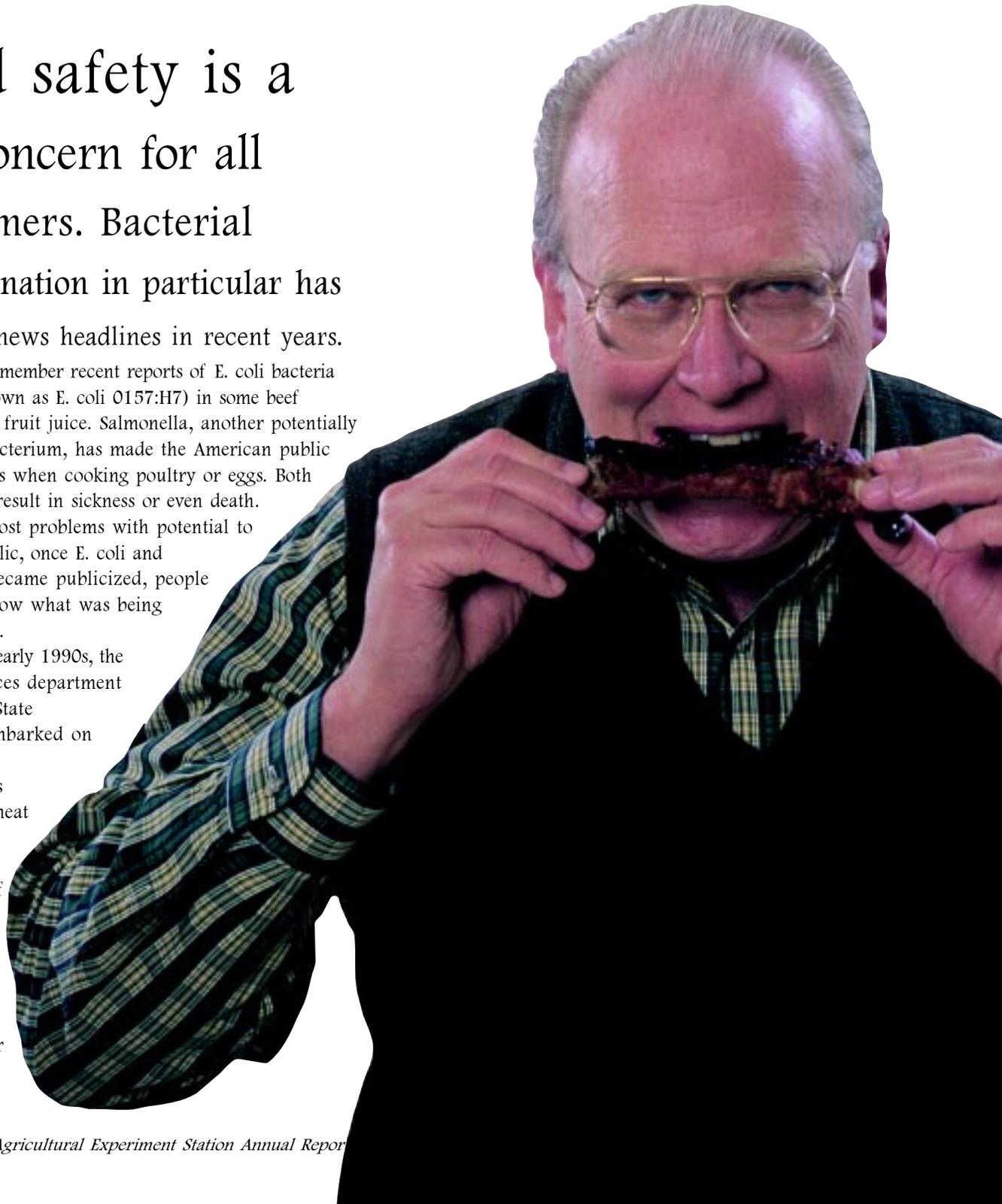
occupied news headlines in recent years.

Most of us remember recent reports of *E. coli* bacteria (officially known as *E. coli* O157:H7) in some beef products and fruit juice. *Salmonella*, another potentially hazardous bacterium, has made the American public more cautious when cooking poultry or eggs. Both bacteria can result in sickness or even death.

Like most problems with potential to harm the public, once *E. coli* and *Salmonella* became publicized, people wanted to know what was being done about it.

In the early 1990s, the animal sciences department at Colorado State University embarked on a mission to emphasize its program in meat science.

Recognizing its position of expertise in meat science research and teaching, as well as the need to better support



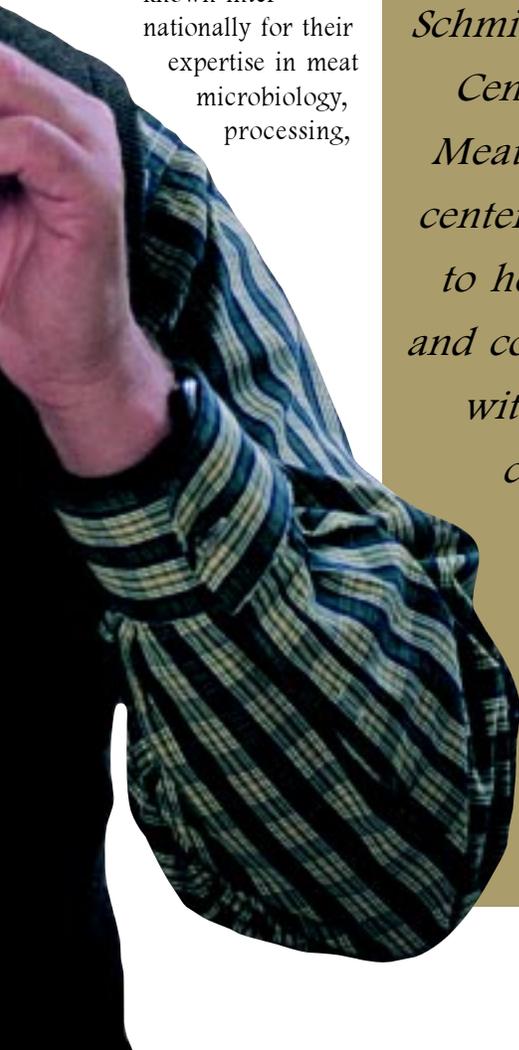
PROBLEM

Center sinks teeth into meat safety concerns

Colorado's \$3 billion animal industries, the animal sciences department established the Center for Red Meat Safety. The center's mission is to help industry and consumers deal with the complex chemical and biological aspects of safe meat production and marketing. The impact of the center's research and its practical application is recognized by consumer groups and the animal industry in Colorado and throughout the world.

The director of the Center for Red Meat Safety is animal sciences professor Glenn Schmidt, who also directs Colorado State University's Meat Science Program.

