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Penstemons in December? Not really, the photo was taken months ago. Many different varieties of penstemons, however, are being raised at the Agricultural Experiment Station’s Farmington Field Station. Some do not survive Utah’s harsh winter months. Those that do endure are used for breeding varieties adapted to Utah’s growing conditions.

Three types are being propagated: dwarf (6 to 12 inches high), medium upright, and tall uprights (up to 5 feet tall). All penstemons are perennial plants with foliage varying from light to deep glossy green. They produce showy tubular, bright colored flowers that range from brilliant red to pink, blue, lavender, violet and purple. A few species with white flowers also have been found.

These ornamentals provide remarkable displays for landscape and garden purposes. Read more about penstemon research on page 130 in this issue of Utah Science.

Back Cover: This photograph was taken after the first seasonal snowfall on the Logan River near the Utah Water Research Laboratory.
EDITORIAL

Refocusing research to better serve Utah

WYNNE THORNE

When Utah Agricultural Experiment Station was established 84 years ago about 80 percent of Utah's people lived in rural communities, and 65 percent depended directly on agriculture for a livelihood. The state was relatively isolated, and information about ways to improve agricultural production, make better use of natural resources, and effectively enhance the economy and the quality of living was scarce.

Agricultural research and its practical application have wrought dramatic changes. Now only 6 percent of our people live on farms, they are producing higher quality crops more efficiently, and their living conditions have vastly improved. Simultaneously, the conditions and methodologies of research, as well as the types of problems needing study have changed.

WIDENING REFERENCES

As more people have come to live under relatively artificial conditions, removed from nature and her phenomena, the Experiment Station has widened its frame of reference. The natural environment is now expected to supply not only an ever greater variety of high quality food at low cost, but also an aesthetically pleasing source of relaxation.

This situation generates a need for continually expanding knowledge and technology, which in turn requires repeated reassessment of research endeavors. The problems inherent in such dynamic flexibility have been particularly acute for the Utah Agricultural Experiment Station because increases in financial support over the past ten years have been substantially less than increased costs of doing research.

A year ago USU initiated a complete review of its on-going research and began to assess the relative priorities crucial to the future of the state. It was obvious that efforts had to be concentrated on fewer problems so that greater accomplishments could be realized in shorter periods of time. The research review and planning process had the goals of: identifying the researchable problems of greatest importance to Utah's agriculture and to rural living, and to her citizens' relation to nature; selecting from these areas not receiving adequate research attention from industry or public agencies in or out of the state; and then correlating the proposed areas with available staff and related resources.

REVIEWING PROPOSALS

Agricultural and community organizations were consulted about problems needing research. Distinguished scientists were brought to the campus from surrounding states and the US Department of Agriculture to review on-going research and recommend changes, while avoiding duplication of efforts in other states. Each college and department participating in Experiment Station research conducted intensive reviews and analyses of their programs and then proposed future courses of action. The proposals were broadly reviewed and comments were returned for further consideration. The net result was: of 175 active projects in July of 1971, 101 were terminated during the year. The other 74 that were revised and carried forward, included many that are scheduled to be terminated within 1 or 2 additional years. Sixty-six new projects were planned and approved for funding on July 1, 1972. The resultant overall 25 percent reduction in number of projects facilitated a refocusing of emphasis on fewer major problem areas.

The primary problem areas agreed on for Utah Agricultural Experiment Station research emphasis are briefly outlined below. Readers who want more information about specific areas, can obtain it on request.

ANIMALS

1. Reproduction and development; improvements in reproductive efficiency (beef, dairy, sheep and poultry), control of infectious and other diseases; and effects of environmental stress factors on reproduction and growth.

2. Group management of cattle, with major emphasis on dairy cattle; effects of herd size, facilities, and social interaction on production; relevance of sanitation, housing and other environmental factors.

3. Toxic substances and safety of animal products as these are relevant to specific Utah conditions.

4. Range livestock management and nutrition.

5. Livestock — big game interrelationships in the use of range and forest lands.

PLANTS

1. Fruits and vegetables.

Reduce frost damage of fruits; control viral and other diseases and insects; develop early-maturing, machine-harvestable tomatoes.

2. Livestock feed enhancement, including improving yields and achieving more efficient production of livestock feed crops.

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3. Small grain breeding and production to develop wheats resistant to new races of dwarf bunt smut and control winter killing of wheat.
4. Range improvements, including development of techniques and plant materials for establishing acreages of vigorously growing, palatable shrubs.
5. Control of weeds through improved practices.
6. Native plants for ornamentals; developing new ornamentals suitable for Utah by selecting and adapting native plants.

FOODS AND NUTRITION
1. New and improved food products.
2. Improve efficiency of food processing techniques.
3. Utilize by-products and dispose of wastes from food processing plants.

NATURAL RESOURCES
1. Conduct an inventory and develop use-criteria for the state's soil, water, climate and associated plants and wildlife.
2. Land-use policies and practices.
3. Optimize long-term use of all natural resources.
4. On-farm use of water, efficiency improvement.
5. Watershed management techniques to improve water supplies and other products.
6. Climate as it affects plant and animal performance.

PEST MANAGEMENT
1. Insects, with major emphasis on alfalfa weevil.
2. Diseases of plants and animals.
3. Weeds and poison plants.
4. Predators, especially in relation to livestock losses.

MAN-RELATED RESEARCH
1. Economic problems of commercial agriculture.
2. Economics of natural resource allocation and management—land, water, and air.
3. Community and human resources, including rural development, migration problems, and quality of living in rural communities.
4. Outdoor recreation and tourism.
5. Ornaments and environmental beauty.

SERVICES RELATED TO RESEARCH
1. Operation of animal disease diagnostic laboratories at Provo and Logan.
2. Soil and feed testing laboratory.
3. Plant disease survey.
5. Air pollution damage survey.

TRANSLATING AGRICULTURE INTO FOOD

When people need new homes, they generally turn to the want ads or to Realtors for help. When a University department needs a home, it turns to those it has served.

For USU’s Food Science and Industry Department — that could equate with virtually everyone in Utah who makes a habit of eating every day, plus former students and many of Utah’s food industries. Past and present research efforts are helping Utah and Intermountain cheese manufacturers, fruit growers, food processors and shippers, and consumers in search of valid nutritional information. The departmental teaching program regularly produces graduates who make additional direct contributions to the U.S. food industry.

Figure 1. Artist’s sketch of the proposed Nutrition and Food Science Center.
Right now, however, without a home to call their own, members of the department are finding themselves seriously hampered. Scattered through six buildings on campus, and with access only to inadequate laboratories that are used for graduate and undergraduate instruction as well as research, their productivity can't be optimized.

The State of Utah recognized USU's need for a Nutrition and Food Science center when it authorized an architectural firm to draw plans for a suitable building. The plans are an accomplished fact. Unfortunately, the financing (estimated $3.4 million) is not.

The University is therefore appealing to those who have already benefitted from the department's efforts—and stand to benefit even more if the building becomes reality. The State is being asked to appropriate $200,000. A federal agency is considering a request for $400,000.

The remaining $700,000 is being sought from private funds. Such donors can specify what area or equipment in the building they want to finance (laboratory, classroom, etc.). Their contribution will be acknowledged by a plaque or name plate in the designated area, or on the equipment.

In seeking money for a building, the USU Food Science and Industry Department is actually asking to be allowed to augment its inputs to the State's economy and the welfare of its citizens. As a mechanism for translating agriculture into food, the department has certainly proved its worth. Under improved working conditions, it could be even more effective.

DECEMBER 1972

New shapes for turkey

CARROLL DRAPER

Dark turkey meat is starting to show up in the market place in unexpected forms. Technological developments in meat binding, and the availability of effective equipment that de-bones and removes sinews and tendons have helped turkey producers respond to consumer demand for different turkey products in variously sized packages.

GROUND TURKEY

Ground dark meat has been leading the list in pounds sold. This is because consumers quickly realized that this product can be used in many recipes using ground meat. Since per capita consumption of hamburger in the United States is 32 pounds annually, it should not be too difficult for ground turkey meat to capture at least some of this market.

Ground turkey is prepared in two steps. The meat to be sold in supermarkets is ground at the processing plant through a three-fourths inch grinding head, packed in 50 pound boxes and sold in a frozen form. The retail store than re-grinds the amount needed for each day from a semi-frozen condition through a 3/16 inch plate.

By contrast, ground turkey meat to be used by institutional feeding establishments is ground initially at the processing plant through a 3/16 inch plate. This meat is then packed in ten pound tubes and sold direct.

STANDARDIZING

Some retail stores have been adding beef fat and selling the products as

Figure 1. Turkey bologna, salami, and frankfurters prepared by a Utah turkey co-op.
“Turkeyburger.” Federal regulations published as a purchasing guide in May 1972, however, state that turkeyburger shall consist of 100 percent turkey meat with skin and fat not in excess of natural proportions. This stipulation will help standardize ground turkey meat with less than 15 percent fat which is an acceptable amount of fat.

THE SAUSAGE SCENE

The turkey industry in Utah has a current goal of selling an estimated 1½ pounds of machine de-boned meat per capita in the state. This is the meat that cannot be separated economically from the carcass with a knife. Specialized machines complete the job. The meat comes from the machine in an emulsified form and is useful in making sausage products. Such products include all-meat frankfurters, bologna, salami, summer and pizza sausage foods.

The Utah State University Food Science Department made turkey salami for approximately 2 years and test marketed this product in several school lunch areas. Detailed records were kept on acceptance of this product by students in the elementary, junior and high schools.

While frankfurters, bologna, turkey sausage were not actually made on a production basis in the Food Science Department, assistance was given to commercial plants in the area of consulting on the development on these products and evaluating these products in the school lunch program.

Foot long, standard and dinner franks made of turkey are now being made and marketed in several outlets. USU chemical analyses of these turkey franks showed 18 percent protein, and 20 percent fat. This is considered to be very acceptable quality.

All-turkey bologna is being purchased for school lunch programs and an ever increasing amount is moving through supermarkets. The relatively mild flavor of this product appeals to many people. In market tests in New York, sales of Chicken Bologna was approximately 12 percent of red meat bologna sales. Preliminary observations with turkey bologna indicate that at least an equal percent is being sold in retail stores that carry the product on a regular basis.

Salami, summer sausage and pizza sausage are finding acceptance in the market place. These products are available in 2 pound chubs or regular 4-inch diameter casings. Pizza sausage has been especially popular in eating establishments catering to teenage groups, while salami is finding its niche in retail outlets.

TURKEY AS A HAM

Approximately five years ago one of the commercial companies did some product developing utilizing turkey dark meat in a smoked cooked turkey loaf. This suggestion was capitalized on by the Food Science Department at Utah State University and considerable research was conducted to develop a turkey ham type product for mass feeding institutions. Undoubtedly this was the first attempt anywhere in the nation to take a ham type product made from turkey meat and test market the product in mass feeding institutions such as the school lunch program. As a result of this early research work the product development by Utah State University, the market testing that followed this product has become fairly well known to the trade.

The results prompted one Utah commercial plant to begin making and distributing this product to supermarket and institutional feeding outlets in sizable quantities. The USU analyses of samples of turkey ham have indicated the product contains approximately 21 percent protein, 13 percent fat and only 200 calories per 3.5 ounce serving. Turkey ham thus is a very desirable product from a nutritional point of view. One of the largest school districts in Utah has ordered several tons of turkey ham on a repeat basis during the last year.

THE SNACK FOOD SYNDROME

Recent indications from the nutritional council indicate that 40 percent of the food currently consumed by Americans is in the form of quick service and snack foods. Emphasis is therefore being placed on making snack turkey sticks of salami, pepperoni, and summer and pizza sausage. These products are in the development stage, but will soon be ready for marketing.

High protein, low calories, ¼ inch thick, white-meat turkey cutlets are being test-marketed in the Sacramento area. This product is ready for frying as is practiced in quick service food establishments.

