Range management, how to grow good pastures at high altitudes, the description of a packing plant, a story on computers, and gross feed efficiency are the subjects of articles in this issue of Utah Science. These five stories have one thing in common; they all concern cattle.

Cattle, both beef and dairy types are a vital part of Utah’s livestock industry, and researchers at the Utah Agricultural Experiment Station are finding new ways to solve the problems facing the beef and dairy industries in the state.

Utah has nearly 75,000 square miles of rangelands. Beef cattle obtain about one-half of their feed from these ranges.

The other half of the beef ration, is produced on 3.3 percent of Utah’s arable land. Thus, pastures are important. Station research has shown that lush pastures can be grown at high altitudes.

Milk production can be vastly increased when effective management methods are introduced in the dairy herd. The heart of any management program is meaningful records. Utah dairymen, as well as those in other western states, are finding that computers can play an important part in their profit picture.

With some dairy cows, the more they eat of the right foods, the more they produce. One vital problem being investigated at the Station is: “Is gross feed efficiency inherited?” Present data seem to show that such is the case. And last but not least, of you’re interested in how one of the most modern packing plants west of the Mississippi handles an animal on the hoof to off, read further in this issue of Utah Science.

### CONTENTS

- Bioclimatology — a practical science
  Gaylon Ashcroft, E. Arlo Richardson and Lois M. Cox
  .................................................. 35
- Search is on for new protein-rich seed crops
  .................................................................. 38
- Increased capacity through better distribution on mountain ranges, C. Wayne Cook
  .................................................................. 39
- Contributions to research
  .................................................................. 42
- Alfalfa weevil now found in 41 states
  .................................................................. 42
- Good pastures are possible — even high and dry,
  Rex F. Nielson
  .................................................................. 43
- Some insects love to eat only weeds
  .................................................................. 46
- Uranium mill wastes as stream pollutants, William F. Sigler
  .................................................................. 47
- Soil scientist, department head dies
  .................................................................. 49
- Influence of sire and ration on differences in gross feed efficiency in dairy cattle, R. C. Lamb and M. J. Anderson
  .................................................................. 50
- Dirty air — a peripatetic peril, Lois M. Cox
  .................................................................. 53
- Assistant director retires
  .................................................................. 57
- The unseen face of Utah agriculture — four stories on new methods and sound management
  Sanpete co-op talks turkey
  .................................................................. 58
  Eggs can be profitable
  .................................................................. 62
  How to take care of a beef
  .................................................................. 65
  Computers serve the dairymen
  .................................................................. 67
- Utah’s little known forest industries, Walter H. Johnson
  .................................................................. 70
- Nematodes may aid fight against insects
  .................................................................. 75
- Ultraviolet-treated apple juice has fresh-juice flavor
  .................................................................. 75
- Dairy herd recordkeeping expanding
  .................................................................. 75

### UTAH SCIENCE

A quarterly devoted to research in agriculture, land and water resources, home and community life, human nutrition and development, and published by the Agricultural Experiment Station, Utah State University, Logan, Utah.

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To avoid overuse of technical terms, trade names of products or equipment sometimes are used. No endorsement of specific products or firms named is intended, nor is criticism implied of those not mentioned.

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Do you experience youth’s exhilaration when confronted by the unknown? Do you still know the joy of a child’s ability to wonder — to not take things for granted? Do you find pleasure in learning how different parts of the natural world operate?

If you can say “yes” to such questions — you should get better acquainted with the principles of Bioclimatology. You already know, use, and are affected by many of them everyday — though you probably are not aware of the process. Once you learn to consciously apply those principles, however, you will have gained an unending opportunity to discover new insights into the dynamic relationships that exist between you and your surroundings.

As an entity, Bioclimatology is a recent science. As a vital though unnamed force in the world, it has existed as long as life. Precipitation, soil, sunlight, plants, air, animals — all of the natural world — this is the province of bioclimatologists. USU’s research and teaching programs in this science, therefore, use tools that are as modern as nuclear fission to study phenomena that predate the dinosaurs.

In this first of six articles, we discuss why Bioclimatology in general warrants your attention. Later articles will describe more specifically how different aspects of bioclimatology affect everyday life in Utah.

HOW IT "WORKS"

The history of the dinosaurs provides a particularly dramatic example of the way Bioclimatology “worked” before man’s influence began so often to outweigh that of nature. These monstrous animals thrived during an era when high temperatures and heavy rainfall prevailed over a region of relatively flat topography. Such a bioclimatic regime produced the large swamps and lush vegetation that are requisites for huge vegetarians. But gradually the climate changed, temperature and rainfall decreased, swamps regressed, mountains appeared, and the vegetation became too sparse to satisfy dinosaurian appetites.

Their own bulk prevented the dinosaurs from traveling very far in search of an adequate food supply. And so, they disappeared from the earth.

In more recent eras, it is generally man’s interferences with nature’s bioclimatic balance that brings about...
such changes. For example, before conservationists intervened, man almost eliminated buffaloes as effectively as the changing climate had abolished dinosaurs. Over many years, the buffalo, the prairie, and the Indian had achieved a satisfactory equilibrium with one another and the climate, despite marginal precipitation. But the white man’s greater efficiency and lesser rationality in killing, coupled with his thoughtless plowing of the prairie, destroyed that balance.

In effect, the technically advanced society of that era assumed the right to create an environment favorable to their concept of “the good life.” Unfortunately, it was even more difficult and rare then, than it is now, for people to recognize and re-evaluate all of the relevant factors in a bioclimatic conglomerate. In the case of the prairie lands the eventual results of such shortsightedness included banishing the Indians and buffaloes to reservations and reaping a dust bowl in the 1930’s.

The idea of trying to work with nature to achieve a certain kind of environment instead of simply trying to overpower the established order is still relatively alien to many people. But diverse examples from past and present indicate that a cooperative approach is usually most effective over the long run. Some of these examples will be presented in later installments of this series.

**PRIMITIVE MAN’S INGENUITY**

As illustrated with the preceding examples, most plants and animals are severely limited in their ability to adapt to, modify, or flee environmental changes. Man is the outstanding exception to this general rule. Almost as soon as man appeared on earth he began devising ways to adapt his environment to fit his needs. Capitalizing on the advantages provided by his brain capacity and his hands, man clothed himself, hung skins over the entrances to his caves, continually invented new uses for fire, and otherwise proceeded to modify his immediate locale.

The primitive societies that came after the cave men, in spite of their limited technology, were sometimes amazingly ingenious in coping with their environment. Consider the ceremonial chambers of the North American cliff dwelling Indians. These chambers routinely include what appear to be one or two chimneys built into the rock walls. Not in a single instance, however, do these “chimneys” show evidence of having been used for fire. Instead, numerous studies indicate that the fire was built in the center of the chamber and the smoke rose through the entrance hole in the roof.

To the casual observer, this seems an instance of remarkably poor design! Why build chimneys and never use them? And why place a large flat rock in front of every chimney? More careful analysis has shown that these “chimneys” were actually ventilating shafts that facilitated the entrance of cool, fresh air. The deflecting rocks helped distribute the incoming air about the chamber and prevented drafts from blowing directly on the fire or the occupants. The participants in the ceremonies thus sat around the small fire in comfort while the polluted air left through the roof.

**INTERACTION EXAMPLES**

Comparable examples of man’s interactions with bioclimatic factors can be cited for every age and every locale. The South Sea Islands presented primitive societies with some perplexing problems. In one instance, a problem was solved through architectural engineering that had early white explorers scoffing until they experienced its effectiveness.

Humidity and temperature are both high in the islands. Wind movement, by contrast, is low except for the all too frequent hurricanes. In addition to the vagaries of the weather, the natives had to outwit substantial populations of unfriendly animals and reptiles.

The natives solved their problem of marauding animals by building their huts on platforms that were raised 10 to 15 feet above ground on stilts. The access ladders were then simply filled up to discourage unwanted visitors. Elevating the huts was also a way to achieve better ventilation. This added height, however, left them highly vulnerable to the hurricane.

To offset that danger, the natives erected a wall of poles around their
huts. They then piled earth against the outside of the poles. The results were twofold. First, light breezes were amplified by the slope of the embankment, which greatly increased the comfort of the huts by promoting air movement through them. Second, the slope was sufficient to deflect the hurricane gales over the tops of the huts. In this case, the natives were adapting bioclimatological phenomena to their own ends.

Man is still busily manipulating his environment. Now, however, his horizons girdle the globe and extend from the depths of the oceans to outer space. But even with these new dimensions to his world, virtually all of his activities include elements that come under the heading of Bioclimatology.

THE MODERN APPROACH

Modern societies are generally much more sophisticated in their concepts and methods. Within the home, many of us now take for granted such things as adequate ventilation, heating and cooling equipment, refrigerators, humidifiers, and the innumerable other gadgets with which we construct a largely artificial environment. Climatic modifications found in the home can range from the arctic cold of the freezer to the tropical heat obtainable under an electric blanket.

In effect, modern man creates personalized climates in his home which favor organisms that increase his comfort or enjoyment, and imposes adverse environments on those he considers detrimental. For example, homes are commonly dehumidified in damp climates to prevent the growth of mildew organisms which destroy clothing and furnishings. Or, the atmosphere in a given room can be deliberately moisturized to ease the breathing of someone who is ill. Food is preserved by subjecting it to high temperatures that destroy potentially dangerous bacteria. Or, it is frozen to prevent the bacteria from even starting to grow.

Outside the home, however, even the most modern man is more likely to search out favorable environments for prized plants than to build a private greenhouse. In other words, once outdoors, we tend to adapt to the environment instead of trying to create an artificial one. For example, we plant tuberous begonias in moist shady locations such as normally occur on the north side of the house, but we put our zinnias or moss roses where they will enjoy warm sunny conditions.

THE NEED FOR PROPORTION

No matter what specific bioclimatological puzzle is under discussion, all of its factors have to be considered on the basis of comparable spheres of influence.

A forest-dwelling rodent, for instance, will respond little if at all to a storm that may maul the forest canopy. But small variations in temperature, humidity, or light intensity under the shrubs or weeds that grow beneath the trees can mean life or death to an entire rodent population. More subtle variations in the microclimate, which are too minimal to influence the rodents, may be vital to still smaller organisms within the forest ecosystem.

On a mesoscale, in the same forest the deer population might be drastically affected by a severe winter storm. The deer, in turn, may adversely affect the rodents' environment by denuding the shrubs.

Similarly, a rock exposed to the sun may significantly influence the life of a neighboring plant by altering wind and moisture patterns and by retaining heat. Such interactions approximate, on a small scale, some that occur between a mountain range and people, thus, the elements that warrant attention in any given bioclimatological situation must always be translated into compatible scales. This means that if you are concerned with raising mink, you will be thinking about different bioclimatic scales than if you were raising Herefords.

THE TANGLED WEB

At first glance, it may not seem too significant to man whether a particular plant species inhabits the sunlit or shady side of a boulder, or whether different kinds of periwinkles find separate ecological niches only a few inches from each other on a rocky shore. However, the presence or absence of a certain form of life in any niche determines
the survival potentials for other species of life, which have similar effects on still others. And ultimately the sequence engulfs man.

Like it or not, then, space-age men are both in and of the natural world. And nature does indeed weave a tangled web.

For instance, lightning (or a discarded match) starts a forest fire. Large acreages of forest and range are destroyed. A watershed becomes essentially nonfunctioning. Cattle and sheep raisers make adjustments in their operations and plans. Local economies are disrupted. Fire-induced changes in the soil, vegetation, and wildlife populations will take years to undo. Meanwhile, the climate in the area and the immediate vicinity is altered on micro- and mesoscales. Temperature patterns shift. Precipitation that would have been welcomed in past years is dreaded because of the new erosion and fast runoff potentials.

Or consider what happened to the African Savannah south of Lake Edward in the Congo after it was included in the Albert National Park. Initially, this area of low grasses supported a wide variety of antelope and various carnivores. After the region was incorporated into the park, the natives were prohibited from following their age-old custom of periodically burning off areas of the grassland. The park authorities thus happened to encourage tree growth. At approximately the same time, an invasion of locusts denuded much of the land. When the savannah vegetation came back, it was primarily as scrub thickets under the trees.

Within the same approximately 9-year period, the mammal population also underwent drastic changes. The numbers of just two of the many kinds of antelope dropped from 25,000 to 4,200. The lion and hyena populations sustained similar decreases. By contrast, as trees became more prevalent, so did elephants. And the elephants eventually became the force that was needed to turn the situation full cycle. They became so numerous that they destroyed many of the trees, and grasses could once more flourish.

The park's animal populations then reverted too close to their original balance.

Such dramas are in progress everyday on every conceivable scale. Some run their full course in a matter of hours — others, like the African incident, may take many years to reach an end point or to revert to something approximating the initial situation.