Schmidt works with a team of five other faculty members known internationally for their expertise in meat microbiology, processing,



Professor Glenn Schmidt directs the Center for Red Meat Safety. The center's mission is to help industry and consumers deal with complex chemical and biological aspects of safe meat production and marketing.

marketing, packaging, safety, quality, livestock behavior, and animal equipment design. Ten graduate students are involved with research and teaching.

Extensive research conducted at the red meat safety center focuses mostly on reduction or elimination of bacterial contamination of red meat during processing. The center's research projects have investigated such practices as bathing animal carcasses with hot water, steam, acetic acid solutions or other food-grade chemical solutions, and steam vacuuming carcasses to remove dirt and fecal contamination. Other studies have looked at effective methods to remove hair from carcasses prior to carcass processing. Even further studies have looked at combinations of techniques used in sequence to reduce contamination.

Many of the techniques developed through research at the Center for Red Meat Safety are now in use at major meat processing companies throughout the nation. Faculty at the center find themselves busy conducting workshops, seminars, and training courses all over the country. Audiences include workers in food services, meat processing, and government agencies, as well as commercial food provisioners and restaurants.

But some of the most important teaching the center is engaged in happens right within the walls of Colorado State University. As Gary Smith, Monfort professor at the center puts it, "We're not just finding answers to meat safety problems. The students who help us unlock the answers to better food safety are the ones who now are going out into industry to put those practices into action. And with that, everybody wins. That's truly a best part of our outreach function," he says.

You might ask if all these techniques actually reduce or eliminate the threat of bacterial contamination of meat products. John Sofos, the center's top authority on meat microbiology, says yes, but cautions, "All these processes can be applied to a product that is still not safe to eat until it's properly cooked."

And that, in a way, is what the Center for Red Meat Safety at Colorado State is all about – because what people don't know can hurt them.

BIO 25/30

Canola-based motor oil roars onto commercial markets

Vegetable oil makes saute sizzle, chips crunch, and salads snap, but does it make motors

hum? It has since Duane Johnson got hold of it. Johnson, associate professor with Colorado State University's Department of Soil and Crop Sciences, has turned this kitchen staple into the motor oil of the future.

Bio 25/30, a blend of canola and soybean oil, is a proven environment-friendly alternative to petroleum motor oils. It drastically reduces vehicle emissions when compared to traditional motor oils, and doesn't pollute the environment when it's produced. Independent tests show a 30 percent reduction of hydrocarbons, a significant decrease in carbon dioxide, and an average of 4.5 percent better fuel economy.

In addition, canola oil is not a hazardous material, unlike petroleum oils. That makes disposal of used Bio 25/30 much easier. Or the oil can be recycled into greases and chain oils that produce no waste – yielding essentially 100 percent recycled products.

The process of making canola-based motor oil is much like the process of making cooking oil: canola seeds and soybeans are crushed, extracting the oil. The remnants of canola seeds are fed to livestock, and the oil continues through a special process to make it the right consistency for motor oil.

Bio 25/30 has generated interest all around the world, with parties from as far away as Guam, Britain, and Jerusalem expressing interest in using and distributing it. Contracts and pending agreements with governments for use of the oil in their vehicles include the states of Wisconsin, Michigan, Ohio, Minnesota, and California, and the countries of Australia, New Zealand, Brazil, Argentina, India, Malaysia, and Germany.



Johnson started research on canola in 1986 and developed the oil in 1993. He's tested Bio25/30 in several vehicles including a 1966 Ford Thunderbird and a 1970 Ford Mustang. The oil is about the same weight as 10W-30 oil.

Agro Management, a company in Colorado Springs, is working with Johnson to commercialize Bio 25/30. The company signed a limited partnership in August 1998 with Thumb Oilseed Producers Cooperative, a Michigan-based cooperative. The partnership will clinch Johnson's dream by industrializing production of the oil and placing it on consumers' shelves within six months to a year.

Bio 25/30 is expected to cost about double what petroleum oil costs, but comes without the added price for disposal of a hazardous material. Most consumers who make the switch to the vegetable-based oil can expect to pay about \$10 more for motor oil per year. Even so, a U.S. Navy cost analysis indicates that Bio 25/30's better fuel economy and decreased disposal costs could save the government between \$3 and \$10 per vehicle. The oil currently is being reviewed for certification for use in warrantied motors.

As a Colorado Agricultural Experiment Station scientist, Johnson looks for alternative

crops that can be raised in Colorado, ensuring that agriculture remains a viable lifestyle in the state. His research in growing canola in the state has focused on the San Luis Valley and the High Plains, where area farmers are raising canola.

"The success of Bio 25/30 helps us reach toward our beginning goal when we developed the oil – to give farmers another option for a viable crop," said Johnson. "It's possible that additional processing plants will be built in rural communities where the oil is grown. That means more jobs and resources for small-town economies, in addition to cleaner air and less waste."

