SUSTAINABLE AGRICULTURE
UTAH SCIENCE is a quarterly magazine devoted primarily to Experiment Station research in agriculture and related areas. Published by the Utah Agricultural Experiment Station, Utah State University, Logan Utah 84322-4845.

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PRINTED ON RECYCLED PAPER
The Dean Retires
After 21 Years
at the Helm
Doyle Matthews. Dean. The title fits.

He fishes a clipping from his desk drawer that contains several adages, the gist of which is that doing what you think is right may not always be popular but it can sure be good for the soul.

He has had ample time to find out. During his 21 years as dean of the College of Agriculture, and 15 years as director of the Utah Agricultural Experiment Station, his folksy demeanor has seemingly been unscathed by internecine battles that characterize campuses as well as corporations. It's easy to see how some people might have thought Doyle was a gullible hayseed, a guileless Aggie.

Wrong. Some campus Doyle-watchers attributed his tenacity to his sheep-raising origins in Idaho. Sheep ranchers never achieved the heroic status of cattle ranchers, which--so the theory goes--encouraged them to observe carefully, speak directly, and act modestly. Perhaps true, perhaps not. Nonetheless, the vestiges of the Idaho farmboy and Extension livestock specialist are reflected in his openness and accessibility.

He has never been handicapped by reticence nor has he been a connoisseur of waffling and obfuscation. A meeting with the Dean refined one's appreciation for brevity and clarity, particularly when that look--a hybrid between a grin and a grimace--came over his face.

You may not like what he said, but there wasn't much doubt about what he meant.

During Matthews's watch, buildings and research facilities sprouted across campus and research budgets burgeoned, all--directly or indirectly--a reflection of his influence. He believed in agriculture and was a forceful and effective advocate for its interests.

And what would he like to be remembered for?

For encouraging good teaching, he says. Building the college's research program. Never forgetting that Extension was a equal partner. "I'd like to think that I helped change the image of agriculture on this campus from sows, cows and plows to one of scientists who are concerned about the food supply."

He doesn't mention any buildings, honors, or awards.

He has degrees (a Ph.D. from Kansas State University in animal breeding, M.S. and B.S. degrees from USU in animal science), publications, honors, qualifications, membership and leadership in all kinds of organizations (including chairman of the Council of Administrative Heads of Agriculture and chairman of the Division of Agriculture for the National Association of State Universities and Land Grant Colleges).

"I'm not embarrassed to say that I survived longer as dean of the college than anyone else," he says. He doesn't mention that he's respected around the country. Dean of deans, some call him.

His heroes? "My father," he says. And two Extension livestock specialists who helped a kid with his 4-H projects.

Kind of corny stuff, but what you'd expect from someone who says he loves his work.

His retirement will be marked by a banquet on campus December 17. You are invited. (Call Jan Pichette at 801-750-2215 for more information.)

He wants to keep his departure low-key, tone down the tributes and mute the paeans of praise, but we don't let someone of his stature simply slip away.

Much can be said about Dean Matthews's achievements, but they can be boiled down to this: He is a friend of the College of Agriculture, Utah State University, higher education, and agriculture who will be remembered for a long, long time.

He is a true-blue Aggie.

KG
The foibles of nature, the fickleness of markets, and the arcane requirements of government programs. What will farmers face next?

Environmental strictures, that's what. More rules and regulations, this time about the use of pesticides and other substances and practices that might pollute the environment.

These regulations will probably be in place within a decade, says USU economist Larry Bond. Farmers will also face closer scrutiny on their efforts to curb soil erosion. Compliance is likely to be voluntary...sort of--compliance will be linked with eligibility for government support programs. The system will probably be similar to the conservation plans that farmers file to participate in the Conservation Reserve Program.

Most farmers blanch at the prospect of more regulations, but researchers are already trying to make compliance as painless as possible. One promising development is new computer software that assesses the environmental risks and profitability associated with alternative farming practices, part of the effort to get SMART (Sustaining and Managing Agricultural Resources for Tomorrow).

Bond is a member of the USDA's National Task Force on Low Input Sustainable Agriculture, which developed the computer programs. The programs will be available in county USU Extension offices and the Soil Conservation Service offices before the end of the year.

SMART consists of two programs with the ungainly names of Budgetor and Planetor. Budgetor is used to enter data for Planetor, the program which marries the ecological and economic consequences of farming. There are other differences as well, including the fact that Planetor budgets for complete rotations of up to 12 years, rather than for a single year, and for several alternative fertility, pest management, and tillage methods.

In addition to assessing profitability and identifying the potential environmental risks posed by pesticides, it estimates how much nitrogen remains in the soil after harvest, information useful in assessing the risk that nitrates will enter the groundwater.

The program can also be used to evaluate energy consumption, assess environmental risks associated with livestock enterprises, and evaluate labor and feed needs and availability for the entire
farm. Returns are shown by each enterprise, by fields, or for the entire farm. It can also calculate net income and the change in net worth.

Bond says many improvements are planned for the next version of the software. Currently, the program cannot evaluate how potential environmental risk varies with different methods and timing of irrigation or with alternative methods of applying pesticides.

Farmers won't welcome increased regulation, but this program will help them cope with it when it occurs. The program could show that the farming practices of many farmers are much more environmentally safe than the general public has been led to believe, Bond says.

"In the long run, there is no conflict between the ecologic and economic dimensions of sustainability," Bond says. "A system must be ecologically sustainable to be productive and profitable over the long run. A system must be productive and profitable over the long run to be sustainable, regardless of its ecological soundness."

Most farmers consider themselves conservationists, although some might bristle if labelled "environmentalists." Bond says the value of many of the concepts encompassed by sustainable agriculture are apparent by answering the following questions: "Would I farm any differently if I had to make a living off my farm for another one hundred or two hundred years?" and "If someone else were farming my land, and I had to live next to it, would I want them to change any of their farming practices?"

Answering "yes" to either or both of those questions probably means some changes in farming practices are in order. And that's probably not such a bad idea. It might even be profitable.

\[ \text{Larry Bond} \quad 750-2320 \]

**SUSTAINABLE AGRICULTURE**

**Easy to Support, Difficult to Implement**

Low-input sustainable agriculture is a lot like motherhood.

In principle, nearly everyone endorses it.

In practice, the consensus can be pitifully thin.

Motherhood is so "American" that few oppose it. Low-input sustainable agriculture (usually known by its incongruous acronym of LISA) encompasses undeniably attractive virtues that, like motherhood, everyone supports. But it also covers knotty problems like pesticide use, organic farming, government subsidies, the fate of the family farm, soil erosion, and the economic resuscitation of rural areas.

It is a small program with some mighty lofty aspirations, which reflects the fact that it was the offspring of noble purpose and political
opportunism. (However, many supporters note that much of the research conducted by land-grant institutions totalling tens of millions of dollars is also consistent with goals of the program.)

LISA reflects the divergent background of its parents. Like a couple wrangling over the future of their child, its supporters sometimes vehemently disagree about the basic goals of the program. Some see it as charting a new course for a moribund agriculture. Others see it as a continuation of slightly flawed but highly successful agricultural policies and practices.

USU soil scientist Phil Rasmussen chafes at those who see the program as a blanket indictment of American agriculture. He studies alternative crops and conservation tillage, both of which are encompassed by LISA, and is familiar with the origin and development of the program. Supporters of the program include adherents of organic farming, conservation groups, environmental groups, farmers, researchers, and politicians of every ideological bent—short, about as disparate a group that is likely to support a single piece of legislation. The support for the program in part reflects the widespread public perception that something is wrong with agriculture as much as it does a search for new opportunities.

"LISA was created in response to pressure by different groups trying to change the emphasis of agriculture. Many feel traditional agriculture is tied to high production and maximum profits, often at the expense of rural economic growth and the rural environment. It is an attempt to address the long-term costs associated with agriculture," Rasmussen says.

He prefers the definition of LISA developed by a joint committee of Experiment Station and Extension Service as systems that are "economically sound, socially acceptable, and environmentally benign." Included under that umbrella definition is research on food quality and safety, farm worker safety, environmental degradation (including the effects of pesticides), the effects of soil erosion, the depletion of the natural resource base, water quality, the resistance to pesticides, and the policies that encourage the adoption of practices that enhance sustainability.

Profitability is also a consideration. A farm that isn't profitable isn't sustainable.

That's a mighty tall order. And it's something akin to changing the course of a supertanker—it won't happen quickly and the final destination is somewhat uncertain.

"In some respects, LISA is nothing new. It's what we've been trying to get farmers to do all along, practices such as integrated pest management, conservation tillage, and other ways to reduce off-farm inputs," Rasmussen says.

A lot of the wrangling concerns the meaning of "low-input." Some have interpreted it to mean a reduction in the inputs per acre, but Rasmussen says that's not always possible, nor even desirable. Sustainability may occasionally require higher inputs, including (usually) a higher level of management.