No organism lives without affecting its environment, and being affected in turn. And the intricate strands that form the ecological web of life will continue to also enmesh mankind, despite assaults by thoughtlessly applied technology. Here, then, is the crux of the challenge that excites bioclimatologists. Here, too, is the reason why an understanding of the principles of bioclimatology can make any individual's life more meaningful.

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**Figure 4.** Even as man's horizons stretch to include outer space, he remains in and of "nature's tangled web."

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**Search is on for new protein-rich seed crops**

Seeds of wild and unfamiliar plants might be developed as new sources of food protein for people around the world.

Since 1957, chemists and botanists in the USDA's Agricultural Research Service have conducted the most comprehensive search ever made for seeds that have potential as sources of protein for human diets.

The ARS scientists have determined the oil and protein content in seed samples representing more than 4,000 species. Of these, 379 species with high percentages of seed-protein were selected for amino acid analysis. This is more than 4 times the number of species for which amino acid values were available when they started the survey.

Amino acids are the building blocks of protein. For optimum growth, all animals, except ruminants such as cows, require in their feed essential amino acids, which the animals cannot synthesize. Man requires eight essential amino acids.

No known plant seed protein contains all eight of these amino acids in the proportions required by man. They might be provided, however, by combining seed proteins. Researchers found that proteins from some of the 379 species have a better pattern of essential amino acids than many currently used seed sources.
Good distribution of cattle over rangeland is essential to effective use of the forage resource. This is particularly true on rough mountain areas and poorly watered ranges. Federal Agencies may classify much of the mountainous summer range unusable because livestock generally are not well distributed. The range manager must base the carrying capacity of the range on the expected unaided distribution of animals.

Cattle naturally overgraze well-watered bottomlands before they move onto sloping lands or areas farther away from water. How to obtain more uniform use of range is a problem that should concern both the range technician and the range user. The objective is to manage toward maximum livestock production and still prevent the deterioration of areas which cattle naturally prefer.

For years we have known that herding, water development, salting, fencing, and trail construction could improve the distribution of livestock over the range, yet evidence of actual benefits in the literature is meager. It is difficult to assess true values to each of the above factors but the Department of Range Science at Utah State University has been studying their influence during the past 8 years.* The study area is typical mountain sage-aspen range and grassy bottoms located in the Cache National Forest. It is grazed from June 10 to September 15.

**DRIFTING LIVESTOCK**

Herding or drifting cattle out of the bottoms onto more sloping terrain has been studied alone and in conjunction with placing salt and developing water. When animals were allowed to remain along streams in the bottoms, the forage on adjacent slopes (35% or less) was used only 7 percent. When animals were drifted, even without the benefit of salt or water on the ridges and plateaus above, forage use averaged 27 percent. Areas adjacent to water where drifting was employed comprised approximately 40 percent of the total range area. Most of the areas where cattle were drifted had 35 percent slopes or less and were adjacent to permanent streams. The average air-dry production of forage on these areas was 630 pounds per acre.

If it is assumed that a lactating cow and calf will consume 35 pounds of air-dry forage per day, 3.6 additional cow-days per acre were obtained by drifting cattle. It was calculated that on 10,000 acres of typical mountain range 1200 cow-months could be obtained by drifting the cattle. In other words, an additional 400 cows could be grazed for 3 months during the summer by drifting the cattle out of the bottoms into other drainages and onto adjacent slopes and benches. These figures might represent 400 cows that otherwise would be cut from the allotment or an additional 400 cows for 3 months on ranges.

*A cooperative study with the U.S. Forest Service and the Utah Cattlemen’s Association.

Figure 1. Drifting cattle from streams and valley bottoms into other drainages and adjacent slopes by riding increases carrying capacity of mountain ranges.

C. WAYNE COOK is Assistant Dean and Professor in the College of Natural Resources.

JUNE 1967
at the beginning of the study in 1959, livestock were drifted twice weekly in most areas. From 1962 to 1966 most pastures were ridden three times a week and even four times if necessary. Cattle were drifted to prevent an over-concentration along any stream and around any one water hole or salt ground.

**SALT PLACEMENT**

The value of salt in obtaining better distribution of livestock on the range has been greatly underrated by both technicians and livestock producers. Some stockmen believe that salt should be placed near water, otherwise when animals consume salt they will become thirsty and go to water almost immediately and walk off flesh and trample down vegetation needlessly. Research has shown that this is by no means the case. Fully half of the time animals consumed water and then salt after which they went to graze for the full day.

Salt should be located away from water in forage producing areas where animals do not go by preference. Sometimes salt should be located on ridges where forage is available between the salted area and normal livestock congregation. Salt should never be placed on small ridges or saddles where cattle would normally travel from one drainage to another. This is not good practice because it merely holds animals on already overgrazed ridges and perhaps restricts the course of their travel along the ridge and onto higher flats. Salting along trails between watering places should be avoided unless animals do not normally travel from one water hole to another. Such a practice may increase the travel between water holes and will not distribute animals on outlying areas.

The quantity of salt for each chosen location will vary, depending upon the grazing capacity around the salt ground or the ability to draw animals into the area by salt and drifting. It is estimated that about 1.5 to 2 pounds of salt will satisfy 1 animal-unit month. When areas have been grazed enough; any remaining salt should be removed. If the salt must be removed because the area around the salt is being overgrazed, a check should be made during following years to determine whether salt is really necessary in this area. Frequent moving of salt grounds may be necessary, but more than 75 percent of the salt placements can become permanent salt grounds that will not vary more than ¼ mile from one year to another. It is often necessary to establish new salt grounds as the season progresses because of the management program or the general freshness and palatability of the vegetation. Salt is not to be considered a nutrient for animal welfare but rather a tool for better livestock distribution. It merely whets the appetite and stimulates glandular action. Animals can go unharmed for a year or more without a salt supplement.

**SALT PLUS DRIFTING**

Proper salt placement coupled with proper drifting increased the carrying capacity 30 percent on three separate allotments in northern Utah. To test the effect of location of salt alone, it was removed during alternate years while drifting continued. When salt was present, animals traveled as much as ¾ mile from water and negotiated any short-distance slope of as much as 45 percent in between. In addition animals were likely to return again and again to the salting area after once being drifted into the area to "find" its location.

Drifting alone increased the capacity by 20 percent on 40 percent of the total range and salting in conjunction with drifting increased the capacity of the range by 30 percent on 70 percent of the total range area. Thus, salt increased the use 10 percent on 40 percent of the range and 30 percent on 30 percent of the range which gives a weighed increase of 18.6 percent as a result of proper salting.

**WATER DEVELOPMENT**

Additional water development is by far the best means of improving the uniformity of range utilization. Recent studies show that from 85 to 150 additional cow months can be obtained from each new water development. The cost of these water developments ranged from a low of $90 to a high of $2000.
Water developments included reservoirs, springs and rain traps (guzzlers). Gullies on drainages are the criterion for the quantity of runoff. Therefore, reservoirs were developed in the upper drainages only where runoff was indicated by a small gulley varying from 3 to 8 feet across and from 2 to 4 feet deep. The drainage areas for water collection varied from 70 to 90 acres in aspen to as much as 300 acres in sagebrush-grass areas. The reservoir bottom should be at least 7 feet below the spillway. Evaporation may take as much as 4 feet, therefore, if the water is to last the full summer grazing season, depth of the reservoir must be emphasized rather than area.

Springs or seeps can be developed at a cost of less than $200 even when war surplus tanks are installed and the water piped to them. Some seeps or springs were developed to catch the water in a reservoir directly below them. In many cases the spring was actually included in the area to be covered with water when the pond was full. Springs and combinations of spring ponds are generally easier to maintain if the area is fenced.

Far too frequently we hear well trained technicians remark that a new water development on the range simply means more overgrazed areas. This is a very unscientific remark and would hold true only when excess livestock are allowed to graze without direction. Water development and directing livestock movements will relieve the overgrazed areas elsewhere rather than create new ones. In any event, the new water development should mean increased grazing capacity brought about through more uniform distribution. Animals must be moved intermittently from certain water holes if the water tends to attract more animals than the surrounding range can carry.

**TRAIL CONSTRUCTION**

The construction of trails through rocks, down timber, and thick brush that hindered or, in some cases, prevented livestock from traveling into forage-producing areas added as much as 75 to 100 additional animal-unit months per $100 cost.

These trails are about 30 to 40 feet wide and, as nearly as possible, are placed on a contour with the topography. Some of these are 1/2 mile long with six or more branches leading into 40- to 80-acre openings that heretofore were lightly used or not used at all. Such trails make it possible to reroute normal livestock travel from one drainage to another or from water onto plateaus and benches. Sometimes these trails make it possible to drift cattle from the head of one drainage to the upper reaches of another without traveling down one drainage and up the other.

Trail construction for livestock distribution offers tremendous possibilities for increasing the carrying capacity of ranges. This tool for obtaining more uniform use of mountain ranges is perhaps the most neglected.

**FENCING IMPROVES DISTRIBUTION**

Fencing mountainous range across drainages to form pastures of 700 to 1,000 acres increased use on all degrees of slope. By placing the division fences across the streams, the cattle were prevented from traveling along the drainages and forced onto the slopes. During all years of study, animals were removed from the areas when use of the most palatable grasses in the bottomland were grazed to about 70 percent of the current growth. Use of slopes greater than 35 percent was more than doubled as a result of cross fencing. Use on more moderate slopes was increased only slightly by fencing. During the 4 years of this cross fencing study, researchers did not drift animals in either the fenced or unfenced areas. Animals, however, were distributed along drainages and among the various drainages. It is believed that more intense drifting, in all cases, would have been beneficial and would have obtained even more uniform utilization.

In changing stock grazing patterns one needs to realize that cattle, like people, are creatures of habit. They often do as they do because they always have. They can be taught and shown new patterns of behavior. Once they are herded to a new flat, they may like it and make (Continued next page)
CONTRIBUTIONS TO RESEARCH
February 1 to May 15, 1967

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it a part of their routine. It may take persistence but they can be encouraged by salt, easy trails, water, and drifting. Remember, range is like a chain with a weak link — the first place of consequential size that is overgrazed determines the capacity of the whole range. Keep every area grazed uniformly and the grazing capacity can be doubled or tripled.

Alfalfa weevil now found in 41 states

The alfalfa weevil has now spread over 41 continental United States. Only Maine, Florida, Texas, Oklahoma, Iowa, Minnesota, and Arizona had not been invaded by this serious pest by the end of 1966. The weevil was reported for the first time last year in Michigan and Wisconsin.

The alfalfa weevil, *Hypera postica*, was first found in the United States near Salt Lake City, Utah in 1904. Although it spread slowly, by 1913 it had swept over Utah and into Idaho.

The weevil has spread rapidly in the Eastern States since it was first recorded in Maryland in 1951. In the East, the infestation involves a slightly different strain of weevil than the one found in the West, and it is believed that the Eastern strain may represent a separate introduction into the country.

Alfalfa weevils travel by flying and crawling. Many are moved during haying operations and may be carried long distances in infested shipments of baled hay or other farm products.

The life cycle of the weevil consists of egg, larva, pupa, and adult stages. In the fall, the adults crawl down into the crowns of alfalfa and seek other sheltered places in alfalfa fields, nearby ditchbanks, or field borders, where they overwinter. In early spring, the weevils become active. Each female lays several hundred eggs in clusters of 2 to 25. In warm weather, the eggs hatch in 1 or 2 weeks. In cool weather, they accumulate in the field until temperatures are favorable for hatching.

The larvae do greatest damage to the first cutting of alfalfa, but they may seriously damage later cuttings in some areas. They feed within the plant tips, on opening upper leaves, and then on the lower leaves, making skeletons of the foliage. Damaged leaves dry rapidly, and the field takes on a grayish to whitish cast.

Figure 4. Rather small but deep reservoirs are not expensive and they are the most effective means of drawing animals into areas they do not normally prefer.

UTAH SCIENCE
Pasture research has been conducted by the Utah Agricultural Experiment Station throughout its history. Work by Bateman and Keller has provided the basis for recommendations on improved pastures for many years. More recent studies by Allred have provided additional information on various mixtures and management practices involving fertilizer, irrigation, and clipping frequency. The results of all these investigations have been of major value to pasture producers in areas where climate and water supplies are similar to those found in Cache Valley. Unfortunately, many areas of the state do not fit this category.

**PASTURE STUDY**

A pasture study was initiated on the Panguitch Experimental Farm on May 2, 1962 to supply information from an area where climate, soil and irrigation supplies are different than those found in Cache Valley. Panguitch is located on the upper reaches of the South fork of the Sevier River. Elevation is 6,700 feet with long, cold, open winters. It is not unusual for frost to occur any month of the year, however, probability data show that frost will occur one year out of two as late as June 17 and as early as August 22. Irrigation supplies are limited and water is supplied on turn. The normal frequency of irrigation is from 21 to 30 days.