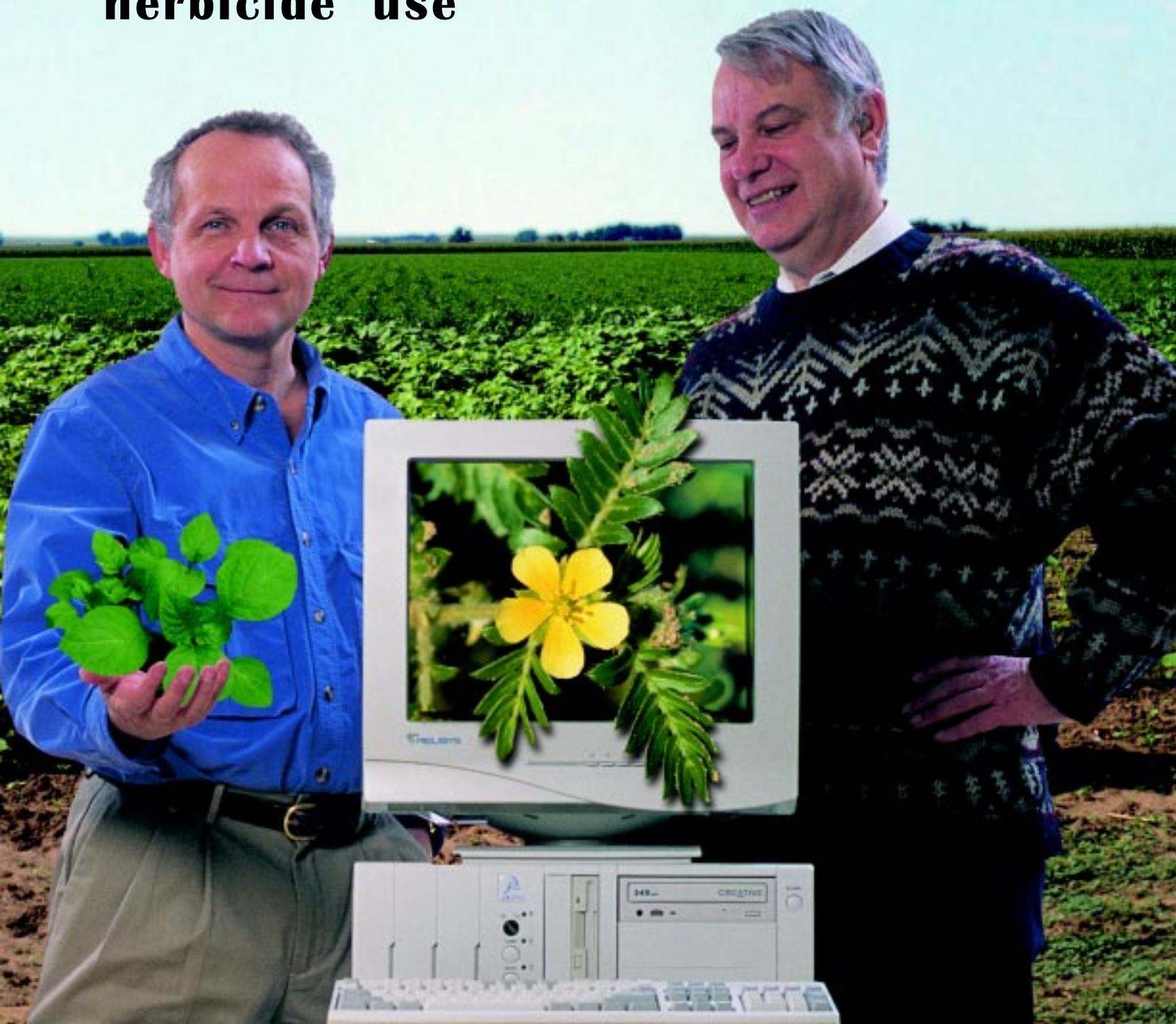
The project makes raising canola a more lucrative proposition for farmers. Farmers in the southern end of the state likely will be most successful in raising canola, a crop that is susceptible to frosts and winterkill. Johnson's current research is showing as much success with the use of safflower and sunflower oils as a motor oil, which opens markets on Colorado's High Plains and the northwestern and southwestern parts of the state.



Duane Johnson started research on alternative uses for canola oil in 1986 and developed environment-friendly Bio-25/30 motor oil in 1993.

SMILE, YOU'RE ON WEEDCAM!

**Bio-economic weed computer
models focus weed control
to lower costs and
herbicide use**



The problem is simple and ubiquitous.

If you've ever grown a garden, it's highly probable that

your good plants shared precious soil, water, and nutrients with weeds. Preventing or controlling weeds isn't easy. You can treat them chemically or get down in the dirt and pull them out by hand. And chances are they will grow back in a couple of weeks. Now imagine if your garden covered 1,000 acres or more. That's the dilemma facing today's crop producers.

Right after World War II, American farmers took advantage of new chemicals like 2,4-D to control weeds in corn. It was cheap and effective, though it has largely been abandoned because of environmental concerns.

Today's agricultural chemical prices have skyrocketed, partly because of increased oil prices (many chemicals are petroleum-based) and partly because of high research and development costs. Mounting concerns over water polluted by agricultural chemicals further complicate the picture.

But farmers can't afford to ignore the issue. Losses from weeds for 46 major commodities in the United States were estimated at \$4.1 billion in 1991. Without herbicides, it is estimated, losses would have been more than \$19 billion.

So agriculture's challenge is formidable: sustain food production by controlling weeds, but do it with fewer chemicals to avoid contaminating soil and water. To meet this challenge, crop producers must be armed with as much information as possible about weeds, control options, and consequences.

Colorado Agricultural Experiment Station researchers Donald Lybecker, a professor of agriculture and resource economics, and Phillip Westra, professor of bioagricultural sciences and pest management, joined forces with United States Department of Agriculture researcher Edward Schweizer to meet the challenge head-

on. They combined their crop and weed science expertise with the number-crunching power of computers to develop bio-economic models that give farmers realistic choices for weed control schemes.

"What's neat about the bio-economic weed computer model," Lybecker says, "is that it integrates scientific information and data with specific information that producers provide about their crops."

A model named Weedcam focuses on irrigated corn production. After corn plants emerge, the producer counts weeds and weed species, measures distribution of the weeds, and records the maturity of the corn and weeds. The computer factors all this with current prices of herbicides available for weed control, costs of custom or self-application of herbicides, efficiency or effectiveness of treatments using various herbicides, and expected price of the crop at harvest. The computer program then delivers weed control choices to the producer with associated costs and estimated profitability.

But that's not the end of the story. The information is archived for future use in a computer database called the Weed Bank. The number of weeds counted in the field, for example, is an important factor regarding application of pre-emergence herbicides in succeeding crops.

Results show that growers who use computer models like Weedcam are about 80 percent more successful in reducing weeds, cutting herbicide applications and costs, and improving profitability than growers who make decisions without their help. Though that's a significant improvement, Lybecker and Westra are constantly tinkering with the models to make them better. "Like any process, we need to fine tune it," Lybecker says. They are considering ways to factor in mechanical weed control, effects of weeds left in the field, and information about risks associated with various levels of control. And finally, the models could include an environmental quality index that rates expected impact on the environment by different weed control schemes.

"The models are doing the job of helping us become smarter about weed control," says Lybecker. "They're useful to crop consultants, Cooperative Extension professionals, and farmers in that never-ending battle against those pesky weeds."

A man wearing a green winter jacket, a pink hood, and yellow gloves is smiling and holding a bunch of purple grapes. He is standing against a white background.

MR. ANTI-FREEZE

**Alginate gel
encapsulation
cuts grape
losses due
to late frosts**

All too often, warm, early spring weather lulls fruit trees into budding only to be blasted by a bitter frost that can kill an entire a

summer's crop. Late frosts after bud break account for more than 40 percent of fruit crop losses in Colorado, making it fruit farmers' number one problem. If the buds would sleep for just a few more days or weeks, the crops might be saved.

Cecil Stushnoff, a Colorado Agricultural Experiment Station horticulturist, has found that buds on fruit trees and plants will stay dormant longer when encapsulated in alginate gel – the same stuff that's used for vitamin, herb, and medicine capsules. Stushnoff and viticulturist Rick Hamman apply alginate gel to buds in early spring to shelter them from cold weather and delay bud break by three to four weeks.

“This is pretty simple, available, and environmentally friendly,” said Stushnoff. “When the buds are ready to bloom, they push through the gel.”

