As towns become cities and the suburbs continue to sprawl, the agriculturist is presented with new problems that can only be solved by change. To state that agriculture is changing does not in any way define the changes or show how these changes can influence those not concerned with agricultural endeavors.

It means little to the ordinary city dweller that more farmers are becoming commuters, the U.S. Forest Service is making soil maps, sewer lagoons are great for ducks, and herbicides can help save cattle on mountainous summer ranges.

The fact remains, however, that agricultural research continues to benefit those living in Utah's urban centers as well as those living in the rural areas. Utah State University researchers can supply information about better lawn care, and how to beat the weeds that grow so well in your city lot, or how to set about growing some native plants in the garden.

There are more than 4,000 different plant species that are native to the Intermountain area. Of these, several hundred are promising for use as choice garden specimens. A few are mentioned on pages 50-52 in this issue of Utah Science. One of them, the dog-tooth-violet is shown on the cover.

Cover photo by James M. Andersen

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UTAH SCIENCE

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UTAH SCIENCE
There's hardly ever just one way to reach an objective. But quite often, one alternative is quicker and easier than the others.

Thanks to USU's Technical Services Division, some bacteriological research can now follow the quicker and easier route. Personnel of Technical Services, which is managed by Jed Merrill, have provided the researchers with a crucial piece of equipment (a fractionater) for $400 less than is asked by its commercial sources.

The research requires that one enzyme from a particular bacterium be separated from all the other proteins of that bacterium. Eventually, the elusive enzyme (L-Asparaginase) is expected to become a weapon against leukemia. Without special equipment, however, protein separation and identification can take weeks or months.

The new instrument (figure 1) comes into its own after various laboratory techniques have partially separated the L-asparaginase from most of the other bacterial proteins. A gel of polyacrylamide is formed in pyrex tubing and the partially purified enzyme is placed on top of the gel. The gel column is then subjected to electrophoresis. This technique separates various protein components into bands on the basis of differences in size and electrical charge.

After the electrophoresis treatment the gels can either be stained for protein (figure 2) or fractionated on the fractionater. Unfortunately, staining destroys the enzyme activity. By contrast, the fractionater delivers the enzyme in a rather pure form, free of other proteins and still enzymatically active. A single gel, about 3 inches long may be quickly and efficiently divided into as many as 100 fractions.

Each individual fraction is then tested to see if it contains the L-asparaginase. This procedure not only produces highly purified enzymes but identifies the fraction containing it. Additional work has indicated that the enzyme is actually composed of four to six smaller proteins.

The ingenuity of USU's Technical Services Division has thus substantially speeded one piece of bacteriological research. And the net result may be a new line of defense for leukemia victims.
A research tool for plant scientists

W. F. Campbell and S. L. Kimball

A few years ago, research in plant science was concerned primarily with testing crop varieties, planting, seeding rates, and fertilizer and irrigation practices. Today, this kind of research is being augmented by venture into subcellular and molecular plant science. Electron microscopes, gas chromatographs, amino acid analyzers, and fluorescence spectrometers are as necessary to research in plant science as are greenhouses and field equipment.

It has been stated that "sight is our dominant sense and our sensory world is primarily a visual one." The development of magnifying glasses, microscopes, and telescopes long ago extended our visual sense to ultra-small or distant objects. The more recently developed electron microscopes, with their almost unlimited capacity for high resolution (magnification), further extended our vision to cellular and subcellular levels of life.

WAVE LENGTHS

The electron microscope is constructed and operated according to the same principles as the light microscope. Each has illuminating, imaging, and image translating systems, figure 1. The primary difference between them is the source of illumination: Instead of visible light rays, which have wave-lengths of from 3,850 to 7,760 Angstroms (254,000-000 Angstroms per inch), the electron microscope uses an electron beam having wavelengths of less than 1 Angstrom. This exceedingly short wavelength is responsible for the high magnification potential of the electron microscope.

The only way we can discern two objects that are close together is by

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UTAH SCIENCE
observing the light rays that pass between them. As objects come closer together (that is, as the distance between them becomes less than the length of the light waves), they appear to be one object because the light rays can no longer pass between them. The minute electron wavelength permits discrimination between objects that are very close together. Tiny objects are “seen” in terms of the light they block. The smaller the wavelengths, the more distinctly can very small objects be seen.

The resolution or magnification potential of an electron microscope depends primarily on its electromagnetic lenses, which focus the electron beam. Presently, the practical resolution limit for most biological research is about 10 Angstroms. The theoretical resolving power of the electron microscope is less than 1 Angstrom, and recent advancements are allowing the newer models to reach a 2-Angstrom resolution.

**GETTING A FIX**

An object becomes visible in a light microscope as the result of light rays being refracted, absorbed, or scattered as they pass through the specimen. The resultant pattern of light and dark, or of colored areas constitutes the image of the object. By contrast, the electron beam of the electron microscope is scattered selectively by the atomic structure of the specimen (some parts won’t let the electrons pass through) to produce an image.

Fixatives are usually combined with stains to gain visible contrast of the specimen under the light microscope. Tissues for the electron microscope are selectively fixed with salts of heavy metals (lead, silver, uranium) to produce electron-dense areas that repel the electron beam as it encounters the specimen. This yields an image of various shades of gray, whereas light-viewed specimens have a variety of stain-imparted colors.

Since the development of the elec-

**Figure 2.** A portion of a normal Ranger alfalfa (*Medicago sativa* L.) leaf cell (Mag. 14,000 X).

**Figure 3.** A portion of a heavy stem nematode (*Ditylenchus dipsaci* Kuhn) infested Ranger alfalfa (*Medicago sativa* L.) leaf cell devoid of the normal green pigmentation (Mag. 14,000 X).

**Figure 4.** Chloroplast of Bermudagrass (*Cynodon dactylon* L.) showing the normal arrangement of grana, stroma and lipid bodies (Mag. 20,000 X).
Figure 5. Chloroplast of Bermudagrass (*Cynodon dactylon* L.) showing disarrangement of internal structure induced by low temperature — 32 F. (Mag. 20,000 X).

Figure 6. Parenchyma cell of bush bean (*Phaseolus vulgaris* L.) seed showing normal development (Mag. 10,000 X).

Figure 7. Parenchyma cell of bush bean (*Phaseolus vulgaris* L.) seed from plants subjected to s-triazine herbicides. Note the increased amount of rough endoplasmic reticulum (RER). (Mag. 10,000 X).

tron microscope, many biologists have directed their efforts to elucidating the intricate mechanisms of the individual cell. The basic structure of most organelles (subcellular, specialized structures such as chloroplasts, mitochondria, vacuoles, nuclei, and endoplasmic reticulum) within cells are well defined, but most pathological peculiarities and physiological properties are not yet fully understood. For example, changes in the cell organelles are often good indicators of what different environmental stresses do to plants, and such changes can tell the plant scientists what portion of a plant's life processes are endangered by a particular stress.

**USU STUDIES**

Students and staff of the Plant Science Department at Utah State University are using the electron microscope to study the effects of stem nematodes (a slender roundworm approximately 1/25-inch long and 1/900-inch wide) on: (1) alfalfa, figures 2 and 3; (2) how low temperatures stress turf, forage grasses and fruit buds, figures 4 and 5; and (3) plant responses to herbicides, figures 6, 7, 8 and 9. Electron microscopy
of nematode tolerant (Lahontan) and susceptible (Ranger) alfalfa varieties has shown that the tolerance difference between these varieties is related only to the rate of infection and degree of host damage, rather than an inoculation resistance. The endoplasmic reticulum (ER), chloroplasts, and nuclei of both alfalfas revealed recognizable symptoms after nematode infection.

The first series of experiments investigating the effects of temperature stresses on turf and forage grasses have been completed. Those on fruit buds are still in progress. Non-hardy grass species (Bermudagrass and Bahiagrass) respond differently to low temperatures — 50, 32 or 23 F — than does a hardy grass (wild rye). At low temperature, the rye chloroplasts enlarged but did not fold and break-up as did those of the non-hardy species. Amounts of ER and vacuolar debris increased in all species as the temperature was lowered. The results clearly indicate that specific parts of the plant cells are affected by temperature stress and that hardy and non-hardy species have cell organelles that may vary in susceptibility. Such information may allow the plant scientist to visually screen species for their stress tolerance.

The s-triazine herbicides (atrazine, igran, simazine) can increase the total crude protein in tolerant plants when applied at sublethal rates. At USU, the electron microscope also is being used to study the effects of these herbicides on alfalfa, snap beans and wheat. We have shown that rough endoplasmic reticulum (complex system of cytoplasmic membranes coated with ribosomes — genetic blueprints for protein synthesis) increased in cells of bean seeds after treatment with the s-triazines, figures 6 and 7. The end portions of the rough endoplasmic reticulum (RER) became swollen and small vesicles formed. These vesicles later enlarged and appeared to contain proteinaceous material. We believe the induced increase in protein reported in a variety of plants may be involved with the increased RER. The increase in RER also may be the plant's way of responding to an environmental stress, and the RER might be involved in the mechanism of herbicide detoxification in plants. Modifications of the RER also might be useful indicators of herbicides in the environment. The electron microscope has given us a better visual understanding of how herbicides affect weeds as well as agronomically important crops, of the type of tissue and cellular destruction caused by nematodes, and of changes wrought to plants at the cellular level by low temperatures.

