USU Researchers
Prepare for
FIRST SPACE CROP

Our foothold in space is becoming less tenuous, but after almost three decades of space exploration, there's still no home-grown food where the atmosphere thins.

That's about to change, albeit slowly. Next year, USU researchers will conduct a landmark study in which wheat will be grown from seed to maturity in space—the first real space crop.

"There have been dozens of experiments involving plants in space, most of them conducted by the Soviets, but growing conditions usually weren't adequate, either due to inadequate light, excessive carbon dioxide, weightlessness, or other problems," says Frank Salisbury, USU crop physiologist.

Almost a decade ago, Salisbury proposed that NASA study the growth of superdwarf wheat in microgravity aboard the space shuttle.

A U.S.-Russian Venture
It's finally about to happen. The effort, a joint experiment with Russian scientists which costs more than a million
dollars, is now scheduled for the Spacelab-Mir mission in mid-1995. Plants aboard Mir can be grown for much longer than on the US space shuttle, whose missions usually last no more than 14 days.

In addition to monitoring growth, wheat will be sampled at several intervals to pinpoint any space-related anomalies.

It won't be easy. For one thing, there's Svet, the growth chamber aboard Mir that was developed by Bulgarian scientists. Svet doesn't provide an ideal environment for plants, "but we have to use what's there," Salisbury says. It's smaller than researchers prefer (plants are grown in an area of about 144 square inches) and its tiny fluorescent lamps don't provide adequate light.

In Svet, seeds germinate between layers of a wick, roots penetrate the wick and grow into an artificial soil. The vegetative portions of the plants grow in an environment similar to the cabin environment, which limits relative humidity. During this mission, however, USU researchers will enclose the plants in ventilated plastic growth bags to facilitate measurements and to control humidity.

Problems with Nutrient Uptake

Small but critical problems with the root-support nodules used with Svet prevent plants from obtaining adequate nourishment. The artificial soil resembles kitty litter, and adsorbs nutrients on its colloidal surface. The ersatz soil doesn't wet easily, and the failure of roots to get water appears to be a major culprit in the poor performance of plants previously grown in weightlessness, where water is distributed by capillary action rather than gravity.

To monitor the distribution of water, researchers will place probes in the root zone instead of in the wick. Probes placed in the wick indicated when the wick was wet, not whether roots were in contact with water.

USU micrometeorologist Gail Bingham is developing the tiny instruments needed to measure levels of carbon dioxide, oxygen, and light, temperature, and soil moisture, information that will be used to calculate photosynthesis, respiration, and transpiration. This information is necessary to monitor plant stress and to improve irrigation.

Space is at a premium aboard Mir. So is energy—all of the instruments that monitor growth and provide light in Svet must operate on the current used by a single 200-watt light bulb.

"Our experiment occupies a relatively small part of the payload. The mission is largely devoted to human medicine, but we're certainly happy to be part of the mission," Salisbury says.

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**Method Reclaims Tainted Milk**

A USU researcher has developed a way to recondition milk tainted by antibiotics.

The method involves placing packets of tiny beads (0.5 to 7 millimeters in diameter) in milk. After milk is stirred for 30-60 minutes, the beads—and the antibiotics—can be removed.

"It's a relatively inexpensive method that can be tailored to specific antibiotics. We wanted it to be very specific to avoid changing the properties of milk," says food microbiologist Bart Weimer.

Antibiotics are heat-stable and aren't removed by pasteurization. Every tanker of milk is now tested for beta-lactam antibiotics (penicillin and its derivatives). Any tainted milk is dumped.

"The Food and Drug Administration is determining whether reconditioned milk can be utilized, but it probably won't be acceptable for fluid consumption, but it may be possible to use it in cheesemaking," Weimer says.

The method has been used to remove beta-lactam antibiotics, but it can be modified to remove any type of antibiotic.

In Utah, Weimer estimates that antibiotic-tainted milk worth at least $500,000 to $1 million must be discarded every year.

The researcher has applied for a patent for the process and is seeking businesses interested in marketing the method.

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How We Absorb IRON

Most Americans are aware of the importance of iron in human nutrition, even though scientists have been baffled by how the body actually absorbs the mineral.

A USU researcher may have cleared up some of the mystery.

Two distinct processes seem to control iron absorption, says USU muscle physiologist Charles Carpenter, who characterized iron uptake in laboratory rats.

At normal concentrations of iron, iron absorption appears to be mediated by enzymes or transport proteins in a manner characteristic of many other physiological processes. This pathway becomes saturated at higher iron concentrations and a second, unregulated process apparently takes over.

“The first process is probably the most important physiologically since it is the means by which our bodies regulate iron status. It may also be a shared pathway for the uptake of other required minerals, such as calcium, manganese and zinc,” Carpenter says.