Turkey steaks approximately ¾ inch in thickness and weigh from 4 to 6 ounces each are being introduced into supermarkets in Utah, during the month of September. These steaks will be prepared from the breast meat of hen turkeys and will be merchandised in the fresh meat counters of supermarkets. These cutlets are designed for frying or baking and can be picked up by the consumer in an unfrozen condition for use within 3 to 5 days after purchasing.

The recent sharp climb in red meat prices has helped catalyze demand for products made from turkey meat. Once consumers have a chance to become acquainted with their nutritional and price advantages, the turkey innovations are expected to gain fair share of the market for meat.
ALFALFA INSECTS RESEARCH GETS NEW DIMENSIONS

Basic or applied. These two words briefly summarize a popular dichotomy of science. To many these are the “east and west” of science, never destined to meet or complement one another. USU, however, has just organized its alfalfa insect research into one project that will optimize a merger of basic and applied research.

Alfalfa production is of substantial economic significance to Utah agriculture. In 1970, about 44 percent of the state’s harvestable acreage produced 1,395,000 tons of alfalfa hay and 3,700,000 pounds of alfalfa seed. This had a value of about $35,000,000, and accounted for nearly one half of Utah’s 1970 value of harvestable crops. Further, much of the alfalfa production supported animal industries of the state.

Historically, Utah has been a leader in the field of alfalfa insect studies. Alfalfa insect work was started in 1904 with the alfalfa weevil investigations by E. G. Titus and continued through studies of lygus bugs, seed chalcids, and pollinators by C. J. Sorensen, F. V. Lieberman, B. A. Hawes, G. E. Bohart, D. W. Davis, and others.

Those who produce alfalfa seed and hay are constantly doing battle with destructive insects. The harmful insects such as the alfalfa weevil, need to be controlled. But the beneficial insects such as predators, parasites and pollinators need to be encouraged. Effective and economical attainment of these two conflicting goals without the use of dangerous chemicals is a principal goal of the new Agricultural Experiment Station Project. This project brings together scientists of the Station and of the College of Science.

FINANCING

Utah State has been the recipient of a large grant to study, in conjunction with four other universities, the interactions of alfalfa agriculture and its associated insects. Drs. D. W. Davis, B. A. Haws, and T. H. Hsiao are responsible for this research funded by the National Science Foundation, the Environmental Protection Agency, and the United States Department of Agriculture. The 5-university work is sponsored by the International Biological Program, and is coordinated nationally through the University of California at Berkeley. Dr. Davis of USU is a member of the 8-man national coordinating board.

ALFALFA WEEVIL

The alfalfa weevil is of major concern in the IBP study. Estimates show that this insect causes annual crop losses of about $56,000,000 in the United States, despite $14,000,000 being spent on its control. Utah State’s role will be to represent the Rocky Mountain states, to study cultural practices, and to study the impact of natural enemies on alfalfa pests. Methods and timing of harvest, irrigation, clipping, harrowing, and flaming will be investigated.

Important and basic studies of phagostimulants in alfalfa that elicit alfalfa weevil feeding have been conducted by Drs. Hsiao and T. M. Farley. These have been coordinated with Dr. Hsiao’s work on plant resistance to alfalfa weevils and the insect’s development cycle and reactions to laboratory rearing. If a reliable source of alfalfa weevils can be secured for laboratory use, other important investigations such as Dr. Youssef’s studies of microsporidian infection in insects can be applied to the alfalfa project.

POLLINATING INSECTS

The USDA-ARS has maintained an effective and respected insect-oriented laboratory at USU for many years. Formerly led by Dr. G. E. Bohart and now directed by Dr. F. D. Parker, laboratory personnel have made notable contributions to knowledge about the biology and taxonomy of wild bees and their parasites and predators. Pioneering research helped develop management techniques for alkali and leaf cutter bees for alfalfa pollination. Honey bees also have been studied for their alfalfa pollen collection. This work will provide a foundation for future research.

Drs. W. A. Brindley and N. N. Youssef, in other research supported by the USDA, are studying the effects of pesticides on bee pollinators. Dr. and Mrs. Hsiao are investigating the effects of hormones upon bees.

The new blending of expertise in agricultural entomology, toxicology, physiology, parasitology, and biochemistry is expected to make efficient and productive use of personnel and funds. The interdisciplinary Experiment Station project, with its supplementary national funding and coordination, should capitalize on past results and optimize future contributions.

STOP IT...

Before You Get Caught!

Moving parts on machinery have a way of grabbing things like loose sleeves and trouser legs... no matter how careful you are. The only safe way to avoid getting caught by moving parts is to make sure they aren’t moving when you work on them. So before you adjust, repair or clean a power machine make certain the power is off. Before you start, STOP IT!
Modern treatments retard spoilage of fruit & produce

D. K. SALUNKHE, M. T. WU and S. JADHAV

Consumer food buying patterns have changed rapidly in recent years. Now, about 40 percent of the food consumed by Americans consists of fruits and vegetables. For instance, the consumption of tomatoes alone has doubled in the past 20 years.

As the U.S. population continues to urbanize, the markets for fresh commodities are increasingly removed from the rural production centers, and transportation plays a much greater part in the overall scheme. Air-freight shipment even allows certain fresh fruits and vegetables such as strawberries to be raised in America and sold in Europe, Australia, New Zealand, and Japan.

Growers, shippers, wholesalers, and retailers therefore now have a common problem. They have to prolong the storage life of fresh produce and maintain its high quality without pricing themselves out of business.

SPOILAGE

Losses due to postharvest deterioration and diseases of fresh produce currently amount to 1 billion dollars annually. In the U.S. about 40 percent of the produce harvested is never consumed because of spoilage. In developing countries where modern facilities of refrigeration and controlled storage are less common, this figure could rise to 60 percent. Deterioration of fresh produce is caused by dehydration, discoloration, too-high or too-low temperatures, overripeness, bruising, and growth of microorganisms such as bacteria or fungi.

In many fruits ripening is associated with a rapid increase in respiration. This sudden upsurge, called the 'climacteric rise' in respiration, is often regarded as a turning point in the life of the fruits, when development and maturation are complete and before senescence and deterioration have set in. The climacteric maximum may occur before or after the fruit is detached from the vine, and this depends upon the fruits and the harvesting procedures. This type of respiratory behavior has not been observed universally in all fruits. Fruits have been classified into 2 types: climacteric and non-climacteric. Apple, apricot, avocado, banana, peach, pear, plum, and tomato belong to the former class and cherry, cucumber, fig, orange, grapefruit, lemon, pineapple, and strawberry belong to the latter class.

Fruits and vegetables are alive even though they are detached from the plant. They carry on respiration, taking in oxygen and giving off carbon dioxide, and gradually depleting their reserved foods such as sugars, acids, and fatty substances. The faster a fruit respires, the faster it ripens, and the sooner it deteriorates.

STORAGE FACTORS

Several methods are employed to prolong the storage life of fruits and vegetables such as low temperature, precooling, waxing, packaging, ionizing radiation, chemical treatments, modified atmosphere, and controlled atmosphere.

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Forty percent of the perishable produce harvested, worth over a billion dollars, is never consumed due to spoilage in the USA.

Losses are much greater in developing countries where storage and processing facilities are poor. Consequently, food has constantly been in short supply.

Some of Utah’s fruits and vegetables take a transcontinental journey before they reach the consumer.

Figure 1. Respiration is the index of living. When respiration increases, the shelf life of produce decreases. Respiration is measured as CO₂ evolved and/or O₂ uptake. Several instruments are employed to measure CO₂ or O₂ or both.
TEMPERATURE

The life processes occurring in harvested produce are essentially destructive. Cold storage is designed to reduce these destructive processes to a minimum. According to Van't Hoff's Law ($Q_{10}$), the rate of chemical reaction is doubled for every $18 \, F$ ($10 \, C$) increase in temperature. In other words, a fruit ripens about twice as fast at $50 \, F$ as it does at $32 \, F$ and about two times as fast at $68 \, F$ as at $50 \, F$. However, in certain fruits the temperature modification can triple or quadruple the rate of respiration, with subsequent rapid deterioration. Therefore optimum low temperatures are vital to delay ripening and deterioration of fresh produce. Optimum storage temperature varies from commodity to commodity. Certain fruits are susceptible to cold injury by temperatures that are not low enough to cause them to freeze. For example mature green tomatoes will be injured so they will not ripen properly if held at $32 \, F$ to $40 \, F$ for longer than 3 to 5 days, although the freezing point of a tomato is about $31 \, F$. Efficient and rapid cooling of certain produce at harvest by hydro-cooling retards the metabolic breakdown of the fruits as well as growth of microflora existing on the fruits. This helps extend storage life. Precooling by vacuum cooling has been successfully applied to lettuce, endive, cabbage, leeks, and onions. It takes 20 minutes to bring temperatures from $75 \, F$ down to $33 \, F$ and materially prolong the shelf-life of these vegetables during transit.

HYDRO-COOLING

Experiments have shown that hydro-cooling of peaches with Chlorox or Captan added to the cooling water significantly reduced decay caused by the brown rot or the Rhizopus fungus. Research conducted at Utah State University for 10 years indicated that hydro-cooled peaches and apricots lasted longer when given antifungal treatment (U-2069) than non-treated fruits. Hydro-cooling Lambert cherries in a solution of antifungal antibiotic, Mycostatin, (400 ppm) and subsequent packaging with Mylar 50 bag (polyethylene) followed by refrigerated storage at $32 \, F$ with 90 percent relative humidity, prolonged shelf-life up to 60 days.

WAXING

Waxing of the fruits restricts shrinkage caused by water loss and lowers the respiration or gas exchange. The wax containing anti-

Figure 2. Storage in a controlled atmosphere containing higher (5% or more) $CO_2$ and lower (5 to 10%) $O_2$ causes fruits to respire less, thus increasing storage life by retarding the ripening process.
fungal chemical is applied commercially on the surface of many fruits such as oranges and apples and at the stem end of tomatoes.

GROWTH REGULATIONS

Kinetic (6'-fururylaminopurine) and N6-benzyladenine have been successfully used to prolong the shelf-life of many kinds of leafy vegetables as lettuce, cabbage, and asparagus. Ethylene and Ethrel (2-chloroethylphosphonic acid) accelerate the ripening of "green wrap" tomato fruits.

IONIZING RADIATION

Pioneering research carried out since 1954 at Utah State University has indicated the potential of ionizing radiation with gamma rays to retard ripening and control micro-organisms. Strawberries treated with a dose of $2 \times 10^3$ rad had their shelf-life extended for about 15 days. Sweet cherries exposed to a dose of $3 \times 10^6$ rad had their storage life extended beyond 30 days. Sprouting of potatoes and onions was inhibited by a $10 \times 10^3$ rad dose. In many countries, radiation has been used commercially in the storage of mushrooms, potatoes, onions, and oranges. However, much more research needs to be done in this area.

CONTROLLED ATMOSPHERE STORAGE

Controlled atmosphere (CA), storage has been used for 50 years, but important improvements have taken place in the last 5 years. Controlled atmosphere storage is now used for such produce as apples, peaches, apricots, lettuce, pears, cherries, tomatoes, asparagus, potatoes, and sugar beets. Controlled atmosphere has no $O_2$ component. This lack prohibits ripening. Controlled atmosphere storage retards the metabolism of fresh produce and reduces the metabolism of micro-organisms and maggots.

Peach, plum and apricot fruits can be kept from 20 days to 1 month in closed containers if $O_2$ and $CO_2$ absorbents are present; pears and apples can be stored for about 3 months under these conditions. Experiments have shown that atmospheres consisting of 1.5 percent $CO_2$ and 2.5 percent $O_2$ inhibit the metabolism of apples and pears. Atmospheres of 10.5 percent $CO_2$ and 2.5 percent $O_2$ extended the shelf-life of cherries. Less decay generally occurred in peaches and nectarines stored at 32 F in 5 percent $CO_2$ than in those kept with zero $CO_2$. The firmness, pectins,
acidity, sugars, and tannins changed more slowly in CA-stored apricots and peaches than in those stored in a conventional refrigerated (CR) room.