(Continued on page 49)
Weed Control in Cities and Towns

LOUIS A. JENSEN

The current interest in upgrading our environment is gratifying. But results demand commitment and action at the individual level. That means attention not only to obvious landscape pollutants such as decrepit buildings and piles of junk cars but also to less obvious undesirable elements such as weeds.

What are weeds? Why are they objectionable? As my little neighbor friend would ask — "Why don't you wike (like) weeds?" Basically, weeds are plants. To the nature lover, all plants (including weeds) have a certain beauty. After the cold bleak winter has passed and spring days warm up, anything fresh and green is quite a welcome sight. Early maturing annual weeds are first plants to grow and many develop attractive blossoms. Unfortunately, those flowers sometimes develop into sharp burs that may attack bare feet or mat the hair of pet animals. Some weeds are poisonous to animals and people. Some are very irritating to the skin, while others cause hay fever.

The usual definition given for a weed is "a weed is a plant out of place". The bell-shaped pink or white blossom of bindweed or morning glory is pretty, but it certainly is out of place in the rose bed. The yellow dandelion also has beauty but not in the front lawn. Thistles in the backyard may be interesting, but their sharp spines make them potentially dangerous.

Wherever there is soil, something will usually grow. Any soil or land area that is not cared for, normally grows a crop of weeds. To keep an area relatively weed free it should be

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Figure 1. Field bindweed or wild morning-glory is widespread and a serious weed throughout Utah. It is extensively distributed in cultivated fields and waste places, and because of a remarkable adaptability to different environmental conditions, may be found at altitudes as high as 10,000 feet. It is a most troublesome weed to eradicate because of the large, fleshy, deep-seated taproot, which may penetrate the soil to a depth of 10 feet, and which may repeatedly give rise to numerous long rhizomes, even when cut off below the crown. It reproduces by seeds and rootstocks. A, drawing showing habit of plant (note several stems arising from the underground rootstocks); B, flower; C, fruit, D, seed.
planted to crops or grass or ornamentals, and cared for with modern scientific methods of weed control.

Like other plants, weeds propagate and spread by seeds. Weed seeds are spread by wind, water, birds, animals, machinery, and people. Once in the soil, some seeds germinate and start to grow right away while others may lie dormant for many years before sprouting. One plant of a common weed pest such as musk thistle has been known to produce over 15,000 seeds, most of which will germinate and grow if they find a suitable seedbed.

Anyone trying to control weeds can choose among many different methods. Each one of which is especially effective in a certain situation.

**Prevention** — This is the best way to solve any problem including weeds. Never let weeds go to seed. Insofar as possible, have all land areas occupied with desirable, efficiently competitive plants such as grass, other groundcover, shrubs or trees. They help to keep weeds out. Avoid bringing weed seeds to your property in such things as topsoil, manure, or seed packets.

**Cultivation, hoeing or digging** — Small weeds are easily controlled by disturbing the soil or cutting their roots. Garden cultivators and power tillers can be used before planting and/or between rows of growing plants. A hoe may seem old fashioned, but many urban dwellers need the exercise and relaxation that can come at the end of a hoe handle. A shovel is a good tool for cutting weed roots below the surface of the soil.

**Cutting** — Weeds can be prevented from producing seeds by removing their top growth. Repeated “topping” often kills the weed, even the persistent perennials.

**Chemicals** — Modern weed chemicals or herbicides have been developed for use in a variety of situations. Their effects can seem to border on witchery. Some are very selective and will take weeds out without harming any associated desirable vegetation. Others are designed to kill virtually everything growing where they are applied. Great care must be taken with these chemicals to avoid serious damage to shrubs, trees, flowers, gardens, and crops. Weed chemicals are usually most effective when used in combination with good management practices. Grass or other desirable vegetation should be encouraged to successfully compete with the weeds by proper fertilization and watering.

Before launching a weed program on either public or private land, determine the kinds of weeds present. Define your desired objectives—in terms of appearance, soil protection, possible erosion by wind or water and the effect of various treatments to adjacent property.

**ALONG ROADS AND STREETS**

Most weeds, especially tall ones,
detract from the appearance of these public areas. Desirable vegetation includes low growing grass adapted to the site and soil conditions. Any existing grass can be encouraged, or new plantings can be made where feasible. Sodar Streambank Wheatgrass is one of the better species to plant along roadsides. Spraying with a selective herbicide such as 2,4-D will help discourage many broadleaved weeds. Mowing once or twice during the summer improves the appearance. Patches of persistent perennial weeds should be treated with more potent herbicides, taking care not to injure nearby desirable vegetation.

**DITCHBANKS AND FENCE LINES**

These are often problem areas because they cannot be mowed or cropped. Weeds growing here produce seed that spreads into surrounding areas. One solution is grazing with small animals such as sheep. Herbicides are effective but must be used with care. The same selective herbicides such as 2,4-D that can be used along roads and streets will work here to help take out broadleaved weeds and leave the grasses. Some weeds can be killed and others suppressed by using a contact spray such as Parquat or Dinitro or even fuel oil. A foli­age spray such as Amitrole will control many types of weeds commonly found along ditch banks and fence lines. If bare ground is wanted, certain soil sterilants might be considered. But these should not be used where roots of desirable shrubs or trees may extend into the treated area.

**AROUND INDUSTRIAL BUILDINGS AND STORAGE AREAS**

Here weeds create a fire hazard, provide hiding places for rodents, and insects, interfere with the use of the space and are unsightly. Paving with asphalt is often desirable. Many weeds, however, can grow up and penetrate asphalt so it is advisable to treat for weeds before paving. Prometryne (Pramitol 25E) is effective and registered for this use. Prepare the area according to directions and apply the herbicide just before laying the asphalt. If the area isn't paved, it is best to treat with a soil sterilant such as Prometryne (Pramitol), Atrazine, (AAtrex), Simazine (Prin­cep), Monuron (Telvar), Diuron (Karmex), Bromacil (Hyvar) or a mixture of the last two—Krovair. Gravel can be laid over areas treated in this way. If weed growth shows up in two or three years, repeat the treatment over the gravel in the fall. Winter precipitation will carry the herbicide into the soil and kill the weeds.

**VACANT LOTS**

As an aid in beautifying cities and towns, city planners and landowners should strive to put vacant lots to some useful purpose. Alternatives include planting to pasture and grazing where livestock are permitted, planting to grass and using as a play area, or planting to vegetables or some other food crop. If none of these are feasible, regular mowing or spraying with a safe herbicide could keep the growth down.

**HOME LAWNS**

A well kept, weed free lawn around every home is an asset to any town or city. Personal pride is the key. A properly established lawn will thrive if given reasonable care. Management must include adequate fertilizing; infrequent, heavy watering; and mowing high and often. Weed problems in lawns are often a result of poor management. Weed chemicals can help, but the management must be changed or the weeds will return. Many broadleaved weeds such as dandelions can be controlled with a selective spray such as 2,4-D, Silvex or compounds containing them. Grassy weeds such as crabgrass can be controlled with pre-emergent herbicides such as Da­chthol, Arsonates or compounds containing them.

**VEGETABLE GARDENS**

Although ruled out by some as too much and too time consuming, a home vegetable garden can control weeds while also supplying fresh produce for the table and providing some relaxing outdoor diversion and exercise for the entire family. But without adequate attention, especially to weeding, the results will be a disappointing and unsightly patch of weeds. The conditions set up in most gardens are ideal for growing weeds. Tillage, hoeing, pulling, chemicals or a combination of these can control the problem. Power-driven garden tillers can help greatly if properly used. Some hand hoeing and pulling is usually necessary. Selective herbicides such as EPTC (Eptam), Chloraben (Amiben), Trifluralin (Treflan), Benefin (Balan) and Alachlor (Las­so) can be used in certain garden vegetables. Follow directions on the container.

**SMALL FRUIT AND BERRY PATCHES**

Tillage and hand weeding is helpful for these crops. Care should be taken to avoid injury to shallow roots of the trees or bushes. Certain herbicides are effective for specific situations. Consult recommendations of universities and herbicide manufacturers.

**AROUND SHRUBS AND IN FLOWER BEDS**

Tillage, digging, hoeing and pulling are effective. Certain herbicides can be used, depending upon the weed problem and ornamental species. Both public officials and individuals concerned with private land can activate effective weed control programs in urban areas. Consultation with the local Extension agent or specialist can be a time-saving first step. The following publications give detailed information to help you identify and control weeds. They are available at County Extension offices and the Bulletin Room, Utah State University, Logan, Utah.}

- *Lawn Weed Control*, Utah State University Extension leaflet 144. Price 15¢.
CONTROLLING TALL LARKSPUR . . .

Utah’s most notorious poisonous weed

Utah harbors many poisonous range plants, but of them all, larkspurs take the biggest toll of livestock in Utah. Low growing species such as Nelson’s larkspur (Delphinium nelsoni Greene) and Anderson’s larkspur (D. andersoni A. Gray) are among the first plants to produce new foliage each spring. When the snow melts early on the spring ranges and the weather remains too cold for the grasses to grow rapidly, hungry cattle often ingest lethal quantities of the low growing larkspurs.

More losses are due to the four species of tall-growing larkspur on Utah’s summer range than to the low-growing species. Two of the tall-growing larkspur species are very restricted in distribution and are of little economic importance. Of the remaining two, duncecap larkspur (D. occidentals S. Wats.) has caused great losses in the states north of Utah but only a few confirmed losses in Utah.