Unregulated Absorption

Carpenter hypothesizes that the second, unregulated process may involve the passage of iron through the “tight junctions” between cells that normally prevent the passage of iron and other substances.

There are indications that these junctions between cells may not be as impenetrable as was once thought. Once these junctions are open, the rate of iron absorption increases with the concentration of iron in an unrestricted manner. “Iron appears to flow through these junctions, much as if a door on a spring were pushed open and could not be closed due to the outgoing flow,” Carpenter says.

The process allowing unregulated absorption at high concentrations of iron probably isn’t important in normal diets, but Carpenter’s hypothesis is consistent with the toxicity that is often associated with high iron intakes.

Carpenter used isotopes to study iron uptake in the upper intestines of rats. He plans to determine whether these processes affect both ferric and ferrous iron, the common ionic forms of the mineral, and whether these processes are involved in interactions between iron and other minerals. Some of these interactions are nutritionally detrimental, and have become increasingly important as more people supplement food with iron and other minerals.

“Learning how these minerals compete with iron could help us develop better dietary recommendations, food fortification guidelines, and mineral supplementation regimens,” Carpenter says.

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Charles Carpenter
LIGHT STRESS:
Widespread but Poorly Understood

No matter how much you pamper a lawn, grass often wilts under the midday sun and may begin to yellow. Seedlings set out in the garden before they have had a chance to harden off can be bleached by sunlight and lose their leaves. And tomato plants nipped by the cold usually seem fine until sunlight hits them, when they succumb to the combination of cold and light stress.

A Cycle of Damage and Repair
Most of us are familiar with these and other manifestations of light stress in plants. Even when outward symptoms are not so obvious, however, light stress causes an expensive cycle of damage and repair in leaves that can markedly reduce crop yields, especially when plants are under an additional stress such as drought.

Light stress will probably take a higher toll in the future as competition for land forces crop production to marginal land, subjecting plants to more stress. Yet, to varying degrees, plants possess biochemical pathways to cope with light stress, an attribute that could be used to genetically engineer crop plants that are more productive under adverse conditions.

"Most of the research involving light stress has involved membranes isolated from chloroplasts, which serve as a model system. Surprisingly little is known about the mechanisms underlying light stress in the field," says USU chemist Danny Blubaugh, who is starting to combine his studies from isolated membranes with studies of light stress in actual plants.

Mechanisms of Light Stress
His findings should clarify whether light stress involves one or two mechanisms. Many researchers believe light stress involves two mechanisms, one under bright light and another under stress conditions and dim light. However,
Blubaugh thinks that the same mechanisms occur, regardless of light intensity. During photosynthesis under bright light, a bottleneck in electron transport supposedly occurs when an electron acceptor becomes overburdened. The excess electrons then react with oxygen, creating a reactive form of oxygen that oxidizes proteins, lipids and other compounds.

Under weak or moderate light, a stressed plant supposedly is less able to remove electrons from water, and instead obtains the electrons by oxidizing its own proteins.

In both cases, a plant's productivity plummets as it devotes energy to resynthesize damaged proteins.

**A Single Mechanism?**

However, Blubaugh says the symptoms of damage under weak and strong light are remarkably similar, indicating that a similar mechanism may be involved.

He thinks damage associated with bright light may be due to the acidification of an area enclosed by the photosynthetic membrane of chloroplasts. The decrease in pH would impair the plant's ability to remove electrons from water, triggering the same sequence of events that occurs when a stressed plant is exposed to low light.

Exposing plants to various stresses and light conditions and analyzing the chemical nature of the damage will determine whether Blubaugh is correct, an important step in the effort to help crops harvest light without succumbing to it.

**Losses due to light stress in plants will increase as crop production is relegated to marginal land.**

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**Recent Grants & Contracts**

**Lynn Dudley**, Plants, Soils & Biometeorology Department, is evaluating the applicable pH ranges for Fe-oxide strips to determine element bioavailability in soils. The research is supported by the Forest Service (USDA).

The Agricultural Research Service (USDA) supports the study of **Nabil Youssef**, Biology Department, concerning the characterization and evaluation of four bacteria as biological control agents of Ascosphaera, a fungus that attacks bee larvae.

**Edward Evans**, Biology Department, is studying the propagation, care, release and monitoring of the beetle Galerucella calmariensis for the biological control of purple loosestrife. His research is funded by the Fish and Wildlife Service (U.S. Department of Interior).

**Anne Anderson**, Biology Department, studies sugar beet disease with funding from the Beet Sugar Foundation.

**Howard Deer**, Animal, Dairy & Veterinary Sciences Department, heads Utah's participation in the National Agricultural Pesticide Impact Assessment Program, which is funded by the Cooperative State Research Service (USDA).

Utah Power & Light Company ( PacifiCorp) funds the research of **Lynn Dudley** and **Esmaiel Malek**, Plants, Soils & Biometeorology Department, concerning the use of saline waste water from electrical power plants for irrigation.