"Instead of maximizing production, sustainability considers the long-term economic consequences. In other words, farmers may accept a lower annual return now in order to have higher production 50 years later," Rasmussen says. It's an admirable concept, but one that Rasmussen says is
"The past offers some answers. However, success largely depends on access to and utilization of new information."

--Phil Rasmussen
difficult to sell to farmers desperately trying to survive this year, much less several decades from now.

Rasmussen say many of those promoting LISA simply don’t understand agriculture and are instead promoting a social or economic agenda that simply doesn’t jibe with the realities of farming. For example, those who recommend replacing all fertilizers with green manure crops apparently don’t realize that these crops can provide nitrogen but can’t replace phosphorus, potassium and micronutrients. And while manure can provide some nutrients, there isn’t enough of it—even if human wastes are used—to provide the nutrients needed by all crops across the nation. "It’s wrong to say we should quit using chemical fertilizers," Rasmussen says, noting that there’s only enough human and livestock manure to blanket 8 to 10 percent of the nation’s cropland.

The gulf that divides supporters is also evident in the views of biotechnology. Some see the development of herbicide-resistant crops and fast-gaining livestock as an integral part of a sustainable agriculture. Others abhor these developments as simply more malevolent tinkering with Mother Nature.

Some think farmers should curb their supposedly lavish use of pesticides and fertilizers. Others think the program will help them farmers use these inputs more efficiently. And goals for the economic renaissance of rural areas are equally divergent, ranging from plans to turn much of the country’s midsection into a grazing area for buffalo to assertions that a dramatic change in the system of agricultural production would exacerbate the decline in rural economic growth.

Even the threat that farmers might be forced to stop using "chemicals"—including many so-called "nonorganic" fertilizers—has prodded industry and agricultural researchers into an pre-emptive defense, including publication a raft of reports. One such report produced at Texas A & M in cooperation with the National Fertilizer and Environmental Research Center of the Tennessee Valley Authority examined the economic impacts of a reduction in chemical use. Their prognosis was grim. The report claimed that consumers would pay $228 more per household annually (in 1989 dollars) if pesticide use was banned and $428 annually if pesticides and inorganic nitrogen fertilizers couldn’t be used. Food prices, the report claimed, would eventually increase by double-digit levels. The volume of grain and cotton exports would decrease by nearly 50 percent. Cultivated acreage would increase by 10 percent and erosion would also skyrocket as land less suitable for crop production was pressed into production.

There may be disagreements over goals, but there’s no doubt that agriculture can benefit from alternatives, some of which may be fostered by LISA. A recent report on alternative agriculture by the National Research Council noted that agriculture is the largest nonpoint source of surface water pollution, soil erosion is a concern in many states, pests are becoming resistant to pesticides, the cost of purchased inputs continues to increase, the agricultural productivity of other nations threatens international markets for U.S. commodities, and costs of federal farm programs continue to escalate even as their benefits to small-scale farmers dwindle.

Some changes definitely appear to be in order, even if they are not as far-reaching as some hope or as grim as others fear.
"Alternative systems emphasize management; biological relationships, such as those between the pest and predator, and natural processes, such as nitrogen fixation instead of chemically intensive methods. The objective is to sustain and enhance rather than reduce and simplify the biological interaction on which production agriculture depends, thereby reducing the harmful off-farm effects of production practices," the National Research Council report noted.\(^1\)

Some critics think Farmer Brown mortgaged the farm and abandoned age-old principles the past few decades during a giddy technological fling. These critics view LISA as a staid partner luring agriculture back to age-old principles in harmony with the natural order of things.

The merits of some practices from the past, such as crop rotation, that have fallen into disfavor deserve more attention. The past is unlikely to hold all of the answers for the future, however.

And LISA won’t strip away technology. It won’t make farming simpler.

It’s farming smarter.

KG

Phil Rasmussen 750-2257

\(^1\)Smith et al. (1990) Impacts of Chemical Use Reduction on Crop Yields and Costs. Agricultural and Food Policy Center, College Station, Texas: Dept. of Agricultural Economics.


\(^3\)National Research Council, 3-4.
The Fieldwork of INNOVATION

No-Till Phil thinks his nickname is o.k., even if it's not exactly accurate. For 10 years, USU soil scientist Philip Rasmussen has encouraged farmers to replace moldboard plows with conservation tillage methods that leave more crop residue on the soil surface to conserve moisture and anchor soil against erosion.

He demonstrated the practice dozens of times, with different varieties and fertilizers, and at various locations around the state. He has talked and written about it hundreds of times, year after year, chiseling away doubt, as he employed the research and Extension methods that land-grant universities have used for more than a century.

"The biggest challenge was to convince farmers that something that looked so bad would actually work," Rasmussen says, referring to the ragged appearance of fields when crop residue is left on the surface instead of turned over and buried.

Today, more than 350 farmers in the state practice some form of conservation tillage on more than 125,000 acres, which have allowed them to shave production costs by more than $2.5 million since 1984.

Because most of these conservation practices reduced rather than eliminated tillage, Rasmussen should be known as Low-Till Phil. Nonetheless the tactics that resulted in a shift in tillage methods are similar to those that will be required to implement practices associated with sustainable agriculture. Farmers want solid proof that a practice works before they tamper with an entire system of production.

Ironically, the land-grant system, which has been criticized for foisting unwise technological innovations on unsuspecting farmers, is now lambasted for failing to promote alternative agricultural practices. Rasmussen has a different perspective, the viewpoint of someone who would have to answer to farmers who follow his advice. It's easy to explore all kinds of ideas on paper. Underwriting those ideas with an investment of tens or hundreds of thousands of dollars tends to make one tread more cautiously.

"Many of the practices recommended for the eastern U.S. such as some types of double-cropping simply won't work here due to the cold temperatures and limited moisture," Rasmussen says.

Rasmussen has helped Miranda yellow peas gain a foothold in the state during the last four years. The protein-rich pea adds organic nitrogen to
the soil (about 50 pounds per acre) which is less prone to leaching than nonorganic sources. The pea is a substitute for soybean meal, which is now imported from other states. Replacing imported soybean meal with the peas could bolster farm revenues by hundreds of thousands of dollars annually.

Utah farmers now grow about 2,000 acres of Miranda peas, but marketing snags and some problems with weed control have to be solved before the crop really takes off. (A similar type of pea for forage, Poneka, seems to grow so vigorously that it outcompetes most weeds, however, and is now being evaluated.) These peas and other alternative crops such as lentils, lupines and black medic show considerable promise, but they aren't soon likely to displace alfalfa as the state's leading crop.

Another promising alternative crop involves a 50-50 mixture of winter hardy Austrian peas and triticale that is planted after corn is harvested. This forage mixture utilizes the moisture provided by spring snowmelt when fields are too wet to work. It's also a symbiotic relationship—the Austrian pea adds protein to the forage mixture and fixes nitrogen while the triticale provides a climbing surface for the pea.

Sustainable agriculture would also benefit from the low-level remote sensing video system that Rasmussen and Extension systems analyst Jim Belliston developed. Unlike satellites, which pass over an area once every nine days and whose vision can be obscured by clouds, the video system could quickly be airborne in an ultra-light or remote-controlled aircraft. The inexpensive system is "low, slow and cheap instead of high, fast and expensive," Rasmussen quips. It may be just the ticket to hone management skills—detecting insect infestations, diagnosing plant diseases, and monitoring irrigation. Images could be coupled with computer-controlled equipment to fertilize fields according to soil type, thus making optimum use of fertilizer and minimizing the risk of runoff and leaching.

Rasmussen notes that a reduction in pesticides will allow insect infestations to increase more rapidly, thus increasing the importance of monitoring. The video system could also reduce the manpower required to scout fields for insects and diseases. "I tell farmers that minimum tillage requires maximum management. The same is true of many other practices associated with sustainable agriculture," Rasmussen says.

Conservation tillage, alternative crops, and a video system—Rasmussen thinks they are good ideas that will probably be part of sustainable agriculture in Utah. Now he has to prove it.

KG
Phil Rasmussen 750-2257
Several Insects Promise to **Control Weeds**

Insects won't displace herbicides but they will help control some weeds, particularly on areas where other types of control aren't feasible.

Several insects have already been deployed against weeds in the state and others are being studied, says USU entomologist Ted Evans.

The introduction of the musk thistle weevil by USU entomologists during the 1970s illustrates how the tactic can be successful. "You can now go anywhere in Utah and find the weevil feeding on the heads of musk thistle," Evans says. County weed boards and farmers now purchase thousands of the weevils annually from biological supply houses to bolster natural populations.

The weevil hasn't eradicated musk thistle—which isn't the objective of biological control (biocontrol)—but it is starting to reduce infestations below the level where they cause significant economic damage, the ultimate goal of biocontrol programs. The weevil prefers early flower heads and is particularly effective in ferreting out isolated plants in areas where herbicides and other types of control aren't feasible.