Low-oxygen CA storage of tomatoes significantly reduces spoilage, inhibits black spot rot, improves tomato quality, and adds as much as 2 weeks to storage life, when compared with tomato fruits stored in air at the comparable temperature. Tomato fruits, initially mature green and held at 55°F for 6 weeks, stored significantly longer in 3 percent O₂ and zero CO₂ than in air. In the case of wheat and rice, controlled atmosphere (15% CO₂) also killed insects and weevils. The use of polyethylene bags to create modified atmosphere (high moisture, high CO₂, low O₂) also extends the shelf-life of fresh produce.

**SUB-ATMOSPHERIC STORAGE**

Sub-atmospheric pressure has recently been used to extend the storage life of fruits. This type of CA storage includes a reduction of atmospheric pressure, and has the same sort of effect as standard CA storage. In S-A storage, however, the ethylene and other gases produced by the respiring fruits are removed by a continuous evacuation of air.

Since ripening fruits produce ethylene in the presence of an adequate oxygen supply, removal of either oxygen or ethylene will delay ripening and extend the marketable life of the produce. In our laboratory, respiration of tomato fruits was reduced when fruits were subjected to presence of 88 mm Hg. The storage life of several fruits and vegetables can be increased from 20 to 92 percent when stored under refrigeration with a pressure of 658 to 709 mm Hg. The storage life of many commodities also is prolonged by ventilating them with air at less than the atmospheric pressure.

According to Dalton's law, in a gas mixture each component exerts the same pressure that it would exert if

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Rural residents of Utah and the other southwestern states are familiar with a group of desert pines known as pinyons. These rugged trees produce crops of protein-rich seeds, or pine-nuts, each fall, and it is from the Spanish name for the seeds, pinones, that they derive their common name. Thousands of southwesterners collect these nuts for recreation, and some collect them for the grocery shelves where they may retail for as much as $2.85 per pound. To the Indians of this region and northern Mexico pinyon nuts were once an important food item and the tree that bears them were treated with respect. For example, the Shoshonis picked their pine nuts off the ground after the cones had opened, and the naturalist John Muir watched the Indians of California beat the nuts loose from their cones with long poles. By contrast, many present-day nut collectors break off cone-bearing limbs, or tear the green cones loose with garden rakes, causing serious damage to the trees and lowering their productivity.

**FOUR U.S. SPECIES**

There are four species of pinyon pine found in the United States, and two of these are native to Utah. The more common of these is the Colorado pinyon (Pinus edulis). It is distributed in our state throughout the high plateau country—from Flaming Gorge in the north, to Cedar City and the Canyonlands country in the south. It is typical of the mesa tops and foothills of the drainage basin of the Colorado River. This pine has small thick-shelled nuts and needles that are clustered in pairs. It might be called the National Park tree, for it is one of the most common species of Canyonlands, Arches, Zion, and Capitol Reef, as well as Mesa Verde and Grand Canyon National Parks.

The other pinyon pine of Utah is the singleleaf pinyon (Pinus monophylla), a tree that has large thin-shelled nuts and needles that are attached individually to the stem. This highly drought-resistant tree is found mainly in the Great Basin, where it forms stands in such mountains as the Raft River, Grouse Creek, Tintic, Canyon, Confusion, Wah Wah, San Francisco, Pine Valley, and Beaver Dam ranges. It is widely distributed across Nevada and southern California, and into Baja California, Mexico.

**SINGLELEAF RANGE**

To the student of tree genetics and evolution, singleleaf pinyon is especially interesting, because its range overlaps those of two other closely-related species. In Utah, singleleaf and Colorado pinyons are found growing together in several areas where the Great Basin borders the plateau country. On the other side of its range, singleleaf pinyon is sometimes associated with Parry pinyon (Pinus quadrifolia) on the international border and in Baja California. Research in the Department of Forest Science at Utah State University has shown that in both areas singleleaf...
pinyon hybridizes with its pine relative.

This tells us that, despite the many millions of years that have elapsed since these species evolved from a common ancestor, they still have the ability to breed with each other. As a result, the genetically controlled characters of one species can be modified by those of the other through the exchange of wind-carried pollen. In the jargon of the geneticist, the species share a common “gene pool.”

Our research in Utah has shown that hybridization is active in some places right now, and has occurred in the past elsewhere. For example, in Tooele, Juab, and Iron Counties there are places where one can find both kinds of pine—the two-needed and the one-needed species. Growing among them are trees that have paired and single needles mixed together in varying proportions. These trees are also intermediate in anatomical features of the needles. Such variable populations are called “hybrid swarms” by geneticists and result from hybridization followed by backcrossing of the hybrids to their parents. We have found a similar hybrid swarm within the Grand Canyon. Recently, U.S. Forest Service researchers in California have artificially produced hybrids of Colorado pinyon and singleleaf pinyon, and their young trees have the same mixture of paired and single needles that we have found in wild hybridized populations.

Careful examination of trees in Utah, Nevada, and Colorado leads us to think that singleleaf pinyon once grew in places where it is now absent along the Colorado River, perhaps as far upstream as Dead Horse Point. We also think that southwesternly winds have, over the ages, carried a light rain of singleleaf pinyon pollen from the Great Basin up onto the Colorado Plateau, making the singleleaf pinyon gene pool available to the Colorado pinyon.

**ONE PROBLEM**

Although our pinyon pine research has carried us far afield, one of our most perplexing problems has arisen just a few miles from campus. Exploration of the Bear River Range and the Bear River Divide has disclosed a group of scattered pinyon pine stands. Four of these are in the mountains overlooking Cache Valley, and one is in the Crawford Mountains east of Randolph. The smallest stand consists of just two trees north of Logan Canyon; the largest is spread over six sections in the Blacksmith Fork area. Of these five small pinyon pine forests, four show evidence of hybridization between singleleaf and Colorado pinyon. This in itself is not surprising in view of the widespread hybridizing elsewhere, but these northern groves are disjunct stands. This means they are far from the main distribution area of their species. Since hybridization has occurred, both pinyon pine species must have been present. Yet the nearest extensive singleleaf pinyon stand is about 70 miles to the west, and the closest Colorado pinyons are 100 miles to the south in the Uinta Basin.

The disjunct groves, therefore, must either represent a new invasion by both species, or else they must be the remains of ancient stands that once grew across northern Utah. Ballistic studies show that the heavy wingless seeds of pinyon pines cannot be carried far by wind, and we doubt that both species have had their seeds carried to these locations by birds or mammals.

**OLD FOREST REMAINS**

For these reasons we think the pinyon groves of Cache and Riche Counties are the remains of old forests that have since disappeared from our area. Singleleaf pinyon could have migrated here from the northern Great Basin at a time when the climate was cooler and moister than now. Colorado pinyon might have moved up the Wasatch from the Uinta Basin, entering the northern counties at a time when it was warmer than today. Being in close proximity, the two closely-related pines could have interbred. Subsequent ecological changes could have caused both species to become extinct in this area, except for fragments of the original forests that happened to occupy certain sheltered sites. These survive to this day as reminders of the climatic changes that accompanied the ice ages of prehistoric times.

*(Continued on page 112)*

**Figure 2.** A singleleaf pinyon pine forest in the Great Basin.
That old adage about blood seems to be proving true. Researchers are finding that they can correlate easily identified components of the blood with productivity.

Determining whether a particular animal is genetically prepotent for certain characteristics has traditionally required time-consuming breeding tests. If the preliminary results of recent USU research are confirmed by in-progress work, animal breeders and producers may soon have access to a much less costly tool.

THE BLOOD TEST

The current work capitalizes on the ubiquity of protein. Sophisticated laboratory techniques are demonstrating that protein is far more than just an essential food nutrient. Various kinds of proteins (united in all having nitrogen as a component) are being identified in animal tissues and body fluids. Both individual and species are known to differ in the kinds of proteins that occur in their body fluids. The USU research is applying the identification techniques to sheep and cow milk and blood.

The differences are often associated with differential electrical charges on the protein molecule, which induce the proteins to migrate at varying rates in an electrical field. This process, known as electrophoresis, permits the separation of individual types of various proteins in milk and blood serum of animals. An example of the type of variation found in milk is shown in figure 1. Samples 1 to 6 are sheep milk. Variation may be noted in the a-s casein region, with samples 4 and 6 having extra bands. Also, samples 5 and 6 have an extra, faster moving band in the β-casein region. Samples 7 to 9 are from cows' milk and are included as an illustration of the tremendous variation between species.

SHEEP TYPING

The USU researchers are now typing sheep for milk β-lactoglobulin, blood serum transferrin (the metal-binding system that transports iron), and red cell hemoglobin (the oxygen carrier) in addition to the previously mentioned milk caseins. Tissue myoglobins (oxygen carriers in muscle) are also being investigated. The primary objectives of the current research are to identify the variation that exists in western range breeds, to establish the gene frequencies for alternative gene forms for each protein type, and to determine whether the genes are in any way related to animal productivity. If productivity-modifying genes can be identified by simple electrophoresis of blood, all phases of the animal industry could benefit.

GENE FREQUENCIES

Gene frequencies observed in a preliminary study with sheep are given in table 1. Much more variation was found in the blood serum transferrin system than in the milk protein systems. TFE was the most frequently occurring transferrin gene, constituting 32 percent of the 5 identified genes. TFE was relatively rare repres...
senting only 6 percent of the total. There was little variation in the milk caseins of sheep. Over 98 percent of the $\beta$-caseins and 96 percent of the $\alpha$ casein genes were of one type.

To study the relationship between the various protein systems and productivity, weaning weight was the trait chosen. It represents a measure of both the milk producing and mothering ability of ewes, and of the livability and growthiness of lambs. Using statistical methods, an estimate of the relative influence of each type within the various systems was obtained (table 2). The blood serum transferrin type of the ewe had the most influence on lamb weaning weight. The largest difference (26.8 kg) was between TF$^A$/TF$^E$ and TF$^D$/TF$^D$. These differences were statistically significant. These tentative results based on a population of approximately 500 sheep indicate some promise of selecting genetically superior breeding animals based on electrophoretic protein typing.

**PRODUCE TREATMENTS**

(Continued from page 108)

it were present alone at the same temperature in the volume occupied by the mixture of gases. The subatmosphere storage conditions accelerate the escape of the ripening hormone (ethylene) from the tissue since diffusion is inversely related to atmospheric pressure. By lowering oxygen tension, fruit sensitivity to the hormone also is reduced. Some of our experiments determined the effects of different levels of vacuum on the ripening. Specifically, we found that low pressure (180-190 mm Hg) retarded tomato fruit ripening the most when the oxygen partial pressure was reduced. When oxygen pressures were held constant, different levels of total hypobaric pressure caused little if any difference in retardation.

**PINYON PINES**

(Continued from page 110)

Looking into the past in this way of course requires a lot of guesswork; and scientific proof for one's ideas is hard to come by. Future research on the pinyon pines will, we hope, give us firmer information about the genetic architecture of these interesting trees. Our immediate plans call for comparative studies of the enzyme chemistry of the pinyon species of Utah and their hybrids. This will give us further insight into the complex problem of pine evolution in the western deserts.