The trial involved alfalfa in various combinations with three grasses that had shown merit in earlier tests. In addition, fertility variables were superimposed on the different mixes. The planting procedure comprised furrowing the land, broadcasting the seed, harrowing and then re-establishing the furrows. Fifty pounds of nitrogen as ammonium nitrate was applied at the time of seeding. Good stands were established on all plots.

The pastures mixtures planted are as follows with the pounds of seed per acre shown in parenthesis.

- **Mix 1** — Alfalfa (1), Intermediate Wheatgrass (14) A-I
- **Mix 2** — Alfalfa (1), Intermediate Wheatgrass (7), Smooth Bromegrass (3), Orchardgrass (4) A-I-S-O
- **Mix 3** — Alfalfa (1), Intermediate Wheatgrass (7), Orchardgrass (7), A-I-O
- **Mix 4** — Alfalfa (1), Smooth Bromegrass (7), Orchardgrass (7) A-S-O
- **Mix 5** — Intermediate Wheatgrass (7), Orchardgrass (4), Smooth Bromegrass (3) I-S-O

Forage yields were measured by first clipping the plots in late June or early July and clipping a second time the first week of September. The grasses were usually in the boot or early head stage and the alfalfa was in early bud at the first clipping.
PERFORMANCE OF DIFFERENT MIXES

A summary of the yield data collected during the 4 years of the trial is presented in Table 1. Yields include both fertilized and unfertilized plots. The highest yields were always obtained from mixes containing intermediate wheatgrass and alfalfa.

It was observed throughout the study that intermediate wheatgrass failed to make a significant regrowth after it had been clipped as late as the early head stage. This summer dormancy can be minimized by making the first clipping prior to the boot stage. Allred in studies at Logan, found that frequent clippings (four or five) of intermediate wheatgrass had a very detrimental effect on the vigor and life of the stand. It is probable that three clippings would be maximum under Panguitch conditions and two clippings would be optimum.

Smooth bromegrass was more productive at Panguitch than orchardgrass. It should be noted however that orchardgrass is not well adapted to the climate of this area. The cold, open winters often cause high losses the seedling year. If the plants aren’t killed out then they are often weakened to a point where they contribute little to the pasture production. Its lack of drought tolerance is another point against orchardgrass and the 30-day irrigation interval is too long to keep this species productive.

Intermediate wheatgrass and smooth bromegrass behaved differently depending upon moisture and temperature in the spring. During seasons when weather was cold and moisture was lacking, intermediate wheatgrass was more productive than brome. When the reverse condition existed, that is, a warm spring with adequate moisture, then the smooth bromegrass was equal to or more productive than the intermediate wheatgrass.

EFFECT OF FERTILIZER

Throughout the trial, fertility variables were superimposed on the plots each year. In 1963, treatments consisted of nitrogen and phosphorous applied singly and in combination at the rate of 100 pounds of N and 44 pounds of P per acre. No evidence was found that any of the plots responded to phosphorous, so it was discontinued as a variable.

The death of the farm superintendent in 1964 resulted in only the first half (50 pounds) of the 100 pound rate of nitrogen being applied. Rates in 1965 were 50 and 100 pound with the 100 pound rate applied as a split application. The 1966 treatments were the same however, all fertilizer was applied at one time.

The response on the various pasture mixes can be observed in Tables 2 and 3 with a summary in Table 4. It is obvious that nitrogen had a significant effect in increasing yields on all plots. Fifty pounds of nitrogen
increased yields up to 1 ton per acre on the most productive mix (alfalfa and intermediate wheatgrass). Increases were most striking on grass plots which lacked alfalfa. This response was confined largely to the first cutting.

When comparing the two rates of nitrogen, table 3, it may be noted the 100 pound rate increased yields over the 50 pound rate in 1966 but not in 1965. This failure of the two years data to agree might have been influenced by season, however, it is more likely due to the 1965 treatment being applied as a split application whereas the 1966 treatment was all applied at one date. Fertilizer had little or no effect on the second cutting even when rates were increased to 100 pounds of nitrogen per acre in single or split application. This lack of response in the second cutting was probably caused by summer dormancy in the grass and/or the long irrigation interval.

It should be noted that the plots with grasses alone required 50 pounds of nitrogen per acre each year to equal yields of the same grasses plus alfalfa of unfertilized plots. It was evident throughout the study that alfalfa made a significant contribution to the total yield. In addition it had a marked influence on the yield of grasses, especially on unfertilized plots.

Earlier studies at the Panguitch farm have shown that alfalfa is the legume best adapted to the area. The bloat hazard from alfalfa in pastures varies with climate and should be considered when including this legume in the mix, however. The Panguitch area has a high bloat incidence and as a result a reasonable balance between the legume and grasses must be maintained to minimize the risk. Seeding 1 pound of alfalfa per acre provided the maximum amount of legume that could safely be grazed. Other pasture plantings on the farm seeded with 3/4 pound of alfalfa seed per acre resulted in a good grass legume balance. Losses from bloat usually occurred when young alfalfa grazed.

![Figure 2. Urine spots show up plainly on nitrogen deficient grass pastures.](image)

**Table 1. Pasture yields in tons per acre dry weight, total of two cuttings**

(Averages of 12 replications)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</tr>
</thead>
<tbody>
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<td>A-I</td>
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<td>3.7</td>
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* A — Alfalfa
I — Intermediate wheatgrass
S — Smooth bromegrass (Manchar)
O — Orchardgrass
Table 2. Pasture yields in tons per acre dry weight as influenced by nitrogen and pasture mix (Averages of four replications)

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Nitrogen rates and pasture mix (Averages of four replications)

<table>
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</thead>
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<tr>
<td>O</td>
<td>N</td>
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<td>A-I</td>
<td>3.1</td>
<td>3.9</td>
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<td>4.1</td>
</tr>
<tr>
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<td>3.3</td>
</tr>
<tr>
<td>A-S-O</td>
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</tr>
<tr>
<td>I-S-O</td>
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<td>3.3</td>
</tr>
</tbody>
</table>

Date harvested: July 3 Sept. 17 June 30 Sept. 3

*O = No fertilizer, N = 50 pounds of nitrogen per acre, N* = 100 pounds of nitrogen per acre

Table 3. Pasture yields in tons per acre dry weight as influenced by nitrogen rates and pasture mix (Averages of four replications)

<table>
<thead>
<tr>
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<th>1966</th>
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<td>A-S-O</td>
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<td>3.3</td>
</tr>
<tr>
<td>I-S-O</td>
<td>2.3</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Date harvested: July 6 Sept. 8 June 30 Sept. 1

*O = No fertilizers, N1 = 50 pounds of nitrogen per acre, N2 = 100 pounds of nitrogen per acre, N* = Nitrogen applied as a split application

Table 4. Pasture yields in tons per acre dry weight as influenced by nitrogen fertilizer (Two cuttings per year, 4-year total)

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<th>% Increase</th>
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<td>21</td>
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<tr>
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<td>17.9</td>
<td>29</td>
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<tr>
<td>I-S-O</td>
<td>9.8</td>
<td>13.9</td>
<td>42</td>
</tr>
</tbody>
</table>

* A - Alfalfa, I - Intermediate wheatgrass, S - Smooth bromegrass (Mancher), O - Orchardgrass

Figure 3. Alfalfa, as part of the pasture mixture increases forage yield over grasses alone. Note the alfalfa mixture on the right.

SOME INSECTS LOVE TO EAT ONLY WEEDS

Insects that have an appetite only for weeds are being tested to find effective biological controls for undesirable plants.

Dr. Lloyd A. Andres, entomologist with USDA's Agricultural Research Service, is leading extensive research and exhaustive explorations throughout the world to obtain weed-destroying insects that are adaptable to climates where weeds are a problem. State experiment stations are cooperating in the ARS program.

One promising insect is a small Altica beetle, native to Europe. It attacks Canada thistle, a weed which is widespread in the northern United States. Last summer, ARS and state scientists released this insect in California, Idaho, Montana, Oregon, and Washington. If the beetle successfully establishes itself in these states, scientists will introduce it in other regions infested by the thistle.

Cinnabar moths and ragwort seed flies have been released in California and Oregon to fight tansy ragwort, or stinking willie, a toxic weed. Another western weed, puncture vine, may succumb to two weevils that attack the stems and seeds of the spiny-fruited plant. Alligatorweed, which clogs southeastern waterways, is yielding to a flea beetle introduced in Florida. Scientists hope its success in that area will be repeated during further tests in other southern areas, including eastern Texas.

These and other insects that mesh with the local environment may become economical, self-perpetuating weed-killers. The search for weed-destroying insects is part of the USDA's continuing program to develop additional safe and effective methods of pest control.

UTAH SCIENCE
Wastes from uranium mills contain several dangerous radioactive and non-radioactive pollutants. In the United States the uranium industry is confined to a few relatively small areas on the Colorado Plateau, known locally as the Four Corners Area. Demands for nuclear weapons in the past 25 years, resulted in extensive development of uranium ore refineries. The magnitude of waste disposal problems was not fully recognized, however, and efficient methods of treating waste were not developed, until tremendous quantities of radioactive materials had been deposited in and along a number of streams in the Colorado River watershed.

RADIUM-226

One of the daughter products of uranium-238 is radium-226. This radioactive substance has a half-life of 1620 years. It is a “bone seeking” alpha emitter and, with the exception of lead-210, no other isotope of the uranium-radium series is considered as hazardous as radium. It causes intense local damage in the human skeleton so that radium is many times more harmful internally than externally. Until recently, radium was not removed from uranium ore because of its low market value. Instead, during the early days of uranium processing, radium was released into streams along with other mill wastes.

In addition to radioactive wastes, uranium mill effluents contain large amounts of non-radioactive but highly toxic chemicals which do considerable damage to water quality, and to the aquatic biota. These chemicals include sulfates, nitrates, chlorides, manganese, iron, lead, arsenic, fluoride, and an assortment of organic compounds.

At the request of the State of New Mexico, and under the provisions of the Federal Water Pollution Control Act, a Conference on Interstate Pollution of the Animas River was held on April 29, 1958. At this Public Health Service Conference, it was brought out that radioactive wastes from the uranium refinery at Durango, Colorado “appeared to present a significant problem in the terms of legitimate desirable uses of the Animas River.”

USU STUDY

In June, 1960, The Department of Wildlife Resources, Utah State University initiated a study on the Animas, the San Miguel, and the Dolores Rivers of southwestern Colorado. Research was directed toward two areas: (1) above and below the uranium mill on the Animas River at Durango, and (2) above and below the uranium mill on the San Miguel River at Uravan, and below the confluence of the San Miguel and Dolores on the Dolores River (figure 1). The Utah State University research was designed to (1) measure the amount of radium-226 in the streams, (2) follow its pattern of deposition, (3) determine its levels in the aquatic plants and animals, and (4) examine the roles of water and bottom sediments as carriers and storage reservoirs of radium.

Radium content in the water below the uranium mill at Durango was five to eight times above the late-1950’s background. Algae, insects, bottom sediments, and fish all accumulated several times background levels. The concentration of radium in water, bottom sediments, algae, and fish of the Animas River decreased from 1958 to 1963. About a 90-percent cleanup evidently occurred between 1955 and 1963.

The amount of cleanup below the uranium mill at Uravan was considerably less encouraging than at Durango. Water below the Uravan mill was generally more acid than it was above the mill. At one time the pH was as low as 4.3 (indicating very acid waters). The water below Uravan was often turbid and multi-colored, the bottom was heavily

* This research project was supported largely by the Public Health Service Division of Radiological Health, Project RH-00077, and in part by the Utah State University. A companion project (AEC Contract No. AT (11-1) - 1023) explored the effects of radium salts on algae and goldfish. A comprehensive report of this research was published as Bulletin 462 — The Effects of Uranium Mill Wastes on Stream Biota, by the Utah Agricultural Experiment Station.
silted and covered with loose, floc-culent material. Living organisms including algae, insects, and fish were difficult to find.

**CATFISH DECLINE**

The channel catfish population in the Dolores River below the uranium mill was seriously depleted after operations began. At one time from 1000 to 2000 channel catfish were taken from the Dolores River for stocking. Reports compiled by the Colorado Department of Game and Fish indicate there were 840 catfish per mile in the Dolores River in 1953. In 1956 this figure had decreased to 180, and in 1963, USU reports indicated it was further reduced to 142 fish per mile. In addi-

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**Figure 2.** The accumulation of radium by two fish species from the Animas River in Colorado.

**Figure 3.** The tailings pile at the Durango, Colorado uranium mill. Notes its close proximity to the Animas River, lower left.

**Figure 4.** Effluents from the uranium mill at Uravan, Colorado entering the San Miguel River. Photo by William Helm.
tion, the fish were in considerably poorer condition than they had been earlier. Prior to 1956, fishermen on the Dolores River caught fish at the rate of several per hour. By 1963, angling success had declined to less than one fish per hour. Quotes from a 1960 field notebook indicate how seriously the fish population of the San Miguel River was being affected: "Many dead suckers along the bank, water discolored by discharge from the Urvan mill, water greenish, milky white — twelve dead fish, stream extremely acid — all insects, algae, and fish dead at this station."