Evans hopes to duplicate this success with Canada thistle, perhaps again utilizing the musk thistle weevil, which feeds on several thistles. USU researchers are studying how this weevil and other insects affect the survival and reproduction of Canada thistle. The study site is a riparian area in Rich County administered by the Bureau of Land Management. The agency is trying to avoid the use of herbicides (which have not proved effective against the thistle at this site). The thistle has spread within the exclosure since the area was fenced to exclude cattle and sheep.

Another potential biocontrol agent is the Canada thistle stem weevil (*Cephalorhynchus litura*), which is now used as a biocontrol agent in several other states. It has been introduced in Utah in recent years but its effectiveness has yet to be carefully assessed. Shoots and stems mined by the weevil often die during the winter, perhaps because wounds are invaded by bacteria and other microorganisms.

"In Montana, some farmer and ranchers feel the weevil has helped considerably but others are more skeptical," Evans says. Last year, he and the BLM introduced 2,500 of these weevils on the plots in Rich County to assess their long-term effects on Canada thistles.

The ball gall fly (*Urophora cardui*) introduced to Rich County from Oregon may also stymie Canada thistle. When this small fly deposits eggs in the stems of the developing shoots, the thistle forms a gall at the site, thus diverting energy and nutrients that the thistle would otherwise allocate to seed production.

Knapweed is another weed targeted for biocontrol. Two species of seed-feeding flies, relatives of the ball gall fly that attacks Canada...
Eight basic steps in the biological control of weeds.

1. Preliminary assessment and review of the weed problem

2. Foreign exploration for and study of insects attacking weed in native environment

3. Tests of host specify to ensure insect attacks only the weed

4. Federal review prior to introduction of the biocontrol agent

5. Quarantine to ensure that only the biocontrol agent is introduced

6. Initial releases and establishment at field sites

7. Wide redistribution of the control agent

8. Evaluation of the success of the biological control agent in reducing weed population
thistle, have reduced seed production by spotted and diffuse knapweed in Montana and other states, and are the cornerstone of a program now carried out by the USDA Animal and Plant Health Inspection Service. USU researchers are studying the weevil on squareose knapweed, a species that infests an area near Tintic which may spread to the west desert. USDA-APHIS is also helping the USU Cooperative Extension Service introduce the weevil on diffuse knapweed in Grand County.

The USU Cooperative Extension Service is also reintroducing a weevil that attacks puncture vine, a weed that invades disturbed areas, orchards, and occasionally rangelands. The weevil has effectively controlled the weed in California and other warmer regions of the west, but Utah’s cold winters apparently snuffed out populations that were introduced during the 1960s. A more cold-tolerant genotype of the weevil has apparently survived in Colorado and the Midwest. Evans and county extension agents are comparing the survivability of the weevils from California and Colorado at sites in Grand, Washington and Box Elder counties.

If all goes well, Evans eventually hopes to establish field nurseries to raise these insects for general distribution throughout the state.

Evans says biocontrol of weeds offers several advantages, including the ability to target control of a specific weed. It is also less environmentally disruptive than herbicides, and will avoid potential groundwater contamination and damage to nontargeted plants. “The potential long-term benefits are tremendous,” Evans says. Once an effective biocontrol agent is established, weeds are controlled at little cost or maintenance. Biocontrol is often the only feasible weed-control method on marginal lands and rangelands.

It’s only a partial solution, however. Biocontrol agents take a long time—often 10 to 20 years—to identify and evaluate. They don’t act quickly enough and control is too sporadic to control many pest infestations in crops. Only a few of the many potential biocontrol agents are likely to be highly successful and have a major impact on the weed population.

There’s also a slight risk that an insect used in biocontrol will attack other plants, a risk that is minimized by careful screening and testing by state and federal agencies before any organisms used in biocontrol are introduced.

“There’s no chance that the insects used as biocontrol agents against musk and Canada thistles will move to a crop such as corn or barley, but there is a chance that they may move to a native or perhaps an endangered species of thistle,” Evans says. “Researchers are well aware of the risk and there haven’t been any major problems.”

Nonetheless, biocontrol offers substantial payoffs. One of the few instances in which the costs and benefits of an insect used in biocontrol has been assessed involves the klamath weed, which infested rangelands in California and other areas of the west. It cost about $750,000 to develop an effective insect biocontrol agent during the late 1940s. By 1981, the control program had resulted in savings of more than $100 million.

Biocontrol methods against other weeds promise similar savings. “When biocontrol works, it’s great,” Evans says. “We are trying to increase the chances that it can be used successfully.”

KG  
Ted Evans 750-2552
New Farming Tactics
May Not Reduce Need for Herbicides

A major tenet of low-input sustainable agriculture concerns the need (and apparent desirability) of reducing herbicide applications. It sounds good in theory.

In practice, well...Jack Evans is skeptical. The USU weed scientist says many Utah farmers should probably be applying more herbicides. And they may have to apply even more if sustainable agriculture gains a larger foothold in the state.

When it concerns weed control, "low-input" may not always be compatible with "sustainable."

Evans says most biocontrol techniques for weeds are developed for rangelands and public lands, and don't control weeds quickly enough to to stave off losses in infested crops.

The reduced tillage practices often associated with sustainable agriculture will probably increase reliance on herbicides. There's also a danger that fields entered in long-term set-aside programs such as the Conservation Reserve Program (CRP) may be choked with weeds that subsequently infest crops. "I see weed populations on some CRP fields that are alarming, including infestations of dyers woad, a weed which usually doesn't threaten cropland," Evans says.

"It appears that some farm policymakers may not fully appreciate the tenacity of weeds. Just because we develop different approaches to farming doesn't necessarily mean that there may be fewer weeds. In fact, it appears that the reverse may be true," Evans says.

Evans says there are more than 300 weed species in Utah. Weed-related losses in the major agronomic crops in the state now exceed $34 million annually (excluding the costs of control).

Indiscriminate herbicide use doesn't appear to be a major problem in Utah. Evans says a larger problem is half-hearted weed control in many fields--many farmers apply enough herbicide to provide partial control but stop well short of effective control. The reasons for this lackadaisical attitude baffle Evans. (He speculates that it may reflect the high proportion of farmers who rely on off-farm employment in Utah.) Whatever the reason, it perpetuates weed problems and is ultimately far more expensive than if herbicides had been applied correctly.

Traces of herbicides have been detected in the groundwater in some states, a problem that Evans thinks is less likely to crop up here, in part because Utah farmers tend to be more conservative--too conservative--in their herbicide use, the relatively small acreage devoted to crops, and the lower rainfall. Most problems associated with herbicide contamination appear to be point contamination related to careless handling, not from field applications.

Farmers are likely to confront more restrictions on herbicide use. Herbicides are likely to be more specific, targeted for a species or family of weeds, good news in the effort to control weeds such as jointed goatgrass, wild oats, wild proso millet, whose biologies are very similar to those of the crops that they infest. More-specific herbicides require more accurate weed identification, which Evans says has been facilitated by the recent publication of a weed identification manual and a
computer program that can identify a weed according to a few of its characteristics.

But perhaps the biggest problem in weed control is that weed scientists are simply overwhelmed. Weeds are at least as biologically diverse as crops, but the biology of weeds has received scant attention, certainly far less than is needed to develop effective controls. But while plant scientists devote years to the study of a single crop species, a beleaguered weed scientist is expected to understand the biology of hundreds of weed species. Evans says harried weed scientists are often hard-pressed to identify weeds and staunch losses for growers, much less develop more sophisticated and environmentally benign control strategies.

Control is even more daunting because races and subspecies of weeds often differ in their susceptibility to controls, especially biological controls. There are, for example, more than 30 species of mustards, with differing tolerances to herbicides. Moreover, the control of some weeds can reduce competition for other weeds, spawning new and perhaps more intractable weedy problems.

Evans isn't all gloom and doom. Techniques such as crop rotation and new competitive crops may alleviate some weedy problems. Still, he is certain that weeds will persist. And so will herbicide use, no matter how farming changes in the foreseeable future.

KG
Jack Evans 750-2242

Initiative Calls for More Support for AG RESEARCH

Spend the interest, not the principle.

Good advice that applies to all kinds of situations, even agricultural research.

A 20-year decline in support has seriously eroded the ability to conduct agricultural research, the cornerstone of an agricultural production and processing system with more than $1 trillion in assets that employs almost 20 percent of the nation's workforce. In effect, the diminished support for agricultural research means we are spending the principle, says H. Paul Rasmussen, director of the Utah Agricultural Experiment Station.

In an effort to shore up the system before it collapses, more than 130 organizations have joined to support the National Initiative for Research on Agriculture, Food and Environment. The initiative calls for an infusion of additional funds for USDA-supported research.