**William Scouten**, Biotechnology Center, studies natural anionic polymers in displacement chromatography with support from the Spendlove Research Foundation.

**John Carman**, Plants, Soils & Biometeorology Department, is developing an embryo rescue system for cotton. The research is funded by EG&G Idaho, Inc.

**Roger Kjelgren**, Plants, Soils & Biometeorology Department, studies seedling establishment with tree shelters in Utah. The research is funded by the Bureau of Reclamation (U.S. Department of Interior).
Center Extends Biotech’s

BENEFITS TO AGRICULTURE AND MEDICINE

Researchers with USU’s Center for Developmental and Molecular Biology are applying the benefits of biotechnology to livestock production and human medicine.

The center, one of seven State of Utah Centers of Excellence at USU, was created in 1993 in cooperation with Hyclone Laboratories, Inc. The Logan-based firm is one of the world’s leading producers of serum. One goal of the Centers of Excellence program is to facilitate technology transfer to Utah-based firms.

The application of genetic engineering in livestock production is hampered by the difficulty of gene transfer to animals, says Kenneth White, embryo molecular biologist and director of the center.

Unlike plants, in which a single cell can be transformed and cloned to create hundreds or thousands of plants, livestock genes are usually transferred to a single embryo at a time. Only after each embryo develops is it possible to determine whether it expresses the desired trait.

However, embryonic stem cells in young embryos have the ability to develop into an entire animal. USU researchers are developing culture systems for these embryonic stem cells, which would make it possible to transform and screen hundreds or even thousands of embryos at a time, markedly reducing the speed and cost of transferring useful traits to livestock.

“It’s definitely a realistic possibility, one that is being studied here and at several other laboratories around the country,” White says.

Combating Disease

Research at the center also involves the culture of tumor-infiltrating lymphocytes (TIL) that destroy tumor cells.

In human medicine, these lymphocytes are often removed, cultured and injected into patients to stem tumor growth. Unfortunately, lymphocytes often can’t be cultured rapidly enough to be beneficial.

USU immunologist Reed Warren and researchers at Hyclone Laboratories, Inc., are developing and testing novel culture fluid that markedly accelerates the growth of these tumor-fighting lymphocytes.

White is also determining whether the effectiveness of TIL cells can be enhanced by inserting the gene controlling the synthesis of a lytic peptide. Lytic peptides are components of the immune systems of insects, frogs, and other species. They destroy the cell membranes of several types of disease agents, including cancer cells, viral infected cells, bacteria, and protozoal parasites.

The ability to synthesize lytic peptides could also bolster disease resistance in livestock. White has inserted a gene that controls synthesis of a lytic peptide into mice. The gene is controlled by a promoter that is activated during the immune response.

Mice that synthesize the lytic peptide will be tested for their resistance to pathogens and tumors.

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Gauging Grazing's Benefits

Results of a 14-year study contradict some widespread assumptions about the effects of livestock grazing.

Jim Bowns doesn't get mad often. Perturbed, maybe, but he's the type who will stiffen his jaw for hours rather than become unhinged.

A glossy four-color photograph in a magazine from an environmental organization has made him as demonstrably mad as he is ever likely to get. It shows cattle lounging on a landscape scoured of any vegetation. The headline and the caption attribute the desolation to grazing by livestock. And it certainly seems that way—those are definitely cows and the landscape is about as inviting as a parking lot in July.

But Bowns knows that the photograph and the caption and the headline and perhaps the entire thesis of the article are wrong—deliberately so, it appears. The cattle were photographed on Mancos shale, a saline soil in southern Utah so inhospitable that little has grown on it for thousands of years, with or without cattle. He points out that the ungrazed area on the other side of the fence sans cattle is equally lacking in vegetation. There are cow pats in the foreground, which means the cows have been eating well, albeit not in the location where the photograph was taken.

In essence, the article blames cattle for a landscape that has been molded largely by geological forces. It is not fair, but a lot of today's debate about livestock grazing strikes Bowns as unfair. And this kind of misinformation rankles him because he seems to be hearing more of it.

The photograph is another example of the slick market-
Bowns thinks aesthetic factors—not range condition—may sway the public’s perception of livestock grazing.
livestock one year out of three.

Cattle and sheep do as well or better on continuously grazed pastures as on deferred rotation (Table 1); rest-rotation was included in 1993 and results won’t be available for six years, or two complete “cycles” of the system.

The only appreciable difference in range condition related to either the species of livestock or the system of grazing, which occurred following the introduction of cattle. For nearly a century, most of the allotments had been grazed only by sheep. Cattle appear to be driving vegetation in a favorable direction. (Range condition is a barometer based largely on the potential composition of species at a site.)

Bowns is convinced that the visual appearance of pastures may be the single most important factor determining the public acceptability of livestock grazing.

