Fall 1986

South Dakota Farm and Home Research

South Dakota State University

south dakota

farm & home research

vol 37, no 4. 1986

Annual Report Issue

Director's comments

Ray Moore
Agricultural Experiment Station

This is the 99th annual report of the South Dakota Experiment Station. It is bulky.

We asked department heads to bring you up to date on the most significant projects in their areas and to speculate about future needs in research. It was hard to edit out any projects—all had meaning to South Dakota agriculture and home life. And the enthusiasm of the departments about the future could not be dampened. Hence the size of this magazine.

But they appear to have left something out.

If you notice that, it is because your definition of agriculture has expanded beyond what is happening between the fencelines. Your definition is more global; it encompasses production, marketing, and use of agricultural commodities. It is our definition, too; and there are reasons much of the "use" has been left out and production ag has been emphasized.

Historically, the mission of the Station has followed the provisions of the Hatch Act of 1887, "to conduct research to provide practical and useful information." Our main purpose is to provide research support to South Dakota's number one industry, agriculture.

That goes beyond the typical "production agriculture" concept. Again, the Hatch Act: "It shall be the object . . . of the State agricultural experiment stations. . . to conduct . . . experiments . . . contributing to the establishment and maintenance of a permanent and effective agricultural industry . . . including researches basic to the problems of agriculture in its broadest aspects, and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer. . . ."

So, since 1887, the Station has stretched the definition of "agriculture." Our research covers not only "how to grow more," preferably with less input. It also includes marketing and adapting that product to consumer preferences.

The citizens group who reviewed the Station in 1986 asked us to expand our "nonproduction" research.

They urged, in particular, that we find more food and nonfood uses of

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Agricultural Engineering

Globalization of agriculture has changed the picture. This country has lost its edge. More nations are agriculturally self sufficient than ever before in our history. They don't need us as much anymore.

International trade policies—the total of trade policies, not just those in agriculture—influence our everyday decisions on the South Dakota farm or ranch, even to the prices we pay for replacement parts for the combine.

Other nations are using the latest in technology to sustain and enhance their agricultural productivity. We may not regain our "edge," but we will also have to use advanced technology if we want to compete effectively in the complex, dynamic, and increasingly competitive world market.

Wherever your farm chores are easier, credit the ag engineers

Technology is what the Agricultural Engineering Department is all about.

Essentially, no single research area of the Agricultural Experiment Station is excluded. In Ag Engineering we integrate and work cooperatively with other disciplines to provide the most research productivity possible.

It's not every day that a brand-new tractor engineered by a university research group comes along. Usually the results of ag engineering research are not so obvious.

Yet livestock producers use efficient natural ventilation systems for confinement buildings, automatic feed handling systems, and farmstead designs that engineers have developed.

Crop producers use improved equipment for applying chemicals, center pivot irrigation with better hydraulic design, low-pressure systems to save energy and water, improved tillage equipment, and ride in tractor cabs that have temperature and acoustical controls. These all come out of ag engineering research.

Every phase of production agriculture benefits as ag engineering research provides the technology to move from human labor and horse power to diesel and electrically powered machines.

SDSU is only research station where trail tubes are studied

Heating ventilation air to the temperature of the air in livestock buildings has long been a major expense for producers. Other universities have focused on geothermal energy to alter ventilation air (heating it in winter and cooling it in summer). These systems use large pipes buried in the ground to extract the geothermal energy.

At SDSU, we are designing and evaluating a system that uses geothermal energy to heat or cool a liquid circulated in a pipe buried in the ground. A liquid-to-air heat exchanger tempers the air just before it is introduced into the confinement building.

Technical feasibility and economic comparisons will be made between the two systems and field tests will be performed at facilities owned and operated by GTA Feeds at Ellis, SD.

Recommendations on types of tillage practices that will limit runoff under low-pressure systems are nearly ready.

Approximately 310,000 acres in South Dakota are irrigated by 3,000 center pivots. Annual energy or fuel cost ranges from $2,000 to $5,000 for each system. Lowering pressure could allow an energy

saving of $500 to $3,000 per system, a possible saving of $1.5 to $6 million annually.

Water losses to evaporation and wind drift are also reduced. Such a reduction in water loss could increase irrigation acreage in South Dakota by 10 to 20% for the same amount of available water.

However, low-pressure nozzles typically distribute water over a smaller area than do high-pressure systems. Without proper and coordinated tillage practices, excessive runoff can occur on many soils. We are correlating the data from slope, soil, and tillage interactions for various types of low-pressure nozzles.

Scientists from Plant Science and the Water Resources Institute participated in the study, which was conducted on the land of a farmer cooperator near Gettysburg. Personnel from the James Valley Research and Extension Center assisted, and we received a sizable equipment donation from one of the major center-pivot manufacturers.

