Cover Picture: Female alfalfa leaf-cutting bee (*Megachile rotundata* Fabr.) collecting nectar from a borage flower. These bees have become the most important wild pollinators of alfalfa in the seven or eight years they have been in this area. They have a short flight range and forage within a few hundred feet of their nests. They nest in such places as nail holes, spaces between overlapping boards, beetle burrows, old wasp nests, and in the pores of lava-block houses. The photograph was taken by W. P. Nye of the USDA Apiculture Research Laboratory on the Utah State University campus. Mr. Nye is well known for his excellent photographs of insects.

Land Grant Universities — U. S. Department of Agriculture Centennial 1862-1962
Let our future be nourished by the past

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U. S. DEPARTMENT OF AGRICULTURE CROPS RESEARCH LABORATORY

Three additional scientists have been added to the laboratory staff for research on sugar beets.

Dr. J. Clair Theurer, research agronomist, a graduate of USU, Dr. Theurer has just completed a PhD in plant breeding at the University of Minnesota. He will work on breeding improved sugar beet varieties.

Dr. Charles L. Schneider, research plant pathologist, a graduate of the University of Minnesota. He was transferred here from the USDA Research Center at Beltsville, Md., and will conduct research on sugar beet diseases.

Albert M. Murphy, research agronomist, MS, University of Wisconsin, was recently transferred here from the USDA laboratory at Twin Falls, Idaho. He will be concerned with research on the production of sugar beets.

There are now 29 federal research workers located in the USDA laboratory as follows:

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<thead>
<tr>
<th>Field</th>
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<tr>
<td>Sugar Beet Research</td>
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<td>Nematode Research</td>
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<td>Oil Crops Research</td>
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<td>Forage Crops Research</td>
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<td><strong>Total</strong></td>
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Dr. W. J. Derksen, assistant professor of climatology during the past year has returned to Holland. Dr. Gaylen Ashcroft is now filling this position.

UTAH FARM AND HOME SCIENCE

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

The magazine will be sent free on request. Address all correspondence to the editor or the authors of the various articles.

Articles appearing in Farm and Home Science may be reprinted if credit is given to the author, Utah State University, and to Farm and Home Science.

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FARM AND HOME SCIENCE
For lining ditches with concrete

NEW SLIPFORM USES FREE-FLOW HOPPER

From above one can look down into the free flow hopper of the experimental slipform and see the semi-cone that provides the expanding surface over which the concrete flows. The concrete tends to pull apart which prevents an arch from forming and stopping the flow. Converging flow would push the particles together and form an arch capable of supporting the concrete above and stopping the flow.

FRANK W. HAWS and C. W. LAURITZEN

It was Simple Simon who tried to carry water in a sieve, but irrigationists have been doing it for years! And not because they did not comprehend the problem, but because the cost of providing leak-proof structures to convey the water was beyond their means to finance or repay. The dollar value of water lost is increasing with each passing year but so are costs of labor and material, so it is not becoming easier to line irrigation ditches. That is, it would not be easier except for two considerations. The first is the government subsidy program — or incentive payments — by which the farmer shares his cost of the project with the federal government. The second, and the one with which we are concerned here, is the relative decrease in the cost of lining ditches with concrete! It’s true, that concrete-lined ditches actually cost less to construct today than the same ditch would have cost 15 years ago. In the period from 1946 to 1960, while the Engineering News Record cost index was increasing from 320 to 800, the unit cost of concrete lining either remained steady or decreased.

What is the reason for this startling inconsistency? It’s simply that concrete ditch linings have succumbed to the machine age. An ingenious device called a “slipform” has made it possible for a crew of three men to complete as much lined ditch in an hour as ten men formerly did in a day!

Development of slipforms

Historically, the slipform dates back to about 1911 when A. W. Gale obtained a patent on a “concrete spreader for ditches, sidewalks, and other surfaces.” In 1915 some linings were placed in Oregon by a subgrade-guided slipform, but it was not until about 1947 that any real interest developed. This long period of inactivity was largely the responsibility of engineers and designers who were convinced that linings required steel reinforcing and strict conformance to grade limits. The Bureau of Reclamation built some good but costly ditches during this period. About 1946, the Bureau organized its “lower cost canal lining committee” and made two important decisions affecting the cost of canal lining:

1. It eliminated steel reinforcing from virtually all concrete canal linings.

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2. It relaxed tolerances as to line and grade for concrete canal linings. These two decisions ushered in the age of slipformed concrete linings. The first canals lined were large, and the pavers were intricate devices mounted on rails. The largest such device spanned 112 feet and was used to line the Delta-Mendota Canal in California. Similar equipment was used in the Columbia Basin. These large rail-mounted pavers were scaled down in size to line the small ditches, but the cost of setting and removing the rails, and continually adjusting the slipform was too great a proportion of the total cost of the lining.

Clyde Shields of the U. S. Bureau of Reclamation built and used a subgrade-guided slip form on the Gila Project at Yuma, Arizona, in 1947. At about this same time a Mr. Fuller of Phoenix, Arizona, developed and built his now famous Fullerform. Many of these devices have been built and sold or leased to contractors, irrigation districts, and individual irrigators. With this and similar equipment built by others, it is estimated that more than 15 million square yards of concrete have been placed in over 4,000 miles of small farm ditches throughout the arid western states during the period from 1946 to 1960. During this same period the U. S. Bureau of Reclamation has placed another 15 to 18 million square yards of concrete in project canals. These include about 300 miles of small canals which were lined with subgrade-guided or crawler-supported equipment.

From 1947 to the present there has been essentially no change in the basic design of the form developed by Shields and Fuller. In some of the larger canals devices have been employed to help maintain grade and alignment control. But these devices, such as mercury switches or sensing elements, control the supporting equipment and do not alter the hopper or finishing sections of the slipform. The added cost of these devices for grade control may not be favorable to small farm ditch lining. A small farm ditch-lining machine should be simple in design and of the type that can be operated with available energy sources.

What is a slipform

A slipform consists of three essential components: (1) a hopper system through which a stiff plastic concrete must flow, (2) a consolidating and smoothing member to compress the loose material as it leaves the hopper section and to give an acceptable finish to the lining, and (3) a supporting structure which controls the grade and alignment of the finished ditch. The forms built by Shields and Fuller combine the elements in one integral unit. The hopper, wide at the top, converges to a narrow section that delivers concrete to the sides and bottom. The finishing section uses the weight of the slipform to compress the concrete, and the long pointed front end riding on the subgrade of the ditch provides the line and grade control. The thickness of the lining is fixed by the vertical displacement of the finishing member. As the name implies, the subgrade-guided slipform takes its control from the subgrade, so line and grade of the lining are no better than the finished subgrade.

If concrete linings are to continue their favorable trend, the slipform must be made as efficient as possible. Labor must be reduced to a minimum; and the finished product must be durable and watertight and conform to specifications for line and grade. The senior author has made an attempt to improve this efficiency by designing a free-flowing hopper. Such a device eliminates the need for a special labor crew to "force" the concrete through the hopper section of the slipform.