That leaves tall larkspur (D. barbeyi Huth) which is found on most of the summer ranges south of Provo and is the most toxic of the tall-growing species. This species produces most of Utah’s costly annual stock losses to poisonous plants. We will concentrate on this species because of its importance in Utah, but generally the information also applies to the other species.

An experimental area was established near Manti in 1960 on the 40,000 acre Manti Canyon Cattle Allotment in central Utah. The upper 8,000 acres of the allotment are in the subalpine zone. This area produces most of the forage and all the tall larkspur. A total of about 345 acres of tall larkspur are scattered in small patches in the most lush vegetation on the range. Since 1955 annual losses have ranged from 1.5% in 1963 up to 13% in 1958. Replacement costs of the poisoned animals would be $2,750 in 1963 and $26,750 in 1958 and the average annual cost exceeds $8,400.

No one knows how many acres in Utah are infested with tall larkspur. We know both cattle and sheep die each year as a direct result of tall larkspur poisoning. The number of livestock involved and their value remains unknown. But if ecologically similar ranges sustain losses similar to those recorded on the Manti Canyon Allotment, the value of cattle poisoned by tall larkspur is about $500,000 per year in Utah. Sheep losses cannot be estimated because the infrequent deaths are not reported.

Tall larkspur appears to be palatable to both cattle and sheep. Sheep select the older, less toxic leaves. Cattle prefer the highly toxic young leaves and seed pods. Cattle sometimes exhibit a marked appetite for tall larkspur, especially the seed pods. Cattle are highly susceptible to alkaloids in the larkspurs and are about 6 times more sensitive than sheep. Sheep can ingest large amounts without apparent evidence of toxicity provided they remain quiet and undisturbed. Sudden bursts of activity after ingesting large quantities of tall larkspur can be fatal to sheep.

The toxicity and palatability of tall larkspur declines with increasing maturity. Its toxicity is also related to the rate of ingestion. Rapid ingestion of abundant new growth is usually lethal. Under these conditions, eating as little as 0.5% of its own weight can be fatal to an animal.

Environmental conditions on Utah’s subalpine ranges contribute to the death losses of cattle. On our subalpine ranges, winter winds produce huge snowdrifts (figure 1). These snowdrifts persist 4 to 10 weeks after the surrounding areas are free of .

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E. H. CRONIN

1Cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Utah Agricultural Experiment Station, Logan, Utah.

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Figure 1. Accumulated by winter winds, this huge snowdrift will persist long after the surrounding snow has melted.
snow. Tall larkspur prospers under these circumstances and often dominate these sites (figure 2). Water from the melting drifts creates a zone of green succulent vegetation as the plants beyond the influence of the melting drifts mature and lose palatability. Quite reasonably, grazing cattle concentrate on the highly palatable succulent vegetation surrounding the melting drift. Unfortunately, they eat the palatable tall larkspur along with the other forage.

Controlling tall larkspur does not require eradication. Instead, the density of tall larkspur simply needs to be reduced to a level at which animals cannot ingest the plant faster than they can metabolize and eliminate its poisonous alkaloids. One way to do this is to increase the proportion of non-poisonous, highly palatable forage which would help to slow the rate of ingestion of tall larkspur. Whatever method is used to prevent livestock losses, must be economically feasible.

The saturated soils of the snow-drift sites are erosion prone. Destruction of the vegetation cover could initiate serious erosion problems reaching far beyond the site. It is imperative, therefore, that control of tall larkspur be selective and include efforts to preserve the erosion-inhibiting vegetation on the snowdrift areas.

Efforts to control tall larkspur were initiated near the turn of the century. Grubbing was one of the earliest methods used but has proved too expensive. Using sheep to graze-it-out has been suggested. On some snow-drift sites only tall larkspur has survived excessive grazing by sheep. Destruction of the associated plants and trampling have resulted in severe soil erosion. In such cases, the tall larkspur may form hummocks as high as a foot above the surrounding eroded surfaces while continuing to prosper.

Tall larkspur can perpetuate itself vegetatively and by seed. Control measures may appear successful, but the tall larkspur usually regains its vigor and density within 2 or 3 years. Its tenacity has discouraged many attempts to control it.

Seedlings of tall larkspur remain inconspicuous for 2 to 3 years while their energies are channeled into the

Figure 2. The water from this slowly melting drift produces a zone of lush vegetation dominated by tall larkspur.

Figure 3. Twenty-two young tall larkspur seedlings are growing in this 4- by 6-inch inclosure. They are first-year plants with one leaf per plant.
development of their root system (figure 3). Only when the root system can support substantial aerial growth does the plant become conspicuous. The vegetative reproductive process, initiated in the crown or root tissues, also develops a substantial root system before producing conspicuous aerial herbage. Therefore, control treatments must be followed by careful examination to detect small one-, two-, or three-leaf plants. Permitting these inconspicuous plants to survive dooms the control program to failure.

Both (2,4,5-T) 2,4,5-trichlorophenoxyacetic acid and (silvex) 2,4,5-trichlorophenoxy propionic acid have provided long term reductions of tall larkspur that should prevent cattle losses (figure 4). The herbicides must be applied prior to flowering for at least 2 years at 4 lb/A each year. While a third application in the third year would further improve the vegetation for grazing, it is unlikely that the third application can be justified on the basis of reducing livestock losses.  

Applications of these herbicides create a brief but potential danger to grazing cattle because of chemical changes in the plants. Tall larkspur contains significantly high concentrations of the poisonous alkaloids following treatments with these herbicides. Also, many plants, including tall larkspur may become more palatable to livestock following treatment with 2,4,5-T and silvex. The danger remains until the plants lose their palatability. This occurs about 3 weeks after the herbicides are applied.

2All agricultural chemicals recommended for use in this report have been registered by the U.S. Department of Agriculture. They should be applied in accordance with the directions on the manufacturer’s label as registered under the Federal Insecticide, Fungicide, and Rodenticide Act.

Following herbicide treatments, the surviving plants, mostly species of grass, grow rapidly to produce very succulent and highly palatable herbage. Attracted by the succulent plants, cattle tend to graze the treated areas heavily for 2 or more years. Controlling tall larkspur with the treatments outlined could be integrated successfully with a deferred rotational grazing system.

Snowdrift sites, where tall larkspur thrives, constitute critical index areas for evaluating proper grazing management in the subalpine zone. While tall larkspur remains on these sites, cattle will continue to be poisoned and proper utilization of the surrounding vegetation will be unlikely. Controlling tall larkspur on the drift sites will permit proper utilization of the surrounding vegetation, improve the forage productivity of the snowdrift sites, and reduce the cost of managing cattle on subalpine grazing lands. All this can be accomplished with chemicals that do not show accumulation in the environment and are not much more toxic to animals than common aspirin or ethyl alcohol.

ELECTRON MICROSCOPE  
(Continued from page 43)

We have attempted a multi-discipline approach to research problems. The work with nematodes was done in cooperation with Dr. G. D. Griffin, United States Department of Agriculture nematologist; temperature stresses with Dr. F. B. Salisbury (turf-grasses) and Dr. D. R. Walker (fruit buds); and herbicide effects with Dr. J. O. Evans. Our electron microscopic studies of wheat subjected to a field-applied herbicide, igran, aided in defining the current governmental regulations calling for applications in the range of 1 pound of active ingredient per acre.

The results of these investigations and of others currently underway benefit not only other plant scientists, but also aid householders trying to manage lawns and gardens, and control pests.

Figure 4. The tall larkspur on this snowdrift site has been controlled by applications of 2,4,5-T. With the exception of the tall larkspur plant in the center foreground, the site now supports a lush strand of mountain brome (Bromus carinatus Hook, and Arn.).
NATIVE PLANTS FOR GARDENS

BERNIECE A. ANDERSEN and ARTHUR H. HOLMGREN

The wave of ecological awareness has stimulated a lot of interest in our native plants. More and more people are asking “Why can't we use our native plant material for domestic plantings?” This idea has a great deal of merit. Certainly we have not begun to take adequate advantage of this great resource. Within the Intermountain area we have more than 4,000 different kinds (species) of plants. Many of these are more attractive and require less care than the exotic plants we buy at the corner nursery. Native plants are marvelously adapted to our climate and soil and promote a certain integral harmony with the landscape. Moreover, our mountainous terrain has for centuries encouraged the isolation of small populations of plants. This has produced distinctive variations between species and within species, some are tall and straight while others are low and ground-hugging. With all this going for it, why then, don't we rush out and get this superior plant material?

There are several reasons—all of them valid. In the first place, native plants, with some few exceptions are just not available through our nurserymen. Digging them from public land is unlawful. Furthermore, as every experienced gardener knows, transplanting plants is a hazardous business at best. Uprooted plants that haven't had the advantage of root pruning, etc., have a high mortality rate. Most wild plants have large spreading roots firmly and deeply locked into rocky soil. Moreover, success in transplanting does not end the liability. Wild plants have a lot of unknown qualities and respond differently to changes in their environment. The neat, compact little bush on a mountain side may become a floppy monster in a garden. For example, a specimen of fringed sagebrush (Artemisia frigida) was introduced into the Holmgren garden a few years ago. In its native habitat in the Uinta Basin, this makes a compact, fine textured mound of gray-green color. In the well irrigated garden habitat it grew a stringy 2½ feet high and blew over in the wind. Perhaps with less water it would be as beautiful as it is in its native habitat. Most gardeners do not have the time or space to devote to this kind of trial and error experimentation.