Another alternative to conventional, high-pressure sprinkler irrigation is trail-tube irrigation, and our research is showing that this method has great promise.

Trail-tube irrigation combines a low-pressure system and tubes connected to the center pivot or linear travel system. The tubes trail behind the boom, distributing the water in a way that minimizes runoff.

This research is receiving additional support from a $98,000 grant from the U.S. Geological Survey. SDSU is the only research station in the U.S. where low-pressure irrigation by trail tubes is being studied.

A study just begun will evaluate the possibility of using drain tiles for irrigation purposes. Entitled "Irr-A-Drain," it will be tested on soils needing drainage at the James Valley station near Redfield. This is also a multidisciplinary project, involving Ag Engineering, Plant Science, and the Water Resources Institute.

Skid-steer tractor has great potential for farm-chore work

Our electric tractors have already been viewed at field days and the State Fair.

Nearly all chores on an eastern South Dakota farm can be handled by a battery powered tractor. Skid steer is the second and smaller prototype built in the Department shop. It uses less energy, . . requires less maintenance, and sharply reduces noise and pollution around the farmstead. Task now is to find a manufacturer.

Designing and building the prototypes has been a long-term project in which researchers from Economics and Electrical Engineering have also participated.

The smaller, skid-steer unit appears to have excellent potential for farm-chore use. Reduced energy costs, less maintenance, and lower emission rates are its particularly desirable characteristics.

We are now focusing on improving overall system design, locating improved batteries, and finding an industrial firm that would be interested in manufacturing the unit commercially.

We are also looking at the feasibility of electrical vehicles of other sizes for agricultural applications. A series of grants totalling over $219,000 from USDA and the National Rural Electric Cooperatives Association has helped support this research.

We have recently developed an automatic weather data network with instruments at six sites: Brookings, Redfield, Oacoma, Gettysburg, Lemmon, and Buffalo Gap. This system automatically monitors temperature, relative humidity, 4-inch soil temperature, wind speed and direction, solar radiation, and rainfall every hour.

It then automatically telephones the data to the AGNET computer at the University of Nebraska, and the data can be used same-day by farmers in, for

example, deciding whether to schedule irrigation or crop drying.

Most of our ag engineering researchers also have teaching duties. A unique project this past year was the design of a constant-depth tillage trip mechanism by students in a required design class. They came up with a prototype that is not activated until a minimum force has been applied and which then resets itself to the predetermined depth in a specified time. This unit will be further tested and refined, with the goal of making it available for manufacture and use in production agriculture.

Like the fisherman, we've already landed big ones, but won't quit

The very nature of research makes it difficult to predict the future. However, the following areas appear to need attention.

1. Development and verification of microprocessor based systems for improving control of air flow rate and distribution for both mechanically and naturally ventilated livestock buildings.

2. Studies of the effects of and methods of controlling soil compaction.

3. Development and validation of management/information systems that employ microprocessor units to monitor, control, and optimize certain processes—fertilizer and chemical application, tractor motor performance, and tillage tool position, for example.

4. Determinations of the quality of our groundwater and of what management and control procedures we need to follow to insure its quality for future generations.

5. Evaluation of the effects of farm laborer environment on the health of farm workers.

Research is a little like fishing. The fisherman sets off with enthusiasm and the goal of hooking a record-maker. Even when he comes home skunked, he learns something. Maybe he was fishing in the wrong place or using the wrong bait. He listens to seasoned fishermen and learns from them. Eventually he catches "the big one."

We have enthusiasm and dedication in our research program, too, and we have already had many successes. We have excellent input, counsel, and cooperation from farmers, other researchers, and industry. Just as the fisherman, we think we are getting better, doing a better job, and will achieve our major goals.

The Department of Agricultural Engineering research program is dedicated to the effective service of production agriculture in South Dakota. Many of our professionals are recognized as national and international leaders in their areas of expertise. They have defined realistic and meaningful goals, and they are making tremendous progress in designing and developing the technology that will help maintain and improve the efficiency, productivity, economic viability, and standard of living of South Dakota farmers and ranchers. □

Compiled and edited by ***Dr. Mylo A. Hellickson****, professor and head, Department of Agricultural Engineering.*

Animal and Range Sciences

We start with rangelands and end with red meat.

That's the gamut of research in the Animal and Range Sciences Department. The forage of grasslands is our state's major natural resource, and it is the goal of our Department to convert it into a high-quality product for human consumption.