Concrete must be made to flow

For the concrete to stand up on the steep side slopes of a ditch, the mix must be stiff and plastic. If the concrete is to move through a narrow hopper, the mix must be loose and liquid. A compromise between these two opposing requirements usually means that

Pictures from left to right: A small irrigation ditch near Providence, Utah, is being lined with concrete using experimental slipform developed by the University. Concrete is delivered to the site in ready-mix truck and a small tractor is used to tow the form. Rear view of the experimental slipform. Concrete must have the right consistancy or side slopes will sluff into the bottom of the ditch. Concrete discharging into the hopper of the slipform. A ditch such as this can be lined at the rate of 700 feet per hour.
the concrete mix is too stiff to move freely through the hopper but just stiff enough to stand up on the side slopes of the ditch.

If the concrete will not flow readily through the hopper, it must be helped along — usually by workers with shovels who poke and prod the mix. This additional labor naturally increases the cost of the lining. If the stiff mix can be made to flow without the addition of external energy, a savings will result and the slipform will continue its favorable trend in reducing costs.

**New hopper uses expanding flow**

If we were to cover an annular disc with a stiff concrete mix, then carefully lift the disc with the material it would support, the external angle of form would not be the same as the internal angle. The smaller external angle indicates how the shear strength of the material is influenced when it lies on an expanding surface. The internal angle shows how it is influenced when the material lies on a contracting surface. In the first case the particles are freed from one another; in the latter they are more tightly locked to each other, and cohesive forces increased because of the side pressures. On this internal surface a stable arch is formed, while on the external surface an unstable arch is formed.

This illustrates that flow from the outer or expanding surface will occur over a wider range of characteristics normally tending to limit flow, than it will from an inner or contracting surface. Using this principle the senior author has built and tested a hopper in which the concrete flows over an expanding surface. This surface was made by attaching a half-cone section with apex at the top to the inside front wall of the hopper. This causes the concrete to flow in a diverging pattern, creating tension in the material and eliminating "arching" or stoppage of the hopper.

This new free-flow hopper has been tested at the River Laboratory and found to operate successfully. It is not necessary to apply any external energy to make the stiff concrete flow, and it can be made to operate in a slipform with only one man to "tend" it. This man's chief function is to guide the chute from the readymix truck and to signal the driver of the vehicle that propels the slipform.

**Other improvements expected**

Further improvements in slipforms are contemplated, some of which are under test at the present time. A tri-wheeled support system, coupled with a "floating" finishing screed, offers promise of reducing the draft required to tow the slipform and at the same time reducing the deviation from grade caused by uneven subgrade conditions. This support system also prevents "side sway" and makes it easy to "steer" the slipform around bends in the ditch.

In a recent test the new slipform was used to line a ditch at the rate of 700 feet per hour with only two men on the slipform!
The plant virus research team tests the infectivity of solutions from a virus synthesis experiment by inoculating leaves of bean plants. Each infection produces a small dead area in the bean leaves.

Tobacco mosaic virus particles magnified 100,000 times by the electron microscope.

**TEST TUBE VIRUS**

VIRUSES are agents which produce disease in men, animals, plants, bacteria, and insects. They are usually smaller than bacteria; in fact, most of them are so small that they cannot be seen with the finest light microscopes. Only the electron microscope, which magnifies 10,000 to 200,000 times, is powerful enough to show the structure of the small viruses. The annual toll of losses caused by viruses throughout the world probably amounts to more than one billion dollars. These huge losses might be lessened if man had chemical treatments to stop the disease processes induced by viruses, but he does not have effective treatments against viruses because he knows so little about how viruses form and how they induce disease. During the past 14 years an intensive research program has been under way at Utah State University to discover some of the secrets of viruses with the hope that the new information gained might ultimately be used for practical virus control purposes.

Viruses have always been inseparably linked with living cells. The experts believed that there was a vital "something" inside a living cell that was needed for virus multiplication and that viruses could only be produced inside living cells by some vital process.

**A new concept of virus formation**

Our virus research program at Utah State University has upset all of these long-standing ideas about viruses. First, we refused to accept the commonly-held theory that virus formation was a "vital process" that could only proceed in the presence of living protoplasm inside a cell. We believed that virus building structures were present in virus infected cells which might be

GEORGE W. COCHRAN, AMRIK S. DHALIWAL, and JOHN L. CHIDESTER

FARM AND HOME SCIENCE
is isolated and then induced to form virus outside the cells. We chose tobacco mosaic virus for our studies because more is known about this virus than any other. The virus consists of a nucleic acid center and an outer protein coat. It has been shown that the protein coat can be removed to leave the nucleic acid center which is still infectious. Several years ago we demonstrated that infectious virus occurs within infected cells in several forms.

Helen Wang and Mrs. Antonia Mikulski-Macheta, assistants, count the dead spots in bean leaves to determine the amount of virus synthesized in a test tube experiment

Dr. George W. Cochran uses a particular agar gel column in the cold laboratory to prepare the virus synthesizing molecules from sap extracted from diseased plants

One of these forms appeared to be a nucleic acid without a protein coat. We assumed that this represented the initial infective stage in the virus formation process and that this would be the first infective form produced if we were successful in isolating a virus-forming mechanism and in inducing it to form new virus outside of living cells.

Our first big problem was to isolate the virus-forming mechanism. We reasoned that molecules needed to form an infective virus molecule would have to be at least as large as the virus molecule being formed. This meant that our isolation procedures should select molecules the size of the virus nucleic acid or larger and reject smaller molecules. We believed that some of the smaller molecules occurring in extracted plant sap might be detrimental to the virus formation process for we knew that the smaller molecule fraction contained ribonuclease and possibly other enzymes that actually destroyed the infectivity of virus nucleic acid. There were two methods that might be used for the isolation of the virus-forming mechanism, centrifugation and gel filtration. We chose gel filtration because it gives clean-cut separations of molecules on a basis of size with one simple operation. By experimentation we determined that a 2 percent particulate agar gel would give the molecular separation desired. There was evidence available from previous work of other scientists that nucleic acids could be synthesized from the triphosphate nucleotides that are known to compose them and it had also been shown that magnesium ions were needed for this reaction.

The first-attempted virus synthesis experiment was successful

We attempted our first virus synthesis experiment on February 12, 1962. We made our own particulate agar gel for the gel filtration isolation of large molecules from sap expressed from tobacco mosaic virus infected tobacco leaves. Fourteen hours earlier the tobacco leaves were inoculated with infectious virus nucleic acid. The extracted sap was washed with a special sugar solution (sucrose 0.25 M, calcium chloride 0.003 M, tris (a buffering chemical) 0.006 M, the final pH was 7.2) down a column consisting of tiny spheres of 2 percent agar packed in a glass tube. The first green-colored material to pass through the column was collected and concentrated until it occupied a volume of about 1/2 teaspoon. Small amounts of penicillin (1 mg) and magnesium chloride (1 mg) and noninfectious tobacco mosaic virus protein (1 mg) were added to the concentrated extract which was then thoroughly mixed. Next it was divided into two equal portions in test tubes. One which received no further treatment served as the control. The other portion was fed the four triphosphate nucleotides (1 mg adenosine triphosphate (ATP), 1 mg uridine triphosphate, 1 mg cytidine triphosphate, 1 mg guanosine triphosphate) which were assumed to be the raw materials needed for the formation of new units of infectious virus nucleic acid. The two test tubes were shaken and allowed to stand for 1 hour at room temperature. The relative amount of virus present in each tube was determined by rubbing a drop of the solution from each tube over opposite halves of 60 glutinosa tobacco leaves. Each infection produced a dead spot (lesion) in the tobacco leaves. These spots were counted to determine the relative amount of virus in each tube. The solution in the control tube produced 77 lesions while the solution in the tube "fed" the chemical raw materials needed for virus formation produced 219 lesions. There were approximately three times as many units of infectious virus in the treated tube after holding for one hour. Calcula-

(Continued on page 83)
Reproductive failures which result in abortion or weak sickly young are a problem of the livestock industry requiring more basic research. The financial well-being of any animal industry depends on the birth of healthy offspring from each female each time she is bred.