Many of our herbaceous plants are successful garden subjects and are easily grown from seeds. As yet, gathering wild plant seed is permitted in Utah. Our wild penstemons are a spectacular group and do very well in cultivation. The sky blue (P. cyananthus), the tall pink (P. palmeri), and the dwarf blue (P. humilus) are excellent perennials and reproduce readily from seed sown directly in the

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Figure 1. Sky blue penstemon (Penstemon cyananthus).

Figure 2. Scarlet trumpeted gilia (Gilia aggregata).
garden as soon as it is mature. They prefer clean cultivation. The scarlet trumpeted gilia, *Gilia aggregata* is found in our mountains and grows beautifully in gardens. They, like the penstemons, prefer full sun.

Wild geraniums, both the pink and white species (*Geranium fremontii* and *Geranium richardsonii*), are full-foliaged and free blooming in semi-shade.

Among the early spring flowers we have dog-tooth-violet (*Erythronium grandiflorum*), spring beauty (*Clatonia lanceolata*), and yellow fritillary (*Fritillaria pudica*). These do best if their seed is planted just where they are to remain. Rich, woody soil is preferred.

*Figure 3. Pink wild geraniums (Geranium fremontii).*

*Mertensias* or bluebells are good dependable additions to home gardens. *Mertensia brevistyla* rather resembles its relatives, the forget-me-nots. *M. ciliata* and *M. oblongifolia* have bell-shaped hanging blossoms.

The beautiful mountain columbines (*Aquilegia caerulea, A. flavescens, and A. formosa*) are somewhat of a challenge. They are not entirely hardy in domestic gardens.

Some wild flowers do too well. *Smilacina* or false solomon seal, at least one of the asters and our native golden rod (*Solidago canadensis*) can become weedy. Most native ferns

*Figure 4. Bluebells (Mertensia ciliata).*

*Figure 5. Sego lilly (Calochortus nuttalii) is one of our wild flowers as yet cannot be successfully grown in home gardens.*

*JUNE 1972*
don't do well but bracken fern (*Pteridium aquilinum*) is often a nuisance.

Many of our native plants belong in rock gardens. Pink phlox (*Phlox longifolia*) and the hairy fleabane daisy (*Erigeron pumilus*) are choice spring bloomers. Stemless goldenweed (*Haplopappus acaulis*) blooms in early summer.

Because they require so many years to reach their full maturity, trees and shrubs are the most important elements in home landscaping. We need to know how well they will grow and what they will look like year after year. This requires carefully conducted research programs.

We do, of course, have a few of our native trees and shrubs available through nurseries. These have proved to be quite successful. They include the beautiful red river birch (*Betula occidentalis*), osier dogwood (*Cornus stolonifera*) with its mahogany colored stems, and Rocky Mountain maple (*Acer glabrum*). Quaking aspen (*Populus tremuloides*) can sometimes be found for sale. Unlike many of the wild stands, these are fine, disease-free specimens.

For new home builders, there is an additional prospect. Two of the most attractive small trees on our foothills are Gambel oak (*Quercus gambelii*) and bigtooth maple (*Acer grandidentatum*). They grow in clones and are characterized by their rustic, irregular form. Both are all but impossible to transplant to a new location, but are very well adapted to their native habitat. In recent years, an increasing number of home builders have taken advantage of their naturally wooded lots by leaving as many of the trees intact as possible — thus having a ready-made landscape. This practice might profitably be applied to other virgin areas. To preserve such a landscape over time, however, the householder must be careful to not radically alter the habitat with too much water or other cultivation practices.

As yet, some wild species have not been successfully grown in gardens. We need experimentation to determine why. Among them are our state flower, the sego lily (*Calochortus nutallii*). Some of our wild violets defy cultivation. These include the little birds foot violet (*Viola beckwithii*) and some of the yellow ones. On the other hand, the blue wood violet (*Viola adunca*) thrives in cultivation.

Because Indian paint brushes (*Castilleja*) are partly parasitic on other plants, they need special conditions that most gardens don't offer.

Whenever civilization incroaches upon a pristine habitat, it is changed. Some plants survive and even increase. Others disappear. This makes the losing of important genetic material an ever present danger. We have some extremely interesting plants that are in very short supply. Of a choice little lady-slipper orchid (*Cypripedium parviflorum*) that was once common on the Wasatch Front, there are now perhaps less than 50 plants still alive.

*Acer grandidentatum* (big tooth maple) is commonly a small tree growing in clones or clumps. However, several specimens in the mountains above Mendon, Utah, grow singly and have developed boles more than 2 feet in diameter. Their height is more than twice that of the more common canyon maple. These are apparently a very rare variant from the others and deserve protection and perhaps propagation.

The prospect of being able to use more choice native plants in the near future, may be excellent. During the last 50 years, field botanists in Utah have accrued a great deal of information about plant growth habits and distribution, and plant scientists have developed very effective techniques for propagation. One year quite soon, new treasures for our garden may be available at our favorite plant market.

Figure 6. Bracken fern (*Pteridium aquilinum*) is one of the few native ferns that is easily domesticated. In fact, it is often a nuisance.
To commute - or not to commute: a new choice for farm families

B. DELWORTH GARDNER and LARRY K. BOND

The composition of the American rural population is changing. Urban families move to the country to escape the noises and congestion of the city, while farm families continue to move to urban centers. Another relatively unpublicized trend may also be taking place and have implications for the future.

National census data reveal that the percentage of all farm operators living off-farm is increasing. These data have been interpreted by Gardner (1969) as evidence of a national trend. This increase in off-farm residency has been catalogued in Utah (table 1) as well as in other states. The explanation for this apparent shift, and the likelihood of its persistence are of consequence to all levels of government as well as to private industry. That is, projections of where people will be living are basic ingredients of all plans for the future.

Research was therefore initiated at Utah State University in 1970 to study residence patterns of farm families in Cache and Sanpete Counties of Utah. The specific objectives were to analyze selected variables that might be expected to influence the place of residence of farm families, and to ascertain how much residence shifting is taking place.

THEORETICAL FRAMEWORK

The variables expected to influence farm family residence location were identified with the help of a theoretical model.¹ The farm family is assumed to employ time, labor, capital, and management services in various combinations of three basic types of activities: 1) consumption, which includes functions necessary to sustain life such as eating and sleeping, and recreational activities such as going to a movie, reading, etc.; 2) farm production operations; and 3) off-farm employment.

Consumption activities are sources of utility (satisfaction) to the family and may be influenced by income, tastes and preferences, and prices— which include time and monetary costs. Income and time act as constraints on consumption. That is, the quantity and quality of goods purchased is constrained by the family's disposable income; while the amount of time spent in consumption activities can never exceed the total time available to the family (24 hours per day per family member). Farm production and off-farm work are sources of income and thereby indirectly influence consumption. The two activities also compete with consumption activities for time. It is assumed that the family tries to maximize its utility (satisfaction) subject to the time and income constraints.

By blending economic theory and a knowledge of agriculture with the theoretical framework just outlined, variables potentially relevant to the choice of residence location were deduced. Each variable selected for

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¹See Bond and Gardner (1971) and Bond (1972).

Table 1. Residence of farm operators in the State of Utah, Cache County and Sanpete County for census years 1950-64.

<table>
<thead>
<tr>
<th></th>
<th>1950</th>
<th>1954</th>
<th>1959</th>
<th>1964</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number reporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>living on farms:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State of Utah</td>
<td>18,203</td>
<td>18,499</td>
<td>13,631</td>
<td>11,166</td>
</tr>
<tr>
<td>Cache County</td>
<td>1,866</td>
<td>1,842</td>
<td>1,407</td>
<td>1,236</td>
</tr>
<tr>
<td>Sanpete County</td>
<td>826</td>
<td>971</td>
<td>590</td>
<td>359</td>
</tr>
<tr>
<td>2. Number reporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>living off-farm:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State of Utah</td>
<td>4,345</td>
<td>3,839</td>
<td>2,989</td>
<td>3,984</td>
</tr>
<tr>
<td>Cache County</td>
<td>166</td>
<td>258</td>
<td>221</td>
<td>361</td>
</tr>
<tr>
<td>Sanpete County</td>
<td>646</td>
<td>372</td>
<td>323</td>
<td>437</td>
</tr>
<tr>
<td>3. Estimated percent</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>living off-farm:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State of Utah</td>
<td>19.4</td>
<td>17.2</td>
<td>18.0</td>
<td>26.3</td>
</tr>
<tr>
<td>Cache County</td>
<td>8.2</td>
<td>12.3</td>
<td>13.6</td>
<td>22.6</td>
</tr>
<tr>
<td>Sanpete County</td>
<td>43.9</td>
<td>27.7</td>
<td>35.4</td>
<td>55.0</td>
</tr>
</tbody>
</table>

Source: U.S. Census of Agriculture

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analysis was expected to have some causal impact on the decision of where the farm family lived. In other words, there was reason to expect that the data for chosen variables, collected from rural-farm residents, would be significantly different than those collected from urban-farm residents.

Urban-farm residents were defined as those living in towns generally over 1,000 in population. Rural-farm residents were those living on farms and in small towns where the availability of goods and services is quite limited.