The National Academy of Sciences studied the issue, and recommended $500 million annually in new funding for USDA-sponsored research. In fiscal year 1991, the proposed funding for the initiative is $73 million. Supporters of the initiative call for $200 million in funding for fiscal year 1992, and a $50 million annual increase in funding thereafter until the target of $500 million is reached.

Rasmussen says the additional funding is desperately needed because inflation and increased costs have diminished the research capacity of Experiment Stations at a time when agriculture faces new challenges ranging from pollution to food safety. The initiative is one of the few pieces of federal legislation for agriculture that has widespread support in the scientific community.

You can help. The wider the support for the initiative, the more likely it will be funded. Rasmussen encourages those interested in agriculture to let their elected representatives know of their support for the initiative. Enthusiastic support by farm and commodity organizations is particularly important.

The initiative supports research in natural resources and the environment; nutrition, food quality and health; processes and new products; markets, trade, and policy; plant systems, and animal systems.
From the Gulf of Mexico to Canada, not much stands in the way of Russian wheat aphids. There is, however, a pocket of resistance in a field near Lehi that researchers hope will eventually spread to the rest of the country.

USU researchers are also determining where the aphids lurk during late summer between their attacks on grain fields. These "bridge hosts" might explain why infestations fluctuate.

The tiny aphids have feasted on wheat and barley fields since they arrived in southern Texas less than a decade ago. Their spread has been aided by the lack of native enemies and their ability to take refuge in the curled leaves of infested plants, where they are shielded from pesticides.

The aphids apparently can't overwinter in northern Utah, but are blown in by the wind. One puzzling aspect is the spotty and unpredictable nature of infestations.

USU entomologist Frank Messina is studying how aphids fare on some native and introduced grasses. Aphids may head for these grasses, which are related to wheat, in the interval between grain harvest and the emergence of fall-planted grain.

A lush grass may initially limit the spread of the aphids. Aphids produce a winged form (alatae) that colonizes other sites when they infest low-quality plants or are overcrowded. Wingless offspring produced when aphids infest better quality grasses are less likely to travel far, Messina says. It's not yet certain how these grasses affect populations, or which attributes of the grasses that attract (or repel) aphids.

Messina monitors changes in aphid population on plots of six grasses--five native or introduced grasses commonly planted on rangelands and acreage entered in the Conservation Reserve Program (Indian ricegrass, bluebunch, intermediate and crested wheatgrasses, and Great Basin wildrye) and a new variety, of grass (Snake River wheatgrass). He will also determine how factors such as simulated grazing and irrigation affect the suitability of the grasses to aphids.

So far it appears that grasses differ in their attractiveness to aphids, Messina says.

The aphid lacks natural predators, but thousands of predators lie in wait in a field west of Lehi in Utah County. The Plant Protection and Quarantine Division of the USDA's Animal and Plant Health Inspection Service has arranged for the release of thousands of lady bird beetles (ladybugs) and six species of parasitic wasps during the past two years, part of a national effort to determine whether these predators are useful in the biological control of the aphid. The imported ladybird beetles are smaller than most native ladybird beetles, which lets them enter the curled leaf and attack the aphid, says Alan Roe, with the USU Plant Pest Diagnostic Laboratory who released the predators and monitors populations at the site. The parasitic wasps lay eggs in the larvae of aphids.

It's hoped that the aphid predators will gain a foothold and spread, thus providing a resident defense against the aphids.

KG

Frank Messina 750-2528
Alan Roe 750-2435
Our Idea of Comfort May Differ from Those of Race Horses

Many animal rights advocates insist that livestock are better off when they have more space and freedom to roam. However, roomier accommodations didn't seem to make much difference to race horses.

Providing race horses with more space didn't make them run faster nor did they really utilize the additional space when it was available, says USU animal scientist Larry Slade.

"Theoretically, a horse that is comfortable and not stressed will perform well. The results indicate that we need to be careful when we assume that animals will prefer more space because we do," Slade said.

Slade studied the performance and behavior of 3-year-old American Quarter Horses that were housed in large stalls (260 square feet) and in conventional stalls (144 square feet). Some horses from conventional stalls were also turned out into adjacent 1-acre paddocks for 4 hours daily.

The horses had been conditioned to racing fitness before the project started. Training continued during the study.

The horses ran slower when they were housed in the larger stalls or when they were turned out in paddocks. None of the horses showed signs of stress under any of the living conditions studied, Slade says.

He notes that race horse trainers prefer to have animals get their exercise during training and don't encourage "extraneous" exercise.

Horses usually stayed at one end of the larger stalls and simply stayed near the gate of the paddock until it was time for them to be let back into their stalls.

"We think of horses as majestic, running creatures," he said. "But they appear to prefer not to have to get out and hustle grass when they can be secure in a stall and be fed hay.

"Housing configurations for horses have ranged from sharing space in the tents of Bedouin masters, to stalls in the cold climates of Icelandic farms, to large elaborate and luxuriously maintained box stalls for Kentucky racing champions," Slade notes. "As long as the living space is maintained in a clean and safe manner, horses appear to do well in many types of living accommodations."

_LH_ Larry Slade  750-2152
Studies Show
Zinc Sulfate Beneficial in Treatment of
MACULAR DEGENERATION
Macular degeneration, the leading cause of vision loss among humans 25 years or older, has become more prevalent as the proportion of elderly increases. Until 1939, only 130 cases were reported in the literature. It is now estimated that macular degeneration afflicts 12 percent of those over 55 years of age.

Zinc is an essential element necessary for the normal function of more than 100 enzymes in the body, and the eye contains the highest concentration of zinc of any tissue. Several studies involving both humans and swine indicated that zinc deficiency was related to macular degeneration.

For those reasons, USU cooperated in a 2-year epidemiological study involving 151 people (95 women and 56 men) to determine the role of oral zinc on the etiology, prevention and/or control of macular degeneration.

Most of the participants, all of whom suffered from macular degeneration in one or both eyes, were from Utah and Idaho, where many families maintain detailed genealogical records. This facilitated efforts to determine whether genetic factors appeared to influence susceptibility to the ailment. (Those suffering from other ailments such as diabetes that might interfere with the evaluation were excluded from the study.)

One-half of the participants received 100 mg. of zinc sulfate daily; the others received a placebo.

Results of this first study clearly showed that the oral administration of 100 mg of zinc sulfate daily reduced the likelihood that macular degeneration would lead to a decline in visual acuity. However, there was some concern about the possible side effects (toxicity, anemia, etc.) associated with zinc sulfate. These concerns were addressed in a 3-year follow-up study that involved 121 people who participated in the original study. All participants in the follow-up study received 100 mg. of zinc sulfate daily. Except for the lack of a control group, all the procedures, techniques and materials were identical to those in the initial study.

Results of both of these studies indicate that supplementing the dietary intake of zinc is beneficial in the long-range control of discoid macular degeneration. Susceptibility to the ailment also appears to be hereditary. Zinc sulfate stabilized or retarded the loss of vision and, even more importantly, delayed or prevented the progression of macular degeneration from one eye to the other. A dose of 100 mg. of zinc sulfate daily is non-toxic, therapeutically safe, effective, inexpensive and has no long-term side effects. Zinc sulfate is the primary treatment currently available for discoid macular degeneration.

Comparative studies on the role of zinc are now underway at USU and the University of Florida. Copies of the report, *The Role of Zinc in Macular Degeneration: A 5-Year Epidemiological Study*, are available from N. C. Leone, M.D., 2500 East Las Olas Blvd., Fort Lauderdale, FL 33301. Results of the first study were reported in the *Archives of Ophthalmology*, 106:192-198 (February 1988). The research was supported by the McDonald-Peterson Foundation, Houston, Texas.
RECENT GRANTS AND CONTRACTS

John Keith and Herbert Fullerton, Economics Department, Robert Lilieholm, Forest Resources Department, and Richard Krannich, Social, Social Work and Anthropology Department, have received funding from the Utah Division of Wildlife Resources and the Utah Division of Water Resources for a statewide fishery management and boating survey.

The National Science Foundation is funding a study of the mechanisms of phytotoxin-host membrane interactions by Jon Takemoto, Biology Department.

Don Snyder, Economics Department, is studying Utah farmland assessment valuation. The study is funded by the Utah Tax Commission.

The National Dairy Promotion and Research Board has funded three projects by researchers with the Nutrition and Food Sciences Department. Conly Hansen is developing a formulation for whipped topping using enzyme-treated, dried retentate powder as a base. Don McMahon is studying the manufacture of fermented foods using pre-mixed dry ingredients. Douglas Dalgleish is improving the properties of highly concentrated milks by altering the functional properties of casein micelles.

Darwin Nielsen, Economics Department, is working on the public lands education project with support from the Utah Department of Agriculture.

NEW FACULTY

Michael Collard is research assistant professor with the Animal, Dairy and Veterinary Sciences Department. He earned a PhD in biochemistry from Washington State University and served a postdoctoral at the University of Michigan where he studied spermatogenic gene expression of cAMP dependent protein kinase.