The sheepmen of the Western United States each year suffer high economic losses from abortion and stillbirth of lambs. Also lambs born weak, die during the first weeks of life. If we look across national boundaries we find that such losses are worldwide. The sheep industry of Australia loses yearly about 10 million lambs during their early life before they reach market age. Many newly developing countries in Asia and Africa depend heavily on sheep for meat and clothing. There is no accurate information available, but it can be assumed that their sheep flocks suffer similar losses.

Relief through research

The economic losses from abortions alarmed the National Woolgrowers' Association. Through its efforts research on the causes of these losses was initiated in 1952 and has been greatly increased since by the experiment stations of California, Colorado, Idaho, Montana, Wyoming, and Utah. The efforts were coordinated in a Western Regional Project. This research is also supported by the Animal Disease and Parasite Research Branch of the Agricultural Research Service of the Department of Agriculture. As a result of the united attack on the problem, the causes of abortions

Solution to the problems connected with

Abortion in sheep

Fig. 1. Well managed herds free of diseases have a lamb crop of 125 percent and more. All the ewes pictured here had twins.

J. STORZ
M. L. MINER

Fig. 2. Part of the pleural and peritoneal cavities of a lamb infected in utero with Vibro fetus. Liver, spleen, stomach, and intestine are covered with fibrinous material indicating an active response of the fetus to the infection.
in sheep were detected, diagnostic methods were improved, the distribution of the diseases was determined, and means for prevention were developed. Investigations conducted at the Utah Station were directed towards (1) epidemiological problems such as what animals are carriers and spreaders of the disease agents between and during outbreaks and (2) the nature of the infectious organisms involved.

Causes of lamb losses

Two major infectious causes of abortions and stillbirths of lambs were found; one is a comma-shaped bacterium, *Vibrio fetus*, and the other an agent of the psittacosis-lymphogranuloma group, referred to as the virus of enzootic abortion of ewes. A counterpart of *Vibrio fetus* causes sterility and abortion in cattle. Agents similar to the virus of enzootic abortion of ewes have a wide distribution throughout the whole animal kingdom and are capable of causing diseases such as pneumonia, encephalomyelitis (inflammation of the brain), arthritis, and enteritis (inflammation of the intestinal tract). Both types of microorganisms are widely distributed in the sheep population of the Intermountain Region. Each one by itself can cause abortion and stillbirth in a flock year after year at a low rate of 1 to 5 percent, which is accepted by some sheepmen as a normal loss. And they both can cause explosive abortion outbreaks of upwards of 50 percent of births but more usually around 20 to 25 percent. Both can occur simultaneously in the same flock. This creates a complex situation and may result in even severer losses requiring more effective measures for control.

Nature of the causative agents

*Vibrio fetus* is a fastidious bacterium that grows only under reduced oxygen atmosphere and that requires relatively rich media for growth under artificial conditions. Recent research has created better methods for the isolation of this organism and has increased the accuracy of diagnosis. The shape of *Vibrio fetus* can vary from small cocccoid cells (cells whose greatest di-
Physiological response of plants to drought

HERMAN H. WIEBE

Moisture is critical to plant growth. Wilted plants grow slowly, if at all, a point of considerable interest to agriculturists and gardeners the world over. Botanists at USU are studying how plants respond physiologically to drought and wilting.

Wilting may be rapid and acute, with almost immediate death of the plant. More generally, plants are subjected to chronic water deficits or drought over prolonged periods of time. Such plants may show wilting only intermittently, as in the middle of the day. Often no wilting is observed, but internal water deficits do occur, and growth is greatly retarded.

Photosynthesis may be reduced

Several physiological mechanisms have been proposed to explain this reduced growth. As the plant wilts, the stomates (small pores or openings in the leaf) close, greatly reducing evaporation (or transpiration) and water loss and permitting the plant to survive temporarily. The closed stomates, however, limit food manufacture (or photosynthesis) in the leaf, since photosynthesis requires carbon dioxide which enters the leaf from the air through the stomates. Wilting, then, will reduce photosynthesis and the plant’s food supply. Lower food reserves (starch and sugars) have indeed been found in plants subjected to repeated wilting.

Cell growth may decrease

Wilting will also reduce cell enlargement and growth. As the plant loses water and approaches the wilted con-
dition, the turgor pressure (hydrostatic pressure) in the cells decreases, and in a wilted leaf the pressure in the cells is too low to hold the leaf erect. Under these conditions the turgor pressure is also too low to cause young cells in the stem or root tips, or in young leaves, to enlarge normally. Water deficit and the accompanying reduction in turgor pressure would, therefore, result in reduced stem elongation and leaf enlargement. Smaller leaves, with smaller cells, are found under drought conditions, especially higher on the plant where evaporation is more severe.

Food may not be transported throughout the plant

The reduced pressure in the leaf cells may also reduce growth by a third mechanism. According to a current theory, the circulation or translocation of food (manufactured in the leaf in photosynthesis) is believed to be brought about by a turgor pressure push from cells in the leaf. The leaf cells are connected with the conducting tissue or phloem (comparable to blood vessels in animals) by extremely small, microscopic pores or plasmodesmata. When cell contents are under turgor pressure, small amounts of cell sap containing food are squeezed or pushed through these microscopic pores into the phloem, and then down the leaf stalk (petiole) along the stem to the younger, growing leaves and to the root. According to this theory, wilted leaves would not have the necessary turgor pressure, and therefore, food exports from leaves to growing regions would be reduced with resulting starvation of the growing regions and reduction in growth.

This last theory has been studied at Utah State University by observing the movement of radioactive carbon, C\(^{14}\), as this is influenced by wilting. One leaf of a plant is enclosed in a plastic container which has been outfitted with a rubber serum vial stopper (fig. 1). Carbon dioxide gas prepared in a special apparatus and containing radioactive carbon, is injected into this chamber with a medical hypodermic syringe. The leaf uses this radioactive carbon dioxide in photosynthesis, and the radioactive sugar thus formed moves out of the leaf to the rest of the plant. In a typical experiment we worked with from two to six plants in various degrees of wilting. A wilted and a normal, turgid plant are shown in fig. 1. After several hours the plants are pressed, dried, and placed in contact with photographic film. The radiations expose the film much the same way as does light, so the plants take their own picture (fig. 2). On these autoradiograms which are comparable to photographic negatives, the darker regions represent the areas of highest C\(^{14}\) concentration. On both plants the leaf which was in the photosynthetic chamber is nearly black. In the plant at the right, which had adequate water, radioactive sugar, labeled with C\(^{14}\), moved to the stem tip, the younger leaves, and the roots. The plant at the left was wilted, and little sugar moved into the roots and younger leaves, so that they are scarcely visible on the autoradiogram.