---

**Table 1. Gene frequencies in serum transferrin as correlated with three milk protein systems of sheep**

<table>
<thead>
<tr>
<th>System</th>
<th>Gene</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>.18</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>.19</td>
</tr>
<tr>
<td>C</td>
<td></td>
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<tr>
<td>E</td>
<td></td>
<td>.06</td>
</tr>
<tr>
<td>AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LG</td>
<td>A</td>
<td>.77</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>.23</td>
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<tr>
<td>CN</td>
<td>+/</td>
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<td></td>
<td>AB</td>
<td>.04</td>
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<tr>
<td></td>
<td>+</td>
<td>.98</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>.02</td>
</tr>
</tbody>
</table>

* The + symbol indicates the most commonly encountered gene

**Table 2. Effect of TF, LG, $\alpha$-S, and $\beta$-CN type of weaning weight of lambs**

<table>
<thead>
<tr>
<th>System</th>
<th>Type of dam</th>
<th>Weaning wt. kg</th>
<th>Type of lamb</th>
<th>Weaning wt. kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA</td>
<td>10.0</td>
<td>AA</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>AB</td>
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<td>AB</td>
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<tr>
<td></td>
<td>AC</td>
<td>-1.0</td>
<td>AC</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>AD</td>
<td>3.3</td>
<td>AD</td>
<td>-2.6</td>
</tr>
<tr>
<td>TF</td>
<td>AE</td>
<td>11.1</td>
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<td></td>
<td>BB</td>
<td>-4.9</td>
<td>BC</td>
<td>3.8</td>
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<td></td>
<td>BC</td>
<td>2.7</td>
<td>BD</td>
<td>-0.1</td>
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<td></td>
<td>BD</td>
<td>1.9</td>
<td>BE</td>
<td>-3.5</td>
</tr>
<tr>
<td></td>
<td>BE</td>
<td>-1.0</td>
<td>CC</td>
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<tr>
<td></td>
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<td>DD</td>
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<td>EE</td>
<td></td>
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<tr>
<td>LG</td>
<td>AA</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AB</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BB</td>
<td>-2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha$-CN</td>
<td>+/+/</td>
<td>-0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>+/AB</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta$-CN</td>
<td>+/+</td>
<td>-6.3</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>+/A</td>
<td>6.3</td>
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</tr>
</tbody>
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* The + symbol indicates the most commonly encountered gene
Genetic improvement of dairy cattle

R. C. LAMB

Increased production from soil, plants, animals, men and machines has characterized American agriculture during the past half century and has been one of the prime factors in creating the most efficient agricultural industry in the world. A very significant by-product of this efficiency is that fewer people are needed to produce the food that we eat, releasing many to produce the multitude of consumer goods and services that we all enjoy.

Increased production by dairy cow has contributed to the overall picture and has been particularly dramatic during the past two decades. This is shown graphically in figure 1 for cows in Utah. Annual milk production per cow has increased 45 percent during the last 20 years for an annual increase of 2.25 percent. About half of this increase is due directly to genetic improvement. Butterfat production has not increased quite as sharply (25 percent), reflecting a trend to fewer cows of the high-fat-producing breeds, and a tendency to select for high milk production with a lower fat content within breeds. This is in response to a consumer demand for low-fat milk and dairy products. The decreasing trend in fat content in milk (from 4.16 to 3.64 percent fat) is also shown in figure 1.

Higher production of dairy cattle, as with any class of livestock, is dependent upon the right combination of genetics, nutrition and management. The advent of artificial insemination in the early 1950s has played a key role in spurring the improvement in milk production per cow. Artificial insemination (AI) made it possible for outstanding bulls to sire thousands rather than a few calves each year. With this opportunity for improved genetics, dairymen reacted by providing more feed and better management to realize the higher potential of the cattle they were developing.

SIRE PREDICTED DIFFERENCE

But, as with any new program, unless improvements continue to be made, the gains soon start to level off. The dairy cattle situation has started to follow this pattern in recent years (figure 1). Fortunately, dairy cattle geneticists at Cornell University and the Dairy Cattle Research Branch of USDA began working in the early 1960s on new tools for selecting the best bulls for use in AI. The result has been an entirely new concept in evaluating dairy sires. This new method, now in use in the national sire proving program, compares the daughters of one bull with all contemporary cows freshening in the same herd during the same time of year. The result is a daughter-herdmate comparison. Adjusting this comparison for number of daughters, number of herdmates and breed average production, a Predicted Difference (PD) is calculated that represents the expected increase or decrease of future daughters over their herdmates. Along with the PD, a repeatability or confidence value is determined. This confidence value tells us how sure we are that the PD is the best estimate of a sire’s true transmitting ability.

The PD program on dairy bulls has been in effect long enough to show that its use will improve the genetic ability of the dairy population for milk production. In a recent study of the USU dairy herd, thirty Holstein bulls were evaluated. These bulls had been selected for use in the USU herd based on the old daughter-dam comparison, out now have a USDA daughter-herdmate comparison available. The most recent USDA sire

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evaluation was used. This included data on all tested daughters of each bull from all across the U.S. The PD values and the performances of daughters in the USU herd of the high, low and middle five sires are shown in table 1.

Because the University herd is above average in production, the deviations of daughters from herdmates was about 300 pounds of fat-corrected-milk (FCM) below the predicted difference estimated by USDA for all levels of bulls. It is clearly obvious, however, that minus PD bulls will sire below average daughters, high plus PD bulls will sire high-producing daughters, and average PD bulls will sire average daughters.

A study by USDA scientists found that for each 100-pound increase in PD for milk of a sire, his daughters returned an average of $3.22 over feed costs per lactation. Thus, the difference between a plus 1,000 pound PD bull and an average bull is $32.20 per daughter per year. Translated into terms of an average-sized Utah herd (66 cows) this could mean a difference in income over feed costs of $2,125 per year.

An evaluation of all AI bulls is made every four months by USDA. A summary of all the AI bulls that are available to Utah dairymen is compiled every four months by the State Extension Dairymen and free copies are available to dairymen from County Agents. Each dairy breed association also compiles this information, plus data on type characteristics transmitted by bulls in their breed. This summary is available to dairymen from the breed organization for a small charge.

**Table 1. Performance of Bulls Used in Utah State University Herd**

<table>
<thead>
<tr>
<th>USDA</th>
<th>Sire Summary</th>
<th>PD Milk</th>
<th>Diff</th>
<th>USU Herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sires</td>
<td>% Repeat</td>
<td></td>
<td></td>
<td>No Dus</td>
</tr>
<tr>
<td>High 5</td>
<td>93</td>
<td>995</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Middle 5</td>
<td>71</td>
<td>188</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Low 5</td>
<td>91</td>
<td>-835</td>
<td>-24</td>
<td>24</td>
</tr>
</tbody>
</table>

**FEED UTILIZATION EFFICIENCY**

While increasing milk production per cow is important, genetic research with dairy cattle at USU for the past decade has had the equally important aim of improving the efficiency with which feed is converted into milk. Three hundred fifty daughters of 22 different sires have been fed individually for a complete first lactation to measure their efficiency of feed conversion. Individual cows varied in gross efficiency from 15 to 35 percent. Both genetics and nutrition were shown to influence this efficiency.

From a nutrition standpoint, production increased as grain consumption increased, but efficiency did not follow the same pattern. Highest average gross efficiency was obtained on a standard ration of hay free choice plus one pound of grain for each 3 pounds of milk (average grain consumption was 10 pounds per day). Efficiency of feed conversion declined if the amount of grain was decreased to 3 or 0 pounds per day or if it was increased to 17 pounds per day.

Sire groups ranged from 21 to 29 percent in gross efficiency. Estimates of heritability of feed efficiency are about .30, which is comparable to estimates of heritability for milk production. In other words, selection for greater efficiency in converting feed to milk should be as effective in increasing the genetic ability of dairy cows for efficiency as has been selection for milk production in contributing to the increases shown in figure 1.

Level of production and gross feed efficiency were highly correlated, suggesting that a practical method for improving efficiency is to continue to test and select for high production.

**PROTEIN AND FAT IN MILK**

It was mentioned earlier that butterfat in milk is losing favor with the consumer, who is now looking at protein as an important component in milk. Beginning in 1962, the USDA Department of Dairy Science began determining the protein content of milk from individual cows in the USU herd. Over the test period, the percent protein in the milk has averaged 3.4 percent. A definite seasonal trend occurs in protein content. The lowest test is recorded during the hot summer months of June, July and August, while the highest is obtained during the cold months of December, January and February. The lactation curve for protein in milk follows the same general shape as that for butterfat, with the low point falling about 90 days after calving, after which it gradually increases throughout the remainder of the lactation. The protein content of milk shows a slight tendency to decrease with advancing age.

The correlation between percent butterfat and percent protein was about .50. This indicates that generally, though not always, high fat milk is also high in protein. However, the correlation is not high enough to enable use of the fat test to predict protein content with adequate accuracy. This correlation also means it will be difficult, though not impossible, to increase protein while decreasing fat content. The heritability of percent protein is about .60, which is higher than for total milk production or gross efficiency, but lower than for butterfat percent.

Evaluation of all available data indicates that the greatest genetic progress in improving dairy production will result from testing all dairy cattle for major components in milk (fat, protein and perhaps lactose); and then selecting for highest milk production first while secondly trying to increase protein test without necessarily increasing fat test. This should give the greatest genetic improvement in total pounds of milk products per cow with the highest feed utilization efficiency.
Rural development: its dimensions and focus

STAN L. ALBRECHT

Concern and dissatisfaction have been expressed from many quarters about the continued concentration of population in large cities. Many have come to accept the view that the bad things happening in large cities (crime, riots, congestion, growing fiscal problems, etc.) must be caused by their largeness and that as the population in the cities continues to increase, they will become more "politically unmanageable, socially intolerable and economically inefficient."

The movement from farm and rural areas to the city has been rather large and rapid for a number of decades. While in 1800 over 90 percent of the population of the United States lived in a rural environment, today approximately 75 percent of our population is urban. Nationally, between 1960 and 1970 about two-fifths of the counties in the United States lost population and an additional one-third of the counties gained at less than the national average. Almost all of the counties losing population are rural counties and for many of these, the population decline has continued for several decades.

The trend in Utah follows closely the national pattern of population distribution. While the population of the State increased by almost 20 percent between 1960 and 1970, 13 of Utah's 29 counties lost population during this period. Of the 13 counties losing population, 10 are classified as being 100 percent rural. In many of these areas, there has been a virtual loss of major economic activity and many of them have little hope for the future. As the active leave, the capacity to maintain community viability diminishes.

Both the State and National trends appear likely to continue at least in part because the out-migration from many rural counties has left behind what is basically an elderly population with the young moving to urban areas in search of employment. This, in turn, results in relatively high death rates, low birth rates and a declining population.

As suggested above, this movement from rural to urban areas not only results in problems for areas left behind but sometimes contributes to the already burdensome problems of the urban community. Many of the migrants from small towns are ill-prepared for the urban life within which they find themselves. Consequently, they are frequently found at the bottom of the social scale in terms of the types of jobs they obtain, the housing they are able to secure, and so on.

Any program of population redistribution, however, implies a willingness or interest on the part of a significant proportion of the urban residents to move to a more rural area. It also implies that there are important characteristics about rural areas that make them appealing and desirable. To ascertain the extent to which this is the case, research is being conducted at Utah State University of the availability and adequacy of services. Interviews also included a number of questions designed to determine attitudes that people hold toward their community. In addition, we sought to determine what combination of factors cause people to feel positive or negative toward their community as a place to live.

Data presented in the tables of this paper were collected through the use of interviews conducted in the homes of a random sample of residents of three rural southern Utah counties, Wayne, Piute, and Beaver,\(^1\) as well as a section of Salt Lake County. The rural counties included in the study were selected because of their history of population loss for several decades. Further, because of our special interest in the provision of health services, these counties offered rather unique characteristics for comparison. While neither Wayne nor Piute counties have hospitals or doctors within their boundaries, Beaver County has two hospitals, three doctors, and two medical technicians.

The urban sample was taken from the western area of Salt Lake County. Communities included in the study were Kearns, Granger, Hunter and Taylorsville. The reason for selecting the urban sample was basically comparative. We wanted to examine the attitudes toward community of both rural and urban residents. Further, the urban area selected is characterized by a fairly high concentration of migrants from rural areas. Thus, this allows us to look at the attitudes of rural residents, rural migrants to an urban area, and persons who have spent most or all of their lives in an urban setting.

It should be emphasized that our Salt Lake sample was drawn only from the Valley West communities. Therefore, our findings are not necessarily generalizable to other areas of the Salt Lake Valley.

A total of 303 interviews were conducted in the three rural counties,

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\(^1\) Additional data have been collected from Carbon County. However, this information was not ready in time for inclusion in this report.
and an additional 173 interviews were completed in Salt Lake County.

