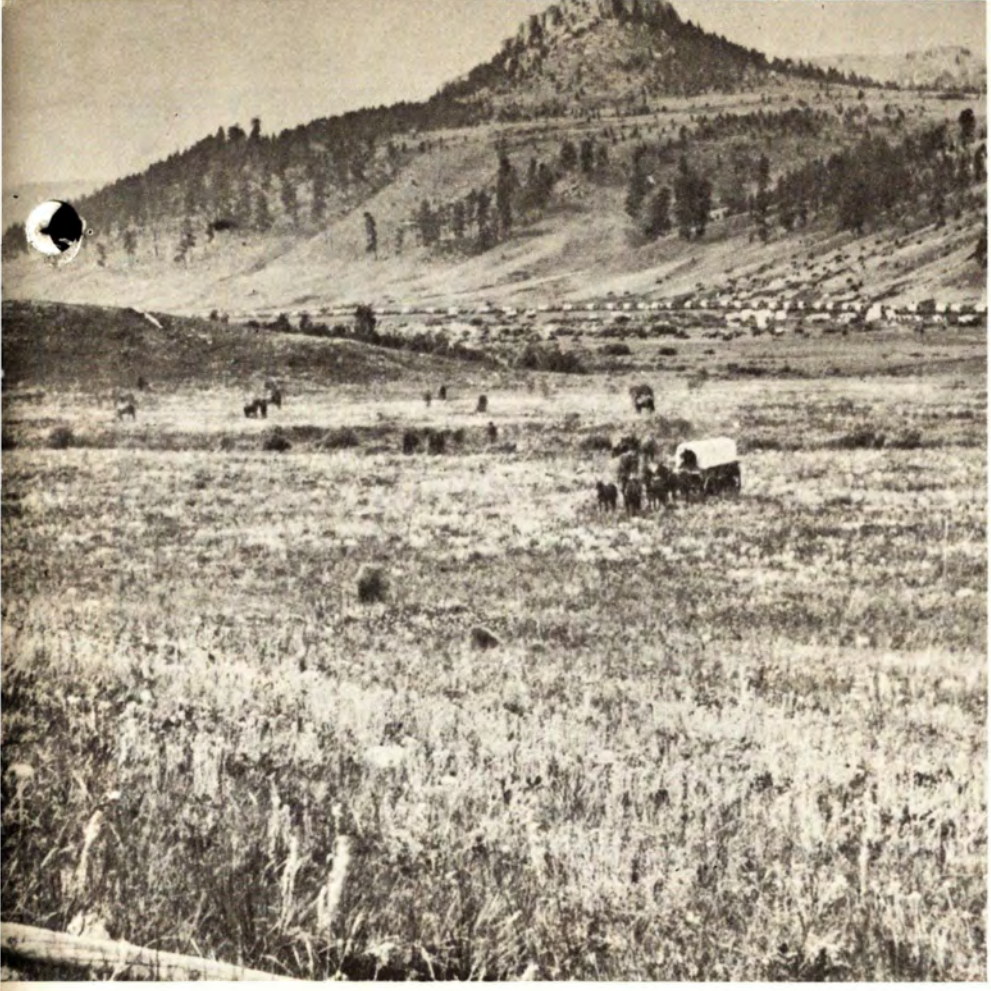
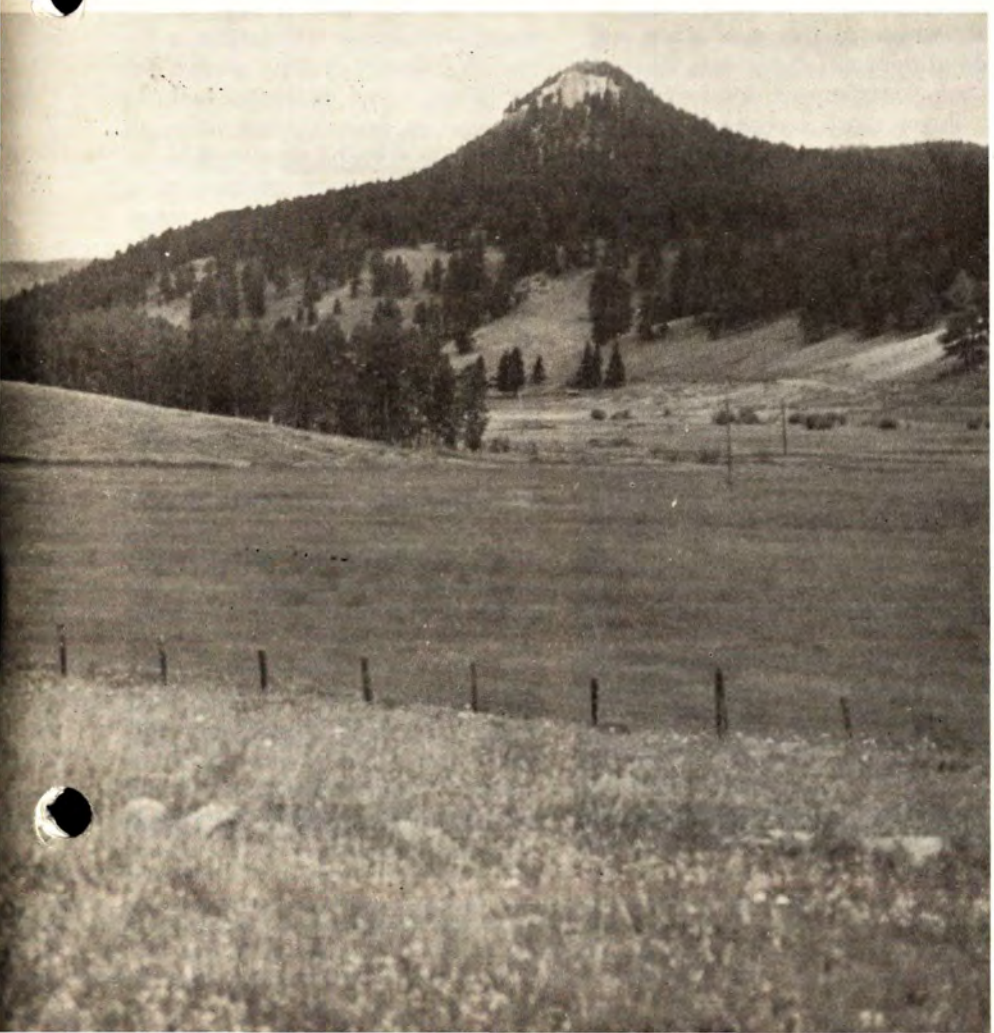
Fall 1971

South Dakota Farm & Home Research: 84th Annual Report

Agricultural Experiment Station, South Dakota State University





South Dakota Farm & Home RESEARCH

Vol. XXII • Fall 1971 • No. 4

1874

Photos taken nearly a century apart show the spread of Black Hills forests (see pages 50-51)

1971

84th
ANNUAL REPORT

Agricultural Experiment Station
South Dakota State University
Brookings

A New Life for the Old Mason Jar

Duane Acker

THAT old home canning standby, the screwtop Mason jar, has found a place in agricultural research at South Dakota State University.

Scientists searching for more effective nitrogen fixing strains of bacteria on legumes in South Dakota soils have found that Mason jars are suitable for testing legume inoculations. They are not *better* than special pyrex laboratory beakers ordinarily used for such research. But they do the job about as well and, what is more important in these times, the Mason jars cost much less.

And therein lies a story of how little things mount up as the Agricultural Experiment Station attempts to get as much as possible out of the South Dakota agricultural research dollar. The agricultural research "business," as any other farm or city business, is caught in the "cost - price" squeeze. Costs have gone up about 35% from 1965-66 through 1970-71, yet income to the Station—in this case state and federal appropriations—has increased only 23%! Competition for faculty has been most severe the past 5 years and so faculty salaries nationwide have risen rapidly—this is our main cost. Laboratory equipment costs have skyrocketed. Even postage rates and utility bills have increased sharply.

By itself, the use of a comparatively few Mason jars in place of pyrex beakers isn't a big savings item in research costs. Neither is the use of ordinary baking dishes for antibiotic assays going to make a big dent in overall costs although they are purchased at a local hardware store at a tenth of the cost of normally-used laboratory pyrex equipment.

Home-made Growth Chamber

An unused section of a heat conducting facility was converted into a home-made growth chamber to provide constant warm temperatures for plants used in nitrogen fixation research. The chamber does the intended job very well in this instance where critical, exacting temperatures and a cooling environment are not necessary. The $25 outlay for materials to construct this growth chamber is mighty small when you consider that commercial equipment to replace it would cost several thousand dollars.

Some of our research personnel are becoming experts at locating

items of U. S. government surplus equipment, often available for payment of no more than shipping charges. These scientists, on their own, keep informed about what is available and how it might be used in their experiments. At least one graduate student got some unanticipated extra training in connection with his studies: he became a carpenter and built a facility for pheasant research with used lumber from an old farmhouse that was being demolished.

Ideas from Staff and Students

These examples—and there are many more—of grassroots savings in departmental laboratory equipment costs illustrate another important factor when it comes to the cost-price squeeze: virtually all of the ideas come from staff members and graduate students who have a genuine concern for getting the research job done well at a minimum of cost. These substitutions, alterations in equipment, and other methods of saving money cannot be applied all the time. There is a limit in cutting corners beyond which diminishing returns result from lack of suitable equipment or inefficient procedures.

In other areas we have reduced number of research projects and project leaders to help meet a decreasing purchasing power, estimated now at only 80% of what it was 5 years ago. Number of senior scientists has been reduced from 88 to 76. Although certain commodity groups have resisted, we have closed out some lower-priority projects and research locations. To increase the productivity of higher-priority projects, money saved from senior scientist positions has been used to add support personnel, technicians and labor.

We have made effective use of the Station statistician in designing research to get the maximum information from the minimum number of animals, plots, acres, or pens. Statistics, an applied branch of mathematics, shows us rather precisely the number of experimental units we need in order to find or demonstrate a difference in performance among experimental treatments with a prescribed level of confidence. The key is carefully pre-planned research that will give answers to South Dakota problems. Computers help by increasing accuracy and speed.

Use Federal Funds, Too

We have actively sought funds from federal agencies to help finance research deemed important to South Dakota but that could not be financed with state and federal appropriations to the experiment station. In fiscal 1970, for example, we had $120,000 in special federal grants and contracts for our research program—in fiscal 1971 we had $201,000.

We have tried to lower administrative expense. In 1967 we combined the Departments of Poultry Science and Animal Science into a single department. In 1969 we combined the Departments of Agronomy and Plant Pathology into a Department of Plant Science. We've organized a central Motor Pool, including extension, research, and the college instructional program, to make most efficient use and maintenance of vehicles. We've "automated" where possible to hold down labor costs. One example is a magnetic tape typewriter system that reduces time and effort formerly expended in proofing, editing, correcting and retyping manuscripts and reports. Output of this typewriter can also be adapted directly to reduce cost of publications.

We are proud of the contributions our Station staff members are making to the economic and human growth of South Dakota. The missions of the Station are clear and the priorities for research are evident.□

contents . . .

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To simplify terminology, trade names of products or equipment are sometimes used. No endorsements of specific products or equipment named is intended, nor is criticism implied of those not mentioned.

84th ANNUAL REPORT

Vol. XXII • Fall 1971 • No. 4

Duane Acker,
Dean, College of Agriculture and Biological Sciences, and Director, Agricultural Experiment Station.

A. L. Musson,
Associate Director, Agricultural Experiment Station.

Edited by: Frank J. Shideler, Editorial Office, South Dakota State University, Brookings, S. D. 57006

South Dakota Farm & Home RESEARCH

SERVING THE PEOPLE OF SOUTH DAKOTA THROUGH TEACHING, RESEARCH, EXTENSION

Close confinement (left) and open-front, pole-type building (right) used in research at Ellis, S. D.

Engineering and the
Production Environment

Few places in the world and none in the United States have climates that are continuously favorable for the most efficient and economical livestock production.

This situation points to the need for climate modification—often called "environmental control"—if livestock producers are to realize the genetic potential of the animals they raise. The Agricultural Engineering Department of the Agricultural Experiment Station for the past few years has been researching various phases of environmental control or controlled environment that have to do with buildings for housing livestock. Much of this research is in cooperation with farmer organizations and business firms.

Complex factors that determine just how much, or how little, climate modification is necessary for a given situation include:

- climate of the area,
- ambient or closely-surrounding temperature,
- humidity and wind velocity preferred by the animal,
- amount of readily available building materials,
- available labor force,
- economic conditions, and
- management ability of the farmer.

For current research subjects other than those on controlled environment housing, see List of Agricultural Engineering Department projects at the end of this section.

The final decision on amount of climate control must be a compromise that considers and welds the above factors into an economically feasible unit for a particular set of conditions on an individual farm. The agricultural engineer and the livestock producer are both looking for the same end result: maximum output per unit dollar invested. While this end result tends to define the problem, it also sets certain restrictions—one example being on design flexibility.

BEEF CATTLE ENVIRONMENT

Pole-type vs. Closed Confinement Buildings

Beef cattle production, the largest single source of agricultural income in South Dakota, might reach even higher levels if ways could be found to blunt effects of summer and winter climate extremes.

Controlled environment units for confined production of feeder cattle have been developed and are being adopted by producers. However, not too much is known about beef animal response to either cold or warm confinement environments. One SDSU research project has compared the environmental conditions of temperature and relative humidity and the performance of beef cattle finished in an open-front pole-type building vs. a closed confinement (warm) building.

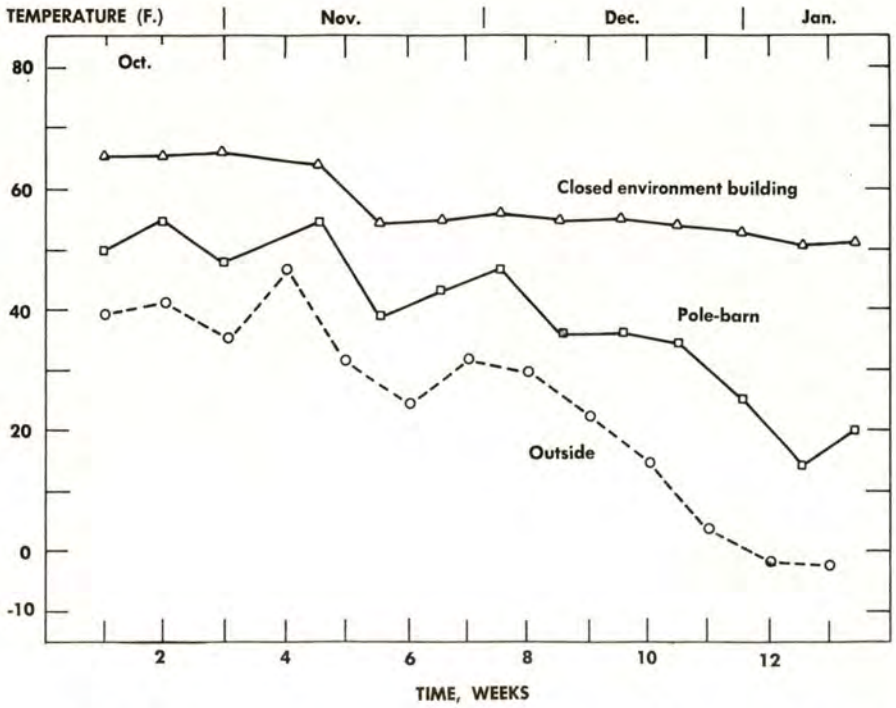
Average daily gain of the animals in the pole-type building was 3.02 pounds while average weekly temperature in the unit averaged 18 degrees warmer than outside temperature which ranged from 47 degrees in October to -3 degrees in January (all temperatures cited here are in Fahrenheit). Average daily gain for the animals fed in the closed confinement building was 2.92 pounds. Average weekly temperature in this building was 33 degrees higher than outside temperature or 15 degrees warmer than pole-barn temperature. Feed conversions for the pole-barn was 8.01 pounds of feed per pound gain and for the closed confinement building it was 8.00 pounds. In this case no significant differences in gain or feed conversion could be attributed to environment.

Evaluation of animal response from April through August revealed that average daily gain was significantly better, while feed conversion was significantly less for animals in the pole-barn area:

	Av. daily gain	Feed conversion
Pole-barn	2.46	2.36
Closed confinement	8.07	7.34

Analysis of environmental conditions showed temperature in the closed environment averaged 9.6 degrees above outside temperature and 5.3 degrees higher than pole-barn temperature. Relative humidity in the pole-barn area slightly exceeded relative humidity in the closed building.

During warm weather operation of the closed confinement area, temperatures at animal level often exceeded temperatures near the ceiling with little ventilation air circulating at animal level. An investigation revealed that ventilation rates provided an adequate amount of moving air. Evaluations of air distribution showed that the summer inlets along the north and south eaves were deflecting the air towards the ceiling and little if any ventilation air reached animal level. Good distribution of winter ventilation air, introduced through a baffled ceiling inlet was observed. To correct the summer ventilation pattern the inlet system was revised to allow both summer and winter ventilation air to be introduced through the center ceiling duct. This system was designed to introduce winter ventilation air into the attic under the south eave and down through the center inlet. This makes maximum use of the effect of solar tempering. Introducing summer air into the attic under the north eave minimizes solar tempering. This system greatly improved summer ventilation and actually reduced environmental temperature in the building as compared with the former system because of increased amount of moisture being evaporated from the slotted floor, pits, waterers, and animals. This ventilation system appears to improve the environment for the animal during periods of high temperature.



Dry bulb temperature in the closed environment, the Pole Barn and Outside, Period 1.

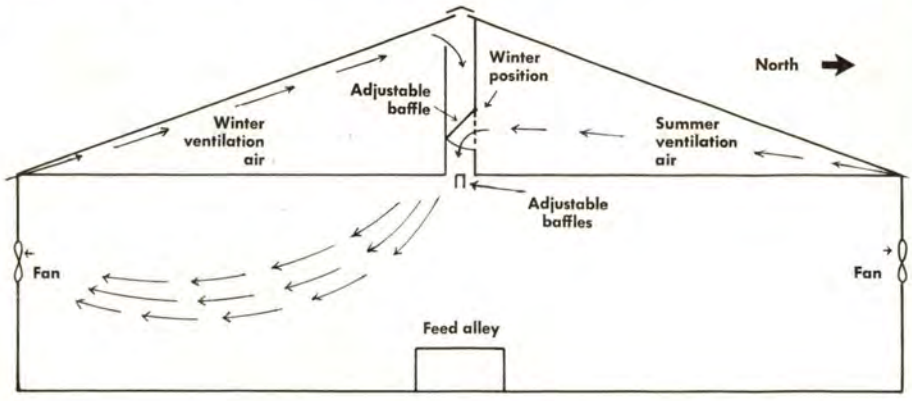
Evaluations of the environmental conditions and the performance of the beef cattle is being continued through additional seasons.

Heat and Moisture Production

Proper design of heating and ventilation systems for a confinement livestock building depends on more precise information on heat and moisture production by the animals. This information is avail-

Paul Remmele, graduate student of Echo, Minn., inspects summer and winter ventilation inlet with adjustable baffles used in a new design of closed environment housing.

Redesigned ventilation system with air flow patterns observed during summer operation indicated.



Drybulb dew point temperature monitoring equipment is used to sense ventilation inlet conditions by Martin L. Hellickson, graduate student of Medora, N. D. Note recording equipment at left.

able for swine, poultry, and dairy cattle but not for a finishing beef confinement building. Information of this type is sought in an experiment in which a total of 480 heat and moisture production observations have been made using drybulb and dew point temperature monitoring and recording equipment. These observations represent heat and moisture production data from animals ranging in weight from 680-770 pounds and at several environmental temperatures.

Additional tests are planned to determine the effect of ventilation rate and of environmental temperature on heat and moisture production.

Effect of Ridge Vent Design

Maintaining a dry environment in an open front pole-type livestock building during extremely cold weather depends on adequate ventilation to remove moisture from the building as rapidly as it is produced. This type of building traditionally has an opening at the ridge (ridge vent) to allow passage of ventilation air. This air movement is caused by the pressure differences of wind forces outside the building and the buoyancy forces acting on heated air given off by the animals within the building.

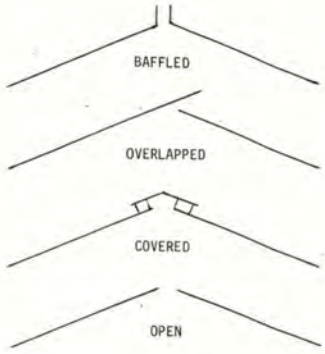
A 1-to-20 scale model of a pole-barn designed to house 200 head of beef cattle is being used in evaluations of differences in ventilation characteristics of four commonly employed ridge vents. Equations developed from the model study will be used to predict the ventilation characteristics of full sized buildings.

SWINE ENVIRONMENT

Heat Pump for Environmental Control

Sow mortality and poor litter performance are often attributed to heat stress during farrowing and lactation. Since cost of cooling an entire swine building in most cases is prohibitive, a system of partial environmental modification is being studied. A heat pump is a basic component of the system.

Ivar R. Dybwad, graduate student from Norway, demonstrates removable ridge vents he used on a scale model building to study ventilation design. Types of vents used illustrated below.



The system was designed for the heat pump to discharge cooled air to the vicinity of the sow's head in the free stall during warm weather. During cold weather, the heat pump is reversed to discharge heated air into the entire farrowing building. Supplemental electric resistance heaters were provided for use during winter operation.

Three flow rates of conditioned air into 15 free stalls were monitored from mid-July to early September, 1970. During this period outside temperature averaged 73.3 degrees, approximately 2 degrees warmer than normal, farrowing barn temperature averaged 73.5 degrees, and the temperature of the air delivered by the heat pump averaged 58.7 degrees. The "conditioned air" in the stalls showed an average difference of less than 2 degrees. However, the *swine effective temperature* (an often-used research measurement based on swine respiration rate) was found to be 16.5 degrees cooler for sows in stalls with highest conditioned air flow rates as compared to sows receiving no cooled air. Sows were observed to show a preference for stalls furnished the highest conditioned air rate.

Average daily gain rates of piglets in cooled stalls was slightly higher, although gains were not statistically significant. However, based on the trend, indications are that economic return from the increased piglet weight gain would amount to more than 90% of the operating cost plus the annual recovery cost of the heat pump. This assumes two farrowings a summer. Not included are factors dealing with prevention of pig mortality that can often occur during extreme summer heat.

The heat pump maintained environmental conditions very well during winter operation although it was more costly than conventional heating systems. However, a portion of this cost is attributed to the necessity of meeting research objectives.

Additional research will study a redesigned winter heating system, still using the heat pump, and to evaluate the heat pump system for spring and fall operation.

Heat pump mounted outside farrowing house for summer cooling and winter warming.

OTHER "ENVIRONMENTS"

Tractor Cab

SDSU ag engineers are going into the tractor cab to study environmental factors there that may affect the performance and comfort of operators. The experimental set-up consists of a tractor cab with air conditioning, ventilation and heating equipment. Air distribution, temperature differentials, pressurization and other factors are being measured in this new research.

Growing-Degree Days for Corn

A new system of rating hybrid corn in terms of "growing-degree days" instead of "days to maturity" recognizes that temperatures make a difference in the corn growth period. Corn starts growing at 50 degrees (F.) and growth is retarded at temperatures above 86 degrees. Climatological information was provided for a new fact sheet to provide South Dakota corn growers with growing-degree days information.

Irrigation, Drainage and Environment

If, or when, irrigation arrives on a large scale in northeastern South Dakota it is going to mean considerable change in environment. Engineering and design are key factors in an irrigation system.

Field studies by the Agricultural Experiment Station have concerned the movement of water through soils under irrigated and drained conditions at the James Valley Research and Extension Center near Redfield. The Center is within the boundaries of the proposed Oahe Unit irrigation project.

Drainage of Oahe Unit lands is a requirement for project success on a long-term basis. Drainage properties of soils must be evaluated prior to drain system design and construction as current project plans require completed drainage systems before application of Oahe water.

Along with drainage studies, various materials and methods are being investigated in efforts to reduce costs. Examples of materials being studied include plastic and concrete drainage pipe along with gravel and glass fiber drain envelope materials.

More knowledge is being sought about drainage system design to control water table elevations and subsequent salt accumulation in the soil profile. Water quality analysis is another phase of the research.

Feedlot Runoff Research

Initial feedlot runoff research was conducted under a project of the Water Resources Institute with Agricultural Engineering Department and Civil Engineering Department as main cooperators.

Previous research has determined the pollution potential of runoff from feedlots by measurement and testing (chemical analysis) of the runoff from several production feedlots. Current additional efforts will evaluate proposed methods of control and treatment. Evaluation will be made of the degree of control and treatment, of the livestock performance, and of the economic considerations to the livestock feeder.

Findings indicate that average losses contained in runoff from feedlots with no control measures are much less than were previously estimated. About 30% of the total pollution potential is associated with snowmelt runoff. Half of the potential is associated with small rainfall events which do not produce runoff from adjacent agricultural land. Control methods known today can economically reduce the pollution potential from feedlots to less than 2% of the total animal excreta.

Anhydrous Ammonia on Grasslands

One of the major deficient nutrients in grassland is nitrogen which is most commonly applied on sod with ammonium nitrate in granular form. Anhydrous ammonia costs almost half as much per unit of nitrogen as granular fertilizer—but it requires injection into the soil. Unsatisfactory equipment and high power requirements of existing applicators are major reasons for the limited use of anhydrous ammonia on grassland.

SDSU ag engineers are designing new equipment for applying anhydrous ammonia to grassland which could make use of the lower cost source of nitrogen. Two new-type applicator knives have been developed and power requirements determined for making economic comparisons of the two nitrogen sources. Fertilized grassland plots at the Pasture Research Center showed no significant yield differences the first year between the two types of nitrogen.

Pasture Interseeding Equipment

More than 800 acres of grassland were interseeded in southeastern South Dakota during development of an experimental machine de-

Vincent Alsaker, graduate student of Rosholt, S.D., demonstrates experimental equipment for applying anhydrous ammonia to grassland. A depth gauge wheel (left) is behind knife through which application is made. A force transducer assembly (center, right) measures draft force required to pull equipment.

signed to interseed legumes and grasses in established grasslands to improve quality and production where other renovation practices may fail. Results were considered favorable by landowners and researchers alike as production was increased without seriously disturbing existing sod while establishing new legumes and grasses.

In a once-over operation the machine cuts a slice of sod and soil which is displaced to the side of the cut furrow. Then a double disk opener with covering chain operates in the furrow to place and cover seed. When the machine operates on the contour, furrows and displaced slices of sod help conserve moisture and minimize erosion.□

SPECIAL SERVICES

Water Quality Laboratory

Within the past year the Water Quality Laboratory, in the Agricultural Engineering Building, has analyzed about 740 samples submitted from throughout the state, cooperating researchers in other departments, and samples associated with research projects of the Water Resources Institute.

The laboratory doesn't analyze water for human consumption, but has processed water samples intended for many other uses. About one fourth of the samples were submitted by private individuals interested in determining the suitability of water for irrigation, livestock, gardening and general household use. The remainder were samples associated with research projects.

Soil samples tested were to determine the effects of irrigation water quality on the rate of salt and alkali accumulation and should not be confused with samples tested by the soils laboratory for fertilizer recommendations.

Additional information on submitting samples for analysis can be obtained by writing to: Water Quality Laboratory, South Dakota State University, Brookings, South Dakota, 57006.