C\(^{14}\) can also be measured with a Geiger counter. The amount of translocation is plotted against diffusion pressure deficit (DPD) for about fifteen plants at various degrees of wilting or turgor in fig. 3. More severely wilted plants were those with DPD of 10 or above, while plants with the lowest DPD, 1 or 2, were most turgid. A definite decrease in translocation was noted as DPD increased or turgor pressure decreased. These results are, then, the same as those obtained from the earlier autoradiographic study. They support the theory, mentioned above, that turgor pressure in the leaf cells is necessary to push, export, or translocate the sugar to other parts of the plant. In wilted plants such translocation is much reduced.

These results also indicate that one mechanism by which limited soil moisture may reduce growth is by a reduction in translocation of plant food with resulting starvation of the growing regions. Whether the mechanism is more important or more critical than the ones mentioned earlier is now being investigated at Utah State University. It is entirely possible that all three mechanisms will, as perhaps others, contribute to growth under drought conditions.
Many historic and scenic places may be found on the national land reserve in Utah, such as these prehistoric cliff dwellings in San Juan County.

The use and economic significance of the national land reserve in Utah

R. D. NIELSON

"The Nation's landlord" — the nickname sometimes tacked onto the U. S. Bureau of Land Management — is charged with the administration of some 467 million acres of public lands and resources in 11 western states. In Utah alone BLM responsibilities extend over 26,466,737 acres, or 48.7 percent of the state's total area.

Administration by the Bureau encompasses the land itself plus water, minerals, forests, range, recreation, wildlife, and any other use made of this vast national land reserve.

Administration of the public domain

Specific responsibility for administration of the public domain has evolved from an 1812 Congressional charge to the General Land Office, a predecessor agency of BLM: "... To perform all actions and things touching or respecting the public lands of the United States."

The federal government during its first hundred years deliberately pursued a policy of disposition of its land estate to spur development and also to raise revenue for operation of the government. There was always more land to the West. This no longer is true.

Yet man's dependence on the land and resources has never diminished. However, an individual or group all too often gives attention to only a
single resource, forgetting the vital interdependence of soil, water, forest, wildlife, and recreation. Improper or inadequate conservation or management of one resource often can lead to disastrous results to other resources.

**Man’s responsibility to choose wisely**

Today man’s responsibility to himself and to future generations demands that he choose as wisely as possible among the many ways in which he can use the land and its resources.

Modern man must have food and water, minerals and fuels, highways and housing, airports and factories, open space and recreation areas, parks and seashores, wildlife refuges and wilderness — just to name a few. Some — such as farmland and forests — can be rejuvenated or replaced. Others — such as mineral deposits — are non-renewable and must be used with as much efficiency and as little waste as possible.

**BLM administration in Utah**

In Utah, approximately 30,000 oil and gas leases involve nearly 18 million acres of the national land reserve administered by the Bureau of Land Management. In addition, approximately 250 mining leases cover more than 325,000 acres. BLM objectives are to administer the national land reserve to conserve the land’s vital minerals for the benefit of today’s citizens and those generations yet unborn.

In another phase of its administration, BLM has jurisdiction over 633,000 acres of forest land in Utah, plus 8 million acres of woodland.

Utah’s livestock industry has a vital interest in another facet of BLM operations. More than 1,200,000 livestock graze on the national land reserve within the state, including some 491 goats, 1,262 horses, 157,128 cattle, and 1,050,063 sheep.

BLM has the responsibility of determining how many animals may be sustained on the forage available on the national land reserve and this is expressed in the term “animal unit months.” The amount of forage one cow needs to sustain itself for one month is the equivalent of one animal unit month.

Administrators also must take into consideration the big game which graze on the national land reserve in Utah — 277,458 deer, 1,650 antelope, 715 elk, 160 mountain sheep, and 65 buffalo.

**Full use of resources.**

A basic BLM aim is to bring resources of the public lands as fully into use as possible. In most cases this full-use policy means multiple use. For example, one tract of land may produce forage for livestock, serve as a watershed, be used for mining, and may even have other uses.

Multiple use of the national land reserve means balanced resource management. It assures the continued role of these lands as a great public storehouse of natural resources.

Under multiple use no individual user can dominate that which belongs to all. At the same time, multiple use does not mean that every use will be allowed on every tract of land.

Multiple use is a planning and programming concept: Lands first must
be classified to determine their highest and best use, and then that use must be interwoven into the entire management system.

**Conservation measures**

Conservation is an essential part of managed use of the renewable resources on the national land reserve. Forage, timber, and other watershed cover; wildlife, water, and soil require conservation measures to insure a continuing supply.

Among principal conservation measures of BLM are fire protection, managed grazing and timber harvesting, planting or reseeding to improve timber stands or range cover, control of noxious weeds and important timber diseases and insect pests, erosion control, and small water storage. Equally important for conservation are the many physical improvements — such as roads, fences, and wells — placed on the public lands to facilitate their use.

Science has given man the key to modern resource conservation, but science alone cannot salvage what is left from decades of waste and despoilment of our land resources. It takes dedication, awareness, and a determination to succeed.

**BLM operates at a profit**

BLM enjoys a position which is somewhat unique among federal agencies. For more than half a century the agency and its predecessors have operated at a substantial profit. During this period, the total revenues which accrued from resource management exceeded expenditures more than eight times.

As a result of BLM management of the national land reserve in Utah, $8,575,243.70 went into the public treasuries during the fiscal year which ended June 30, 1961. Of that total, $2,962,057.77 was paid by BLM to the state of Utah as the latter’s share of receipts from mineral leasing, grazing, land and timber sales, and other operations administered by the Bureau.

Of the eight and one-half million dollars in receipts, $7,805,371.39 was realized from mineral leasing, $345,959.92 from grazing, $63,826.62 from sale of lands and materials, $18,669.13 from such activity as right-of-way payments and sale of government property, and $341,779.97 from fees and services.

In these and other ways the relatively few BLM employees in Utah (approximately 200) are administering nearly half of Utah’s land area in the best interest of the state and nation.
Selection of high yielding grasses and legumes for a pasture mix and applying proper fertility, irrigation, and cow management has permitted an increase in per acre production of butterfat from 131 pounds to as much as 450 pounds per acre.

RESEARCH IN THE ANIMAL SCIENCES

JAMES A. BENNETT

A

IMAL agriculture is essential for the proper nourishment of mankind. The science and art of raising livestock rank among the greatest of all the sciences and arts. Although the domestication and raising of animals are as old as civilization some of the old problems are as yet unsolved and new problems are continually appearing.

DR. JAMES A. BENNETT is head of the Department of Animal Husbandry. This article is the second of a series reviewing some of the research accomplishments and future plans of the Experiment Station in broad subject areas. The first article discussed the plant sciences. Other articles will discuss renewable resources, social sciences, family life, and plant and animal diseases.

FOR SEPTEMBER 1962

The sturdy pioneers who brought animals across the plains to Utah as a source of food, power, and fiber founded an important animal production industry in the arid West. As this industry has developed, problems have arisen. The scientists at the Utah Agricultural Experiment Station have been allied with the producers in meeting and attempting to solve these troublesome problems.

The past

It was recognized early that for animal production to be profitable, high quality products must be marketed and efficient production practices followed. Shortly after 1900 the value of improved breeds had been demonstrated and the use of purebred sires was expanding rapidly. Over the years Experiment Station personnel have assisted in developing standards for evaluating sires. Through the application of classification standards Utah beef cattle now compare favorably with the best in the range area. In recent years techniques have been developed whereby livestock men may evaluate more accurately performance in beef cattle and sheep and estimate levels of transmission of desirable production traits. The proved sire program carried out at the Dairy Experimental Farm has verified the effectiveness of this breeding method and has helped give Utah's dairy cattle an enviable national reputation. Crossing of turkey strains has been found to increase hatchability 10
Cattlemen inspect the bulls and the records at the end of a bull performance test.