After a brief introduction and some preliminary questions, each of the subjects interviewed in the study was asked to indicate how well he or she liked living in the community where they lived. While general satisfaction with community was expressed by most of the respondents, the percentage responding that they were "very much" satisfied varied greatly between the rural and urban areas. Seventy-four percent, 77 percent, and 80 percent of the Piute, Wayne, and Beaver County residents, respectively, stated that they were very much satisfied with living in their community. On the other hand, 42 percent of the urban respondents selected this response.

The trend identified by this question carried over to each of the additional questions dealing with community satisfaction. Each of the subjects was shown a map depicting the state of Utah divided into the eight geographic regions designated by the State as multi-county areas (see Figure 1). Subjects were asked to select the area on the map where they would most like to live and where they would least like to live. Tables 1 and 2 show the responses to this question.

The residents of Wayne and Beaver Counties are clearly most satisfied with their own area as a place to live as judged by responses to this question. Ninety-three and 83 percent of the Wayne and Beaver respondents, respectively, selected their own area as where they would most want to live. Fifty-one percent of the Piute respondents and 45 percent of those from Salt Lake County selected their own area. However, with the Piute respondents, most of those selecting an area, other than their own selected a neighboring rural area. Responses from Salt Lake were much more varied. Perhaps the most interesting observation is that over half of the urban respondents said they would prefer living other than where they now reside. Further, less than two percent of the rural respondents would prefer living in the Salt Lake-Tooele area with other Wasatch Front Counties receiving little, if any, more interest.

Turning to the other side of the coin, there was a high degree of consensus among the residents of the three rural counties that the Salt Lake-Tooele region was the area of the state where they would least like to live. Between 50 and 62 percent of the rural subjects gave this response. The only other area rejected by a significant proportion of our subjects was the "out of state" category. Many of the persons selecting this category were more specific in indicating some large city as being most undesirable as a place to live.

Even with the Salt Lake sample, a larger percentage picked the Salt Lake-Tooele area than any other as where they would least like to live. However, responses from the urban sample were widely scattered among the various alternatives available.

When asked what it was that made the area selected more attractive than where they now were, two general types of responses were emphasized by the urban sample. The first of these had to do with size of population and friendliness of the people, while the other had to do with access to the out-of-doors and the absence of a polluted environment. Forty-five percent of the urban respondents mentioned they would prefer a smaller town, frequently mentioning that people were more friendly in such areas. Another 45 percent said they would like greater access to an out-of-doors area where pollution and crowding were not problems. Twenty percent of the urban residents said they would be willing to take up to a 10 percent or greater cut in their level of living in order to live in an area with the above-mentioned characteristics. The major factor holding them back was the unavailability of jobs in these areas.

Figure 1. Suppose you could live anywhere you wanted in Utah or even outside of the State. Please look at the map and indicate where you would most like and where you would least like to live. (Circle number of one choice in each column.) (Interview form)
In order to get a better idea of what it is that makes a community attractive to its residents, all of the subjects were asked to list what they perceived as being the major advantages of living in their community and what they perceived as being the major disadvantages of living there. Table 3 lists the four factors that were most frequently mentioned by the subjects in each county as being the major advantages of their area.

Respondents in all three of the rural counties listed access to the out-of-doors and open spaces as being one of the major advantages of living in their area. As discussed above, this was frequently mentioned by the urban sample as something they felt was important but didn’t have where they lived. Access to the out-of-doors was mentioned first in both Beaver and Piute Counties and third in Wayne County. All three counties also mentioned their area as being a “good place to raise a family” and placed this factor either first or second in order of importance. A third factor, friendliness of the people, was again a consensus item for the rural counties. Finally, Beaver and Wayne County residents mentioned absence of a polluted environment as being the fourth major advantage of their area. Piute County residents substituted quality of schools for this item.

When we turn to the advantages of urban living as perceived by our Salt Lake County sample, we discover that availability of good shopping facilities is most frequently mentioned as a major advantage of living in that area. The second factor mentioned, a good place to raise a family, coincides with the emphasis placed on this item by the rural samples. The other two factors most frequently mentioned by the urban samples were quality of religious life and quality of schools.

Table 4 presents those factors which were perceived by our respondents as being the major disadvantages of living in their area. Again, we see a good deal of consensus on the part of our rural respondents. Wayne and Piute respondents rank the absence of adequate medical and health facilities as being the most serious problem faced by their communities. Beaver County residents with two hospitals, did not view this as a problem for their area. All three counties were in agreement that their areas were in serious need of job opportunities for young people and better shopping facilities. Beaver and Wayne County residents ranked their areas low in terms of local opportunities for earning a liveable income and Beaver and Piute Counties included the absence of opportunities for cultural refinement as being one of the four major problems of their area.

Turning to our urban sample, we find that more people listed inadequate recreational opportunities as the major disadvantage than any other. The next two most frequently mentioned factors were similar to those stressed by the rural sample—availability of good jobs for young people and opportunities for cultural refinement. The fourth factor mentioned as a major disadvantage of urban living was one mentioned as a major advantage of rural living by most of our rural samples—absence of a polluted environment.
### Table 1. Area where respondents would most like to live

<table>
<thead>
<tr>
<th>Where Respondents Now Live</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 4</th>
<th>Area 5</th>
<th>Area 6</th>
<th>Area 7</th>
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<th>Area 9</th>
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<tr>
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<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
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<tr>
<td>Beaver</td>
<td>149 82.8</td>
<td>1 0</td>
<td>5 2.8</td>
<td>0 0</td>
<td>6 3.3</td>
<td>1 0</td>
<td>2 1.1</td>
<td>3 1.7</td>
<td>13 7.2</td>
</tr>
<tr>
<td>Wayne</td>
<td>0 0</td>
<td>1 1.4</td>
<td>64 93</td>
<td>1 1.4</td>
<td>0 0</td>
<td>2 3</td>
<td>0 0</td>
<td>1 1.4</td>
<td>0 0</td>
</tr>
<tr>
<td>Piute</td>
<td>19 35.2</td>
<td>0 0</td>
<td>28 51</td>
<td>0 0</td>
<td>4 7.4</td>
<td>1 2</td>
<td>0 0</td>
<td>1 2</td>
<td>1 2</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>10 5.8</td>
<td>10 5.8</td>
<td>5 2.9</td>
<td>7 4</td>
<td>23 13.3</td>
<td>78 45.1</td>
<td>12 6.9</td>
<td>4 2.3</td>
<td>23 13.3</td>
</tr>
</tbody>
</table>

### Table 2. Area where respondents would least like to live

<table>
<thead>
<tr>
<th>Where Respondents Now Live</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 4</th>
<th>Area 5</th>
<th>Area 6</th>
<th>Area 7</th>
<th>Area 8</th>
<th>Area 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
</tr>
<tr>
<td>Beaver</td>
<td>14 7.8</td>
<td>7 3.9</td>
<td>2 1.1</td>
<td>0 0</td>
<td>0 0</td>
<td>90 50</td>
<td>0 0</td>
<td>1 0.6</td>
<td>56 31.1</td>
</tr>
<tr>
<td>Wayne</td>
<td>2 2.9</td>
<td>4 5.8</td>
<td>0 0</td>
<td>4 5.8</td>
<td>5 7.2</td>
<td>43 62.3</td>
<td>1 1.4</td>
<td>4 5.8</td>
<td>5 7.2</td>
</tr>
<tr>
<td>Piute</td>
<td>0 0</td>
<td>2 3.7</td>
<td>1 1.9</td>
<td>2 3.7</td>
<td>0 0</td>
<td>28 51.9</td>
<td>0 0</td>
<td>1 1.9</td>
<td>17 31.5</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>15 8.7</td>
<td>26 15</td>
<td>11 6.4</td>
<td>16 9.2</td>
<td>2 1.2</td>
<td>29 16.8</td>
<td>7 4</td>
<td>6 3.5</td>
<td>25 14.5</td>
</tr>
</tbody>
</table>
Table 3. What are the major advantages of living in your community

<table>
<thead>
<tr>
<th>Most frequently mentioned in order of rank</th>
<th>Beaver</th>
<th>Wayne</th>
<th>Plute</th>
<th>Salt Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Access to out-of-doors and wide open spaces</td>
<td>A good place to raise a family</td>
<td>A good place to raise a family</td>
<td>Availability of good shopping facilities</td>
</tr>
<tr>
<td>1</td>
<td>Good place to raise a family</td>
<td>Friendliness of the people</td>
<td>Access to out-of-doors and wide open spaces</td>
<td>A good place to raise a family</td>
</tr>
<tr>
<td>2</td>
<td>Friendliness of the people</td>
<td>Access to out-of-doors and wide open spaces</td>
<td>Friendliness of the people</td>
<td>Quality of religious life</td>
</tr>
<tr>
<td>3</td>
<td>Absence of a polluted environment</td>
<td>Absence of a polluted environment</td>
<td>Quality of schools and other educational facilities</td>
<td>Quality of schools and other educational facilities</td>
</tr>
</tbody>
</table>

Table 4. What are the major disadvantages of living in your community

<table>
<thead>
<tr>
<th>Most frequently mentioned in order of rank</th>
<th>Beaver</th>
<th>Wayne</th>
<th>Plute</th>
<th>Salt Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Availability of good jobs for young people</td>
<td>Adequacy of medical and health facilities</td>
<td>Adequacy of medical and health facilities</td>
<td>Recreational opportunity</td>
</tr>
<tr>
<td>1</td>
<td>Availability of good shopping facilities</td>
<td>Availability of good jobs for young people</td>
<td>Availability of good jobs for young people</td>
<td>Availability of good jobs for young people</td>
</tr>
<tr>
<td>2</td>
<td>Opportunities for cultural refinement</td>
<td>Opportunities for earning a liveable income</td>
<td>Availability of good shopping facilities</td>
<td>Opportunities for cultural refinement</td>
</tr>
<tr>
<td>3</td>
<td>Opportunities for earning a liveable income</td>
<td>Availability of good shopping facilities</td>
<td>Opportunity for cultural refinement</td>
<td>Absence of a polluted environment</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The above data seem to demonstrate that there are a number of important factors that affect how people feel about and respond to their community. Many individuals choose what may be viewed in strictly economic terms as a lower standard of living to obtain other things that they value and deem important. Thus, while we may be able to demonstrate that it would be economically advantageous to migrate from rural Utah to the Wasatch Front, we must recognize other variables that go into that decision. Many persons in rural areas appear to choose not to migrate, even though they may be better off financially if they were to do so.

Clearly, people perceive values which can be realized in their own community which may have to be given up in migration and which make up for income lost by not choosing that option. Our data suggest that these values center around several areas. Many people clearly value such things as access to the outdoors, including outdoor recreation, as well as an unpolluted environment. Others emphasize the importance of closeness to family and kin and the primary relationships they are able to maintain in smaller, rural communities. Here relationships are more often seen as being close and person-oriented rather than being secondary and object-oriented. Persons used to close, personal relationships — such as knowing practically everyone one associates with on a first-name basis — frequently find it hard to adjust to the more impersonal relationships that characterize urban settings.

Many people seem to feel that giving up these things for the economic advantages of urban living is too much to pay. The point seems clearly to be that what is defined as "the good life" is an individual decision. We cannot decide for someone else. Obviously, different individuals are going to put emphasis on different things. While there may be some ideal state of affairs that constitutes the maximum in quality of life, ultimately each individual will still have his own value hierarchy which defines what is ideal for him. We may disagree with his emphasis, but it is not our place to tell him that he is wrong. Rather, it is more our role to determine as best we can such things as minimum or ideal levels of services that will meet the social values of communities and of individuals and then to determine what variables can be manipulated to increase the probability of attaining the same.

