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Seeking a Turn-around for Cancer

Stephen J. Kleinschuster

Despite millions of dollars (and hours) invested in research, cancer continues to increase dramatically within the human population. One major reason researchers are having minimal success in combating the disease has been the lack of suitable animal models in which to observe tumor systems and experiment with cancer’s manifestations. But we now have an excellent chance of eliminating this particular constraint.

In 1974, I became intrigued with the potential of using bovine “cancer eye” (ocular squamous-cell carcinoma) as a model for the study of human carcinoma (the kind of cancer that most commonly attacks breast, colon, skin, lung, bladder, or any other site having epithelial tissue). Prior to that time, cancer eye had been of interest primarily to stockmen who were annually absorbing millions of dollars in losses because of the cancer’s effects on their mature, fully-proved breeding cows. Since the problem was viewed as a local economic problem, the available literature holds little scientific data about the biology of cancer eye. This gap in our knowledge is aggravating, but it does not negate the potential value of cancer eye as a model with which to evolve immunotherapeutic procedures that will be effective against human carcinomas.

Why Turn to Cattle?

Current practices in human cancer immunotherapy are of necessity based on nonuniform accounts of individual case histories as well as data from laboratory experiments with rodents. The case histories are frequently more subjective than objective, and rodent experiments tend to produce results of questionable validity for several reasons. Generally, experimental rodents are unrealistically inbred and are almost always young, healthy adults. The tumors studied are usually either chemically induced or transplanted cell lines (neither of which produce benign precursors). The cancers are normally sarcomas (involving connective tissue) rather than carcinomas, and they are characteristically slow to metastasize (seed-off elsewhere in the body).

In contrast to the rodent models, the human population is outbred and cancer primarily afflicts the older individuals. Additionally, human malignancies are mostly naturally-occurring carcinomas that often have a benign precursor stage, and rapid metastases are the rule rather than the exception.

Unfortunately, the existing approaches to human cancer immunotherapy (which include: 1) its use in cases of advanced cancer only after other forms of treatment have failed; 2) multiple treatments with immunologically active agents that are safe if given once, but potentially lethal when given more than once; 3) administration of those agents by routes that have been noncurative in laboratory animals; 4) arbitrary modification of procedures in the course of a case) may be mostly inappropriate.

Various reasons support the hypothesis that by using cattle cancer eye as a model tumor system, it should be possible to
develop valid, data-based procedures for treating human carcinomas. Bovine ocular squamous cell carcinoma lacks all the disadvantages of the rodent models, while fulfilling many of our exacting requirements for a tumor system which duplicates many of the human disease characteristics. The advantages of the bovine tumor system include: 1) the size of the animal, which allows the taking of large samples of tissue and quantities of blood without adverse effects; 2) the long life span of the animal, which permits adequate follow-up studies; 3) surgical techniques and drug doses that resemble those used in humans; and, most importantly, 4) the lesions readily metastasize, and are naturally-occurring carcinomas which develop and grow slowly in an outbred strain of animals, exactly as in the human situation. Additionally, cancer eye goes through defined precursor stages, and the location of the lesions facilitates observation and experimentation with minimal stress for the animal.

First Experiments

In 1975, in conjunction with Herbert J. Rapp, Director of the Laboratory of Immunobiology at the National Cancer Institute, a series of experiments with Hereford cattle was initiated to test some of our hypotheses.

Because of its “track” record, we used a derivative of a bacterium called BCG (Bacille Calmette-Guerin) to try to stimulate the immune systems of the cows to reject their cancer eye tumors. Europeans have long used attenuated BCG as a prophylactic agent against tuberculosis, and they noted serendipitously that the leukemia rates among those receiving the injection were lower than among those who did not. This observation led to other studies, and finally to one in which Dr. Rapp demonstrated that BCG, as the sole treatment, could cause regression of malignant tumors as well as eliminate regional lymph node metastases. Live BCG, however, can cause tuberculosis in mammals, so in our experiments we used a non-TB producing vaccine consisting of dead BCG cell walls compounded in mineral oil, which, in turn, was suspended in a water emulsion.

The 42 Hereford cattle used in the experiment were obtained at random from various ranchers and sales barns and were divided into 3 experimental groups. One group of 24 received BCG vaccine (study animals); the second group received a “fake” vaccine (controls); the remaining animals received no treatment whatsoever (untreated controls). The tumors were matched according to size and location. Each tumor in group 1 and 2 animals was injected once, intralesionally, with

Figure 1. Regression of bovine ocular squamous cell carcinoma of nictitating membrane and lacrimal lake after treatment with active BCG vaccine: A) day of treatment, B) 1 wk, C) 2 wks, D) 4 wks, E) 12 wks, and F) 64 wks after treatment.
either 0.25 cc of BCG vaccine or the placebo per each calculated 1.0 cc volume of tumor.

Of 24 animals in the group receiving BCG vaccine, 17 (71 percent) responded to treatment. At the end of the 18-month experiment, 7 of the 24 were free of visible tumor, 2 had tumors that were regressing and 8 evidenced arrested tumor growth (Figures 1 and 2). The time lag before initial response varied widely among the animals, but the response process was virtually identical in all cases.

We first saw an inflammation that persisted for up to 3 weeks. When that subsided, the tumors began to regress. During the regression stage we saw no signs of tissue necrosis (death). The tumors simply shrank. None of the 18 animals that had been divided between the sham-treated and untreated control groups showed any signs of tumor regression.

Figure 2. Regression of bovine ocular squamous cell carcinoma of lateral corneoscleral junction after treatment with active BCG vaccine: A) day of treatment, B) 2 wks, C) 8 wks, D) 11 wks, E) 13 wks, and F) 31 wks after treatment.

Current Work

Experiments now in progress at USU are comparing the therapeutic usefulness of local surgery versus intralesional injections of the BCG cell-wall vaccine. Historically, in cases of human cancer, surgery has routinely been the first therapeutic choice. If BCG is used at all, it is usually tried only following normal surgical procedures. Our experience with cattle (and guinea pigs) indicates that this is too late. To exert its beneficial effect, the BCG must contact the main body of an actively growing tumor prior to any surgical disturbance.

We are hoping that our present and subsequent series of experiments will clarify whether BCG can be used as a primary therapeutic agent against certain human cancers. The work should also prove whether, if surgery is indicated, it should be performed following BCG therapy and not before. Our suspicion is that, in at least some cases, the BCG may do the job on its own. In cases requiring surgery, however, we'll have to know how much time it takes for the BCG to adequately program the body's immune system to reject any potentially malignant cells that evade surgery.

Based on our results to date, the BCG approach is being tried by a European consortium (in collaboration with the USU group) on certain human head and neck cancers. The first cases have apparently responded very well.

Other Possible Models

At USU, we are also investigating whether equine malignant melanoma (pigmented skin...
cancer) can be used as a model for the study of human malignant melanoma. The equine disease, which commonly attacks older white horses and mules, is remarkably similar to human malignant melanoma. Cancer eye and equine melanoma are both naturally occurring tumors with benign precursor lesions. Our research group is the only one to have initiated immunotherapeutic trials with afflicted horses and mules. Our early results with BCG cell-wall vaccine have been very encouraging.

Bovine lymphoma (leukemia) may also be suitable as a model for the comparable human disease. Our efforts in this regard are currently concentrated on acquiring enough animals to allow us to run pilot experiments.

As previously mentioned, our largest obstacle is the lack of scientific literature and data concerned with the basic biology of all 3 diseases. It is extremely difficult to perform therapeutic trials and clinical research while at the same time studying the basic biology of the disease which one is attempting to cure.

Before we can optimize our progress toward developing immunotherapeutic agents and clinical procedures for the treatment of human carcinomas, we must first more thoroughly understand the basic biology of these tumor systems. The start has been made and the potentials are obvious, but the speed with which they can be realized will be proportional to the resources afforded us.

Stephen J. Kleinschuster is Associate Professor, Department of Animal, Dairy, and Veterinary Sciences, USU.

Comparative Medicine: A Source of Insights

Lois M. Cox

Genetic diseases do leave tracks. The following and deciphering of those tracks, however, can be exceedingly difficult and time consuming. And the time lapse becomes especially frustrating to investigators as they see family groups affected by crippling handicaps and untimely deaths.

Hereditary multiple exostosis (HME) is one such disease. HME, which causes disfiguring and disabling malformations in growing bones, has a remarkably ancient record. Typical lesions have been confirmed in vertebrate fossils from 130 million years ago. The occurrence of HME malformations in human beings however, was first officially noted in 1814. Over the years, the disease has been described in horses, dogs, domestic cats, lions, and lizards. As chance would have it, no one tried using any of these shorter-lived, nonhuman animals as investigative tools.

Then, in 1968, a USU Professor of Veterinary Science, J. LeGrande Shupe, became intrigued by what he saw in a 5-year-old, registered, thoroughbred stallion. The clinical diagnosis was multiple exostosis. Fortunately, owners of the horse were willing to let him be used in a research program that might define what had gone wrong, why, and how.

Elsewhere at USU, Eldon J. Gardner, a geneticist and Professor of Biology, had been engaged in studying and counseling a family that was affected with what appeared to be hereditary bone problems. By 1968, his long-term work had started to indicate a possible pattern of inheritance.
As Dr. Shupe and Arland Olson (Research Associate, Veterinary Science) began to accumulate information about the stallion and his progeny, they also began to compare notes with Dr. Gardner. As Dr. Shupe described the situation, "We gradually became convinced that the horse was a valid, spontaneous medical model of HME in man. By using the equine model, we could track, compare, and confirm phenomena over several generations in less than the prohibitive long time that would be required in human families."

The Lesions

Horses affected by HME often have conical, bony protuberances when they are born. These growths are especially palpable on the legs and ribs. As such horses age, the lesions become increasingly obvious until the horse is approximately 4 years old, when its skeletal growth ceases.

Similarly, lesions in affected human beings can usually be diagnosed early in life, before they are 5 years old. But even when relatives and physicians are alert for signs, the condition is rarely identified before the infant is 12 to 18 months old. The age differential between horses and human beings may occur because the newborn foal has a more fully developed muscle/bone system than does a newborn baby. In people (as in horses) ribs and limbs are common sites of lesions. But pelvis, shoulder blades, and vertebrae are also often involved in human beings. Actually, lesions have been found on all bones (except those of the head) in people and horses.

In both species, the lesions tend to be bilateral in occurrence, and relatively symmetrical. According to Dr. Shupe, "When examined grossly, microscopically in tissue sections, and by x-ray, lesions from both horses and people are remarkably similar (Figures 1a and 2b). We believe this similarity is a prime reason for accepting the horses as a valid model of HME in people."

Figure 1a. The rib from a 4-year-old horse has typical spongy bone tumors (osteochondromas), with a massive one at the left and two smaller ones to the right.

Figure 1b. The portion of a human femur from just above the knee joint has one massive (1) and two small (2), pedunculated tumors (osteochondromas).
Among human HME patients whose records are complete, lesions diagnosed during childhood generally enlarge in a rather haphazard and poorly organized manner until skeletal growth ceases. The USU researchers have seen several recurrences of benign lesions after surgery. Lesions usually do not change appreciably during adulthood, but exceptions do occur. Such exceptions (fortunately infrequent) are a major cause for concern because they may signal that a benign bone tumor is becoming malignant. Most malignancies that have developed in HME cases have been seen during the fourth or fifth decades of life.