LIST OF PROJECTS

AGRICULTURAL ENGINEERING

S-291 Weather Information for Agriculture. (W. F. Lytle)

S-339 Effect of the Climate and Micro-climate of South Dakota on Agriculture. (W. F. Lytle)

S-395 Farm Feed Handling Center. (H. H. DeLong)

S-474 Livestock, Poultry, and Human Environmental Studies. (M. Hellickson and H. G. Young)

S-483 Farmstead Electric Power Use and Safety. (M. Hellickson and H. H. DeLong)

S-536 Applying and Developing Principles and Methods for Application of Anhydrous Ammonia. (P. Turnquist and C. Johnson)

S-562 Drainage Investigations of an Oahe Unit Soil. (D. W. DeBoer and J. L. Wiersma)

S-563 Development of a Saline-Water Balance Mathematical Model. (D. W. DeBoer and S. T. Chu)

S-564 Principles and Prototype Components for Greater Comfort and Efficiency of Tractor Operators. (P. K. Turnquist and C. E. Johnson)

S-565 Climtaic Resources of the North Central Region. (W. F. Lytle)

S-977 Agricultural Engineering Research Farm. (J. L. Wiersma)

PROJECTS COOPERATIVE WITH WATER RESOURCES INSTITUTE:

WRI-A-017-SDAK Evaluation and Functional Operation of Irrigation Systems. (Delvin D. Brosz)

WRI-A-020-SDAK Significance of Rainfall in Salt and Sodium Accumulations Under Irrigation. (John M. Madden).

WRI-A-023-SDAK Investigation of Time Parameter of Watersheds. (Shu Tung Chu and William Lytle)

WRI-A-025-SDAK Pollution Potential of Runoff from Livestock Feeding Operations. (John R. Andersen, James Dornbush, and John Madden)

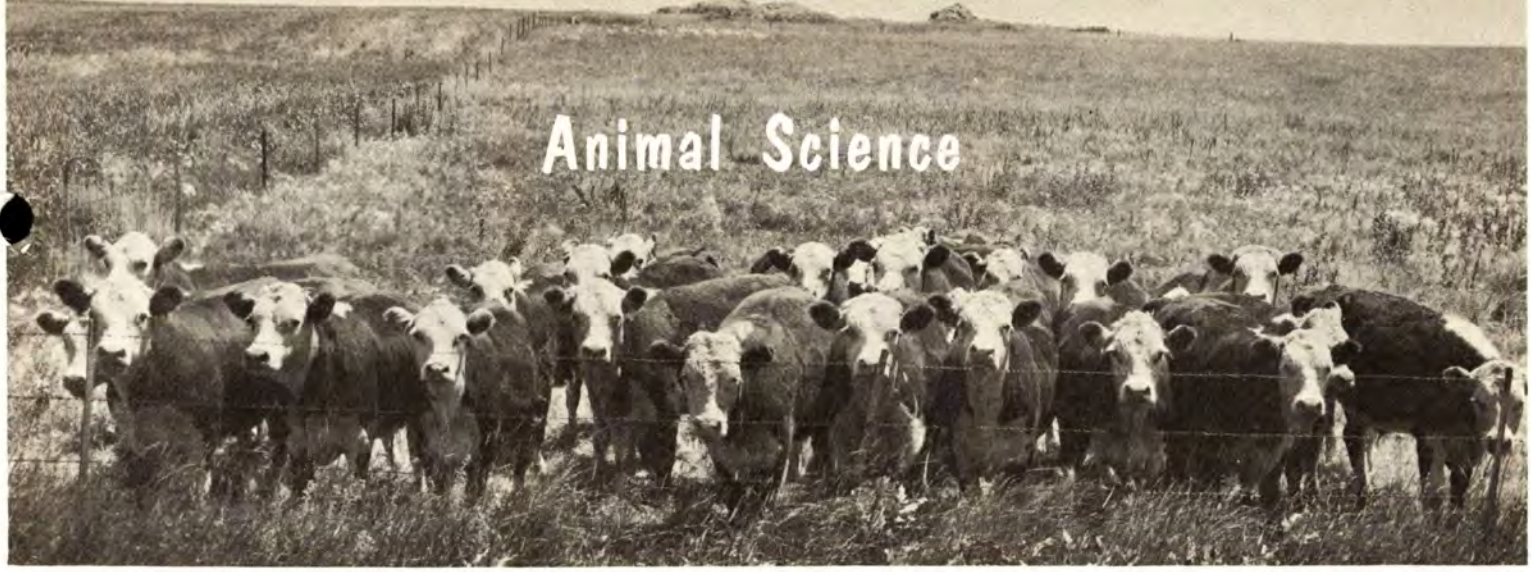
WRI-A-027-SDAK Preliminary Investigation of a Groundwater Management Program for the Big Sioux River. (J. L. Wiersma and Delvin D. Brosz)

Pasture interseeder (left).

Right after interseeding (right).

Small plants start to show in new furrow (left).

Same pasture as above a few months later (right).



Important for livestock profits . . .

Animal Nutrition Research

For current research subjects other than on nutrition, see List of Animal Science Department projects at the end of this section.

EAT it or ride it, gather its eggs or shear it for wool, the animal produced by a South Dakota livestock grower has to be fed and fed right if there's going to be a profit in the picture.

That's why research in the Animal Science Department puts heavy stress on nutrition. Nutrition research may involve several facets. For example: what to feed (specific and supplemental ingredients); when to feed (to grow, to finish, the time of year); where it is fed (pasture, feedlot, inside a building); how it is fed (moisture content, pelleted, feedlot or grazed); even why it is fed (economics, availability, emergencies).

All South Dakotans are in agriculture, either directly or indirectly, so proper livestock nutrition carries a lot of weight as far as the state's economy is concerned. Seemingly minor improvements through research can have wide-ranging effects. Look at these Crop and Livestock Reporting Service estimates to get an idea of the size of South Dakota's livestock industry:

	Number on farms (head)	Total value
All cattle and calves	4,498,000	$854,620,000
Hogs and pigs	2,009,000	47,212,000
All sheep and lambs	1,121,000	27,465,000
Chickens	5,694,000	6,263,000
Turkeys	1,400,000	6,200,000

Total value of all catergories is estimated at $941,822,000. These figures do not take into account a South Dakota horse population estimated at around 85,000 by another source. South Dakota's turkey industry contributes up to $6 million in agricultural income from over a million market turkeys. Eggs produced by chickens contribute $24.5 million in income.

Here are selected progress reports which touch on the subject of livestock nutrition research at the SDSU Agricultural Experiment Station over the past several months:

SWINE

Cooked Soybeans

The decision on use of cooked, whole soybeans as a protein and energy source in swine rations has become mainly one of economics now that research has determined some of the advantages as well as pitfalls. Cooking costs per ton range from $5 to $25 depending on amount processed annually. Each dollar of cooking cost makes an added expense of 3 cents a bushel to the initial cost of raw soybeans.

Pigs gained about the same on rations of cooked soybeans or soybean meal. However, pigs on cooked whole soybeans required about 6% less feed than those on soybean meal. The reason is attributed to higher energy of the cooked beans resulting from their fat or oil content. (Whole beans are sometimes called "full-fat" beans).

Pig performance will be severely reduced unless whole soybeans are properly cooked. The beans must be heated to at least 225 degrees (F.) to destroy an anti-growth factor or growth inhibitor. A technique of cooking beans 3 to 5 minutes in a commercial infrared cooker that raised the temperature to 255 degrees successfully overcame the disadvantage of the anti-growth factor.

High-Lysine Corn

High-lysine and -tryptophane corn containing the *opaque*-2 gene is not grown extensively in South Dakota. Animal scientists (and plant scientists, too) are evaluating this type of corn as livestock feed to have information available if needed in the future by South Dakota producers.

Main advantage of high-lysine corn in swine rations is that less supplemental protein is needed to formulate a ration meeting requirements of the pig.

If *opaque-2* corn can be produced at the same cost and with similar yields as current hybrids, savings in feed cost might become an important factor for swine producers. It can be assumed that part of this advantage would go to corn grow-

ers through an increased price. SDSU growing-finishing research comparing normal and *opaque-2* corn includes one experiment based on recommended and low levels of protein and another experiment comparing free-choice and complete mix.

Pigs fed either type of corn initially showed similar rates of gain and feed efficiency when on recommended protein rations (16% to 14%). However, when low protein (12% to 10%) rations were fed, pigs on the high-lysine corn gained 0.39 pound per day faster and required 21% less feed per unit of gain than pigs on normal corn. Pigs fed the low protein-normal corn ration produced carcasses with less lean, lower percent of lean cuts, more backfat, and greater percent of fat in the loin eye muscle.

Similar rates and efficiency of gain were noted for pigs fed either type of corn and supplement on a free-choice basis. Pigs on the high-lysine ration, however, consumed an average of a half pound less supplement and a half pound more corn daily resulting in more economical production. Protein supplement was consumed in excess by pigs fed the normal corn. They selected daily diet averaging 16.7% protein while pigs on high-lysine corn averaged 13% protein. About 15% more feed was required per pound of gain when *opaque-2* corn was fed in complete mixed ration than when it was fed free-choice. In the normal corn trials, 30% more feed was needed by pigs on the ground and mixed diets.

Protein Needs and Housing

Previous research shows that about 9% less feed was required for pigs in environment - controlled housing under South Dakota conditions. Now, additional information is sought on protein needs of barrows and gilts under differing housing conditions.

Experiments indicate that pigs from 35 pounds to market weight housed in a controlled environment building during winter, gain at a similar rate but much more efficiently than those housed in an open-front building. Barrows gained faster than gilts but also required slightly more feed per unit of gain. A ration containing 13.7% protein fed to pigs from 35 pounds to 115 pounds followed by a 10.9% protein diet to market weight was not adequate. Faster and more efficient gains were noted for a diet containing 15.4% protein during growing phase and 12.8% protein during finishing.

Wheat for Corn

Wheat that replaces corn in growing-finishing swine rations has an advantage because of its relatively high protein content. Compared with corn, wheat is about equal in energy value, digestibility and palatability—and also deficient in the same amino acids, mainly lysine.

Experiments indicate that economics – price differential between corn and wheat—is an important factor to be considered as well as performance. Pigs self-fed a supplemented corn ration gained faster, more efficiently, and at less cost (under 1970 and 1971 conditions) than pigs on three other rations using wheat as the grain.

Ration Preference

No matter how economically and nutritionally suitable a ration, it won't do much good if pigs don't eat enough of it. Then how do you find out if early weaned pigs like the taste of what they eat? When more than one ration is fed "cafeteria" style at the same time (free choice), pigs often show a preference for rations with some form of sugar or sweetener. But when these "sweetened" diets are fed as the only source of feed, research has found that the pigs don't always eat any more than they do of a diet that does not contain sugar.

Average daily gain and feed efficiency were not significantly different for 4-week-old pigs in comparing a basal ration, a second ration with whey, and a third with whey plus sugar. The rations were fed either free-choice at all times or by "single-stimulus," a method of exposing pigs to one diet at a time at 4-hour intervals. On the average, pigs on both "taste-panel" methods showed a preference for the same ration in each comparison. On a free-choice basis of palatability testing, young pigs consumed more of a diet containing sugar in preference to one without if both are available at all times. However, if only one ration was available, adding sugar didn't greatly increase consumption.

Conclusion could be that a simple corn-soybean meal-rolled oats diet is quite satisfactory for pigs weaned at 3-4 weeks and is not improved by including 10% whey or 10% whey and 5% sugar.

BEEF CATTLE

Corn Moisture Content

Feeding high-moisture corn probably is the most economical and efficient way of using grain in cattle rations under current conditions in the Upper Midwest. Harvesting time or convenience as well as other advantages usually favor high-moisture grain. Unfavorable natural drying conditions and the expense

Swine experiments at Eureka.

John Lacey, assistant in animal science, and David Rodgers, graduate student of Valentine, Nebr., adjust fecal bag used in animal nutrition research at Cottonwood.

of mechanical drying are "built-in" disadvantages for feeding dry corn.

Unfortunately, various other factors enter the picture when consideration is given to feeding high-moisture corn. Nutrition research indicates interrelationships among moisture content of grain, grain processing methods, levels of roughage, and moisture content of roughage. Results from various ways of processing grain are not the same for all grains and under all conditions. The type of animals and feed factors are both involved as well as climatic environment. However, because feed costs represent such a large percentage of total cost of growing and finishing cattle, relatively small improvements in feed efficiency can result in substantial savings—if not offset by processing method costs.

Research involving corn moisture levels reveals, in brief:

Dry vs. high moisture corn—

Fed with low roughage levels (10% or less of diet dry matter)—Differences were small. Frequently dry grain was favored on basis of rate of gain. Small differences in feed efficiency frequently favored high-moisture corn.

Fed with higher roughage levels (20% or more of diet dry matter)—Value of high-moisture corn improved, especially when fed with haylage and with rolled grain.

Rolled or whole dry corn grain with roughage up to 20% level—No consistent differences noted on basis of rate of gain. Rolled grain was generally consumed at a lower level but with sometimes slight improvement in feed efficiency. Whole grain is used efficiently although apparent whole kernels appear in the feces. Feces dry matter is mainly undigested feed – mostly corn even if grain is finely ground or rolled.

Rolled or whole dry corn grain with roughage as high as 65% of dry diet—Advantage for rolling the corn was small for steers from 500- to 800-pound weights.

Rolled or whole high-moisture corn grain with low (20% or less) roughage levels—Little, if any, advantage noted for rolling grain.

Rolled or whole high-moisture corn grain with higher (20% or more) roughage levels—Advantage of rolling high-moisture grain is apparent, more so with haylage than with hay. Grain replacement value of forage increased with higher levels of forage in the diet. This increase was more for haylage than for hay and more with rolled corn.

Dry and high-moisture corn fed with limited corn silage (10-20 pounds daily)—Differences were small.

Rolled or whole corn fed with limited corn silage—Very little difference.

Abscessed livers—More abscessed livers were noted in cattle fed rolled corn. Incidence apparently was not affected by moisture content of grain. Of cattle examined, 7.8% of those fed whole corn had abscessed livers compared with 16.2% of those fed rolled corn.

Sawdust as Roughage Replacement

Pine sawdust, an accumulating by-product of western South Dakota's lumber industry, may become more than just a bothersome pollutant lying around in piles or smoking up the atmosphere if burned.

SDSU researchers are looking for ways to use non-nutritive components (in this case sawdust) to replace at least some of the roughage in cattle feeder and finishing rations. Essentially, the idea is based on the fact that only ruminants are able to simplify (digest) cellulose into energy. Man is accumulating vast amounts of waste cellulose in various forms, one of them being sawdust. However, other substances in wood (lignin is one) are not so easy to digest and actually may be toxic.

Proceeding carefully step by step, here's what has been found so far:

Sawdust intake by cattle—Sawdust at up to 10% as replacement for dehydrated alfalfa meal in a 45% corn ration resulted in weight gains comparable to those of animals fed a no-sawdust ration. Sawdust fed at even higher than 10% levels produced few toxicity symptoms. Laboratory studies revealed dry matter digestibility was in favor of the sawdust ration.

In feeder cattle diets — Heifers fed sawdust-corn silage were the most efficient in use of dry matter followed by those fed alfalfa-concentrate or corn silage in research which also included a sawdust-concentrate as the fourth experimental diet. Amounts of sawdust used were 23.3% in the silage and 20% in the concentrate.

In cattle finishing diets—No difference was noted in average daily gains and in carcass data between heifers on a diet including 10% ground alfalfa hay (alfalfa-concentrate used as a "control") and 5% sawdust and 5% ground alfalfa (alfalfa-sawdust concentrate). Heifers on the control consumed 0.7 of a pound more feed per head daily and required an additional 25 pounds of feed per 100 pounds of gain. Condemnations because of liver abscesses were below what is considered normal for fed cattle.

Additional needed research includes: how much higher pine sawdust replacement levels can go, sawdust particle size and moisture content, possibilities of using pine bark rather than sawdust, and types of diets for best use of pine sawdust as a feedstuff.

Effects of Shelter

Providing shelter with inside feeding improved cattle weight

gains in experiments with each of four different protein supplements. During a two-phase 167-day trial (corn silage ration and high-grain ration), gains were about the same for cattle fed soybean meal, biuret, or liquid supplement. A corn-urea supplement lowered feed consumption and gains about 6% compared to soybean meal. In this experiment cattle kept outside consumed 2.5% less feed, gained 7.5% less, and required 5.5% more feed than the cattle fed under shelter.

POULTRY

Low Protein Diets

A turkey starter diet that produces marketable birds at a saving of $10 a ton in feed costs is a result of SDSU research with low-protein rations for growing turkeys and laying hens.

The lower cost comes from using some 60% to 75% less-than-normal amounts of protein, the most costly part of a ration. The typical 30% protein corn-soybean starter diet was reduced to a 23% protein diet by replacing soybean meal with corn. As the birds grew older the protein levels were reduced to 16% and 14% respectively. Both dietary series contained supplements of 2% each of fish meal, dried whey, alfalfa meal, lysine and methionine and recommended levels of minerals and vitamins.

Although maximum growth rates were not attained with the low protein diets, feed efficiencies were not significantly affected.

Similar studies were conducted with laying hens, using a typical 16% protein diet and diluting it to 9% with glucose. Lysine, methionine, tryptophane and isoleucine have been shown to improve production on this diet.

In addition to reducing feed costs, these lower level protein diets point to another means by which protein supplements can be conserved for use by humans if this should become necessary in the future.

HORSES

Weaning Foals Early

SDSU research reveals that a foal can be weaned without ill effects about 5 months earlier than the normal nursing time, leaving the dam free for work and pleasure uses that much sooner. It's done nutritionally with a handy-to-use dry ration that doesn't affect normal growth and development – something horse owners have been interested in for a long time.

Foals weaned at the age of 30 days were fed a diet of mixed grain and hay, plus a commercial preparation similar to mare's milk but in pelleted or dry form. They were compared with other foals which were permitted to nurse their mothers for about the normal 6 months.

The nursing foals grew slightly better and were "bloomier" for about 4 months. Then the early-weaned foals began to "catch up." When the foals had reached 6 months of age all of them were at about the same stage of development. "Personality" problems – if any are caused by lack of full-term mothering–have not surfaced midway in the 3-year research project. Little difference is noticed among the foals in training to lead, stand, walk, trot, pose, and in general attitudes and aggressiveness toward other horses and man.

SHEEP

Confinement Rearing of Sheep

Confinement or semi-confinement management systems have increased rapidly in the production of cattle, poultry, and swine. On paper, confinement systems for sheep as compared to pasturing would appear to have advantages for use of labor saving equipment, intensifying production, permitting use of pasture land for higher production from other crops, and decreasing parasite-disease-predator losses.

However, it doesn't always turn out that way, according to SDSU studies comparing performance of sheep under confinement management with those on pasture. Confined sheep were on either elevated slotted floors or straw bedding in a building. The other ewes were on pasture during summer and in dry-lot in winter.

Ewes on pasture were generally heavier, carried more condition, had higher lambing percentage, fewer were barren, and they produced larger fleece weights than ewes in confinement all year. While birth weights were heavier for

Sawdust-corn silage while being put up during experiments at Newell. Close-up of silage at left.

lambs from confined ewes, pasture ewes had more twins which affected birth weights. Rate of gain to 30 days and to weaning were highest for lambs from pasture the first year but lowest the second year. Feed costs were lower the second year when confined ewes were fed according to production. No internal parasite eggs were found in lambs from all treatments and only on two occasions in ewes on confinement, indicating these ewes were nearly free of internal parasites.□

LIST OF PROJECTS
ANIMAL SCIENCE

S-167 The Improvement of Beef Cattle through Breeding. (C. A. Dinkel)

S-212 Nutritional Requirements of Sows. (R. C. Wahlstrom) (Terminated)

S-251 Protein and Amino Acids Studies with Growing-Finishing Swine. (R. C. Wahlstrom) (Terminated)

S-418 Range and Grass Investigations in Western South Dakota. (F. R. Gartner and W. W. Thompson) (Terminated)

S-481 A Study of Temperature Changes within the Reproductive Glands of the Male and Female. (A. E. Dracy and L. F. Bush) (Terminated)

S-459 Predicting and Improving the Fertility of Male Farm Animals. (T. D. Rich) (Terminated)

S-460 Confinement Rearing of Sheep. (L. F. Bush)

S-485 Growing and Finishing Cattle on Pasture. (L. B. Embry and R. A. Moore)

S-486 Growing and Finishing Feedlot Heifers. (L. B. Embry)

S-487 Estrus Control and Induced Twinning in Beef Cattle. (T. D. Rich)

S-494 Nature and Utilization of Genetic Variation Influencing Economic Traits in the Fowl. (W. C. Morgan)

S-495 Mating and Management Systems for Beef Cows and Calves. (A. L. Slyter)

S-496 The Management of Weaning Foals at 30 Days and 180 Days of Age. (P. H. Kohler) (Terminated)

S-497 The Effect of Composition, Distribution and Quantity of Lipids on Meat Quality. (W. J. Costello)

S-498 Evaluation of Ration Ingredients and Methods of Feeding Swine. (R. C. Wahlstrom and G. W. Libal)

S-499 Roughage Utilization by Ruminants. (L. D. Kamstra, L. B. Embry and D. R. Shelby)

S-509 Alkaline Buffers with Corn Silage and High-Concentrate Rations for Beef Cattle. (L. B. Embry, R. M. Luther and G. F. Gastler) (Terminated)

S-510 Utilization of Non-Protein Nitrogen (NPN) Compounds by Beef Cattle and Sheep. (R. M. Luther and L. B. Embry)

S-512 Feed Processing and Storing for Beef Cattle and Sheep. (L. B. Embry and R. M. Luther)

S-513 Pork Quality: Its Relationship to Production, Carcass and Meat Traits. (W. J. Costello)

S-514 Characterization of Rachitogenic Activity in Soybeans. (C. W. Carlson and I. S. Palmer)

S-539 Effect of Summer Range Condition and Winter Supplementation on Herbage and Livestock Production. (J. K. Lewis, M. R. Haferkamp and R. M Luther)

S-540 Procedures for Controlling Insects Affecting Livestock. (P. H. Kohler)

S-544 Improved Processing and Utilization of Poultry Products. (C. W. Carlson, O. E. Olson and E. M. Rust)

S-559 Improved Performance of Layer Type Chickens through the Use of Feed Additives. (E. Guenthner, C. W. Carlson and O. E. Olson)

S-560 Amino Acid Supplementation of Low Protein Diets for Layers. (C. W. Carlson and O. E. Olson)

S-561 Tree Encroachment into Black Hills Grassland: Ecology and Management Options. (F. R. Gartner, W. W. Thompson and E. M. White)

S-566 Weaning Age and Management Systems for Fall Born Beef Calves. (W. C. McCone)

S-573 Low Protein with Amino Acids for Young Turkeys as Influencing Aortic Rupture. (C. W. Carlson and E. Guenthner)

S-580 Utilizing Wheat for Swine Production. (J. W. McCarty and R. C. Wahlstrom)

S-581 Weaning Systems for Range Lambs. (A. L. Slyter)

S-582 Nutrition, Breed of Sire, Management on Lifetime Reproductive Performance of Early Weaned Ewe Lambs. (A. L. Slyter)

S-951 Antelope Range. (W. R. Trevillyan)

S-955 Range Field Station. (A. J. Herndon)

Lee Briggs, a meat lab technician, uses special microscopic equipment to determine numbers and sizes of pork muscle fibers.

Bacteriology

Viruses found in South Dakota are inoculated into leg muscles to test susceptibility of young birds. The cabinet is airtight as a safety precaution to prevent escape of virus.

Seeking ways to predict outbreaks . . .

Equine Encephalitis

THE sleeping sickness epidemic among horses in Texas that erupted into a national emergency last summer emphasizes importance of South Dakota research concerning at least two other equine encephalitis disease types found in man, horses, and pheasants in this state.

The outbreak of Venezuelan equine encephalomyelitis (VEE), which jumped the U. S.-Mexican border and reportedly killed hundreds of horses in Texas, apparently was at least temporarily confined to that state. This resulted from horse vaccination, horse shipment embargoes, and massive mosquito control efforts. VEE, mainly mosquito-transmitted, is highly infectious to man and to domestic and wild animals.

The Agricultural Experiment Station at SDSU for the past 6 years has been studying sleeping sickness and related virus diseases that are transmitted by mosquitoes. One result has been the establishment of an arbovirus laboratory at SDSU which cooperates in sleeping sickness virus surveillance for the state health department. (The term *arbovirus* is used to designate and differentiate the viruses transmitted by blood-sucking insects including mosquitoes).

Nine different mosquito-transmitted viruses have been isolated in Bacteriology Department laboratories at SDSU. Out of three major encephalitis viruses that can afflict horses, so far one of the equine encephalitis isolations in South Dakota was of the Western type (WEE) from mosquitoes and another was of the Eastern type (EEE) from pheasants.

Mosquito-Transmitted Virus Studies

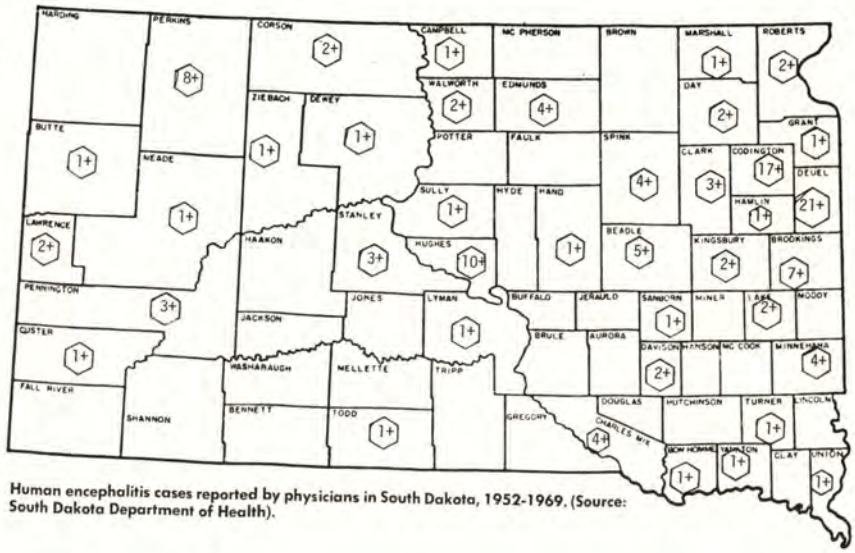
A preliminary survey and study of VEE last summer found no indications of the disease in South Dakota. Research on other equine encephalitis viruses included a survey of WEE within a 6-county area in the southwestern quarter of the state. Investigators in this one survey obtained blood samples from 154 horses, 87 rodents, 59 Canadian geese, 31 song birds, 22 chickens, 3 pigeons and collected 68,500 mosquitoes. These specimens will be investigated for VEE, WEE, EEE and other arboviruses.

An ultimate objective of the South Dakota research is to devise a method for predicting the probability of occurrence of human encephalitis. The predictions would be obtained from a computer model that would depend upon a myriad of data from research. The computer input data would take into account such factors as just which

For current research subjects other than that reported below on equine encephalitis and other virus research, see List of Bacteriology Department projects at the end of this section.

disease-producing arboviruses are in South Dakota, identity of the important vectors and reservoirs of these viruses, current prevalence of encephalitis types in the state, an established arbovirus surveillance program (which could also serve as a model for other North Central States), and the ecological conditions needed which influence perpetuation of the viruses.

Relationships, if any, would need to be established among occurrences of the virus diseases in the human population and in other animals. In other words, the research would work with factors—many as yet unknown—which involve man; domestic and wild animals such as horses, cattle and deer; wild and domestic birds including pheasants, chickens, migratory birds; and insects such as mosquitoes and perhaps even body mites and lice on birds. Out of that group some are virus carriers, some are virus hosts or reservoirs—and some die as a result of encephalitis infection.



Human encephalitis cases reported by physicians in South Dakota, 1952-1969. (Source: South Dakota Department of Health).

Basic Information Needed

At the outset, SDSU researchers had to get at some of the basics which might at first appear far afield for bacteriologists or virologists. A survey of fluctuating occurrence of South Dakota horse encephalitis cases revealed, for instance, that each year horses are infected and some die from WEE. Incidentally, as a result of surveys it was estimated that South Dakota has a horse population of 85,000—a figure not available in agricultural census figures for at least the past decade. The figure also indicates the extent of a potential sleeping sickness virus-susceptible host or reservoir for transmission by mosquitoes.