STUDY RESULTS

Some Differences

Farm families living in rural areas and those living in urban centers were compared on the basis of the variables deduced from the model. In both Cache and Sanpete Counties, more dairy farmers lived in rural areas than did operators of crop farms or other livestock enterprises. This was logical since dairy farms require a substantial daily labor input the year round. In both counties, the farms of the rural-living operators were significantly farther from an urban center than were those operated by families living in an urban center.

Mechanization can substitute for labor. The higher the capital-labor ratio (investment of capital relative to labor inputs) the greater the probability that the family can spend substantial time away from the farm. Thus families living off-farm would be expected to have a relatively high capital-labor ratio. This expected relationship held in Sanpete County, but not in Cache County.

Urban-living farm families in Cache County earn a significantly higher percentage of their net incomes from off-farm sources than do rural-living farm families. No significant difference between groups was noted in Sanpete County. A partial explanation for the divergent results may be that Cache County residents have more employment opportunities available to them.

Some Similarities

The characteristics of rural-living and urban-living farm families were unexpectedly similar with respect to some variables. It had been hypothesized that wives with non-farm backgrounds would live in urban centers in greater proportions than those reared on farms. However, no such significant correlations were noted for either county. With respect to farm tenure, it had been expected that part-owners and tenants would live in urban centers in greater proportions than full owners. This was not the case in either county. Acres irrigated was another variable that was insignificant. That is, the number of acres under irrigation was not significantly different between rural-living and urban-living farm operators.

The ages of the farm operators and their total net incomes were not significant sources of differentiation in either county. Despite the fact that urban-living farm families in Cache County earn a significantly greater percentage of their income from off-farm sources than do rural-living farm families, the net incomes of the two groups were not significantly different.

Ninety-eight percent of all the farm families interviewed were members of the Church of Jesus Christ of Latter-day Saints. Both the operator and his wife were asked if they held a church position. Despite the fact that rural-living farm families have to travel farther to church functions, they held as many positions as did those living in urban centers.

PREDICTING RESIDENCE LOCATION

After each variable was analyzed individually, all variables were considered as a unit and used in a mathematical technique known as a "discriminant function." The purpose of this phase of the analysis was to ascertain if there were some function of all variables taken compositely that could successfully predict which families would be rural-farm and which would be urban-farm residents. The results were generally quite acceptable. If the variables discussed above were known in advance for a specific family, its residence choice could be predicted, either on the farm or in town, with about 85 percent accuracy.

FAMILIES NOT SHIFTING RESIDENCE

Although the percentage of off-farm residency has been increasing in both counties, the increase is apparently not due to people actually deciding to live off the farm. Very few farm families in either of the counties have shifted residence during the past two decades. Each year, however, the number of farm operators dwindles nationally as farm families abandon agriculture. Some of these farms are purchased by farm operators who expand their operations. Others are purchased by families entering agriculture for the first time. The results of this limited Utah (Continued on page 68)
The designers of the Logan, Utah, sewage lagoons probably did not realize they were constructing a waterfowl refuge. But Logan's water treatment facility constitutes a refuge for thousands of ducks and other waterfowl during the summer and fall. The lagoons are so attractive to ducks that some species raised several hundred ducklings on the lagoon system during the summer of 1970.

These side effects of the lagoons were recognized during an investigation by the Utah Cooperative Wildlife Research Unit and the Department of Wildlife Resources at Utah State University. The Unit is studying the causes of botulism in ducks using the lagoons during late summer and early fall. Botulism, the scourge of western ducks for over half a century in many of the western marshlands, first appeared on the lagoons in 1969 and recurred in 1970 and 1971. Unfortunately, answers to some major problems of botulism remain elusive, but surprising discoveries have been made about the waterfowl populations that use the lagoons.

Logan's sewage lagoon system was completed in January, 1968, and is located about 2 miles west of the city. The facility consists of 7 ponds divided by 12 foot-wide dikes. Each pond is lined with heavy clay to prevent contamination of ground water, and the dikes are covered with crushed rock to control erosion and weeds. The ponds vary from 6 to 8 feet in depth and provide a total of 457 surface acres of water. Approximately 20 acre-feet of water pass through the system each day.

Waterfowl counts on the lagoons began in the summer of 1969, but it was not until the summer of 1970 that an extensive survey of bird populations was undertaken. Beginning in July of that year, counts were made at least twice and usually 3 times a week through September. On a typical duck-counting day, spotting telescopes and binoculars were in place and counting was begun by the time the sun's rays were just beginning to cross the valley. At each of the ponds a count of the total number of birds of each species was made by slowly sweeping the ponds with the tele-

![Figure 1. Logan, Utah sewage lagoons.](image1)

![Figure 2. Hundreds of seagulls visit the Logan sewage lagoons every year.](image2)
scopes. Juvenile birds were recorded separately so that production on the ponds could be estimated.

By the middle of September in 1970, nearly 10,000 birds were being counted on the lagoons daily. The predominate duck species included redheads, ruddy ducks, shovellers, pintails, mallards, gadwalls, and American widgeons. Other species such as coots, Canada geese, eared grebes and gulls were also seen. The lagoons were used by ducks and water birds even more extensively after hunting season opened in October. Two days after opening day, the number of birds counted jumped to approximately 15,500. The lagoons were obviously serving as a refuge during the hunting season, and they probably helped to keep many ducks in the valley that otherwise would have flown to more distant places of safety.

Ducklings were seen on the lagoons in the summers of 1970 and 1971. Redhead ducklings were the first ones to be noticed, about the first of July, but teal, mallard, gadwall and pintail broods were discovered soon afterward. Since the lagoons have no emergent vegetation and provide no suitable habitat for duck nests, all these broods had to have been hatched elsewhere and then brought to the lagoons soon after hatching.

By the end of the 1970 summer, the counts of juvenile birds indicated that the redheads had raised about 1,125 young on the sewage lagoons. The next in order of young reared were teal (50), eared grebes (37),

Figure 3. Grebe nest on Logan sewage lagoon complex.

Figure 4. Fall migrations bring thousands of ducks to the sewage lagoons as they wing their way south.
mallards (12), gadwalls (6), and pintails (5). This totaled 1,235 young reared or about 2.7 young per surface acre. The number reared was somewhat less in 1971 with only 675 young, mostly redhead. This was equivalent to 1.5 young reared per surface acre.

The sewage lagoon records compare favorably with estimates of young waterfowl reared on natural march areas in Northern Utah. Estimates in 1956 and 1957 at the Ogden Bay refuge indicated that between 1.5 and 3.0 ducks were being reared per surface acre of water1. The same study showed a total of between 3.5 and 7.5 ducks reared per surface acre on the north pond at Westpoint, Utah. The highest 1950 rearing estimate for natural water areas in Utah was 14.9 ducks per surface acre of Knudson Marsh west of Brigham City2. This is exceptionally high, however, and rates between 1 and 4 per surface acre are the rule.

By far the most intriguing birds to bring forth families on the lagoons were the eared grebes. Unlike the ducks, these small divers mated, built their nests and laid their eggs on the floating mats of vegetation within the lagoons. Courtship displays and nest building activities of the grebes were first noticed about mid July. The business of duck counting was subsequently often interrupted while the researchers concentrated on enjoying the spectacle of dancing and cooping grebes. Nest building was accomplished by pairs of grebes diving to the bottom of the ponds to obtain succulent pond weeds. The weeds were piled haphazardly in one spot on the surface of the water until they could be poked into an acceptable, though precarious, floating green nest.

The grebes, however, were evidently not concerned with the structural integrity of their nests. This dramatized an incident that occurred about the end of July when a nest count revealed a total of 81 nests on one of the ponds. Six days later, after a series of wind storms, only four of the nests remained. Fortunately, the grebes’ lack of engineering excellence is offset by their ability to quickly build new nests. Within four days the lagoons were adorned by 73 grebe nests.

Cubed hay gives better gains

JOHN E. BUTCHER and NORRIS J. STENQUIST

The form of the hay you feed beef animals does make a difference in their growth. This was borne out in recent feed trials at Utah State University. Cubed alfalfa produced significantly better gains—three-fourths pound per head per day—and feed efficiency among light-weight Hereford calves than did chopped hay of essentially the same quality, taken from the same stack.

The chopped hay was processed through a stationary chopper with a coarse screen and the dry hay ranged from dust to two inch stems. The cubed hay was chopped and cubed in stationary machines, without additives. The cubes were 1½ inch square with one to two inch lengths and the fineness of the hay ranged from dust to ½ inch lengths.

The study involved 66 calves, approximately equal numbers of steers and heifers, with beginning weights near 350 pounds. The animals on cubes ate more hay, resulting in higher gains. There were indications, however, that the cubes also may have been a bit better in digestibility.

Most research does not measure feed wastage. However, these animals were fed to meet their appetite and the wastage, considered an important factor, was measured (table 1). The greater amount of waste from the heifer feeding may be related to uncovered mangers and high snow and rain fall. It was interesting that both heifers and steers left mostly stems

(Continued on page 68)

Table 1. Comparison of chopped alfalfa hay and cubed alfalfa for growth of Hereford heifer (group fed), and steer (individually fed), calves.