**WASTES HARM BIOTA**

Uranium mill wastes are an important factor in limiting or extirpating aquatic biota below uranium mills. Radium-contaminated sediments have been transported downstream from the Animas, San Miguel, and Dolores Rivers into the Colorado River system. It has been shown that radium concentrations in some Lake Mead sediments are approximately three times the background level of the basin streams. There is evidence that once radium becomes a part of a stream environment, it constitutes a relatively long-term continuous source of water and aquatic biota contamination. Dissolved radium below the uranium mill at Urvan ranged up to several hundred times background and averaged about 50 times background. These values did not diminish over the 3-year USU study period.

**CAN BE CONTROLLED**

Water pollution from uranium mill wastes can be effectively reduced by presently known methods. It should be emphasized that the Maximum Permissible Limits as defined by national and international agencies are intended to be truly maximal and always include recommendations that no exposure to radium and no change in water quality are the desired goals. Waste treatment procedures which have been applied so effectively by some segments of the uranium industry should be carried out as nearly as possible in all areas. Damage to stream biota by wastes which are treatable is indefensible. The legitimate use of a stream below pollution sources must be considered, but the natural aquatic habitat should be preserved regardless of present use.

Another critical problem concerning uranium milling wastes is the large amount of solid ore tailings deposited near streams. These tailings contain most of the radium originally present in the ore, and are subject to leaching and erosion. The problem has been compounded by the closure of uranium mills, several of which have left large tailings piles unattended and uncontrolled. It is extremely important, as pointed out by a recent Federal Water Pollution Control Administration report, that permanent control measures be taken to stabilize and control these wastes for the continued protection of the water environment.

**SOIL SCIENTIST, DEPT. HEAD DIES**

Dr. Sterling A. Taylor, Professor and Head of the Department of Soils and Meteorology at Utah State University, passed away June 8 at his home following an illness of several weeks.

Dr. Taylor was born February 16, 1918 in Salem, Utah, a son of Angus Danley and Margrette Martin Taylor. He married Frances Galssett Taylor May 29, 1941.

Dr. Taylor had an international reputation in Soil Physics and Irrigation. He presented scientific papers in Spain, France, Roumania, Italy, Australia and at numerous meetings in the U.S.A.

He authored a book, “Physics of Irrigated Soils,” the only current textbook available for general soil physics. He also authored 93 scientific papers dealing with soils, irrigation, climate and soil-water-plant relations. They have been published in professional journals throughout the world in several languages.

Dr. Sterling A. Taylor, Consultant

Dr. Taylor was an outstanding teacher, having trained students from 49 different countries. He served as special consultant for the International Cooperation Administration in India and Venezuela, as special consultant for the state of California in determining water requirements for crops, and as a soil physics consultant for U.S. Food and Agricultural Organization in Egypt. He also served as special consultant concerning irrigation problems for many private concerns.

Dr. Taylor obtained his B.S. Degree and was commissioned an officer in the U.S. Army at Utah State University. He received his Doctorate at Cornell University in 1949 and joined the staff at Utah State University the same year.

**Military Service**

He entered the U.S. Army as a Second Lieutenant in May, 1941, serving until 1946 when he was released with the rank of Major. He remained in the Army Reserve after World War II and was instructor for the Command and General Staff School. He was recently promoted to full Colonel and received an appointment from the Pentagon as Commander of Reserve Research Mobilization.
Influence of sire and ration on differences in gross feed efficiency in dairy cattle

R. C. LAMB and M. J. ANDERSON

Individual dairy cows vary widely in their ability to efficiently convert feed nutrients into milk. If the factors which control these differences can be determined then herds can be managed in a manner that will increase the net profits to dairymen. Hopefully, genetic control is involved, as well as feed and management practices; so that greater efficiency can be attained through selection of superior breeding stock.

In the March issue of Utah Science, the percent gross feed efficiency was defined as the energy produced in the milk as a percent of the digestible energy consumed, and a method for determining this was described. Using this method, USDA and Utah State University dairy scientists have recently studied the gross efficiency of 200 daughters of 14 Holstein sires. Individual cows ranged from 17 to 34 percent in gross efficiency. Both sire and ration were found to influence efficiency. Other influences on gross efficiency are currently being analyzed and will be reported in a subsequent article.

SOURCE OF INFORMATION

The data for the study came from first lactation records of 200 daughters of 14 Holstein sires, started between October 1958 and January 1965. The sires were selected from many lines within the Holstein breed and from nearly all geographical areas of the United States and included one sire from New Zealand.

Daughters of each sire were divided at random into two groups at first calving. During the entire first lactation one-half of the daughters of each sire were fed a standard ration consisting of all of the high-quality alfalfa hay the cow would eat plus a concentrate ration fed at the rate of 1 pound for each 3.5 pounds of 4 percent fat-corrected milk (FCM) produced. The concentrate ration consisted of 79 percent steam rolled barley, 19 percent molasses dried beet pulp, 1 percent trace mineral salt and 1 percent di-calcium phosphate.

The other half received only alfalfa hay but were allowed all they would consume. Both groups of daughters were fed from the same lot of high-quality second cutting alfalfa and were allowed free access to trace mineral salt, dicalcium phosphate, and water. All other management was the same for the two groups. The cows were housed in a loose-housing system and milked in a parlor. Milk weights were recorded each milking and butterfat samples taken twice each month. Individual daily consumption, except for minerals and water, was recorded throughout the 305-day lactation period.

Figure 1. Highly efficient cows are valuable as breeding stock. This cow, one of the most efficient to date, has two sons in service. Her maternal brother was recently leased for use in artificial insemination.

ROBERT C. LAMB and MELVIN J. ANDERSON are Research Scientists with the Dairy Cattle Research Branch, Agriculture Research Service, USDA, working as federal collaborators with the Department of Dairy Science, Utah State University, Logan.
DIFFERENCES IN CONSUMPTION

Tables 1 and 2 show for each ration and sire group: (1) the number of daughters, (2) average consumption of hay and grain per cow on a per day basis, (3) total consumption per cow of digestible dry matter (DDM) for the entire lactation, (4) actual production per cow of 4 percent FCM for the lactation, and (5) gross feed efficiency. As shown in the tables, there were considerable differences in consumption, production, and efficiency among sire groups and rations.

On the all-forage ration, consumption averages for sire groups ranged from 27 to 36 pounds of hay per day with an overall average of 32 pounds. Actual consumption by individual cows ranged from 25 to 40 pounds of hay per day. On the standard ration, overall consumption averaged 27 pounds of hay and 10 pounds of concentrate per cow per day. Hay consumption for individual cows ranged from 20 to 33 pounds per day and concentrate consumption ranged from 7 to 14 pounds per day.

To put consumption for the two rations on a more comparable basis, total consumption for the lactation is shown as pounds of digestible dry matter (DDM) consumed. On the average, 100 pounds of alfalfa hay contained 53 pounds of DDM while 100 pounds of concentrate contained 78 pounds of DDM. On this basis, cows on the all forage ration consumed an average of 77 percent as much digestible dry matter as their half-sisters on the standard ration. However, some individual cows on all forage consumed more DDM than some cows consumed when they were allowed forage plus concentrate.

PRODUCTION DIFFERENCES

Milk production varied even more than feed consumption, ranging from less than 6,000 pounds to 8,500 pounds of 4 percent FCM on the all forage ration, and from less than 8,500 pounds to nearly 12,000 pounds of 4 percent FCM on the standard ration. Converting these

**Table 1. A comparison of average feed consumption, milk production and gross feed efficiency among sire groups on the all forage ration**

<table>
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<tr>
<th>Sire Group</th>
<th>No. Dtrs</th>
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<td>8</td>
<td>32.2</td>
<td>0</td>
<td>5,100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>5,178</td>
</tr>
</tbody>
</table>

**Table 2. A comparison of average feed consumption, milk production and gross feed efficiency among sire groups on the standard ration**

<table>
<thead>
<tr>
<th>Sire Group</th>
<th>No. Dtrs</th>
<th>Average Consumption per cow per day</th>
<th>Lactation Totals</th>
<th>Gross Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hay</td>
<td>Grain</td>
<td>DDM</td>
</tr>
<tr>
<td>A</td>
<td>6</td>
<td>25.4</td>
<td>9.9</td>
<td>6,404</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>26.4</td>
<td>9.2</td>
<td>6,498</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
<td>27.6</td>
<td>10.1</td>
<td>6,844</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>26.7</td>
<td>9.4</td>
<td>6,497</td>
</tr>
<tr>
<td>E</td>
<td>10</td>
<td>26.5</td>
<td>9.3</td>
<td>6,402</td>
</tr>
<tr>
<td>F</td>
<td>7</td>
<td>24.8</td>
<td>7.7</td>
<td>5,772</td>
</tr>
<tr>
<td>G</td>
<td>3</td>
<td>26.1</td>
<td>8.6</td>
<td>6,139</td>
</tr>
<tr>
<td>H</td>
<td>5</td>
<td>28.5</td>
<td>10.5</td>
<td>7,044</td>
</tr>
<tr>
<td>I</td>
<td>10</td>
<td>29.0</td>
<td>11.3</td>
<td>7,309</td>
</tr>
<tr>
<td>J</td>
<td>10</td>
<td>29.4</td>
<td>11.2</td>
<td>7,361</td>
</tr>
<tr>
<td>K</td>
<td>10</td>
<td>29.0</td>
<td>10.5</td>
<td>7,079</td>
</tr>
<tr>
<td>L</td>
<td>9</td>
<td>28.2</td>
<td>9.7</td>
<td>6,771</td>
</tr>
<tr>
<td>M</td>
<td>9</td>
<td>27.1</td>
<td>10.0</td>
<td>6,692</td>
</tr>
<tr>
<td>N</td>
<td>5</td>
<td>26.3</td>
<td>9.7</td>
<td>6,438</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>6,732</td>
</tr>
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</table>
production figures to a standard 2X-305-ME basis, production of 4 percent FCM was approximately 9,500 pounds on all forage and 13,500 pounds on the standard ration.

Actual FCM production of individual cows ranged from 4,500 to 9,700 pounds on all forage and from 7,200 to 14,600 pounds on the standard ration. Cows produced an average of 70 percent as much on all forage as did their half-sisters on the standard ration.

GROSS EFFICIENCY

Gross feed efficiency is the ratio of energy output to energy input expressed as a percentage. Energy input was determined by measuring the actual consumption of feed by individual cows, by determining the digestibility of the feeds, and calculating from this the energy (calories) contained in the digested portion of the dry matter in the feed. In this study, 1 pound of dry matter from hay contained an average of 1150 digestible calories and 1 pound of dry matter from grain contained an average of 1750 digestible calories. Energy output was determined by multiplying the pounds of 4 percent FCM by 340, the average number of calories in a pound of milk containing 4 percent fat.

Gross efficiency of sire groups varied between 22 and 26 percent on all forage and between 25 and 30 percent on the standard ration. Individual cows ranged in gross efficiency from 17 to 34 percent.

Because of the variability among cows, there was considerable overlap between the two rations in efficiency. However, these results indicate that the addition of some grain to the ration tends to increase the efficiency with which the cows are able to use their feed. This may partially result from the grain being less bulky and more digestible, permitting the cow to consume more digestible energy which in turn makes more energy available for milk production.

Every sire group except one (Sire G) averaged higher in gross efficiency on the standard ration than on all forage. Sire G was the bull from New Zealand whose daughters ranked very high in that country on an all forage diet. Since most cows in New Zealand do not receive any grain, frozen semen was imported to this country by the USDA specifically for use on this project to see if there was a difference in the ability of New Zealand dairy animals to perform on an all forage ration. Unfortunately, part of the semen from this bull was lost and only 7 daughters were available. Although this is only a small sample, all indications are that these cattle are different from Holsteins in this country. The daughters of this sire were the most efficient group on all forage but the least efficient on the standard ration, which suggests that they did not respond normally to grain feeding.

PRACTICAL APPLICATION

Statistical analysis indicated highly significant differences among sires and rations for production, consumption, and gross efficiency. This significant difference between rations was expected. The significant difference among sires was not surprising either, although it was not previously known whether sire groups would differ in efficiency. On the assumption that at least part of this difference among sire groups is genetic, it would appear that gross efficiency is a characteristic for which cows can be selected. However, more precise information concerning genetic control of feed efficiency is needed to estimate how much or how fast genetic progress can be made.

The statistical analysis showed that there was no significant interaction between sires and rations. This means that on the average, selection of the best sires on the performance of their daughters on a ration within the range studied will also select the best sires for any other ration within this range. In other words, if present conditions were to change so that feed grains become scarce it would not be necessary to change the direction of a selection program to develop a cow that would produce efficiently on a limited grain or even on an all forage ration. Studies are currently underway at the Utah station to determine if there is a sire-by-ration interaction when the ration differences are widened to include high grain feeding.