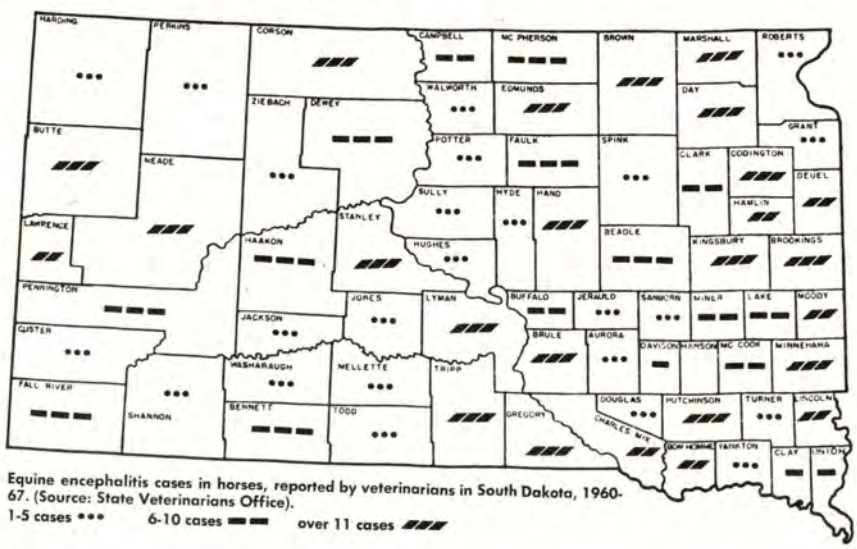
During one survey in 1971 covering a small portion of the state, three human cases of clinically diagnosed encephalitis were recorded.

Because the mosquito is the most important South Dakota vector, hundreds of thousands of them have been trapped and tens of thousands have been identified as SDSU virologists seek to learn more about the nature and species of encephalitis carriers.

Major Mosquito Species

Out of the score of mosquito species so far identified as a result of the surveys, the three major predominant species of eastern South Dakota make up about 90% of the total collected. The most abundant of the three found in this survey—*Culex tarsalis*—occurs throughout South Dakota and is considered the most important vector of WEE in the United States. Eight WEE viruses have been isolated from this species as well as isolations of Cache Valley (CV) and Turlock viruses, two other types found in wild animal species. Entomologists say that females of *Culex tarsalis* feed on bird blood as well as attacking domestic animals and man. This observation, under the circumstances, may be enlightening in studies of encephalitis relationships between pheasants and mosquitoes.

The second most abundant mosquito species, *Aedes trivittatus,* was involved with isolations of CV, Turlock, and a type of California encephalitis virus (CE). The third species, *Aedes vexans,* termed the most important pest mosquito in the state, is known as a WEE virus carrier and isolations of EEE and CV have also been obtained from them.

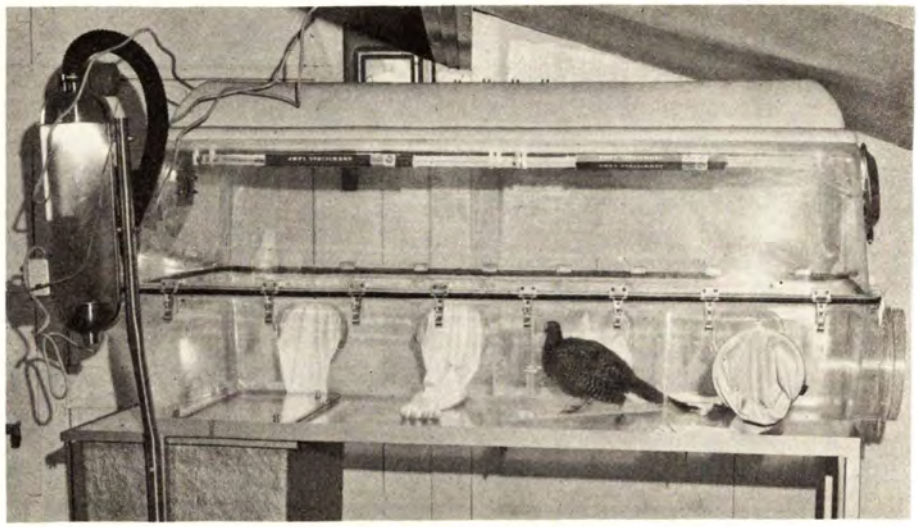


Equine encephalitis cases in horses, reported by veterinarians in South Dakota, 1960-67. (Source: State Veterinarians Office).
1-5 cases ••• 6-10 cases ▬▬ over 11 cases ▰▰▰

Mosquito Control Important

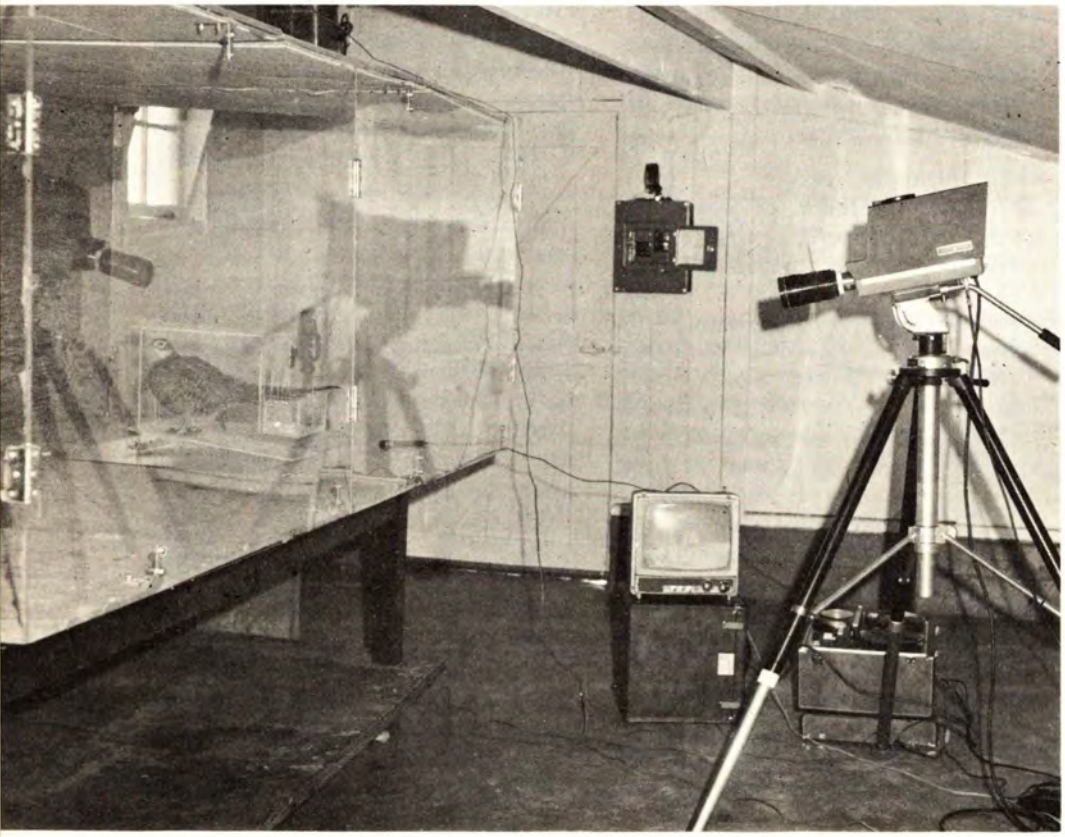
Partly as a result of this research background, SDSU bacteriologists suggest that in South Dakota the mosquito should be considered a public health problem, and that an urgent need exists for a statewide mosquito control program. In 1971 a total of 23 virus isolations were made from mosquitoes trapped in western South Dakota, including new ones from the Pine Ridge In-

Pheasants are bled to detect prevalence of arbo-antibodies in their blood. Presence of antibodies (produced by the body to protect it against an invading destructive organism) indicate indirectly that certain viruses do infect pheasants.



Extensive precautions are taken in SDSU laboratories to prevent possible spread or contamination during research with potentially dangerous viruses. Some of the equipment was designed and constructed at SDSU. A pheasant is shown here in a germ-free cabinet. The plexiglass cabinets are used for quarantine of artificially infected birds for observing WEE and EEE symptoms. The mechanism at the left filters and sterilizes air (removes viruses from the air) and then circulates the air in the cabinet.

A closed circuit television system is used to observe effects of noise or other sound on disease-stressed pheasants in an accoustical sound chamber (left).



Early symptoms of encephalitis-infected pheasant involve movement in circular pattern. Later day-by-day noticeable progressive symptoms include paralysis, semi-erect posture, fluffed feathers, chalky diarrhea material, constricted and inward-folded claws, inability to stand.

dian Reservation and Angostura irrigation districts.

In the late 1960's one of the viruses isolated from pheasants in SDSU bacteriological laboratories was subsequently identified as Eastern encephalitis. Later a field investigation resulted in identification of EEE in 11% of more than 750 wild pheasants from 18 counties.

Widespread Virus Activity

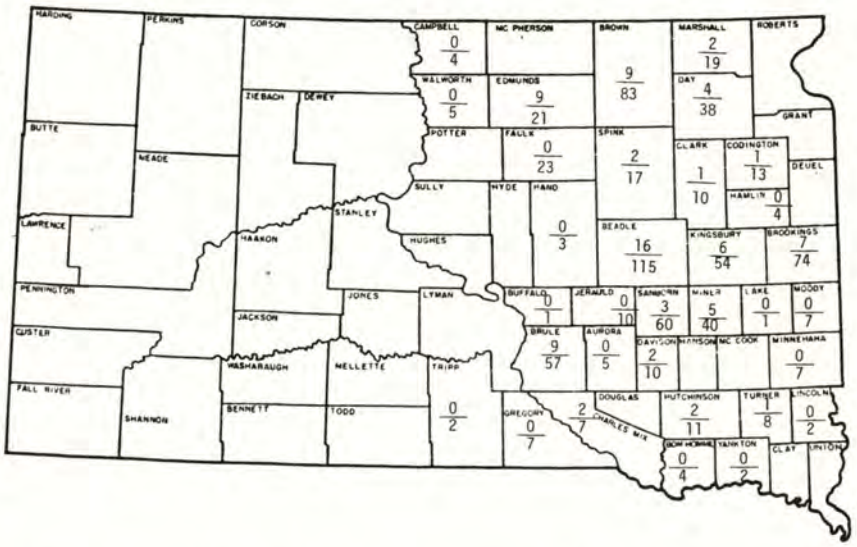
Thus, EEE was added to WEE, CE, CV and Turlock viruses which provides evidence suggesting the comparatively widespread activity of these arboviruses in domestic animals, wild animals and man in South Dakota. Extensive Eastern encephalitis virus outbreaks on commercial pheasant farms in the eastern United States over the past 35 years in some instances have killed as high as 85% of the thousands of birds involved.

Laboratory studies of pheasant mortality due to experimental inoculations of different amounts of WEE and CV viruses show the birds were less susceptible to these agents than to EEE. Pheasants did not succumb to CE or Turlock viruses. WEE strains of the virus isolated from South Dakota mosquito vectors were lethal to the birds and EEE virus was more pathogenic to pheasant chicks than the WEE virus. Further investigations are underway on viruses found in this state and their virulence to pheasants.

Could Become Widespread

Although equine encephalitis in South Dakota during recent years has not been of epidemic proportions in man or animals, the virologist in charge of the current SDSU investigations points out that nevertheless all factors are present so that under certain conditions outbreaks could become serious. For instance, in commenting on last summer's VEE outbreak in Texas the virologist said, "Although we've found no VEE in South Dakota, we do have the insects that could transmit the virus once it might become established here."

Vaccination programs, mosquito control and several other specific procedures for prevention and/or control of these types of diseases are beyond the realm of virologists.



Distribution of EEE infected pheasants in South Dakota counties, 1965-67.
Note: Not all counties were surveyed during the period.
X = top figure number of EEE positive birds.
X = bottom figure number birds tested in county.

However, the research now underway involving several departments of the Agricultural Experiment Station plus that planned and proposed for the future, hopefully will pinpoint the activities in which municipal, state and federal groups should be concerned. Learning more about equine encephalitis basics will permit more effective cooperation among physicians, veterinarians, bacteriologists, wildlife specialists, public health authorities, and the individual citizen.□

LIST OF PROJECTS
BACTERIOLOGY

S-606 Improve Laboratory Techniques in the Isolation of Listeria monocytogenes from Infected Livestock. (T. R. Wilkinson).

H-519 Physiological Studies of Biological Nitrogen-Fixing Organisms in Soil. (R. M. Pengra)

H-530 Bacterial Growth Yields from Synthetic Organic Compounds. (G. J. Prochazka)

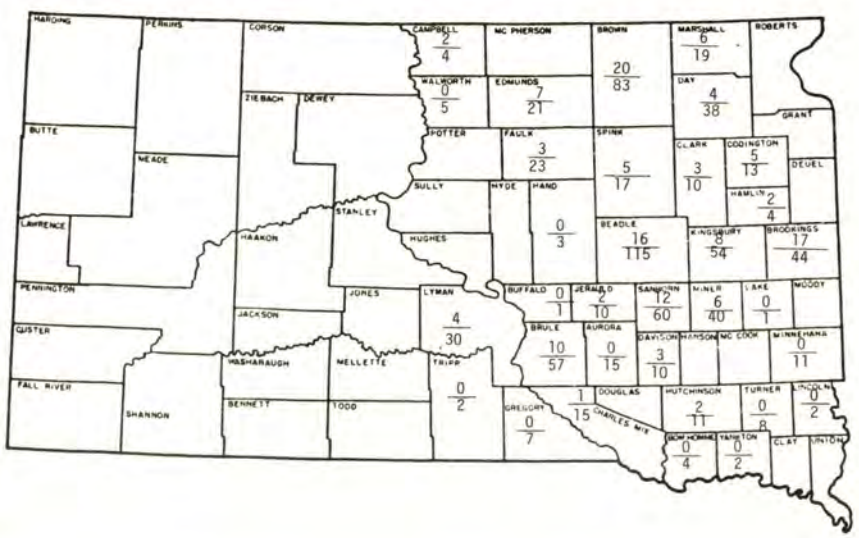
S-493 Effects of Eastern and Western Encephalitis Viruses on Pheasants. (G. C. Parikh)

H-445 Market Quality of Convenience Foods. (Paul Middaugh)

H-542 Animal Waste Management with Pollution Control. (Paul Middaugh)

S-412 Epidemiology and Classification of Epizootic Hemorrhagic Disease Virus of White-Tailed Deer. (G. C. Parikh)

Distribution of WEE infected pheasants in South Dakota counties 1965-67.
Note: Not all counties surveyed during the period.
X = top figure number WEE positive birds.
X = bottom figure number birds tested in county.



A Botany-Biology staff member (right) shows a visiting SDSU class how to trip an "insect cage" at a research site near Cottonwood.

Still a lot to learn about

Our Prairie Ecosystems

SCIENTISTS are literally going to the grassroots in western South Dakota to gradually arrange the pieces of a giant jigsaw puzzle that makes up the prairie ecosystem.

They'll be at it for a long time. However, year by year knowledge is being gained that helps us understand more about the complex relationships and mutual dependencies among the prairie inhabitants that range from microscopic organisms in the soil to cattle consuming prairie products and finally to man himself.

The Botany-Biology Department is one of several Agricultural Experiment Station departments now engaged in research aimed at learning more about our environment. Some of the research involves direct Station support. Some of it is a spin-off of a Grassland Biome Subprogram which is part of world-wide investigations by the International Biological Program concerned with the biological basis of productivity and human welfare. The SDSU part of these studies are mainly at the Range Field Station east of Cottonwood in western South Dakota.

What Doesn't Meet the Eye

"Fantastic" is the way botanists working at the grassroots describe just the production of plant material below the surface of the soil. Their studies basically involve the relationships of above- and below-ground growth of plants. The botanists and biologists are interested in determining how much a plant manufactures during a season, how much goes into storage in the roots, how much goes to other plant parts, how much dies and falls as litter to decompose, how much is consumed by parasites and animals. It is all a part of gaining more understanding of ecosystems to be used as a basis for grassland management.

The accompanying charts illustrate the amounts of above- and below-surface plant material which were determined for one period in 1970 at Cottonwood. Although detailed evaluations are not yet complete it is readily apparent that there is a difference between ungrazed prairie and prairie which has a history of previous heavy grazing by cattle. Just what happens during the time the prairie is being grazed by cattle will be determined in future investigations.

For current research subjects other than those discussed here, see List of Botany-Biology Department projects at the end of this section.

Most Production from Few Species

The studies at Cottonwood and elsewhere in South Dakota indicate that some 80% of all plant material comes from about a dozen dominant species. At Cottonwood alone three dominant grasses made up from 73% to 92% of the total plant material. The remaining 20%, on a statewide basis, consists of up to 400 different species most of which are botanically classed as "rare" and can be considered as endangered or possibly facing extinction. The situation is that a few very important plants now produce most of the plant material on our changing prairies. It means that if something

Cottonwood experimental site species (percentages of total weight) May 1970

	Ungrazed (high range condition)	Heavily grazed history (low range condition)
Western wheatgrass	80	1
Blue grama	8	24
Buffalograss	4	48
Total	92	73
Other species	8	27

should occur—a disease or an insect attack, for instance—that endangers one or more of these species, the losses could be extensive and widespread. The "minority" plants have contributed something—the exact importance is not yet fully known—during the thousands of years of prairie development and their disappearance will have an effect on the grasslands. For example, many of these plants are legumes which contribute nitrogen that is used by the dominant species.

Another phase of the overall investigation of grasslands is a study of these basic plant communities as they existed prior to man's extensive use of the prairie for agricultural purposes. Undisturbed natural areas are being sought and carefully used to provide sources of plants for persons who want to help in recreating the "total prairie" in some parts of the state. Because these undisturbed areas are so few, and because attempts are made to keep them undisturbed, seeds from the rare plants are in somewhat short supply.

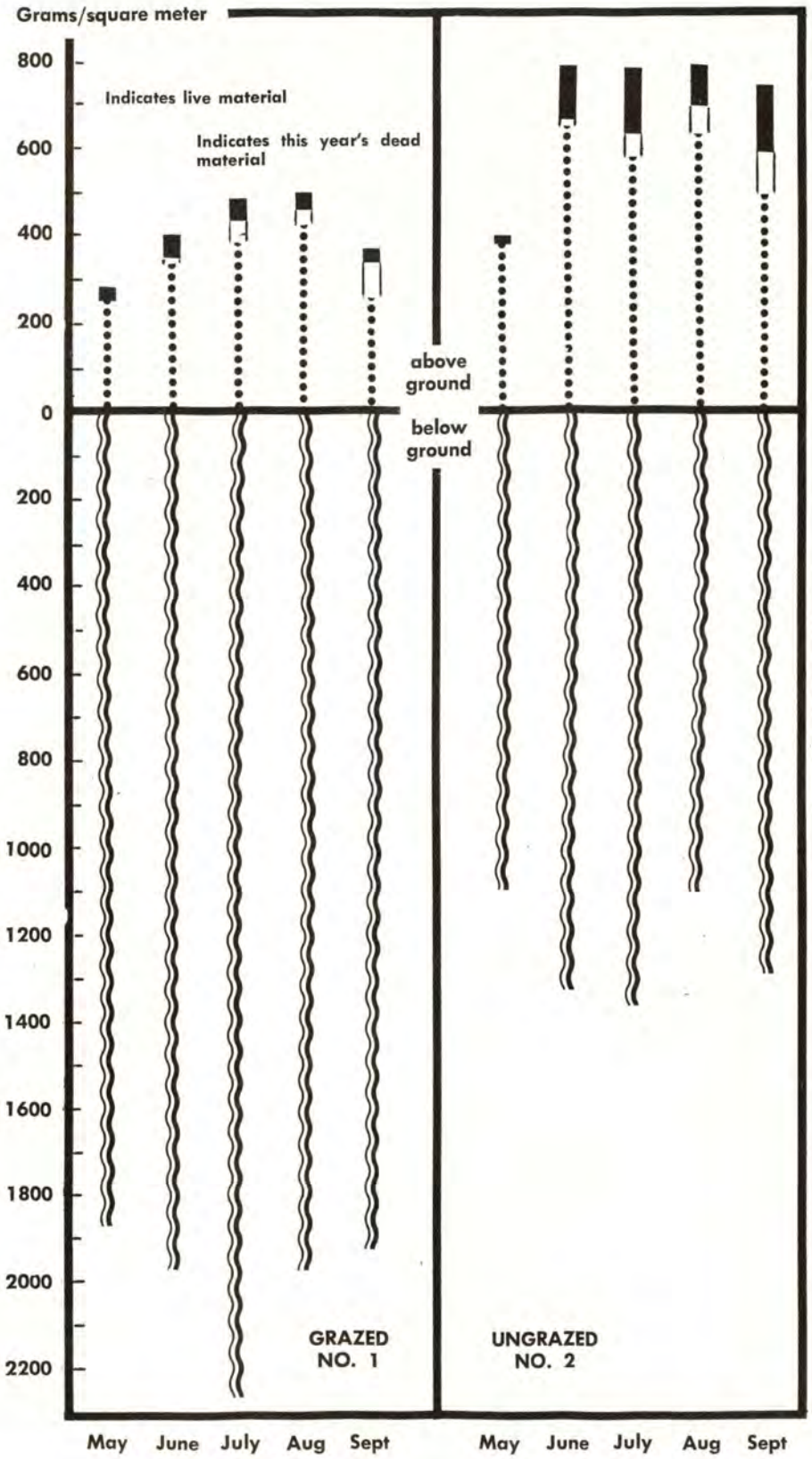
As an outgrowth of techniques in tissue culture research in Agricultural Experiment Station laboratories, attempts are being made to determine if these vegetative propagation methods can be used with some of the native plants. The idea is to investigate possibilities of maintaining gene pools so that lost populations may be re-established to provide the diversity necessary for stability while at the same time enhancing the aesthetic value of our prairie areas.

Lake and Soil Algae

Biologists are also studying the effects that nutrients washed into

Above and below ground plant biomass of an experimental site near Cottonwood (No. 1) which has a history of heavy cattle grazing. Although combined in these charts, the above ground materials include live shoots, dead material from production of the current season, older dead material, mulch, and crowns. Below ground the components consist of rhizomes and roots.

Compare the below ground biomass in illustration No. 1 with illustration No. 2 of a nearby ungrazed experimental site.



prairie lakes in eastern South Dakota have on growth of algae—the "nuisance blooms" of that green scum that occurs on many of our lakes. The continuing research compares what was originally considered a relatively "clean" lake with a nearby lake representing more typical highly eutrophic conditions. Algal populations were found to remain about the same in the highly eutrophic lake for the summers of 1970 and 1971. However, a 10-fold increase in summer algal populations was noted the second year for the "clean" lake. This increase in algal cells accompanied a less than 2-fold increase in nitrate-nitrogen and phosphate-phosphorus levels in the lake. Possible sources of these nutrients are runoff in the lake basin, ground water (possibly enriched by agricultural fertilization), seepage from cabin septic tanks and outhouses, and inflow from an adjacent marsh. Hydrological studies would be necessary to pinpoint the sources of nutrient enrichment.

Algae grow in the soil also, although they are not as evident perhaps as the type which forms the green scum on our lakes. The place that soil algae—sometimes seen as "moss"—have in the ecosystem is not fully known but preliminary indications lead SDSU biologists to believe these microscopic organisms made up of hair-like branching parts may be a factor, although small, in control of soil erosion. The algae may have a beneficial contribution because during wet periods they have a tendency to hold the soil together. They go dormant when the soil is dry and help form a slight mat or crust on the surface. Although never abundant, soil algae have been found to increase as plant cover and mulch were removed from the soil as a result of cattle grazing. Some forms of soil algae are also involved in nitrogen fixation.

Plant Identification

Although not directly connected with the botanical and biological studies of the ecosystem of South Dakota's prairies, a largely unheralded service performed by the department is identifcation of plants. During the year at least 160 such identifications were made from samples sent in to the laboratory or at on-site inspections. Plant identification requests included those from the general public, SDSU Extension and Station personnel, law enforcement agencies, and others. In one case when youngsters became ill after eating seeds found in a field, a SDSU botanist was called in to identify the seeds. His finding: the seeds were from the waterhemlock, one of the most poisonous of plants.□

LIST OF PROJECTS
BOTANY-BIOLOGY

S-426 Study of Somatic Cells of Higher Plants by Means of Tissue Culture. (D. J. Holden.)

S-549 The Genetic Effects of Ethyl Methanesulfonate on the Tomato. (R. H. Whalen.)

S-550 The Inheritance of Resistance to Some Virus Diseases in Maize. (R. H. Whalen.)

S-590 Ecological Factors Influencing the Production of Algae in Northern Prairie Lakes. (Lois Haertel.)

Herbage weight estimates are calibrated by carefully separating and weighing parts of the larger samples in IBP research at Cottonwood. Ruby Herndon, technician, weighs separated herbage samples from one of these parts on a gram balance.

After soil samples at Cottonwood are thoroughly "washed" in a special root washer, the roots are dried at low temperature, weighed and ashed. The sample in the plastic bag on the left is from a 0- to 2-inch depth, the right sample is from a 20- to 24-inch depth.

Dairy Science

New uses for

A Cheese Manufacturing By-product

South Dakota reached major status as a cheese manufacturing state during the past decade with current annual output of more than 50 million pounds providing a substantial impact on the state's economy.

On the other hand, more cheese also means larger amounts of a by-product: whey. Currently, uses for this by-product are relatively limited. Excess whey could trigger potential pollution problems in streams and lakes.

Dairy scientists at South Dakota State University are emphasizing research on processing and uses of this by-product, not only from a pollution standpoint, but also from the idea of converting some constituents of whey into useful products.

There's a lot of whey in cheese manufacturing: for each pound of cheese, some 9 pounds of whey remain as a by-product. South Dakota's annual whey production then exceeds 450 million pounds. This would be more than enough to provide every man, woman and child in the state with 650 pounds of the pale, unpalatable liquid.

In whey research, during operation of the ultra filtration equipment (the vat is shown here), most of the milk sugar (lactose) and much of the milk minerals are removed along with more than five-sixths of the water. The proteins are concentrated many-fold.

For current research subjects other than on use of and processing of whey, see List of Dairy Science Department projects at the end of this section.

Only about 50% of whey remaining from manufacture of cheese is currently converted into useful products. These include dried whey for human or animal consumption; whey processed to remove milk sugar (lactose) for food and pharmaceuticals; whey fed in liquid form to swine.

It's the remaining 50% that can pose a problem unless new uses or satisfactory disposal methods are found. Every SDSU Dairy Science Department staff member and several graduate students are involved in some manner in seeking new or improved ways to process or use whey. The problem is further complicated because many cheese plants in South Dakota are not of a size to absorb the large equipment investments and large volumes necessary for presently used whey drying or processing methods.

Whey Processing

Reverse osmosis equipment, originally developed to purify brackish

water, is now available for removing part of the water from whey. This reduces bulk and makes it more economical to transport the by-product to drying plants for additional processing. Commercial application of this process is just getting started. A modification of this equipment is used in SDSU dairy science labs to remove some of the lactose and salts along with part of the water. The remaining protein concentrate can be dried and used in many food products. This process is called ultrafiltration.

Food Uses for Dried Whey

Dried whey is also being used to develop new dairy foods. One of them is a sweetened, condensed, caramelized milk product similar to the Spanish-named *dulce de leche*, long and extensively savored in Latin America. The Americanized product is being made experimentally by partially replacing sugar with dried whey. The result is slightly less sweet than the Latin American product and considered to be more acceptable to North Americans.

Dried whey is also one of the ingredients in cheese-like spreads being developed by using the technique employed previously at the Agricultural Experiment Station for making a low-fat dairy spread (40% milk fat).