<table>
<thead>
<tr>
<th>Animals</th>
<th>Aug. begin wt.</th>
<th>Aug. end wt.</th>
<th>Aug. day gain</th>
<th>Aug. day feed</th>
<th>Aug. day feed waste</th>
<th>Feed eff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 heifers</td>
<td>354</td>
<td>389</td>
<td>0.62</td>
<td>14.1</td>
<td>0.6</td>
<td>22.7</td>
</tr>
<tr>
<td>17 heifers</td>
<td>354</td>
<td>433</td>
<td>1.40</td>
<td>17.4</td>
<td>0.7</td>
<td>12.4</td>
</tr>
<tr>
<td>16 steers</td>
<td>336</td>
<td>414</td>
<td>1.08</td>
<td>11.9</td>
<td>0.1</td>
<td>11.0</td>
</tr>
<tr>
<td>16 steers</td>
<td>334</td>
<td>483</td>
<td>1.84</td>
<td>17.2</td>
<td>0.4</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Utah is discovery country! Utah has more national parks than any other state in the United States with the exception of California. California has just as many. Utah has more national monuments and national forests than most states. Utah has high mountains, streams, and lakes. Utah has canyons, unique in the world over. Utah has a rich historical and cultural heritage. Utah is the home of outstanding contemporary Indians and was the home of a classic prehistoric culture. Utah has exciting and challenging white water rivers. Utah has lakes ranging from small alpine ponds teeming with trout to Lake Powell offering 1800 miles of shore line, every inch a discovery. Utah, indeed, has "the greatest show on earth." Summer, Winter, Spring, Fall, Utah is discovery country!

Each year nearly 5 million nonresident tourists visit Utah. Unfortunately, they are hardly here long enough to find why Utah is called discovery country. To 1½ million tourist families or nearly 30 percent of all those who visit, Utah is no more than a long thin strip of black asphalt. Utah is just a wide place in the road that millions of tourists pass through on their way to vacations in Colorado, Yellowstone, California, Las Vegas, Disneyland, and Grand Canyon.

Last summer nearly one-third of all the tourist families that passed through Utah did so without spending a single night. Another 51 percent stayed only one night. On the average, tourists spent 1.3 nights in Utah last summer. This is hardly adequate time in which to discover Utah. In fact, it is just barely time to get through Utah.

Five million tourists spent $65 million in Utah last year. Five million tourists spent $320 million in Colorado in 1968. Tourist parties spent an average of five and one-half days in Colorado.

Although comparable data are difficult to obtain, it has been suggested that tourist length-of-stay in Utah is ranked fourth or fifth—fourth or fifth from the bottom of all fifty states and the District of Columbia.

While it is unfortunate that Utah is not realizing full economic and manpower growth from tourism, it is particularly alarming in light of the fact that tourism development may be one of the only opportunities to better the economic welfare of many of Utah's rural areas.

Why isn't Utah realizing her full economic potential from tourism? What problems must Utah overcome to reap economic and manpower growth from tourism?

In some cases the problems listed below are no more than personal opinion, while in other cases empirical data support their existence. In addition, this list is not considered all inclusive. The major problems of tourism development in Utah can be grouped under six areas, some of which are very much inter-related: (1) In-state attitude, (2) Image, (3) Access and facilities, (4) Capital, (5) Seasonality, and (6) Know-how.

1. In-State attitudes: Negative attitudes toward tourism development in Utah are difficult to document, but they can be experienced in many of Utah's rural areas. The tourist, as an outsider, is often regarded as suspect and a threat to traditional community values. Although the uncordial atmosphere may be the result of rural provincialism, it may be a hangover from early Mormon pioneer attitudes. Increasing length-of-tourist-stay is most critical to increasing the dollar output from tourism. An air of indifference and a lack of warm welcome

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will not encourage the visitor to spend an extra day.

In some cases, the type of business and industry necessary to serve the tourist is not regarded highly in a community. Possibly this reflects protestant ethic values since tourist income is derived from leisure activities. The dollar a tourist leaves in a community spends just as well as a dollar derived from agriculture or hard industry. Utah communities cannot survive without agricultural or industrial income but neither can they afford to disregard the tourist dollar.

Another in-state attitude that may hinder tourism development involves land classification. The mention of changing the classification of a national monument to a national park automatically elicits strong controversy and denunciation. Likewise, creating a new national park or monument is regarded as unwise even if the land is already under public ownership. Granted, some land use conflicts do arise as the result of land classification changes. However, the ample data available on tourist behavior strongly suggests that tourism in the Intermountain and Rocky Mountain West is oriented to national parks and monuments. National parks and monuments seem to have significantly more status among tourists and thus generate more dollars than do national recreation areas, national forests, state parks and other areas. Community rivalries and landowner sportsman relationships also bear upon the success of tourism in Utah.

2. Image: Consumer psychologists tell us that people buy products and services not only because of the inherent or physical qualities, but also because of some perceived image or personality of the product. It is suggested that they buy those products which have personalities most similar to their own or which are most congenial.

States have personalities and their success in tourism may be modified by their image. Recent research conducted by Utah State University's Institute for the Study of Outdoor Recreation and Tourism attempted to ascribe image profiles to Colorado, Montana, Utah and Wyoming as perceived by nonresidents of these states. It was assumed that the state with the highest vacation destination preference would have the "best" image or personality and vice versa. In the final analysis Utah was the least preferred state for a vacation, and, consequently, considered to have the worst image. Utah was thought to be a desert state, hot in the summer, with significantly less snow than the other states in the winter, occupied by conservative residents who were less receptive to vacation visitors and generally looked and dressed like Amish Mennonites or Hutterites.

Successful tourism development in Utah may hinge to a great degree on changing this image. While many would argue that Utah's uniqueness is her attractiveness, it may well be that Utah is good only for a fast and casual glance by the tourist who hurries on to be hosted for an extended time by people in other states that he believes to be less exotic or "more like home."

Changing an image is a long and involved process. Utah will have to support a continual advertising and information program, not to attract more people to the state, but to inform them of the real Utah. We must also capitalize on every opportunity to sell ourselves as people.

3. Access and Facilities: Access and facilities problems are specific to certain regions in Utah, as well as being generally wide spread.

Research on tourists strongly suggests that quality access routes are a critical element in developing a tourist destination area. Tourists generally adhere to well-traveled routes in pursuit of recreation activities, attractions, or accommodations. They are particularly reluctant to venture on unknown, unpaved roads. Unplanned road development, however, is not the answer to successful tourist development. Access routes must follow existing or potential patterns of traffic flow. For example, since Utah's national parks and monuments are significant attractions, the southwestern parks, Zion and Bryce Canyon, must be effectively linked with the southeastern parks, Capitol Reef, Arches, and Canyonlands. Likewise, access must tie to Utah communities since they serve as the accommodations base and dollar depository.

The spectrum of facilities, from private resorts to public campgrounds, is incomplete in quantity and quality in Utah. Improved restaurants, motels, resorts, and other private accommodations and services are desperately needed in many areas.

Public facilities are probably more significant to tourism development in Utah than in the majority of states. Since Utah is 75 percent publicly owned (second largest public ownership in the continental United States), state and federal agencies can have a major impact on tourism with their smallest change in policy or management. Likewise, public investment or lack of it, in recreation facilities, can make or break some regions of the state. In cases where public agencies control miles and miles of highway right-of-way, they are obligated to provide accommodations or release property for private investment.

4. Capital: Investment capital for recreation and tourism enterprises has been sadly lacking in Utah. Utah banks are reluctant to lend money for these enterprises. Very often money is invested from outside of Utah and the income generated generally flows back to this outside source. Efforts to better document tourism facility development opportunities, successes, and problems will help to alleviate some fears which Utah bankers may have of tourism development.

5. Seasonality is a significant problem. Many Utah areas, however, have the potential to extend their seasons beyond the traditional summer period, but are not realizing the opportunity. In other regions of Utah a short tourist season will always be a problem. Seasonality often also creates seasonally high unemployment. While a long
season is desirable, the fact that seasonal jobs are better than none at all must not be overlooked.

Although increasing tourist length-of-stay through-out of Utah is a valid goal, it is particularly important to areas characterized by rigid seasonality. In areas having a short season, extra efforts should be made to expand length-of-stay. It is the general rule that tourist expenditures per unit of time increases with length of stay.

6. Know-how: Technical knowledge is necessary to develop and operate a successful tourist industry. Until recently, Utah's tourist industry has been poorly served in this regard. Utah State University, however, has recently developed educational programs to help the tourism segment of Utah's economy.

Educational needs run the full gamut from training for waitresses and service station attendants to special programs for business managers and community leaders. In many cases communities must be helped to recognize their tourism resources and potentials, and then assisted in overcoming various constraints. Investment from outside of Utah, while certainly welcome, is often a reflection of the resident's lack of knowledge or inability to recognize potential. Tourism deserves state and local educational support similar to that given agriculture, mining, and commodity industry in Utah.

Tourism development must be in accord with environmental constraints. Utah tourism is based upon natural resources and natural phenomena. Rampant and uncontrolled development could ruin the attractions that development sought to exploit. Since today's tourist is a sophisticated and knowledgeable traveler, tourism development must be quality development. Today's traveler wants quality and is willing to pay for it.

While tourism is no panacea for all Utah's problems, it will eventually be the sole solution for growth and development in some regions of Utah. The potential has thus far been virtually unscratched. Much is yet to be discovered—after all, Utah is discovery country.

WHAT IS RURAL DEVELOPMENT?