Once in bloom, their development catches up with normal growth and crops are ready to harvest on schedule.

The soil and climate in western Colorado are perfect to raise high-quality grapes such as those grown in California and Europe for wine – except for occasional late frosts. Stushnoff's technique has been successful for three years in grape crops near Grand Junction. Researchers growing peaches in Georgia likely will use the technique this spring if early warm weather patterns are expected.

In Colorado, alginate gel can be sprayed on plants any time between mid-March and the second week of April. A hard rain, or lots of it, will wash the solution off, but in most cases, the treatment delays bud break in about 40 percent of the crop. Although some fruit may be lost to a late frost, the treatment helps prevent catastrophe.

Stushnoff and others have been unable to find any significant negative effects of the treatment. Fruit still has the same maturity date, yield, and quality.

“Our biggest question is, do you try to prevent something you aren't sure will happen? If there isn't a late frost, it's not economical to apply the gel,” said Stushnoff. However, winter weather can be monitored closely, and if temperatures start to rise too early, the alginate gel encapsulation can be applied quickly and efficiently.

That, indeed, is part of the beauty of this technique. It's simple. It's effective. And, although cost analysis hasn't been conducted, it should be affordable.

Stushnoff stumbled upon the idea when looking for ways to freeze-dry plants to preserve them for genetic development.

When water was extracted from plant samples, the samples could be cryo-preserved – or frozen – and kept in liquid nitrogen.

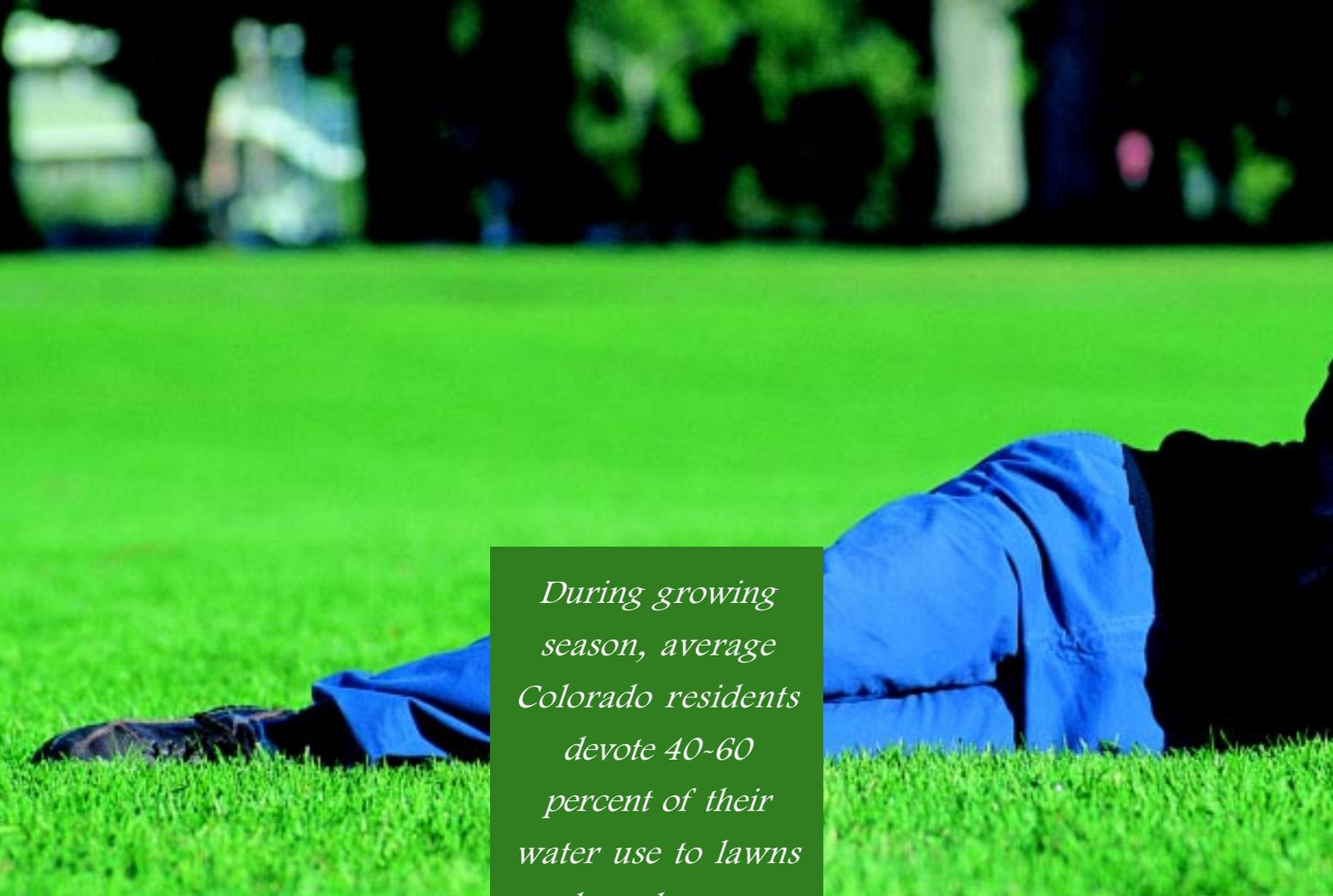
Incredibly, many plants, once devoid of water, survive minus 321 degree Fahrenheit temperatures.

Because water within plants freezes, extracting

water from a plant drastically increases its resistance to cold. Stushnoff reasoned that if the effects of freezing can be manipulated so much in a laboratory, why not try to change the effect of cold weather on plants? Even a few degrees of temperature resistance can make the difference between a total crop loss and a productive season.

Stushnoff and other researchers continue to look for ways to make the gel more stable, give it more lasting-power in wet weather, and increase its effectiveness on the entire crop. By adding white latex paint to the formula, for example, they are able to delay bud break even more. The white color reflects sunlight, keeping the buds cooler in deceptively warm early-spring weather and giving Colorado fruits crops a better chance to survive late frosts.

*Horticulturist
Cecil Stushnoff has
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alginate gel.*



During growing season, average Colorado residents devote 40-60 percent of their water use to lawns and gardens, says researcher Tony Koski. Add this to skyrocketing population growth, and you can see an enormous problem taking shape in Colorado's future.

Tony Koski dreams in green: a beautiful green carpet of grass

that grows very slowly, needs very little water or fertilizer, doesn't get ugly when the kids romp on it, and stays green and healthy despite disease and drought. Koski's not the only one dreaming it. Turf managers and grounds keepers at corporations, city parks, schools, and golf courses all wish that Koski's dream could become a reality. Of course, anyone concerned about the environment loves Koski's dream with its implications of reduced fertilizer and pesticide use. And homeowners

would love the hundreds of thousands of dollars that could be saved with lower water bills.