Characterizing Whey Lipids

Some milk fat (lipids) remain in whey when it is removed from the cheese vats. Most of this fat can be removed as "whey cream" by putting the whey through a separator. Characteristics of this fat are being studied to determine differences between it and the fat in the original milk. Chemical differences appear to be small; however, there is a characteristic whey flavor. Attempts will be made to remove this flavor so that the fat in whey cream can be used in a wider range of food products.

Whey Protein in Calf Nutrition

Nutrition research indicates that milk supplemented with a high biological value protein (such as is present in colostrum milk) will increase growth weights in milk-fed calves. Whey protein concentrate—obtained by the modified reverse osmosis process — is being used to supplement milk for young calves. This research has just started.

Dried Whey Reduces Milk Fat Drop

Cows fed high-grain, low-roughage diets produce milk which sometimes drops to less than 2% fat. Milk producers feeding high levels of grain to obtain higher energy rations often experience this problem. SDSU research has determined that feeding dried whey in the grain ration (up to 14%) prevents some of the drop in fat percentage. Minerals in the whey appear to be the component primarily responsible for reducing the fat percentage and probably act as a buffer to pH changes in the rumen. Lactose (milk sugar), however, seems to also play a role.

Currently, dried whey is being fed to milking cows on a normal ration to see if any unique benefits result.

Changes in Rumen Microflora

Does dried whey fed to cows cause changes in the rumen microflora (protozoa and bacteria)? Apparently not much. Samples of rumen fluid from cows fed high-grain low-roughage diets with and without dried whey showed only slight differences in the microflora. The differences were not great enough to explain the reason why whey partially prevents the drop in fat percentage.

Whey in Ensiled Forages

Dried whey is being added to various ensiled forages in attempts to improve quality. Addition to reconstituted alfalfa haylage appears to hold some promise.

Lactose Utilization by Ruminants

It is generally considered that adult ruminants do not produce the enzyme lactase in their digestive system and therefore can use only small amounts of lactose, the major component of dried whey. However, because cows on high-grain, low-roughage experiments seemingly were able to effectively use rather high levels of lactose, SDSU dairy scientists are further studying lactose digestibility by adult ruminants.□

Filter tubes (white horizontal bars, center) through which whey molasses flows under pressure. The smaller sugar, mineral and other molecules are forced or filtered through to the outside. Larger protein particles remain inside.

LIST OF PROJECTS
DAIRY SCIENCE

S-184 Improving Dairy Cattle through Breeding, with Special Emphasis on Selection. (H. H. Voelker and W. L. Turner).

S-405 Analysis of Dairy Products. (R. J. Baker).

S-500 Polar Lipids in Dairy and Related Foods. (J. G. Parsons).

S-501 New and Modified Dairy Foods. (K. R. Spurgeon and S. W. Seas).

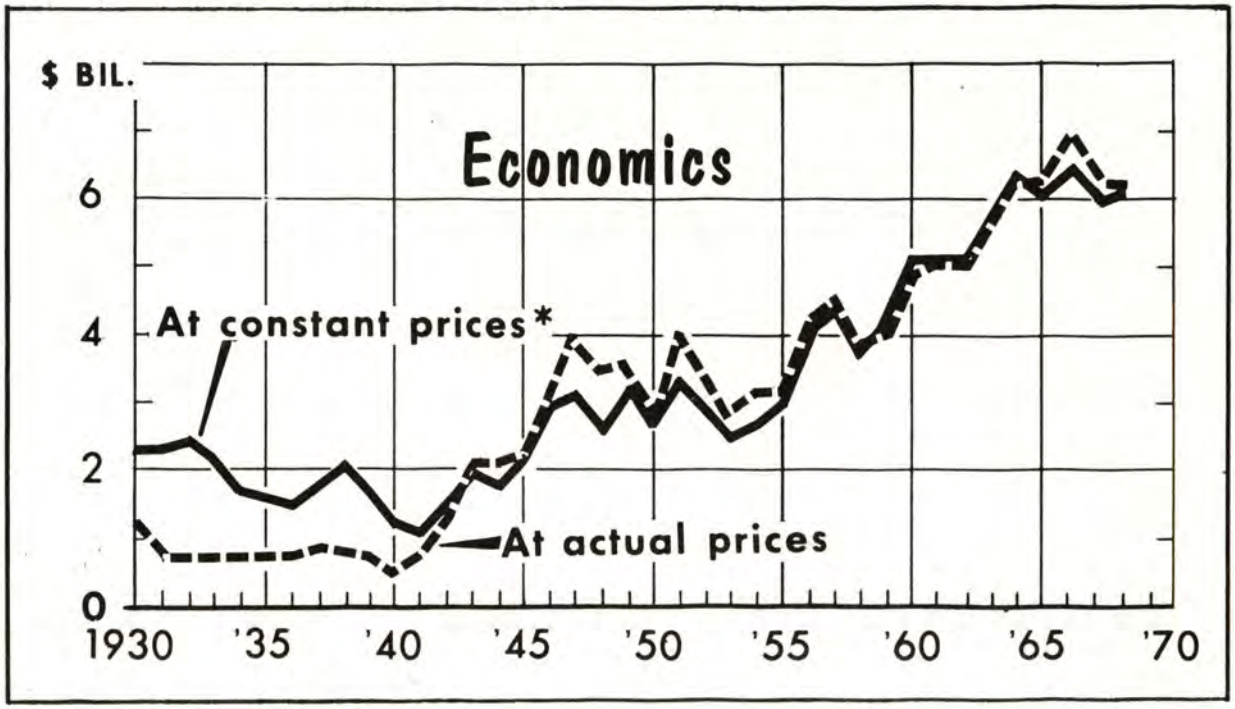
S-515 Whey Utilization by Dairy Cattle. (D. J. Schingoethe, H. H. Voelker and R. J. Baker).

S-541 Growth Inhibitors in Soybeans. (D. J. Schingoethe and J. G. Parsons).

S-571 Comparative Values of Feeds for Dairy Cattle. (H. H. Voelker, D. J. Schingoethe and M. J. Owens).

State Wide Service Lab.
(Dairy Science Department)

Chemical Analysis	
Babcock test	217
Mojonnier solids	46
Mojonnier fat	100
Kohman analysis on butter	14
Titratable acidity cream	9
Acid degree value cream	3
Freezing point determination	216
Test on Anhydrous butter oil	
Free fatty acid	41
peroxide value	50
fat	55
moisture	55
sediment	43
Total	**849**
Bacteriological Analysis	
Standard Plate Count	91
Coliform	41
Direct Microscopic Count	3
Yeast and Mold	27
Proteolytic	29
Wisconsin Mastitis Test	11
Antibiotic test	2
Total	**204**



Pinpointing the HOW for

Economic Development

For current research subjects other than those on economic development, see List of Economics Department projects at the end of this section.

So you think of "economic development" as a high-sounding phrase confined to academic ivory towers or that it soars in the future beyond your niche in the scheme of things?

Every person on this planet has a common goal of improving his "level of life," although he may not be especially aware of it. The *HOW* for this improvement is a different matter, for it is as varied as an individual's values.

But generally the *HOW* can be lumped into one or a combination of these:

an increase in income,
a more equitable distribution of income,
an increase in employment opportunities,
a more pleasant and invigorating every day life.

Virtually all research by economists at South Dakota State University has a common goal of developing and improving use of the state's resources—land, labor, capital, and management. Both farm and non-farm aspects of South Dakota living are touched because the two are so closely related.

Take a look at these examples of the *"HOWS"* that economists at SDSU are working on to increase economic development in South Dakota:

- A computerized accounting system that gives a farmer or rancher the financial data he needs to make effective management decisions.

Agriculture with its 45,000 individual farms and ranches is the state's major industry. Thus, basic to economic development is sound management of those farms and ranches. Farm management research aims at developing and using management tools and securing information to help farmers and ranchers make the complex decisions required in a highly capitalized farm business. A typical farm or ranch in central South Dakota in 1970 required a $175,000 investment, $82,500 higher than just 10 years ago.

- Economic data for specific South Dakota areas is now available to help wheat farmers determine the most profitable farm enterprise at various combinations of crop and livestock product prices.

This was developed from a regional research effort that in South Dakota included 26 counties divided into eight sub-areas, each representing a specific type of farming. The information is avaible to farmers through publications containing a model-farm-analysis for each area. A research study is now being developed for evaluating government farm programs under varying assumptions.

- A first-ever computer adaptation that more than halves the time needed previously for feasibility analyses of business records and competitive conditions required by those businesses pondering mergers or consolidations.

Marketing research involves several projects to help South Dakota cope with the dynamic agricultural industry. Development of the computer model was a result of the

growing number of requests for information and help from business firms such as grain elevators or farm supply firms. The model is flexible enough to be used for various enterprises in various time periods. It is a first for this type of computer adaptation and should have nationwide application.

- An adequate supply of credit is important in economic development.

Studies are being made to identify credit requirements and how lending institutions can adjust and are adjusting to meet these needs. Three out of every four South Dakota farmers surveyed believe that adequate amounts of credit are available in their area—despite the rapid increases of capital needed for modern farming.

- Ways are being investigated for South Dakota to produce, process, and distribute food and fiber under the new technologies that have out-paced and out-moded the traditional methods involving farm and agri-business organization.

Broadly defined, marketing is the creation and delivery of a standard of living to society. Nationally, a total of nearly $70 billion is required annually to handle, process, transport and distribute food from farmers to domestic consumers—a sum nearly five times the total realized net income from farming in recent years. Changing technologies from the farm through to the consumer have a direct impact upon economic development in South Dakota. For example, while South Dakota "lost" nearly 12,000 farms during the 1960's, the average size increased almost 200 acres to 978 acres. Meanwhile the number of country elevators decreased by 122 to 411. One of the changes faced is the increasing demand for specific quality factors such as in grain and grain products.

- Because much of South Dakota's production is shipped to other areas for processing, the state's share of consumer food purchases is largely limited to only the value added by farmers in basic production. A marketing study is exploring opportunities for more in-state processing of agricultural products. The aim would be to take advantage of value added by the processor plus the resulting increased local employment and income.

Net South Dakota outshipments of feeder cattle are estimated to have nearly doubled between 1964 and 1970. Decline in cattle feeding was partly responsible but coupled with that was continued increase in beef cow numbers in the state. South Dakota is becoming more important as a feeder cattle exporter and less important in recent years in cattle feeding and in beef slaughter. Areas that process farm products receive the value added by the processor and also benefit from employment offered by the processing industry. A marketing study is in progress which will analyze opportunities for increasing employment and income by processing more agricultural products in a 10-county area in east central South Dakota.

- Although South Dakota's high quality corn and spring wheat have a worldwide reputation, this high quality alone isn't enough to offset comparatively high transportation costs because of the state's inaccessibility to a seaport. Reducing transportation costs won't be easy—but is not considered impossible even in a state where more than 300 miles of railroad track have been abandoned in the past few years.

Transportation costs play a vital role in determining the competitiveness of South Dakota agricultural products in external markets. A study is underway to determine the economic feasibility of using intermodal containers to transport South Dakota bulk grain. It addition to preserving the identity of a quality product, reports show handling costs and product damage are significantly reduced by this transportation method. Another investigation centers around the size of grain elevators and their location in South Dakota. A grain flow study will provide data on transportation needs vital to the elevator location investigation.

- Proposed state legislation for a semi-compulsory, per-head checkoff system to finance beef promotion could be broadened to cover other South Dakota farm products and also other programs in addition to promotion.

For example, the checkoff proposal of up to 10 cents per head of cattle sold could also be used to pay the state's share of the cost of expanding the Federal-State livestock market news service in South Dakota. The analysis of problems and opportunities in legislated statewide beef promotion programs was made at the request of the Interim Committee on Agriculture of the South Dakota legislature.

- South Dakota's potential available labor force from rural areas amounts to about 10% of the total rural population, investigations indicate. Furthermore, underemployment in terms of persons actually willing to change jobs or seek additional employment may not be as great as currently thought.

Population considered in the labor force study was of persons living in the open countryside and did not include those living in small towns. The population was successively narrowed through application of criteria such as age, education, and desire to work. Other findings of the survey: skill levels were generally low; 14% of males and 9% of females hold two jobs; 92% would not move to take a better job; 68% would not commute to work; 65% would not travel to learn a new skill; 42% would not learn a new skill if

new jobs were available; 78% were satisfied with their present occupation.

- Irrigation impact and development investigations that continue to draw high priority are pinpointing optimum economic farm organization under irrigation; relationships of capital-labor under irrigation and dryland farming; as well as potential pitfalls.

Alternative methods of farm organization under various systems of irrigation are being investigated. Other findings: the most economic organization under irrigation (of a representative 1,600-acre farm with irrigation potential of 920 acres in north-central South Dakota) was a livestock feeding operation using irrigated feed and forage crops. A farming system that involves intensive capital may replace one with intensive labor when only grain production is considered. But when irrigation is considered under a total farm concept including livestock feeding alternatives, a labor intensive system may replace a capital intensive system. Preliminary findings point to unprofitability of using capital intensive irrigation systems to irrigate marginal lands.

- It's generally assumed that large-scale water resource projects, such as those on the Missouri River, have a beneficial developmental effect on the region in which they are situated.

SDSU economists are investigating the nature of the impact of water resource projects, and who within the state receives the benefits. This is a new, 3-year study. Another study nearing completion attempts to relate levels of water pollutants in the Big Sioux River to sources of pollution. Results of this research are considered important because they could influence decisions on cost-sharing should such measures be taken to maintain or improve the quality of water in the Big Sioux. As part of an overall study of weather modification, economists will help evaluate potential effects to the state under the assumption that increases in precipitation are possible and practical.

- When economic development is studied, there is usually a search for a "prime mover" that triggers the action. These prime movers change with time, conditions and regions—studies seek to pinpoint one or more that is applicable now.

The *HOW* of economic development of a region is not necessarily obvious and firmly established. A "prime mover" may deal with available natural resources, sufficient capital, entrepreneurial ability (or the ability of someone who would make decisions to undertake an enterprise), and, more recently, education. The *HOW* of South Dakota economic development as far as SDSU economics research is currently concerned involves a prime mover consisting of what is referred to as a growth perspective that embraces resources, capital, entrepreneurship and education.□

LIST OF PROJECTS
ECONOMICS

S-489 Economic Analysis of Irrigation Systems Applicable to the Northern Plains. (Gordon D. Rose and J. E. Wiebe)

S-502 Farm Corporations—Their Possible Role in Solving the Farm Tenure Problem of Gaining and Maintaining Control Over Land and Other Resources. (Russell L. Berry)

H-504 Impact of Structural Changes in Agriculture on Credit Needs and Availability in South Dakota. (Herbert R. Allen)

H-532 Factors Affecting the Role of Farmers and Ranchers in Livestock Marketing. (Raymond O. Gaarder)

H-533 Egg Prices and Pricing in South Dakota. (William Kohlmeyer)

S-535 Impacts of Institutions and Government Policies on Area and Community Development in South Dakota. (Gordon D. Rose)

H-575 Economic Analysis of Pollution Control Measures Associated With Alternative Land Uses. (J. E. Wiebe)

H-583 Analysis of the Transportion of Grain and Farm Supplies within South Dakota. (William F. Payne)

S-586 Economic Analysis of Beef Production in Southeast South Dakota. (Wallace G. Aanderud)

H-587 The Structure of the Fertilizer Input Market in South Dakota. (Richard K. Rudel)

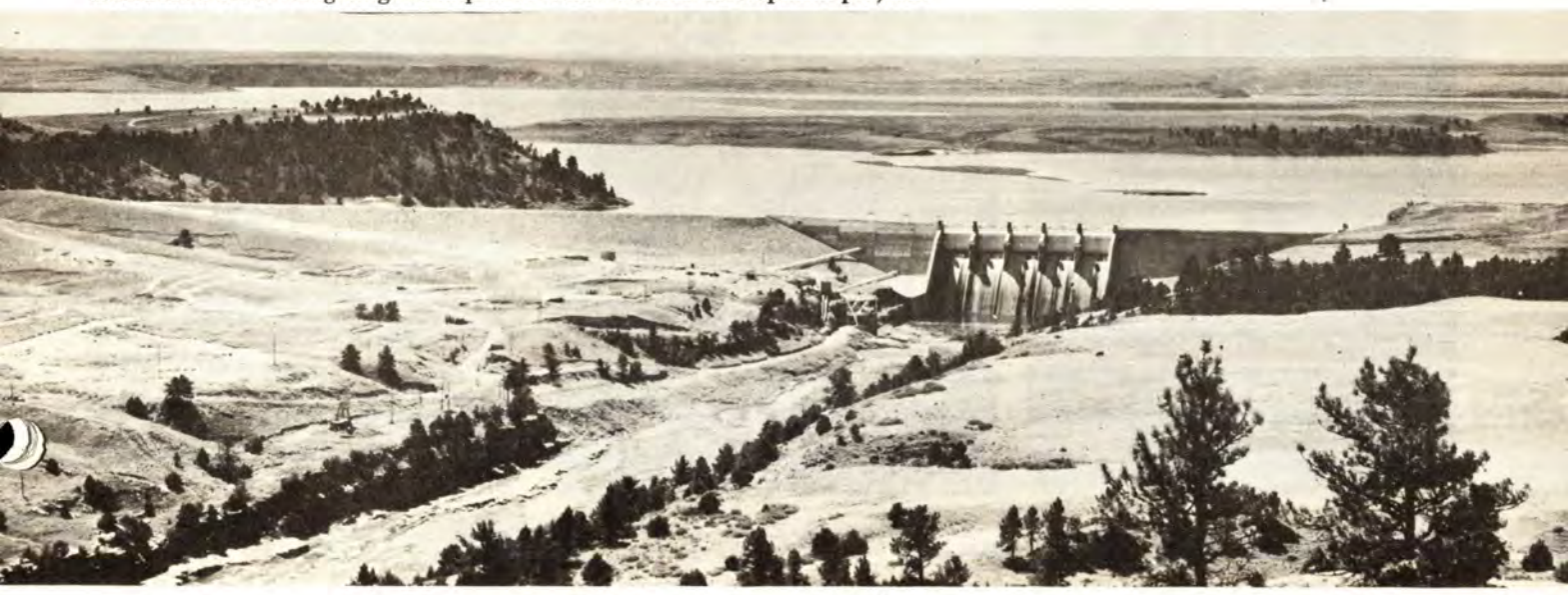
H-588 Alternative Marketing Opportunities and Techniques for Grain and Farm Supply Firms. (Arthur B. Sogn)

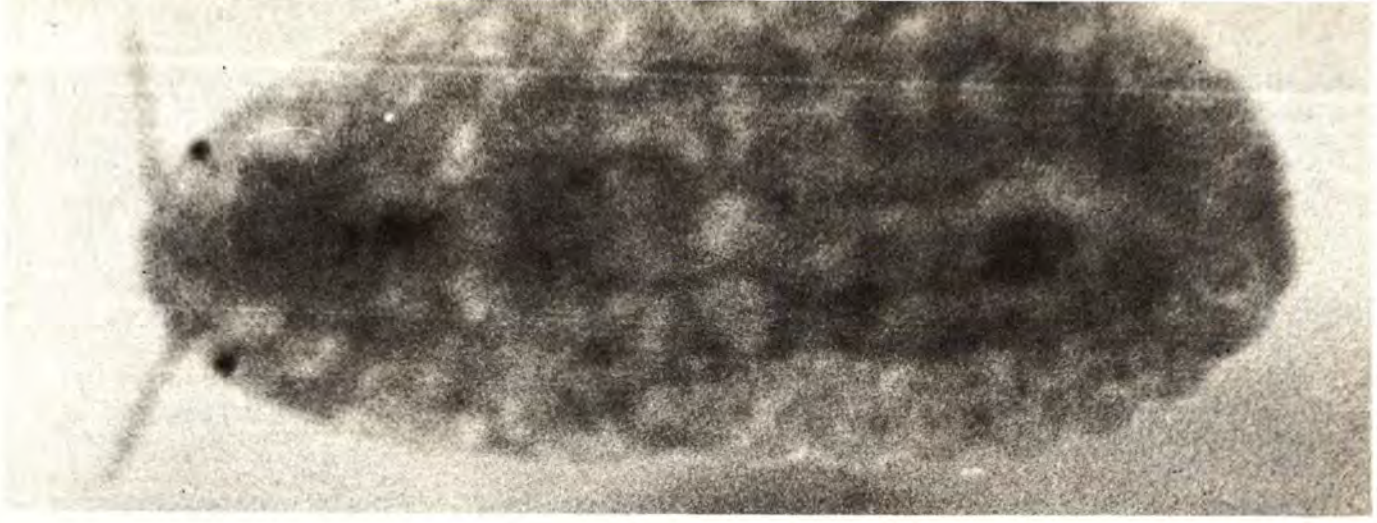
H-603 The Economics of Institutional Arrangements for Viable Rural Communities in the Great Plains. (Gordon D. Rose)

PROJECTS COOPERATIVE WITH WATER RESOURCES INSTITUTE:

WRI-B-009-SDAK Economic Analysis of Irrigation Systems Applicable to the Northern Great Plains. (Gordon D. Rose and Wallace Aanderud)

Economists are investigating the impact of water resource development projects.





Another "consumer" on the range: the mealybug. Actual size is smaller than a pinhead. Huge mealybug populations feed on sap from grass plants over a wide area.

Entomology-Zoology

Considering insects as "Unmarketable Animals"

One group of "animals" in South Dakota is not only unmarketable but it consumes or damages crop and livestock products worth millions of dollars annually.

These "unmarketable animals" consist of only the few most-damaging insects out of scores of different kinds which gorge themselves on crops that South Dakota farmers and ranchers spend hard earned money and a lot of work to raise.

For instance:

Corn rootworms still eat an estimated $5 million chunk out of South Dakota's corn crop despite the fact that control efforts bring savings of $15 million.

Greenbugs feast on $1 million worth of sorghum and $4 million worth of wheat in some years.

Alfalfa insects—with the alfalfa weevil heading the list—cause an estimated $6 million in damage.

European corn borer damage varies greatly year by year. In 1971, an extremely heavy infestation is estimated to have caused around $25 million in yield loss.

Two insects alone—horn fly and face fly—have a high damage price tag for cattle producers.

Just keeping "even" with these costly insects will be a major accomplishment but ways are being devised through research at the Agricultural Experiment Station to lessen the damage, perhaps even recoup some losses. It may come as a surprise to many persons that a goodly portion of this Entomology-Zoology Department research is aimed at finding pest controls of a non-chemical nature.

Alfalfa Insects

It's too early just yet to tell if an "imported" insect will be able to gain and maintain a foothold in South Dakota to prey on its main enemy, the alfalfa weevil. About 3,000 of the insects have been released in western South Dakota during the past 4 years. Entomologists keep tab on survival through use of check cages in fields in the vicinity where the insects were released.

These particular wasp-like insects of European origin, (which are about the size of the "B" in their scientific name, *Bathyplectes anurus*), were obtained from a federal parasite introduction laboratory in New Jersey. They reportedly have helped reduce alfalfa weevil populations in eastern states by attacking the larval stage. Even if the New Jersey import as well as several others become fully established in South Dakota, entomologists look upon them as helpers needed in addition to other control methods to aid man in the battle to substantially reduce losses from alfalfa weevil.

Another "imported" insect, now well established in several South Dakota areas, is given much of the credit for increasing alfalfa seed yields in fields where they are used. The insect, the alfalfa leaf-cutter bee, was first brought to South Dakota several years ago from Utah where it gained renown for its ability—and industriousness—in pollinating alfalfa flowers.

The alfalfa leaf-cutter bee was given major credit for better than a 100-pound-an-acre seed yield on a 5-acre field of second cutting alfalfa north of Brookings. The state average alfalfa seed production is usually about 60 pounds per acre.

But the leaf-cutter bee has "native" enemies, the most serious be-

For current research subjects other than those reported below, see List of Entomology-Zoology Department projects at the end of this section.

ing larder beetles which invade the nests and destroy the stored food and immature bees. Entomologists were unsuccessful in attempts to reduce larder beetle infestations by using protein paste bait with chlorinated hydrocarbon insecticides. Now entomologists are looking into sanitation-like procedures which would exclude predators by eliminating situations favorable for their buildup. The idea is to force the leaf-cutter bees to use new and fresh nesting materials each year by installing a one-way, funnel-like escape hatch on their overwintering nests.

Corn Rootworm

Research with the corn rootworm, an expected problem insect in South Dakota for years to come, follows several directions at SDSU. One concerns possible buildup of resistance to currently recommended insecticides. Several years ago western corn rootworm began developing resistance to the chlorinated hydrocarbon compounds then in use. Tests this year, however, indicate no resistance to materials in the organophosphorous and carbamate groups now used for control.

Insecticide evaluations for larval control include registered as well as new, unregistered experimental materials. One promising new insecticide is an entirely different type of compound which provides at least one chemical in case the rootworms begin to build up resistance to current materials.

Evaluations of different corn rootworm insecticide treatments near Hot Springs showed a range of 13% to nearly 28% in yield increase (11 to 24 bushels) over untreated corn. Applications of the insecticides were made at planting time for control of larvae. Research entomologists consider this the best plan of attack.

Up to 99% control of adult corn rootworms was obtained in Moody County by spraying insecticides from aircraft. Various insecticides and combinations, including registered and unregistered, were used with both ultra low volume (ULV) and normal spraying methods. Adult rootworms appear during the critical, few-day pollination and fertilization stages of corn growth when the plants are too high for effective control with ground equipment.

European Corn Borer

Infestations of European corn borer the past 2 years, believed to be a cyclic appearance of the insect, have been costly in some areas of South Dakota.

Some states have reported control of both corn borer and corn rootworm with Furadan. Unfortunately, this is not the case in South Dakota. Evaluations show that the insecticide applied at planting time using recommended rates for corn rootworm did not give control of first brood corn borer. At rates two to four times greater than "normal," the insecticide applied at planting time into the furrow as well as in a band gave 15% to 50% corn borer control. However, these excessive rates are heavier than registered rates and, additionally, are not economical under present conditions. The insecticide is systemic (taken up by the plant) in its action as far as corn borer control is concerned.

Most corn borer control is by aerial application during the 10-day-or-less critical time when borer larvae are going into the whorl and stalk of the plant. Aerial applications in both granular and liquid forms for heavy borer infestations in Yankton, Beadle and Sanborn counties resulted in better than 75% control.

Experiments with aerial application next year are planned with a new "foam" type material. This material reduces the spray drift problem and tends to flow into whorls of the plant rather than remain on leaves as do other sprays.

Greenbugs in Grain Sorghum

Some systemic-type insecticides banded over the row at planting time, as is done for corn rootworm control in corn, have given as much as 85% reduction in greenbug populations in dryland grain sorghum. Yield increases of up to 30% over untreated sorghum have been recorded.

Insect-contact chemicals flown on during heavy infestations have given more than 99% reduction in greenbug populations.

Greenbugs in Winter Wheat

Damaging infestations of greenbugs in winter wheat in 1968-69 prompted new research for this crop. However, during the past 2 years the infestations have been comparatively light. The reason ap-

Entomologists use several types of check cages in fields to keep tab of beneficial insects imported to South Dakota. Some natural insect enemies of alfalfa weevil have been released in the western part of the state.

Greenbug research goes on all year. This winter-time laboratory photo shows a greenbug "cage" which is kept in fall-like temperatures in the growth chamber (background). Inspecting the cage are John E. Kvenberg (left), graduate research assistant, and Phillip A. Jones, survey entomologist with the Agricultural Experiment Station.

parently is because droughts have kept greenbug populations in check about the time the insect moves from sorghum to winter wheat. Although the fortunate conditions that greatly reduced greenbug populations "naturally" precluded research on actual insect control, investigations are underway to determine if the systemic insecticides affect wheat quality.

Greenbug research continues in laboratories during winter months where more is being learned about their growth and development as well as the activities of their predators and parasites. One possibility for the future: determining, under certain conditions of weather and other factors, that it might be better to let the insect enemies of greenbugs take over for a time rather than spray an insecticide which would reduce populations of both. To be tested next year are synthetic hormone type materials that are applied by aircraft and which interrupt the normal pattern of greenbug growth.