“The deferred rotation pastures look the best—the grass is tall and it waves in the breeze. The pastures that are grazed continuously are grazed down, and even though the range condition may not have changed that much, people say it looks overgrazed. I now make recommendations as much on the aesthetic factors, because I know the importance of appearances.”

“It certainly helps if we don’t have to move animals among pastures,” Olson says. “However, my philosophy is that grazing systems should be used to improve a pasture. It’s a bonus if you also can improve animal performance in the process.”

Although the debate over grazing on public lands often centers on range condition, the preservation of archeological sites and ecology, Bowns is convinced that many critics simply object to the presence of cow pats—and of cattle per se. As a result, he fears that much of what has been learned about livestock grazing and range condition may fall on deaf ears.

Administrators with government agencies that manage allotments on public land often prefer rest rotation, which supposedly gives seedlings a chance to become established, although it means there’s much less forage than with a continuous or deferred grazing. Bowns says this preference is “based largely on supposition, not science. I believe deferred rotation is as good as rest rotation.”

“Rest rotation is a popular system, even though there’s been no good scientific validation to support its popularity. There hasn’t been a single replicated experiment involving rest rotation conducted anywhere in the country, although there have been some unreplicated studies,” Olson says.

The study on Cedar Mountain will be the first definitive examination of rest rotation grazing, whose supposed benefits underlie some of the assumptions that now govern the management of grazing on public lands.

A New Ecological Perspective

The results of the study prompted Bowns to revise his theories about the forces that shape rangeland ecology. He originally accepted the prevalent theory at the time, which was based on the range succession model that hypothesized that range-lands would revert to their original condition if livestock or other disturbances were removed, much as a spring returns to its original shape after it has been compressed.

The Cedar Mountain allotments offered a solid test of that theory. Grazing by sheep had “driven” the composition of vegetation in a certain direction. Other areas had received little, if any, grazing by sheep.

![Image of a landscape with hills and grasslands.](image-url)
I thought that if we grazed this properly or excluded grazing entirely, the original vegetation would come back. But it doesn’t—or at least it hasn’t in the last 14 years,” Bowns says.

Instead, rangeland appears to reach a steady state, one that permanently mirrors the effects of grazing and other uses. (In Figure 1, note the similarities in the pattern of indicator species on ungrazed exclosures and on pastures grazed by sheep and cattle.) Instead of a coiled spring, rangeland is like clay—it mirrors the forces that shape it. “Even though you remove livestock, rangeland does not revert to its previous condition,” Bowns says. “If an area was overgrazed, you push vegetation back to a certain type, and there’s little chance it will revert to its former condition.”

Bowns has gathered information on about 35 species of plants, six of which—ubiquitous key species—serve as barometers on the changes associated with various grazing systems: tarweed (Madia glomerata), an undesirable forb associated with overgrazing by sheep; Kentucky bluegrass (Poa pratensis), grazing-tolerant and highly preferred by livestock and wildlife, Letterman needlegrass (Stipa lettermanii), an aggressive grass that dominates pastures grazed by sheep, slender wheatgrass (Agropyron trachycaulum) and mountain brome (Bromus carinatus), both of which are more abundant in pristine vegetation, American vetch (Vicia americana), a desirable forb that tends to be more abundant in pastures that have not been grazed by sheep.

For several years, things seemed to be going according to theory: There were noticeable changes in the relative abundance of the indicator species depending on the type of livestock and grazing intensity.

That changed during the withering drought of 1989-90 (Figure 2). Grazing-induced trends paled in comparison to the effects of moisture, or the lack of it. “There was a noticeable change in the composition of species during the drought. Obviously, grazing was implicated, but the patterns were the same in ungrazed areas as in grazed areas.

“Had this study terminated after eight years—which is a relatively long time for a study of this type—before the drought occurred, we would have come to an entirely different conclusion,” Bowns says.

Bowns is now using the relationship between precipitation and forage production to predict stocking rates.

“I don’t doubt that there has been overgrazing. I think most of the West was overgrazed at one time,” Bowns says. Simply removing livestock doesn’t mean the vegetation will revert to

Figure 1. Changes in number of indicator species on pastures subjected to cattle-sheep rotation and on ungrazed exclosures.
a pristine condition. "If you're going to dramatically increase the productivity of many rangelands, you're going to have to chain, plow, spray or even reseed them," Bowns says.

It also means that the changes associated with grazing may be preferable to those that accompany the "natural" course of events.

Biodiversity and Livestock Grazing

Bowns is convinced that managing ranges for livestock is not incompatible with other objectives, including a marked increase in biodiversity.

"We have had a disproportionate increase in the number of elk on the study site, more than on other locations in the area that are not grazed or that are grazed much less intensively," Bowns says, an observation shared by many residents of the area and those who work at the site.