"We're working on it," says Koski, turfgrass researcher and associate professor in the Department of Horticulture and Landscape Architecture at Colorado State University. These advances don't come easily, though – especially since there are so many variations in Colorado soils, turfgrass use, water quality, availability, and price.

"It's impossible to prescribe one kind of grass or one kind of watering scheme that solves all problems," says Koski.

It has been said that the lawn is America's biggest contribution to landscaping. The endless green carpet continues across property lines and on for miles through subdivisions, suburbs, and even entire cities. Colorado is no different. Yet here, in the West, there are other considerations – mainly, the scarcity of water. During the



GREEN DREAMS

The never ending search for the perfect turfgrass

growing season, average Colorado residents devote anywhere from 40 to 60 percent of their domestic water use to lawns and gardens. Add this to Colorado's skyrocketing population growth, and you can see an enormous problem taking shape in Colorado's future.

Koski's team of turfgrass researchers is looking under every leaf, so to speak, for ways to head off crises. A summary of their findings:

Contrary to popular belief, the larger, more massive root systems of some Kentucky bluegrass varieties don't make them more drought resistant. The best drought-resistant varieties have a greater percentage of their roots more deeply rooted in the soil. Deep rooting often depends more on soil structure and variety characteristics than on management techniques, Koski says.

Leaving clippings on the lawn during mowing doesn't lessen water requirements, but does partially recycle nitrogen and other nutrients. Annual fertilizer needs were reduced by as much as 30 to 40 percent.

A plant growth regulator called trinexapac-ethyl or TE could improve the ability of Kentucky bluegrass to resist traffic damage like that sustained on sports fields. Because TE reduces vertical shoot growth, its use on golf

courses reduces clipping production 40 to 55 percent. That alone can provide significant savings in wages, equipment, and maintenance. It does not, however, reduce water use.

Studies on Kentucky bluegrass, tall fescue, and buffalograss show that buffalograss can provide acceptable lawn quality when irrigated with just 35 percent of the water recommended for Kentucky bluegrass. Also, current irrigation recommendations for Kentucky bluegrass may be overstated; acceptable quality may be obtained with 10 percent to 15 percent less water than most people use now.

Frequent, light irrigation may produce a higher quality bluegrass turf than the current practice of less frequent, heavy irrigation. Koski cautions that this finding flies in the face of what has been taught for many years and that more research is needed before he recommends changing watering practices.

Koski says these results don't mean they have all the answers for the perfect green carpet. "It does mean that we have some answers that get us closer, considering resources, environment, and desires of people – and that's what research is for."

In the meantime, he'll just keep on dreaming.

Genetically engineered potatoes resist fungal diseases

FEAST OR FUNGUS

Yesterday's
science fiction is
today's reality. Advances in
biology – especially in the field of

genetic engineering – allow scientists to safely do marvelous things that were only dreamed of a few short years ago. Nowhere is this more evident than in the food production industry. Scientists now can engineer the genetic makeup of plants to make them grow bigger and better than ever before, without the use of chemical pesticides and fertilizers. What's more, they are devising ways to give these plants natural resistance to disease and insect pests.

The potato is a good example. The potato is the fourth most widely used world food crop, after wheat, rice, and corn. In Colorado, besides being an important fresh market crop, potatoes are a \$25 million seed crop. But potatoes historically have been susceptible to fungal diseases. In fact, history records that potato fungal diseases have been responsible for starvation, death, and mass immigration. A hundred and fifty years ago, potato blight was the main cause of the infamous Irish Potato Famine. Potatoes were a main staple of the Irish diet. When the crop failed, millions died. Millions more immigrated to America and Europe to avoid the same fate.

Colorado potato producers annually lose around \$15 million to potato blight. Most serious are early blight and late blight, diseases that attack leaves and flesh of the potato, leaving it unusable for consumption or seed stock.

Colorado State University associate professor of biology Anireddy S. N. Reddy is a researcher whose goal is to engineer potato genetics to produce varieties that naturally resist fungal diseases. The traditional way to do this is to crossbreed varieties of potato plants that produce good potatoes but may be susceptible to disease with naturally disease-resistant wild varieties to produce offspring with some of the traits of both. By crossing the offspring with other disease-resistant varieties, the

resistance is enhanced. The obvious drawbacks to the method are time, accuracy, and compatibility of varieties. First, you must identify plants with the desired traits and then get them to crossbreed successfully. Then, you wait to see what happens. After years of crosses, the eventual outcome is, hopefully, a variety of plant with the desired traits. Reddy has a better method.

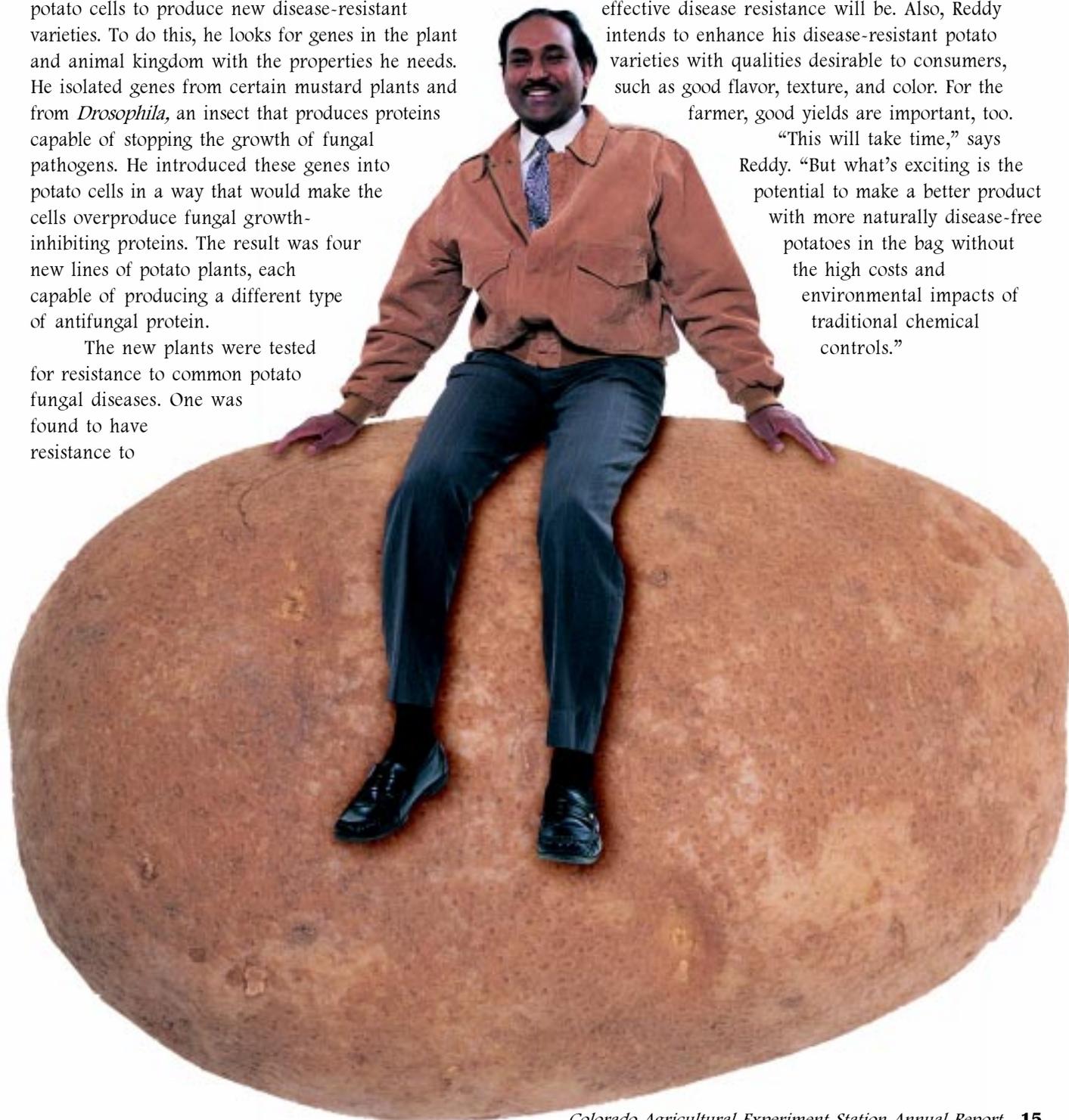
Reddy manipulates the genetic makeup of potato cells to produce new disease-resistant varieties. To do this, he looks for genes in the plant and animal kingdom with the properties he needs. He isolated genes from certain mustard plants and from *Drosophila*, an insect that produces proteins capable of stopping the growth of fungal pathogens. He introduced these genes into potato cells in a way that would make the cells overproduce fungal growth-inhibiting proteins. The result was four new lines of potato plants, each capable of producing a different type of antifungal protein.