Cattle Insects

Success with ultra low volume (ULV) aerial spraying has opened additional investigations in continuing research to lessen losses caused by horn and face flies on range livestock. In addition to extreme annoyance to animals, large numbers of the flies can result in reduced milk production of dairy cows an estimated 10%-20% and prevent weight gains of beef cattle by as much as a half pound a day.

ULV spraying research with low-flying aircraft (50-75 foot altitudes) has used comparatively small amounts (1 to 12 ounces an acre) of concentrated organic phosphate compounds such as malathion, vapona, and dibrom. Some 2,500 head of cattle owned by cooperating ranchers in central and south-central South Dakota were involved in these investigations. Horn fly counts have been reduced by as much as 78% on cows and 82.4% on calves the day following applications. The research, pioneered in South Dakota, has helped determine the most suitable spray materials as well as timing and frequency of spraying based on seasonal population trends of the insects. Aircraft have advantages of wide range and ability to spray cattle in remote areas. The ULV idea for ground use with back-pack sprayers for control of the flies in feedlots is continuing as more adaptable equipment is sought.

An offshoot of the ULV research is a comprehensive investigation of possible side effects these insecticide treatments might have on non-target insects associated with horn and face flies. For instance, many natural enemies of horn and face flies have been found in cattle dung. These include beetles, parasitic wasps and nematodes which prey upon larval stages, especially, of face and horn flies. Twenty different kinds of beetles were found overwintering in just four "cow pies" collected from one range site. More than half of these insects are suspected to directly affect the welfare of the flies, either by feeding on fly eggs or larvae or by disrupting the habitat. Investigations have been made to determine just how effective certain predators are in holding back fly populations, and new studies will be made to see what effect, if any, the insecticides are having on the natural enemies.

Research, which resulted in the improved method of blunting losses caused by horn and face flies, is also delving into the life and habits of species of dung-dwelling scarab beetles. One role of these beetles is decomposition of cattle manure — (natural "recycling" on the range?). Such dung beetles help disrupt the habitats of troublesome horn and face flies. The importance of the scarab beetle, where it fits into the picture, and how ULV spraying might affect its life cycle is also an objective of current research.

Range Grass Insects

Animals are not the only consumers on grasslands over a vast area in South Dakota. Large populations of a pinhead-size sap-sucking insect have been found to at least equal and perhaps surpass cattle, on a per-acre basis, when it comes to using grass as feed.

The insect—commonly known as the mealybug—is not a newcomer. Apparently it has been here all along. Only within the past 18 months, however, has Agricultural Experiment Station research helped to establish the importance of

the insect on grasslands of South Dakota, and probably of the entire Northern Plains as well. Although studies show that hordes of mealybugs consume more plant sap on a per-acre basis than beef cattle grazing at a proper stocking rate, it remains to be discovered if this insect is actually friend or foe of beef cattle producers. The question goes into the largely unknown areas of grassland ecosystems which only now are being intensively investigated. In other words, the actual effect of mealybugs on total grass growth is unknown. It might just be that they have some as yet unrecognized function and without them some other even more voracious insect might take over causing greater losses.

Since 1968 SDSU entomologists have reported mealybugs on buffalograss and blue grama in eastern South Dakota. Latest findings near Cottonwood indicate even heavier populations west of the Missouri River. The insects generally live in the crowns of plants, causing injury by extracting plant sap (phloem) and by excreting honeydew, which can form a medium for growth of various species of fungus. Entomologists believe a combination of overstocking, dry weather, and high mealybug populations may be the reason for spotted grass kills noted on some ranges.

What to do about mealybugs? Until more is learned about the role these scale insects play in the grassland ecosystem, about the only thing a range livestock producer can do is to maintain high range condition and resign himself to the fact he's contributing a large amount of plant sap to an inconspicious "bug." Research has found that the mealybug populations in low condition range were about twice as high as populations in high condition range. This was because high condition range was also populated with more natural enemies of the mealybugs. If the mealybug does turn out to be a villain, insecticide control would be virtually impossible because of the millions of acres involved, finding a suitable chemical without residue problems, and possibilities of upsetting the delicate natural grasslands balance which apparently has been built up over a long period.

Continuing research to learn more about the mealybug is taking SDSU entomologists to ranches in western South Dakota where they are attempting to learn more about relationships of mealybugs and their natural enemies plus studying the specifics regarding plant species and distribution. The mealybug research meshes with a portion of the South Dakota phase of the Grassland Biome subprogram of the International Biological Program (IBP), a worldwide effort involving more than 50 countries concerned with the biological basis of productivity and human welfare.□

LIST OF PROJECTS
ENTOMOLOGY-ZOOLOGY

H-288 Investigations of the Alfalfa Insect Situation on South Dakota. (R. J. Walstrom)

S-406 Survey Entomology. (P. A. Jones)

H-601 Absorption, Placental Transfer and Utilization of Iron Compounds by Swine. (R. N. Swanson)

S-473 Body Tissue Distribution of Ammonia Loads and Embryonic Mortality. (M. H. Roller)

S-505 Investigations in the Ecology and Control of the Western and Northern Corn Rootworm in South Dakota. (P. A. Jones)

S-506 Biology, Ecology, Behavior and Control of Certain Dipterous Insects on Livestock in South Dakota. (E. U. Balsbaugh)

S-507 A Study of the Pesticide Residues and of Parasites in Big Game of South Dakota. (E. J. Hugghins)

H-522 Biology and Integrated Control of the Greenbug on Sorghums and Small Grain. (P. A. Jones)

H-552 Use of Antihyperlipemic Agents in the Control of the Hog Roundworm, *Ascaris lumbricoides* Suum. (A. Greichus)

H-553 Potential Limitations in Grass Production in Western South Dakota Due to Insects and Mites. (B. McDaniel)

H-557 Environmental Implications of Pesticide Usage. (R. J. Walstrom)

While corn insects cause losses of millions of dollars annually in South Dakota, the cost would be far greater if growers did not have information available about control measures determined through research and testing. Much of the information on insect control is disseminated by the Cooperative Extension Service. Benjamin H. Kantack, Extension entomologist, here inspects insect damaged corn in a field near Centerville.

Home Economics

Interest centers on smoked pheasant at this table but other new foods using South Dakota products are also being developed in SDSU home economics research laboratories.

Foods, carpets, clothing . . .

Helping the Consumer

HOME Economics research at South Dakota State University is zeroing in to help consumers—be they women with laundry problems, men purchasing clothes, households seeking the best buys in carpets, or people sitting down to a meal of South Dakota wild game.

Behind much of this research is the idea that the South Dakota product—from wheat to buffalo meat—is the best there is for its intended use. The research in some cases aims at encouraging processors to use more South Dakota crops by finding new uses or new methods of preparation.

Although home economics and tourism are in different realms, Agricultural Experiment Station research by the former hopefully will benefit the latter by encouraging sportsmen to sample South Dakota wild game hunting. Home ec researchers do this, in part, by showing the various ways the successful hunter can prepare his South Dakota pheasant, deer and other wild game. For the consumer who prefers to get his "wild game" at the food store, research is looking into processing methods that could help make it available in various forms.

Spruced-Up Wild Game Preparation

Development of new uses as well as more tantalizing regular methods for preparation of domestically raised birds has resulted in such food innovations as pheasant pate, smoked pheasant, smoked pheasant pate, and freeze-dried pheasant products. Palatability of SDSU-type smoked whole pheasants has been shown to be highly acceptable for a food that can be produced in quantity for restaurants and distributed to specialty food stores. Several levels of salt brine and cover brine were investigated in connection with smoking of pheasants.

Meat scraps from the pheasant carcass, after the choice breast and thigh were removed, have been ground and blended to make a pate that will suit the taste of the gourmet. The product has possibilities as a special-food canned item.

Freeze-drying pheasant meat may offer a new wrinkle for commercial processing. Perhaps there awaits a suitable market whereby a consumer could take freeze-dried pheasant and reconstiute it, along with a dried sauce preparation, into a tasty addition to a meal. Technical aspects of freeze-drying remain to be investigated.

For current research subjects other than those discussed below, see List of Home Economics Department projects at the end of this section.

Home ec researchers don't pretend to tell nimrods how to get a deer—that's left to the skill and luck of the hunter. They have found, however, that type of forage consumed by deer—such as mountain mahogany browse—is not alone responsible for sometimes-undesirable flavor in venison. When other adverse factors occur, however, the effects of different types of browse may be more noticeable. A taste panel working with the researchers indicated no appreciable difference in flavor or juiciness between a buck and a doe deer but did detect a more intense (but acceptable) aroma of the meat from the doe. A good "trophy" indicates an older buck, and age is likely to be an important factor in acceptability of the meat.

After the hunter has his deer, he can turn to research results which indicate how best to prepare various cuts of meat, how long he can keep venison in frozen storage (at least 6 months without loss in quality), how to smoke deer meat. Recipes have been developed for tasty deerburgers and venison bologna.

SDSU home economics researchers are big boosters of South Dakota beef, pork and lamb. But for consumers who desire a temporary change of fare, home ec research in labs and kitchens may soon be plugging another South Dakota product—buffalo meat. Preliminary work has started with various cuts of buffalo to determine cooking methods which will result in the most acceptable product and to develop new buffalo meat recipes.

South Dakota Wheat

South Dakota produces hard red winter wheat, hard red spring wheat, and durum wheat giving triple-threat possibilities for different marketing channels. Research is attempting to develop highly acceptable and palatable freeze-dried wheat products—including snack-food items — which have multiple-use possibilities. The process would be adaptable to commercial development — it isn't something that could be done at home. Advantages of a freeze-dried product made from whole wheat kernels would include an inexpensive source of protein and other nutrients of whole wheat, convenience in storage, and reconstitutability.

Appearance of fabrics is checked in the laboratory under standarized conditions. Nancy Bracht, a student from Twin Brooks, S.D., assists Cora R. Sivers, associate professor, in fabric evaluation.

Wear, Laundry Factors of New Fabrics

How do some of the new fabrics stand up during the wear and tear of use and laundering? Home ec researchers had a convenient, ready-made method of evaluating at least one of the fabrics. Girls in dormitories on the SDSU campus used durable press polyester/cotton blend pillow cases for a 45-week period. Each week the pillow cases were returned to the laboratory for laundering and evaluation. After the final period of use the pillow cases are being evaluated for appearance retention, measured for dimensional change, and analyzed for residual strength.

Hard Water Laundering Problems

Home economics researchers, studying home laundering problems caused by hard water in some places in South Dakota, went directly to those areas to help the consumer. Laundering white fabrics is especially vexing to homemakers in these hard water areas. Women in the northeastern counties of Day, Marshall and Roberts (and one county in Minnesota) volunteered to help in the research by home-laundering swatches of white fabrics along with their regular laundry. Periodically the "at-home" researchers would return laundered

Special "paper" thermometers, consisting of strips of sensitized paper sealed in glass tubes, are dipped into wash water by homemakers cooperating in research on hard water problems. Changed color of sensitized paper provides a permanent lab record of water temperature used in that particular washing.

swatches to the textile laboratory at Brookings for measuring loss of whiteness. In this way researchers were able to obtain data on different home methods, amount of detergent used, types of water, and water softeners. With the data being obtained in this cooperative effort, textile researchers will attempt to work out methods for improving results for specific problems.

Carpet Selection

Buying a carpet usually involves a major expenditure and is not expected to be repeated very often. Research was designed to get information that would help the carpet buyer when floor coverings are being considered.

Pieces of carpet, 4x5 feet in size and representing two different price levels, were placed in the hallway of a building at SDSU where student traffic was heavy. Periodically the carpet samples were cleaned and measured for wear, color retention, and other properties which would be valuable for a carpet buyer to know.

Some factors brought out in the research: The longer a carpet is used, the more frequent is the need for cleaning to maintain appearance. Higher priced wool, acrylic, and nylon changed less in pile height – retained shape – than the lower priced carpeting. Wool carpeting did not show soiling as soon as the synthetic fibers. Nylon carpeting after 3 years heavy traffic changed least in appearance and in thickness.

Men's Clothing Buying Habits

Consumer and retailer alike should be interested in what influences South Dakota men in their purchase of clothing. To find out more about it home economics researchers went right to the source: they asked 1,682 South Dakota men about their clothing buying habits.

Conclusions: West River and East River South Dakota males are about the same when they go into a clothing store and make their selections. There are some differences, however. Both East and West River men indicated that store window displays were their most important source of new fashion ideas. Wife and female associates and television ranked next in order of importance for East River men. But West River men ranked television and male associates as most important sources of new fashion ideas.

West River men preferred to shop alone more than did East River men. However, if a shopping companion was desired, the wife was preferred.

More than half of the men responding to the survey couldn't recall the brand name of the last specific clothing item selected. From these responses the investigators concluded that when a South Dakota male goes out to buy clothes he isn't particularly concerned with brand names.□

LIST OF PROJECTS
HOME ECONOMICS

S-429 Fabrics and Water Problems. (L. O. Lund and C. R. Sivers)

H-337 Carpeting Qualities. (L. O. Lund and C. R. Sivers)

H-464 Clothing Buying Practices of Young Adult Women. (L. O. Lund and A. Hsia)

H-468 End-Use Performance of Sheetings. (L. O. Lund and C. R. Sivers)

S-479 Use of Pheasants in Promoting Tourism, Economic Diversification in South Dakota. (F. M. Hettler)

S-577 Effect of Iron Supplementation on Blood Levels of Iron. (E. Rust and L. Guild)

H-578 Utilization of Wheat and Wheat Products for Human Consumption. (E. Rust, D. Deethardt and L. Guild)

H-579 Low-Income Women's Sewing Practices. (A. Hsia)

Better methods of preparing wild game are studied in home economics research labs. Taste panels assist in evaluation of the foods. A new bulletin, "You Have Your Deer, Now Enjoy Its Meat," is the result of part of this research.

Horticulture-Forestry research for

An Enhanced Environment

Demonstrational fence line planting in McCrory Gardens, horticultural-forestry research site near SDSU campus.

A BRIGHT red, banana-shaped dwarf pepper that you can enjoy looking at as well as eating is an illustration of the double-barreled results often obtained from South Dakota State University research aimed at improved productivity as well as enhancement of the environment.

This yet un-named sweet pepper was developed as a part of the Agricultural Experiment Station vegetable breeding program. These plants color their fruit early to provide the eye-catchers and palate-pleasers.

Horticulture-Forestry Department research additionally ranges far from the home garden to include commercial applications as well as improvement of living conditions and recreational opportunities.

TREES, A SOUTH DAKOTA ASSET

Reservoir Tree Establishment

Trees are definite assets throughout South Dakota. In recent years attention has centered toward establishing more trees along the Missouri River reservoirs to enhance the environment, make the area more attractive and pleasant for leisure or recreational use.

Conditions are not suitable for tree growth everywhere along the network of Missouri River reservoirs. Loss of time and effort results when trial and error methods must be used to determine the favorable as well as the less adapted sites. SDSU researchers, who have been studing the ecology along the reservoirs, believe they have found at least a partial solution: "indicator" plants. Certain plants have been observed to grow on sites having soils, moisture levels and other conditions most favorable for growing trees. These plants include dock, cocklebur and snowberry.

Planting Windbreaks

Extensive windbreak and shelterbelt plantings have been a part of the South Dakota scene for many years. Windbreaks contribute substantially to improved living in rural communities. On ranches and farms they contribute to lowered home-heating costs in winter or provide a cooling effect in hot summer. Planting new windbreaks or renovating the old is a continual process.

Research has demonstrated that trees even generally considered well adapted to South Dakota such as green ash, elm, or hackberry, must be grown with seed obtained from superior sources. For example, researchers have found that green ash seed from Nebraska sources produced trees adequate in hardiness and they grew faster than trees grown from seed gathered in South Dakota. Green ash and elms from North Dakota seed grew slowly and trees from Kansas and Oklahoma seed lacked hardiness. Hackberry trees from South Dakota seed were superior to hackberry trees from seed sources in Nebraska and other states to the south.

For current research subjects other than those reported below, see List of Horticulture-Forestry Department projects at the end of this section.

Nurse Crops for Trees

How about a nurse crop to help protect newly planted trees? This protection is especially needed for ponderosa pine, an important species in windbreaks but too often so difficult to establish their use is curtailed.

Shingles or other protective devices around each small tree may serve as protection from wind. Even weeds were found to serve an important role in protecting trans-

planted pines from wind and provide other beneficial microclimatic effects. However, weeds actively grow throughout the season and are competitive with the trees for soil moisture.

Research is underway to determine the feasibility of planting rye as a nurse crop. Within the late summer-seeded rye planting, rows 3 feet wide were treated with the herbicide treflan which was incorporated into the soil for weed control. Trees were planted immediately afterwards. Researchers noted that during the ensuing season the herbicide was effective in controlling weeds in the 3-foot rows and rye controlled weeds between the rows. Rye gave wind protection to the young trees and, additionally, matured early in July so as not to compete with trees for moisture in late summer. The trees are growing as well as those grown under customarily-practiced clean cultivation.

Help in Selecting Trees

A comprehensive, new publication by the Horticulture-Forestry Department is a boon for South Dakotans interested in planting trees as ornamentals or shade trees. The publication, Bulletin 578 "Deciduous Trees for South Dakota Landscapes," carries a wealth of information on what to plant as well as on what not to plant, suggestions for use, and descriptions of scores of tree species.

New Pear for Home Orchard

South Dakotans who enjoy the relaxing efforts of growing flowers, vegetables and fruit in home gardens will have a new dessert pear available within a couple of years. Propagation wood of the dessert pear developed by the Agricultural Experiment Station was released to nurseries in 1971. Trees of this new pear will be grown in 1972 and 1973 and will be available to the public in 1974. This pear, which will be given a name when it becomes available in 1974, resulted from a cross made in 1954. Parents are Ewart, a variety from Ohio, and a South Dakota selection of unknown parentage resulting from a cross by the late N. E. Hansen and selected by the late S. A. McCrory.

Seed Sources from Europe

Young seedlings of the shrubby mugho pine obtained from Europe are being grown with the goal of selecting superior clones of various shapes and sizes for South Dakota landscapes. Seedlings are now in flats ready for transplanting to nursery rows in 1972. Native green ash and maple trees showing superior growth habits also are being selected and propagated for evaluation as trees for landscape purposes.

Controlling Lily Blooms

Delicate Amazon lily flowers are prized by florists for making corsages. But up until now there has been no dependable way of knowing when the unpredictable plants would bloom. SDSU research has determined that flowering may be easily regulated by controlling bulb temperatures. Schedules for year-round flowering of this lily are being perfected in SDSU experimental greenhouses.

The amateur indoor gardener might also find the Amazon lily of interest as it has potential as an attractive house plant.□

LIST OF PROJECTS
HORTICULTURE-FORESTRY

H-622 Vegetable Breeding and Cultural Practices. (Paul Prashar)

MS-551 Forest Ecological Succession on Missouri River Reservoirs. (Paul Collins)

H-528 Developing Improved Fruit Varieties and Fruit Cultural Practices for South Dakota. (Ronald M. Peterson).

S-526 Improving Floral Crop Production and Management. (David Adams)

S-525 Effect of Spacing on the Survival, Growth and Effectiveness of Windbreaks in South Dakota. (Paul Collins)

S-524 Selection of Adapted Species and Strains of Trees and Shrubs for South Dakota Farms. (Paul Collins)

H-523 Developing Improved Tomatoes for Home and Commercial Production in South Dakota. (Paul Prashar)

S-476 Campus Landscape Design. (LeRoy Johnson)

S-475 Selection and Propagation of Woody Plants for the Northern Plains. (Dale Herman)

H-174 Collecting, Preserving, Cataloging of Fruit Plants. (Ronald M. Peterson)

Small pines growing between rows of rye in an experimental plot.

Wonder Gold, a new sweet bell pepper developed at SDSU.

McCrory Garden visitors may inspect many varieties of lawn and garden plant species.

Big bluestem, once dominant throughout eastern South Dakota, is used in warm season grass research. Note difference in grass from favorable sites (left) and from less favorable sites (right).

More knowledge needed . . .

Soils, a Basic Resource

For current research subjects other than those on soils as discussed below, see List of Projects for the Plant Science Department at the end of this section.

It may take 25 years to finish surveying and classifying all soils in the state, but meanwhile there's a continuing need for more detailed information about soils, which make up an exceedingly complex and basic South Dakota natural resource.

We've got to know more about how to use soils, how to protect them, and in some cases how to restore many of their properties which have been damaged.

Research has already given us a vast amount of knowledge and information about South Dakota soils. Considerably more is probably known about South Dakota soils than we are effectively using for most economical production, prevention of pollution and erosion as well as for establishment of man-made facilities such as highways, buildings, recreational sites, airports and homes.

Increasing Demands

Another factor becoming apparent is our more extensive and increasing *demands* on our soil:

The farmer or rancher earns his livelihood with a demand for extraction of nutrients and water from the soil through the medium of a crop that may be a plant or the animal that eats it.

The road builder, the city planner, the airport designer demand more land to fill expanding space requirements.

Both urban centers and rural areas will often make demands on soil for disposal of wastes.

Recreation facilities that need large wide-open spaces demand soils that support growth of trees and grass.

There's a demand that soils "absorb" a long list of chemicals introduced by industry and agriculture.

In fact, all of us should be increasingly aware that we are making demands on the soil while we look for food, clothing, shelter, a vacation spot and a way to get there, or just by staying home and enjoying our own "little acre."

Soils offer so many complexities in makeup and distribution that even going full tilt soil scientists will keep busy for years attempting to gain more knowledge. Currently about three dozen professional soil scientists are working with various South Dakota organizations which cooperate in soils research. The Agricultural Experiment Station at SDSU is one of those organizations.

SOIL COMPLEXITIES

To get an idea of soil complexity consider that South Dakota has about 500 different soil series or kinds which are distinctive in makeup, slope, location or by other factors. Every farm or ranch may consist of several local kinds or types of soils. Every soil consists of mineral and organic matter, water, and air in varying amounts. All the billions of particles in a cubic foot of a loam soil, for example, are calculated to have a total surface area of about 560,000 square feet—more than equal to a strip a mile long and over 100 feet wide. A teaspoonful of soil may also contain billions of living organisms upon which crop growth, soil fertility, and soil development depend.

Soil Surveys Form Base

The base for much of what has previously been done in soils research and probably will continue to be so in the future are the surveys of soils, usually by counties, which is one major function of USDA's Soil Conservation Service. Actively helping SCS in South Dakota are the Bureau of Indian Affairs, Bureau of Reclamation, Missouri River Basin Investigations Agency, and the Agricultural Experiment Station. The state highway department, the state and U. S. Geological Surveys and the U. S. Forest Service and other organizations may become involved in certain circumstances.

Less than half of South Dakota's 48,611,904 acres have been covered by detailed soil surveys over the past 50 years. It is estimated that up to 25 years will be needed to complete soil surveying for all of South Dakota and readying the information for agricultural and other uses. Future research may discover easier and faster methods for making the surveys. Remote sensing is seen as one possibility.

Soil surveys completed and published are for these counties: Jerauld, Day, Clay, Spink, Brookings, Hand, Minnehaha, Codington, Washabaugh, Bennett and Shannon. Field work has been completed and surveys are in the process of being published for Davison, Lake, Sully, Todd, Marshall, Roberts, Hughes, Lincoln, and Mellette counties.

Out of what has been done has come soils information used for agriculture, land evaluation, building sites, recreational areas, tree planting sites, range improvement projects, location of roads and other structures, evaluation of soil suitability for sewage lagoons and septic tank absorption fields, drainage, frost action, and as sources of topsoil, sand, gravel, fill, and many others.

Farm, Ranch Planning Important

But the most important use of soil surveys is for individual farm and ranch planning—to treat each acre according to its best capability. Research workers combine their knowledge to place soils in groups depending upon soil capabilities and limitations. There are eight such groups but rarely would all be found on one farm. These eight capability groups form the common meeting ground for the person who uses the soil and the persons who have studied the soils down to the most minute detail. The researcher, for example, uses soil surveys to extend the research data from fertility experiments.

While considerable fertilizer research has been conducted and will continue, much has also been done in experiments that are not primarily concerned with fertilizers.

Land Evaluation

As a direct result of soil surveys and soil scientists' research, a series of county land evaluation guides is being published by the Agricultural Experiment Station for use by buyers and sellers of land, lending agencies, appraisers, directors of equalization, and others. Data from more than 2,700 land sales were keyed along with crop and grass production data to the environmental factors of precipitation, temperature, natural vegetation, slope, height above sea level, soil parent material and actual makeup of soils to determine the relationships of these factors on prices paid for land. Aiding with preparation of the land evaluation guides were county directors of equalization and the South Dakota Department of Revenue.

Enter the Computer

Yield predictions for average and improved management determined by the cooperative soil survey for all soil series in the state are now available on computer tape. In addition, computer tapes have been prepared showing for each of the nearly 500 soils of the state the capability classification, the range site or pasture suitability group, the wind erosion classification, the permissible soil loss, and the hydrologic group. These data are used extensively to provide answers to queries from throughout the state about soils. Also being prepared for computerization are engineering properties of the soil series—shrink-swell potential, suitability of the soil for septic tank absorption fields or for sewage lagoons, for shallow excavations such as for basements.

One evaluation based on applying up-to-date soil and crop management technology indicates that income could be boosted by 42% in a 10 - million - acre northeastern South Dakota area—without in-

Analyzing plants to determine what the soil needs.

creasing an acre of crops, without irrigating, or without raising market prices.

Reclamation of Soils

Possibilities of improving claypans in either dryland or irrigated soils are currently being investigated near Redfield. Claypans, the unfavorable physical conditions that hamper plant root growth, are spotted on productive land over large areas of South Dakota. They may be caused by both natural and man-related factors. Deep tillage or removal of claypan-causing sodium or magnesium salts, or a combination of the two, are major phases of these new experiments. The area under experimentation (about 12 acres) is being subjected to deep and shallow tillage, with and without various soil amendments, such as gypsum, and under irrigated and non-irrigated conditions. The goal is to evaluate possible procedures for the economic treatment of these soils to improve their manageability and performance.

Deterioration of soils even to the point where they become completely unsuitable for agriculture may result from either improper management practices or use of low quality irrigation water. Findings in this research may furnish more guides needed to prevent such losses and to improve lands already so affected.

Nutrient Enrichment of Waters

How much do soil erosion and water runoff that contain elements from the soil and fertilizers contribute to nitrogen and phosphorus enrichment of our water resources? Attempts to find out are being made through an assessment of pollution properties of certain agricultural practices. Runoff water from plots at Madison and Garden City is being analyzed for soil chemical elements. Effects of different management practices on water quality are being evaluated.

New Tillage Research

Additional new research in 1972 will concern tillage. One experiment will investigate chisel plowing as a possible replacement for conventional moldboard plowing under South Dakota conditions. Although chisel plowing is not new in this state, some basic features to be investigated are water intake, weed control, soil compaction, and soil tilth using different shovel types and different fall and spring dates for the tillage operations. Research elsewhere has shown advantages of chisel plowing in soil conservation because stubble remains on the surface and for increasing water intake of the soil.

Another tillage experiment — identified as "no-till"—will use a fluted or waffle coulter on a once-over basis. In experiments elsewhere it has been determined that when no-till is used without adding nitrogen fertilizer, corn yields tend to be lowered. This is probably because the reduced tillage action results in less aeriation and subsequently less activity by organisms that break down nitrogen into a form used by plants.

New Tool in Soil Surveying?

Remote sensing is a new tool being tried to determine its usefulness in development of soil surveys. More accurate soil maps are seen as one possible benefit from remote sensing and another, depending upon success of further research, may be reduction in ground survey and identification time. In preliminary cooperative research of the Plant Science Department and the Remote Sensing Institute, soil scientists interpreting color infrared aerial photos taken from an altitude of 14,000 feet were able to identify differences in at least one set of soil features more accurately than for those shown on current ground-surveyed maps of the experimental area in north-central South Dakota.