Bowns has unsuccessfully sought funding to confirm these observations. "We can't do it all. Ideally, ecosystem management—a popular concept these days—would involve an assessment all of the birds, mammals, big game and other animals. We've got deer, cougars, coyotes, foxes, birds—even some wild turkeys—forest grouse, and the species that prey on them, but we don't have the

Figure 2. Percent frequency of indicator species on pastures subject to cattle-sheep rotation grazing and on ungrazed exclosures.

All Exclosures Combined

Cattle-Sheep Rotation
resources to quantify these changes."

Nonetheless, the researchers are making an inventory of all the deer and elk that they see on the site during a day. "That's not as good as I would like, but it's the best we can do under the circumstances.

"Ecosystem management is exactly what we're doing. Gullies are healing, and there are improvements in vegetation and in wildlife. I can't see anything negative in what we're doing," Bowns says.

**The Importance of Long-Term Studies**

Perhaps the most important—or at least the most widely used—barometer of the value of a research project is the number of scientific publications generated. By that standard, Bowns admits he appears to have fallen short.

That's largely because studies of the long-term impact of grazing proceed at a glacial pace, one that mirrors the natural course of events.

"Many administrators don't like to invest in these long-term studies because they are relatively expensive and the scientific output appears to be low because you have to wait for plant communities to respond," says John Malechek, head of USU's Range Science Department. "It looks like outmoded research. But separating the effects of climate from man-induced effects vis-a-vis grazing is one of the most important issues we confront in range science."

Many government agencies and universities have discontinued similar long term studies and many of the remaining projects appear to be in jeopardy, Malechek says. "To my knowledge, this study is the only study of this type involving high-mountain ranges in the region."

As much as he loves the study and the area, Bowns is anxious to hand over the reins. No wonder. Every year, more than 20 miles of fence must be erected and taken down. Two thousand animals—1,700 sheep and 300 cattle—must be weighed three times a grazing season, which requires two or three days each time, from sun-up until sundown.

And the measurements along transects over a mile long each take half a day to complete. "I calculated the other day that I have measured over 91,000 plots. There's a collection of data that can't be duplicated."

Bowns says, much of it that he lacks time to fully analyze. "We have 14 years worth of data on the changes in vegetation. There aren't any similar long-term studies that show the changes that we're starting to detect.

"I'm convinced that we should address some of these questions now, or they won't get answered. No one else is going to do it for us."

**Opinions**

Increased interest in the fate of public lands has been accompanied by an avalanche of criticism of livestock grazing, some of it by people whose only contact with a cow is via hamburger and who know precious little about rangeland ecology. Nonetheless, these critics have strong opinions on the topic.

That's fair. Strong opinions don't bother Bowns, who harbors a few of them himself. Uninformed opinions are a different matter, especially when they concern rangeland ecology.

"The term 'overgrazing' bothers me. I've spent 36 years of my life and 10 years in college to learn about range ecology. Now, anyone thinks they can go out and tell me that the range is overgrazed. They don't know the vegetation. They don't know the soils. They don't know anything about range management. But everybody is an expert," Bowns says.

"This bothers me. This bothers me a lot."

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New Model Pinpoints EVAPORATION RATES

What happens when a hot, dry breeze blows over a field?

Common sense suggests that evaporation increases when air first enters the field. As air absorbs more moisture, thereby reducing its water-holding capacity, evaporation supposedly decreases. Or so it seemed. For years, scientists included this assumption in models describing how the advection of warm, dry air affects evaporation rates.

Advection is the transport of any atmospheric property, such as temperature or moisture, by horizontal currents of air. It affects the water requirements of crops in arid regions—it can sometimes double water losses—and influences evaporation over much of the earth's surface.

However, USU biometeorologist Larry Hipps found that evaporation does not decrease as air moves over a field. The reason appears to be stomatal conductance. Plant stomata open as relative humidity increases, thereby letting them maintain high transpiration rates downwind, a factor that was not considered in current models.

The complex relationship between advection and evaporation depends on factors such as distance downwind, available energy, temperature, humidity and turbulence, short bursts of activity. In field studies, Hipps and graduate student Alexandro Zermen measure wind, temperature and humidity 20 times a second.

Hipps says their findings will result in a better model of the relationship between advection and evaporation, which will be useful in predicting the water requirements of crops and evaporation on various landscapes, an important factor in studies of global climate and hydrology.

Process Improves the Attributes of SKIM MILK

Food scientists with Utah State University have patented a process that dramatically improves the appearance and mouthfeel of skim milk.

The process involves the addition of rennet, the enzyme normally used to coagulate milk for cheesemaking. After a relatively short time, the coagulating action of the enzyme is terminated by pasteurization. In cheesemaking, coagulation continues until large curds are formed.