Utah scientists have developed and perfected equipment for measuring digestibility and metabolizable energy value of range forage by grazing animals.

Veterinarians cooperate with other state and federal agencies to help reduce losses from disease by providing diagnostic services and by developing treatments and preventative programs.

High altitude was demonstrated to affect hatchability of turkey eggs adversely. Utah poultry scientists discovered that increasing oxygen supply to the eggs during incubation gave up to 15 percent increase in hatchability. This knowledge has helped in the development of a thriving turkey hatching industry in the state.

Intensive nutrition research has been productive. In former years the use of alfalfa, which was abundant and cheap, was given close attention for use in diets for livestock and poultry. Other products were studied as they became plentiful. Sugar beet by-products were found to be deficient in essential nutrients. Addition of supplemental phosphorus to beet pulp rations gave dramatic gain increases in fattening cat-
tle. High levels of barley in poultry rations have proved satisfactory.

Management studies of irrigated pastures by Utah Station scientists and of their use by dairy cattle for maximum production of dairy products from roughage have attracted worldwide attention.

More healthful and efficient methods of producing dairy products have been developed over the years. Methods of producing higher quality cheese, the hot rind means of salvaging dead batches; and new dips are examples of some results of research in this area.

Using the results of research, members of the Department of Veterinary Science working closely with the Utah State and United States Departments of Agriculture have carried out disease control and eradication programs. First efforts of these programs were directed toward tuberculosis and brucellosis. Both of these diseases have been reduced to less than one-half of one percent incidence in Utah. In fact, brucellosis is on its way to being eradicated as Utah is the first state west of the Missouri River to have certified brucellosis-free counties (San Juan and Grand).

An eradication program for pullorum disease of chickens and turkeys was also implemented. This disease has been eliminated from the turkey

Sheep strains and crosses have been measured in detail to select those best adapted to Utah range conditions and those producing the largest lamb crops and the heaviest fleeces

The influence of hydrogen peroxide on cheese cultures is being checked by direct count and culture studies. Studies on its use in making Swiss and cheddar cheeses are encouraging

Nutritional deficiencies have caused heavy losses in poultry. Research has shown how to prevent these losses.
An eradication program based on research results has eliminated pullorum disease from turkey breeding flocks and almost eliminated it from chicken flocks.

Crossing turkey strains has resulted in nearly 15 percent increase in hatchability and 5 percent increase in feed efficiency.

Breeding flocks of the state and almost eliminated from the chicken flocks.

The problems of reproduction have been a major area of research by Utah scientists over the years. They have demonstrated that a phosphorus deficiency is a cause of post-parturient hemoglobinuria in dairy cattle in certain areas of Utah. The infectious causes of abortion and sterility, vibriosis in sheep, and trichomoniasis in cattle have been more clearly delineated so that effective preventative measures can be followed. They have shown that vaccination and sanitary management procedures will control vibriosis and that precise diagnosis and the use of chemotherapy to treat infected bulls will control trichomoniasis.

Increased use of halogenated hydrocarbons and organic phosphorus insecticides has presented serious problems. Painstaking research by Station scientists, in which several departments cooperated, was conducted to measure the amount of residue on sprayed forage, the effect of this residue on consuming animals, and the amount of insecticide going into human food products of animal origin, such as meat, fats, milk, and eggs. Results helped in setting up tolerance levels and in working out safe methods of using these potent compounds.

Fluorosis in farm animals in some of the industrial areas of the state has been studied extensively by Utah Station scientists aided by industrial grants. Results of this research have clarified much confusion as to the amount of ingested fluorine necessary to cause damage and as to the effects of fluorine on cattle. It has also produced more accurate diagnostic methods with a better understanding of the correlation between the amount of fluorine ingested, the length of time ingested, and its effects on the teeth and bones of animals.
Present research is of strongly basic nature although some applied research is also under way. Only a few examples can be cited here. The new animal metabolism building provides the facilities necessary for intensive nutrition investigations. Such studies as the influence of the amount and form of nitrogen provided upon rumen function, the interrelation among nutrients, and stress and its influence upon the physiology of the animal are explored here. Studies of the interrelations among amino acids in poultry diets and of the influence of adding enzymes to rations high in barley are other examples of basic nutrition studies. Studies of efficiency of feed utilization, the replacement value of concentrates in dairy cattle rations, and the value of high quality roughage from pasture and hays for production in dairy cows are also being conducted.

Breeding studies are under way to ascertain more effective tools for improving animals. Methods of developing superior lines of livestock are under test. Line breeding accompanied by selection on the basis of performance in cattle, crossing of breeds in sheep, and the effectiveness of selection for solids-not-fat in the milk of dairy cattle are some of the systems being evaluated. The relative influence of heredity and environment upon tenderness and other quality factors in meat is being explored.

Attention is also being given to animal reproduction. Hormones are being studied in detail. Attempts are made to measure hormone secretion levels more accurately and animal response to hormone stimulation. The causes of early embryonic death in cattle are currently being studied from many angles; infection, hormone imbalance, genetics, and pathology.

Personnel of the Animal Disease and Parasite Branch of the Agriculture Research Service of the U. S. Department of Agriculture located on the campus have been studying the effect of several poisonous plants on animals. Of particular interest are the deforming effects on sheep and cattle embryos when certain plants are fed at specific times early in gestation.

The possibility that a toxic plant substance is the primary cause of bristle disease in cattle is being investigated. Coccidiosis of cattle and ascariasis of sheep are also currently under study.

In poultry, staphylococcosis of turkeys and respiratory diseases of chickens and turkeys are the biggest causes of economic loss. Research on the former disease has led to improved preventative measures and to discovery of an antibiotic effective in treatment of outbreaks. Current research is aimed at a basic understanding of the mechanism of infection of staphylococci, a problem in all animals including man. While there are good vaccines for prevention of Newcastle disease and infectious bronchitis, no adequate control measures are available for mycoplasmosis (chronic respiratory disease of infectious sinusitis). Present emphasis is directed towards learning of interrelations between these disease agents.

Animal research of the future

More efficient, productive, and economical rations for breeding and fattening animals of all species are a certainty for the future. More knowledge of rumen function, interrelations of amino acids, and the other nutrients, that will come from research now under way will give the framework for these advancements.

Superior strains of farm animals, tailor-made for specific environmental situations, are on the way. Animals with faster growth rates, more efficient feed utilization, higher survival rates, and yielding carcasses of high quality meat with little excess fat will become available. Breeding methods now under study will give the tools to make these possible.

Reproductive levels will be raised. More effective disease control, improved rations, and management practices will make this possible. The use of valuable sires may be extended to enable production of offspring 15 to 20 years after the death of the sire through improved methods of semen preservation and artificial insemination. Transplanting of ova may become a practical reality. Synchronization of estrus with the resultant regulation of conception on a herd or group basis promises to be available soon for commercial producers.

Hereditary defects will be materially reduced. Basic studies of the gene, the hereditary unit, and of the physiological processes associated with the expression of the gene will be helpful in this. Indeed the animal scientist of the future may be able to synthesize chromosome by chromosome or possibly gene by gene, germ cells of almost perfect heredity.