D. Layne Coppock, assistant professor with the Range Science Department, earned a PhD in animal science from Colorado State University and was employed at the International Livestock Center, Ethiopia. His research interests include range animal nutrition, systems ecology/modeling, and international rangeland management.

Jodi Huggenvik joined the Animal, Dairy and Veterinary Sciences Department as research associate in toxicology. She was a postdoctoral fellow at the University of Michigan where she studied the transcriptional regulation by cAMP dependent kinase. She earned a PhD degree in biochemistry/biophysics from Washington State University.

Donald Jensen joins the Plant, Soils and Biometeorology Department as state climatologist and associate professor after having held several positions with the Soil Conservation Service in the western states. He earned a PhD degree in hydrology from USU.

Roger Kjelgren, assistant professor with the Plant, Soils and Biometeorology Department, will be studying water conservation in landscapes. He earned a PhD degree in urban horticulture from the University of Washington and came to USU from the Department of Plant and Soil Sciences, Southern Illinois University.

Billy Smith is veterinarian with the Animal, Dairy and Veterinary Sciences Department. He recently received a DVM degree from Louisiana State University.

Bart Weimer, assistant professor with the Nutrition and Food Sciences Department, a PhD from USU and served a postdoctoral at the University of Melbourne in Australia. He will combine research in dairy processing with Extension duties.
For decades, farmers have applied excess irrigation water—often 30 to 50 percent more water than crops need—to leach salts from the root zone. However, USU researchers have found that it may not be necessary to leach salts for months or even years at a time, which could be an extremely useful water-conserving tactic.

But it’s not quite that simple. A change in one facet of crop production usually means other things must change as well. In this case, farmers need more information—much more—before they can simply turn down the spigot on their crops.

To apply just enough water to meet a crop’s needs without leaching, farmers must accurately determine evapotranspiration (evaporation and transpiration) and must apply irrigation water uniformly, says USU soil chemist Lynn Dudley. That can be costly. Changes in the laws governing the "use it or lose it" concept governing the allocation of water in the West, which encourage farmers to irrigate when water is available, regardless of need, may also be in order.

USU researchers are studying plots irrigated with saline wastewater from a power plant, which contains about 10 times more total salt, 25 times more chloride and 50 times more boron than fresh irrigation water taken from an adjacent river.

Some plots irrigated with saline wastewater haven’t been leached for 14 years, without an appreciable decrease in forage yields. High boron levels caused grain yields to decrease, however.

Some published reports indicated that alfalfa yields should decrease when salinity reaches 2 deciSiemens per meter (dS/m), a measure of electrical conductivity used to determine salinity. (The higher the value, the greater the salinity.)

"Salinity in the upper 2 feet of some of our plots is now 6 to 8 dS/m and has reached 14 to 20 dS/m in the lower soil profile," Dudley says.

USU research suggests that farmers can safely "bank" salt in the lower two-thirds of the soil profile for years at a time. Dudley says the disparities between their findings and the results of other studies that showed a need for frequent leaching probably reflected differences in research methods. Many small-scale studies involved soil of uniform salinity. In fields, however, salinity is seldom uniform in the root zone, so plants can extract water from less-saline nooks and crannies.

Salinity isn’t the only factor to consider, however. Dudley is determining how soil salinity affects plants’ ability to utilize nitrogen. One concern is that high salinity levels in the lower soil profile might prevent roots from utilizing nitrogen, which might increase potential groundwater contamination by nitrates. His research is one of the first attempts to assess the tradeoffs between these factors.

Like many attempts to reduce the inputs required by agriculture, better management will be required before farmers can reduce leaching. Nevertheless, as agriculture is forced to compete with thirsty industries and cities for water, the savings may be worth the effort. The findings are also likely to be useful in protecting the quality of groundwater.

KG

Lynn Dudley 750-2184
IS THERE ENOUGH WATER for Both Farms and Cities Along the Wasatch Front?

Cities and farms along the Wasatch Front are located over aquifers containing billions of gallons of water. How will we divvy up the precious liquid?

Researchers studying the allocation of water in Salt Lake, Davis and Weber counties say less water will be used for agriculture as more water is needed to slake the thirst of cities. Any reductions in agriculture's share of water--both surface and groundwater--reflects a disparity in economic clout:

Municipal and industrial users can usually afford to pay about 10 times as much for high-quality water as farmers.

Farms in the region won't be parched, however. Substantial amounts of irrigation water will be available as land is converted from agriculture to other uses. Some farmers can trade their rights to high-quality water for lower quality water, which is already occurring. Others will make more efficient use of water. (Analysts estimate

Aquifers in the Salt Lake Valley*

that agriculture uses about 85 percent of available water in the west. This means that reducing the amount of water used by agriculture by less than 20 percent through conservation or other means would double the amount of water available for municipal and industrial use.) Some farming practices, such as irrigation methods, chemical application, and crop rotations, may have to change to avoid contaminating groundwater.

Experiment Station economists Terry Glover and Herbert Fullerton and irrigation/groundwater engineer Richard Peralta are assessing the economic consequences of changes in water use along the Wasatch Front, including those associated with measures to protect the quality of groundwater quality.

So far, it doesn’t appear as if agriculture will be seriously affected if market forces are allowed to guide water allocation.

Agricultural users currently can afford to pay about $10 to $30 per acre-foot (about 326,000 gallons) while municipal and industrial users pay $100 to $400 per acre-foot, says Fullerton. At those prices, water will continue to be diverted to non-agricultural uses, as has accompanied urbanization in Arizona where “water for taking showers and flushing toilets was worth more than growing citrus,” Fullerton says.

"Fortunately, Utah has taken a reasonable approach to allowing the market to work," Fullerton says. Marginal changes in water use, those that don’t affect third parties, have proceeded rather smoothly, unlike in many western states where water-related transactions are mired in a costly legal thicket.

"There are opportunities for a remunerative conversion of agricultural water to municipal and industrial uses," Fullerton says, noting that he identified more than 4,000 official water-related transactions during an 8-year period, which is only "the tip of the iceberg" since many similar transactions that did not involve changes of use or points of diversion weren’t officially recorded.

The Salt Lake area lies over a two-layer aquifer system while the East Shore, an area north of Salt Lake City bounded by the Wasatch Front mountains and the Great Salt Lake that stretches from Farmington to Willard, lies over a three-layer aquifer. The upper, shallow aquifer contains low-quality water and is seldom tapped except for occasional irrigation. The lowest aquifer contains the high-quality water suitable for industrial and municipal use.

Any limits on pumping from the lower aquifer should have little effect on agriculture. One-third to one-fourth of the water used in Salt Lake County is groundwater, and of that amount, only 3 percent is pumped for irrigation. In Weber and Davis counties, about 16 percent of the groundwater is used for irrigation.

Increased pumping will diminish the flow of some artesian wells used for agricultural purposes. Another concern is the risk that the lower aquifer will be contaminated by water from the upper aquifer, Peralta says, which could accompany a decline in the water table.

The water table in the East Shore area in Davis and Weber counties has already declined somewhat as estimated annual groundwater use increased from 107,000 acre-feet from 1964 to 1968 to 117,000 acre-feet during 1969 to 1982. Groundwater levels in the southeastern part of the valley have declined by 5 to 15 feet. Some experts think that removing an additional 65,000 acre-feet annually may cause groundwater levels in some parts of the valley to decline by as much as 40 to 60 feet during the next 30 years, which could exacerbate downward movement of water from the upper aquifer, and lead to modest increases in pumping costs.

Among the risks associated with increased pumping are saltwater intrusion from the Great Salt
Lake and the contamination or drying up of some wells.

State agencies already carefully monitor pumping and the placement of wells. Peralta uses simulation/optimization models to determine withdrawal strategies that will sustain groundwater yields, which can involve conservation as well as drilling new wells, and protecting water quality. Other objectives include maximizing groundwater use, net economic return, and coordinating the use of ground and surface water.

Peralta found that the proper placement of wells should allow pumping to increase by 15 to 25 percent in the Salt Lake County annually without threatening sustained yield. In Weber and Davis counties, it also appears that groundwater removal could increase significantly without affecting sustained yield, although springs, artesian wells and other free-flowing sources of water may dry up, including those that are used for agriculture or replenish wetlands. "It's a tradeoff," Peralta says.

A USU-developed computer program used by Extension and Soil Conservation Service offices in the state, CANDI (Chemical AND Irrigation), considers soil characteristics, rainfall, stream boundaries, irrigation schedules, and other factors to help farmers and rural homeowners avoid contamination of groundwater and wells.

Peralta says water management is complex because groundwater and surface water can't be treated as separate entities. For example, a river may recharge an aquifer in the spring when surface water levels are high. The flow of water may be reversed, however, when surface water levels decline.