The new plants were tested for resistance to common potato fungal diseases. One was found to have resistance to

early blight. The other types are being analyzed for additional disease resistance. Reddy hopes to develop a potato line that overproduces more than one antifungal protein to increase disease resistance against a broad spectrum of fungal pathogens.

Reddy is quick to point out that even though he's made progress, there's much more work ahead. Several generations must be grown to determine how effective disease resistance will be. Also, Reddy intends to enhance his disease-resistant potato varieties with qualities desirable to consumers, such as good flavor, texture, and color. For the farmer, good yields are important, too.

"This will take time," says Reddy. "But what's exciting is the potential to make a better product with more naturally disease-free potatoes in the bag without the high costs and environmental impacts of traditional chemical controls."



**NO EASY
GAME OF**



**PICK AND
CHOOSE**

**Researching a
new strategy to
balance demands
on vital riparian
areas**

For many years, ranchers have grazed livestock on public rangelands. But, intensive,

extended grazing in some areas has taken a toll. Cattle favor some plants over others and have grazed some areas so heavily that some species of their favorite plants no longer grow there. These are but the first moves in a complex game that appears to pit the cattle and cattle ranchers against the environment, environmentalists, and against people who enjoy the environment for recreation.

Wayne Leininger and Joe Trlica are looking for a new set of rules that will make everyone a winner. The two are rangeland ecosystem science researchers for the Colorado Agricultural Experiment Station. Since 1985, they've been finding ways to turn livestock grazing on rangelands from a problem into a tool to help manage forests.

The game takes place in riparian areas – the area around streams, rivers, and lakes.

“Riparian areas comprise only about 1 percent of the land area,” says Trlica. “That’s a small percentage for such an important part of the ecosystem. It’s where everyone wants to picnic, camp, fish, and hike. When you add wildlife and livestock to the cluster on that small area of land, you have conflicts.”

The Colorado State Forest Service and United States Forest Service have grazing regulations for forests, but those regulations aren’t entirely based on research. They called on Leininger and Trlica to take a scientific look at how livestock affect riparian areas.

The two started their research by looking at the number of willows in riparian areas. The number and health of willows in a riparian area are a good yardstick for assessing grazing impacts for the simple reason that animals like to eat them. But Leininger and Trlica stress

that willows are more than just food. Willows stabilize stream banks, filter sediments from runoff, provide habitat, and keep water cool by shading streams from the sun. By finding a way to help promote the growth of willows, they would be helping promote the entire ecosystem. The trick was to find a way to help the willows without detriment to the cattle, which gain the most nutritional value from grazing the abundant vegetation found in riparian areas during the spring.

Leininger and Trlica found that cattle eat willows only during certain seasons because of taste preferences and availability of other forage. They much prefer willows in late summer and early fall – just when willows are most easily damaged by heavy grazing.

The discovery allows ranchers and range managers to work together using grazing to enhance forests and rangelands. Encouraging grazing in riparian areas in spring or early summer, rather than late summer and early fall, gives willows more time to recover, preserving natural habitat.

In addition, the project shows that proper grazing does not affect water quality or vegetation on riparian areas. Previously, it was believed that because livestock kept native riparian grasses short near a stream, more sediment washed into the water, affecting its quality. However, Leininger and Trlica found that it isn’t the height of riparian vegetation that affects the amount of sediment that reaches streams. Rather, it’s the type of plants and the density of vegetation close to the ground that affects water quality.

Leininger and Trlica have shown that grazing can be used as a tool for controlling wildlife diversity because it helps determine the type of habitat in a riparian area, and habitat determines shade, food, and nesting resources for a variety of wildlife. For example, robins like areas that are mostly grass – ideal areas for livestock grazing. Other birds prefer to nest in willows, so they congregate in riparian areas with woody plants. The type of birds in an area affects both the birds’ prey and animals that prey on them. By using cattle to create a balance of wooded and grassy riparian areas, range managers can balance wildlife diversity as well as livestock grazing.



You could call them insect cops. They're Colorado State University researchers who work with local growers to guard against creeping, crawling attacks on western Colorado fruit.

Western Colorado offers a cornucopia of juicy apples; tasty peaches; plump, premium grapes; and other fruit products nationally recognized for superb quality. But all too often, pesky insects and diseases cause problems.

That's when professor of bioagricultural sciences Boris Kondratieff and his colleagues step in to protect western Colorado's fruit-growing industry.

For example, in 1985, a tourist carrying apples from eastern Colorado was stopped at a California highway agricultural inspection station only to learn that apple maggots had hitched a ride in the on-board fruit.