One caution must be suggested in looking at the data presented in the tables. There seems to be little question that many of the attitudes that urban residents hold about rural life are based on unrealistic nostalgia about what that life is like. Nevertheless, we cannot deny that there is something about life in the larger city that is dissatisfying to a relatively large proportion of people. What is more, even if one wants to argue that reversing the migration from rural to urban areas is neither feasible nor desirable, the possibility of improving the quality of life and service delivery in rural America and rural Utah still deserves our concern and attention. In the case of education, for example, if rurally educated children must compete for jobs in an urban marketplace with urban educated children, every effort should be put forth to make rural education equal in quality.

In conclusion, rural development may very well be an idea whose time has come. There is much about rural life that is good and much that can be done to make it even better. The principle goal of an expanded program of rural development research will not be that of simply adding another layer to the already high stack of dusty and frequently unread reports on rural life, but to provide a basis for action programs for rural people. Traditional commodity-oriented research programs in Landgrant Universities have paid handsome dividends for agricultural development. The goal now is to apply the same effort and skills that have worked so well for commercial agriculture to the solving of some of the "human" and "social" problems of development of rural America. Since this program of research has strong action goals, the Extension Service and other action agencies will have an important role in carrying programs backed by research findings to the solving of pressing rural problems. Hopefully, such action-oriented agencies will view themselves as partners with the researcher in this important effort.


RESEARCH NOTES
ABOUT STRESS

Stress is a result of environment. Adaptability, whether inherited or acquired, is a method by which the animal copes with stress, whether imposed by weather, disease, or specific management practices.

USU research has shown that the amount of feed available to the animals will influence the reproductive performance of both sheep and cattle. This relationship is more critical during the breeding season than during pregnancy.

Severe chilling did not adversely affect maintenance of pregnancy in sheep up to the point of causing maternal death. Such deaths in sheep were associated with a body temperature lowered by as much as 14°F.

Various diseases can be especially stressful during pregnancy. Some of these problems have been solved by vaccination, but others are still unsolved.

Moving animals, e.g., from feedlot to range, can interfere with normal breeding cycles, probably because of hormonal responses to the stress involved. The social structure attained in groups of animals has also been observed to influence normal breeding cycles. This structure usually involved dominant/subordinate interactions.

Much of the research that supports these statements has been conducted at USU within regional cooperative projects. Such projects unite the efforts of researchers in many states and federal laboratories.
Men and swine have a number of physiological and anatomic similarities that make swine an excellent animal model for human-related research. The pig has similar intestinal systems which metabolize nutrients in approximately the same manner as man. They suffer from similar degenerative diseases as man such as anemia, ulcers, atherosclerosis and cardiac disease.

The infant pig, three days to one month of age, has proven particularly well-adapted for research involving nutrients needed for bone growth. An infant pig fed a formulated diet in the laboratory will double his 3-day weight by the time he is 15 days old and will double his 15-day weight by the time he is 30 days old. This rapid rate of growth provides a sensitive measure for the nutritional quality of a diet.

ANTACIDS AND NUTRITION

The USU scientists are trying to solve some of the health problems that people experience which are believed to be nutritional in origin. In one series of balance trials, sodium bicarbonate buffer was infused into the stomachs of young pigs at a rate calculated to neutralize the gastric acid. During the control period pigs were infused with a saline solution. The research demonstrated the influence of gastric acidity on calcium and iron absorption, and the results (table 1) are relevant to people who use antacids excessively or who have partial gastrectomies. Since gastric acid is necessary for optimum absorption and utilization of dietary calcium and iron, its lack or neutralization will affect nutrient utilization.

The long-term goal of this research is to determine the relationship between nutrient-intake and utilization and some common nutritional deficiencies such as iron deficiency anemia and osteoporosis.

Table 1. Effect of intra-gastric infusion of sodium bicarbonate on the utilization of dietary calcium and iron by pigs

<table>
<thead>
<tr>
<th>Period</th>
<th>Ca, % Apparent absorption</th>
<th>Fe, % Apparent absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>35.0 ± 3.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.9 ± 8.6</td>
</tr>
<tr>
<td>NaHCO₃</td>
<td>30.5 ± 2.2</td>
<td>25.7 ± 6.1</td>
</tr>
</tbody>
</table>

<sup>a</sup> Mean ± standard error. Eight observations per treatment.

D. G. HENDRICKS is an Assistant Professor in the Department of Nutrition and Food Science.
A. W. MAHONEY is an Associate Professor in the Department of Nutrition and Food Service.

DECEMBER 1972
DIETARY COMPONENTS AND NUTRIENT AVAILABILITY

In other experiments, researchers are checking the effects of different levels of soybean protein and vitamin D on bone strength. The phytin phosphorus in soybean flour is largely unavailable (cannot be digested) to the infant pig. Therefore, unless pigs on a basically soybean diet are supplemented with inorganic phosphorus, their bones suffer from impaired mineral deposition and they have rickets (figure 1). Adding vitamin D to the soybean diet does not overcome this deficiency.

A comparison of a normal bone with a rachitic bone (figure 2) graphically illustrates why bones differ in strength. The compactly mineralized bone from a control animal is strong, while the spongy bone from the poorly nurtured pig is weak (table 2).

Using a chemical analysis in conjunction with bone-strength studies and photographs, it is obvious that only optimum nutrition can produce the bone strength and elasticity that correlate with a strong skeletal structure.

The infant pig is giving nutritionists basic nutritional information that is impossible to get directly from humans. Such insights can then be adapted to the correction of nutritional problems in the human population.

Figure 2. Photographs (5x) of cross sections of rachitic bone (left) and normal bone (right) from infant pigs.

Table 2. Weight, density, composition and strength of bones from baby pigs fed different levels of soybean protein and vitamin D.

<table>
<thead>
<tr>
<th>Dietary vitamin D, IU/kg</th>
<th>250</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary protein, %</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>No. of observations</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>±SE1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femur wt, g</td>
<td>64.7</td>
<td>67.4</td>
</tr>
<tr>
<td>Femur density</td>
<td>1.17</td>
<td>1.17</td>
</tr>
<tr>
<td>8th rib wt, g</td>
<td>6.2</td>
<td>5.9</td>
</tr>
<tr>
<td>8th rib density</td>
<td>1.23</td>
<td>1.24</td>
</tr>
<tr>
<td>Humeral analyses, dry, fat-free basis, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>46.9</td>
<td>45.8</td>
</tr>
<tr>
<td>Ca</td>
<td>16.4</td>
<td>15.9</td>
</tr>
<tr>
<td>P</td>
<td>8.7</td>
<td>8.5</td>
</tr>
<tr>
<td>Mg</td>
<td>0.35</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Femur strength

| Breaking load, kg      | 74  | 64  | 49  | 43  | 6    |
| Bending moment, kg-cm  | 147 | 126 | 94  | 84  | 13   |
| Moment of inertia, cm^4| 0.16| 0.15| 0.09| 0.11| 0.00 |
| Breaking stress, kg/cm^2| 671 | 598 | 628 | 532 | 47   |
| Young's modulus of elasticity, 1000 kg/cm^2 | 7.1 | 7.5 | 6.0 | 6.0 | 0.6 |

1 Standard error of the mean
A PERENNIAL DILEMMA . . .

Spring frosts and fruit trees

DAVID R. WALKER and SCHUYLER D. SEELEY

Trying to grow fruit in Utah has always been a gamble. And in 7 of the last 10 years, the growers have lost—badly.

Trying to grow fruit in Utah has always been a gamble. And in 7 of the last 10 years, the growers have lost—badly.

If 1968 is used as an example of a rare “good” year, the magnitude of the loss is obvious. The Utah fruit crop was valued at $8 million in 1968. Virtually the entire crop was lost in 1972. Other years have seen from 34 to 1/2 of the crop wiped out.

And the primary villain is always the same—a spring frost (temperatures of 20 to 25°F) that catches the trees in a susceptible stage.

Utah State University researchers have been trying to solve the problem for a number of years. They have learned a lot, but still do not have the answer.

FRUIT TREE IDIOSYNCRASIES

Not even unseasonably warm temperatures in November and December can induce fruit trees to start growing. Yet a few warm temperatures in the spring and growth begins, and with that growth comes susceptibility to frosts.

The reason for this seeming discrepancy is that trees have a rest period, an internal mechanism that functions during late fall and early winter. This “rest” mechanism prevents tree growth in winter months even though favorable growing conditions occur. The rest period is completed in Utah near mid-January. From then on, growth will occur after the temperature reaches 40°F or higher.

In 1972, for example, warm weather in late February and March activated many fruit tree buds. Thus the late March temperatures of 12 to 15°F were devastating in some areas. Since Cache County had not experienced such warm temperatures in early February and March, the fruit buds there weren’t killed in late March; but they were killed in mid-April when another cold spell hit after warm sunny days.

THE HEATING ALTERNATIVE

Fruit buds can be protected from frost damage by modifying either the environmental temperature or the physiology of the tree. Heating orchards has been practiced for decades in the citrus industry and to some extent with other fruit crops. Many Washington State growers are routinely equipped to heat their orchards. Utah growers, however, have more problems with heating than do most other growers. Utah’s fruit trees are planted largely on foothill bench land. These areas are subject to considerable wind flow out of the canyons, which blows the heated air down into the valleys and makes orchard heating impractical.

To avoid frost damage, the temperature in an orchard has to be maintained at or above 28°F. Growers using 50 heaters per acre can generally raise the temperature about 5°F in their orchard if there is not more than 5 mph wind. Thus, if the temperature drops below 23°F, or if wind velocity exceeds 5 mph, the crop may be lost despite the heating efforts.

Heating orchards is expensive. Growers burn oil in return-stack heaters that use 5 to 10 gallons per night per heater, depending on how long heating is necessary. Thus, oil and

Figure 1. A small airplane motor powers this circulating orchard fan which mixes the cooler layers of air along the ground with the warmer air above to help prevent frost damage.
labor cost $50 to $100 per acre per night. Natural and propane gas are also being used in an attempt to reduce the smoke and increase the radiative heat. These materials are delivered by underground pipes to gas burners in the orchard. Such systems are more expensive, but are being adopted rapidly with the stricter burning codes that are going into effect in many areas.

Growers in the Intermountain area have heated as many as 20 nights during the spring. If they could predict at the start of the season how many nights they would need to heat, they might give up before they start and not heat at all. But growers who start heating in the spring do not know whether it will be 1, 5 or 20 nights that they will need to heat their orchard. On the 8th or maybe the 12th night of heating they wonder if they should continue heating or if they should stop and at least save the money that will be invested if they have to heat 20 nights. Then too, there is always the possibility of not being able to save the crop even by heating because of low temperatures.

Less than 10 percent of Utah's fruit growers are equipped to heat their orchards. Those that heated their orchards just a few crucial times this spring were among the rare growers who are harvesting a 1972 fruit crop. But there are never any guarantees.

**THE SPRINKLING ALTERNATIVE**

Fruit buds have been saved by spraying water on the trees during freezing temperatures. Water must be applied continuously while the temperature is below 32°F. As the water freezes on the branches it gives off heat which prevents the bark temperature from going below 23°F. There are some problems associated with this: 1) A grower needs a source of water usually before the canal water is available in the spring. Thus a reservoir would be necessary. 2) Growers would need sufficient sprinkler pipe to cover their entire orchard at one time and 3) breakage of limbs often occurs as a result of the weight of the ice.

**THE CHEMICAL ALTERNATIVE**

Another way to protect the fruit crop involves altering the internal chemistry of the tree so as to delay its growth in the spring or make it more resistant to cold. With this goal in mind, USU researchers have attempted to determine what chemical and morphological changes occur within the plant during the winter as outside temperatures vary.

We have measured chemical constituents within the plant throughout the dormant season during which the bud survival potential shifts from -25°F to 27°F, and correlated these with plant hardiness. We have measured proteins, lipids, nucleic acids, carbohydrates (sugars, starches) and plant hormones. As yet we have not observed a constituent which correlates well with plant hardiness though we do have a few interesting leads. If we can determine what (if any) chemical is responsible for cold hardiness, we may be able to synthesize it, apply it to the trees, and hopefully extend the rest period into late spring despite any early warm temperatures.