The project, which is funded by the USDA's Cooperative State Research Service, also involves Extension pesticide specialist Howard Deer, entomologist Diane Alston, and geographer Doug Ramsey.

KG
Herbert Fullerton 750-2324
Terry Glover 750-2297
Richard Peralta 750-2786
Helping Ranchers Make the RIGHT CHOICES

Many ranchers in the state can claim—with considerable justification—that they already know plenty about low-input agriculture, knowledge that has helped them survive when rangelands wilted and profit margins withered.

And sustainability? No doubt. Just look at the ranches that have been owned by families for generations.

True enough, but USU range economists think ranchers may overlook some important wrinkles in low-input sustainable ranching.

"There are a number of ways that ranchers can improve the management of range livestock," says range economist John Workman. A key to success is making the right choices. Ranchers can't make all possible improvements and should concentrate on those that give the biggest bang for the buck. Many don't.

According to traditional wisdom, herd size is limited by inadequate spring grazing, so many ranchers spend considerable time and money trying to remove that barrier to herd expansion. For example, in a medium-sized herd (100 to 300 cows), it's estimated that increasing the production of spring forage by 10 percent would increase returns by about $250 annually. Grazing two weeks earlier in the spring could save about $550. And increasing both range readiness by two weeks and forage production by 10 percent means a rancher could pocket an additional $1,000.

"At first blush, those sound important," Workman says. But focusing on this barrier may divert attention from more profitable alternatives.

Other studies indicate that increasing the calf crop by 5 percent would increase returns by more than $3,500 and a 5 percent increase in weaning weights could fatten returns by $2,000. Savings would exceed $1,100 if hay production costs could be reduced by 5 percent.

There's no shortage of options—early weaning, breeding replacement heifers to calve as 2-year-olds instead of 3-year-olds, purchasing instead of raising replacements, substituting winter grazing for baled hay, and replacing European breeds with exotic cross-breds are some of the alternatives that Workman and graduate student Scott Evans are examining.

One promising alternative is to bunch-rake hay into small piles or stacks and protect them with temporary electric fences until winter feeding, a tactic that is popular in eastern Oregon and at the Deseret Ranch in Utah.

"Low-input techniques may not differ that markedly from many ranch management techniques that are used now, although we'll be looking for ways to cut purchased inputs such as gasoline, Evans says. However, most range management techniques have been examined in isolation, which isn't of much help when ranchers must select only a few of the most promising ones.

To make choices easier and more logical, the range economists will compare alternatives simultaneously using computer techniques (linear programming) that incorporate constraints, such as
limited acreage and money, that a rancher normally has to consider. A rancher can then identify alternatives with the biggest payoffs.

The findings will be included in a ranch management handbook, one that will also teach ranchers how to use these linear programming techniques on their home computers. One key to better management is better records, Workman notes. The business records required for taxes usually aren't adequate for modern planning.

Choosing the right thing to do is more important than doing things right, Workman adds, paraphrasing an adage coined by another economist.

Few enterprises can match ranching for sustainability and careful use of natural resources. "If managed properly, grazing can occur in perpetuity. Cattle tread softly on the land, utilizing perennial plants and requiring only modest investments in fences and handling facilities," Workman says.

Scott Evans 750-3161
John Workman 750-2541

Training Livestock Could Cut Oil, Pesticide Use

A serious oil shortage could increase interest in a different type of herbicide-free, self-propelled weed control. No gasoline required.

Sheep.

Yes, sheep. They and other livestock could reduce American agriculture's oil consumption and pesticide use, says a researcher who thinks livestock can be trained to control weeds, to avoid grazing sensitive areas along waterways, to avoid eating poisonous plants and to make grazing more compatible with the recreational use of public lands.

Range scientist Fred Provenza says there has been considerable research on how rats and other laboratory animals learn, but few of these findings have been applied to domestic livestock. He is determining whether livestock learn as well as their laboratory counterparts.

So far, the results are promising. For example, some lambs still avoid palatable plants two years after they were taught not to eat them. In Oregon, the U.S. Forest Service is training sheep to control weeds in Douglas fir plantations. A fruit grower in Washington State is trying similar techniques to teach sheep to eat weeds and not nibble on fruit trees.

Federal land managers in the Intermountain West spend millions of dollars annually renovating rangelands so they contain plants that are more palatable to livestock. Provenza says it would be far more economical to train livestock to graze existing vegetation than to change vegetation to fit the tastebuds of livestock.

It may even be possible to teach livestock to reduce grazing on riparian areas along streams and lakes, thus reducing a major source of conflict between ranchers and recreational users of public lands, as well as improving water quality and the habitat for fish and wildlife.

"Some ranchers have really been surprised by what we've done," Provenza says. "As one rancher
said, 'I guess livestock are a lot smarter than we've given them credit for.' Provenza's findings also confirm the observations of farmers and ranchers who notice marked differences in the grazing preferences of livestock.

Provenza is studying several learning regimes, some which involve "averting" livestock to a food by administering a compound that gives them a mildly upset stomach after they consume the food. Other studies involve determining the best ages for learning (young animals learn more readily) and the influence of other animals on learning (a young animal's mother is more influential than its peers).

He is also identifying the natural compounds in plants that deter grazing.

KG
Fred Provenza 750-1604

A Ban on Grazing
Unlikely to Improve Some Rangelands

Are bovine and ovine appetites preventing an ecological renaissance on public rangelands?

Many Americans think so and want to banish cattle and sheep to other pastures. Once livestock nibbling stopped, so the theory goes, native vegetation would flourish, wildlife populations would bound back to presettlement abundance, and the West would green up nicely.

The public may savor this theory but many ecologists don't swallow some of its underlying premises. According to range ecologist Neil West, a ban on grazing would probably aid the recovery of native flora and fauna on some resilient rangelands such as riparian areas (which would also probably recover with properly managed grazing). In many other areas, however, the absence of livestock would hardly be noticeable...or it might be detrimental.

Range scientists decry overgrazing but note that the culprit has usually been poor management, not livestock per se. Many critics don't make the distinction. The view of livestock as despoilers seems to be gaining strength in spite of evidence that livestock are ecologically useful substitutes for pesticides, bulldozers and fire employed in modern rangeland management.

Many rangelands where a bleat or a bellow never again reverberated could become weed-choked, eroded wastelands with starving wildlife.

"Many environmentalists mistakenly view wildlands as obeying the rules of a zero-sum game in which there must be clear losers for every winner," West says. In other words, any gains by livestock supposedly are accompanied by proportional losses to other organisms.

Another prevalent misconception is that ecosystems are stable and reflect a natural balance. West characterizes this view as "folklore that most modern ecologists have abandoned." Conditions on rangelands were not stable before livestock were introduced, so it's fruitless to try to revert to some mythic period of ecological stability. "This makes it more difficult to promulgate regulations, but it illustrates the need for a much more flexible and opportunistic style of management," West says.

Many other changes accompanied the introduction of livestock, a fact which often makes it difficult to decipher which changes were solely due to livestock. For example, the period from 1500 to 1900 has been characterized as a "little Ice Age," a period much wetter and cooler than this century, which fostered other kinds of plants. Thus, some of the changes in vegetation may be due to climate rather than livestock. And while poor management of too many livestock resulted in excessive grazing, some of the massive erosion during the 1880s and...
1890s was inflicted by the deluges and winds associated with unusually huge thunderstorms. The elimination of wildlife predators and the removal of Native American populations were also "unnatural" changes whose consequences are often overlooked.

Today, global climatic change and other man-induced changes have nudged rangelands in a manner that may make it impossible to regain the so-called pristine conditions prior to the 1800s. And it may be impossible to undo some of the changes caused by grazing simply by ceasing grazing.

The real issue, West says, is proper management to protect the environment, chiefly soils, which will continue to be an issue with or without grazing. Unfortunately, a ban on grazing would eliminate one of the most effective management tools left to managers.

Abundant moisture and nutrients in riparian areas, among the areas that have been seriously affected by overgrazing, means they quickly recover from grazing. The beneficial effects attributable to a lack of grazing would be less apparent or negligible in drier regions at higher altitudes.

On pinyon-juniper rangelands, for example, removing livestock would have few beneficial effects, in part due to the longevity of junipers (up to 2,000 years) and and pinyons (up to 500 years). Grazing reduced competition from herbaceous species, thus making more nutrients and other resources available for shrubs and trees, which are photosynthetically active most of the year. The resulting shift in vegetation didn't change the fundamental productivity of the land, but did increase the production of unpalatable biomass.

It may not be possible to easily reverse these changes, however. On some rangelands, one of the worst courses of action is to simply let nature take its course.