Aside from the possible malignant tumor, HME threatens adult human beings with limitations on arm and leg movements and interference with normal muscle action. "Obviously," says Dr. Shupe, "the location and size of the lesions are crucial. When the lesions infringe upon major blood vessels or nerves, they can impair circulation or neurological responses, especially in the arms or legs. Partial paralysis has resulted in some individuals, when their tumors pressed on adjacent peripheral nerves."

In addition, HME affects its victim's mental health. The disease can drastically alter the pattern and activities of a life, particularly when it deforms an arm or leg.

The Genetics

Since 1968 USU's HME stallion has been mated with more than 20 mares, and 18 colts have been produced. Seven second-generation progeny have resulted from intermatings of animals sired by the original...
stallion, providing excellent long-range study material.

As Dr. Gardner put it, "The genetic pattern displayed by the affected stallion (III-1 in Figure 3) and his progeny is that of inheritance involving a single dominant gene (A). Mating III-1 to different mares, all clinically free from multiple exostosis and genotypically aa, produced foals that averaged half free from the trait (aa) and half afflicted (Aa). The stallion was therefore assumed to be heterozygous (Aa) for the disease-inducing gene.

"Data on the second generation horses have further demonstrated both the dominant nature of the gene (A) and the heterozygous genotype of all adequately tested, affected animals."

Karyotype (chromosome) studies are utilizing blood cell cultures of the stallion (III-1) and nine of his descendants. To date, the researchers have found no persistent numerical or structural abnormalities in the chromosomes, but this phase of the investigation is far from over.

The affected human families being studied have also consistently showed a pattern of inheritance (Figure 4) controlled by a single, dominant gene. Some early descriptions of HME in people suggested that the disease was probably transmitted through an unaffected female in one-quarter of the cases that involved inheritance through the mother. Later reports, however, refuted that idea, even though it is acknowledged that a modifying gene or hormonal difference could affect expression of the disease in women. The USU work has indicated a 100 percent

Figure 3. This pedigree chart illustrates the inheritance pattern of equine HME.

Figure 4. This pedigree chart of one of the human families affected by HME shows the same inheritance pattern evidenced by the horses.
gene A effect, with no implication of modifying factors in people or horses. Members of the USU study-group families that do not carry the HME gene (A) have not passed on this serious hereditary condition.

Dr. Gardner also commented that, "some reports of families whose clinical and radiographic examinations have been completed for three or more generations, mention spontaneous cases of HME. Suggested causes include radiation resulting in a gene mutation, severe illness, or certain drug therapies during pregnancies. If we are to gain a true understanding of HME, more of these spontaneous cases must be investigated and properly documented."

Goals for Tomorrow

According to Dr. Shupe and Dr. Gardner, their work has progressed to a stage at which they can calculate risk factors and identify individuals who are not at risk for HME. Their ever-more-detailed genetic studies should eventually identify the chromosome, and perhaps even the area within that chromosome, primarily responsible for triggering HME. Drawing upon their accumulating data, the researchers will continue to offer a fact-based counseling service to members of HME-affected human families.

Simultaneously, the researchers are tracking the sequence of tumor development. They are also comparing the metabolism of normal bones with that of the HME bone tumors relative to elements such as fluoride, calcium and phosphorus. This meticulous work could answer questions of importance to a wide range of bone diseases.

In the tradition of Pasteur and innumerable other scientists, a model provided by a nonhuman animal is once again a key ingredient in efforts to deal with human disease.

Lois M. Cox is Science Writer, Agricultural Experiment Station Publications, USU.

A New Branch Diagnostic Lab

Kent R. Van Kampen and Ross A. Smart

Figure 1. Artist's conception of the new USU Animal Disease Diagnostic Laboratory.
Many livestock diseases can be treated by the owner or veterinarian in the field or barn, but some diseases require isolation and detailed identification of their causes before proper treatment can be started. Such identification sometimes requires observation of specific chemical or pathological changes in the body tissues. At Utah State University, personnel in the Diagnostic Laboratory under the direction of Ross A. Smart, DVM, can take samples from affected animals to diagnose bone and tissue diseases, run tests on their blood and other fluids, and generally check for the presence in the animal of viruses, bacteria, and toxic chemicals from plants or other sources. If worse comes to worse, the USU facility can run gross post mortems on animals to offset further losses.

The original Branch Diagnostic Laboratory in Utah County had been opened in 1941 by Utah State University but with financing which limited future expansion. The construction of Interstate 15 and the Provo on-ramp directly in front of the laboratory added difficult access for patrons to an already-serious space problem.

In 1976, the accrediting committee of the American Association of Veterinary Laboratory Diagnosticians inspected the diagnostic laboratory in Logan and the Branch Laboratory in Provo and then recommended the abandonment of the Provo facility. Because of a recognized need, however, the administration at Utah State University, the Utah County Commissioners, and Utah County Representative, Dave Harvey, decided to cooperate in developing a new laboratory. The facility will be attached to the present animal shelter in Utah County. It will contain several times more square feet of space, and be able to service the disease diagnostic problems of large and small animals in central and southern Utah.

Utah County will finance the building of the laboratory (Figures 1 and 2) and diagnostic work will be handled by Utah State University staff members through funding from the Utah State Legislature.

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Ross A. Smart is Professor, Department of Animal, Dairy, and Veterinary Sciences.
Hows and Whys of Healthy Plants

Neal Van Alfen

There is hardly a plant grown in Utah that doesn't struggle with at least one disease problem.

Economic loss caused by these diseases is difficult to determine. It is estimated, however, that plant diseases are responsible for a loss of 10 percent of the nationwide agricultural production. To Utah growers this would represent a yearly loss of over 10 million dollars. To this can be added the real but incalculable value of ornamentals and home garden crops lost to plant diseases.

Control Potentials

In Utah and other arid states, plant diseases are more subtle than in more humid areas. Pathogens that attack the foliage of plants are relatively uncommon in arid climates. These, of course, are the easiest organisms to see and control since protective chemicals are readily placed on the surface of the leaf. But diseases such as those that produce cankers on trees, attack the roots of plants, grow in the vascular systems of plants and/or are transmitted by insects do not need humid conditions. These diseases, all of which are very common in Utah, are by far the most difficult to control.

Figure 1. Dutch elm disease in a Chinese Elm (foreground). This is one of several plant diseases which is likely to become established soon in Utah. It has the potential of killing most of our American elm trees.
We lack good pesticides that can penetrate the soil or the plant itself to selectively eliminate such pathogens. Control methods for soil-borne, vascular-inhabiting, virus-induced and/or canker diseases are reminiscent of turn-of-the-century medicine. The quarantine sign was then the most effective way we had to limit the spread of diseases that we didn't know how to control. Quarantining sick plants is less than an ideal defense. So, as an alternative, we look for resistance to the invasive disease in the affected plant species.

Obtaining resistance to diseases not amenable to other controls is, however, a difficult task. The procedures have been very effective for some diseases but totally ineffective for others. Even when plant breeders manage to find and to enhance resistance, their job is not finished. In all too many cases, the disease organism soon overcomes the initial resistance factor and a new one must be found. In wheat (and similar crops), for example, the organisms need an average of less than 10 years to overcome resistance. This is dangerously close to the number of years required to develop and release a new resistant species.

The state of Utah currently supports three plant pathologists to do research, teaching, and extension work relative to plant diseases. This small staff means that we have had to be selective about research projects. As a result, we've only been able to activate work on a few of the state's most urgent problems.

**Research Targets**

Pinto beans are an important crop in Southeastern Utah. A root disease of these beans is apparently reducing the yield in our fields by up to 30 percent. Much work has been done on this disease in other bean growing areas, and controls have been developed. Unfortunately we can't transfer these methods to controlling the disease in Utah since we grow our beans under dryland conditions and the methods were developed for irrigated land.

**Utah's unique soil and climatic conditions preclude routine transfer of plant disease research results developed in other parts of the country**

The bean root rot illustrates a number of problems we have with plant diseases in Utah. First, a number of the bean growers are not aware of the severity of this problem. The root rot can actually kill the bean plant, but normally it damages the root system just enough so that it doesn't efficiently extract moisture and nutrients from the soil. Since these plants are grown without irrigation or fertilization, the foliage symptoms of the disease can be confused with the effects typical of water or nutrient deficiencies. Most growers therefore assume that the plant's difficulties are due to water or nutrient stress inherent in the type of culture being used. Without healthy plants to compare with the diseased ones, they have no way of knowing how much the disease costs them each year.

Second, although much research has been done on this plant disease in other parts of the country, our unique soil and climatic conditions preclude routine transfer of those results. Because plant diseases are greatly influenced by environment, disease problems and control procedures inevitably vary with geographic areas. Therefore, we must do much of our own research rather than rely entirely upon that done in other states.

We are currently studying the factors which contribute to the bean root rot problem in Utah. Simultaneously, we are trying to develop controls which would be economically feasible to use under our dryland conditions.

Another disease that we feel has priority for our research efforts is one that affects how long alfalfa stands remain productive. Throughout the state alfalfa stands are going out of production sooner then they should. Bacterial wilt of alfalfa is undoubtedly responsible for the loss of some plants in every field, but another disease, crown rot, appears to be the main culprit. Crown rot gradually destroys the crown of the alfalfa plant. The disease organisms slowly invade the living tissue and, over a period of years, lower production, and eventually kill the plants. Depending upon circumstances, which we currently don't fully understand, an alfalfa field can become nonproductive within 5 years. We are currently working to determine which organisms cause crown rot in Utah, which circumstances and practices favor the disease, and how to control it.

Research projects that have been underway for many years are being continued by two plant pathologists despite their retirement. A mycoplasma disease of sweet cherries has devastated our orchards for many years, at times killing every tree in the orchard.
within a very short time. Bryce N. Wadley initiated a program of breeding sweet cherry trees for resistance to this disease before his retirement. With his assistance this program is being continued.

Another Emeritus professor, Orson S. Cannon, is continuing his research to obtain resistance to the curly top virus in tomato plants. Any homeowner who has seen his tomato plants die one by one in a bad curly top year will appreciate the tomato plants being developed by Dr. Cannon.

**Extension Work**

Until recently the weakest link in the plant pathology program at USU has been our lack of an extension plant pathologist. Currently we have a 1/3 time extension plant pathologist; the position will soon become full time. This scientist will help identify the plant diseases present in Utah and then provide information to farmers and homeowners on the best methods of controlling these diseases. This type of person has been needed for a long time. Many of the diseases listed in Table 1 as having adequate controls are not being controlled in Utah because people are often not aware that their plants have the disease or that there is anything that can be done to control it.

Growers or homeowners who think that they have a plant disease problem should contact their county agents for assistance in identifying the disease and its control. If the county agent is unable to help, he will arrange for a consultation with the extension plant pathologist.

Despite all the work that has already been done in Utah to control plant diseases, many diseases still need attention (Table 1). This is partly due to the diseases that need constant attention (e.g., the rusts, smuts, and bunts of grains), but it is also because new diseases appear with disconcerting frequency. In Utah, individuals working on these plant disease problems include not only our limited plant pathologist staff that is supported by the state, but also retired plant pathologists, scientists in other disciplines, and USDA plant pathologists. Unfortunately, the diseases have been able to outpace our research capacity.