The coagulation of casein micelles alters the refraction of light, eliminating the pale blue tint associated with skim milk, and makes skim milk appear as white as milk containing 2 percent fat, says USU food scientist Paul Savello. More than three-quarters of those participating in taste tests also indicated that the milk had a creamier mouthfeel.

"The process is very simple and completely safe. The caloric content of skim milk remains the same because no other calorie-containing additives are used in the process," Savello says. Moreover, the procedure should be compatible with methods used in milk processing plants.

"Considering the extent of research concerning the action of rennet on milk, we were surprised that this method hadn't been investigated previously," Savello says.

Researchers are now adapting the process for commercial operations and will license the technology.
How much methane do cattle produce?

Researchers with Utah State University have begun a 3-year project to find out, part of an effort to curb the emission of so-called greenhouse gases that have been implicated in global warming. The $500,000 project is funded by the Global Change Division of the U.S. Environmental Protection Agency.

The study involves fitting cattle on rangeland or pastures with simple devices that sample the air exhaled by cattle.

Some researchers estimate that ruminants produce about 20 percent of global methane emissions, of which cattle are the major source, says USU range livestock nutritionist Ken Olson. However, these estimates are based on confined animals, not free-roaming cattle on rangelands.

"Methane produced by cattle doesn’t appear to be an inconsequential factor in global warming, although some researchers claim livestock generate much less methane than these estimates suggest. It’s important to determine how much methane livestock actually produce," Olson says.

Improving Beef Production

The study will also determine if changes in diets and production systems that improve the efficiency of beef production will also cut methane emissions.

"Many of the press accounts of this research have treated it as a frivolous use of tax dollars. It isn’t. I don’t know the importance of global warming, but it is important to determine the amount of gases that cattle emit that might contribute to global warming.

Improving forage quality could reduce methane emissions. It also improves the efficiency of beef production.
“And I want people to know that whether or not we do anything about global warming, this project provides an opportunity to conduct good agricultural research by developing improved production practices,” Olson says.

Olson says rumen microorganisms that thrive on grain-based diets produce much less methane than those that thrive on forage-based diets.

“The poorer the quality of forage, the more methane produced,” Olson says. Forage quality is also a major factor in the efficiency of beef production.

The study also involves animal scientist Randy Wiedmeier and range scientist Roger Banner.

The device used to measure methane was developed by animal scientists and environmental engineers at Washington State University. It consists of an airtight, lightweight hollow yoke constructed from plastic pipe. A vacuum is created in the yoke and small-diameter hose connects the yoke to the nose of the cow, thereby sampling exhaled air for several hours.

Air collected in this manner can then be analyzed to determine the concentration of exhaled methane. Measuring amounts of another compound released in the rumen makes it possible for researchers to determine the total amount of methane produced.

Field studies will be conducted on native and improved pastures on experimental farms of the Utah Agricultural Experiment Station.

The USU researchers will determine whether a method of raising calves to reach slaughter weights at a younger age also substantially reduces methane emissions.

“It makes sense that the sooner livestock can be slaughtered, the less methane they will produce during their lifetimes,” Olson says.

Olson notes that methane is 10 times as reactive as carbon dioxide, another gas implicated in global warming. Fortunately, methane has a relatively short half life.

“This means that any reduction in methane production could quickly aid efforts to reduce global warming,” Olson says.

Similar research will be conducted in other regions of the United States. The USU research will apply to the Intermountain region.

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Regional Focus Could
BOOST PARK’S
ECONOMIC BENEFITS

When the Great Basin National Park was created in 1988, many hoped it would spur economic growth in western Utah and eastern Nevada.

While some economic benefits have trickled to the area, there’s been no economic bonanza.

Why? It’s largely because there’s not much to hold visitors in the region. Most people visit the park and then leave, spending their time and money elsewhere, according to USU recreation researcher Dale Blahna.

A 1988 survey indicated that most of the 70,000 visitors to the park annually stayed only a day or two and spent about $24 daily per person. Visitor expenditures had little impact on the regional economy.

“There’s little in the region except a few motels and restaurants to hold these dollars. Most visitors go outside the region after a short visit,” Blahna says.

Emphasize Other Attractions

Blahna says a regional approach could stem the leakage of visitor dollars. That includes expanding interpretive services in the park, bolstering services in adjacent areas, and capitalizing on the area’s other historical and natural amenities, such as archeological sites, wildlife refuges, and historic mines and railways.

This would be better than simply encouraging an increase in the number of visitors to the park, which would degrade park resources in the long run. With current spending patterns, “there would have to be a huge increase visitation for the region to reap any substantial economic benefits,” Blahna says.

KG Dale Blahna 797-2544
Russian Wheat Aphid Control on Alternate Hosts May Reduce Threat to Crops

The ability to control Russian wheat aphid when they lurk in grasses could reduce the threat that they pose to crop hosts.