Meanwhile, back in Colorado, some adult flies were trapped in



Mesa County. Because the apple maggot is a major economic pest in many fruit-growing areas of the United States, it wasn't long before California authorities threatened to quarantine Colorado-grown apples.

That was bad news for western Colorado's multimillion-dollar apple industry. Kondratieff teamed up with Eugene Nelson, Cooperative Extension entomologist at Grand Junction, and graduate student Mary Kroening to see what they could do. The team proved the western Colorado apple industry not guilty by developing a trapping system for area orchards to detect apple maggots. They showed that apple maggots in western Colorado attacked native hawthorne shrubs and had not yet adapted to apples. The apples intercepted earlier in California had been grown in an eastern Colorado homeowner's backyard and were infested with maggots that had adapted to eastern, but not western Colorado apples. Nevertheless, today, western Colorado apple orchards constantly are monitored for apple maggots and other insect pests.

In the early '90s, Western Slope peach growers presented Colorado State's bug cops with another big case. Trees in some area peach orchards had turned yellow, lost branches, and suffered reduced production. Growers and researchers suspected Western X-disease, a viral-like disease caused by a microorganism carried and often spread by several species of leafhoppers that frequent peach orchards. Kondratieff assembled a team that included Harold Larsen, Cooperative Extension fruit disease specialist at the Orchard Mesa Research Center near Grand Junction, and graduate student Judy Welch. The case took an interesting twist when the team visited orchards to trap and identify leafhoppers. Limited presence of Western X-disease was confirmed in some orchards, but in those cases, they didn't find the leafhoppers. And in the places the leafhopper was present, they didn't find Western X-disease. The plot had thickened. The team was able to dig up the crucial clue in – of course – the soil.

The chemistry of many western soils keeps iron from being adequately absorbed by plant roots. This nutrient deficiency, known as chlorosis, often causes leaf yellowing and limb dieback like that found in the peach orchards. Unfortunately, Larsen says, treating affected trees with supplemental iron for this problem has been ineffective or only temporarily helpful. He continues to look for answers.

Protecting Colorado fruit crops from insect threats

THE BUG COPS

Western Colorado's expanding wine grape industry is getting attention from Colorado State's bug cops, too. Wine grapes are a new industry with production mainly in Mesa and Delta counties. There is a great potential market for high-mountain, sun-ripened grapes that produce exciting new wines. To ward off problems from pests, Kondratieff teamed with Rick Zimmerman, researcher at Rogers Mesa Research Center, and Rick Hamman, researcher at Orchard Mesa Research Center, to learn what insects were associated with Colorado grapes. The end result is a publication that lists insect and pest problems and makes control recommendations for grape producers.

"Are we really insect cops?" muses Kondratieff. "We investigate the problems and advise growers what to do about them. We try to protect growers and consumers from the ravages of nature. Our main weapons are good science, research, and hard work. That's what we're about."

**Precision
farming
techniques
fine-tune
modern
agriculture**

ACRES OF ACCURACY



The words “accuracy” or “precision” suggest quality, durability, and efficiency, as in a fine watch or a nicely crafted automobile.

Yet these words must also describe America’s agricultural industry as it enters the 21st Century. Today’s society and economic realities are beginning to place more demands on agriculture to be more cost-effective and environmentally conscious in producing the crops that make up the bulk of the world’s food supply.

But being precise in agriculture is not easy because of mother nature’s whims. Uncertainties of weather, insect, and weed infestations or even variations in soil types and nutrient availability are big challenges for most producers. Another challenge is to avoid polluting our environment with agricultural chemicals, which also are expensive. Today’s farmers reach for research and sophisticated technology to even the odds.

Enter the concept of precision farming – a crop-management system employing computer modeling, global positioning satellites, and computer-aided harvesters that measure crop yields in different parts of the field. This same technology gives “smart” fertilizer and pesticide application machines the ability to lay down materials accurately and according to need.

Paul Ayers, professor in the Department of Chemical and Bioresource engineering at Colorado State University, explains, “We’ll often see different soil types and varying weed infestations within the same field. The practice of applying a uniform amount of herbicides over the entire field often is expensive and wasteful.”

Ayers’ research concentrates on variable-rate application using direct-nozzle injection, a technology that allows the sprayer to vary the rate of material applied to the crop according to herbicide demand at any place in the field. A computer tracks the exact location of the sprayer in the field using signals from global positioning satellites thousands of miles out in space. This information is combined with other data from field maps to determine herbicide application rates for different parts of the field. The computer then controls how much material is applied and where.

Ayers is quick to point out that smart machines don’t take over the job of good management in farming.

There is no replacement for sound business practices and judgment. Instead, precision farming tools respond to the needs of the farmer, making part of his operation leaner, cleaner, and more precise with the help of advanced technology.

Precision farming involves three basic elements: information, intelligence, and interaction. Information is the data about such factors as past crop yields, soil type, fertilization, and presence of pests. Intelligence is the process that analyzes gathered data and makes decisions using established science and research. Interaction combines the best intelligence with the best machines to produce more crops economically and with minimal environmental impacts.

So far, Ayers’ work mostly has been with equipment manufacturers and commercial applicators to test new methods and industry claims of effectiveness. He also frequently expands his work as a team researcher on joint projects with other Colorado State researchers and scientists with the U.S. Department of Agriculture.

Presently, few producers employ precision farming techniques. Outfitting an operation with computers, global positioning equipment, and sprayers is expensive enough to make most farmers think twice. But Ayers believes that as the industry progresses and as techniques and machines become more available and affordable, precision farming will become much more common.

“In certain conditions it just makes good sense,” he says. “The ultimate goal is to implement sound management techniques with smart machines to avoid the practice of spray and pray!”

*Precision farming
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Department of Food Science and Human Nutrition
Department of Human Development and Family Studies

College of Engineering
Department of Atmospheric Science
Department of Chemical and Bioresource Engineering
Department of Civil Engineering