Whether or not they are recognized as such, plant diseases are causing economic losses to Utah’s gardens, orchards, fields, forests, and rangelands. Research is needed if we are to learn how to control these potentially costly although often inconspicuous problems. Utah’s climates, soils, and topographic conditions often preclude adapting results from work done on the same diseases in other areas.

### Table 1. Important Plant Diseases of Utah

<table>
<thead>
<tr>
<th>Disease</th>
<th>Importance</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruit and ornamental trees</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Powdery mildew of apple, cherry &amp; shade trees</td>
<td>Common on some varieties</td>
<td>Easily controlled by fungicide sprays.</td>
</tr>
<tr>
<td>Cytospora canker of fruit and shade trees</td>
<td>Very destructive to peach, cherry, apple, poplar, and mountain ash trees</td>
<td>No good control known</td>
</tr>
<tr>
<td>Fire blight of pome fruits and ornamentals</td>
<td>Can cause the loss of major branches on trees during some years</td>
<td>Can be controlled by sprays</td>
</tr>
<tr>
<td>Coryneum blight of apricots and peaches</td>
<td>Disfigures fruit after rainy periods</td>
<td>Can be controlled by sprays</td>
</tr>
<tr>
<td>X-disease of cherries and peaches</td>
<td>Can result in the loss of whole orchards</td>
<td>No good control — resistant cherry trees being developed</td>
</tr>
<tr>
<td>Crown rot of dwarf apple trees</td>
<td>A significant number of trees die each year</td>
<td>Known controls are not very effective</td>
</tr>
</tbody>
</table>
### Important Plant Diseases of Utah (Cont.)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
<th>Control Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root rot</td>
<td>Can cause loss of a wide variety of trees grown in heavy soils</td>
<td>Control irrigation</td>
</tr>
<tr>
<td>Pear decline</td>
<td>A new disease in Utah that could destroy pear industry</td>
<td>Can be controlled by injecting antibiotic into trees</td>
</tr>
<tr>
<td>Blossom and stem blight of cherries</td>
<td>Appears to be responsible for considerable damage</td>
<td>More work must be done to identify cause of disease before controls are recommended</td>
</tr>
<tr>
<td>Crown gall</td>
<td>Sporadically causes loss of young fruit trees</td>
<td>New biological control methods available</td>
</tr>
<tr>
<td>Peach replant problem</td>
<td>Peach trees do poorly when planted where peaches have previously grown</td>
<td>Soil fumigation helps reduce losses</td>
</tr>
<tr>
<td>Sour cherry yellows</td>
<td>Most orchards over 15 yrs old are totally infected resulting in reduced yields</td>
<td>None known</td>
</tr>
<tr>
<td>Verticillium wilt</td>
<td>Causes occasional loss of maple, ash, catalpa, and various fruit trees</td>
<td>Controls are not very effective.</td>
</tr>
<tr>
<td>Iron chlorosis</td>
<td>A large percentage of trees in Utah suffer from iron deficiencies</td>
<td>Controls available</td>
</tr>
<tr>
<td>Dutch elm disease</td>
<td>Hasn’t been found in Utah yet — but is in surrounding states; could kill all of our American elms</td>
<td>Controls are available — but are expensive</td>
</tr>
<tr>
<td>Aspen leaf blights</td>
<td>Most ornamental aspen trees are affected</td>
<td>Good controls need to be developed</td>
</tr>
<tr>
<td>Vegetable Crop Diseases</td>
<td>Foliage disease — present after summer rains and overhead irrigation</td>
<td>Good control available</td>
</tr>
<tr>
<td>Early blight of potatoes</td>
<td>A sporadic problem on russet potatoes</td>
<td>Use of certified seed and cultural control methods reduce problems</td>
</tr>
<tr>
<td>Potato leaf curl</td>
<td>Serious on some crops (e.g., potatoes, melons)</td>
<td>Resistance available in some crops (e.g., tomato)</td>
</tr>
<tr>
<td>Fusarium and verticillium wilts</td>
<td>Widespread and serious on potatoes</td>
<td>No known effective control procedures</td>
</tr>
<tr>
<td>Rhizoctonia stem canker of potato</td>
<td>In some years results in death or reduced yield in many different vegetable species (e.g., tomato, beets, beans)</td>
<td>Some resistant varieties available</td>
</tr>
</tbody>
</table>

December 1977
Figure 2. Root rot in an apple tree (above) and a rose plant (below). Nutrient and water stress from lack of roots results in the mineral deficiency and dieback symptoms. This is one of Utah’s most common plant diseases.

Neal K. Van Alfen is Assistant Professor, Department of Biology, and Plant Pathologist, University Extension, USU.

### Important Plant Diseases of Utah (Cont.)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring rot of potato</td>
<td>Can be devastating</td>
<td></td>
</tr>
<tr>
<td>Root-knot nematode</td>
<td>Sporadically causes losses in many different types of plants</td>
<td>Soil treatments available</td>
</tr>
<tr>
<td>Powdery mildew</td>
<td>Can reduce yields; some squash and melons particularly susceptible</td>
<td>Can be controlled by sprays</td>
</tr>
<tr>
<td>Pink root of onion</td>
<td>Serious problem for our onion growers</td>
<td>Soil treatments can reduce problems</td>
</tr>
<tr>
<td>Corn smut</td>
<td>Can cause small losses in some varieties</td>
<td>Resistance is available</td>
</tr>
<tr>
<td>Field Crops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snow mold of wheat</td>
<td>Extensive losses in some years</td>
<td>New control methods being developed at USU</td>
</tr>
<tr>
<td>Bunts and smuts of grain</td>
<td>A recurring problem due to the pathogen’s ability to change and overcome a plant’s resistance</td>
<td>Resistant varieties and seed treatment</td>
</tr>
<tr>
<td>Rusts of grains</td>
<td>Same as bunts and smuts</td>
<td>Resistance varieties</td>
</tr>
<tr>
<td>Foot rots of grains</td>
<td>They are common on barley, less so on wheat</td>
<td>Research is being initiated on this problem</td>
</tr>
<tr>
<td>Powdery mildew of sugar beets</td>
<td>Appeared in the state only a few years ago and has been a serious problem since then</td>
<td>Sprays will control this disease</td>
</tr>
<tr>
<td>Curly top of sugar beets</td>
<td>A periodic problem which can result in economic losses</td>
<td>There are varieties with some resistance</td>
</tr>
<tr>
<td>Sugar beet cyst nematode</td>
<td>Utah was the first place this nematode was found and it has been a problem ever since</td>
<td>Soil treatments and some resistance</td>
</tr>
<tr>
<td>Pinto bean root rot</td>
<td>Very serious problem in Southeastern Utah</td>
<td>No known control, research is in progress</td>
</tr>
<tr>
<td>Forage Crop Diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterial wilt alfalfa</td>
<td>Disease is present throughout the state</td>
<td>Resistant varieties must be used</td>
</tr>
<tr>
<td>Phytophthora root rot</td>
<td>A problem in low parts of fields</td>
<td>Some new varieties are resistant</td>
</tr>
<tr>
<td>Alfalfa stem and foliage diseases</td>
<td>Have not been considered a problem in the past, but need reassessment where overhead irrigation is used</td>
<td>None practiced</td>
</tr>
<tr>
<td>Crown rot of alfalfa</td>
<td>Found in most fields over a year old — probably associated with stand decline</td>
<td>Research is being started on this problem</td>
</tr>
<tr>
<td>Stem nematode/alfalfa</td>
<td>Serious on first crop alfalfa in some parts of the state</td>
<td>Resistant varieties are available</td>
</tr>
<tr>
<td>Range grasses and shrubs</td>
<td>Some studies have suggested that serious losses are occurring but no work has been done in Utah on this problem</td>
<td>None practiced</td>
</tr>
<tr>
<td>Ornamental and Houseplants</td>
<td>Homeowners are continually losing plants to disease</td>
<td>Depends upon disease</td>
</tr>
</tbody>
</table>

1Research currently being done on this problem in Utah.
2Research on this problem could result in significant economic savings to Utahns.
You want an eye-pleasing back yard, but you can't afford to hire professional advice! You've already discovered that virtually none of the available gardening books are geared to the demands Utah’s harsh environment places on plants. And knowledgeable advice has proved hard to find among your neighbors. So how do you begin to think about your landscaping project—much less activate it?

Well, living in Utah gives you access to a superb, inexpensive (free) source of information. At The Farmington Display Gardens, located at the crossroads of Highways 89 and 91 (just north of Lagoon), you not only will find information, you can also actually see how newly developed and old standbys among plants respond to Utah conditions.

For approximately 20 years, personnel at the Farmington Gardens have been testing trees, shrubs, flowers and ground covers (that were developed elsewhere) for their adaptability to Utah’s climate and soils. At the same time, they have perfected many of their own special creations. Of all the plants tested, only the best are kept, and these are continually reviewed and replaced if something better comes along.

Besides seeing the ongoing varietal test plots, you can browse around four evolving garden types at Farmington. The gardens give you a chance to see how specific plants look in yard-sized settings (through self-guided or prearranged, accompanied tours, and clearly-labeled plant materials). The display gardens are designated as: mostly annuals, mostly perennials, ground covers, and mostly naturally occurring Utah plants in a dry riverbed atmosphere.

Because the gardens have been a continuing project, visitors can now see trees and shrubs at (or approaching) their mature size. In combination with their varietal trials, the Gardens also are steadily defining the long-term adaptability of various grasses and other perennial ground covers to Utah’s climate.

Doing the Planning

Whether before or after you visit Farmington, as you contemplate your currently naked back yard, your first decision has to be whether you want a formal or an informal effect. Basically, the formal landscape involves sharply defined boundaries and squared corners. The informal approach, which is more popular these days, depends on blurred boundaries and curves. So, if we assume you want the informal effect, a prime objective will be to soften the look of corners—of the yard itself and of your house. Such softening is best achieved with certain kinds of plant combinations.

But before you can begin to choose specific plants, you have some observing and thinking to get out of the way. The kinds of questions you need to answer include:

What kind of soil do you have? Is it the same all through the yard?
Will availability of water be a factor?
Do you need or want large, square-cornered expanses of grass, or can your grass areas be used as flexible components of an overall plan?
Do you have, or are you planning to build fences that will modify light, moisture, and wind exposures?
Are you partial to an "in-a-forest" effect, or would you be more comfortable with a relatively "open" yard?
What about weeding? Would you be willing either to use chemicals or to invest the time needed to keep flower beds attractive?

How much money can you put into plants on an annual, periodic, or one-time basis?
Is attracting birds a factor for you?
What is the direction (and velocity) of prevailing winds in your area?
How heavy will the people traffic be, and how do you want it to “flow” through the yard?

Limiting the Options

By the time you’ve considered all possible planning questions, you’ll know whether you want solid grass in the middle and other plants around the edges, or a jigsaw of grass plots and plantings (Figures 1 and 2). You should also have defined your time and dollar landscaping budgets, and gained a reasonably intimate knowledge of your yard’s idiosyncrasies.

For the sake of illustration, let’s assume that you have an average-sized suburban lot. Your family and life style dictate an informal landscape with an uninterrupted, substantial grassy area for the children’s play ground. Your budget constraints indicate that you need a low-upkeep arrangement, one that can be developed gradually over 3 to 4 years.