Eradication of certain diseases, new and better drugs, more solid immunity, and superior management practices are promises for the future that will give greater growth and performance in animals with resultant improved quality and economy of food.

All of these things will be vitally significant against an impending "doomsday," the day when the margin of balance between world population and food production becomes so close that mankind will have extreme difficulty in finding adequate sustenance on this planet. Scientists at the Utah Agricultural Experiment Station will not achieve these developments by themselves, but their efforts will be combined with those of other scientists through the Land Grant System. The challenge exists. Only through research can the problems of today and tomorrow be solved.
Four measures to gauge the

EFFICIENCY

OF FARM ENTERPRISES

The financial success of the farmer is closely tied to size of enterprise, wise use of labor, high rates of production, and feeding efficiency with farm animals.

EARNEST M. MORRISON

WHY does one farmer succeed when another does not? How can a farmer measure his efficiency and his chances of success? For years a major effort has been made by members of the staff of the Department of Agricultural Economics to conduct studies to determine measure of efficiency on major farm enterprises.

The production activities we have noted have been many but only a few can be presented here. Those selected for presentation are: (1) size of enterprise, (2) labor use, (3) rates of production, and (4) feeding efficiency. The conclusions presented come from our research with both crop and livestock enterprises.

How large a business

Size of enterprise is generally associated with efficiency in use of factors of production. Up to a point, larger enterprises allow for efficiencies that reflect in lower cost per unit. It is possible to have enterprises that are too large or too small for most economical operation. However, on diversified farms in Utah, the problem generally seems to be that individual enterprises are too small for most economical operation.

Most economies of size operate through reduced cost per unit. Labor, power, and machinery, and overhead inputs generally can be used more effectively because certain minimums must be had regardless of the total product. When the minimum level can be exceeded to where fuller use of the resources results, cost per unit of product will decrease, and the net return per unit will increase.

The objectives of the operator are the governing influence in size determination. If an enterprise is operated as a major source of income, then the operator should give careful consideration to the economies that are associated with size. In most all cases, the enterprises are operated as only part of the total farm activities but if a minimum economic size cannot be attained in all enterprises then consideration should be given to reducing the number.

Labor efficiency

The labor input in agricultural production is an important item of cost and especially for the more intensive labor-using enterprises that are associated with diversified irrigated farm operations in Utah. For this reason, good labor efficiency increases financial success in all areas and under all kinds of economic conditions. In periods of high labor cost levels, efficient use of labor is especially important.

There are no set recommendations that can be made that will apply to all enterprises or be equally useful to all farm operators. There are some general rules, however, that should be helpful to a farmer in checking the strong and weak points of his labor program. We assume that farmers are not interested in spending more time at a particular task than is necessary, or doing a job the "hard way," when the same effort could be more rewarding in other areas.

Some of the more important methods we have found to be useful in improving labor efficiency on farms are as follows: (1) increase the size of unit to where the fixed resources can be more fully used and the advantages of specialization can be had. (2) Make full use of machinery and equipment.
where their use will not cost more than is saved by the greater effectiveness of labor. Be sure to take advantage of small equipment. (3) Improve the farm layout, field arrangements, and building design and arrangement so that operations can be performed with a minimum of wasted time and motion. (4) Carefully plan the operations to be accomplished, make sure that only necessary work is done, time the operation properly. (5) Make sure working conditions, methods of compensation, and attitudes toward work are such to make for efficiency. (6) Study the job carefully, find ways to combine operations, tasks, and motions and carefully train all workers in the best techniques and methods.

Productivity rates

Rates of production refer to the yield per acre of crops and the pounds of product per animal. Good yields are important to financial success because first, all fixed costs are constant regardless of the amount of product obtained. As a result, the costs per unit are lower on farms with high production rates than on those with low. Second, many of the inputs such as fertilizer, water, and seed, can be controlled by the operator and his actions can largely govern the level of yield. A proper level of production then will be one where it is pushed up to the point where the cost of the last application of inputs is just equal to the value of the extra product that results.

Although some of the forces that affect production are entirely outside the control of the farmer, many within his control do exist and are important causes of production levels. Some general considerations that result in improved crop yields include (1) ap-

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Animals lacking a high potential will, of course, perform their best under ideal conditions but even then they may be relatively unprofitable regardless of the quality of other inputs connected with them.

(2) Manage and care for the animals in such a manner that they can be kept healthy, growing, and producing. Poor health or poor care can take away the advantages of a good feed or a potentially good animal.

(3) Feed a good quality, well balanced ration. A ration that appears to have the proper amounts of the right ingredients may give poor results if made from poor quality feeds or han-

Propriate selection of crops for the type of soil available, (2) strict adherence to the use of high quality seed and plants of the right variety for the area, (3) use of the right kind and amount of fertilizer applied at the proper time, (4) adequate seedbed preparation, (5) adequate amounts of water properly timed coupled with adequate drainage, (6) timely planting, cultivating, weeding, and harvesting.

Some general suggestions that result in improved livestock production rates include, (1) starting with good quality stock and using careful selection and breeding practices, (2) feeding balanced rations in proportion to production response, (3) exercising care and proper timing in feeding, (4) providing adequate care and housing, (5) combining feeds best adapted to the product in such a way as to claim all complementary, supplementary, and substitution advantages.

Feeding efficiency

With nearly all livestock enterprises feeding efficiency will have an important bearing on financial success because feed is a major input. Feeding efficiency can be measured by merely calculating the amount of feed consumed per unit of product — the feed conversion ratio — or it may be measured by calculating the cost of feed per unit of product or some quantity of receipts. Measures that reduce the inputs and outputs to dollar and cent figures have the advantage of measuring economic efficiency as well.

Some practical considerations for anyone operating livestock enterprises who desires to attain both physical and economic feeding efficiency are listed:

(1) Maintain the quality of livestock that can potentially make good use of feed. Animals differ individually by breed, by variety, and by strain in their inherent ability to utilize feed. In some types of animal production this would mean a well-planned and directed selection and breeding program. In other types, this would mean careful buying from a source where a well-planned and directed selection and breeding program was in existence.
dled in such a way as to allow the ratio to deteriorate in quality.

(4) Study and know the appropriate rates of substitution of one feed for another. In addition to substituting for each other some feeds actually add to the value of other feeds when fed in combination. The amount of one grain that will replace another grain or even a roughage should be known and substitutions made when an advantage in cost can be obtained.

(5) From study and observation, know the physical response or growth rate that can normally be expected for the kind of livestock being raised. Gains past a certain age or weight are usually obtained only at greater quantities of input. For example, broilers weighting more than three pounds will grow at a slower rate and require more feed than they did up to that weight.

(6) Timing of all feed inputs is important to obtain good and continuous growth rates and hence desirable feeding efficiency. In practice, the value of some operations can be partially, if not entirely, nullified by improper timing of the operation. For example,

if laying hens are not cared for on a rather fixed schedule they can be thrown out of production even though they may be given the best quality of feed and other inputs.

The best production practices for a producer to follow will be those that fit his resources and situation best. Each producer should constantly be alert to alternative practices and find and use the most profitable. He should become convinced of the value of performing all operations at the right time if he desires to make a maximum financial return.

Method

The association between various production practices and financial success has been noted from use of a technique called cross-tabular analysis. By this technique, production records of individual enterprises were sorted into groups classified according to a selected activity and the association with other activities and financial success was noted. This, in effect, holds the influence of the selected activities constant within a class range while the changes in others are measured.