Research evaluating remote sensing for mapping range conditions is being conducted in Bennett and Perkins counties.

Soil-Plant Relationships

Simultaneous ground and aerial observations of the soil-plant environment at Redfield aim at improving efficiency of water use, especially under irrigated conditions. This cooperative experiment with the Remote Sensing Institute will investigate possibilities of aerial surveillance of ground and plant canopy conditions with an objective of being able to determine moisture needs of various crops from imagery obtained by overflights involving a comparatively large area. The current research is on fallow, dryland grain sorghum, and irrigated grain sorghum on the Redfield Irrigation Research Farm.

An outdoor class session for Plant Science Department students at the Agricultural Engineering Department's irrigation research farm south of Brookings. These experimental plots were used for research by a graduate student in plant science.

Within the soil and plant environment water and salts (including nutrients) are being continually cycled to or from the soil surface. As an understanding of the hydrologic and salt cycle is achieved, soil and water resources can be developed in a manner which will improve the quality of our environment. This experiment is designed to learn more about soil-plant relationships and practical methods of measuring them.

Preliminary results, show that rate of movement of water through Beotia silt loam soil at Redfield is more rapid than anticipated. Observations of plant canopy temperatures and plant dimension changes indicate that these may be useful in the future as water stress indicators for irrigation scheduling.□

(Plant Science Department report continues, next page.)

Service and Other Types of Activities of the Plant Science Department

Foundation Seed Stock

Foundation Seed Production for 1971

Corn	Acres
Single Crosses	47
Inbreds	5
Sorghum	
SD102	3
Rancher	5
Reliance ms	2
Exp. Hybrid (forage)	4
Soybeans	
Minn. 11-59-121	12
Corsoy	10
Chippewa 64	15
Minn. 59-213	2
Amsoy 71	8
Oats	
Burnett	40
SDI 541	106
Trio	10
Froker	18
James Hulless	1
Kota	4
Barley	
SD 640	180
Nordic	30
Larker	8
Mll	6
Burk	2
Primus II	13
HRS Wheat	
Waldron	25
Chris	28
Era	10
HRW Wheat	
Centurk	84
Winoka	16
SD6753	7
Rye	
Coloma	9
Cougar	11
Alfalfa	
Travois	24
Teton	50
Flax	
Linott	8
Oahe Intermediate Wheatgrass	9
Pierre Side Oats Grama	2
Lodorm Green Needlegrass	1

Seed Certification Service

	Acres
Application	**30,001**
Certified Inspected Acres:	
Corn	252
Sorghum (Hybrid)	40
Sorghum (Open-Pollinated)	497
Soybeans	992
HRW Wheat	1,076
HRS Wheat	3,375
Durum Wheat	498
Rye	2,116
Triticale	105
Oats	8,043
Barley	1,876
Flax	1,962
Proso Millet	100
Foxtail Millet	172
Alfalfa	583
Wheatgrass	754
Switchgrass	16
Side-Oats Grama	2
Green Needlegrass	1
Creeping Meadow Foxtail	84
Kentucky Bluegrass	1,168
Sudan Grass	90
Wildrye	10
Bromegrass	18
Trees	4
Production Inspected Acres:	
Corn	4,078
Rejected Acres	572
Canceled Acres	1,518
Total Acres Inspected	**28,483**
Number of Fields	702
Number of Producers	270

Seed Lab Samples

Service samples	4,586
Certified samples	1,146
Department of Agriculture samples	384
Total	6,116

Plant Disease Service

Loose Smut of Barley embryo test	250
Dutch elm disease diagnosis	150
Specimens received for disease diagnosis	680
Acres of potatoes inspected 3 times for seed certification	1,288

Variety Trials

Small Grains	Entries	Locations Seeded
Spring wheat	21	6
Winter wheat	20	8
Triticales	4	6
Rye	12	4
Barley	11	6
Oats	24	7
Flax	13	3

Corn Performance Trials. Total of 159 entries grown at seven locations. Entries vary from 28 to 67 per trial.

Grain Sorghum Performance Trials. Total of 56 entries grown at seven locations. Entries ranged from 16 to 41 per trial.

A form of remote sensing. A moving scanner on elevated track records data on the crop below. This experiment at Redfield relates to soil-plant environment studies. Data from overflights by aircraft of the Remote Sensing Institute are also used in this research.

Soil Testing Laboratory

Farmer soil samples by month
1970-1971

July	162
August	769
September	823
October	1,201
November	524
December	301
January	243
February	308
March	788
April	1,054
May	208
June	101
Total	6,482
Total plant samples from farmers	61
Total NO_3-N soil samples from farmers	302
Total Zn soil samples from farmers	355
Research soil samples, total	2,670
Research plant samples, total	3,545

LIST OF PROJECTS

PLANT SCIENCE

H-25 Breeding and Testing of Oats, Flax and Rye for South Dakota Conditions. (D. L. Reeves).

H-66 Breeding of Superior Field Corn Hybrids. (D. B. Shank)

H-148 Soybean Breeding and Soybean and Oilseed Production. (A. O. Lunden)

H-181 Breeding and Testing Wheat. (D. G. Wells)

S-183 The Surveying of Soils in South Dakota. (F. C. Westin)

S-256 Cultural Practices for Improving the Efficiency and Stability of Crop Production in South Dakota. (F. Shubeck)

S-303 Breeding and Testing of Barley for South Dakota and Upper Midwest Conditions. (P. B. Price)

S-401 Foundation Seed Stocks Division. (G. W. Erion and J. Weber)

S-402 Seed Certification. (J. D. Colburn)

S-403 Seed Testing. (R. C. Kinch)

S-404 Variety Testing. (J. Bonnemann)

S-409 Characterization of Range Soil Group Used in Range Site Classification. (E. M. White)

S-427 Development and Improvement of Laboratory Methods for Determining Forage Quality. (J. Ross)

S-517 Crop and Soil Management with and without Supplemental Water. (L. O. Fine)

H-518 Nutrient Enrichment of Waters by Soils and Sediments. (E. M. White)

H-520 Cereal and Forage Crop Virus Diseases, Their Identity, Effect and Control. (W. Gardner)

H-545 The Breeding and Testing of Superior Grasses Adapted to South Dakota. (J. Ross)

H-546 Forage Legume Genetics, Breeding, and Management. (M. D. Rumbaugh)

H-547 Mineral Content of Bread Wheats Produced in South Dakota—Levels and Factors Affecting. (L. O. Fine)

H-548 Investigation of Heterosis During the Gametophyte Generation of Autotetraploid Plants. (M. D. Rumbaugh and R. H. Whalen)

H-558 Protein Separations by Visual Protein Reference Boards. (R. C. Kinch)

H-567 Nucleic Acid and Protein Synthesis in Winter Cereal Seedlings During and Following Cold Acclimation. (D. G. Kenefick)

S-568 Efficiency of Beef Cattle Production in South Dakota with Various Methods of Land Use and Cattle Management. (C. R. Krueger)

S-570 Development of Soil Testing Procedures and a Soil Testing Program for Determining the Soil Fertility of South Dakota. (P. L. Carson and R.Ward)

S-592 The Identity, Extent, and Control of Forest, Shade and Shelterbelt Tree Diseases in South Dakota. (J. Otta)

S-593 The Occurrence, Effect, and Control of Bacterial Plant Diseases in South Dakota. (J. Otta)

S-594 Grain Sorghum Breeding and Production. (A. O. Lunden)

H-595 A Study of the Hydraulic and Physical Properties of the Soil-Plant Environment Using Remote Sensing, Field and Laboratory Techniques. (M. L. Horton)

S-596 Epidemiology of Wheat Rusts. (G. W. Buchenau)

H-597 Plant Growth Control. (W. E. Arnold and W. B. O'Neal)

H-598 Foliar and Root Diseases of Alfalfa. (G. Semeniuk and M. D. Rumbaugh)

S-599 Physiology of the Flax Plant in Relation to Seed Production and Quality of Oil. (C. D. Dybing)

S-600 Nematode Diseases of Range Grasses and Their Control. (J. D. Smolik)

S-602 The Effect of Foliar Diseases on Quality and Yield in Forage Grasses. (C. J. Mankin and J. G. Ross)

S-604 Control of the Major Diseases of Hybrid Corn Through the Development of Disease Resistant Inbred Lines. (C. M. Nagel, J. Jenison, and D. B. Shank)

H-605 Toxigenic and Pathogenic Capabilities of Fungi Isolated from Animal Tissues and Their Feeds. (G. Semeniuk, and W. U. Knudtson)

S-609 Crop and Soil Management and Associated Plant-Plant Environment Relationships. (P. D. Evenson)

S-954 Plant and Soil Science—Highmore. (F. Holmes)

S-960 Plant Science Administration. (R. Moore)

S-970 Northeast Research Farm. (Q. Kingsley)

S-971 Research Substation — Presho. (H. Geise)

S-979 Plant Science Farm. (H. Lund)

PROJECTS COOPERATIVE WITH WATER RESOURCES INSTITUTE:

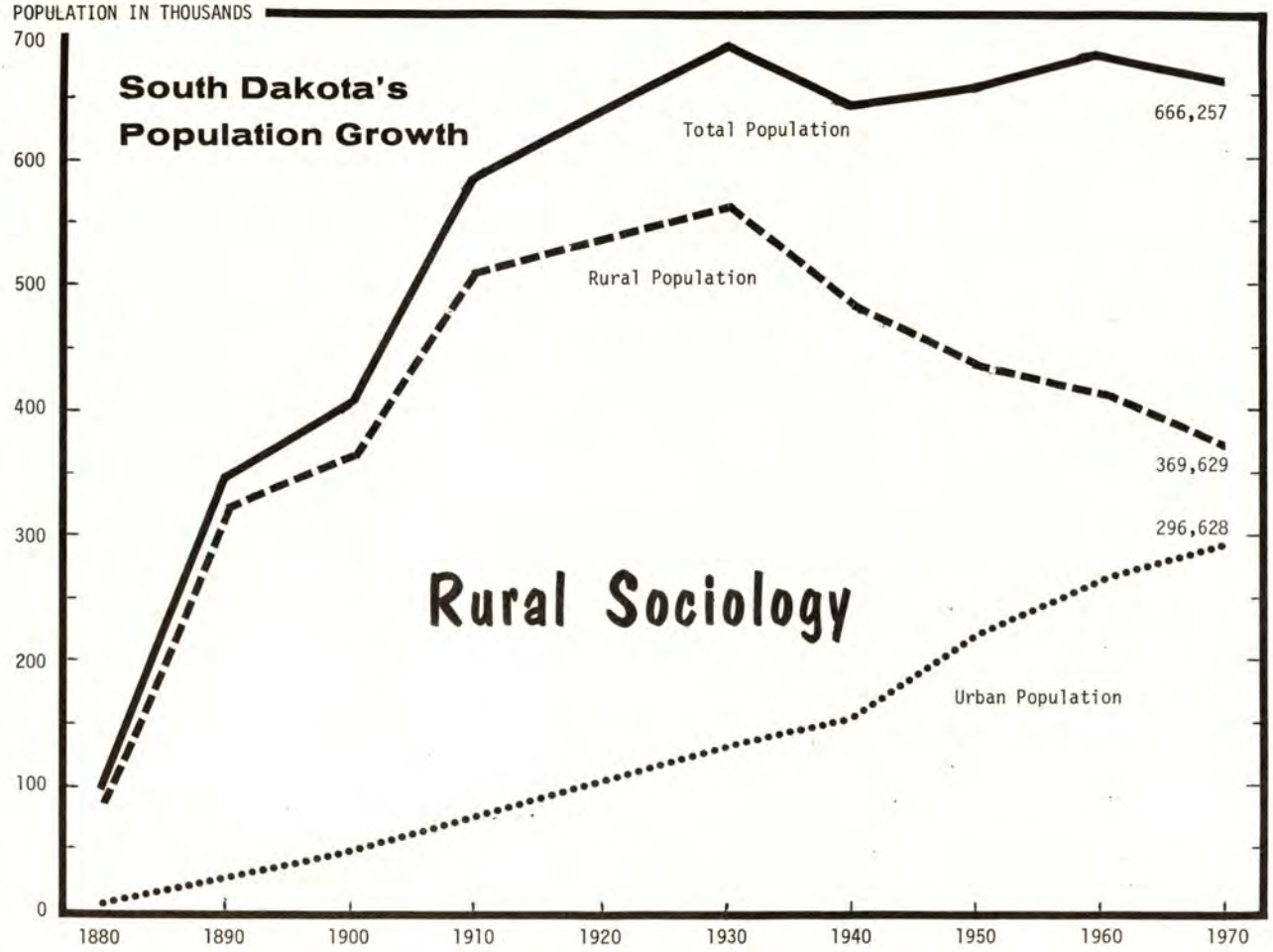
WRI-A-018-SDAK Understanding and Improving the Soil-Plant Environment for More Efficient Utilization of Water. (Maurice Horton)

WRI-B-004-SDAK Salinity Above a Water Table as Affected by Rainfall and Irrigation. (Maurice Horton)

WRI-A-026-SDAK Increasing Water Utilization Efficiency of a Pasture Grass by Increasing Aftermath Through Plant Selection. (James G. Ross)

Tobacco (right) is grown in Agricultural Experiment Station research plots—but not as a crop. Because certain tobacco plants are highly susceptible to ozone injury, they are used in several places in South Dakota to detect smog-type air pollution.

Upgrading barley as a livestock feed is being attempted at SDSU. One experiment involves crossing Primus II, a top South Dakota barley, with a non-adapted but higher lysine barley called Hiproly (below). Success would provide a new variety of great value to South Dakota.



Looking for answers why . . .

Dakotans Stay, or Leave

For current research subjects other than those on population studies as discussed below, see List of Rural Sociology Department projects at the end of this section.

COULD South Dakota's population losses that prompt hand wringing and doomsaying be not quite all that bad?

There's one school of thought, albeit a quiet minority, that asks: In this age of new interest in environment, ecology and enriched social life, are population losses a trend to be deplored or applauded? Additionally, there's the suggestion that perhaps under this new-wave concept the "quality of life" for South Dakotans is, or will be, at a significantly advanced stage due to lowering population densities.

Translated another way it might be argued that South Dakota's major "image" product is open spaces, fresh air and an infinite variety of climate. If so, the contention continues, window dress this product, put a price tag on it, add a promotional campaign, and you're in business selling a "natural" resource.

Unfortunately, it doesn't quite turn out that way. Too extreme plus or minus population changes bring up difficult problems that have wide-ranging impacts. The Department of Rural Sociology at the South Dakota State University Agricultural Experiment Station is currently focusing research attention on obtaining more specific data about South Dakota's population. Part of the aim is to put "handles" on some of the problems or difficulties thereby enhancing the possibility that we can come to grips with them.

Downward Population Trend

U. S. census figures show a total loss of 14,257 persons from 1960 to 1970 in South Dakota, continuing a downward trend of several previous decades.

These figures bring up some basic questions:

What are the causes of the population drop?

Is there really anything that can be done about it?

What will be the population of South Dakota in 1975, or in 1980, if something can—or even cannot—be done about losses due to out-migration?

If, for example, in-depth studies can pinpoint major *causes* of the state's population decline, some of

the potential solutions may become more apparent. By investigating the *causes*, more effective ways may be uncovered to concentrate efforts in these specific areas for possible improvement. If declining population trends do have certain advantages, it would be well to know about these too.

Projections for the years ahead are needed regardless of change in population trends – stabilized, increased, or declining to new lows. These projections could form one of the devices for use by agencies and groups involved in planning and development, business, government, taxation, schools, marketing, recreation, and a variety of other places where numbers of people—or lack of them—are concerned.

Study Who Goes, Who Stays

A population study of South Dakota at this time involves finding out more about the people who have left the state as well as about those who remain. Although South Dakota had 78,303 more births than deaths during the decade 1960 to 1970, a total of 92,560 more persons moved out of the state than moved into it. This out-migration helps explain why South Dakota had a loss in total population of 14,257 (-2.1%) the past decade.

This out-migration suggests certain questions: What parts of the state are experiencing the greatest loss or gain? What are the characteristics of the persons who are leaving? Why did the number of children under 5 years of age decline 35% from the decade of the 1960's, whereas the decline nationwide was only 15%? Why did the number of people 75 years of age and older increase 38% in South Dakota during the 1960's? What are some of the factors that may account for population change in the state? What will the South Dakota population be in 1975? or in 1980?

SDSU population studies go beyond mere numbers or stratified head counts. For instance, research has included measuring the extent to which rural poverty families possess those "culture of poverty" characteristics most often assigned poverty families in America. Findings show that rural South Dakota poverty people differ significantly from the stereotyped images often reported from urban ghetto studies. Of the 14 characteristics examined, 91 of the 120 families (in the study) possessed less than half of the characteristics while the remaining 29 possessed from only 8 to 11 of them.

Reports of Studies Available

As an initial answer to some of the questions, the first report of 1970 census data studies was in Bulletin 580, *South Dakota Population and Net Migration 1960-1970.* This is a descriptive analysis of population change and net-migration in tentative state planning districts, in counties, and in incorporated places. According to this analysis, the population loss was related to the decline in farm population, reduced growth for the state's major cities, lowering birth rates, and continuing out-migration. The estimated 92,560 population loss from 1960 to 1970 due to net out-migration is roughly equivalent to the loss of a population the size of Pierre or Vermillion every year for 10 continuous years. It is estimated that in the last three decades South Dakota has lost more than a quarter million people due to net out-migration.

A second report was Bulletin 586, *Reference Tables: Population Change of Counties and Incorporated Places in South Dakota 1950-1970.* This report provides a convenient source book of population count and population change for the counties and all incorporated places in the state for the years 1950, 1960, and 1970.

More Analyses Upcoming

Additional studies are planned and results will be reported in additions to the series of "population" bulletins. Examples:

An examination is to be made of changes in age and sex structure statewide as well as for state planning districts, counties, and selected segments of the state's population such as rural-urban residence, race, and others. This report will provide population profiles for each county, city over 10,000, state planning district, and the state as a whole for 1960 and 1970 together with supporting tables giving the actual factual information.

The 10 - year - old publication, *South Dakota Population and Farm Census Facts*, is to be updated to provide reliable and meaningful information to legislators, county agents, educators, and community business and labor leaders regarding related current population and agricultural changes.

An analysis is scheduled to study the effect of births, deaths and migration on changes in the composition of the population by age in the state for the 1960-1970 decade. Among other things, this study will investigate the relative significance of net out-migration, changing birth rates and rural depopulation as it affects population age structure for South Dakota and selected geographical sub-divisions.

A cooperative inter-departmental study is aimed at providing population projections by size, age and sex for the state as well as for tentative state planning districts and counties for 1975 and 1980.□

LIST OF PROJECTS
RURAL SOCIOLOGY

S-454 Occuptional and Educational Choices of Rural Youth. (R. M. Dimit)

S-516 Social and Institutional Aspect of Human Behavior Affecting Natural Resource Development and Conservation. (D. R. Field, R. M. Dimit and O. E. Lanham)

S-529 Characteristics of Low Income Families in Eastern South Dakota. (M. P. Riley)

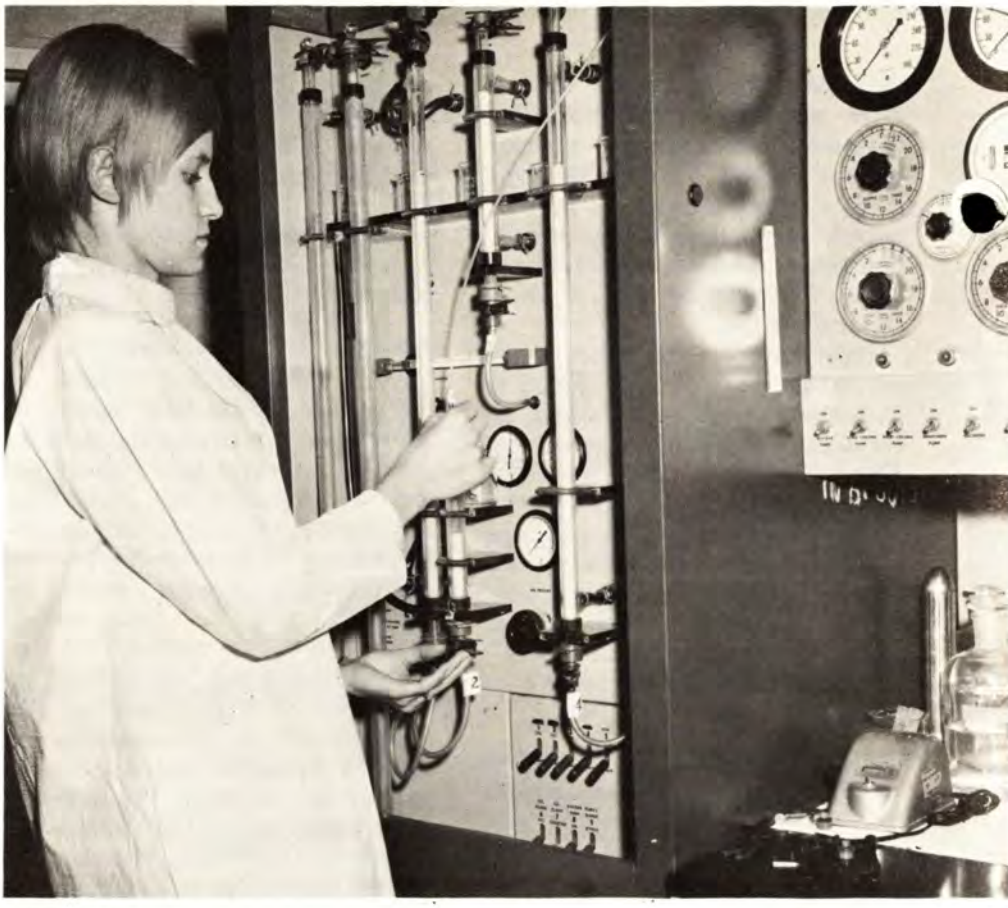
S-543 The Relation of Population to Social Changes in the North Central Region 1960-1970. (M. P. Riley)

S-572 Relationship of Human and Institutional Resources to Future Development in Non-Metropolitan Areas of South Dakota. (R. M. Dimit and O. E. Lanham)

S-621 Manpower Programs and Needs for South Dakota. (R. M. Dimit and R. T. Wagner)

Station Biochemistry

Supporting role for Expanding Research



Elaine Nelson, technical assistant in station biochemistry, at an amino acid analyzer.

CATALYST, a good old basic chemistry term, might also be descriptive of South Dakota State University research biochemists.

The term in chemistry signifies an agent that triggers a change in rate of a chemical reaction. The analogy to Agricultural Experiment Station biochemists rests on their job of providing basic information used by scientists in other fields to trigger changes in a wide variety of "reactions."

For example, an animal scientist seeking improved livestock rations, or a plant scientist attempting to find the "why's" of crop plant winterkill, or persons monitoring the subtle changes in our environment —they all go to the biochemist for highly specialized information dealing with the chemistry of living matter. The biochemist, if not exactly a "catalyst," is a technical cooperator or the extra arm that enables scientists in other fields to expand the scope of their research.

For current research subjects other than those on the role of the biochemist as reported below, see List of Station Biochemistry Department projects at the end of this section.

Winterkill in Small Grains

Why are some varieties of a cereal grain winter hardy while others are not? An answer would be an item worth millions of dollars. For example, South Dakota winter wheat producers each year face the prospect of planting a crop in the fall only to discover a reduced stand in parts or all of a field in the spring. Frequently the cause is winterkill.

A SDSU plant scientist studying this winterkill question is looking at protein biosynthesis as a measure of plant growth response to experimentally controlled changes in temperature. In cooperation with station biochemistry he uses a radioisotope to tag an amino acid, which is later identified in newly formed plant proteins. This research project goes into some of the basic, complex activities going on in living cells of cereal plants.

In part, the winter handiness factor of plants as it concerns winter wheat in South Dakota, appears to be caused by too much "heat" at the wrong time of year. If the combination of temperature change and timing triggers new growth, plants become vulnerable to freeze injury—a situation particularly serious in early spring. Evidence so far supports a suggestion that hardy plant varieties often have the capacity for "stalling" growth during short, warm-up periods making them less susceptible to freeze injury. But what carries this message to stall growth and how is it carried out in plant cells? Answers are being sought in continuing research on the winter hardiness problem.

Mercury in the Environment

More knowledge is sought about mercury and its compounds in the South Dakota environment in a new cooperative project that combines the know-how of both a poultry scientist and a biochemist. Part of the project involves a study of chicken embryos from eggs which have been injected with various mercury compounds, including methyl mercury, and a study of rats

that have been fed mercury compounds. Another phase is to investigate the effects of mercury through the growth and laying period of chickens as well as in the subsequent generations of chicks. Objectives are to determine what level of mercury reduces or prevents embryo development and, at the lower mercury levels, to determine if the intake of mercury under normal, or natural, conditions has any effect on chickens. This might help answer questions regarding reduced hatchability under certain natural conditions of mercury occurrence.

Using a new technique called flameless atomic absorption spectrometry, biochemists have studied potential accumulations of mercury by pheasants which may eat mercury-treated seeds in the field. Results indicate no cause for concern. However, a study of another bird—the cormorant—indicated that at some point in its migration or wandering, its diet contained more mercury than might be considered desirable. Continued studies have suggested that the source is not the South Dakota lakes near where the birds were taken. Whatever the source, it is not believed to necessarily be man's activities but rather nature itself.

Coloring Egg Yolks

The highly competitive poultry industry keeps poultry research nutritionists busy improving feeding practices. The biochemist assists with analyses of grains, or blood samples, and in designing diets containing the appropriate levels of amino acids, those important building blocks of proteins. The biochemist helps determine the minute amounts of certain feed ingredients to produce eggs with yolks of predetermined color to supply specific requirements of various food industries. One of the "coloring" ingredients is xanthophyll which occurs in several feeds, including alfalfa.

Too Much, Too Little Selenium

Selenium is an essential element for poultry although measured in only parts per million. Addition of only a few p.p.m. of selenium beyond the essential level, however, can be injurious or lethal for poultry. The nutritionist and biochemist combine their talents and knowledge to determine how much selenium is necessary for poultry, how much might cause toxicity, and how much can be added to diets without producing meat or eggs that contain levels possibly harmful to man.

Pesticides and Wildlife

Fish and wildlife are important natural resources of South Dakota.

Biochemists are helping wildlife scientists evaluate the role of pesticides accumulating in tissues of wildlife. Certain insecticides, often referred to as chlorinated hydrocarbons, are very persistent and disappear from our environment very slowly. They seem to be everywhere and almost all fish and game contain some of them. Usually, the levels found are too low to be considered dangerous, but in a few species at the top of the food chain there can be concentrations that suggest a possible harmful effect. Thus, pheasants and grain- or grass-eating game usually contain only low levels. Often found to contain high levels are cormorants and pelicans whose food habits put them at the top of a food chain which allows for the buildup of pesticide concentration. Work now in progress is to determine the significance of these levels to the behavior and general health of these birds.

Copper for Swine

The search continues for practices that may increase the efficiency of livestock production. In England, scientists seeking replacements for certain antibiotics have been adding rather high levels of copper to swine diets to stimulate weight gains by an average of about 8%. Although copper sulfate – the compound containing the metal—is not approved for use in swine rations in the United States, it has been used experimentally as researchers delve into factors of growth response, possible toxicity, and potential residual effects.

What about in South Dakota, a state where livestock production is a kingpin of the economy? What happens when copper is added to normal swine rations fed in this state? Swine nutritionists enlisted the aid of the Agricultural Experiment Station biochemists to get some answers. They helped the swine nutritionists to determine exactly the amount of copper they were working with, what was the borderline between too little for effect and too much that might be injurious, and how it affects various tissues of the animal body. Additionally, there were interactions of zinc and iron, which were found to provide a "safety factor" to lessen the potential of toxicity of the copper when it was supplemented.

Although the amount of copper involved in the SDSU swine study ranged to a maximum of 500 parts per million (p.p.m.), biochemists soon helped determine that levels much above 250 p.p.m. would be in the toxic zone.