It is as you begin to think about choosing your plants, however, that landscaping becomes peculiarly personal. There is no one, guaranteed-results formula that can be applied. Each of us differs in our perceptions of, and reactions to, certain combinations of colors, sizes and textures (whether in plants, or clothes, or furniture, or whatever). Each of us must therefore become individually familiar with the available plant alternatives and then do our own informed choosing.

That is one point at which you may want to visit the Farmington Display Gardens. These gardens provide unique opportunities to see a variety of plants growing in diverse landscapes, which can be a far different experience than seeing them in pots at a nursery. A series of carefully timed visits can also help you understand how the plants develop from juveniles to senior citizens, and how each responds to the seasons. These changes are important factors to consider if you want your mature yard to fulfill your preplanting hopes.

In evaluating flowers for your yard, don’t neglect perennials.

Creating the Landscape

To simplify, we’ll work from a limited list of possible trees, shrubs, and ground covers (Table 1). All of the plants mentioned can be seen at the Farmington Display Gardens, along with others that could be used for the same purposes.

We’ll arbitrarily give your backyard a shape and indicate potential locations for certain types of plants (Figure 1). The crucial point to remember is that these suggestions are not edicts from on high. Each has to be filtered through your personal assortment of likes and dislikes, as well as related to your yard’s characteristics.

Obviously, if you need shade, one of your first-year investments should be in a tree that can do the job. Besides some fast growing deciduous trees, we’ve listed a couple of evergreens that are much slower growing but might be preferable for certain situations.

Your other first-year goal should be to get your yard “framed.” The ground covers, low shrubs (Table 2) and annual flowers (Table 3) can come later. In choosing your framing plants, you’ll want to mix deciduous and evergreen types for a year-round balanced effect. You’ll also want to think in terms of each one’s ultimate size and shape, together with their color compatibilities.

In evaluating flowers for your yard, don’t neglect perennials. Many Utah gardeners ignore all perennials because there are so few that will produce flowers in midsummer under our environmental conditions. But by carefully blending annuals and perennials you can achieve exceptionally beautiful effects. The staff at the Farmington Gardens can give you specific advice as to which “blends” will work in your yard.

Figure 1 and its indicated alternative plants are merely one way to landscape a yard. The same basic dimensions could be used with any number of designs (Figure 2). And even more possibilities will become apparent if you visit the Farmington Gardens periodically through one or more seasons.

Project leaders at the Utah Agricultural Experiment Station’s Farmington Research Unit are Alvin R. Hamson and William A. (Bill) Varga.

Photos by Bill Varga, Karen Tucker and Carol Grundmann.

Utah Science
Figure 1. Example of back yard planting arrangement which can be used as is or flipped over for a mirror image. All shrubs and trees should be planted in the first year except as marked for second or third year.
Plume Cockcomb
Celosia plumosa

Petunia
Petunia species hybrid
A view of splay Gardens

Chrysanthemum
Chrysanthemum montfolium

Lupine
Lupinus hybrid
Homeowners in search of interior decorating ideas visit stores where entire color schemes are brought to life in a display of coordinated furniture. But where can a homeowner in search of landscaping ideas go and see anything more exciting than rows and rows of potted plants?

Easy you say, go visit your neighbors. At times that may work. However, not everyone is endowed with creative neighbors. But everyone does have free access to the display gardens at Utah’s Agricultural Experiment Station’s Farmington Research Unit.

Personnel at Farmington Display Gardens have spent 20 years developing yard-sized
settings of plants suited to Utah's climates and soils. They have information available on annuals, perennials, ground covers, trees and shrubs. In addition to the gardens, there are ongoing varietal test plots.

A potential visitor to the Farmington display gardens, however, would do well to follow the advice in Bill Varga's article and analyze his own landscaping situation before making the visit. Garden personnel are glad to answer questions, and they especially encourage people who are doing serious landscaping to visit the gardens in each of the four seasons.
Figure 2. There are many choices in shapes for the ornamental garden. Focus of interest (splash of color, play area) is signified by X.

Table 1. A limited list of possible trees and framing plants which do well in Utah.

<table>
<thead>
<tr>
<th>Year 1 or 2 Major Trees (in descending order of speed growth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous Mulberry</td>
</tr>
<tr>
<td>Summit Green Ash</td>
</tr>
<tr>
<td>Paper or Canoe Birch</td>
</tr>
<tr>
<td>Norway Maple</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coniferous</th>
<th>Height 40'</th>
<th>Width 15'</th>
<th>Moderately fast growing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austrian Pine</td>
<td>Pinus nigra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorado Blue Spruce</td>
<td>Picea pungens glauca</td>
<td>80'- 100'</td>
<td>20'- 25'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 1 or 2 Framing plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillspire</td>
</tr>
<tr>
<td>Eastern Red Cedar</td>
</tr>
<tr>
<td>Rocky Mountain Juniper</td>
</tr>
</tbody>
</table>

Utah Science
Crabapple  *Malus scheideckeri*  20'  Fall color; rosepink flower in May; dense foliage, upright; dark green foliage
Eastern Redbud  *Cercis canadensis*  25'  Richly green leaves; rosepink flower in May; round-headed
Washington Thorn  *Crataegus phaenopyrum* to 20'  Orange red fall color, white flower, red fruits can persist into winter. Most graceful Hawthorn, least susceptible to fireblight
Thundercloud  *Prunus cerasifera* 'Atpopurpurea'  20' 20'  Purple foliage plum; light pink flower; light, open limb structure
Evergreen snowball  *Viburnum rhytidophyllum* Height approx 10' Width  Evergreen; off-white flowers in clusters 4"-8" across; scarlet fruit that turns black
Fragrant snowball  *Viburnum carlcephalum*  7'  5'  Fragrant white flowers in dense clusters 4"-5"
Common Lilac  *Syringa vulgaris*  10'  15'  Many varieties that differ in flower color and shape

Table 2.  A limited list of possible shrubs and ground covers which do well in Utah.

<table>
<thead>
<tr>
<th>Year 3 or 4 Shrubs</th>
<th>Height</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning Bush</td>
<td>Euonymus alata 4' 4'</td>
<td>Deciduous; slow to medium growth; can give good screening hedge; red leaves in fall</td>
</tr>
<tr>
<td>Euonymus</td>
<td>Euonymus fortunei 'Sarcoxie' 4'</td>
<td>Evergreen; prefers shade to semi-shade; can be used as hedge</td>
</tr>
<tr>
<td>Shrubby Cinquefoil</td>
<td>Potentilla fruticosa 'Gold drop' 2' 3'</td>
<td>Deciduous; green foliage; yellow flowers all season</td>
</tr>
<tr>
<td>Cotoneaster</td>
<td>Cotoneaster salicifolia 'Repandens' 14' 4'</td>
<td>Semi-evergreen; high, arching branches—can be used as screen; pink flowers, red fruits</td>
</tr>
<tr>
<td>Cotoneaster</td>
<td>Cotoneaster divaricata 5'</td>
<td>Deciduous; profuse pink flowers, red fruits; stiff branches spreading from center</td>
</tr>
<tr>
<td>English yew</td>
<td>Taxus baccata 'Repandens' 2'</td>
<td>Red fruits have poisonous seeds; shade loving; spreading</td>
</tr>
<tr>
<td>Firethorn</td>
<td>Pyracantha coccinea 8'-10'</td>
<td>Semi-evergreen; orange-red berries in fall; rounded bush</td>
</tr>
</tbody>
</table>

Low Growing Shrubs

| Tam | Juniperus sabina 'Tamariscifolia' Height 18'-36' | Width 10' | Green to bluegreen; symmetrical spreading; dense |
| Buffalo Juniper | Juniperus sabina 'Buffalo' 12' 8' | Bright green; feathery spreading; shade tolerant |
| Bar Harbor Juniper | Juniperus horizontalis 'Bar Harbor' 12' 8' | Blue-gray, but has red-purple cast in winter; spreading, shade tolerant; fast growing |

Ground Covers

| Spring cinquefoil | Potentilla verna 2''-3'' | Bright green foliage; yellow flowers all season |
| Wooley Thyme     | Thymus lanuginosus 2''-3'' | Dense, small, gray leaves |
| Carpet bugle     | Ajuga (var. species) | Low mat of foliage; flower spikes 4''-6'' high; full sun to partial shade; some spread by runners; different color leaves |
Table 3. A limited list of possible annual flowers which do well in Utah.