Although the above results indicate that on the average we don't need to select sires for the performance of their daughters on specific rations, the different pattern exhibited by the New Zealand bull does suggest that it is possible to select for performance on a specific ration (in this case all forage) and make progress.

The relationship between feed consumption and gross feed efficiency was found to be essentially zero. This tells us that feed intake cannot be used as an indication of the efficiency of the cow for producing milk. The correlation between production and gross efficiency was .77. This indicates that considerable progress can be and probably has been made in selecting for gross feed efficiency in dairy cattle by selecting for production. Since it is relatively simple to select for production but rather impractical for dairymen to make the measurements of feed intake necessary to calculate gross efficiency, selection on the basis of production still appears to be the most practical approach for genetically increasing feed conversion efficiency in dairy cattle.

RESOURCE MISUSE

SERIOUS BLIGHT

Man's misuse of natural resources may be the most serious blight affecting contemporary civilization — not excluding the possibility of widespread war. — U.S. House Subcommittee on Science, Research and Development.
DIRTY AIR - A PERIPATETIC PERIL

LOIS M. COX

Modern man didn't invent air pollution, but he has shown remarkable talent for promoting the spread of new forms. By coupling an aptitude for technology with an arrogant disregard for consequences, we've loosed a Pandora's box of atmospheric ills. Now we must try to undo what was done, and avoid comparable mistakes in the future.

Utah's awakening concern for the state of her air is matched at the national and even world levels. The current well-publicized efforts to achieve and maintain clean air are admirable, though overdue, but they will fail unless you and I accept a measure of personal responsibility. We help pollute the air every time we drive our cars, burn trash, use an aerosol pesticide, light a cigarette, or heat our homes.

We therefore will soon have to face up to questions such as: "How much would I be willing to pay for gadgets to cut the pollutant output of my car, rather than give up driving?" "Would I leave my car at the outskirts of a metropolitan area and use as mass transit system if the shift were not legally mandatory?" "How much would I pay in taxes to compensate for revenues lost through the banning of certain industrial activities?"

The air we breathe can no longer be taken for granted, not even in communities that seem to be far from freeways and factories. The earth's atmosphere is a global affair — and capricious air currents play strange games. Smog is not intimidated by political boundaries. In addition, economic progress and technology are a "you can't have one without the other" package, and technology often goes hand in hand with air pollution (figure 1).

The 1967 USU-sponsored Agri-

LOIS COX is Technical Writer for the Utah Agricultural Experiment Station and the Division of University Research.

JUNE 1967

Figure 1. Economic progress and technology go hand in hand with air pollution.
culture-Industry Conference in Salt Lake City helped spotlight some local problems and pointed out possible roads to solutions.

THE UTAH SITUATION

Utah is not immune to air pollution. All of the essential ingredients are here, and their effects are already uncomfortably obvious along the Wasatch Front. No area in the state, however, has a monopoly on such problems. The unpleasant truth is that virtually every valley in Utah (and the rest of the intermountain west) could quickly find itself suffocating under a similar blanket of pollutants.

Our valleys literally “invite” air pollution problems. This is especially true during the winter months, when large, high-pressure cells tend to develop over Utah. These cells favor the persistence of stable masses of air. Normally, atmospheric pollutants move from their sources both vertically and horizontally. When valley walls and a stable air mass hinder such dispersal, the pollutants tend to stay put.

Winds, or the movements of masses of air, are a function of many factors, a prime one being temperature. During the winter in Utah, air currents in the upper atmosphere often operate in such a way that warm air is layered on top of cold air. The cold air traps smoke, miscellaneous pollutants, and moisture. Eventually smog forms and necessarily continues to thicken (figure 3) until an active storm or cold front moves in.

In 1960, Utah formally acknowledged its air pollution problems with a basic plan for state-wide air pollution control. The Utah State Department of Health was designated as the agency responsible for air pollution matters. Then in 1963, the legislature acted to define air pollution, and to make the causing of air pollution a misdemeanor. The same legislature gave counties the power to pass ordinances to control air pollution.

Much of the work now being done in Utah is concerned with identifying and measuring the components of our air pollution. These materials are in the air regardless of whether we can “see” them as smog, or think we are surrounded by clear, pure air. Relative visibility is not always a valid criterion for air pollution concentration.

Although hampered by limited funds, the State Department of Health has established monitoring systems, initiated public information
programs, and gained the cooperation of industries as well as federal and local agencies. In 1965, in cooperation with the USPHS in Las Vegas, the Department increased its 10-station radiological surveillance network to 20 stations. These are located in:

Logan           Roosevelt
Ogden           Moab
Delta           Parowan
Cedar City      Dugway
Tooele          Enterprise
Salt Lake City  Richfield
Price           Beaver
Provo           St. George
Bryce Canyon    Milford
Garrison        Wendover

In Provo, Ogden, and Salt Lake City, readings are also taken of:

a. Wind velocity and speed — automatically recorded.
b. SO₂ concentrations — automatically recorded.
c. Total particulates* — determined daily.
d. Maximum-minimum temperatures — recorded daily.
e. With the help of the Air Pollution Division of the U.S. Public Health Service, corrosion plates have been obtained and will be installed at each of the 20 surveillance stations.

With just the existing check points, however, data collection on Utah's air pollution is totally inadequate. Many areas of the state are not being sampled at all. Little is known about prevailing dispersion patterns within and between valleys. And pollution conditions can vary so much on a block to block basis, that several sampling stations might be needed just within one community to provide valid data.

WHAT ARE THE POLLUTANTS?

Automobiles are a prime source of air pollutants in Utah as they are throughout the U.S. Their most significant emissions are: carbon di-

oxide, carbon monoxide, nitrogen oxides, aldehydes and acids, nitrogen-containing organics, phenols, particulates, and lead salts. The four main emission points are: tailpipe exhaust, crankcase vent, carburetor, and gasoline tank. The 3.75 million autos in Los Angeles County put forth about 10,000 tons of carbon monoxide, 2,000 tons of hydrocarbons, and 530 tons of nitrogen oxides EVERY DAY.

Problematical pollutants in Utah, as well as elsewhere, also include dust, smoke, fumes, mineral particles, and pesticides. All of these are susceptible to some degree of control if we choose to exert it. A speaker at the 1967 Agriculture-Industry Conference emphasized that the key to clean air is in the hands of the individual. All he has to do is exercise more care at the personal level and exert pressure on federal, state, and local government agencies.

About 125 million tons of the principal air pollutants are spewed into the atmosphere over the United States every year. The sources and amounts of this pollution are tabulated below:

In Utah, industry sources of air pollutants are the only offenders who have moved to correct the situation. According to another conference participant, cities and counties are major contributors but have shown little inclination to take corrective action.

WHY WORRY?

Air pollution is a factor in a number of respiratory ailments and various forms of discomfort. At relatively low levels of exposure, the irritation of eye, nose, and throat membranes is commonplace in people, and costly damage to livestock and vegetation may occur.

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount Million tons/yr.</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>74.8</td>
<td>59.9</td>
</tr>
<tr>
<td>Industry</td>
<td>23.4</td>
<td>18.7</td>
</tr>
<tr>
<td>Generation of electricity</td>
<td>15.7</td>
<td>12.5</td>
</tr>
<tr>
<td>Space heating</td>
<td>7.8</td>
<td>6.3</td>
</tr>
<tr>
<td>Refuse disposal</td>
<td>3.3</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>125</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

* Particulates are small suspended particles of solid materials.
Researchers have found that the incidence of chronic bronchitis among British mailmen who deliver mail in areas of heavy air pollution is three times as high as among those who work in cleaner areas. More deaths from chronic pulmonary disease have been noted in high-pollution areas of Buffalo, N.Y., than in otherwise comparable neighborhoods. Boston policemen working around high concentrations of carbon monoxide have proved more susceptible to common colds than those with different working conditions. A child born in New York City after World War II has inhaled the pollution equivalent of nine cigarettes per day, every day of his life.

California research has showed that ozone (formed from nitric oxide) has a fatiguing effect on experimental animals. Ozone and other automobile-produced pollutants predispose animals to respiratory infections. Ozone has even been implicated in the deranging of carbohydrate (and perhaps protein) metabolism.

Participants in an AMA meeting in Los Angeles in 1966 stressed the urgent need for taking protective measures against air pollution and for financially supporting extensive and intensive research. Considering only air-borne carcinogens (cancer-producing substances), a member of the PHS in Cincinnati noted that only four types have been studied. Dangerously little is known about atmospheric anti-carcinogens and cocarcinogens. It was also pointed out that we have yet to identify all of today's pollutants in various parts of the world — and tomorrow may bring a whole new group. One thing that is certain, however, is that the combustion of hydrocarbons, including coal, gasoline, and oil, constitutes a major source of measurable atmospheric carcinogens.

LIVESTOCK AND VEGETATION

Animals may be adversely affected by various air pollutants. For example, when animals eat forage contaminated by excessive airborne fluorides (a waste from certain industrial processes), a condition known as fluorosis may result. Fluorosis of livestock has been a serious problem in Utah, many areas in the United States, and several foreign countries (figure 4). Research conducted at Utah State University since 1952 has supplied valuable information relative to this disease. A comprehensive guide has been compiled from results of research at the University to facilitate diagnosing and evaluating fluorosis.

Data obtained from the fluorosis experiments at Utah State University have been used to establish standards for the diagnosis, evaluation, prognosis, and prevention of fluorosis of livestock in various parts of the United States, Ireland, Switzerland, and Germany, and other countries. The findings have also been used to assist with the establishing of fluorine tolerance levels for man.

The adverse effects of air pollution on vegetation were recognized more than a century ago. As with animals, the degree of toxicity of various air pollutants varies with different types of vegetation as well as with the type and concentration of the pollutant. Sulfur dioxide, fluorides, and ethylene were the principal pollutants first recognized. More recently, increasing importance has been attached to photochemical air pollution. Its typical toxic components are created when nitrogen oxides and hydrocarbons (such as emitted by automobiles) interact with sunlight. Ozone and peroxy-acetyl-nitrate or PAN are especially significant products of this so-called photolytic reaction. Scientists are certain that the ozone and PAN in Los Angeles smogs are responsible for the serious decline in the area’s citrus and salad crops. Air-borne fluorides have been reported to have caused orange and lemon trees in Florida to produce smaller yields.

THE TIME IS NOW

Air pollution is not likely to become self-limiting. This truism and its inherent threat to mankind have been acknowledged at the Federal level by the President. He is calling for an “air quality law,” and for the

Figure 4. This cow shows the effects of high levels of fluoride intake. The vertebral column was fused, leg joints were stiff and lame and emaciation, rough hair and thickened skin were obvious.
establishment of regional commissions to enforce control over airsheds that will disregard state and local boundaries when necessary. Secretary J. W. Gardner of the Health, Education, and Welfare Department has been directed to begin a new research program with special emphasis on fuel additives and their pollution potentials.

In Utah, Governor Rampton has outlined three provisions that he considers essential to any air pollution bill for the state. Scientists and air pollution experts have cautioned that flexibility must be built into any law if we are to allow for technological progress and for differing conditions between areas. Cooperation and good judgment, however, cannot be legislated. Each of us has to decide that clean air is worth paying for, whether in personal inconvenience or in dollars.

It would seem logical to provide the State Department of Health with access to an advisory group including meteorologists, physiologists, and engineers, as well as representatives of industrial and public interests. Certainly, as noted at the USU Agriculture-Industry Conference, responsibility for devising and enforcing pollution standards must be accompanied by the means for enforcement.

Conference participants also reiterated the need for research; particularly for research into problems that are peculiar to the intermountain arid west. We can borrow data on such factors as automobile pollutants from California or other states, but Utah's special problems will have to be researched here. Initially, of course, we must come to a better understanding of what the problems are. This means monitoring stations and identification of local air current patterns.

Many, if not all, of the necessary studies can be done through the state's universities. Scientists already on the scene at Utah State University and the University of Utah constitute an excellent nucleus of competent personnel.

(Continued on page 64)

Assistant Director Retires

David A. Burgoyne, after more than 45 years of service to Utah State University and the Utah Agricultural Experiment Station, retired March 31, 1967.

Mr. Burgoyne served with six directors of the Station, was acting director several times and was twice acting dean of the College of Agriculture.

During his years with the Station he budgeted millions of dollars, handled thousands of research projects, dealt with hundreds of staff members and advised hundreds of foreign students engaged in agricultural study and research.

He and his gracious wife, Allie Peterson Burgoyne, offered their friendship and the hospitality of their home to uncounted foreign students, visitors, friends and neighbors.

Mr. Burgoyne was born in Montpelier, Idaho. He came to Logan with other members of his family in 1908. He attended elementary school in Logan but went back summers to Bear Lake to work on the farm.