Grasses and other alternate hosts are "reservoirs of infection" for the insect pest, says USU entomologist Frank Messina, who is studying aphid survival in many native and introduced grasses where the aphids seek refuge between the harvest and replanting of small grains.

Although biocontrol agents have been extensively studied in small grains, little is known about their effectiveness on alternate hosts. On small grains, the curling of leaves of infested plants shelters aphids from predators and contact insecticides.

With a grant from the Cooperative State Research Service (USDA), Messina is determining whether the morphology of grasses confers similar advantages, or whether aphids on grasses are more vulnerable to predation by common green lacewings and the 14 spotted ladybird beetle, which has been imported as a potential biocontrol agent.

The Russian wheat aphid, which first appeared in the U.S. in the 1980s, has caused an estimated $1 billion in damage to small grains. It surfaced in Utah in 1988. Control tactics in Utah include the release of natural predators on rangelands and other areas where spraying is not economically feasible, in addition to spraying crops with systemic insecticides.

Survival on Range Grasses

Messina found that aphid survival and reproduction on six species of perennial range grasses—four wheat-grasses (crested, Snake River, bluebunch and intermediate pubescent) and Great Basin wildrye and Indian ricegrass—didn't improve on grasses that were more closely related to the aphid's host crops of wheat and barley, nor did it improve on grasses that originated from the same area as the aphid.

The species of grass also didn't influence the production of alates, the winged stage of the aphid that's
more likely to migrate. There was a “maternal effect,” however. When mothers were crowded on plants, their daughters were more likely to develop into alates.

Other findings also bode well for aphid control. With some types of aphids, moderate crowding can also spur aphid growth due to an increase in the flow of nutrient-rich phloem sap that a plant produces in response to aphid damage. However, there was no growth spurt when Russian wheat aphids infested grasses and wheat.

Many of the experiments involved uncrowded plants, however. Under field conditions, grasses senesce (age) sooner because they face more competition, which may encourage aphids to migrate to more succulent grasses along roadsides or in recently seeded areas. These areas could serve as “bridges” for infestations, Messina says.

“If plants have ample water, early grazing may make some grasses more susceptible to aphids because the regrowth is more palatable than mature foliage on ungrazed plants,” Messina says. Early grazing (as simulated by clipping) resulted in more aphids on bluebunch, Snake River, crested and intermediate wheatgrasses, but not on Indian ricegrass and Great Basin wildrye.

The complex life cycle of aphids includes sexual and asexual stages. Fortunately, Russian wheat aphids in North America don’t seem to enter an egg-producing sexual generation. Aphids usually overwinter as eggs, although nymphs are also somewhat cold-hardy.

None Survive Winter

Messina determined that nymphs and adults on the six perennial grasses couldn’t survive a normal winter in northern Utah, although a few almost made it.

Tufts of crested wheatgrass provided the most cover, which helped a few nymphs survive until early March. Thus infestations in northern Utah are due to migration, not overwintering. Aphids might survive a warm winter, however, which apparently happened in Box Elder County a few years ago. New egg-laying genotypes could appear, conferring the ability to overwinter—and resulting in heavier infestations.

The entomologist is also studying how the bird cherry-oat aphid, which usually occurs with the Russian wheat aphid in crops and in alternate hosts, might affect the number of Russian wheat aphids. The bird cherry-oat aphid may compete with the Russia wheat aphid (a beneficial effect) or it could be an alternate source of prey, thereby diverting predators from the Russian wheat aphid.

“We hope our findings concerning the interactions between alternate hosts, competitors and predators will be applicable to crops,” Messina says.

Leafy Spurge?
GET A GOAT

Cattle hate leafy spurge. Goats love it. Sheep can go either way, depending on their upbringing.

For decades, ranchers have noticed similar differences in livestock palates. Researchers have now confirmed their observations.

The findings will be useful in stemming the invasion of the prolific weed, particularly along ditchbanks where infestations often start as floating seeds lodge along streambanks.

“Goats actually seek out leafy spurge. Sheep won’t graze it unless they are conditioned to the weed early in life,” says USU range ecologist Neil West, who directed the studies of graduate student Saud Al-Rowaily on the role of livestock grazing in weed control on rangeland in cooperation with John Walker, range scientist with the USDA’s Sheep Station near DuBois, Idaho.

Intensive Grazing Required

Sheep didn’t choose areas with dense concentrations of flowering spurge, but that didn’t deter goats. Goats were also much more effective than sheep in keeping the weed from flowering and setting seed.

Nonetheless, it takes intensive grazing pressure to make a difference. Based on clipping studies, 80 percent of plants had to be defoliated at least three times to make a dent in spurge growth and reproduction.

West says grazing won’t control the weed, but it could be a component of the biocontrol program that is now being developed, which will rely largely on insects that attack the weed.