<table>
<thead>
<tr>
<th>PLANT</th>
<th>BEST UTAH VARIETY</th>
<th>COLOR</th>
<th>HEIGHT inches</th>
<th>PLACEMENT</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alyssum</td>
<td>New Carpet of Snow</td>
<td>White</td>
<td>4</td>
<td>Border</td>
<td>Drought resistant</td>
</tr>
<tr>
<td>Alyssum</td>
<td>Royal Carpet</td>
<td>Violet-blue</td>
<td>5</td>
<td>Border</td>
<td>Tolerates light frost</td>
</tr>
<tr>
<td>Celosia plumosa</td>
<td>Red Fox</td>
<td>Carmine-red flower bronze foliage</td>
<td>24</td>
<td>Filler</td>
<td>Excellent filler color</td>
</tr>
<tr>
<td>Celosia plumosa</td>
<td>Golden Triumph</td>
<td>Golden-yellow plum green leaves</td>
<td>30</td>
<td>Background</td>
<td>Tender to frost</td>
</tr>
<tr>
<td>Coleus</td>
<td>Carefree Mix</td>
<td>Orange to yellow</td>
<td>15</td>
<td>Filler</td>
<td>Look for new varieties</td>
</tr>
<tr>
<td>Calendula</td>
<td>Pacific Beauties</td>
<td>Violet-red</td>
<td>30</td>
<td>Background</td>
<td>Rangy plant</td>
</tr>
<tr>
<td>Cosmos</td>
<td>Diablo</td>
<td>Silver foliage</td>
<td>12</td>
<td>Filler</td>
<td>Excellent contrast with Black Opal petunia</td>
</tr>
<tr>
<td>Dusty Miller</td>
<td>Cineraria Maritima</td>
<td>Mixed colors</td>
<td>8</td>
<td>Excellent border</td>
<td>Flower closes at night and \nresopens next morning</td>
</tr>
<tr>
<td>Dahlias</td>
<td>Early Bird</td>
<td>Mixed colors</td>
<td>15</td>
<td>Filler</td>
<td>Use Dylox to control tobacco budworm</td>
</tr>
<tr>
<td>Gazania</td>
<td>Sunshine Hybrids</td>
<td>Wide range of color</td>
<td>6</td>
<td>Semi-shade</td>
<td>The new varieties are grown from seed</td>
</tr>
<tr>
<td>Geranium</td>
<td>Carefree</td>
<td>Mixed colors</td>
<td>15</td>
<td>Filler</td>
<td>Accent</td>
</tr>
<tr>
<td>Geranium</td>
<td>New Era</td>
<td>Mixed colors</td>
<td>24</td>
<td>Border</td>
<td>Use in hanging baskets</td>
</tr>
<tr>
<td>Hollyhock</td>
<td>Silver Puffs</td>
<td>Pink</td>
<td>8</td>
<td>Border shade</td>
<td>Need some shade in Utah</td>
</tr>
<tr>
<td>Impatiens</td>
<td>Elfin Dwarfs</td>
<td>Mixed colors</td>
<td>8</td>
<td>Border</td>
<td>Compact plant with large flowers</td>
</tr>
<tr>
<td>Impatiens</td>
<td>Shadeglow</td>
<td>Mixed colors</td>
<td>12</td>
<td>Filler</td>
<td>Compact plant with large flowers</td>
</tr>
<tr>
<td>Impatiens</td>
<td>Ripples</td>
<td>Bi-color</td>
<td>12</td>
<td>Filler</td>
<td>Excellent</td>
</tr>
<tr>
<td>Lobelia</td>
<td>Crystal Palace</td>
<td>Blue</td>
<td>6</td>
<td>Semi-shade border</td>
<td>Use Dylox for tobacco budworm control of all infested petunias</td>
</tr>
<tr>
<td>Marigold</td>
<td>Fantastic</td>
<td>Orange</td>
<td>24</td>
<td>Background</td>
<td>Excellent</td>
</tr>
<tr>
<td>Marigold</td>
<td>Extra Dwarf Dolly</td>
<td>Yellow &amp; Gold</td>
<td>10</td>
<td>Border</td>
<td>Mounds well</td>
</tr>
<tr>
<td>Marigold</td>
<td>Gold Lady</td>
<td>Gold</td>
<td>19</td>
<td>Filler</td>
<td>Good dwarf</td>
</tr>
<tr>
<td>Marigold</td>
<td>Golden Boy</td>
<td>Yellow gold</td>
<td>8</td>
<td>Border</td>
<td>Drought resistant</td>
</tr>
<tr>
<td>Marigold</td>
<td>Ruffled Red</td>
<td>Red tinge</td>
<td>12</td>
<td>Filler</td>
<td>Excellent</td>
</tr>
<tr>
<td>Nierembergia</td>
<td>Regal Robe</td>
<td>Blue</td>
<td>6</td>
<td>Border</td>
<td>Excellent for tobacco control of all infested petunias</td>
</tr>
<tr>
<td>Petunia</td>
<td>Purple Waters</td>
<td>Purple</td>
<td>12</td>
<td>Filler</td>
<td>Drought resistant</td>
</tr>
<tr>
<td>Petunia</td>
<td>Sugar Daddy</td>
<td>Lavender</td>
<td>15</td>
<td>Filler</td>
<td>Good dwarf</td>
</tr>
<tr>
<td>Petunia</td>
<td>Cover Girl</td>
<td>Pink</td>
<td>12</td>
<td>Filler</td>
<td>Compact plants</td>
</tr>
<tr>
<td>Petunia</td>
<td>Maxi-Red</td>
<td>Red</td>
<td>12</td>
<td>Filler</td>
<td>Excellent zinnia</td>
</tr>
<tr>
<td>Petunia</td>
<td>Zig Zag</td>
<td>Bi-color</td>
<td>12</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Petunia</td>
<td>Pink Cascade</td>
<td>Pink</td>
<td>12</td>
<td>Hanging basket</td>
<td></td>
</tr>
<tr>
<td>Petunia</td>
<td>Victory</td>
<td>Red</td>
<td>12</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Petunia</td>
<td>Maxi-White</td>
<td>White</td>
<td>12</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Petunia</td>
<td>Sundance</td>
<td>Coral</td>
<td>12</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Petunia</td>
<td>Lilac Time</td>
<td>Lavender</td>
<td>12</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Salvia</td>
<td>Hot Pants</td>
<td>Red</td>
<td>16</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Portulaca</td>
<td>Sunglo Mix</td>
<td>Mixed</td>
<td>5</td>
<td>Border</td>
<td></td>
</tr>
<tr>
<td>Snapdragon</td>
<td>Floral Carpet</td>
<td>Mixed</td>
<td>8</td>
<td>Border</td>
<td></td>
</tr>
<tr>
<td>Verbena</td>
<td>Amethyst</td>
<td>Violet-blue</td>
<td>8</td>
<td>Border</td>
<td></td>
</tr>
<tr>
<td>Verbena</td>
<td>Blaze</td>
<td>Scarlet</td>
<td>10</td>
<td>Border</td>
<td></td>
</tr>
<tr>
<td>Dwarf Periwinkle</td>
<td>Little Blanche</td>
<td>White</td>
<td>10</td>
<td>Border</td>
<td></td>
</tr>
<tr>
<td>Zinnia</td>
<td>Peter Pan</td>
<td>Mixed</td>
<td>14</td>
<td>Filler</td>
<td></td>
</tr>
<tr>
<td>Zinnia</td>
<td>Ruffles Hybrid</td>
<td>Pink or scarlet</td>
<td>24</td>
<td>Background</td>
<td></td>
</tr>
</tbody>
</table>
Livestock, Forage Growth, and Nature’s Variability

Lois M. Cox

Seems as if you can’t take anything for granted these days! And in livestock/range management, at least part of the uncertainty traces to the doings of researchers such as Neil E. West, Professor of Range Science at USU, and Juan Gasto, currently at the University of Coahuila in Mexico. The paradox of research bringing complication rather than clarification occurs mostly because new knowledge so often reaccentuates the intricacies of Nature’s operations.

A case in point is the information West and Gasto gathered during their 7-year study of the growth patterns of shadscale (Atriplex confertifolia) and winterfat (Ceratoides lanata) in Utah’s Curlew Valley. Both of these cold-winter desert shrubs are important sources of forage for grazing livestock.

According to Dr. West, what he and Dr. Gasto discovered about the annual growth patterns of these shrubs raises doubts about the wisdom of thoughtlessly adhering to preset dates for particular management procedures. Their data also prove that fundamental assumptions inherent in rest-rotation grazing practices can no longer be taken as immutable.

On the other hand, their research gave them no cause to argue with such principles of livestock/range management as:

1) Long-term success depends on uniting proper kinds and numbers of animals with appropriate kinds and numbers of plants.

2) The plant’s stage of growth when grazed is crucial to its own survival and to the nutritional welfare of the grazing animal.

3) Desert vegetation (because of its harsh environment) is especially susceptible to irreversible damage if grazing is poorly timed or too heavy.

An Atriplex confertifolia community in Curlew Valley.
The Research

West and Gasto tracked the annual development of shadscale and winterfat shrubs that had been protected since 1967 from the appetites of livestock and rabbits. Each year's growth patterns were described in terms of preidentified stages (Table 1). They simultaneously collected temperature and precipitation data at the same sites. By extending their work over 7 years, says Dr. West, "We were able to observe phenomena that we would never have seen in the usual 2- to 3-year study." Their procedures and methods of analysis will be detailed in a 1978 issue of the Journal of Range Management.

As the researchers catalogued the dates when the development phases occurred (Table 2), significant variations between years could not be ignored. The range in average date of first flowering, for example, was 44 days for shadscale and 29 days for winterfat. Similarly, each year's temperature and precipitation data were rarely identical with the 7-year average values calculated by the scientists at the close of the study.

The Results

In general, winterfat progressed through its growth stages more slowly than did shadscale. Both shrub species, however, responded to colder than average spring temperatures with a delay in their normal progression of phases, while warmer than average accelerated the process.

Drier than average years foreshortened the normal sequence of shrub development, with reproductive phases going uncompleted. Winterfat was more severely affected than shadscale by this kind of adversity. Total winter precipitation was of major importance to the shrubs, although warmer and/or drier than average spring or summer conditions could (and did) offset even above-average winter precipitation (as in 1966). June seemed to be the outside edge for rainfall effectiveness. Moisture received after that month had little (if any) influence on shrub development.

The So What?

For livestock/range managers, these research results dramatize a need for alertness to annual variations in the development patterns of their range vegetation. Inflexible devotion to certain calendar dates for turning in or rounding up livestock relative to a given desert range, and/or to arbitrarily prescribed grazing rates, are not likely to optimize long-term productivity.

One year's excessive use is not easily undone in deserts. If over 70 percent of the current annual growth of shadscale and winterfat shrubs is eaten during their period of growth, the plants will die. After a year of slightly less intensive use, shrubs require 10 or more years of rest to recover their original size. Thus, the heavy use of forage standardly recommended for the "use" periods of rest-rotation systems may be destructively excessive relative to salt desert shrub ranges.

Also, since seed production cannot be relied upon as an invariably annual event in the desert (phase 7, Table 2), Dr. West points out that "with unthinking application of a rest-rotation grazing plan, a dry, hot 'rest' year would mean the reaping of few or none of the an-

Table 1. Development Phases and the numerical codes used to denote them in Table 2.

<table>
<thead>
<tr>
<th>Score</th>
<th>Development Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Winter dormancy</td>
</tr>
<tr>
<td>2</td>
<td>Leaves regreening, apical leaf buds swelling</td>
</tr>
<tr>
<td>3</td>
<td>Twigs elongating</td>
</tr>
<tr>
<td>4</td>
<td>Floral buds developing</td>
</tr>
<tr>
<td>5</td>
<td>Flowers opening</td>
</tr>
<tr>
<td>6</td>
<td>Fruit developing (male flowers dying)</td>
</tr>
<tr>
<td>7</td>
<td>Fruit disseminating</td>
</tr>
<tr>
<td>8</td>
<td>Summer dormancy beginning, leaves turning grey-green</td>
</tr>
<tr>
<td>9</td>
<td>Leaf buds swelling after late summer or early fall rains</td>
</tr>
<tr>
<td>10</td>
<td>Twig elongation after late summer or early fall rains</td>
</tr>
</tbody>
</table>
Table 2. Mean date (± days standard deviation) of first observed occurrence of each phase each year and over the seven years for even species (Development Phases described in Table 1)

<table>
<thead>
<tr>
<th>Species</th>
<th>Year</th>
<th>Development Phase Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Shadscale</td>
<td>1966</td>
<td>18 Apr±. 2</td>
</tr>
<tr>
<td></td>
<td>1967</td>
<td>30 Apr±. 4</td>
</tr>
<tr>
<td></td>
<td>1968</td>
<td>2 Apr±. 8</td>
</tr>
<tr>
<td></td>
<td>1969</td>
<td>5 Apr±. 0</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>10 Apr±. 9</td>
</tr>
<tr>
<td></td>
<td>1973</td>
<td>19 Apr±. 0</td>
</tr>
<tr>
<td>mean</td>
<td>11 Apr±. 10</td>
<td>20 Apr±. 14</td>
</tr>
<tr>
<td>Winterfat</td>
<td>1966</td>
<td>17 Apr±. 0</td>
</tr>
<tr>
<td></td>
<td>1967</td>
<td>7 Apr±. 6</td>
</tr>
<tr>
<td></td>
<td>1968</td>
<td>28 Mar±. 3</td>
</tr>
<tr>
<td></td>
<td>1969</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>28 Mar±. 0</td>
</tr>
<tr>
<td></td>
<td>1972</td>
<td>22 Apr±. 9</td>
</tr>
<tr>
<td></td>
<td>1973</td>
<td>19 Apr±. 0</td>
</tr>
<tr>
<td>mean</td>
<td>8 Apr±. 10</td>
<td>29 Apr±. 18</td>
</tr>
</tbody>
</table>

* Some plants already in phase 2 when sampling began.
*** Not observed.
** Regreening after summer dormancy was only observed in non-fruiting individuals in 1968.

anticipated benefits from reproduction. Moderate annual use is better than a rest-rotation approach in managing salt desert ranges. The date that livestock should be removed is best gauged by observing the plants' progression through growth stages—not by consulting a calendar."