JAY C. ANDERSEN

For many years the most popular diagnosis of the farm problem has been "too many farmers". Urban problems are currently being attributed to "too many disadvantaged persons in the central cities." These two situations are related. Children of the excess farmers in the past comprise many of today's ghetto residents. Through all levels of government there is a great push to provide jobs and community services in rural areas to alleviate both urban and rural problems. Jobs and improved living conditions are expected to draw people from the cities and keep them in rural areas.

During the 1960's the problems of low wages and under-employment in farming were somewhat alleviated by sustained national economic progress that generated non-farm jobs at good wages. As a consequence, the farm population declined by 40 percent, while the farms increased in size and efficiency in most of the country. Per capita disposable income of farm people (including off-farm income), which was only 54 percent of that of non-farm people in 1960, had risen to about 75 percent at the end of the decade. But despite the narrowed income disparity, the migration continued at a rapid rate, seemingly to be slowed only by lack of people left on the farm.

The problem is larger than a farm income disadvantage. The migration process that accompanies the trend toward larger, more efficient farms is bringing stress to shrinking rural communities. As the population declines, the availability of local leadership and the quality of many services such as schools, medical help, highways, and retail sales outlets also declines.

Paradoxically, however, the out-migration from agriculture is not necessarily antagonistic to rural development. There can be little or no advantage in keeping people in occupations where they cannot earn a decent living. The well-being of the people involved is the important factor in rural development. Number of people or number of jobs may be poor indicators of the well-being of an area. Worthwhile or "real" rural development equates with an expanding range of effective choices open to rural people. Such expansion may take the form of any or several of the following:

1. Increased per capita real incomes to expand the choices in consumer goods and services.
2. Improved distribution of incomes and wealth to expand the choices open to the poor people.
3. Improved mobility of human and other resources to expand the choices of employment and to allow people to respond to alternative opportunities as they become available.
4. Improved community diversity to expand the choices among quantity and quality of goods and public and private services available to rural people.
5. Improved quality of life as perceived by rural people. Environmental surroundings, and recreational and cultural opportunities are examples.
By these criteria, providing more jobs or getting a factory for the town may not constitute progress at all. The nature of the jobs, their wages, and the kinds of industries involved are critical.

Past efforts at rural development have been largely based on income transfers of various kinds, which constitute welfare payments. Farm programs have been a means of transferring income from non-farm to farm residents. The decline in agriculture’s political power and a growing dissatisfaction in Congress with the emphasis on the big and non-poverty segments of the farm population is operating to reduce these farm programs. Anyway, such programs hardly represent a true rural development policy.

A long-run, nonsubsidized adjustment to the problem requires that efficient, competitive enterprises be encouraged to locate in rural regions. Agricultural and nonagricultural firms will flourish only if they are located advantageously for obtaining resources and for marketing their products. Only a limited number of rural regions have the characteristics to attract a substantial development by many industries. Failure to recognize the kinds of businesses and farming suited to a particular region can lead to a need for subsidization or to bankruptcy and failure. There are reasons why big cities have developed where and when they did. These reasons are related to the ease of communication and transportation which is so important to many businesses. Face to face communication with numerous people is often essential. Rural areas may be suitable for enterprises in which the dependence on ready access to many people and other businesses is minimal, but even then, advantages in labor or other costs, or in the setting are usually needed to offset disadvantages.

Chances of success in developing a rural area are greatly enhanced if local growth centers are designated. If every town seeks its own development, none may be able to provide sufficient services and amenities to be attractive. But if area-wide concentration is focused on one community that is within commuting distance of several others, a sufficiently enticing “package” may be developed. This implies that the poorest and supposedly most deserving places may not be the ones that develop nor should they automatically be the ones to receive help. As development resources are scarce, the need for wise management implies that they should be concentrated on the few places where they will yield the highest returns. Concentration is necessary because, below a threshold level, investment may be dissipated and produce no developing effect.

The point can be illustrated with an analogy.

Let us suppose that one hundred hungry unemployed women are asking for relief. If we give each of them one dollar a day, it will cost us one hundred dollars daily, and allow them to buy just enough food to survive till the next day and our next distribution. After some time, all our money will be spent, while the women will continue finding themselves in the same needy conditions. The effect of our aid has been to impoverish us, without solving their problem in the longrun. Instead of this, if we give one woman a sewing machine, she will be able, from now on, to earn a living for herself and her family, and will need no relief any more. Besides, it is to be hoped that her business will prosper, and that she will soon hire another woman to sew the buttons, maybe a third one for linings, and so on. The sewing machine has been the trigger inducing development. It has been a sound investment, a factor of growth and progress.

It should be noted that, in the case of such a policy, we would definitely not want to give the sewing machine to an elderly and sick woman. She may be the most needy among the poor lot, but she is also the one who would use the machine with the least efficiency. We would give the machine instead to a young and healthy woman who would make most advantage of it by working many hours a day. This may seem to be a social inequity; however, it is a very sound development policy.

Policies that emphasize aid for sick and dying communities are often promoted in rural development. Some concern with fairness and equity is surely warranted, but the government’s frequent efforts in this direction should be called relief or charity rather than investment for development.

We often are told that good local leadership and dedication can promote growth in dying areas, but this depends on specific conditions and the resources available. In some situations, the leadership and dedication may be able to produce no more good than does pouring sand in a rat-hole.

Towns or other local governments often give substantial tax or other concessions in inducing industry to locate in their area. Careful consideration must be given to whether such concessions are worth it. Of particular concern is the local government ownership of fixed buildings, land, and developments. In many cases, no assurance is in hand that the industry will not relocate, leaving the community without an industry, but with a big debt and no way to recover the investment.

Our conclusion is that there is no magic in development. To succeed, it must be a cold calculating business. If an area can develop its resources to be more effective in the market place than competing areas then development may occur. Otherwise, mobility and outmigration may be the most appropriate solution. Careful and realistic study of the potentials and options is needed.

Regional climatic planning

E. ARLO RICHARDSON

Due to the wide variation in the climate of the state caused by the divergence of latitude, elevation, and other topographic features, the state has been divided into seven semi-homogenous climatic regions or zones. It is recognized that the climate in each zone may vary considerably from one locality to another, but use of these divisions does make it possible to present in a more manageable form a general review of the climate of the state and its variability.

While each of these divisions cover rather large areas of the state, studies have shown that, in general, the probabilities given do represent a fair guide to the variability of weather conditions at most locations within each region. If a more accurate estimate for a specific locality is desired, these same probabilities can be applied to the long term averages for specific locations within each division. The divisions are outlined on the map below.

If the information given in these summaries does not meet your needs please feel free to contact the author who is the National Weather Service Climatologist for Utah stationed at Utah State University, Logan, Utah 84322.

Data for the months of April, May, and June appeared in the March 1972 issue of Utah Science.

JULY

The first few days of July are normally among the driest of the year. Very few frontal systems reach the state during this month. By the second week of the month, however, moisture from the Gulf of Mexico finds its way into the southern part of the state and the summer thunderstorm season usually begins. This moist air moves progressively northward and westward and the number and intensity of thunderstorms near their peak toward the end of the month. These thunderstorms create a serious hazard to careless campers and hikers who sometimes get caught in flash floods in the more remote areas of the state. Twenty-three percent of the reported cases of damage from flash floods occurred during July. The month ties with June for the largest number of reports of damage from hail, 24 percent.

July is normally the warmest month of the year. On the average, the warmest temperatures occur about the 25th of the month. The warmest July temperature ever recorded was 115 degrees on July 1, 1950 at Zion.

E. ARLO RICHARDSON is the National Weather Service Climatologist for Utah stationed at Utah State University.
JULY

DIVISION TEMPERATURE DATA

<table>
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<th>Div #</th>
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DIVISION PRECIPITATION DATA

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* Div no 1—Western, 2—Dixie, 3—North Central, 4—South Central, 5—Northern Mountains, 6—Uinta Basin, 7—South East
* Less than .05 inches

National Park. The coolest minimum was 19 degrees on the 2nd of July in 1902 at Loa. The greatest 24-hour rainfall for the month (3.24 inches) occurred at Escalante on July 12, 1932.

AUGUST

The intermittent northward flow of warm moist air from the Gulf of Mexico continues to dominate the circulation pattern during much of August, but usually begins to taper off in the northwestern part of the state during the latter part of the month. Forty percent of the reported cases of damage from flash floods or heavy rain occurred during August. Danger from lightning also reaches a peak with 36 percent of the reported cases. The month ties with May for second place in the number of reported tornadoes.

After the late July peak, temperatures normally begin to moderate, but August averages only a few degrees lower than July. In some of the cooler areas of the state, the first frost of the fall season may occur during the latter part of the month. The warmest temperature ever recorded during August was 113 degrees on August 4, 1892 at Saint George. The coolest minimum was 20 degrees on the 24th in 1926 at Woodruff. The third heaviest 24-hour rainfall for any month occurred at Blanding on August 1, 1968, when 4.59 inches was recorded.