Later he attended Brigham Young College in Logan for 3 years of high school and 1 year of college work, leading to an elementary education certificate. He entered Utah State — then called Agricultural College of Utah — in the fall of 1916.

After an interruption from September 1918, to February 1919, for World War I army service he returned to Utah State to earn a Bachelor's degree in commerce in 1919.

It was in August, 1921, that Mr. Burgoyne became executive secretary to William Peterson, director of the Agricultural Experiment Station. Later he was to serve under Directors P. V. Cardon, Lowry Nelson, R. H. Walker, D. Wynne Thorne and the present director K. W. Hill.

In 1936-37 he took sabbatical leave and earned a Masters degree in agricultural economics at the University of Illinois. At various times, during periods of absence of the directors, and between directors, he served as acting director of the Station.

From July to December, 1940, and again for the 1962-63 school year he served as acting dean of the College of Agriculture. He was appointed as associate professor in 1953 and professor in 1959.

His congenial disposition and genuine desire to be of service have been appreciated by staff members, visitors, foreign students, and university, state, and federal administrators. Mr. Burgoyne's saving sense of humor is valued by all those who have worked with him.

Many times his excellent memory served to solve historical questions and problems relating to the Station and University.

Both the Burgoynes have been active in University and Civic affairs. Mrs. Burgoyne has welcomed hundreds of new faculty members and their families to Logan and the University community.

Nearly 400 friends and associates gathered to pay tribute to the Burgoynes at a banquet held March 31, 1967. Hundreds more, not in attendance, have extended their wishes to Dave and Allie for a long and happy retirement.
THE UNSEEN FACE OF
four stories of new methods

Sanpete co-op
talks turkey

Turkeys plus cooperation spell success for many Sanpete County farm operators. The Moroni Feed Company and about 110 of its cooperative members illustrate the lesson.

What started out as a vocational agricultural project in the late 1920's has grown to be the leading agricultural business in Sanpete County.

The Moroni Feed Company was born in the midst of the depression. It was organized in the spring of 1937, when local turkey raisers banded together to organize a feed company through which they could hire their feeds ground and mixed cheaper than they could be purchased on the open market. The origin of the organization goes back to the 1920's, however, when farmers raised small flocks of turkeys by hatching home-raised eggs under turkey hens.

When the depression hit, the People's Sugar Company, the chief manufacturing and agricultural project in the area, discontinued operation. Several banks in Sanpete County were also forced to close. Young people were forced to leave the valley to find livelihood. Turkey raising seemed to be the only means of recovering, in part at least, some financial income.

FIELD DRESSING

Because turkey growing was relatively successful in the valley, the Utah Poultry Producers Co-operative Association, based at Salt Lake City, built a modern turkey processing plant at Moroni in 1935. The plant was operated by the co-op until 1940 when it was purchased by the Moroni Feed Company. Prior to this time, the birds were slaughtered in the fields where the flocks were located. This was a primitive operation and the sanitation left much to be desired.

The individual grower hired as many people as possible to come to his flocks in the field. A rude scaffold, with poles laid across the top, was erected. The turkeys were hung from these poles by ropes tied to their legs and killed. Flat irons, rocks or any other available weights were attached to the turkeys heads to minimize blood splattering. The pinners dry picked the birds' feathers. (Today at the processing plant the birds are given a semi-scaling before being picked.) After the pinners were through, the birds' heads and feet were washed in a tub of water and they were put to cool in whatever accomodations were available, including barns, cellars and even attics. Eventually they were

Figure 1. The Moroni Feed Company has outgrown the original buildings of the old People's Sugar Company purchased in 1940. The operation has been enlarged several times to accommodate bulk storage, the egg hatchery, diagnostic lab, mixing and milling equipment, etc. Presently, plans are underway for major remodeling.
graded, crated, and sold to buyers who came to the farms to make their bids.

OXYGEN FACTOR

Instead of small farm flocks of 500 with the eggs hatched right on the farm, the members started purchasing day-old poults from southern Utah, California, and Oregon. No breeding was attempted in the Sanpete area because it was thought the climate was not suited to it. However, research conducted at Utah State University eventually solved this problem by discovering that oxygen was the critical factor in turkey egg hatchability. With this discovery came the modification of incubating procedures which resulted in a 15 to 20 percent greater hatch. The association built a new hatchery in 1952 which was expanded in 1966. Now incubators with modified atmospheres, process more than 3 million eggs per season. This many eggs produce about 2 million saleable poults. The Moroni Feed Company maintains a breeding flock of 22,000 hens and purchases the rest of the eggs, chiefly from southern California.

As the association expanded, the members realized that the feed grains could be purchased, milled, and mixed in their own facilities at greater savings. The vacated property of the People's Sugar Company was purchased in 1940. The set-up was conveniently located on the Denver and Rio Grande tracks. After installing the machinery, the feed department did a gross business of $80,000 during the year. In 1966, more business than this was conducted in 1 month. Although the feed department sells to other livestock growers, more than 75 percent of its business is done with the turkey growers.

TURKEY RATIONS

The business of the association is carried out by a general-manager and three other department managers. The general-manager, Ralph Blackham, also oversees the feed and hardware department. Under his direction are the feedmill, hardware store, finance department and veterinary diagnostic laboratory. Mr. Blackham emphasizes that co-op growers are a lot more careful about feeding their turkeys than they are their own children. And for perfectly logical reasons.

In the first place, it is hardly necessary to fatten up a child to market specifications by the time he's 7 months old. But if sales are expected, it is necessary to do this to a

Figure 2. Within hours after hatching the turkey poults are sexed and boxed for delivery to co-op growers.

Figure 3. A typical Sanpete County turkey flock about ready for processing into ready-to-cook table fare.
turkey. In the second place, people — civilized people, at least — would rather eat turkeys than children.

The list of foods served a turkey from the day of its birth until it has reached the comparatively mature age of 8 weeks will probably stack up, in length at least, with the menu served at the most elaborate state dinners at the White House.

During its first 8 weeks a turkey receives a "starting ration," which contain the following: ground corn, ground wheat, ground barley, ground oats, fish meal, meat meal, soy bean meal, dried milk, alfalfa meal, bran, ground limestone, salt, manganese sulphate, cod liver oil and as a kind of apertif, various combinations of vitamins. With some variations, a similar diet is fed until the bird is ready for market.

CO-OP MARKETING

By 1948 it became apparent that something should be done to market the turkeys on a cooperative basis. Buyers had been purchasing the dressed birds up to that time. During the war years, the turkey business had boomed, but by 1948 the marketing pressure had changed from a seller's market to a buyer's market. A membership application was submitted to Norbest Turkey Growers Association and in 1949 the Manti Feed Company was accepted as a full member of Norbest.

The Manti Feed Company co-operative actually consists of four main divisions: (1) hatching and breeding, (2) feed and hardware, (3) processing and marketing, and (4) farm machinery and service station.

Clifford Blackham is in charge of the turkey hatcher, breeder farm, and range breeder rearing operations.

Roy Moss is responsible for the service station, farm machinery sales and service, and the distribution of propane gas. Seventy full-time employees are required to staff the entire organization and when the turkey-killing season rolls around, another 380 people are hired for the 6-month period.

LaMont Blackham oversees the processing and marketing division and is justly proud of the killing and dressing plant which compares favorably with any in the United States. Some 500,000 pounds of turkey can be processed each 24 hours. The type of turkey raised by the co-operative helps boost this production poundage. The Moroni Feed Company has, throughout the years, established a reputation for raising large birds which are used mainly in the national hotel and restaurant trade.

BY-PRODUCTS USE

As the company has grown, so has its ability to utilize the by-products of turkey processing. During the processing season which usually starts June 1 and lasts through December 20, about 1,500 tons of feathers and offal will be produced. In addition to this, 30 tons of grease will be rendered. The feathers, which are 85 to 90 percent protein, and the offal meal which is 60 percent protein are then processed and combined into the feed mixtures, which in turn are fed back to the flocks.

LaMont Blackham also manages
the by-products rendering plant. In the rendering plant five huge pressure cookers thoroughly sterilize and break down the offal into meal that can be easily mixed in with the turkey rations.

**PLUCKED AND DUCKED**

When the kill line is in operation, the turkeys are unloaded, killed, partially scalded, mechanically plucked and then hung on a conveyor line where pin feathers are removed by operators stationed along the line. After they are eviscerated and graded, they are plunged into vats of slush ice where the animal heat is quickly removed. More than 200 tons of slush ice are used each 24-hour period when the kill chain is in operation. They are next vacuum packed in heat shrinkable plastic bags. The packaged bird is then plunged into 190°F water which causes the plastic bag to shrink and conform to the body contours. The birds are then packed and frozen. From then on, the marketing is taken over by Norbest which distributes nationwide.

The turkeys are graded into three classes: A — which means a perfect carcass; B — the carcass is poorly flesched or a piece of skin is missing, and C — where a part (whole wing) is missing or breast blister is removed.

Mr. Blackham indicated that the national rejection rate in turkey processing plants is more than 2 percent. The Moroni operation which is federally inspected by a full-time veterinarian and four lay inspectors has a rejection rate of only 1.25 percent. This is attributed to an excellent disease prevention program by the growers and veterinarian assistants by the co-op. One full-time veterinarian, Dr. Royal Bagley, is employed by the co-op to assist growers in spotting disease and stopping its spread among the flocks.

Dr. Donald C. Dobson, a poultry nutritionist of USU’s Agricultural Experiment Station is stationed at Snow College in Ephraim. His research work together with that of Dr. Jay O. Anderson at Logan provide information for the highly scientific turkey feeding practices.

Dr. Alan J. Thomas of USU, stationed at Provo, does blood testing work. In addition, Drs. Ross A. Smart and Merthy L. Miner of the Agricultural Experiment Station staff also spend the summer months working with the turkey raisers.

The Moroni Feed Company is guided by a board of five directors each elected for a 2-year term. The board elects its own president, vice-president, and secretary-treasurer.

The organization is run democratically. At the annual March membership meetings, individual department financial statements are presented to the members in detail.

(Continued next page)
Some discussions of Utah's egg industry are clouded with pessimism. It is quickly pointed out that the laying-hen business is in the doldrums. Profit margins are slim although there is a deficit production in Utah and eggs must be imported, chiefly from California, to meet the demand. As in other livestock production operations, efficient management is the key to financial success.

There are those poultrymen who manage to raise layers at a healthy profit, however. One such is Chester Fassio, Hunter, Utah, who believes in making chickens pay. His two modern laying-hen operations, one at Hunter the other at Harriman, are models of labor utilization, sanitation, and disease control.

Mr. Fassio has his main operation at his home in Hunter, Utah where he has built facilities for cleaning, grading, packaging, and selling eggs. More than 175 cases of eggs per week are sold directly to drive-in customers.

(Continued from previous page)

With the relatively small membership, meetings are informal and many questions relative to the business operation are discussed. New board members are nominated and elected from the floor. Very little, if any, political activity, as such, is carried on. All major decisions such as expansion, policy, credit decisions, and plans of operation for the coming year are also discussed at this time.

Figure 6. After being sealed in form fitting plastic bags the birds are frozen and packaged ready for shipment throughout the United States.

FROM HEN TO HOUSEWIFE

At Hunter he has nine laying houses where 28,000 hens are housed. The feeding, watering, and egg collection are completely automated. The hens nest in compartments built over a moveable belt. When a switch is thrown, the belt moves along, bringing the eggs to one point in the coop where one man collects, boxes, then loads and wheels them on an especially designed cart to the processing building. There an employee picks up the eggs a tray at a time by means of a pneumatic lifter and places them on rollers which move them through the washer, candler, grader, and packager.

For reasons of sanitation, the water and detergent solution used to wash the eggs is not recirculated through the machine. After it passes over the eggs, the solution is drained away. This prevents build-up of any contamination.

After the eggs are candled and graded, two other employees package them and send them on another belt where they receive a fine spray of mineral oil. This coating of oil helps to preserve market quality. The lids are closed automatically and the packages move to a revolving table where another employee packs them in cases for delivery to dairies, stores, and drive-in customers.

After the eggs are packed in cases, they are wheeled to a large cooling room.

TWO OPERATIONS

Increased demand for eggs necessitated an expansion, but land prices in the Hunter area were too high to make it feasible. This problem, together with increasing suburbanization, necessitated a move to the

UTAH SCIENCE
Harriman area. There he purchased land and built two-, three-, and four-sectioned open-span buildings. There, 32,000 layers are caged in a semi-automated operation which allows one full-time man to care for the flock. In this set-up, feed is not augered to the hens, but is ladled into the feed troughs on either side from a battery-powered cart which passes between the cages. Eggs are collected and packed in bulk egg cases from another electric cart. The operator stands on the back and using both hands, fills the crates with eggs as the cart proceeds between the cages.

SANITATION

Sanitation — manure treatment and disposal, disease prevention, and egg handling procedures — are essential components of profitable poultry management.