Obviously, the West/Gasto research results have complicated the lives of conscientious livestock/range managers by providing new evidence of how stubbornly nature resists simplified predictability. But at the same time, their work enhances the likelihood that those managers will be able to achieve long-term productivity on desert range lands.
Theory + Practice = Competent Dietitians

Bonita W. Wyse, Barbara M. Prater, and Joan E. Staggers

Helping people figure out who should eat how much of which foods is a major responsibility of the professional dietitian. In effect, a registered dietitian (RD) translates the science of nutrition into practical applications. But such an ability comes only after a great deal of study and training. To make that process as efficient as possible, the Department of Nutrition and Food Sciences at USU developed a Coordinated Undergraduate Program (CUP) in Medical Dietetics.

In the CUP, classroom information is reinforced by clinical experiences in hospitals and community agencies. When the CUP concept received developmental accreditation status in August 1973 from the American Dietetic Association, Utah State was one of the 12 universities in the country that already had such a program in operation. Since that time over 70 colleges and universities have developed similar programs. The CUP at Utah State, however, is the only one of its kind being offered by a public institution in Utah, Idaho, Colorado, Nevada, Arizona, New Mexico, or Wyoming.

The overall objective of our CUP in Medical Dietetics is to prepare professionals who upon graduation can function successfully as clinical dietitians in a beginning level position in a hospital, metabolic research unit, outpatient clinic, or community agency. Upon completion of the 4-year program, the graduates receive their Bachelor of Science degree and are qualified to take the national registration examination to become registered dietitians.

What Graduates Do

Registered dietitians from our CUP are helping people in the intermountain west in a variety of ways. One graduate is the clinical dietitian at the Logan Hospital. There she helps people in northern Utah adjust their diets after they have had a heart attack, have high blood pressure, or are diagnosed as having diabetes mellitus or any other medical ailment that requires changes in dietary patterns. The Logan Hospital had not had a full time dietitian for over 8 years when she took the position. Another recent graduate was hired by the hospital in St. George. She is in charge of the dietary education of its patients, while an administrative dietitian (also a USU graduate) is responsible for the patient food service.

Several of our graduates are working as dietitians in small rural community hospitals. One graduate wrote that he was situated in a small town in Montana where he was not only director of the dietary department for a 114 bed hospital but acted as consultant for the meals-on-wheels program for the senior citizens and was the dietary consultant for three small nursing homes. Other graduates are employed in large metropolitan areas. One graduate who is employed in Illinois has become so specialized that she spends most of her time helping people with kidney disease adjust to their new diets.

How the CUP Works

The CUP in medical dietetics at Utah State University differs from the traditional academic dietetics program in that it coordinates
theoretical and applied aspects of the curriculum in actual clinical settings. Students can thus apply, analyze, integrate, and evaluate their knowledge in a real-world environment. Traditionally, students graduating from a 4-year baccalaureate program in dietetics have applied for an additional year of experience (internship). That internship would complete the clinical experiences requisite to taking the national registration examination of the American Dietetic Association. Our CUP allows the dietetic student to be educated in less time to a greater degree of proficiency.

Students are accepted into the program at the beginning of their junior year after they have completed the necessary preprofessional and general education courses.

During the fall and winter quarters of the student's junior year, clinical experiences are provided at the Logan Hospital, a 125-bed facility in Cache Valley. A clinical instructor, who is a registered dietitian, identifies patients who illustrate the concepts being discussed and studied in class. These patients are typical of cases that the graduates are likely to encounter when they begin to practice as registered dietitians. The students review the medical charts, interview the patients, discuss the patients with other members of the health care team when appropriate, and develop nutritional care plans.

Also during their junior fall quarter, the students are enrolled in a community nutrition course where clinical experiences are provided in cooperation with the Utah State Cooperative Extension Division. The students become familiar with various
community nutrition-support systems and with the role of dietitians in the community. They also begin to work directly with families in the community who have nutritional problems. These are often young families with several growing children. The students are involved with their families for three quarters, learning primarily about the nutrition and feeding problems of children. During the same time, the students will become acquainted with other families who are being helped by an Expanded Food and Nutrition Education Program (EFNEP) aide.

During spring quarter of their junior year, the students travel once a week with a clinical instructor to the McKay-Dee Hospital in Ogden. This is a new, 400-bed facility where the students can meet a more diverse group of patients and be involved in the operation of a larger, more metropolitan hospital.

During the fall of their senior year the students relocate in Salt Lake City for 15 weeks where the Veteran's Administration Hospital has given program members access to office space and a classroom. Here they take classes with students from Brigham Young University who have a similar program; each university providing a clinical instructor. The students take three academic courses (equivalent to 22 quarter hours) during the 15 weeks that they are in Salt Lake City. Course material is taught on Mondays by the clinical instructors and outside resource people. Tuesday through Friday the students are scheduled in their respective clinical facilities for 8 hours each day.

While in Salt Lake City, the students have a 7-week rotation on the medical-surgical units at either Veteran's Administration Hospital, University Medical Center or LDS Hospital. In addition, the following clinical experiences are provided: 1 week of orientation; 2 weeks in the Primary Children's Hospital; 1 week in the renal dialysis unit at the University Medical Center; 1 week of clinical research; 1 week in the Bryner Clinic (well-child) or maternal-infant clinic; and 2 weeks of gerontology. These last 2 weeks are cooperatively designed with the faculty at the Rocky Mountain Gerontology Center and includes the nursing home care unit at the Veteran's Administration Hospital and an outpatient clinic at the County Senior Citizens Housing Project.

Following the 15 weeks of on-the-job learning in Salt Lake City, our students return to the Logan campus to take courses in research methodology, advanced human nutrition, statistics, and mammalian physiology. They continue to develop their clinical dietetics skills by individualized activities in a clinical dietetic practicum. Students who are within 45 hours of graduation and will have accumulated more than 186 credit hours by graduation, may apply to the School of Graduate Studies and designate certain of their last quarters' course hours as applying toward a graduate degree in nutrition.

The Results

Nineteen students have graduated from the Coordinated Undergraduate Program in Medical Dietetics at Utah State University since the first group in the spring of 1975. All graduates wishing employment are employed.

In addition to their excellent employment records, our graduates' scores on the national registration examination offered by the American Dietetic Association have been outstanding. To date none of our graduates has failed the registration exam while nationally 27 percent of the candidates have not passed. On the most recent test, the USU candidates averaged 83 percent; nationally, candidates averaged 75 percent.

Both staff and students seem to have reason to be satisfied with our CUP program. And from all reports, so are the people being served by our graduates.

Bonita W. Wyse is Assistant Professor, Department of Nutrition and Food Sciences, and Director, Medical Dietetics Program, USU.

Barbara M. Prater is Associate Professor, Department of Nutrition and Food Sciences, USU, and Clinical Coordinator in Salt Lake City.

Joan E. Staggers is Clinical Instructor in Medical Dietetics, Department of Nutrition and Food Sciences, USU.

Utah Science
Aldicarb: A New Nematicide for Control of the Sugarbeet Nematode

G. D. Griffin

Figure 1. Clampco Chisel: A simple and effective sidedress application method of applying Temik.

About 8,800 ha (22,000 ac) of sugarbeets are grown in the state of Utah. Approximately 6,000 ha (15,080 ac) of these are treated annually at a cost of more than a million dollars to control the sugarbeet nematode, *Heterodera schachtii* Schm. Such control means the difference between profit and loss and is essential to the economic well-being of the sugarbeet industry in Utah.

Fumigants

The soil fumigants dichloropropene-dichloropropane mixture (D-D) and 1, 3 dichloropropene (1, 3 D) have been used extensively and successfully for more than 2 decades in areas where a scarcity of land precludes a 4- to 5-year crop rotation.

With a 1- to 2-year rotation, the soil is best fumigated in the fall of the year, while soil temperatures are still above 7°C (45°F). Under these conditions, both control and sugarbeet yields are excellent.

When fall soil fumigation is not practical or is prohibited by adverse weather, however, the grower must rely on a spring application. He must then delay planting approximately 7 to 10
days after fumigation to allow the
chemical to leave the soil and to
avoid phytotoxicity. This wait
also may mean loss of crucial soil
moisture.

**Systemics**

Recent studies have shown the
efficacy of aldicarb (Temik) \[*2-
methyl-2-(methylthio)-propio-
analdehyde oxime\] in controlling the
sugarbeet nematode. Use of this
systemic chemical has resulted in
yields comparable to those
obtained with soil fumigation or
crop rotation.

The following methods have
incorporated aldicarb (10 percent
and 15 percent granular formul-
ations) into the soil and achieved
excellent control of nematodes.

**At-Planting-Time Applications**

*Soil-diversion* (Ruskin method) —
Aldicarb granules are metered
trough a granular applicator
mounted in front of the sugarbeet
planters. Furrow shovels, set flat
on the ground, divert about 5 cm
(2 in) of soil mulch. The granules
are applied in a 12.5 cm (5 in)
band behind the shovel. To cover
the granules immediately,
weeders mounted behind the
shovel pull the displaced soil
mulch back over the row. This
process, commonly called the
"Ruskin Method," makes an ex-
cellent seed bed.

*Sidet rod* — The nematicide
granules are metered into the soil
through a tube attached to a
chisel or disc opener. The
granules are placed into the soil at
depth of 7.5 to 12.5 cm (3 to 5
in) and 5 to 7.5 cm (2 to 3 in) to

\[\text{*Trade Name, aldicarb=common name}\]

the side of the seed bed. A chain
or scratcher fills the opening left
by the chisel or disc. This method
may be used where excessive
debri would interfere with the
Ruskin Method. Since soil must
be moist enough to ensure con-
tinual uptake of the chemical by
the plant feeder roots, sidetress-
ing places the chemical into the
soil at a depth where drying of the
top 5 to 7.5 cm (2 to 3 in) will not
interfere with chemical activation
and plant uptake. The chisel is a
better choice than a disc opener
for heavy, and/or wet soil.

*Herbicide (liquid or granular) application equipment can also
be used when the same procedure is followed.*

**Post-Planting-Time
of Applications:**

The same chisel procedures
are followed as for at-planting-
time applications, except that
special care must be taken to
minimize possible damage to the
root system. In sidetress-
ing, applications must be 10 to 15 cm (4
to 6 in) deep and 10 to 15 cm (4
to 6 in) from the roots, depending
on the stage of plant develop-
ment. Irrigation must immediate-
ly follow application and must be
sufficient to carry the chemical to
the plant root zone.

Post-planting application has
proven valuable in areas where
severe nematode damage is
possible and no preplanting or at-
planting application was made.
Any post-planting application
should be made as early as pos-
sible while the sugarbeets are small
and nematode damage is still
minimal.

Aldicarb has given excellent
results with all four application
methods and is now used com-
mercially for sugarbeet nematode
control. At a 30 kg (27 lb) rate of
the 15 G granules, aldicarb com-
pares favorably to a D-D mixture
and to 1, 3 D in increasing
sugarbeet yields (Tables 1-4).

Utah Science
A Cautionary Note

Aldicarb is a moisture-activated nematicide and must be in solution in the plant rhizosphere (root zone) before it can control the sugarbeet cyst nematode. With inadequate soil moisture, aldicarb precipitates onto soil particles and can give only poor control. Adequacy of soil moisture is especially important in the first 8-12 weeks of plant growth, depending on the nematode population density. In some areas of Utah, sugarbeets do not receive their first irrigation until approximately the first of July. By this time the ground tends to be extremely dry, with the plants showing signs of wilting; if this occurs in aldicarb-treated soil, nematode control will be poor and so will yields. If proper soil moisture cannot be maintained during the first weeks after planting, a method of control other than aldicarb, should be used.