This team of the animal scientist who know pigs and the biochemist who knows about the chemistry of living matter found, among other things, that the response to copper was much less than reported for the English pigs. They also found that copper accumulation in the livers of these pigs, generally taken as an indication of potential copper toxicity, was less when zinc was added to the diets along with the copper.

Other Activities

SDSU biochemists often are called upon to range afield from strictly research activities and perform vital service-type activites. One example: the South Dakota meat inspection program is a responsibility of the state veterinarian. He asked the Agricultural Experiment Station Biochemistry Department to make chemical analyses to assist in assuring production of unadulterated products from South Dakota meat plants and that quality requirements are met.□

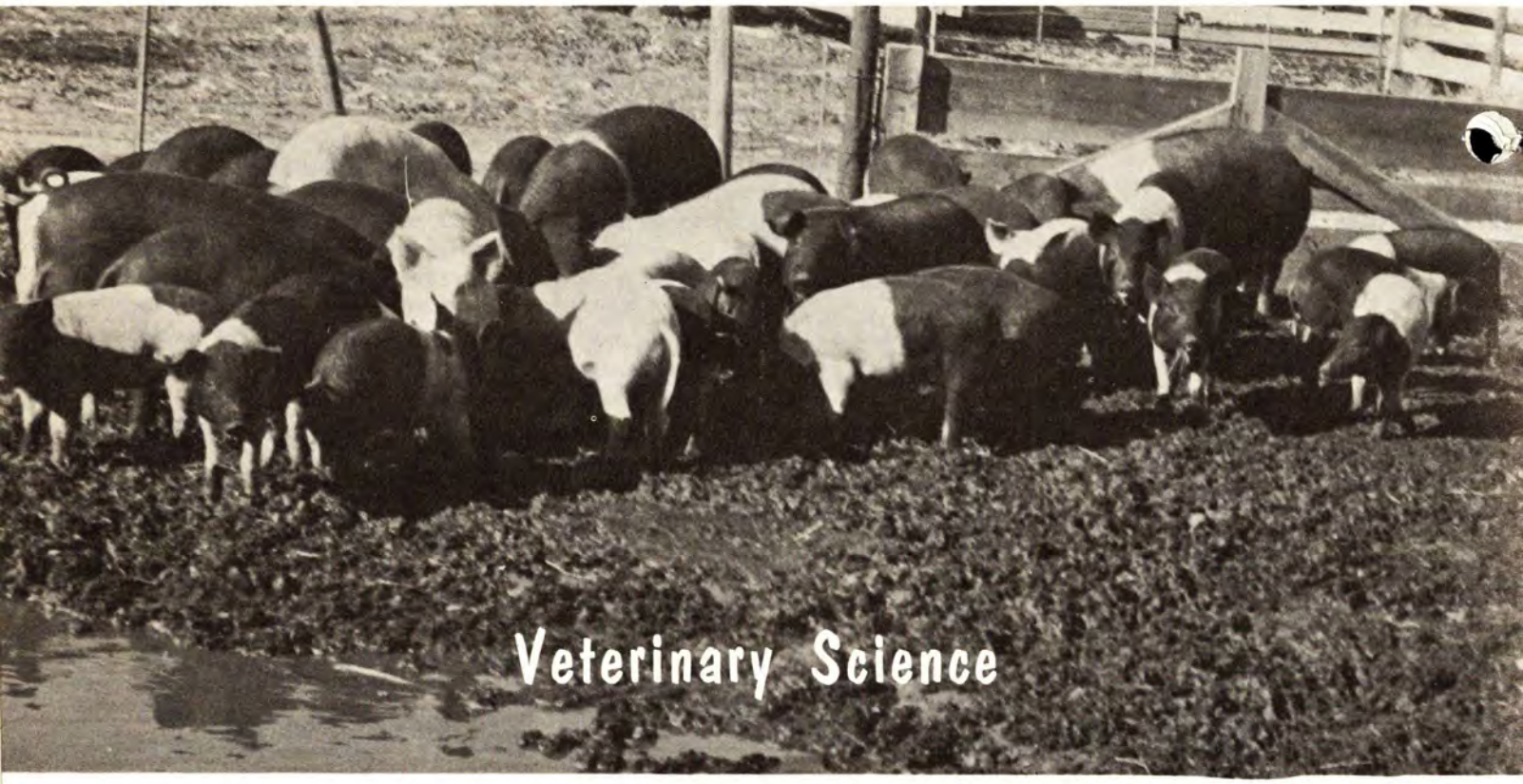
LIST OF PROJECTS
STATION BIOCHEMISTRY

S-407 Analytical Services. (O. E. Olson, G. F. Gastler and Y. A. Greichus)

S-424 Urinary Calculi of Cattle and Sheep. (R. J. Emerick and L. B. Embry)

S-508 Biochemistry of Selenium. (I. S. Palmer and A. W. Halverson)

S-554 Physiological and Behavioral Effects of DDT, DDD and DDE on Penned Cormorants. (Y. A. Greichus, A. Greichus and E. J. Bicknell)



Veterinary Science

Knowledge gained about animal diseases . . .

Newly Isolated Reovirus

For current research subjects other than those discussed on isolation of reovirus, below, see List of Veterinary Science Department projects at the end of this section.

First reported isolation in the United States of a reovirus from swine at South Dakota State University last year provides another step in gaining new knowledge needed for control or prevention of animal diseases causing losses running into millions of dollars.

Significance of the reovirus isolation and its possible action as a contributing agent to a wide variety of swine disease problems is not yet known. However, since the first isolation of this virus it has now also been recovered from swine herds with abortions, enteritis, pneumonia, and poor-doing animals.

The isolation of this virus in increasing numbers from swine has been attributed to the use of a tissue culture system developed and used by the Animal Disease Research and Diagnostic Laboratory headquartered on the SDSU campus. The main advantage of the system is that it enables virus isolations to be made from field cases.

Reovirus Role Not Fully Known

While the exact role of reovirus infection in animals is not fully known, recent reports indicate that various reovirus types may cause disease conditions in man, cats, dogs, swine, and calves. The virus isolation at SDSU has been classed as Reovirus Type III: *R*=respiratory, *e* = enteric (intestinal), *o* = orphan, and the type number signifies that there are two other types (I and II) in this group of viruses.

The original case where the virus was isolated was complicated by the fact that parasites were associated with the disease process. However, the finding that pneumonia was transmitted by the virus alone to susceptible animals indicated that the viral agent may have been the underlying cause, or agent, in this pneumonic problem. The virus isolation resulted from studies of animals submitted to SDSU for evaluation after 14 of 60 feeder pigs died on an eastern South Dakota farm.

Swine Pneumonia in South Dakota

Importance attached to the possibility the new isolate may be a contributing factor to field cases of respiratory diseases is seen in the fact that U. S. swine producers in a recent survey indicated pneumonia was the most common cause of death among hogs. Reovirus infection is seen, as of now, as one of many bits of new knowledge needed because of the many different agents known to cause swine pneumonia including bacteria, mycoplasma, viruses, and parasites.

The importance of swine pneumonia in South Dakota is reflected in the fact that nearly a fourth of the requests for Research and Diagnostic Laboratory assistance involve

Poor doing pigs and swine respiratory problems trouble some South Dakota producers. The young pigs shown above have developed a rough hair coat indicating development of disease problems. On the same farm, the larger pigs (left) at about 6 months of age show difference in size attributed to respiratory and enteric problems. Reovirus Type III has been isolated from the herd on this farm.

swine. Pneumonia was present in about 20% of the disease conditions investigated. South Dakota ranked eighth nationally with 3,375,000 pigs born in 1970, an increase of 18% over 1969. Hog and pig deaths in the state for 1970 are estimated at 153,000. If requests for SDSU laboratory assistance are a criterion, something like 30,000 pigs were lost in South Dakota last year due to pneumonia. In addition to death losses, pneumonia also accounts for slow gains, poor feed utilization and poor performance.

Swine Abortion

Significance, if any, of the reovirus to swine abortion is unknown although isolation of this virus from several abortion cases will be a factor considered in continuing investigations. One of the major objectives of the original project at SDSU was to develop better methods of diagnosis of abortion diseases. In the course of working toward these objectives, some of the better methods are proving to be very effective tools in the diagnosis of diseases other than abortion and stillbirths.

Ecomonic losses to swine owners from aborted pigs are difficult to pinpoint. Loss to the swine industry by feeding sows that either abort or have stillborn fetuses is figured on the basis of $20-$25 per female. If 1% of pregnant sows abort, this type of loss could range from $80,000 to $100,000 annually in South Dakota.

Cattle Abortions

Procedures developed during this project are now being used for routine diagnosis of cattle abortion.

Due to a larger number of cases of abortion in cattle, the team effort of the Department of Veterinary Science to study the most common causes of this disease condition has changed from one of developing better methods of diagnosis to one of more research and of prevention. Because of the smaller overall number of swine abortion cases submitted to the laboratory, the method of developing diagnostic procedures is still one of the prime efforts in this phase of the project.

Records obtained from the first 3 years of the livestock reproduction study indicated that about one third of the 1,556 bovine abortions and stillbirths were diagnosed as caused by specific infectious agents. The rate of diagnosis of abortion investigations is quite favorable in relation to the information obtained at other diagnostic laboratories throughout the U. S.

About 50% of the diagnoses of bovine abortions were attributed to the virus disease, IBR or rednose. Sixteen percent were caused by bacterial agents—including Bang's disease or Brucellosis and Leptospirosis—while fungi accounted for another 10%. It is interesting to note that the once-feared disease of Brucellosis or Bang's disease was found in only eight cases during the 3 years the project has been active.

In addition to major efforts in studies related to abortion, research interest is moving more into the specific causes and control of enteritis, more commonly called diarrhea or scours of young calves and pigs. Research efforts within the Veterinary Science Department are being combined to approach the scours problem of young calves and pigs in the same manner as for the abortion problem.□

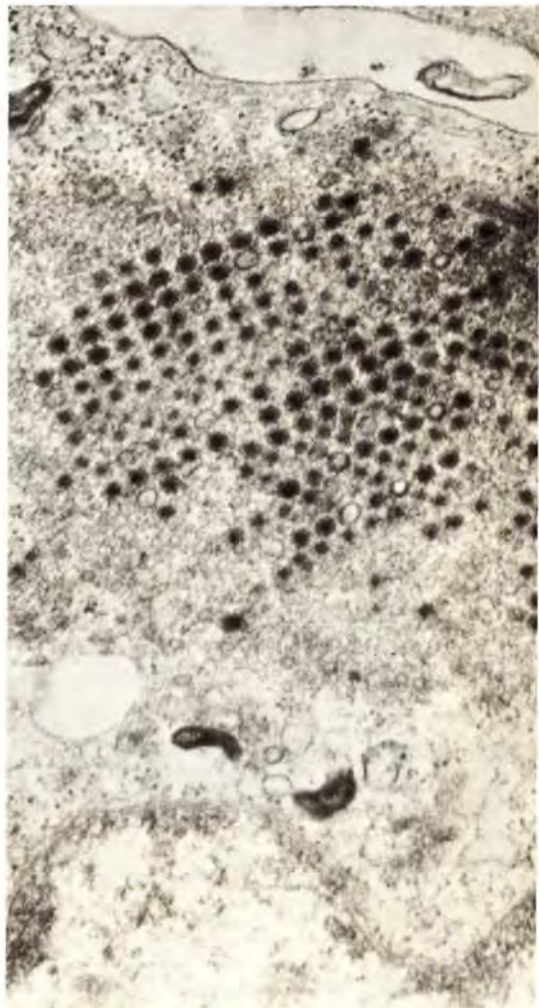
LIST OF PROJECTS
VETERINARY SCIENCE

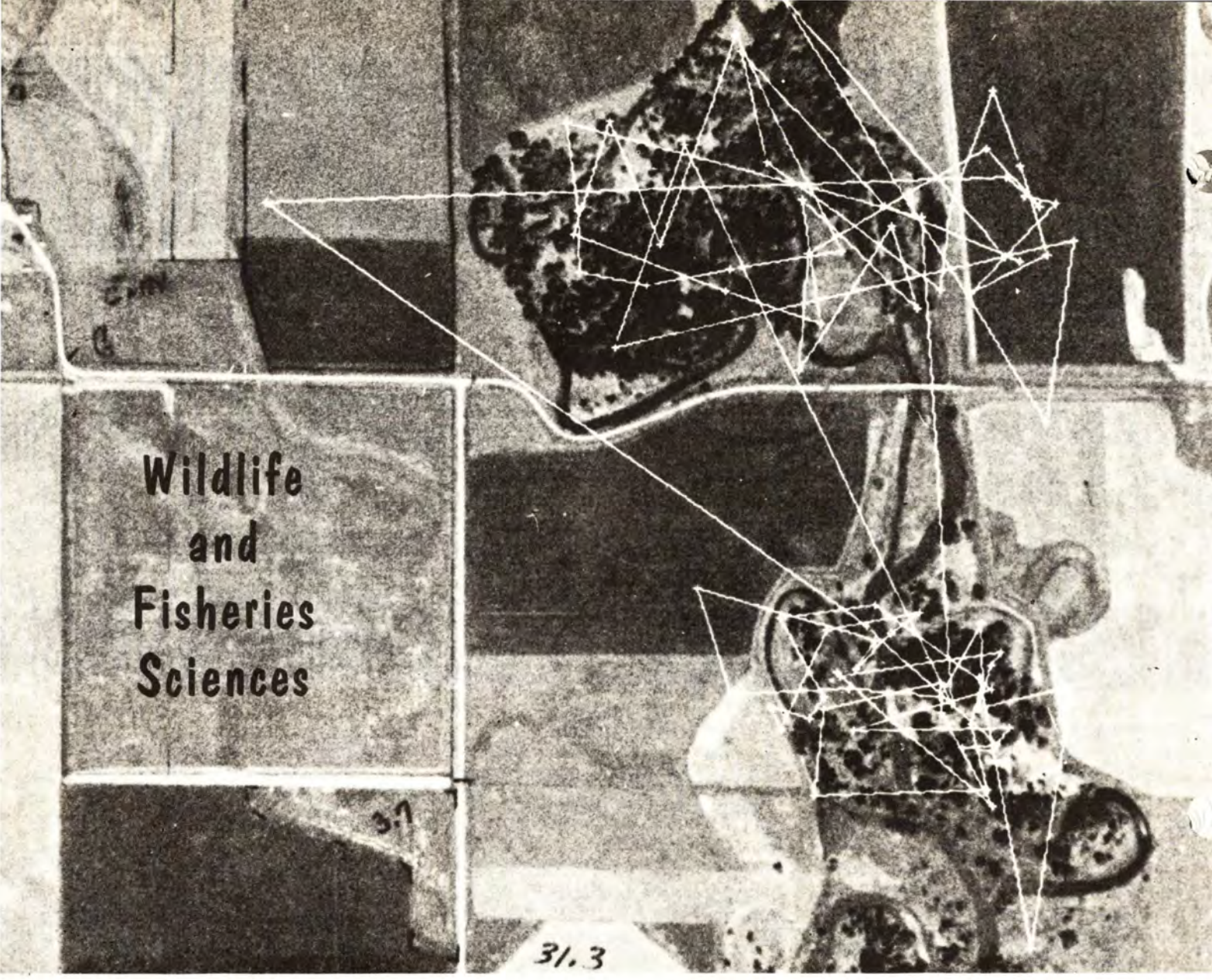
S-803 Enteric Disease of Young Animals. (E. J. Bicknell, K. D. Weide and C. A. Kirkbride)

S-804 Pathogenesis of Bovine Mastitis. (C. A. Kirkbride, D. Young and E. J. Bicknell)

S-805 Reproductive Diseases of Livestock. (C. A. Kirkbride and E. J. Bicknell)

Reovirus particles (small black dots) appear in the cytoplasm of infected pig thyroid tissue culture cells in this electron micrograph.





White lines, diagramed by a computer, show a 2-week roosting and feeding pattern of an adult pheasant superimposed on aerial photo of a study area in eastern South Dakota farmland. Tiny radio transmitters (see photo next page) give signals enabling researchers to pinpoint coordinate locations of birds at specific times. Coordinates processed by an IBM computer diagram the bird's movements providing information about use of natural cover. Area shown is about a half mile on a side.

For current research subjects other than reported below on production and welfare of fish and wildlife, see List of Projects for the Department of Wildlife and Fisheries Sciences at the end of this section.

Something like growing a crop . . .

Wildlife Production

WILDLIFE is a "producible" resource high on the list of pluses for South Dakota. It is a factor in the state's economy to say nothing of the enjoyment and recreation that fish, wild mammals and birds afford to residents and visitors alike.

Although some of the general principles apply, the production of a "crop" of wildlife isn't quite the same as growing wheat or corn or beefsteak, ham or lamb chops. Wildlife production, however, does take know-how and that is where research comes in to provide knowledge, much of which is related to proper and practical management.

The South Dakota Department of Game, Fish, and Parks reports that sportsmen in South Dakota paid more than $2 million for various licenses last year. Game and fish are estimated to be worth upwards of $50 million annually to the state's economy. A nationwide survey a few years ago showed 33 million sport fishermen and hunters spent $4 billion to fish and hunt.

Wildlife research at South Dakota State University centers in the

Agricultural Experiment Station's Department of Wildlife and Fisheries Sciences of which the Cooperative Wildlife Research Unit is a part. The Unit includes these cooperating agencies: South Dakota Department of Game, Fish and Parks; U. S. Bureau of Sport Fisheries and Wildlife; the Wildlife Management Institute; and the Agricultural Experiment Station. Wildlife research is also done in these other SDSU departments: Entomology-Zoology, Station Biochemistry, and Botany-Biology.

Some of the wildlife "production" and "welfare" research in progress or recently completed through this cooperative effort includes:

PRODUCTION

Deer Food in Black Hills

The exact foods animals eat during the various seasons must be known for man to help in the proper management of the habitat for production of these plant or animal foods. For example, when a deer feeds heavily on a certain food such as cedar or pine, it means the preferred and more nutritious foods are unavailable. Habitat management procedures are then deemed necessary. Fire, under strictly controlled conditions, might be one such management tool to set back ecological succession to a stage where ground vegetation and shrubs are dominate instead of a thick overstory forest.

Completion of the first study of food habits of deer in the southern Black Hills has helped pinpoint the most important forages during various seasons. Food actually consumed by deer was determined through analyses of stomach samples.

In the fall, studies showed, the most important food species for the deer (white-tailed and mule deer) were kinnikinnick, grasses, Oregon grape, snowberry and forbs (plants such as aster, goldenrod and wild strawberry).

As winter moved in the food habits changed. The most important deer food species became ponderosa pine, mountain mahogany, and common juniper. Other winter foods of importance were kinnikinnick, forbs, grasses, snowberry and Rocky Mountain juniper. White-tailed deer in the Black Hills move out of the higher areas during winter and concentrate in other areas—they have winter and summer ranges. Winter range food is usually critical because of these animal concentrations. Generally, it is the food supply, not the cold conditions themselves, that cause seasonal deer movement. Food habits change in winter when snow covers ground vegetation. Thus ground juniper might be eaten in large quantities during November, while higher growing shrubs, such as choke cherry, are eaten more in the later winter months.

An analysis of summer food showed the most important to be alfalfa, clover, grasses and forbs.

Another study just underway will attempt to establish deer and cattle forage relationships on a deer winter range in the Black Hills. Five "pastures" are being used in the study which will include open forest, open slope, natural prairie, and bottomland.

Deer, Cattle Feeding Areas

Differences in use or preference between deer and cattle for specific feeding areas have already been determined for the northern Black Hills. Three areas were used in the summer studies and each contained an aspen community, a pine community, and a mixed aspen-pine community.

The aspen communities appeared to represent better feeding areas for both deer and cattle than the mixed aspen-pine or pine communities. However, white-tailed deer use was greatest in the mixed, intermediate in the aspen, and least in the pine. On the other hand cattle use was greatest in the aspen, intermediate in the mixed, and least in the pine. Use estimates were made by pellet group and chip density.

Greatest production of air-dried forage, used as a measure, was 589 pounds an acre under the least dense aspen stands. Moderately dense mixed aspen-pine stands produced 415 pounds of air-dried forage an acre and the most dense pine stands produced only 215 pounds. These findings emphasize why wildlife managers and foresters are both trying to balance proper tree stand to get maximum tree growth and ground vegetation each year. A thinner stand of trees permits penetration of sunlight that promotes growth of ground vegetation. Thick stands of trees do not permit as much sunlight penetration for growth of ground vegetation and, additionally, the trees do not put on as much annual growth as those in thinner stands.

Mourning Dove Populations

The younger, or immature, South Dakota mourning doves are more

Tiny radio transmitter on back of wild pheasant just prior to release.

likely than adults to winter in Mexico where hunters have a "greater influence" on their population. This is one finding from a study of population dynamics and migrational distribution of mourning doves.

Although banding in the current study was done in the summers of 1969 and 1970, banding of mourning doves has been recorded in South Dakota since 1917. During that time 44,842 doves have been banded, including 44.4% adults, 41.3% immatures and the remainder juveniles, locals and unknowns. Recoveries totaled 2.3% from hunting and 0.5% from nonhunting with 86% being from Texas, Mexico, and South Dakota.

Under present mortality, at least 2.6 immatures per female would have to be alive by the start of the hunting season to maintain a stationary population. Before South Dakota began hunting doves (a season was opened starting in 1967) the hunting mortality of South Dakota doves shot in other states was about 5% of the population. After opening of South Dakota's season about 8% of the dove population was shot. These figures indicate the relatively small part hunting has on the total mortality. Most wildlife species have high mortality rates and doves are no exception: annual rates being estimated at minimum and maximum of 51.7% and 54% for adults, 60.3% and 65% for immatures.

Activities of Pheasants

The key to management and improvement of pheasant populations is more knowledge about the movement, behavior and other activities of the famed South Dakota game bird. Several years ago banding and marking were relied upon almost exclusively for checking activities of the birds. Then tiny radio transmitters were attached to the birds so their "broadcast" wanderings could be recorded at centralized receiving stations. Latest addition to the study is the use of computers which process radioed location coordinates into a diagram or map of the bird's movements.

One finding about pheasants is that, generally, there's not a lot of widespread shifting of birds from one place to another and that birds live in a definite home area.

During a study of about 18 months using 1,117 pheasant locations, the radio-equipped birds furnished data for making computerized maps that indicated their most widespread travels averaged slightly more than two-thirds of a mile. Smallest amount of movement during one 30-day period in November-December when birds were confined to residual cover was about a tenth of a mile.

Their "activity radius" during the bi-weekly periods ranged from 0.09 of a mile to 0.45 of a mile and averaged 0.14 of a mile. Smallest movements from activity centers occurred during the last 2 weeks in June and brood capture data indicated this time as the peak hatch period.

Home range sizes during 2-week study periods averaged 33.6 acres and varied from 21 to 71.5 acres. The smallest ranges were in the last 2 weeks of June and first 2 weeks of October when they averaged around 21.5 acres. Summer ranges were almost constant during July and early August at about 36 acres but then zoomed to the maximum of 71.5 acres the final 2 weeks of August. Total home range area, based on all locations, averaged 76.2 acres (less than one-eighth of a square mile) and compared to 98.2 acres in 1969 and 54.2 acres in 1970.

Earlier studies, during two relatively mild winters, revealed birds moved less than a quarter mile from roosting areas to cornfields and weed patches to feed. Eight out of 10 pheasant cock territories observed encompassed roadsides which contained undisturbed cover. Home ranges for six radio-equipped hens contained undisturbed cover in which nests for three of four hens were situated. During summer, adult birds and hens with broods were in cornfields during the day and returned to small grain, soilbank, and alfalfa fields to roost. One hen moved her one-week-old brood nearly a half mile after the alfalfa was mowed.

Super-Saturation of Nutrients

Relative to the needs of aquatic plants in Lake Poinsett, nutrient concentrations in the lake's water are in a state of super-saturation, a year's study of the system ending in April 1971 has revealed. The study ascribes the advanced degree of eutrophication in the lake to the large annual nutrient load entering and retained in the lake basin.

The study measured annual surface discharge (runoff from the watershed) and inflow from the Big Sioux River into Lake Poinsett. Totals of 12 tons of phosphorus, 14 tons of nitrate nitrogen, and many tons of organic carbon were recorded for the period. The Big Sioux-Dry Lake system contributed 63% of the phosphorus, 45% of the nitrate nitrogen, and 43% of the organic carbon load with the remainder entering from the Lake Albert drainage. Out of the annual load of nutrients transported into the lake, 33% of the nitrate nitrogen, 40% of the organic carbon, and 70% of the phosphorus was retained by the lake or lost in ways other than water discharge.

Although these totals are low compared to the amount of fertilizer put on the land involved, it is all in immediately-useable form because of being in solution.

WILDLIFE AND FISH WELFARE

Insecticides and Pheasants

Wildlife specialists point out that changes in behavior or activities of birds are factors which must be considered in game management.

Then, even if pesticides are present in non-lethal amounts, do they cause abnormalities in behavior and activities of pheasants?

In previous SDSU research it was found that offspring of pheasants given dieldrin were more easily caught by hand. Easier capture implies inability to escape from predators or perhaps detect danger in their habitat from mowing machines, swathers and similar sources.

Additional research has centered on the social interactions of the birds within their own groups. These studies found that dieldrin did not affect dominance-subordi-

nation patterns when fed to both penned pheasants and to chickens. In other words, the insecticide did not cause a change in the establishment of pecking-order which, it was concluded, begins to develop in pheasant chicks at about 3 weeks of age. Chickens were used in the experiment as one of the "controls" because they have a definite and strong peck order in each flock. Pheasant flocks apparently have a looser order and might not show the effects of the pesticide.

In still another study, an attempt was made to learn more about what happens to orphaned pheasant chicks—why they are sometimes adopted and sometimes killed by non-incubating pheasant hens. Results indicated that seeing or hearing chicks by the pheasant hens had no effect on their adoption or killing of chicks. Sub-lethal doses of dieldrin also had no effect on chick adoption under conditions of this study. During the 1969 and 1970 study, 35% and 49% of hens tested adopted and brooded chicks, 38% and 26% intentionally killed chicks, 6% and 14% both adopted and killed chicks, and 18% and 11% did neither.

Lake Bottom Residents

Despite the highly eutrophic condition of eastern South Dakota's Lake Poinsett, the average standing "crop" of bottom-dwelling macroscopic organisms was found to be about average in comparison with other lakes. Of all sampling stations in bottom sand, mud and sand-mud mixtures, 40% of average numbers and 77% of average annual dry weight consisted of organisms from eight species of *Chironomus,* a worm-like immature form of a small fly resembling a mosquito. Studies of this type are useful to determine food habits of fish as well as for monitoring changes in lake water chemistry.

Agriculture and Lake Pollution

Major differences in at least two northern South Dakota prairie lakes appear to be influenced by agricultural practices on the watersheds, according to studies of Lake Herman and Enemy Swim Lake. These lakes are within the same geographic area (Coteau des Prairies) and appear to have been similar prior to cultivation on their watersheds. Now most of the Lake Herman watershed is cultivated cropland while very little of the Enemy Swim watershed is cultivated.

Differences in water quality were reflected in phytoplankton populations which were lower and subject to less variation in Enemy Swim than those in Lake Herman. The level in populations of Lake Herman was about 20 times that of Enemy Swim. Earlier studies indicated total dissolved nutrients are about twice as high in Lake Herman as in Enemy Swim and total phosphorus is 10 times higher. About 7 feet of silt and muck cover the bottom of Lake Herman.

Insects, a Popular Fish Food

Crustaceans, aquatic insects and fish were the most important food items found in stomach samples of four fish species from a small northeastern South Dakota impoundment.