A plant growth inhibitor called abscisic acid, appears to have promise and be associated with plant dormancy. We are now studying this chemical in detail.

Another possibility centers on growth promoters rather than growth inhibitors. A growth promoting chemical may become active during mid-winter signalling the end of the rest period and readying the tree for growth to occur when temperatures are favorable. Gibberellic acid is one of the hormones known to promote growth in the spring. We are now studying the levels of this hormone in the plant as they fluctuate through the year, and are experimenting with chemicals that can retard its formation. Such retardation might extend the rest period and delay fruit bud development.

**A MECHANICAL POSSIBILITY**

Tree growth in the early spring obviously depends on warm temperatures. Since trees can absorb heat from sunlight, tree temperatures are often higher than air temperatures. Applying reflective materials to the trunk and branches might therefore reduce the tree’s absorption of energy from the sun and delay bud development. We plan to apply suitable materials to trees in the field in mid-winter and keep them on the trees until bloom. Temperatures in the buds and bark of the camouflaged trees will be compared with tissues of untreated trees, and relative bloom dates will be noted. Maybe we need to refrigerate the tree to keep it from growing early in the spring. We are also studying the effect root temperatures have on tree growth.

**COMPLICATIONS HAMPERING RESEARCH**

Frost hardiness work is limited to orchards during a few months of the year. The lack of control under field conditions precludes reproducible information because of the variable environmental temperatures. Faster progress would be made if we had access to repeatable environmental conditions to which trees could be exposed. This would require environmental chambers tall enough to accommodate 7-foot, bearing trees, and versatile enough to provide various temperatures both above and below freezing.

Trees at various stages of development would be placed in the growth chambers and subjected to specific temperature treatments so that repeatable and meaningful conclusions could be obtained. Relative cold hardness ratings and plant hormone levels would then be determined and correlated with stages of bud development and temperature. These correlations would help identify the chemicals that affect cold hardiness and facilitate regulation of bud physiology through application of a spray. The correlations would also help climatologists forecast the severity of damage that might be expected with certain weather conditions.
Some sweet cherries resistant to western x-disease

Western x-disease poses its serious threat to sweet cherries, but peaches, sour cherries, some plums and some Prunus species may also become infected. Chokecherries serve as a natural source of the infective agent, which is spread from infected plants by at least 11 species of leafhoppers.

The infective agent of western x-disease was considered to be a virus for more than 30 years. But then tetracycline antibiotic was introduced into infected trees and it caused remission of symptoms. In addition, electron microscope pictures of diseased tissue showed small pleomorphic (variously shaped) inclusions without rigid cell walls. So western x-disease is currently blamed on mycoplasmalike organisms.

Mycoplasmas are highly variable in appearance and were considered bacterial until 1966. The International Committee on the Nomenclature of Bacteria, at its 1966 deliberations, recognized the mycoplasmas as sufficiently distinct from bacteria to warrant placing the mycoplasmas in a different class. The mycoplasmas can be grown in cell-free media, are resistant or immune to penicillin, but are inhibited by tetracycline antibiotics. They are small and may be intermediate in size between bacteria and viruses.

The mycoplasmalike organisms that cause diseases in plants differ from those in animals and insects in that the mycoplasmas in plants multiply only within the cells of host plants, whereas mycoplasmas multiply outside the cell. Also, few of the numerous attempts to grow mycoplasmalike organisms that cause diseases in plants in cell-free media have been successful, and none of these organisms that have been grown have been pathogenic to plants.

 Utah Orchards

Natural spread of western-x disease within orchards in Utah occurs most rapidly from infected sweet cherry trees growing on mazzard rootstocks. Such trees decline slowly and produce little marketable fruit. Trees growing on mahaleb rootstocks often die with-

Figure 1. An orchard cherry tree that has been hard hit by western x-disease. Note the sparse, wilted leaves and tiny fruits.

Bryce N. Wadley is a Professor, Plant Pathology, in the Department of Botany and Federal Collaborator, Agricultural Research Service.

December 1972
in a year after infection, so there is little likelihood of mahaleb rootstocks serving as sources of the infective agent.

Attempts to control western x-disease in Utah orchards by removing diseased trees failed because infected trees could not be detected easily until 2 or more years after they had been infected. The infective agent moves slowly through susceptible plant tissues. Seldom does a tree have all of its branches infected until it has been infected for several years.

Although antibiotics may eventually control western x-disease, such treatment is not yet practical. Top-working Bing, Lambert, or other sweet cherry varieties on the framework of mahaleb rootstocks provides resistance that may be adequate if natural spread is not rapid. Mahaleb appears to be immune to infection; however, trees propagated as single shoots on it usually die shortly after infection because of girdling induced at the graft union by the infective agent.

Resistant sweet cherry varieties may provide a more reliable control of western x-disease than any other means.

**TESTING EXISTING SWEET CHERRY VARIETIES**

Many sweet cherry varieties and research selections have been tested during a 10-year period for resistance or susceptibility to western x-disease. Some tests were made at Utah Agricultural Experiment Station field plots, and observations have also been made in commercial orchards throughout Utah. Sweet cherry varieties were obtained from many sources in the United States and from Canada, Asia, and Europe through the USDA Plant Introduction Station. More than 80 sweet cherry varieties and 40 numbered research selections were inoculated in field plot tests. Although tests are not yet complete from all tests, a few varieties showed definite resistance to inoculations.

Napoleon (Royal Ann) cherries appeared to be the most susceptible variety grown in Utah orchards, but Bing and Lambert, the commonly grown commercial varieties, were not much more resistant. Black Tartarian and Burbank appeared to be resistant to natural spread, but were susceptible to inoculation by grafting.

Napa Long Stem Bing, a California variety from Napa Valley, resisted natural spread in California and recovered from infection when inoculated in Utah tests. It has fairly good fruit quality, but tends to set light crops. It is susceptible to bacterial canker, but is tolerant of necrotic rusty mottle diseases.

Dicke Braune Blankenburger, a plant introduction from Germany, was resistant to infection when inoculated. The trees were vigorous and productive and the fruit size was acceptable. Unfortunately the fruit has bitter flavor that is objectionable for fresh market usage.

Coop’s Special, a variety from California, was resistant to infection, but the fruit was low in quality and small in size. Leaf and fruit symptoms indicated probable infection with little cherry and necrotic rusty mottle viruses.

P8-343 and P8-419, research selections from a USDA breeding project at Prosser, Wash., showed some resistance when inoculated. However, the level of resistance and the quality of fruit may not be acceptable for Utah. Black Tartarian and Burbank produce soft fruits and are useful only as pollinizers.

**BREEDING NEW SWEET CHERRY SELECTIONS**

Since none of the above varieties was acceptable to growers who observed them for fruit quality in our field plots, we are working to produce new selections with good fruit quality and resistance to western x-diseases. We are also working to incorporate resistance to spring frosts, doubling, rain splitting, and other serious diseases.

Our work has been difficult because the western x-disease agent could not be grown in culture and could not be mechanically inoculated into test trees. Leafhopper vectors were not efficient transmitters. Dodder was used successfully to inoculate herbaceous host plants, but attempts to take the infective agent back to fruit trees with dodder failed.

We have, therefore, used buds or

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*Figure 2. Cherries from a tree infected with western x (top) compared to normal fruit from an uninfected tree (bottom).*
other tissues from infected branches and grafted them to healthy test trees. Since the infective agent is not completely systemic, 100-percent transmission is seldom achieved. No quick test for resistance or fruit quality is available. Our best results were obtained when test selections were grafted on mahaleb rootstocks and grown for 1 year before inoculation in August. Symptoms usually developed the following summer. Trees that did not wilt the first summer were reinoculated to determine escapes. Trees that did not wilt in either of the two tests were considered resistant and were held for further testing. Some selections produced fruit the third growing season, but others did not produce fruit until the fourth or fifth growing season.

Napa Long Stem Bing and Dicke Braune Blankenburger were selected as sources of resistance for obtaining new selections. Since these varieties are highly self sterile, all seeds produced should be crosses with a compatible pollinizer variety. A large number of varieties and research selections served as possible pollinizers. Seeds were germinated and grown in the greenhouse at Logan, Utah. Five to 10 trees of each seedling were propagated on mahaleb rootstocks in field plots at Farmington, Utah, for testing.

Approximately 600 different seedling selections have now been tested for resistance to western x-disease. About 300 ranked from probably resistant to resistant. Nearly 200 have produced sufficient fruit for evaluation of quality. A high percentage of the resistant trees were discarded because of poor fruit quality. Many produced small, soft, or bitter fruits. Several selections appeared promising to growers and were planted in commercial orchards for further testing. Some of the best selections were late blooming and also appeared to be resistant to doubling and rain cracking. Some were resistant to spring frosts in 1970 and 1971 when many commercial orchards produced light crops because of frost injury. In March 1972, however, extremely low temperatures eliminated all sweet cherry fruits in Utah orchards, so further evaluation must await another year.

Pollination studies and controlled crosses were made in 1971, using some of the best seedling selections as sources of resistance and good commercial varieties or promising research selections as sources of pollen. Bing and Lambert pollen was compatible with some seedling selections, but not with others. Nearly 200 crosses were successful. Germination of the seeds yielded 120 seedlings that will be tested for resistance to western x-disease and for fruit quality.

Figure 3. Young cherry trees planted in rows at the Farmington Farm. More than a hundred different varieties and selections were tested to find those with resistance to western x-disease. Three trees in the middle have succumbed to the disease.

B. DELWORTH GARDNER

Land-use zoning, particularly in urban areas, has been with us for a long time. But recently pressure has been mounting for more and more revisions of land-use zoning regulations in rural as well as urban areas. No level of government, whether federal, state, or local is exempt from such pressure. At the local level, developers are asking city councils for zoning changes which will permit construction of shopping centers in residential areas, and urban development in agricultural areas; single-family home-owners are petitioning to prevent the building of neighborhood multi-family apartment houses; industrial parks are being created by the score; and zoning regulations are ever more restrictive in specifying what land owners can and cannot do with and to their land.

STATE ACTIVITIES

The states are necessarily becoming more embroiled in land-use zoning. Today’s land-related problems of environmental protection, urban sprawl, housing areas for the poor, and expanding needs for outdoor recreation and industrial development often cross city, county, and sometimes even state boundaries. There seems to be no alternative to invoking...
governmental responsibility and action above the local level if these problems are to be equitably solved. Many states are, therefore, legislating a statewide framework for land-use planning. Even political parties have inserted land-use planks into their state and county platforms for 1972.

Within the past two years, Maine, Vermont, and Florida have passed laws bringing many types of new developments under state control. In Vermont, for instance, the state must grant a permit for any land development that involves more than one acre. Previously, only Hawaii had statewide land-use laws. Many other states have enacted broad controls that restrict the development of shorelands, scenic areas, river valleys, and other specialized areas, and thus supplement various degrees local zoning authority.

Pennsylvania and Michigan are among more than a dozen states, many heavily industrialized, that are studying ways of increasing state regulation of new development. Other states are setting standards that their local governments must follow in making land-use decisions. Massachusetts, for example, reviews local zoning laws to insure that adequate space is set aside for low-cost housing. In May 1972, Colorado set statewide standards covering such things as tree removal and drainage for all new residential and commercial subdivisions.

**FEDERAL EFFORTS**

At the federal level, land-use control is seldom referred to as zoning, but the effects are the same. Federal lands have been and are being set aside for specific uses such as national forests, parks, monuments and wilderness areas, but recent efforts have gone far beyond passive land acquisition and allocation to given uses.

A case in point is a big omnibus bill that was reported out of the House Environmental Subcommittee of the House Interior Committee on May 4, 1972. This bill provides for comprehensive planning in the use of both public and private lands. For the first time, a federal bill is calling for the 470 million acres of unappropriated public lands administered by the Bureau of Land Management to be left in public ownership and managed in the interests of the public. A new grant-in-aid program for the states is proposed to direct the use of non-federal lands, and requires the coordination of public and private land planning. Among other things, the bill establishes a public-land classification system to be carried out by the land management agencies under strict Congressional control.