TEST-TUBE VIRUS

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tions based on reliable experimental data of other scientists indicate that the actual virus increase in the 1/4 teaspoon volume in the "chemically fed" tube was 71 billion virus particles.

Later experiments confirm results

Numerous later experiments were conducted with slight variations in conditions but with similar results. It was found that it was not necessary to add virus protein or penicillin to get the virus increase. In most of the subsequent experiments the increase in virus concentration was correlated with the progress of the incubation. At the beginning there would be no measurable difference between the "chemically fed" and the control solutions. After 10 minutes a slight increase could usually be noted in the "fed" tube. This increased more at 20 minutes and reached a maximum at 30 minutes when frequently there were four virus units for every one virus unit in the control tube. The formation of virus appeared to stop at about 30 minutes and the amount of virus in the "chemically fed" tube usually decreased with time after 30 minutes because the newly-formed infectious nucleic acid was inactivated by traces of ribonuclease (a destructive enzyme) which was present.

The formation of radioactive virus from radioactive adenosine triphosphate

Unquestionable proof of the formation of virus in a test tube outside of living cells was obtained when a special radioactive adenosine triphosphate was substituted for the normal chemical. The special ATP carried carbon 14 which gives off radiation that can be detected by a Geiger counter. The virus synthesizing molecules were prepared in the usual manner with virus protein and radioactive ATP being added before dividing the virus-making preparation into two portions. This insured that each tube carried the same amount of radioactive ATP. Nothing more was added to the control tube while magnesium chloride and the three other triphosphate nucleotides were added to the "treated" or "chemically fed" tube. During and after a 30 minute incubation period the virus protein coated the newly formed virus nucleic acid to make nucleoprotein virus rods that could be purified by centrifugation. After purification, the amount of radioactivity in the virus from the tube receiving all the necessary raw materials was almost three times as great as that in the control tube where only one essential raw material was supplied. This proved unequivocally that virus synthesis had occurred in the test tube. The purification procedures used selected only nucleoprotein virus while eliminating small molecules such as ATP.

Evidence that virus formation can proceed for an indefinite time in a test tube

It was found that the same virus-forming system could be activated repeatedly to produce new virus by merely supplying new raw materials and removing the newly synthesized virus. In many previous experiments we had observed that the synthesis stopped after 30 minutes of incubation. In this experiment we used the centrifuge to
separate the virus-forming molecules from the newly manufactured virus. The virus-forming molecules were then resuspended in a fresh solution of raw material chemicals and incubated for a second 30 minute period. The same procedure was used to recover the virus-forming molecules and to give them a third incubation. Data obtained from counts of infectivity and also from counts of radioactivity indicated that the efficiency of the system in making new virus was almost the same for the third "batch" of synthesized virus as for the first. This seemed to indicate that the virus-forming mechanism would work indefinitely and suggested to us that we could make a continuous flow apparatus containing the virus-making molecules which would deliver newly synthesized virus at an outlet while being fed with the chemical raw materials at an inlet. We are now building such an apparatus.

The significance of our virus synthesizing research

We have shown for the first time that virus synthesis can take place away from a living cell. This is a fact of tremendous importance for it means that the actual biochemistry of the virus formation process can be studied without all of the complications of the other cellular processes. Within a few short years the biochemistry of virus formation will be well understood. With this new knowledge man will then be able to devise new control methods which will stop virus multiplication without interfering with other cell physiology. Our work should open entirely new vistas in virology and medicine bringing us ever closer to an understanding of the nature of life itself.

ABORTION IN SHEEP

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ising and straight avenue towards effective prevention of vibriosis in sheep.

Vaccination against infection with the virus of enzootic abortion of ewes is practiced in several European countries. It will be necessary to study the immune mechanism in this disease in more detail since the few vaccination trials in this country have been disappointing. We need to find a procedure for prevention under the conditions which exist here.

**How can sheepmen control abortions?**

There are means to help reduce the hazards of infection. General sanitary precautions are recommended during lambing season. The aborted fetuses and their placentas should be removed immediately from the flock and buried. Ewes that abort should be segregated as long as they have vaginal discharge. The feed and water supply of pregnant ewes should be kept free of infectious material. Sheep from *Vibrio fetus* and virus-infected flocks should not be sold for breeding purposes to other herds since latently infected animals cannot be detected. It is also not advisable to introduce animals from herds free of such infections into flocks where vibriosis or virus abortion is enzootic. A most effective control is a self-contained flock with only a minimum of necessary replacements from outside herds.

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**research reports**

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**Loafing stalls for dairy cows**

**INDIVIDUAL** loafing stalls in open type shed housing for dairy animals have been successful in keeping cows clean and reducing the amount of bedding required to maintain the shed when compared with conventional open shed housing.

In an experiment conducted from March 1 to April 15, 1962, at Snow Field Station, it required about 80 percent less bedding to maintain a shed with individual stalls for cows compared to the conventional open type shed with built-up manure pack. In Utah where the supply of bedding is limited and expensive, this will amount to a substantial savings to the dairyman. Not only did it require less bedding, but the cows housed in the individual stalls were freer from dirt and manure.

Most cows adjust readily to the change from conventional housing to loose stall type housing in cold weather. In this experiment, it was necessary to "train" two cows out of fourteen to lie in the stall. The training consisted of tying the animals in the stall for one night. No more problems were encountered with these animals during cold weather. As warmer weather approached, there appeared to be a tendency for the animals to lie in the corral rather than in the stalls. These problems will be studied further on a drylot operation during 1963.

—Donald C. Dobson

**Germination of seed barley and wheat reduced by seed treatment**

Low germination tests of treated certified seed barley samples which failed to meet certification standards for blue tag quality seed led to a study to determine the effect of seed treatment on the germination of seed grains.

Samples of seed barley cleaned and treated following harvest in 1961 were submitted to the State Seed Laboratory the last part of December for germination and purity analysis. All samples were low in germination. The seed was bright, plump, and of high quality except for germination, and there was no visible evidence of damage to cause a reduction in germination. Germination tests of three samples drawn in February from the balance of the uncleaned seed stored at the farm were uniform and averaged 91.58 percent.

This suggested the possibility of injury to the seed through germicidal treatment. The untreated seed stored at the farm was later sampled following treatment. It averaged 87.83 percent
storage period of the treated grain or even distribution of the chemical was not applied uniformly to some lots of seed barley and wheat seed that has a germination near the minimum standards for blue or red tag seed. Seed germinating 86 percent before treatment would qualify as certified blue tag seed, but if the germination were reduced 3 percent following treatment, the same seed would qualify only as red tag seed. Likewise, seed germinating 80 to 82 percent before treatment and less than 80 percent after would not qualify as red tag quality and could not be marketed as certified seed.

There was some indication that the chemical was not applied uniformly to some lots of seed barley low in germination and the treatment may have exceeded the recommended dosage. The seed analyst did observe seedling injury attributable to seed treatment. Either excessive chemical or the long storage period of the treated grain or a combination of the two could account for the low germination; and the uneven distribution of the chemical may explain the variation in germination of samples drawn.

Phytotoxicity is known to be one of the hazards of treating seed grain with mercury compounds. Experimental tests in the Pacific Northwest indicate that three mercurials tested on wheat were relatively safe when used at the recommended rates. However, at higher rates, these chemicals were phytotoxic. The degree of phytotoxicity increased with increased rate of application and the mercury preparations exhibited varying degrees of phytotoxicity at rates above one ounce per bushel.