Black crappies depended on zooplankton (50%) and aquatic insects (40%) as major food sources. Insects made up 54% and were the dominant forage of white crappies while zooplankton made up 36% and fish 21%. Perch relied on aquatic insects and crayfish as major food sources with 33% of each in the samples while fish were dominant in 25% of the samples. Microcrustaceans were the major food items in 75% of white suckers with debris the dominant in 25%. Young-of-the-year fish fed totally on zooplankton with the exception of largemouth bass which occasionally took aquatic insects.

Basic information about food habits of fish sought in this experiment was aimed at determining the food chain within a pond. In this way the carrying capacity level of fish for the pond can be determined.

Visitor Potentials of Wetlands

Prairie wetlands are deemed to have a potential as places where visitors such as school groups and the general public can go for nature interpretation and obtain better understanding of the ecology of a given area.

A study of visitor preferences at one established wildlife-interpretive trail shows: 79% of visitors preferred a self-guiding trail with maps, pictures and signs an important aspect; 91% believed that natural features and wildlife on prairie marshes would be of enough interest to justify additional facilities. The investigators also devised a method for rating prairie wetlands as nature study areas with 22% of marshlands evaluated ranking as "excellent." Purpose of this study was to identify certain wetlands ideally situated to communities and highways which could be developed as "nature interpretation centers."

Protection from Botulism

Botulism causes considerable loss of pheasants on game farms and of wild waterfowl in South Dakota. Frequently in late summer large populations of the toxic bacteria causing botulism build up in the soil of pens where birds are held or in mud flats of drying lakes. Pheasants and other birds drink water or feed in these areas and contract the disease.

Toxoids, or "protector" materials, are produced from the toxins that cause the disease. In a study just completed a toxoid produced from one of the two strains of botulism bacteria which kill pheasants in South Dakota and a commercial toxoid were used to inoculate one group of penned adult birds. Another group was not inoculated. Later both groups were "challenged" or exposed with toxin from the two botulism strains lethal to pheasants. Those pheasants protected with toxoid survived, while the others succumed. This study revealed that game farm operators might best protect their flocks by inoculating each bird with a suitable toxoid such as used in this experiment.

General Custer and Forest Management

(See photos on cover and next pages.)

After nearly 100 years, photographs taken during General Custer's official exploration expedition into the Black Hills are being used in a SDSU research spin-off for instruction in ecology and wildlife management courses as well as for

COVER PHOTO — A camp in 1874 of the Custer Black Hills exploration party near Deerfield, in present western Pennington County (top photo). This is from an Illingworth photo from the original glass plate. The bottom photo, taken of the same area in 1971, shows the much larger spread of the forest. Where covered wagons formerly rolled on a spread of wild flowers in this mountain valley, there is now a cultivated crop. (Top photo courtesy of South Dakota State Historical Society.)

Photographer Illingworth took the photo at left, above, after the 1874 exploration party's wagon train had passed through Castle Creek Valley. The tracks of the wagons trailblazing this road can be seen faintly along the creek in the valley. In 1971 trees and other vegeta-

possible forest management. General Custer's exploration of the then little-known Black Hills—2 years before Little Big Horn—confirmed the presence of gold and sparked a population influx which in turn helped trigger the 1876 Indian wars.

With Custer in the Black Hills was photographer William Illingworth who recorded various scenes which are being relocated and photographed today for comparison. Through the use of diaries, maps and other historical records, more than half of the old photographic sites have been identified and re-photographed for use in an upcoming publication to provide "visual documentation of successional changes in the Black Hills pine forest."

Other locations photographed originally in 1927 and re-photographed in 1958 by the late Dr. Homer L. Shantz of the University of Arizona are also available for comparison. The publication, along with teaching slides, is anticipated to be of considerable use to writers and historians as well as to ecologists and biologists. The U. S. Forest Service, historical societies and many individuals have shown interest in the Agricultural Experiment Station project.

The project leader notes that the study will help to illustrate past mistakes and provide guidance for better forest management in the future. Since settlement by man, the Black Hills pine forest has encroached on some large open areas where elk formerly lived in abundance. Pines have become so thick and stunted in some areas that only an estimated third of the moisture falling on trees reaches the soil. The concern of timber, wildlife, and watershed interests is in an overabundance of trees per acre in

tion obscure much of the detail which could be observed nearly 100 years previously. Man has hard surfaced almost the exact trace of the early trail. In the 1971 photo on page 51 note the two large rock outcrops (upper left) which can be matched with those of the old photo. While taking the 1971 photo, Agricultural Experiment Station personnel discovered that some snags of burned trees (showing at lower right of old photo) were still standing. Apparently a forest fire had burned through the area years before leaving only the durable heartwood of some trees which have withstood weathering for at least a century. (Photo at left courtesy of South Dakota State Historical Society.)

many areas. This "closing" of the Hills by the pines is directly related to fire protection of the forest.

Completion of field studies, photography, and historical research is expected in 1972 and publication of the findings is anticipated shortly thereafter.□

LIST OF PROJECTS
WILDLIFE AND FISHERIES SCIENCES

S-521 Studies of movement, behavior, and activities of the ring-necked pheasant. Agricultural Experiment Station. D. R. Progulske.

S-555 Management of farm ponds in South Dakota for fish production. Agricultural Experiment Station. J. G. Nickum.

S-615 Ecology of wetlands and waterfowl production in eastern South Dakota. Agricultural Experiment Station. J. M. Gates.

S-556 Visual documentation of successional changes of the Black Hills pine forest. Agricultural Experiment Station. D. R. Progulske.

Life history and ecology of the blackfooted ferret (*Mustela nigripes*) in the wild. Cooperative Wildlife Research Unit. R. L. Linder.

Deer and cattle forage relationships on a deer winter range in the Black Hills. Cooperative Wildlife Research Unit. R. B. Dahlgren.

Use of electropkoresis to determine sub-populations of pheasants in South Dakota. Cooperative Wildlife Research Unit. R. B. Dahlgren.

Evaluation of chemosterilants as inhibitors of reproduction in raccoons. Cooperative Wildlife Research Unit. R. L. Linder.

Effects of dieldrin and polychlorinated biphenyls on pheasant reproduction and behavior. Cooperative Wildlife Research Unit. R. B. Dahlgren.

Aspen and pine communities as related to deer usage. Cooperative Wildlife Research Unit. R. L. Linder.

Population dynamics of morning doves in South Dakota. Cooperative Wildlife Research Unit. R. L. Linder.

Effects of dieldrin on social hierarchy in pheasants. Cooperative Wildlife Research Unit. R. L. Linder.

Use of waterfowl production areas by ducks and coots. Cooperative Wildlife Research Unit. R. L. Linder.

Wild breeding for pheasant production in areas of deficient nesting cover. Cooperative Wildlife Research Unit. R. L. Linder.

An evaluation of the giant Canadian goose restoration project in western South Dakota. Cooperative Wildlife Research Unit. R. L. Linder.

An evaluation of fish shelters in Lake Poinsett. Cooperative Fishery Unit. D. C. Hales.

Food selectivity of the black bullhead in Lake Poinsett. Cooperative Fishery Unit. D. C. Hales.

Nutrient transport in the Big Sioux River - Lake Poinsett complex. Cooperative Fishery Unit. D. C. Hales.

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——. See Carlson, C. W. (An. Sci.)

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Shank, D. B. See Shubeck, F. E.

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——. See Carson, P. L.

——. See Grenz, G. K.

——. See Williamson, E. J.

Wells, D. G. See Lay, C. L.

——. See Sompaew, V.

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——. See Derscheid, L. A.

——. See Frazee, C. J.

——. See Williamson, E. J.

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Wright, W. G. See Derscheid, L. A.

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Station Biochemistry

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Arnold, R. L. See Thompson, O. J.

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——. See Halverson, A. W.

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——. See Johnson, C.

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Kleven, S. H. See Lucas, T. E.

Knudtson, W. U. See Bicknell, E. J.

——. See Kirkbride, C. A.

Kumar, M. C. See Lucas, T. E.

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——. See Sheets, R. G.

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Financial Statement

SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Statement of Disbursements by Source of Funds for Year Ended June 30, 1971

Source of Funds	Expenditures 6-30-70	Expenditures 6-30-71
1. State Appropriations (General Fund)	$2,060,327.88	$2,198,535.95
2. Continuing Federal Appropriations (State Treasurer)	744,848.00	831,909.00
3. Continuing Federal Appropriations (Local)	45,139.82	39,833.06
4. Federal Grants and Contracts (USDA)	57,708.76*	71,849.78
5. Federal Grants and Contracts (not USDA)	62,998.30*	92,581.98
6. State Agencies Grants	41,947.50*	84,973.52
7. Private Grants and Contracts	86,714.42*	100,453.82
8. Internal and Statewide Services	138,419.98*	139,873.47
9. Industry Services	31,301.16*	40,177.74
10. Replacement Livestock Purchases	200,137.34*	213,877.95
TOTAL	$3,469,543.16	$3,814,066.27
Sales Income to General Fund	189,472.94	396,718.70
Net Support from General Fund	$1,870,854.94*	$1,801,817.25

*Reclassified from 1970 Annual Report

Station Staff Members

Agricultural Experiment Station
July 1, 1970—June 30, 1971

REGENTS OF EDUCATION

Hon. Lauren Lewis, President ..... Sioux Falls
Hon. James I. Deam, Vice President ..... Yankton
Hon. John Larson, Secretary ..... Chamberlain
Hon. Richard Battey ..... Redfield
Hon. Harry Witt ..... Butler
Hon. Marian Hersrud ..... Lemmon
Hon. Charles H. Burke ..... Pierre
Hon. Richard D. Gibb,
Commissioner of Higher Education ..... Pierre
Hon. Jerry Fischer
Budget and Finance Officer ..... Pierre

EXECUTIVE

H. M. Briggs, Ph.D. ..... President
D. C. Acker, Ph.D. ..... Dean and Director
A. L. Musson, Ph.D. ..... Associate Director
B. L. Brage, Ph.D. ..... Associate Dean
W. A. Bugg, B.S.A. ..... Director of Finanec
R. M. Howard, M.S. ..... Director of
Institute of Biological Sciences

STATION STATISTICIAN

W. L. Tucker, Ph.D. ..... Associate Professor

AGRICULTURAL ENGINEERING

D. L. Moe, D.Sc. ..... Professor and Head
D. D. Brosz, M.S. ..... Instructor
S. T. Chu, Ph.D. ..... Assistant Professor
D. W. DeBoer, Ph.D. ..... Associate Professor
H. H. De Long, M.S. ..... Professor
A. C. Dittman, B.S. ..... Research Associate
E. A. Dowding, M.S. ..... Instructor
C. L. Hanson, M.S. (USDA) ..... Assistant
Professor
M. A. Hellickson, Ph.D. ..... Assistant Professor
J. R. Hoover, M.S. (USDA) ..... Instructor
Clarence Johnson, Ph.D. ..... Associate Professor
T. M. Klosterman, B. S. ..... Research Farm
Superintendent
W. F. Lytle, M.S. ..... Associate Professor
J. M. Madden, M.S. ..... Instructor
G. C. McVey, Ph.D. ..... Associate Professor
C. A. Onstad, M. S. (USDA) ..... Instructor
Walter Spuhler, M. S. (USDA) ..... Assistant
Professor
R. J. Svec, B.S. ..... Assistant in Mechanized Ag
P. K. Turnquist, Ph.D. ..... Professor
P. N. Wheeldon, B.S. ..... Draftsman
J. L. Wiersma, Ph.D. ..... Professor
H. G. Young, M.S. ..... Assistant Professor

APPOINTMENTS

A. C. Dittman, Research Associate 6/21/71
G. C. McVey, Associate Professor 9/10/70

RESIGNATIONS

R. J. Svec, Assistant in Mechanized
Ag 5/30/71

ANIMAL SCIENCE

C. S. Menzies, Ph.D. ..... Professor and Head
L. F. Bush, Ph.D. ..... Associate Professor
F. M. Byers, B.S. ..... Assistant in Animal Science
C. W. Carlson, Ph.D. ..... Professor
W. J. Costello, Ph.D. ..... Assistant Professor
B. E. Davidson, B.S. ..... Assistant in
Animal Science
C. A. Dinkel, Ph.D. ..... Professor
L. R. Dunn, B.S. ..... Assistant in Animal Science
L. B. Embry, Ph.D. ..... Professor
F. R. Gartner, Ph.D. ..... Associate Professor
D. H. Gee, Ph.D. ..... Instructor
Cecil Graber, B.S. Assistant in Animal Science
Edmund Guenthner, M.S. ..... Instructor
Marshall Haferkamp, M.S. ..... Assistant in
Animal Science
C. E. Holmquist, B.S. ..... Assistant in
Animal Science
I. B. Johnson, M.Agr. ..... Professor Emeritus
L. D. Kamstra, Ph.D. ..... Professor
Wallace Koester, B.S. ..... Assistant in
Animal Science
P. H. Kohler, Ph.D. ..... Professor
P. R. Kruce, B.S. ..... Assistant in Animal Science
J. R. Lacey, M.S. ..... Assistant in Animal Science
J. K. Lewis, M.S. ..... Associate Professor
G. W. Libal, M.S. ..... Instructor
Michael Lund, B.S. Assistant in Animal Scienec
R. M. Luther, Ph.D. ..... Associate Professor
J. W. McCarty, M.S. ..... Associate Professor
W. C. McCone, M.S. ..... Associate Professor
W. C. Morgan, Ph.D. ..... Professor
W. R. Parker, M.S. ..... Assistant in
Animal Science
P. E. Plumart, M.S. ..... Assistant Professor
T. D. Rich, Ph.D. ..... Assistant Professor
A. L. Slyter, Ph.D. ..... Assistant Professor
R. J. Smith, B.S. ..... Assistant in Animal Science
Herbert Sorbel, M.S. ..... Assistant in
Animal Science
Wesley Thompson, M.S. ..... Assistant in
Animal Science
R. C. Wahlstrom, Ph.D. ..... Professor

APPOINTMENTS

F. M. Byers, Assistant in Animal
Science 7/1/70
B. E. Davidson, Assistant in Animal
Science 2/1/71
D. H. Gee, Instructor 7/1/70
P. R. Kruce, Assistant in Animal
Science 2/1/71
J. R. Lacey, Assistant in Animal
Science 2/1/71

RESIGNATIONS

Cecil Graber, Assistant in Animal
Science 7/31/70
Marshall Haferkamp, Assistant in Animal
Science 8/24/70
Herbert Sorbel, Assistant in Animal
Science 7/31/70

BACTERIOLOGY

R. M. Pengra, Ph.D. ..... Professor and Head
Joseph Gadberry, M.S. ..... Instructor
D. R. Larson, M.S. ..... Assistant in Bacteriology
P. R. Middaugh, Ph.D. ..... Professor
G. C. Parikh, Ph.D. ..... Associate Professor
G. J. Prochazka, Ph.D. ..... Associate Professor
R. S. Shave, B.S. ..... Assistant in Bacteriology
R. J. Stangland, M.S. ..... Assistant in
Bacteriology
J. A. Turner, B.S. ..... Research Assistant
Suzanne VanMeeteren, B.S. ..... Assistant in
Bacteriology
T. R. Wilkinson, Ph.D. ..... Assistant Professor

APPOINTMENTS

D. R. Larson, Assistant in Bacteriology 2/1/70
R. S. Shave, Assistant in Bacteriology 2/1/71
R. J. Stangland, Assistant in
Bacteriology 6/1/70
Suzanne VanMeeteren, Assistant in
Bacteriology 2/1/71
T. R. Wilkinson, Assistant Professor 8/16/70

RESIGNATIONS

Joseph Gadberry, Instructor 8/15/70
J. A. Turner, Research Assistant 1/31/71

BOTANY-BIOLOGY

G. A. Myers, Ph.D. ..... Professor and Head
D. J. Holden, Ph.D. ..... Professor
R. H. Whalen, Ph.D. ..... Assistant Professor

DAIRY SCIENCE

J. Orville Young, Ph.D. ..... Professor and Head
R. J. Baker, Ph.D. ..... Professor
Emery Bartle, M.S. ..... Associate Professor
M. J. Owens, M.S. ..... Assistant in Dairy Science
J. G. Parsons, Ph.D. ..... Assistant Professor
D. J. Schingoethe, Ph.D. ..... Assistant Professor
S. W. Seas, M.S. ..... Associate Professor
K. R. Spurgeon, Ph.D. ..... Professor
Paul Stake, B.S. ..... Assistant in Dairy Science
Howard H. Voelker, Ph.D. ..... Professor

ECONOMICS

J. E. Thompson, Ph.D. ..... Professor and Head
H. R. Allen, Ph.D. ..... Assistant Professor
R. L. Berry, Ph.D. ..... Associate Professor
R. O. Gaarder, Ph.D. ..... Associate Professor
H. A. Gilbert, Ph.D. ..... Associate Professor
William Kohlmeyer, M.S. ..... Professor
A. O. Lockner, Ph.D. ..... Associate Professor
C. C. Micheel, M.S. (USDA) ..... Assistant
Professor
Max Myers, Ph.D. ..... Professor
W. F. Payne, Ph.D. ..... Assistant Professor
G. D. Rose, Ph.D. ..... Associate Professor
R. K. Rudel, M.S. ..... Assistant Professor
John Sanderson, Ph.D. ..... Assistant Professor
K. O. Scofield, B.S. ..... Assistant in Economics
A. B. Sogn, M.S. ..... Assistant Professor
E. O. Ullrich, M.S. (USDA) ..... Assistant
Professor
J. E. Wiebe, Ph.D. ..... Assistant Professor

APPOINTMENTS

W. F. Payne, Assistant Professor 9/1/70
R. K. Rudel, Assistant Professor 2/1/71

RESIGNATIONS

John Sanderson, Assistant Professor 9/8/70

ENTOMOLOGY-ZOOLOGY

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E. U. Balsbaugh, Ph.D. — Associate Professor
T. F. Branson, Ph.D. (USDA) — Instructor
C. O. Calkins, M.S. (USDA) — Instructor
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Ralph Gustin, M.S. (USDA) — Instructor
E. W. Hamilton, Ph.D. (USDA) — Associate Professor
E. J. Hugghins, Ph.D. — Professor
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R. W. Kieckhefer, Ph.D. (USDA) — Associate Professor
V. M. Kirk, Ph.D. (USDA) — Professor
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Burruss McDaniel, Ph.D. — Associate Professor
E. E. Ortman, Ph.D. (USDA) — Professor
M. H. Roller, Ph.D. — Associate Professor
W. N. Stoner, Ph.D. (USDA) — Professor
G. R. Sutter, Ph.D. (USDA) — Associate Professor
R. N. Swanson, Ph.D. — Associate Professor

HOME ECONOMICS

Frances M. Hettler, Ph.D. — Professor and Head
Louise Guild, M.S. — Assistant Professor
Lillian O. Lund, M.S. — Professor
Mary E. Rust, Ph.D. — Professor
Cora R. Sivers, M.S. — Assistant Professor
Rena Wills, M.S. — Associate Professor

HORTICULTURE-FORESTRY

R. M. Peterson, Ph.D. — Professor and Head
D. G. Adams, Ph.D. — Associate Professor
H. G. Cady, B.S. — Assistant in Forestry
P. E. Collins, Ph.D. — Associate Professor
N. P. Evers, B.S. — Assistant in Horticulture
D. E. Herman, Ph.D. — Assistant Professor
L. C. Johnson, M.S. — Associate Professor
D. P. Prashar, Ph.D. — Associate Professor
W. A. Urdahl, B.S. — Assistant in Horticulture
J. R. Waples, B.S. — Assistant in Horticulture

PLANT SCIENCE

R. A. Moore, Ph.D. — Professor and Head
W. E. Arnold, Ph.D. — Assistant Professor
F. L. Bode, B.S. — Assistant
J. J. Bonnemann, M.S. — Assistant Agronomist
G. W. Buchenau, Ph.D. — Associate Professor
P. L. Carson, M.S. — Professor
J. D. Colburn, M.S. — Associate Professor
C. D. Dybing, Ph.D. (USDA) — Associate Professor
G. W. Erion, M.S. — Assistant Professor
P. D. Evenson, M.S. — Assistant Professor
L. O. Fine, Ph.D. — Professor
C. J. Frazee, Ph.D. — Assistant Professor
W. S. Gardner, Ph.D. — Associate Professor
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S. G. Jensen, Ph.D. (USDA) — Associate Professor
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Q. S. Kingsley, M.S. — Assistant Professor
Charles Krueger, Ph.D. — Assistant Professor
A. O. Lunden, Ph.D. — Associate Professor
C. J. Mankin, Ph.D. — Professor
C. M. Nagel, Ph.D. — Professor
T. C. Olson, Ph.D. (USDA) — Associate Professor
W. B. O'Neal, B.S. — Assistant
J. D. Otta, Ph.D. — Assistant Professor
P. B. Price, Ph.D. (USDA) — Associate Professor
D. L. Reeves, Ph.D. — Assistant Professor
J. G. Ross, Ph.D. — Professor
M. D. Rumbaugh, Ph.D. — Professor
George Semeniuk, Ph.D. — Professor
D. B. Shank, Ph.D. — Professor
D. G. Shannon, B.S. — Assistant
F. E. Shubeck, Ph.D. — Professor
James Smolik, M.S. — Assistant
W. D. Stegmeier, M.S. — Assistant
C. E. Stymiest, M.S. — Instructor
R. T. Thaden, B.S. — Assistant
J. R. Thysell, M.S. (USDA) — Assistant Professor
R. C. Ward, M.S. — Instructor
J. B. Weber, B.S. — Instructor
D. G. Wells, Ph.D. — Professor
F. C. Westin, Ph.D. — Professor
E. M. White, Ph.D. — Professor
R. S. Wong, B.S. — Assistant

APPOINTMENTS

F. L. Bode, Assistant — 7/1/70
J. R. Jenison, Assistant — 7/1/70
W. B. O'Neal, Assistant — 9/15/70
D. G. Shannon, Assistant — 2/1/71
R. S. Wong, Assistant — 4/1/71

RESIGNATIONS

D. R. Hovland, Associate Professor — 8/31/70
W. D. Stegmeier, Assistant — 3/25/71
C. E. Stymiest, Instructor — 9/15/70

PUBLICATIONS

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Barbara Hartinger, B.S. — Assistant Editor
Wanda Leonard, B.S. — Assistant Agricultural Publications Editor

APPOINTMENTS

J. L. Pates, Agricultural Information Editor — 9/1/70
Wanda Leonard, Assistant Agricultural Publications Editor — 9/1/70

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H. M. Sauer, M.S. — Professor and Head
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M. P. Riley, Ph.D. — Professor

STATION BIOCHEMISTRY

O. E. Olson, Ph.D. — Professor and Head
R. J. Emerick, Ph.D. — Professor
G. F. Gastler, M.S. — Associate Professor
Yvonne A. Greichus, Ph.D. — Associate Professor
P. L. Guss, Ph.D. (USDA) — Assistant Professor
Alice Holm, M.A. — Assistant in Biochemistry
H. R. King, M.S. — Assistant in Biochemistry
A. W. Halverson, Ph.D. — Professor
L. C. Novotny, B.S. — Assistant
I. S. Palmer, Ph.D. — Associate Professor
E. I. Whitehead, M.S. — Professor

APPOINTMENTS

Alice Holm, Assistant in Biochemistry — 9/1/70
L. C. Novotny, Assistant in Biochemistry — 7/1/70

VETERINARY SCIENCE

K. D. Weide, D.V.M., Ph.D. — Professor and Head
W. E. Bailie, D.V.M., Ph.D. — Associate Professor
E. J. Bicknell, D.V.M., Ph.D. — Associate Professor
R. J. Bury, D.V.M. — Instructor
Janice Fuller, B.S. — Assistant
G. S. Harshfield, D.V.M. — Professor Emeritus
Sharon Irvine, B.S. — Assistant in Veterinary Science
M. M. Kieffer, B.S. — Assistant in Veterinary Science
C. A. Kirkbride, D.V.M. — Assistant Professor
W. U. Knudtson, M.S. — Instructor
T. J. Langpap, B.S. — Assistant in Veterinary Science
Carol Ann Larson, B.S. — Assistant in Veterinary Science
T. E. Lucas, D.V.M., M.S. — Assistant Professor
Janet Mattson, B.S. — Assistant in Veterinary Science
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Connie Phillips, B.S. — Assistant in Veterinary Science
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David Reed, Ph.D. — Assistant Professor
M. G. Robl, Ph.D. — Assistant Professor
Hazel J. Shave, B.S. — Assistant in Veterinary Science
I. J. Stotz, B.S. — Assistant in Veterinary Science
J. B. Taylor, D.V.M. — Professor Emeritus

APPOINTMENTS

Sharon Irvine, Assistant in Veterinary Science — 8/1/70
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Janet Mattson, Assistant in Veterinary Science — 7/1/70
Connie Phillips, Assistant in Veterinary Science — 8/1/70
R. L. Pierce, Assistant in Veterinary Science — 7/1/70
M. G. Robl, Assistant Professor — 10/16/70

RESIGNATIONS

W. E. Bailie, Associate Professor — 6/30/70
Janice Fuller, Assistant in Veterinary Science — 6/30/71

WILDLIFE AND FISHERIES SCIENCES

D. R. Progulske, Ph.D. — Professor and Head
R. L. Applegate, M.S. (USDI) — Instructor
R. B. Dahlgren, M.S. (USDI) — Instructor
J. M. Gates, Ph.D. — Assistant Professor
Douglas Harr, B.S. — Instructor
R. L. Linder, Ph.D. (USDI) — Associate Professor
J. G. Nickum, Ph.D. — Associate Professor

APPOINTMENTS

J. M. Gates, Assistant Professor — 9/1/70

RESIGNATIONS

Douglas Harr, Instructor — 6/18/71

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James Olson, M.S. — Superintendent Pasture Research Center, Norbeck
Frank Holmes — Superintendent Central Substation, Highmore
A. J. Herndon, B.S. — Superintendent Range Field Station, Cottonwood
Carl Erickson, M.S. (USDA) — Superintendent U. S. Irrigation and Dryland Field Station, Newell
W. R. Trevillyan, B.S. — Superintendent Antelope Range Field Station, Buffalo
R. M. Luther, Ph.D. — Research Manager Southeast South Dakota Experiment Farm, Beresford
J. F. Fredrikson, B.S. — Superintendent Southeast South Dakota Experiment Farm, Beresford
B. E. Lawrensen, B.S. Assistant Superintendent Southeast South Dakota Experiment Farm, Beresford
L. B. Dye — Superintendent Irrigation Research Substation, Redfield

APPOINTMENTS

R. M. Luther, Research Manager — 7/1/70 Southeast South Dakota Experiment Farm, Beresford

RESIGNATIONS

Albert Dittman, Superintendent — 6/21/71 North Central Substation, Eureka

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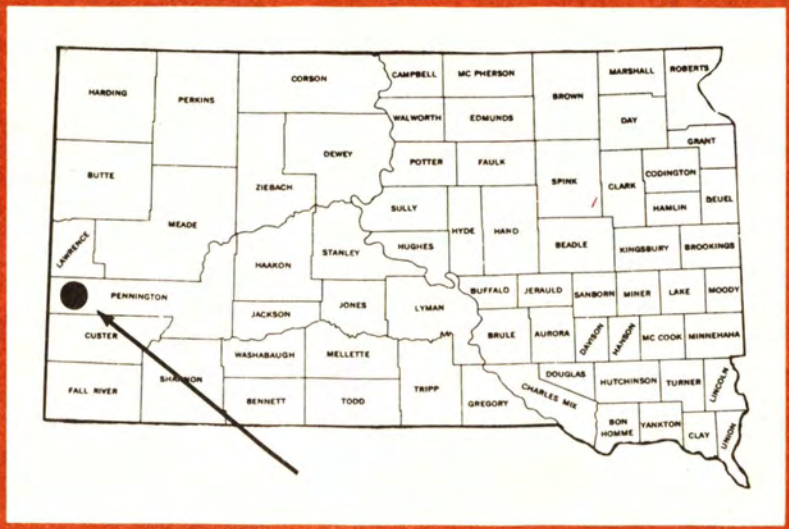

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