College of Liberal Arts
Department of Sociology

College of Natural Resources
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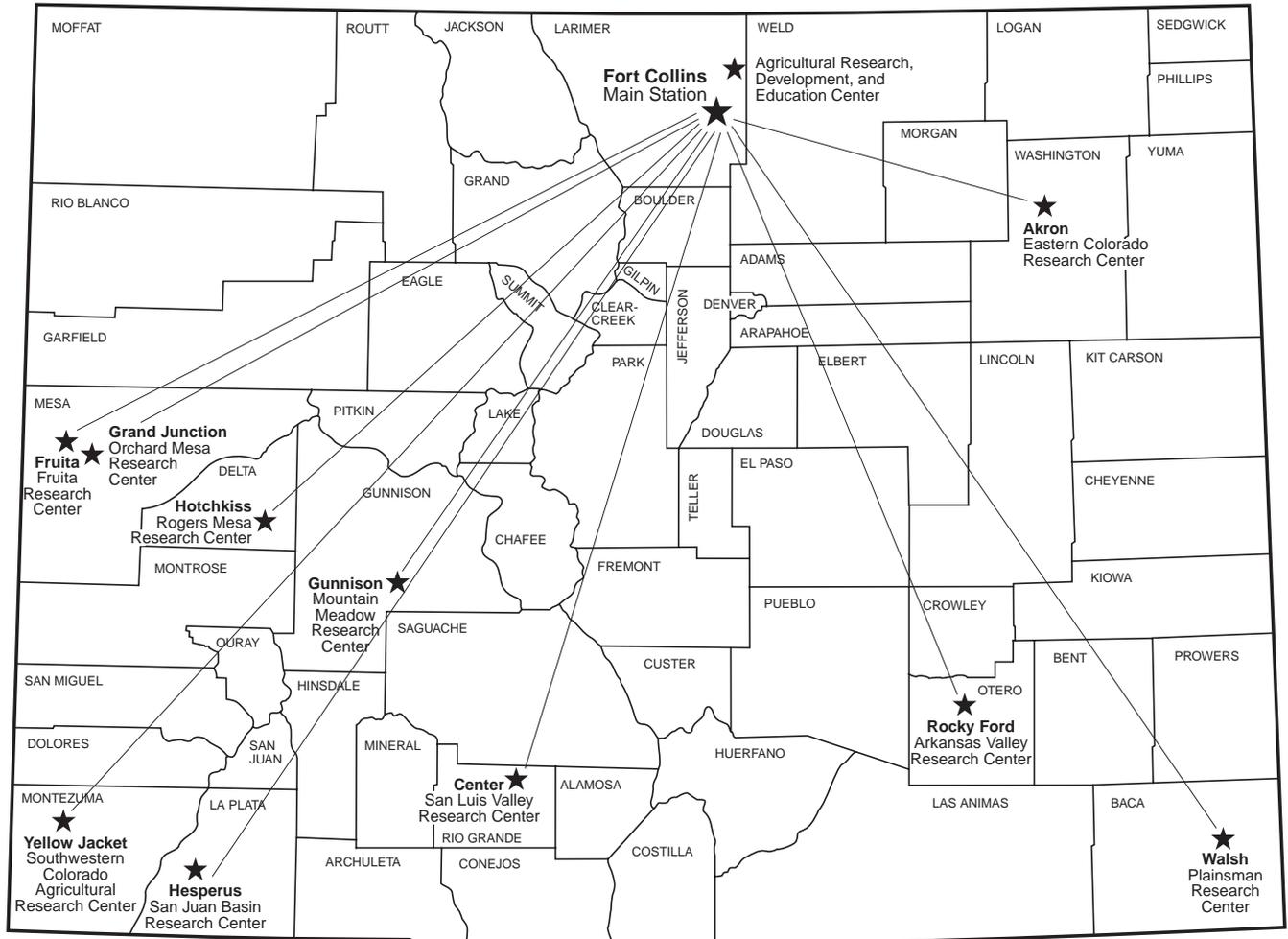
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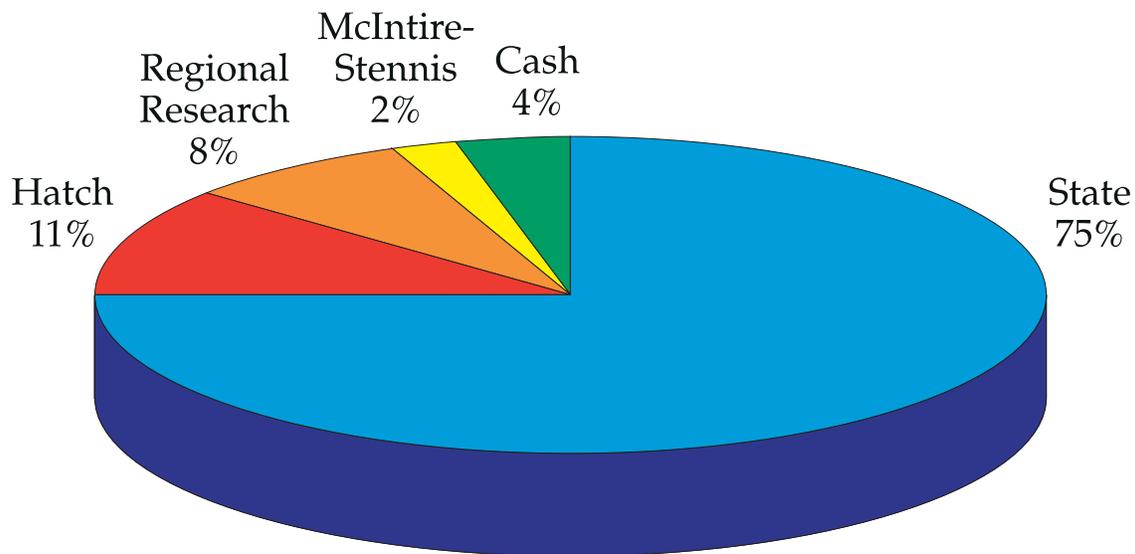
Colorado Agricultural Experiment Station Funding for Fiscal Year 1999

The Agricultural Experiment Station at Colorado State University is funded by appropriations from the Colorado legislature through the Colorado Commission on Higher Education, appropriations from the federal government through the U.S. Department of Agriculture, and from self-generated income through the sale of commodities. The relative amount of each funding source is shown in the chart for the state fiscal year 1998-1999 and federal fiscal year 1997-1998.

- State – funds appropriated by the Colorado legislature
- Hatch – funds appropriated by the federal government to each land-grant university for support of a base research program in agriculture. These funds are authorized by the Agricultural Research, Education and Extension Reform Act of 1998 and administered by the Cooperative States Research, Education, and Extension Service of the U.S. Department of Agriculture. The funds are pro-rated to each state based on a formula that includes several factors such as rural population, number of farms, and so forth.

- Regional research – a portion of the Hatch funds are mandated by Congress to be applied to research problems that are regional in nature. Funds are allocated the same as Hatch funds.
- McIntire-Stennis – funds appropriated by the federal government to support research in forestry and forest resources. Funds are allocated the same as Hatch funds.
- Cash – funds originating from the sale of goods and services associated with Colorado Agricultural Experiment Station programs. Commodities sold include crops and livestock, which are by-products of crop and livestock research programs.

In addition to the above direct-funding sources, scientists supported by the Agricultural Experiment Station are active in securing contract and grant funding from numerous private sources as well as state and federal agencies. In the 1997-1998 fiscal year, contract and grant funding from these external sources contributed an additional \$20,000,000 of support to our research programs.



Total Budget: \$13,035,138