In his Hunter operation, Mr. Fassio allows the manure to accumulate until the flocks are rotated. However, moisture is controlled and chemicals are applied which curtail the fly problem. At Harriman, the manure is mechanically swept from under the cages into a small, bin-carrying electric truck at least once a week. The bin is dumped into a conventional truck and emptied on farmland away from the premises. This weekly collection of the manure effectively breaks the fly life cycle and keeps the operation almost fly free.

The open span buildings at Harriman can also be "blown out" with air jets to prevent the dust buildup.

At both operations antibiotics can be added to the water periodically to prevent disease outbreaks and the laying houses can be ventilated during hot weather to lessen the temperature stress on the birds.

The two flocks are kept completely separate. Chickens are never transferred from one flock to the other. All replacements are purchased as day old chicks and raised at the respective locations. The distance between Hunter and Harriman also serves as a safety factor if any epidemic disease should occur.

COMPARING THE TWO

Mr. Fassio, by having both types of operations, is endeavoring to find out which gives the best returns. He figures that at the end of this year he will have an adequate picture of which set-up — cage or floor — offers the most economic advantages. Each method has its good points and problems.

His interest in poultry has lead Mr. Fassio to seek knowledge of

Figure 1. Carroll L. Draper, Extension Poultryman, examines the caged-layer operation of Chester Fassio at Harriman, Utah.

Figure 2. Eggs, a layer at a time, are lifted onto the washing machine in the egg packing plant at Hunter, Utah.
poultry management both in the United States and abroad. He has attended meetings and investigated poultry-raising procedures in England and he is presently serving as President of the National Egg Council. His success demonstrates that a person interested in raising laying hens can turn a profit if he keeps abreast of advancing knowledge and management practices, and retains a positive interest in putting out a superior product to meet a definite demand.

Figure 3. The eggs are packaged as they come from the grader.

Figure 4. Sent on down the line, the packages slide onto a revolving table where they are packed in delivery cases.
How to take care of a beef

Utah's largest beef packer and one of the most efficient plants west of the Mississippi River is located in the small northern Utah city of Hyrum.

The E. A. Miller and Sons Packing Co., headed by Lynn and Ernest (Junior) Miller, processes more than 65,000 beef animals per year.

In 1964, the Miller plant was putting 150 animals per day through the killing line, but expanding West Coast markets necessitated increased production and storage facilities. After a 2-year construction and remodeling program, a day's production had been upped to 300 animals.

The construction added a new wing, killing floor, an enclosed loading dock, and increased cooling capacity. The new plant now has cold storage for 1,000 carcasses. One room alone can hold ½ million pounds of beef.

KILL FLOOR

The new kill floor, in operation for a little more than a year, is staffed with 22 men and can handle 40 beeves per hour. The killing unit is a two-story structure on three levels. It provides 8,620 square feet of production facilities. The beef are dressed on the second floor and edible offal processing and storage take place on the intermediate level. The semi-basement level houses all inedible product handling and manure, blood, hide and grease interception facilities.

Cattle, prior to killing, are held in covered pens and chutes. Automatic one-way gates are installed in the chute leading directly to the kill floor. The hinged gates are pushed back into wall slots by the passing animal and then spring closed behind it.

The animals are stunned by firing a .22 caliber hollow point bullet into the head and then are raised to the bleeding rail on the second floor by power hoist. The animals are bunched while bleeding on a dead rail section. From there they are fed onto a conveyor chain by two sets of air operated fingers which move in proper sequence by a cam-operated valve on an 8-tooth sprocket. This sprocket is 8 feet in circumference thus the cattle are fed into the chain on 8 foot centers. This spacing is maintained throughout the dressing process.

SWIFT SLAUGHTER

After bleeding out, horns sawed off, the heads are removed, washed and the tongue is dropped. The head and tongue are placed on an overhead conveyor for movement to the government inspector's station.

Legs are skinned and cut off with an air operated hockcutter. Transfer from the bleeding rail to the dressing conveyor is accomplished by pneumatic jacks on a section of

Figure 1. After the carcass has been hided it passes the eviscerating table where it is automatically lowered to within reach of the operator. As the viscera are removed they are transferred to the stainless steel table where they are examined for evidence of disease by a federal inspector.

Figure 2. An operator standing on a pneumatic platform saws the carcass in two. The platform lowers as the beef is split.
the track that can be raised or lowered. When these jacks are out of position even \( \frac{1}{4} \) inch, an electrical contact is broken, a red light goes on and the conveyor cannot move. This is to preclude pulling a carcass into the open section of track and dropping it to the floor. There are five such safety devices on the dressing conveyor.

The conveyors are operated by an ingenious time clock capable of infinite settings from 1 second to 1 hour. It is actually set at 1 \( \frac{1}{4} \) minute which allows 40 movements per hour. Thus, 40 cattle per hour are dressed out. A buzzer sounds 2 seconds before the conveyor starts as a warning to the butchers. The carcasses move 8 feet and stop at the next operator's station until the cycle is completed and repeated.

The killing floor can approach 55 beef per hour by speeding up the time clock and supplementing the crew.

The carcass is now ready for the mechanical tripper which pulls off the hide.

### Hide Tripper

Operators in this unit stand on pneumatic platforms and work in pairs. The puller virtually peels the hide off the carcass, performing four operations formerly done by hand. It sides, rumps, backs, and skins the tail. Only 52 seconds are required to chain up the carcass and hide, recover hide chains and unchain the carcass. The operators on the platform follow the hide up and remove any snags with their air knives.

At this same station, another man working in front of the carcass saws the brisket and rods and ties the weasand (throat and gullet). The carcass is now ready for evisceration, and passes over the viscera inspection table. As the viscera are removed, they fall onto a 30-foot long endless table built of stainless steel. It is synchronized with the conveyor movement and moves 8 feet with each 8-foot movement of the chain. It is one of three such tables in the Western United States and the only one in Utah. It is sterilized with 180°F water at each movement and condemned products fall off the end of the table without manual handling. Government inspectors examine the viscera on this
Computers serve the dairymen

Business minded dairymen are using the computer as a management tool. Today’s competition pressures and slim profit margins make efficient record keeping essential to herd improvement and continued profits. By using computers, dairymen obtain complete and accurate information on which to base feeding, culling, and breeding decisions.

Bliss H. Crandall, former staff member of the Utah Agricultural Experiment Station and the late Lyman Rich, former Extension dairymen foresaw the uses of computers in dairying back in 1951. They set up a record system upon which dairy herd improvement could be based. The work load increased as the idea took hold. In 1955, Mr. Crandall moved to Provo, Utah and there ran his computing service on a part-time basis. With the expansion of the Dairy Herd Improvement Association which added the computer services to its overall program, the work load became so great that in 1958 he devoted full-time to the operation. His two sons, Lynn and Ken, assist him in running the business which employs 30 people (figure 1).

WHY COMPUTERS?

Dairy Herd Improvement Computing Service (DHI), as the Crandall’s business is known, was the first to make machine processed records available to the farmer. At present it is the only service which provides disposable up-to-date individual cow records. It is one of 12 centers in the country which provide management information to DHIA affiliated dairymen.

The growth of computerized rec-

Figure 1. Bliss H. Crandall and his sons Ken and Lynn examine a monthly cow report on one of the more than 1,400 herds served by the Dairy Herd Improvement Computing Service.
Record keeping systems throughout the United States is mushrooming. The Dairy Herd Improvement Association was quick to grasp the advantages of computers for the ordinary dairyman. By adapting their records to computer programming, the production of DHIA herds have climbed to new levels. Based on 1966 data, a comparison of DHIA and non-DHIA cows in Utah shows the following production levels: DHIA cows averaged 12,620 pounds of milk and non-DHIA cows averaged 7,870 pounds. In dollars and cents, the 4,759-pound-per-cow difference was worth $223 at $4.70 per cwt. For an average-sized herd of 49 cows, the total increased production equalled an additional $10,960 gross income.

At present, more than 22,000 cows in Utah are on DHIA testing but these represent only 25 percent of the state's cows. John Barnard, Extension Dairyman stated that because of the new industry developments, non-DHIA herds are 30 years behind.

A vital part of the DHIA program in the states mentioned are the monthly individual cow records put out by the Crandalls.

The latest model IBM computers enable the Crandalls and their work force to care for more than 1,400 DHIA affiliated dairy farms in the western states. DHIA herds in the Montana, Wyoming, Colorado, New Mexico, Arizona, California, Nevada and part of Idaho are serviced by the Crandalls — more than 125,000 cows per month. They provide this service at the nominal cost to the dairymen ranging from 10 to 11 cents per cow per month. For an annual cost of $1.20 to $1.32 per cow, the herd owner receives an up-to-date production record for each cow which includes age at calving, breeding and birthdate of all calves, number of dates in production, the sire of each calf, previous lactations, complete production data, etc. (figure 2).

**NEW SYSTEM**

With the new IBM Computer System 360 (figure 3) the basic monthly information from the dairy farm received via the monthly DHIA records is rapidly processed on the individual monthly cow record. Current test-day data on each cow are punched into a separate IBM card. These data are then transformed via a card-read punch to the computers direct access storage. This portion

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**Figure 2.** This individual monthly cow record is one of more than 125,000 sent out each month to dairymen in the Western States. Note that the cow's relative value to the herd is shown at far right.
of the system is comprised of two disk storage drives with interchangeable disk packs. Each disk pack stores up to 7 million characters of data, all instantly available to the computer for processing and updating. The lifetime history of from 15,000 to 20,000 cows can be stored on each disk pack.

**EACH COW HAS RECORD**

This feature, coupled with a printer that produces reports at the rate of 1100 lines a minute, enables DHI to generate an original individual cow record each month on every one of the 125,000 cows in addition to the standard DHIA monthly cow record which covers each herd. This record is updated each month so the last month’s record can be thrown away. This prevents the build-up of voluminous records files and keeps the system simple to use.

Because of the computer’s processing speed and the availability of more historical data in the disk files, the Crandalls are able to give the dairymen additional information on the monthly individual cow record to assist him in appraising the relative value of each cow in his herd. Eventually, this record may include financial information already computed in the form of a statement.

In addition to test day data, current month, and lactation-to-date production data, the report also provides a monthly updated forecast of each cow’s milk production during the 305-day “ideal” lactation goal. Vast amounts of data, compiled from studies made of 2 million monthly cow records, are now instantly available to the computer, enabling it to project these extrapolated 305-day figures with much greater accuracy than ever before possible.

**COW’S VALUE**

Another highly important feature of the new individual cow record is a monthly computation of the cow’s relative value as compared with the rest of the herd. To accomplish this the computer first calculates the extrapolated 305-day mature equivalent for the herd then compares this equivalent with each cow’s projected 305-day totals. The cow’s relative value is shown on the report in terms of plus-or-minus milk and fat production, and as a percentage of the herd’s mature equivalent.

Accurate breeding records are essential to efficient herd management today. Because of the System 360’s speed and storage capacity, the dairymen are now given a complete breeding history of every cow, updated and printed each month as a part of the individual cow record. The breeding record shows the month and day of each breeding, days in milk at first breeding or days between breedings, sires used, date diagnosed pregnant, and the date the cow is due to calve.

**SUPERIOR INFORMATION**

Other decision-making aids included on the individual cow record include dates calculated by the computer as the proper dates to either breed or dry off the cow. The Crandalls work closely with DHIA officials and County Extension Agents to up-date their records and provide more information.

By using computer services such as the Crandalls offer, dairymen have at their disposal complete and superior management information at a fraction of the cost involved in any other records system. By subscribing to such services dairymen with both large and small operations can keep abreast of increasing competition by making decisions based on historical data within their herds. They also can obtain accurate production forecasts.

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Figure 3. Ken Crandall replaces a disk pack on one of the IBM System 360 computer’s two disk storage drives, while Lynn adjusts controls of the console.

**PROTECT your HOME and GARDEN**

where 15 percent of all pesticides purchased are used to help preserve a healthy, attractive, productive environment for work and play.

**JUNE 1967**
With all the sagebrush to see, most Utahns are unaware that there are 4 million acres of commercial forests in the state. These commercial forests, consisting of spruce, fir, pine and aspen are hidden in the mountain tops and are largely under federal administration (figure 1). Besides providing watershed, recreation, and other benefits, these forests also provide the timber which is the life blood of a small but highly interesting group of forest products industries. These industries can be broadly classified as logging, primary manufacturing, secondary manufacturing, and woodland.

Utah's forest industries account for the employment of approximately 1,350 persons. This figure includes 850 full-time and 500 part-time employees. Their annual forest-derived payroll is nearly $4.5 million. The annual wholesale value of the products which they produce is conservatively estimated at $16.4 million.

Forest product manufacturers are the chief contributors to the economy of Garfield County. They also contribute substantially to the economies of Summit, Uintah and San Juan counties.

Utah ranks approximately 43rd among the 50 states in the value of its forest products. Among the 11 contiguous western states it ranks 10th.