For example, removing livestock from rangelands dominated by large, woody unpalatable plants would not mean a return of the fire regime that once reduced woody plants but maintained herbaceous plants. West says livestock removed the fine, uniformly spaced ground cover that provided fuel for ground fires every 25-50 years. Unless livestock continue to remove fuel, the introduced annuals that are now found on most rangelands and woody plants would fan intense summer firestorms, resulting in temperatures hot enough to sterilize the soil surface and conferring an advantage to rapidly germinating plants, including nefarious invaders such as cheatgrass, red brome and mustards. Without reseeding, "a spiral of degradation" would start as strong winds and rainfall eroded bare soil in mid-summer, further damaging the land's ability to recover.

"Under these conditions, removing livestock would mean a loss of the ability to manage land for other values," West says. Livestock are a much more dependable range management tool than fire and have become increasingly important as more restrictions are placed on the use of chemicals and mechanical treatments.

Letting nature take its course also didn't heal rangeland near Tintic that had been seriously overgrazed several decades ago. Even on pastures that had not been grazed for 13 years (during one of the wettest periods of the century), sagebrush continued to flourish and perennial grasses had not increased.

"Sagebrush can live up to 100 years, which allows them to control space and resources," West says. Unless managers intervene, sagebrush would continue to dominate. Even without grazing, the depleted seed reserves meant that the herbaceous plants removed by overgrazing did not automatically reappear. (After the study was
completed, a wildfire converted the area to near-solid cheatgrass.)

"If we remove livestock from arid and semi-arid uplands, there will not automatically be a flush of the original herbaceous species. Rather, there's likely to be a flush of introduced weeds. And if fire removes woody plants, more weeds are likely to grow, followed by more fires and even greater erosion," West says.

Many of these weeds remain green for only about 6 weeks every year and are of little value to wildlife. They also crowd out the palatable shrubs that wildlife rely on for protein during the winter.

"Wildlife supporters are among the most vocal opponents of livestock grazing, but wildlife will be among the most seriously impacted if livestock are removed," West says. He cites the work of USU range scientist Phil Urness who has developed management regimes in which livestock prevent the buildup of fuel that would eventually favor fires that would kill the vegetation preferred by elk and other wildlife along the Wasatch Front.

Range scientist John Malechek says some may have overstated the evidence that grazing has beneficial effects on an individual plant, but it's clear that grazing can have beneficial effects on a plant community. "Most of the grass species developed under grazing by ungulates. It probably doesn't make much difference what type of animals does the grazing. What is important, however, is management. Livestock are usually confined while wild ungulates usually move after grazing." He notes that overgrazing by elk and bison in Yellowstone National Park, which has reduced the shrubs favored by moose, whitetail deer and mule deer, demonstrates that livestock are not the only source of overgrazing.

"Grazing can be natural or unnatural, harmful or beneficial, depending on the circumstances. Everyone agrees that we need to avoid overgrazing."

Malechek says. "But there's excellent evidence that carefully managed grazing is compatible with an improvement in range condition."

When Americans are asked to choose between extra hamburger or unspoiled wilderness, it's no surprise that they opt for nature, or what they think is natural. But grazing is not natural. Livestock have been on some rangelands for more than century, long enough for grazing to have become part of the natural scheme of things. It can also be beneficial.
Saving Endangered Plants While

**STOPPING GRASSHOPPERS**

When grasshoppers pillage rangelands, the fate of the dwarf bearclaw poppy and the silver pincushion cactus might hang in the balance.

Insecticides used to control grasshoppers may be the problem. The poppy, the cactus and dozens of other plants in Utah such as toad-flax cress and Jones cycladenia are on the brink of extinction. Insecticides that decimate pollinators along with grasshoppers could mean the irretrievable loss of these species.

Researchers are trying to determine which of these threatened and endangered plants depend on insects for pollination. If so, it may be necessary to protect them when insecticides are applied to control grasshoppers, perhaps by creating a "buffer zone" around known plant populations.

The problem is that no one knows how many of these species rely on pollination to reproduce, and, if they are pollinated, how they are pollinated, says Vince Tepedino, research entomologist with the Bee Biology and Systematics Laboratory (Agricultural Research Service) at USU. And it isn't easy to find out.

Simply getting to the plants can be difficult. Some isolated populations are reached only by backpacking to a remote site and camping there for several weeks. Once there, researchers spend hours on end hunkering over plants, mimicking natural pollination and snagging and identifying every insect that visits the flowers.

Since 1988, researchers have been scrutinizing about 20 of the 40 plant species in Nebraska, Colorado, Utah, Arizona and New Mexico that are listed as threatened or endangered. Many of these species are found on federally owned land where insecticides are occasionally applied to control severe grasshopper infestations. (In Utah where the Bureau of Land Management and the Forest Service administer almost 60 percent of the land, 17 plant species are listed as threatened or endangered.)

Each species must be studied for 2 to 4 weeks to determine the type of pollination involved (plants can be self-pollinated, cross-pollinated, or a combination of the two methods) and, if cross pollinated, which insects or other organisms are responsible.

It's painstaking, tedious work. Determining the type of pollination involves four or five treatments, each of which must be repeated 15 to 20 times, in which flowers are caged to exclude pollinators and grains of pollen are transferred by hand from the anthers to stigmatic surfaces. Some plants have such tiny reproductive parts that they must be pollinated under a microscope, no mean feat while hunched over a small plant in the middle of rangeland, forest, or desert.

Plants may present nectar or pollen several
Uinta basin hookless cactus (Sclerocactus glaucus) found on rangeland south of Myton. Pollinated by several species of ground-nesting solitary bees.
times a day, so the insect visitors that are lured to these plants must also be sampled several times a day. "The only way to be sure that all potential pollinators have been collected is to sample when all insects are active, which is usually from sunrise to sundown," Tepedino says. Night collection may be required for a few night-blooming plants.

"Surprisingly, almost all of the 20 species that we have studied so far are pollinated by insects or other organisms such as hummingbirds," Tepedino says. That was unexpected because insect visitation is generally considered to be density dependent, that is, the greater the number of plants of a species, the more insects they should attract.

Theoretically, as the number of these plants dwindled, there should have been a decline in the number of insects that pollinated these plants, thus creating selection pressure for self-pollination. Plants might also become less showy as their ability to attract insects becomes less important.

"This doesn't seem to be happening," Tepedino says. What will happen if fewer pollinators visit plants? No one knows for certain, but it probably won't augur well for the plants. The detrimental effects depend on several factors, including the proportion of pollinators removed, the effectiveness of pollination, the seed bank in the soil, and the life span of a plant.

"We're not talking about sudden elimination but a gradual decrease in recruitment. Short-lived perennials might hang on for decades while long-lived perennials might not be affected for hundreds of years. The situation would be much more critical for annuals and biennials, such as the few remaining clay phacelia found near Spanish Fork," Tepedino says.

The study is part of a larger integrated pest management project to find better and safer ways to control grasshoppers. The project involves several federal agencies and departments, and universities in several states. Those involved in the USU research are entomologist Terry L. Griswold, and graduate students Susan Geer, William Bowlin, Sedonia Sipes and Robert Fitts.

Their findings may aid the survival of the Uinta Basin hookless cactus and the last chance townsendia, two of the plants in Utah listed as threatened and endangered. Few people know of these plants. The plants' relative obscurity reflects the fact that their precarious existence doesn't conflict with human activity, including, it is hoped, grasshopper control.
Many fruit growers in Utah are already realizing the benefits of integrated pest management (IPM), one of the cornerstones of sustainable agriculture.

USU entomologist Diane Alston estimates that 60 percent of the fruit growers in the state use at least some IPM methods, in which all options—including pesticides when necessary—are marshalled to control pests.

Those who equate "low-input" with loafing and letting nature take its course had better not plan on growing fruit.

"I think there was a misconception that low input meant a reduction in labor and management. The opposite may be true. Sustainable agriculture may mean more labor-intensive management," Alston says.

Sustainable agriculture also requires information—and lots of it.

Many of the concepts encompassed by sustainable agriculture are nothing new, just variants of practices that frugal farmers have honed over the decades. Other practices reflect new research findings and add a new dimension to agriculture.

"Farmers have been practicing sustainable agriculture since agriculture began," Alston says, although some of these techniques were abandoned during the 1950s and 1960s when new pesticides encouraged growers to rely almost totally on chemicals to control pests. Hindsight has clarified the dangers in that approach—insecticide-resistant pests, disruption of the ecological balance in orchards, consumer concern over pesticide residues, and increasing costs. Increasingly, growers are finding that IPM makes good business and ecological sense.

Some people associate IPM with field crops such as grain and are somewhat surprised by the success of IPM in fruit production, considering growers' reliance on pesticides. Alston says the reliance on pesticides is one of the reasons why fruit production is well suited to IPM. Another major factor is the ability to encourage resident populations of beneficial organisms in the perennial fruit crops.

During an average year, a grower may apply pesticides four to six times per season. When pest infestations are worse, an apple or pear grower may use as many as three applications of acaricides to fend off mites, three to five applications of fungicides, and as many as three applications of antibiotics to ward off fire blight, in addition to three or four insecticide applications that are usually required to control codling moth.