In addition to rate of application of the mercurial, the germination of grain is affected by its moisture content and the length of storage after treatment. The Illinois Agricultural Experimental Station and the Field Crops Research Branch, Agricultural Research Service, USDA in summarizing experimental results in treating oat and wheat seed stated that damage to germination by volatile mercury compounds was increased with an increase in dosage, time, and moisture. The germination of seed wheat treated with Ceresan M at the ½ ounce rate (recommended rate for barley, oats, and wheat) was reduced 3.7 and 3.6 percent, when stored under two simulated commercial storage conditions for 150 days. There was no significant reduction in germination when the Ceresan M was used at the ¼ ounce rate, but the germination was greatly reduced, 13 and 13.7 percent, at the one ounce rate. The authors concluded that if lightly infected or nearly disease-free seed is treated and stored two or more weeks before planting, Ceresan M should be applied at half the standard rate to obtain maximum yields. The germination of wheat was significantly reduced by several volatile fungicides used at the recommended dosage when stored 10 months in closed jars at room temperature. Other research workers reported that Ceresan M markedly decreased both the normal and total germination of wheat when stored 30 days in closed bottles at room temperature. This same treatment had little effect on barley and apparently none on oats.

The organic mercurials are the predominant chemicals used for treating small gains due to their high seed disinfecting efficiency, however these disinfectants can be injurious to seed grain. Proper dosage is important and the recommendation of the manufacturer should be followed closely. These data are not presented to discourage seed treatment, but rather to emphasize the importance of using caution in applying chemicals to seed grain and avoid storing treated seed for extended periods of time.

—Golden L. Stoker

Progress against insecticide-resistant insects

Chemicals that overcome resistance of houseflies and mosquitoes to malathion have been found. In laboratory experiments these insects were killed when treated with malathion combined with a synergist (a nontoxic chemical that boosts or restores toxicity to an insecticide).
Research has been finding out how organophosphate insecticides such as malathion and parathion kill insects, how insects develop resistance to these insecticides, and how to overcome such resistance. To date the research has shown that: 1) Organophosphate insecticides are toxic to susceptible insects because they inhibit the activity of a vital enzyme, ali-esterase. 2) Resistant insects detoxify these insecticides more rapidly than susceptible insects. There is less ali-esterase in the resistant insects. And ali-esterase is changed to a new enzyme enabling the detoxification.

Several materials were tested in combination with malathion in an effort to block the insect's ability to resist the insecticide. These materials, derivatives of phosphoric acid, inhibited the ali-esterase enzyme. Three of the most effective synergists tested were tri-phenyl phosphate, and tributyl phosphorotrithioate. These compounds are in the same chemical family as malathion but are not effective insecticides by themselves. These synergists greatly reduced or completely overcame the resistance of adult houseflies and mosquito larvae.

The exact process by which synergists work is still not fully understood. The most logical explanation is that they inhibit the ability of insects to degrade malathion by the cleavage of chemical bonds. A better understanding of the mode of action of insecticides and how resistance develops in insects may lead to more effective materials or combinations of them for controlling resistant as well as non-resistant insects.

Source of lamb flavors

Lamb meat gets its characteristic flavor from the fat, probably from minor constituents called carbonyls, according to a USDA study. This is also true of both beef and pork. The lean contributes a flavor that is apparently common to all meats. Continuing research to isolate and identify these flavor components may point the way to methods of enhancing or modifying the taste of lamb to increase its acceptance by many consumers.

Since the full flavor of meat develops only through cooking, the chemists must identify both the chemical constituents of the aroma produced by heat and the precursors of these constituents in the raw meat.

Cooked patties made from ground lamb with all the fat removed had only the general taste of meat—not the characteristic lamb flavor. Chemists then trapped the aromas produced by heating rendered lamb fat and obtained a substance with a strong mutton odor. When the substance was treated with a chemical to remove the carbonyls, the mutton aroma was reduced.

State lands

The Utah State Land Board administered about 3 million acres in 1960. Of this, approximately 600,000 acres were not leased for grazing. The 2.4 million acres leased returned about $113,000. Research by Utah Station economists indicates that, if state land were sold for an average of $4.25 an acre and the proceeds invested at 4 percent, returns to the Board would be four times greater than those realized from grazing leases. Taxes, after total transfer to the tax roles, would more than equal returns from grazing leases.

—N. Keith Roberts

Grazing desert plants

Studies at the Utah Station show that desert plants that normally tolerate defoliation to the extent of 50 percent during the winter months lose vigor in the spring even when grazed lightly (25 percent).

—C. Wayne Cook

Control of western x in sweet cherries

Studies of control of western x-disease virus in sweet cherries by removal of diseased trees, as identified by leaf and fruit symptoms, indicate control by this means may not be possible. Natural spread of the virus continues to be slow between cherry orchards, but is rapid within orchards. Infected trees cannot be recognized early enough after infection that removal will prevent natural spread.

For example, the 1962 inspection showed that in an orchard where 3 trees were found with leaf symptoms in May 1961, 100 more had wilted and died during the previous July and August. Because of the large number of wilting trees, drought was suspected as a possible cause of wilt. In 1962 more than 200 diseased trees were found with leaf symptoms with an additional 200 or more showing wilt and decline. Trees were on both mazzard and mahaleb stocks. This orchard is only ¼ mile from another orchard that has been eliminated since 1956 with all of the remaining trees infected in 1961.

—Bryce N. Wadley

These, then, are some of the lessons we have learned in a century of agricultural evolution related to science and its application:

That organized research can be a major force in the advancement of society;
That basic studies undergird applications;
That organized communication channels can speed the applications of research;
And that freedom is essential to productive research.

Of these five, the last is most important. Give us freedom to inquire, and the answers will be found.

—C. A. Elvehjem
CONTRIBUTIONS TO RESEARCH
May 1 to August 1, 1962

National Institutes of Health
$180,624 for the training of students in basic and biochemical genetics
$34,896 for infiltration studies of unsteady open-channel fluid flow
$23,538 for induction and analysis of eye mutations in drosophila
$10,300 for a study of protoplasmic influence on ion distribution
$5,898 for experimental study of tissue eosinophil transformation

National Institutes of Health
$250,000 for constructing and equipping a new research laboratory

National Science Foundation
$20,600 for research on communication signals in birds

Atomic Energy Commission
$10,000 to continue the study of lime-induced chlorosis through the use of radioisotopes
$5,697 for a study of the effects of x-irradiation on the embryos of invertebrate animals

U. S. Steel Corporation
$12,100 for study of fluorosis in plants and animals

$3,500 for research on the effect of irrigation, cultural practices, and nitrogen sources on distribution of nitrate nitrogen in the soil and the yield and sucrose content of sugar beets

Utah Power and Light Company
$10,050 for farm electrification studies
Telluride Power Company
$725
California Research Corporation
$7,000 for study of the use of petroleum mulches in vegetable crop production
Stanford Research Foundation
$3,570 for a study of the function of molybdenum in biological systems
Boswell Foundation
$1,200 for wheat improvement
Ogden Grain Exchange
$470 for study of the effects of insecticides on pollinating insects
Union Carbide Company
$400 for a study of miscellaneous insects

Dow Chemical
2720 pounds of mixed fertilizer for agronomic tests

FARM AND HOME SCIENCE