LOGGING

Broadly defined, logging includes all endeavors which pertain to the harvesting of timber, its delivery to manufacturing plants, and the reconditioning of harvesting sites. Thus, logging includes the construction of access roads, the disposal of slash and other debris, and provisions for the growth of new trees in addition to the more obvious functions of felling and limbing trees and bucking and transporting logs. About 340 Utahns work in the yearly timber harvest.

WALTER H. JOHNSON

Because adverse weather conditions seal off the mountain roads for a large part of the year, Utah logging is a seasonal occupation which varies from 4 to 8 months.

According to U.S. Forest Service statistics, a total of 12,005,000 cubic feet of sawlogs and other roundwood products were harvested from Utah's forests in 1962 (table 1). Though the volume of sawlogs harvested has probably increased since 1962, it is unlikely that the volume of the other roundwood products has changed perceptibly.

PRIMARY MANUFACTURING

Primary forest products manufacturing involves the transformation of logs into other, more refined products, such as lumber, veneer, and pulp. Active primary manufacturing

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facilities in Utah include 48 sawmills, three planing mills, and one excelsior plant. Employment at these facilities totals 400.

THE LUMBER INDUSTRY

Sawmilling represents the single most important forest-based industrial activity in Utah. The current production of lumber in the State is 72.9 million board feet per year.* This does not include an estimated 4.6 million board feet of sawed timber products such as mine timbers and railroad ties. Major lumber species in order of decreasing importance are Engelmann spruce, ponderosa pine, lodgepole pine, the true firs (white and alpine), Douglas-fir and aspen.

The state's active sawmills vary greatly in size (table 2). The five largest mills, for example, produce 67 percent of the total lumber output while the 32 smallest mills collectively produce less than 7 percent. The disparity is heightened because the large mills are better able to maintain large log inventories to tide them over the winter and slack periods. As a result, they operate on a year-around basis as opposed to the small mills which generally operate only a few months each year.

Surprisingly, the majority of Utah produced lumber is marketed in other states (figure 2). The largest market is California (primarily southern California) which absorbs 27.75 million bd. ft. of the Utah output. Other markets are the Midwest which consumes 13.76 million bd. ft. and the states adjacent to Utah which take 12.73 million bd. ft. Utah uses only 20.67 million bd. ft. or 28.3 percent of its own product — less than the consumption by greater Los Angeles alone.

* The board foot is the common unit for measuring lumber quantity. One board foot is equivalent to a piece of wood 1 inch thick and 12 inches square.
EXPORT REASONS

The large exports of Utah lumber are even more surprising when one considers that 150 million bd. ft. must be imported each year to satisfy the State's lumber needs. The explanation for this paradoxical situation is twofold. First, geography dictates that some out-state markets are more alluring to some mills than are in-state markets. The dynamic Los Angeles market, for instance, is within convenient reach of the larger sawmills in the southern and even northern portions of the State. Likewise, the Midwest is a ready outlet for the mills in eastern Utah.

The second and perhaps more important reason is related to the characteristics of the various woods. Native Utah woods are not so suitable for certain uses as are those from other regions. Because of this, numerous hardwood species are imported from eastern states and foreign countries for cabinet, furniture and other secondary manufacturing purposes, and large quantities of softwoods such as coastal Douglas fir, redwood and larch are imported for a wide variety of construction purposes. By the same token, some Utah species have unique properties which are in demand elsewhere. Aspen, for example, is rapidly gaining an excellent reputation for its great resiliency or shock resistance, and is in great demand for pallets, crates and similar products subjected to rough handling.

OTHER PRIMARY MANUFACTURING

As mentioned earlier, other primary manufacturing in Utah is performed by three planing mills and an excelsior plant. The planing mills serve a vital function by purchasing rough, unseasoned lumber from small sawmills and raising its market value by seasoning, surfacing, and grading it. Because the planing mills handle relatively large amounts of lumber, they are in a much better position to locate profitable lumber markets than are the small sawmills. Without these planing mills, many of the small sawmills could not survive. Together, the three planing mills process a total of 18 million bd. ft. of lumber each year. This includes approximately 6 million bd. ft. of lumber which is rough milled in Star Valley, Wyoming. Since virtually all of the Wyoming lumber is eventually marketed in California, the actual amount of Utah processed lumber marketed in that state exceeds 31 million bd. ft.

In the Cedar City branch plant of the American Excelsior Company, a handful of men convert some 5,000...
tons of aspen to excelsior (shredded wood) each year. The excelsior is formed into 70 pound bales which, with few exceptions, are marketed in southern California. The excelsior is used as a packing material for melons and industrial and consumer products. It is also used in the manufacture of cooling pads.

SECONDARY MANUFACTURING

Secondary manufacturing involves the transformation of primary forest products into still more refined products — such as when lumber and veneer are combined with metal hardware to form furniture.

About 525 Utahns are engaged in secondary manufacturing. This figure, does not include general carpenters, retail sales personnel nor any non-retail employees of retail lumber yards.

Unlike the primary producers, Utah’s secondary manufacturers are heavily concentrated in the urban areas of the State. As figure 1 indicates, Salt Lake, Weber and Utah counties provide more than 80 percent of the secondary manufacturing jobs.

Utah has nine cabinet shops, four wood furniture factories, two manufacturers of pre-fabricated wood houses, one manufacturer of roof decking, three door factories, one moulding plant, two box factories, two pallet manufacturers, one saddle tree plant and one producer of cooling pads. In addition, survey stakes, box shooks, baled planer shavings, roof trusses, dunnage and flower flats are produced.

THE PRODUCTS

Besides cabinets (mostly kitchen) cabinet shops also produce kitchen counters, doors, and general millwork items such as windows and door frames. Most of the work is performed for local building contractors and competition among the shops is keen.

The manufacture of doors and door components represents one of the largest of Utah’s forest industries. More than 600,000 assembled and unassembled doors are produced annually. Most of these are marketed in the midwestern and eastern states. One manufacturer, The Schumacher Company in Morgan County, produces door components which are shipped to a parent plant in Ohio for assembly.

A unique forest industry is the manufacture of saddle trees. These are the basic wooden frames which are covered with various leathers and eventually become riding saddles. The Standard Saddle Tree Company of Vernal is one of only five or six saddle tree producers in the entire nation. The company, reluctant to divulge exact production figures, would only allow that “several thousand” saddle trees are produced in the Vernal plant each year. Markets for these trees cover the United States and Canada. Lodgepole pine, rather abundant in the Uintah Basin, is used exclusively because of its excellent strength-to-weight ratio.

The concept of factory built houses is rapidly gaining acceptance in the United States. Indeed, some industrial estimates claim that as many as 20 percent of all newly built American houses today are pre-fabricated. Since the houses are built on an assembly line basis, construction costs are lower than those
associated with traditional on-site construction methods.

In Utah, pre-fabricated homes are now built by two firms: The Boise Cascade Corporation in West Jordan and Intermountain Precision-Bilt Homes in Ogden. These firms currently produce about 700 houses and other buildings each year. Up to 90 percent of each structure consists of wood.

WOODLAND UTILIZATION

Pinyon-juniper woodlands cover 12 million acres in Utah. This represents more than 20 percent of the State's total land area. Because of their small size and poor form, these woodland trees are little utilized. For this reason, they are often considered a liability and not a productive resource.

Of the miscellaneous products obtained from the pinyon-juniper type only three: Christmas trees, fence posts, and fireplace wood are considered important at this time.

Approximately 20,000 Christmas trees were harvested from public lands in Utah last year. About one-half of these trees were pinyon pines growing on Bureau of Land Management lands. The remainder consisted mostly of spruces and firs from U.S. Forest Service lands. About 70 percent of all of these trees were cut in the seven southwestern counties of the State.

The durability of cedar fence posts has long been recognized in Utah. Earlier figures indicate that at one time as many as 80,000 cedar fence posts were cut annually. In the face of competition from steel posts, however, the annual cut of cedar posts has dropped to its current level of about 50,000. The majority of these are taken from Bureau of Land Management lands. The post cutting center in Utah is located at Kanab. Other harvesting sites of importance are Cedar City and Fort Duchesne.

Throughout its range, pinyon pine is a preferred fireplace wood. Properly prepared, it is long burning and has a lively blue and yellow flame. Last year about 2200 tons of seasoned pinyon fireplace wood were sold. Most of this was marketed locally and in the larger urban areas of the State. Several cutters trucked firewood as far away as San Francisco where they peddled it in residential areas. Though pinyon fireplace wood is harvested in many parts of Utah, the main activity is centered at Duchesne.

The total wholesale value of all the pinyon-juniper products obtained in the State amounts to less than 90,000 dollars per year. About 80 persons are engaged in harvesting and preparing them — all on a part-time basis.

LUMBER PROBLEMS

Utah's forest industries are not without their problems. The lumber industry, perhaps more than any other, is facing the greatest challenges. The availability and quality of timber and the question of what to do with milling residues are topics of much concern among sawmill owners.

While the overall availability of timber in the State is good, past cutting patterns are forcing the relocation of several mills and the permanent shut-down of others. Wasatch County, once a major producer of lumber, today hasn't a single active sawmill. And Summit County, though still a major producer, is facing an increasingly acute timber shortage. To avoid shutdown, at least one Summit County mill is importing logs from Wyoming.

Counties in which major increases in lumber production are taking place are Sanpete and Uintah counties. The annual production in Uintah County now exceeds 10 million bd. ft., and the figure for Sanpete County is expected to reach as much as 8 million bd. ft., within a few years. Virtually all of the lumber cut in Sanpete County will be aspen.

Under the administration of the U.S. Forest Service, Utah's forests are being geared for sustained yield. This means that the allowable cut of timber on the forests must be matched or excelled by new growth. This promises stability for the future inasmuch as sawmills will eventually have to adjust to the allowable timber cut in their area. Equally important, they will be able to count on that cut in the future.

The problem of timber quality, while serious, is one which Utah's sawmills are learning to live with. Not only is much of the timber of small size, but the logs often contain large amounts of defects such as knots, decay, and insect damage. The yield of lumber from such timber is low in both quantity and quality. To meet the challenge, new equipment is being developed which can mill low quality logs faster, more accurately, and with less waste than ever before. One such piece of equipment now in use will efficiently process logs as small as 6 inches in diameter.

PROTECT your FARM with its quality FOOD and FIBER products from the ravages of insects, weeds, diseases and other destructive pests. Guard against hazards resulting from improper use of pesticides.

PROTECT your WATER, SOIL, and AIR—our basic natural resources—from accidental contamination by pesticides or other chemicals on the farm, in the forest, or in the city.
Nematodes may aid
fight against insects

Nematodes, tiny worms visible only under microscopes, could help man control some important insect enemies.

A variety of the tiny worms, named the DD136 Nematode kills houseflies, codling moths — the proverbial worm in the apple — boll weevils, and other insects.

EASILY REARED

The nematodes are easily reared in large numbers at low cost and can be stored in cans for long periods without food or insect host. When needed, they would simply be mixed in a water solution and sprayed with conventional equipment.

DD 136 Nematodes seek out vital chemicals occurring naturally in the bodies of insects and which are essential to the nematodes' growth and reproduction. Their effect on the insects is amplified by a bacterial partner in the nematodes' bodies which kills insects after contact. These bacteria are harmless to the nematode and important to its nutrition.

Dr. Dutky of the Insect Pathology Pioneering Research Laboratory, Beltsville, Md., reported promising results against codling moths and peach tree borers. Borers and boll worms deep within plant tissue, where conventional sprays would not reach, were killed by the nematodes. Promising results have also been obtained by using the nematodes in a spray to stop houseflies from breeding in poultry manure.

Ultraviolet treated apple juice has fresh juice flavor

Apple cider with all the flavor of the fresh juice can be preserved without chemicals or heat by ultraviolet irradiation.

In the new process developed by USDA's Agricultural Research Service, the cider is exposed to ultraviolet light which greatly reduces the number of microorganisms present. The simple process requires inexpensive equipment, and consists essentially of pumping cider across the surface of germicidal lamp tubes to give maximum exposure to the ultraviolet rays.

By passing fresh cider through a battery of three germicidal lamps the cider's microbial count was reduced by 85 percent. A second treatment pushed total reduction to 98 percent.

Storage tests showed that cider passed two, three, or four times through the ultraviolet lamps could be kept under refrigeration for up to 35 days without appreciable growth of microorganisms. This is about the same degree of microbiological control achieved with chemical additives. If added protection is desired, preservatives may be added to retard growth of the surviving microorganisms. Untreated cider will not ordinarily keep under refrigeration for more than 7 days.

A panel of taste judges agreed that radiation-treated cider had the flavor of fresh, untreated cider.

Units for treating cider by ultraviolet irradiation can be assembled from commercially available components. Details on the construction of such units can be obtained from the ARS Eastern Utilization Research and Development Division, 600 East Mermaid Lane, Philadelphia, Pa. 19118.