Gerald D. Griffin is Federal Collaborator, ARS, Department of Plant Science, USU.

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### Table 1. Comparative effectiveness of aldicarb and dichloropropene-dichloropropane (D-D) in increasing sugarbeet yields

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (Ib/ac)</th>
<th>Method of application</th>
<th>Yields (ton/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Ruskin</td>
<td>62 (28.1)</td>
</tr>
<tr>
<td>D-D</td>
<td>280 (250)</td>
<td>30.5 cm (12 in) centers</td>
<td>61 (27.8)</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>34 (15.4)</td>
</tr>
</tbody>
</table>

*10% granules
+D-D was applied 10 days before planting. All treatments were planted the same day.

### Table 2. Effect of different nematicide treatments on sugarbeet yields (light nematode infestation)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (Ib/ac)</th>
<th>Application</th>
<th>Yield (ton/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Ruskin</td>
<td>43 (19.35)</td>
</tr>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Clampco Chisel</td>
<td>47 (21.16)</td>
</tr>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Power incorporation</td>
<td>42 (19.09)</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>28 (12.63)</td>
</tr>
</tbody>
</table>

*10% granules

### Table 3. Effect of different nematicide treatments on sugarbeet yields (heavy nematode infestation)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (Ib/ac)</th>
<th>Application</th>
<th>Yield (ton/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Ruskin</td>
<td>41 (18.67)</td>
</tr>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Clampco Chisel</td>
<td>43 (19.32)</td>
</tr>
<tr>
<td>Aldicarb</td>
<td>45 (40)</td>
<td>Power incorporation</td>
<td>27 (12.04)</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>15 (6.90)</td>
</tr>
</tbody>
</table>

*10% granules

### Table 4. Effect of aldicarb post-planting-time application on sugarbeet yields

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (Ib/ac)</th>
<th>Yield (ton/ac)</th>
<th>Increase (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field 1+</td>
<td>45-10G (40-10G)</td>
<td>42 (19.1)</td>
<td>9 (4.2)</td>
</tr>
<tr>
<td>Field 2+</td>
<td>30-150G (27-15G)</td>
<td>41 (18.4)</td>
<td>11 (5.0)</td>
</tr>
<tr>
<td>Field 3+</td>
<td>45-10G (40-10G)</td>
<td>23 (10.3)</td>
<td>7 (3.2)</td>
</tr>
</tbody>
</table>

*Applied with disc opener
+Applied with Clampco Chisel
Age of plants at sidedress treatment: Field 1. 47 days, Field 2. 61 days, Field 3. 77 days

December 1977
Projects in Progress
Lois M. Cox

In this regular feature of Utah Science we briefly describe some of the research in progress across the USU campus. Each installment is a scant sampling of the remarkably diverse research scene.

Insiders/Outsider—Why?

Sally (age 5) declines more invitations to "come over and play" than Peggy (another 5-year-old) dreams of receiving. At 14, Jeff can persuade just about anybody (regardless of age) to do just about anything, while 13-year-old George is either ignored or actively rejected by the same people. What makes these differences? Did Peggy and George somehow miss out on learning certain social skills?

With Jay D. Schvaneveldt (Professor and Head of the department) as coordinator, several members of the Department of Family and Human Development are involved in a regional research project that may provide answers to such questions. Researchers at campuses in each of 10 western states are investigating particular segments of a topic they have labeled "the development of social competencies in children." By 1980, they expect to fit the segments together to produce reasonably comprehensive insights into the hows and whys of popular versus shunned (or isolated) youngsters.

The USU team is going to concentrate on preschool and junior high school age youths. Their emphasis will be on investigating differences in interpersonal skills...
(empathy and recognition of another person's perspectives) that characterize the popular and unpopular individuals.

Led by Assistant Professors Gerald R. Adams and J. Craig Peery, the researchers will first identify popular and unpopular children among 30 to 40 preschoolers and an equal numbers of young adolescents. The identification will be accomplished through interviews of peers, parents, and teachers. The youngsters in each category will then be unobtrusively tested for their abilities to empathize (understand how someone else would feel in certain situations) and to solve problems from an imagined point of view.

To the data they gain from these standardized techniques, the researchers will add information about parent/child interactions and relationships (from both points of view) and teachers' assessments of the youngsters' behaviors. Other objective methods will be used to rate the children as to physical attractiveness, verbal fluency, and how each perceives his or her own ability to determine the future.

"Then," says Dr. Adams, "we'll begin to analyze our mounds of statistics, while simultaneously doing the follow-up studies of our first groups of young people. At the same time, we will start to repeat the original procedures with new groups, and to compare urban with rural preschoolers and adolescents. Ultimately, if we can keep track of enough of our youngsters over time, we expect to have a valid definition of the primary factors that function in making a person either an insider or an outsider."

But not even the most optimistic members of the research team are anticipating a steady, trouble-free rate of progress toward that definition. The potential snags are too obvious. One possibility is for the meticulous data collection process to indicate that some youngsters who have the social skills assumed requisite to popularity are deliberately choosing not to use them. That would immediately give the researchers a whole new category of questions to try to answer. Or, perhaps some individuals identified by the tests as popular will simultaneously prove not to have those social skills. Again, the research team would be confronted by a many-sided, unsought puzzle within a puzzle. Insights into the hows and whys of such variables could come slowly.

Nevertheless, when coordinated with the results of the studies being done elsewhere in the region, the evolving USU data will help provide badly needed clues to the roots of the problems (such as high suicide rates, soaring crime and delinquency, and battered children), which are believed related to social isolation. Even on their own, the USU results, according to Dr. Adams, "will be usable by parents, teachers, church units, and anyone concerned with the welfare of modern-day youngsters. We will periodically interpret what we discover and put it into forms that can be applied at practical levels. As an example, if it turns out that very early (preschool) intrafamily experiences vitally affect a child's later social competencies, we would develop ways to show parents how to enhance their children's potentials."

Whose Value Counts

Unlikely as it may sound, what the consumer values in milk is not what the producer is being encouraged to produce. Traditionally, milk has been priced at the farm on the basis of its butterfat content. The higher the butterfat, the higher the amount paid the dairyman. Current consumer behavior, however, indicates that the protein in the milk is more sought after at the retail level than is the butterfat.

As delivered by the cow, milk contains butterfat and water, and a composite of protein, lactose, and minerals that is called the SNF (solids-not-fat) fraction. The prevailing pricing mechanism for milk operates in terms of two categories: butterfat and skim (SNF plus water), with price variations geared totally to the butterfat content. The nationwide result (except in California) is a lack of incentive for dairymen to increase their herds' production of the protein-containing SNF.

The California exception was created about 10 years ago when that state shifted to a component pricing system. Since then, California dairymen have been paid relative to the SNF as well as the butterfat content of their milk.

A team of USU researchers, led by Morris D. Whitaker, Associate Professor of Economics, is trying to predict what might happen in Utah if a component pricing system were activated. Their primary concern is whether individual dairymen could (and would) increase SNF production in
response to such a pricing change. But Dr. Whitaker points out that the team also wants to know more about how a component pricing system might affect prices now being paid to producers, and thus their income. “Hopefully,” he comments, “our research will provide some clues to ways Utah dairymen might best adjust their herds and other resources to increase SNF production.”

Much of the team’s initial effort has been devoted to gathering and analyzing basic data acquired from California and Oregon. Simultaneously, a collaborative effort with personnel of Utah’s DHIA (Dairy Herd Improvement Association) is developing a database for Utah. Plans call for 8,000 cows to be tested on a regular basis for their protein as well as their butterfat and total milk production. The butterfat-oriented income produced by the tested herds will then be compared with what they would have generated under various hypothesized component pricing formulas and with the earnings of comparable herds operating under the California system.

According to Dr. Whitaker, “The collection of these and other data will gradually be combined with analytical procedures and the development of predictive mathematical models. By our target termination date of 1980, we expect to be ready to make recommendations that will benefit producers and processors alike. Almost by definition, such recommendations would translate consumer preferences into production criteria.”

When that comes to pass, what consumers value most in milk will be what Utah’s milk pricing system pays this state’s producers to deliver.

But Rarely a Bite to Eat!

To most people, forests and big game seem automatically compatible. Not so! And when the forest in question equates with summer range for the big game, an incompatibility can pose serious problems for the managers of the game. The lodgepole pine forest type provides a vivid example.

“In Utah,” says Philip Urness (Associate Professor of Range Science), “extensive stands of unlogged lodgepole pine dominate much of the Uinta Mountain range. The area’s mule deer and elk depend on the lodgepole pine lands for their summer range. Since the quality and quantity of their summer forage determine how well these animals are equipped to withstand the stress of winter, we decided to initiate definitive research.”

Two graduate students (William B. Collins for elk, and Joseph A. Deschamp for deer) under the direction of Dr. Urness, have been struggling toward that goal. Their immediate problems included: no inventory of forage plants in Utah’s lodgepole pine habitat, no indication of which of these noncatalogued plant species the deer and elk might prefer to eat, and a lack of information about the ability of the lodgepole pine types of forage plants to satisfy the poorly defined nutritional needs of the animals.

The inventory would be relatively easy to acquire. But collecting the animal data was another matter. Before collection could begin, the researchers had
to "tame" some elk and deer. Only with animals used to their presence could they stay close enough to observe precisely how much of which plants was eaten. Then too, without controllable animals, continuity of observations would be virtually impossible to achieve. So fawns and calves a few days old were obtained, bottle raised, handled repeatedly, and taught to accept being transported in trucks.

Prior to the readying of the animals, the lands to be used for each species were vegetatively categorized and inventoried. Five basic divisions seemed logical: wet meadows, upland dry meadows, clear cuts, mature forest, and stagnant forest. After the researchers had determined what was growing in each of the 5 categories, on what kinds of soils, the animals were brought in.

Based on more than 1000 hours of observations of the deer and elk, the researchers were finally prepared to draw some conclusions—one of which was a major surprise. Both the deer and the elk showed a gourmet's delight when the menu included mushrooms. In fact, the areas supporting mature and/or stagnant forest were voluntarily grazed only when they did contain mushrooms. At other times, their characteristically dense tree growth obviously discouraged grazing interest.

The deer and elk were also quite similar in favoring the relatively small meadows (wet and dry), clearcut areas (except for their overly exposed centers), and revegetated, abandoned roads. The "catch" is that these categories account for substantially less acreage (10 vs 90 percent) than do the forage-short mature and stagnant forest lands.

On a plant species basis, mushrooms had to be ranked as outstandingly palatable (but, from the animals' viewpoint, in regretfully short and fleeting supply). Next in preference came forbs such as dandelion and aster. The deer ate little of the grass and sedge plants, both of which categories are important components of the total forage resource of meadows. In contrast, the elk ate considerable amounts of these forages, but their behavior clearly indicated that they preferred forbs over either one. Similarly, the abundant grouse whortleberry, a browse plant that is prevalent in the mature forest stands, was rarely taken if alternatives were at hand. Willow, another browse type, was exceedingly popular with the deer, who probably would have consumed far more if it had been available.

On-going research is defining the nutritional "worth" of the forage plants used by deer and elk. Those results, however, will not be fully useful until more is known about the animals' physiological requirements. Also, no matter how nutritious the forage turns out to be, its scarcity will remain a problem unless logging or wildfires create more open areas.