SEPTEMBER

September is normally a transition month between the summer thunderstorms and the onset of the October stormy period. Occasional thunderstorms still occur early in the month, especially in the southern part of the state. The mild temperatures and dry weather make ideal conditions to enjoy the gorgeous fall colors which the frost produces in the nearby canyons and mountains. The warmest temperatures ever recorded during September was 110 degrees on September 1, 1950 at Saint George. The lowest minimum for the month was 2 degrees on September 25, 1926 at Woodruff.
### AUGUST

#### DIVISION TEMPERATURE DATA

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# Div no 1—Western, 2—Dixie, 3—North Central, 4—South Central, 5—Northern Mountains, 6—Uinta Basin, 7—South East

* Less than .05 inches

### SEPTEMBER

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# Div no 1—Western, 2—Dixie, 3—North Central, 4—South Central, 5—Northern Mountains, 6—Uinta Basin, 7—South East

* Less than .05 inches
Land type surveys on the Dixie National Forest

During the past few years, utilization of National Forest lands has been intensified. In addition to the longtime uses for grazing, timber, wildlife, recreation and for watersheds, forest lands are now being used more extensively for summer home sites, mineral exploration, and for numerous other purposes. Roads and pipelines are often constructed in connection with these developments. Soil erosion, stream and reservoir sedimentation, and environmental degradation result if proper management practices are not followed. Because the land manager has the responsibility to protect the land resource from these unfavorable situations, he needs a thorough understanding of the limitations and capabilities of the landscape for which he is responsible.

RONALD K. TEW is a Soil Scientist at Dixie National Forest, Cedar City, Utah.

LAND TYPES

The Forest Service is currently using land type surveys to provide basic data for making land management decisions. Land types are visually identifiable areas having similar land forms, soils, geology, and vegetation that reflect the influence of climate. Because these variables are easily recognized in the field, forest lands can be grouped into rather homogeneous units for management.

Figure 1. Land type delineations on aerial photography.
The primary value of this approach to land classification is that it provides a technique for field men to analyze the factors which produce a given landscape and to integrate these variables. Also, the survey provides immediate information on the kind, amount, location and potential of land within a mapping area. With this information available, many management problems can be readily identified.

MAPPING PROCEDURES

The first step in making a land type survey is to identify the different land forms. This is usually done by viewing small scale (1:40,000) aerial photography stereoscopically. Delineations of the different mapping units are made directly on the photos (figure 1). Areas having similar land forms are grouped into a common unit. Descriptions of the topography, soils, geology and vegetation are obtained by on-site inspection. Further refinement of the mapping units can then be made by grouping areas having common land forms into units with similar soils, geology and vegetation potential. After the field mapping is complete, the land type delineations and mapping symbols are transferred from the aerial photos to a 2-inch-to-the-mile base map (figure 2). This map is accompanied by a report describing each mapping unit (table 1).

EVALUATIONS

The size of a land type designation on a map depends on the uniformity of the landscape and on the significance of characteristics that can be interpreted readily to identify hazards and productivity potentials. The main objective is to identify areas for which sound land management decisions can be made. These decisions are made after the potential of each land type has been evaluated for grazing and timber productivity, suitably for roads and recreation sites, potentials for various types of wildlife, suitability for small buildings, stock watering ponds, etc.

<table>
<thead>
<tr>
<th>Table 1. Basic data contained in a typical land type description</th>
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<tr>
<td>Land type 41</td>
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<tr>
<td>Extent: 8,253 acres, 5.63 percent of mapping area</td>
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<tr>
<td>Topography: Slope — 25 to 30 percent, Aspect — North and east</td>
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<tr>
<td>Elevation — 7,600 to 8,500 ft</td>
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<tr>
<td>Land form: Smooth pediment surfaces</td>
</tr>
<tr>
<td>Geology: Pink limestone and calcareous shale from the Wasatch</td>
</tr>
<tr>
<td>formation</td>
</tr>
<tr>
<td>Vegetation: Pinyon, juniper, big sagebrush, serviceberry, blue</td>
</tr>
<tr>
<td>grama, and Indian ricegrass</td>
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<tr>
<td>Annual precipitation: 16 to 21 inches</td>
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<td>Typical soils:</td>
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<table>
<thead>
<tr>
<th>Percent of area</th>
<th>Horizon</th>
<th>Depth (in.)</th>
<th>Soil texture</th>
<th>Coarse fragments (% by vol.)</th>
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<td>fractured bedrock</td>
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Soil classification:
Primary soil. Typic Argiboroll, fine-loamy, mixed
Secondary soil. Typic Ustorthent, fine-loamy, mixed, calcareous, frigid

Figure 2. A 2-inch-to-the-mile base map showing land type delineations on the Paunsaugunt Plateau in southern Utah.
made on the most appropriate use or uses for that land type.

To obtain the greatest benefit from a report, the land manager should study the interpretations given by the specialists and then visit each land type in the field to evaluate the present land management. Although evaluations on each unit may change with time because of changing land use patterns, the basic information on geology, geomorphology, topography, climate, and soil remains rather constant. For this reason, the data have lasting value for multiple-use planning.

**AG NOTES**

Figures recently compiled by the United States Department of Agriculture indicate per-acre real estate taxes paid by American farmers have risen 34-percent since 1967.

- Over the past 3 years, American agriculture has declined by 45,000 farms annually.

- During 1972, the USDA is looking to implement a broad program designed to help farmers control pests more effectively and more economically, while at the same time reducing the amount of DDT and other chemical pesticides currently being used.

- For every man, woman and child in the United States, American farmers produced 27 bushels of corn during 1971.

- North American farmers shipped 1,163 million bushels of wheat and wheat products throughout the world during 1970 making this continent the world’s largest wheat exporter.

- The percentage American families spend of their disposable income on food is expected to drop this year (1972) from the 1971 rate of 16-percent to around 15.5-percent, according to the USDA.

- When converted to meat and milk, United States’ forage crops produce an annual income equaling the total dollars brought in by soybeans, cotton, rice, wheat and tobacco.

- United States’ egg production hit a record high of 71.6 billion eggs during 1971, up 2-percent from the previous high (of 70.0 billion) produced during 1970.

- United States honey production was down last year. At 206,326,000 lbs., it was 11 percent below the 1970 output. The USDA points to a decline in the number of bee colonies, plus a lower yield of honey per colony, as the factors contributing to the lower production.

- If you didn’t eat a total of 321 eggs—either shelled or processed—during 1970, you’re behind the average as reported by the USDA.

- During 1970, American’s spent $114 billion for food, accounting for some 16-percent of their disposable income. If American consumers were spending the same percentage of their take-home pay today as they did 20 years ago, they would be spending in the range of $40 billion more for food per year.

- During the early months of 1972, the average per-ton price for baled alfalfa hay was $40.

- In 1 hour, a modern combine can harvest enough wheat to produce the bread for 220,000 sandwiches!
CUBED HAY GIVES BETTER GAINS

(Continued from page 57)

from the chopped hay, but reversed this preference with the cubes by leaving "fines" (dust).

The animals fed cubes outgained those receiving chopped hay by more than three-fourths of a pound per day. On the average, over an 85-day feeding period, the steers fed cubes ate 5.3 pounds per day more than those getting chopped hay. The heifers on cubes ate an average of 3.3 pounds per day more than those fed chopped hay, over a 57-day test period.

All of the steers had access to shelter and were individually fed in covered feed boxes. They also received equal parts of pelleted beet pulp and rolled barley. This concentrate was fed equally to all animals, beginning at a rate of one pound per day and gradually increased to four pounds per steer per day by the end of the 85-day period. The difference in average daily gain between the cubed and chopped alfalfa hay for the steers decreased as the quantity of grain was increased. The method of starting the steers on a small amount of grain and gradually increasing it is common in a warm-up or backgrounding program designed to get the animals ready to go into a fattening lot.

The heifers were divided into the two groups and were group fed only chopped or cubed alfalfa. They were fed in open pens with no shelter for the animals or the feed.

Visual observations during the study indicated that the outstanding result from feeding cubes was the increased skeletal growth seen in the animals. The greatest advantage from feeding cubes seemed to be realized with animals weighing under 500 pounds. Other studies and experiments, however, indicate that animals weighing 700 pounds and over also benefit from being fed cubes. This advantage is not so apparent, however.

Due to the great variability in the hay prices, we have not attempted an economic analysis of the data from these trials. We do know that the cubing increases the cost of the hay. Feeders may make their own determinations by comparing the price of comparable alfalfa hay in chopped and cubed form and then considering this price differential as it might relate to the differences in daily gain, feed consumption and feed efficiency indicated in table 1.

WILDLIFE NOTES

Baby alligators are eight inches long when first hatched and grow one foot a year, reaching maturity at six years.

The tiny, mouselike vole is more numerous than any other warm-blooded mammal, having as many as one hundred offspring in a single year.

The seal gives the appearance of being three-footed because of its two rear flippers being joined together. Two separate flippers are in front.

The female burrowing owl lays its eggs in the shape of a horseshoe, the clutch numbering from six to seven eggs.

The ring-necked pheasant has the longest tail of any American game bird.

The young of copperheads are born equipped with fangs and venom. Fortunately, copperheads are not aggressive and bites are rare.

COMMUTE OR NOT TO COMMUTE

(Continued from page 54)

study strongly suggest that the majority of those entering agriculture for the first time are (and remain) urban dwellers. Of all the operators interviewed who had entered agriculture during the past decade, twice as many had lived in urban centers as on the farm. And of these, none had shifted from urban to rural living after they began farming. Also, more of the farm operators who have left agriculture altogether had lived in rural rather than in urban areas. Thus, the percent of farm operators residing in urban places continues to increase.