Leafy spurge is widespread in the Northern Great Plains. It has infested almost 1 million acres in Montana and is starting to invade Idaho and Utah. It is not possible to eradicate and it’s uneconomical to control with herbicides.

In North Dakota, spurge-related losses total almost $15 million annually due to the reduction in forage production and utilization. Cattle will not graze areas where leafy spurge cover is 10 to 20 percent.
Method Identifies **KIDS**
**Who Most NEED HELP**

Some kids are more likely to get in trouble.

That’s not startling news. But it would certainly help if teachers knew that Randy is likely to smoke marijuana while Tony wouldn’t touch a cigarette, or that Susan is likely to join a gang while Bob probably wouldn’t even consider doing so.

Focusing on the kids who need help could dramatically reduce the incidence of problems such as drug abuse, teen pregnancy, and gang involvement.

It would also make the best use of scarce resources.

How? The answer, says USU educational psychologist Randall Jones, may be to employ a system of “psychosocial measures.”

The measures, which are based on the theory of psychologist Erik Erikson, place children in four categories (identities), based on the degree to which they explore the options available to them (exploration), and the degree to which they commit themselves to their choices (commitment). Kids with different identities often have dramatically different perspectives on life—and certain problem behaviors.

**Four “Identities”**

Foreclosed individuals have strong commitments but have done little exploration of their options in life, including such areas as religion, politics, sex roles, lifestyle, and occupations. Diffused individuals have made few commitments and have done little exploration. Those in moratorium have explored their options but are not committed to their choices, while those classified as achievers have explored their options and

The results of several studies show that an adolescent's "identity" is related to certain problem behaviors.
are committed to their choices.

"I'll grant that there are more than four types of kids, but no other model consistently identifies kids likely to have problems," Jones says.

The identity of adolescents is clearly related to the risk of certain problem behaviors, as is evident in the results of a survey of more than 2,000 junior high and high school students in Utah and Arizona.

"Students classified as diffused were five to seven times more likely to have engaged in substance abuse than students classified as foreclosed," Jones says. "In the seventh grade, fewer than 10 percent of the foreclosed students and 40 percent of the diffused students had tried marijuana.

"By the twelfth grade, 30 percent of the foreclosed kids and 80 percent of the diffused kids had experimented with marijuana." The pattern of cocaine use was similar--by the twelfth grade, 10 percent of the foreclosed students and 30 percent of the diffused students had experimented with the drug.

Foreclosed adolescents with a rigid identity seem to be at less risk--but only until they are exposed to other circumstances and pressures. Under these circumstances, their strong commitment to abstinence, which is based on external standards, is likely to crumble, Jones says.

Scores Are Accurate Predictors

One study showed that adolescents in a treatment center had higher than usual foreclosure scores. "Even though they were less likely to get involved with drugs, once they did, they were more likely to develop problems," Jones says.

The same pattern was evident in a survey of the sexual activity of undergraduates at USU and the University of Arizona. Foreclosed students were much less likely to be sexually active than were diffused students.

However, when foreclosed students did become sexually active, they were less likely to use contraceptives.

Jones says schools do an excellent job of increasing knowledge, even about issues such as the consequences of drug abuse. What schools need, he feels, are better ways to link knowledge to observable decreases in risky and health-threatening behavior.

He first became interested in the method while working with the Navy on a program to stem drug abuse. Many sailors tested positive for drug use when they entered the Navy. "That indicated to me that it would be far better to prevent the problem than react to it after it occurs. Teenagers are the last gateway. We need to help them avoid decisions that will mortgage their future," Jones says.

Next year, Jones will try the method in a high school in Roy, Utah.

"Our objective isn't to make every kid into an achiever, but to match the type of interventions and treatments to needs," he says.

On Small Plots, CRUSTS CURB EROSION

The conventional wisdom is that microphytic crusts in desert regions reduce soil erosion. There's been surprisingly little objective proof for the belief, however.

Now--finally--there's some proof that these crusts reduce erosion by wind and water...well, at least on tiny plots (about a square meter) that were subjected to artificial wind and rain.

On these plots in the Capital Reef National Park, wind erosion was greater where the microphytic crusts had been mechanically removed than on plots where the crusts were intact or had been killed with chemicals and remained in place.

Other tests showed that microphytic crusts seem to reduce the initial entry of water into the soil, but didn't seem to affect subsequent infiltration.

"As expected, the removal of crusts accelerated wind and water erosion," says USU range ecologist Neil West, who conducted the study with range scientist Jim Dobrowolski. West strongly cautions against extrapolating the results to other sites and other conditions. "We need to study more realistic treatment on a larger scale and at several sites to really determine the roles of microphytic crusts," he says.

The experiments involved artificial treatments and the complete removal or killing of crusts. Hikers, livestock or off-road vehicles usually only partially disrupt these crusts, and may have different effects, West says.
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