That's a lot of pesticide applications, but Alston says Utah growers rely far less on pesticides than growers in many other midwestern and eastern
states where high humidity favors the organisms causing apple scab and other diseases. Nonetheless, many growers in the state have gravitated to IPM, and no longer spray according to a fixed schedule but monitor insect infestations and weather conditions before spraying, and take advantage of beneficial insects and other allies.

One of these growers is Rey Allred from Payson who has used IPM techniques on his 400 acres of tart cherries, peaches and apples for six years. "We're doing less spraying and spending less time spraying. Things have appreciably changed," he says.

Family members spend about six hours a week scouting and monitoring insect and disease infestations on strategically located blocks, ranging in size from an acre to 40 acres.

The most spectacular savings have been realized in mite control. Allred says they previously
used heavy applications of acaricides to kill all mites--and--unfortunately--wiped out beneficial predators as well. In contrast, this year they applied two light applications, enough to kill only immature mites, and have sprayed only 20 of 106 acres of apples. Monitoring infestations also lets him carefully target areas for spraying, which could be a few acres, a border or a few rows. "The spraying schedule is more complicated but the savings are tremendous," Allred says. In addition to spending less on pesticides, he saves wear and tear on spraying equipment (each sprayer and tractor represents an investment of $25,000 to $35,000).

The reduction in pesticide residues on fruit has been an "intangible" benefit that so far hasn't resulted in higher prices, although Allred notes that some buyers now require records of spraying or test fruit for pesticide residues.
Alston says growers should be able to reduce the number of pesticide applications to control secondary pests such as mites, aphids, leafminers and leafhoppers. These pests usually attack foliage and tend to feed where they are vulnerable to attacks by natural predators such as predatory mites, ladybeetles, and parasitic wasps. It is more difficult to avoid spraying to control insects that directly attack fruit, however.

An IPM program considers all factors that affect insect, disease and weed management, including the surrounding environment. Some types of groundcover harbor beneficial insects and other organisms that help control pests. Research is clarifying the value of the right type of groundcover.

For example, Alston found it was necessary to spray to control mites in orchards where ground vegetation covered less than 15 percent of the orchard floor but not in orchards where vegetation covered 20 to 100 percent of the orchard floor.

The type of groundcover is also important. Grasses tend to keep out weeds such as field bindweed and morning-glory that harbor spider mites. Simply relying on native vegetation (as many growers do) may result in weeds that provide refuge for insect pests. (However, a grower who eliminated mite-infested bindweed at the wrong time might encourage mites to migrate up into fruit trees. Under some circumstances, it might be better to delay bindweed control until trees are less susceptible to damage and weather conditions aren't conducive to mite outbreaks.)

Timing of pesticide applications is critical. The goal is to apply pesticides when insects are vulnerable and when the damage they inflict exceeds the costs of control—the economic threshold of injury. Growers in the state rely on computerized weather models developed at USU to monitor the stages of insect development and to predict when pesticide applications are necessary.

USU researchers are also developing simpler monitoring methods, in part because most orchards in the state are family-operated enterprises in which family members, not commercial firms, handle scouting. “These people can’t spend hours every day to sample an orchard block,” Alston says. Pheromone traps, which lure insects with scents, are now in widespread use to monitor populations. USU researchers have also developed an easier method of sampling mites. Instead of counting tiny mites, growers simply determine the number of leaves that are infested, and refer to a table to determine whether mite infestation warrants control.

A computerized data base to help growers identify the weeds, insects, mites and diseases is being developed by USU Extension horticulture specialist Tony Hatch.

Alston says the emphasis on sustainable agriculture is fostering closer ties between growers, land-grant universities, and the Extension Service simply because growers need more help interpreting and applying information. It is also encouraging the flow of information between disciplines.

Low-input sustainable agriculture probably won’t mean that growers abandon pesticides and other chemicals, if for no other reason than “organically grown” fruit tends to cost about twice as much as conventionally grown fruit. Nonetheless, growers remember how demand for apples plummeted following the "Alar scare" and are anxious to avoid a similar episode.

Consumers who prefer fruit grown in pesticide-free orchards can expect to pay higher prices for blemished fruit. Some think it’s an acceptable tradeoff.

Others don’t. In Utah, many growers are trying their best to protect fruit and reduce pesticide applications. And most have been remarkably successful.
Study Weighs Advantages, Disadvantages of Sod in Orchards

In fruit production, vegetation (or lack of it) on the orchard floor often affects what happens in tree canopies. A USU researcher is assessing how different types of orchard floor management systems affect fruit yields and quality.

Sod is one alternative. A mantle of sod on the orchard floor has several advantages, says plant scientist J. LaMar Anderson. Sod curbs soil erosion, reduces compaction by heavy equipment, and allows access to the orchard early in the season and during wet weather. A sodded orchard is also cooler in the fall, which can improve the color and quality of apples.

However, cooler temperatures in sodded orchards can increase the danger of freeze damage in the spring, as happened several years ago in an experimental orchard—frost killed blossoms on the lower half of sweet cherry trees in a sodded area but did not affect trees on bare ground. Sod also competes with trees for nutrients and water, and requires the use of sprinkler instead of furrow irrigation.

Most apple and cherry orchards in Utah are located on slopes and are usually sodded to reduce erosion. Erosion control is probably the biggest advantage associated with sod. Where possible, growers in the state often eliminate vegetation from peach orchards, which are more tolerant of warmer temperatures associated with bare ground.

Even though growers are familiar with the advantages and disadvantages of sod, it’s not known whether some types of cover crops may be better than others. Anderson is studying several different types of cover crops, including grasses and legumes, as alternatives to the Kentucky bluegrass sod or native vegetation used in many orchards.

One study involves the performance of sour cherries on two types of rootstocks. Some plots were seeded with varieties of perennial ryegrass or red fescue, two grasses that are included in a popular orchard mixture. To determine the relationship between vegetation, tree growth, and cherry yields, Anderson removed vegetation from a 1-square meter area around the trunk or from a 1-meter-wide strip down the row. On other plots, trees were located in areas where all vegetation is removed, either by cultivation or with a herbicide (glyphosate).

Trees are 5 years old. Last year, yields were not assessed due to frost damage, but yields will be compared this year. So far it appears that the tree growth (as determined by trunk diameter) was proportional to the amount of vegetation that had been removed around the tree, apparently because there was less competition for water, Anderson says.

Sour cherry trees on plots where vegetation had been controlled with glyphosate had a diameter of 4 1/2 inches while trees on plots where sod had been allowed to grow next to the trunk had a diameter of 3 1/4 inches. Trees started in sod would eventually become are large as those grown on bare

Sod curbs soil erosion, reduces compaction, and facilitates access to the orchard but it also increases the risk of frost damage and competes with trees for nutrients and water.
ground, but growers would reap smaller yields for several years until that occurred, Anderson says. For that reason, he doesn’t recommend putting in sod until trees are well-established, about two years after planting.

This year, cherry trees on sodded areas bloomed about three days later than trees on bare ground, Anderson says, another factor that could be important. There were similar differences in blooming between the type of rootstocks.

Legumes might be satisfactory as cover crops, but Anderson says there’s a tradeoff involved. The nitrogen that legumes fix is beneficial early in the growing season, but not when fruit matures since it encourages vegetative growth, which delays the maturation of fruit and harms fruit quality, resulting in apples with poor color and keeping quality, for example. Legumes, especially conventional alfalfa varieties, usually harbor more insect pests such as mites and diseases than do grasses. (Deep-rooted conventional alfalfa varieties also compete more effectively with trees for water.)

Among the legumes Anderson is testing are berseem clover, dwarf English trefoil, and Australian subclover, annual legumes that reseed themselves. The subclover hasn’t seemed to fare well during the region's cold winters.

Entomologist Diane Alston is determining the number of insect pests and nematologist Gerald Griffin is monitoring nematode populations in the various types of cover crops. Alston is also determining whether cover crops compete with trees for the pollinators that are essential in fruit production.

A Program to Avoid Harmful Residues in Beef

Cattle producers in the state are participating in a program to make sure beef remains free of harmful residues.

The voluntary Beef Quality Assurance program "may be the most important project cattle producers can undertake in the next decade," says Norris Stenquist, USU Extension livestock specialist. He notes that a food safety scare could seriously jeopardize consumers' favorable views of beef, much as the concern about Alar residues caused sales of apples to plummet.

Similar Beef Quality Assurance programs have been implemented in 17 states. The program involves keeping accurate records concerning the use of all drugs, antibiotics and other products, selecting the proper injection sites, and rigorously observing proper withdrawal times.

Stenquist says the program is supported by the Utah Cattlemen's Association, other producer groups and pharmaceutical firms. Provisions of the program are being explained at meetings held around the state.

"There are no shortcuts when it comes to assuring the safety and wholesomeness of beef," Stenquist says. "Food product safety is not an option. It is the key to survival."