In that regard, Dr. Urness points out that "the welfare of deer and elk living in the Uintas could be enhanced by clear-cutting small (5 X 20 ha—10 X 40 ac) areas in mature and stagnant stands of lodgepole pine."
Such treatment, followed by subsequent thinning of the regenerating pines has been proved to produce large advantages for the animals, while also benefiting the tree stand. This kind of artificial modification is becoming increasingly urgent as more and more natural meadows are converted into roads or reduced in value to the animals by recreational activities.

Unfortunately, the US Forest Service, which has jurisdiction over these lands, has only very limited funds that can be applied to improving wildlife habitat. The summer-forage production potentials will therefore go unrealized unless commercial loggers can begin to reap an economic value from the available pines. At present, the market is marginal and plans to cut have been repeatedly delayed or abandoned.

Profit or Loss—
A Question of Taste!

Even the most efficient sheepmen around may record a loss rather than a profit if consumers do not like the taste of their product—lamb.

To help put a handle on some of the variables involved in such taste-judgments, two USU scientists have been cooperating in a 3-year regional research project. The program (involving personnel at several western universities) was designed to find out whether heavy (over 66 pounds, carcass weight) lambs are acceptable to the consumer. The USU staff members (Assistant Professors Charlotte Brennand and Von T. Mendenhall of the Nutrition and Food Sciences Department) have been primarily concerned with trying to correlate certain animal and carcass characteristics with consumer taste ratings of the ultimately derived meats.

Their data sheets on the lambs have included breed, sex, carcass weight, relationship of that weight to percent of trimmable fat (and of lean meat), and type (soft/oily or normal/hard) fat. The consumer taste preference ratings have necessarily involved less objective measures such as personal evaluations of tenderness, flavor, juiciness, and general acceptability. So, to maximize the validity of these nonobjective ratings, the researchers drew upon both trained taste panels and average consumers.

Professor Brennand has been simultaneously identifying and quantifying the flavor components in meat samples that are used in the taste tests. As Professor Brennand says, “Previous
trials had shown that not even trained ‘tasters’ could differentiate among totally lean samples of beef, lamb, and pork. The emphasis this time has therefore been on analyzing the fat. Eventually, our flavor component data may help (at a preslaughter stage) to identify animals with high potentials for producing consumer-preferred meats."

Opinions from “average” consumers have been obtained on the basis of half-carcass and individual-cut purchases. Families in Utah that bought half-carcasses of test animals from the Nutrition and Food Science Department were asked to fill out a standardized questionnaire. At the same time, the other half-carcasses were sold in California supermarkets after being broken into regular retail cuts. The same kind of questionnaire was stuffed in the bottom of each package.

Many crucial correlations among breeds, weights, and yields are awaiting further statistical analyses. But Brennand and Mendenhall agree that their preliminary results indicate good news for the producers of lambs. On a taste basis, heavy lambs rated better than or equal to the lighter animals in acceptability. Additionally, heavier types seem to produce more fat as well as more lean. That means that the commonly voiced consumer preferences for larger rib “eyes” and for two instead of one roast per hind leg are more readily satisfied by the heavier animals.

For producers, consumer acceptance of heavier animals can mean a wider margin of profit. With each ewe capable of raising just so many lambs in her lifetime, total returns are maximized with heavier lambs. According to Dr. Mendenhall, “Under current production conditions, potential returns exceed the costs of putting on the extra weight. The profit figures could probably be upped even more if genetic selection were imposed on flocks to favor lambs that put on weight as lean meat rather than fat.”

**Plant-Plugging Pathogens**

Consistently neglect to water the average plant, and you get a droopy plant. The remedy for this common, cause/effect phenomenon is easy—add water. But what about plants that look wilted despite adequate watering? What you have there, is a phenomenon that has claimed the research attention of many plant pathologists, among them, Neal Van Alfen, Assistant Professor of Biology at USU.

Dr. Van Alfen says that such plants (which can include alfalfa, tomatoes, melons, potatoes, elms, and oaks) quite often turn out to be harboring a pathogenic (disease-producing) bacterium or fungus. “These pathogens,” he explains, “are particularly frustrating to researchers because they live inside the vascular (fluid-carrying) system of their host. That gives them immunity to contact-chemical pesticides. It also guarantees their toxins (poisonous products) access to transportation throughout the host plant.”

These wilt-inducing organisms can apparently be combatted only by a resistance factor within their target species. Unfortunately, as plant breeders know too well, that resistance can be hard to come by. Dutch Elm wilt disease is a prime example. Plant breeders have been trying for three generations to develop American elm trees that could withstand the attacks of Ceratocystis ulmi (the wilt-inducing fungus). Meanwhile, the fungus, whose line of advance will soon have it marching across Utah, continues to kill over 90 percent of all the American elm trees it encounters.

In contrast, Corynebacterium insidiosum (the bacterium that causes wilt in alfalfa) has been less recalcitrant. Plant breeders have been able to create varieties of alfalfa that incorporate considerable resistance to wilt disease. But even in a field planted to a resistant variety, losses can go to 10 percent.

The score is likely to continue to favor the wilt-inducing pathogens unless plant pathologists manage to give plant breeders new tools. Which, of course, is precisely what Van Alfen wants to do. As he puts it, “First we have to understand how the pathogen kills its host. Once we’ve defined its method, we ought to be able to see what characteristics or anatomical features in the hosts might be offsetting. At that stage, the plant breeders could begin to manipulate their breeding stocks toward enhancing resistance to wilt disease. To get us to that stage, we’re using wilt in alfalfa as a sort of model system.”

Beyond their susceptible and resistant alfalfas, Van Alfen and his co-workers started with other assorted “knowns,” among them: Organisms that are pathogenic to

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plants typically produce one or more compounds that may have toxic effects on their hosts. These toxins, but not their source organisms, vary in their powers of discrimination. Some can affect only one target species. Some are more versatile.

The researchers also knew that toxins already linked with wilt diseases are mostly bulky molecules that tend to be nondiscriminating (each one causes wilting in cuttings from various plant species). Incidentally, that lack of specificity has been an especially baffling aspect of cause/effect investigations of wilt diseases. It is a little like trying to choose among identical looking chances on a punch board.

The toxins of both C. ulmi (elms) and C. insidiosum (alfalfa) fit the general pattern. In addition, the traditional assumption had been that the elm- and alfalfa-invading organisms did their damage by destroying their hosts' cellular membranes. Van Alfen and his co-workers, however, were able to show that, instead, they induced wilting by the simple expedient of blocking their hosts' fluid-transport systems.

According to Van Alfen, "Remarkably small amounts of the wilt toxins (less than 2 micrograms*) rapidly reduce water movements through stems of many kinds of plants besides elms and alfalfa." After more hours of tedious molecule tracking, the researchers also realized that the toxins might not be doing their plugging on a direct basis. Too many unrelated molecules (similar in size and weight to those of the toxins) had proved equally able to induce wilting in plants by mechanically obstructing their flow of fluids.

These insights, while obviously valuable, still left the plant breeders without an efficient way to identify wilt-resistant plants. Currently, therefore, Van Alfen is thinking in these terms: Do all wilt-producing organisms and their toxins operate on the plugging principle? Are there physiological and/or anatomical characteristics that consistently differentiate between susceptible and resistant plants within a target species? Could plant breeders use wilt-inducing toxins (or a mimicking molecule) as a screening tool to identify which plants should be encouraged to reproduce?

In seeking answers to these questions, Van Alfen and his students Rastri Dey and Vicky Allard first had to establish baseline data. This they did by challenging alfalfa plants in the laboratory with wilt-inducing toxins from C. insidiosum and defining all measurable effects on the plants. Now they are beginning to compare those data with what has happened in diseased plants collected from the field. If the comparisons identify significant similarities, the implication will be that the C. insidiosum toxin is truly the culprit in alfalfa wilt disease. They can then go on to determine exactly how and why resistant/susceptible alfalfas differ in their responses to the toxin. The hope, of course, is that their alfalfa model will be a valid indicator of how all wilt diseases function.

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* 1 microgram=1 millionth of a gram
1 gram=.035 ounce
Science Short
Where Do They Go?

Keith Smith and Gilbert Long

To answer this question about vocational agriculture graduates, teachers of vocational agriculture in Utah high schools were surveyed. The teachers were asked to list all graduates of their 1969 agriculture class who had taken from one to four years in vocational agriculture. Teachers in 23 high schools submitted usable data, and a total of 345 graduates were reported. From these graduates, a random sample of 148 names was selected. Questionnaires were sent to each of these individuals in the spring of 1975. Usable data came in on 85 responses for a 57.4 percent return.

Of the 85 responding vocational agriculture graduates, 14.1 percent were in full-time farming at the time of the study. An additional 8.2 percent were in other work but were farming part-time, making a total of 22.3 percent of the graduates in full or part-time farming. Another 14.1 percent were in related agriculture occupations. Of the remaining respondents, 7 percent were in college, 3 percent were in agriculturally-related fields, 1.2 percent were on LDS missions, and 1.2 were unemployed.

Almost 40 percent of our 85 graduates were in some phase of agriculture. This is especially significant considering that only 34.1 percent of these individuals' fathers were engaged in full time farming operations.

Our survey also indicated that 43.5 percent of the respondents expected to be involved in some phase of agriculture in the future. Of these, 20 percent said they planned on full-time farming, 19 percent planned to enter some agriculture-related field, the rest anticipated farming. With 13 percent still undecided, the agriculture statistics might go even higher.

Ninety-four percent of the graduates said they would take vocational agriculture again in high school if they were repeating that education. Apparently taking vocational agriculture in high school had been considered useful.

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Science Short

USU's Stake in NASA's Space Shuttle

Individuals, commercial interests, government agencies, indeed, any organization with the price, are being encouraged to buy cargo room aboard NASA's first shuttle test vehicle, the Enterprise.

Thanks to R. Gilbert Moore, general manager of Thiokol's Ogden plant, some of that cargo room will be occupied by experiments of three competitively chosen students at USU. Mr. Moore, the first private individual to take advantage of NASA's desire to sell room aboard their shuttle project. The criteria applied to the students' proposals included the student's creativity and originality, and the experiment's practicability in terms of weight requirements and completion potential.

The experiments themselves can center on topics ranging from plant responses to conditions in space to the effects of space conditions on manufacturing processes. Adkins, Elwell, and Edwards are interested in bacteria, optical surfaces, and the sun's x-ray emissions, respectively.

Having been chosen to participate in the space shuttle research, Adkins, Elwell, and Edwards are each being given a tuition-free scholarship to USU (renewable for 3 additional years). Each student will also receive professional help in taking his research from idea to shuttle-riding readiness. In conjunction with opportunities to see some of the prelaunch tests of shuttle components, the students are being included in the USU-made, shuttle-describing movie that will be shown aboard some of Western Airline's long distance flights and elsewhere.

Subsequent personal purchases of scientific cargo room on the shuttle by Dr. L. R. Megill of USU's Space Science group and then by other USU scientists assured student access to the shuttle for 3 years. In each of those years, the shuttle area purchased by the USU faculty members will house projects designed and built by high school students who have qualified for USU's three annually awarded scholarships. Specific information about how high school students can apply for the USU space-shuttle research program can be obtained by writing Dr. Megill, UMC 41, Utah State University, Logan, Utah 84322.