**LAND USE PROBLEMS IN UTAH**

Utah faces nearly all of the myriad land-use problems that exist elsewhere. Our best agricultural land is being continually encroached upon by urban, transportation, and recreational development. A titanic struggle is occurring over whether our high-mountain areas are to be used as wilderness or developed as more accessible recreational sites. We have our share of urban sprawl and leapfrog development along the Wasatch Front. Perhaps most serious of all, much of the current land development involves cabins and summer homes being built near prime recreation areas. Ill-suited land parcels are being used for these purposes and existing communities are finding that providing local services to their new residents is burdensome. This is only a partial listing of land-use problems currently of interest to all Utahns.

**WHY NOW?**

Why are we being deluged now with all these problems? The explanation is not hard to find. It is well-known that population has rapidly increased in the U.S. since World War II, although it is showing signs of slowing down. The demand for goods and services annually reaches a new all-time high due to higher and higher per capita incomes as well as larger numbers of people. These two factors, economic prosperity and population growth, have greatly increased the demand for various services from our land base, which is relatively fixed in supply.

**PHILOSOPHICAL RATIONALE**

Our legal, political, and economic institutions have permitted much of the U.S. to be appropriated for private uses. Whether land is publicly or privately owned, however, every individual is subject to the effects of land-use decisions made by others. Zoning and other forms of public control represent either efforts to regulate uses of land that offend generally-accepted moral and aesthetic sensibilities, whether or not the owner of the land ascribes to them, or permit the community to capture "public" benefits which private land owners are not willing to supply if left unregulated. This "public" characteristic of land is the most compelling philosophical basis for land-use zoning.

Another, more mundane basis is composed largely of economic considerations. Because land is relatively fixed in supply, population growth and increasing incomes tend to drive land prices up. Land parcels with superior site and productivity advantages can then earn high rents. Land thus indirectly captures many of the productivity profits brought about by technological advance. This phenomenon is especially apparent in modern agriculture, where land prices continue to rise, even when returns to labor and non-land capital are low.

In other words, the income and wealth distribution fabric of society is closely intertwined with land ownership. This is why land confiscation and redistribution is a popular tool for reallocating income and wealth in the less-developed countries of the world. Land reform in advanced countries seldom involves expropriation by government (although condemnation by eminent domain proceedings is quite common). But even land-use controls such as zoning and taxation serve to shift the distribution of costs and benefits of owning and managing land. This is what makes zoning such a potent and often
emotional political issue. By government edict, and often arbitrarily, zoning conveys benefits on some portion of the population while taking them away from another. In theory, the net impact of zoning should be to improve the well-being of the aggregate community. Ideally, zoning represents a vehicle that society can use to eliminate or mitigate social and economic inequity and rid itself of the more blatant nuisances.

SOME PROS AND CONS OF ZONING

While zoning may effectively eliminate many negative social effects such as leap-frog development, urban sprawl, and unsightly nuisances in residential areas, its costs may be inordinately high. After all, zoning is a public decision about land use that attempts to prevent undesirable private activities. Thus, exclusive residential areas are zoned against social nuisances such as factory smoke and college students living in multiple-family housing units. By government prescription, part of the total demand for a given land parcel is simply ruled out of existence. The land market is thereby eliminated as an efficient allocating device. This is at once the potential advantage and disadvantage of zoning. Free market allocations of land may facilitate undesirable private activity that needs to be curbed. But, on the other hand, it is easy to underestimate the real costs of zoning. It is true that socially obnoxious results of private activity (such as factory smoke) may be controlled by zoning. But at the same time, society may lose the concomitant private production (the factory's potential output).

Zoning suffers from other defects as well, the most important being its political limitations. Even when effective, it is cumbersome and inflexible. If zoning is to mean anything, it must prevent a land owner from doing something he would otherwise do. Where local government is weak, zoning laws often simply cannot prevail against the political pressures that inevitably arise. This is another reason for increased state activity in the zoning field. Any governmental unit involved in considering zoning extensions or shifts must try to identify and assess all legitimate social concerns. Private interests will inevitably want to change zoning regulations primarily because of wealth gains they hope to secure. Since those who can effectively bring pressure are often developers and large land holders who are already relatively wealthy, there is always some danger that the rich will profit from zoning changes at the expense of the not-so-rich and the poor who lack political clout.

In recent years, groups of environmental activists have also become very potent in the political arena, and have often been effective in counter-balancing the extremes of the developers. The environmentalists too, however, many times have promoted high income, elitist uses of scarce land resources that discriminate against the poor and the politically unorganized.

Unfortunately, in this area as in so many others, power is the name of the game. Since this is a fact of life, citizen groups affected by zoning decisions must become organized and exert whatever influence they can to protect their interests. If all affected parties do so and the zoning agency really listens to each one, perhaps the political process can sort out the conflicts, and decisions in the public interest will emerge.

AG NOTES

If you drive your farm vehicle on the road, use the Slow Moving Vehicle emblem for your protection—day or night. Studies show the majority of farm vehicle accidents occur during daylight hours on dry, open highway.

Stop trouble before it starts. Run a safety check around your home and replace worn wiring, destroy greasy rags and clean up oil spills.

Tall crops cut visibility at intersections and increase the possibility of accidents. Consider motorists, and seed corners with a low growing legume, and you will help increase the visibility of approaching vehicles.

Machinery and children are an unsafe combination on any farm.

Match your fire extinguisher with the fire. Be sure to read the operating instructions on your extinguisher: “A” type on paper or wood, “B” type on gas or oil, “C” type on electrical fires.

A fire extinguisher is a small investment that could prove big in returns. Keep one in your home, your car and on all of your farm vehicles.

Respect the danger of electricity. When working on any electrical appliance in your home, make certain it's unplugged. When maintenance is needed on your electrical system, unless you are qualified, play it safe and call a certified electrician.

During 1970, an estimated 200,000 people suffered disabling injuries in agricultural accidents and 2,400 were killed. Protect yourself by observing safety rules and wearing personal protective equipment.

Always wear filter and cartridge respirators when working in heavy dust and chemicals.

Respect the danger of electricity. When operating large machinery, keep an eye peeled for power lines—above and below.

When fire strikes, seconds count. Keep an extinguisher handy, and know your fire department's phone number.
The penstemon is a native American plant genus with most species found in the western United States and Canada but with some species located in the cooler parts of Mexico. All are perennial plants, and many have evergreen leaves with interesting variations in size, form, and color from light to deep glossy green. Showy tubular flowers of bright colors ranging from brilliant red to pink, blue, lavender, violet, and purple are borne profusely on plants which vary from compact ground cover dwarf types—6 to 12 inches high—through medium sized to upright plants as tall as 5 feet. A few species with white flowers also have been found.

There has been a wide range of color in the dwarf ground cover types as well as in the upright types. At first, the lines of each were predominantly purple but through selection and crossing, good types have been developed in varying shades of purple, lavender, pink and scarlet. These different color types have been developing in varying plant sizes from the dwarf ground cover lines, and from short to tall in the upright lines.

**WHICH TYPE TO CHOOSE?**

One of the difficulties in penstemon breeding has been the elimination of the many interesting types to reduce the number of selections to the relatively few outstanding lines that should be released. For instance, on size of plants we have lines which are dwarf with a good flower type. The same is true for the medium and tall selections. Consequently, selections will be based on plant size with interesting variations in color, flower arrangement, size of corolla, perennial habit and general eye appeal.

Penstemons grow best in deep, well drained soil with full exposure to sun but require less water than most garden perennials.

As garden flowers, they offer home owners a rich opportunity to add a new and very interesting group of flowers to their gardens. They have been utilized to only a limited extent, however, because they are known by so few gardeners. As penstemons become better known their cultivation should increase rapidly.

At the Utah Agricultural Experiment Station, the improvement of penstemon has been underway for many years to develop good horticultural types. We have concentrated on types which could be used as ground covers as well as those that would be suitable for growing as upright types in the gardens. Of the dwarf species, *menziesii*, *fruiticosus* and *davidsonii* form very attractive plants that are suitable as ground covers. Outstanding upright types have been obtained from the species *alpinus*, *hirsutus*, *calicosis*, and *glaber*.

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**U T A H S C I E N C E**
GROUND COVERS

The dwarf types grow and bloom in the spring starting about May 10. If the weather remains cool, they continue to bloom for 3 to 4 weeks. We now have some lines that will bloom a second time in the fall, but not as profusely as in the spring. Many lines have been discarded because of the lack of winter hardiness. All of the ground cover types are evergreens with some pink in the leaves of many lines during the winter.

The present ground cover types are winter hardy if they are allowed to overwinter out of doors. Plants grown in the greenhouse should be hardened moderately before transplanting to the field after the danger of severe freezing has passed.

BLOOMING

We have been growing a large number of upright lines of a few species that are suitable for gardens. At first we had several difficulties. All lines bore flowers on only one side of the stem, therefore they were not good ornamental types. Through the use of selection and crossing, followed by further selection, types were obtained with flowers all around the stems. These are far more beautiful than the original types and are suitable as cut flowers.

There are now many variations in upright types in color, type of plant growth, height of plants, size of the corolla, earliness, and length of blooming period. Through selection, lines have been developed that will bloom in the spring and again in the fall. If the flower stems are removed as soon as their blooming has been completed, some plants will flower almost continuously.

There is a tremendous difference between the upright types. We have eliminated all those types that had weak connections at the base of the plants. For a good horticultural variety the stems should be upright, strong, and with good flowers without leaves in the flower head. We now have many lines which show these characteristics.

RELEASES

The increasing of the upright lines requires a longer time than for the dwarf types as each plant will have only a few stems for propagation. The first upright types will be vegetatively propagated. We now have a few lines ready for increase and within a year we will have a sufficient number to release several lines. It is now the plan to develop lines which will be propagated by seed to reduce the cost to increase plants for release.

With the rich diversity of plant types, it has been possible to develop selections which are suitable for any location in home flower gardens. Dwarf types are particularly interesting in rock gardens, as border plants or as ground covers. The available sizes permit effective use in the garden as borders, specimens, or background plantings.

In the spring of 1972 a small number of plants from four selections were released through two nurseries in Salt Lake City. These lines varied from pink to purple. The Utah Agricultural Experiment Station will again release a number of good dwarf ground cover lines this year which will be sufficiently hardened for our Utah conditions.

To strengthen our penstemon breeding program we have made an effort to obtain as many species as possible during the past 2 years. Several native species have been obtained from different sections of the united States. Through the excellent cooperation from the American Penstemon Society, we have obtained many species which are found growing in other sections of the country, principally from the western United States. Early in July of 1972, the senior author met with the Penstemon Society group in the northeastern part of Oregon where many additional species were obtained.

All of the different species will be collected and grown at Farmington where an objective appraisal of each species can be made. Species of penstemon obtained from the various areas will be carefully labeled as to their origin. While crosses between species are difficult to make, some are possible by utilizing newer breeding techniques. It is hoped that by so doing, many valuable plant types can be obtained.

Visitors to the Utah Agricultural Experiment Station ornamental research center at Farmington will find many attractive penstemons and other ornamental plants to observe throughout the growing season.

AG NOTES

Accidents involving the feet and toes account for about one out of every 10 disabling work injuries. When it comes to personal protective equipment on the ranch or farm, one of the least dispensable items is the safety shoe.

A recent study revealed that 59 percent of accidental work injuries to farm family members or employees resulted in 2 or more days of lost time.

When repairing farm machinery, STOP IT, before working on it.

Since the Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA) went into effect, all agricultural employers who employ one or more persons have been covered by the law.

The Williams-Steiger Occupational Health and Safety Act (OSHA) requires the use of the slow moving vehicle (SMV) emblem on all farm vehicles traveling on public roads at less than 25 mph and operated by farm or ranch employees.

A farm employer must report to the nearest OSHA office and on-the-job fatality or accident that hospitalizes five or more workers.