Range is more than a place to run cattle. It is a total environment

Rangeland occupies about 53%, or 26,134,000 acres, of the total land area of South Dakota. Livestock is its product. Range produces more than 12 million AUM's (animal unit months) of feed and forage and supports, partly or entirely, 37% of all cattle, 45% of cows and heifers that calve, 42% of all calves born, and 69% of all sheep and lambs raised in the state.

If we could double the carrying capacity on only half of the state's rangeland (from 0.3 to 0.5 AUM's per acre), the value of the forage portion of the added grazing alone would be $20 to $30 million annually.

But the value of rangeland is more than that of providing grazing for livestock.

It also serves watersheds and wildlife, and is a source of plant germ plasm for the future. Major projects in our Department are devoted to increasing range forage productivity while conserving soil and water resources.

We come at rangeland improvement from many angles. One is mechanical treatments which are site-specific and cost effective. Part of this approach involves claypan; we have learned that some chemical properties of claypans improve following mechanical treatment. Another aspect is prescribed burning; we are documenting the recovery of vegetation after burning, but recovery will need to be correlated with figures for livestock gains on regrowth forage.

We are also checking rangelands from the air. Satellite image data can be used effectively to monitor tonnage, species composition, and stage of growth. These data, collected from overpasses at the Cottonwood research station, are fed into a computer to simulate range condition. We will then be able to predict range condition more accurately and quickly for livestock producers.

The rangelands of central and eastern South Dakota are badly in need of improvement. We must accomplish this without high risk and costly tillage, and without losses from deferment or failure. Improvement through grazing management appears to be the best alternative. We are keeping cattle on two typical management systems (continuous and repeated seasonal grazing) and on grazing deferment for cool- and warm-season grasses. This is a long-term project, but we will report to you as we progress.

Undesirable plants invade or prosper in overused range. One is the prickly pear.

In 1981, 14 western South Dakota counties had moderate to severe infestations of prickly pear, totaling over 1,300,000 acres. On test sites in 1984, we were able to increase grass production by as much as 50%. This also is a continuing project, but we know already that cost effectiveness is a realistic expectation.

Cattle type must match producer's system and consumer preferences

There are approximately 1.5 million beef cows in the state. The cow-calf unit is the primary way we harvest South Dakota's vast forage resource.

Output is relatively easy to measure; it is as simple as putting an animal on a scale, for example. However, with costs of production continuing to increase, it is important to also measure **input**, including land and feed requirements, for example.

We are identifying the primary factors that potentially influence cow efficiency, such as breed type, cow size, and level of milk production.

In a current project, individual feed intake of heifers is measured through weaning of their first calves. Following weaning, the 2-year-old females are sent to the Antelope research station for evaluation of subsequent lifetime productivity as brood cows.

This study estimates heritability of cow efficiency and will provide an indication of the effectiveness of selecting cows based on first calf success.

Since it's hard to measure feed intake, a better approach for the producer is to select for traits that are genetically correlated to efficiency and easier to measure. So we are looking for these correlations, such as between the cow's own weaning and yearling weight and her first calf's weaning weight.

It is important in all our research to match cattle type to available feed resources, while producing beef which meets consumer demands.

Reproductive performance, growth rate, feed conversion, carcass composition, marketing, and management strategies should be simultaneously considered in evaluating net economic efficiency of various cattle types under alternative production systems.

Endless job to collect feeding values; nature throws us curves

We are trying to produce leaner cattle. One bottleneck is that we do not know the amino acid needs for maximum muscle growth. Basic studies in ruminant amino acid metabolism are a start toward recommendations to the producer.

We are also concerned about calf losses due to shrink, sickness, and death that are associated with getting the calves into feedlot. These losses are one of the cattle industry's greatest liabilities.

Consequently, we have evaluated the preconditioning program, following both preconditioned and conventional calves from 6 weeks preweaning through slaughter weight, watching their health, weight gain, and many other variables.

Over one million calves are produced in South Dakota annually. Improving stress management will make our calves more valuable at sale time and more efficient in the feedlot.

Cattle feedstuffs in South Dakota are extremely varied, and made even more so by the wide choices of inexpensive byproduct and residue materials. Our

Doubling the stocking rate could more than double ranch income, but only if the rangeland is **not** allowed to deteriorate. Central and eastern rangelands badly need improvement. Measures must be site-specific, whether they are mechanical treatments, prescribed burning, or individualized grazing management systems.

climate also leaves us with unusual feeds—crops that have been drought, moisture, or freeze damaged.

The feeding value of many of these materials is not known, and it is impossible at present to assign a monetary value to them. Over the years we are building a data base of chemical compositions and feed values for as many of these products as possible, so that farmers and feeders can determine market values and formulate balanced rations.

Consider: four more pigs/sow/year from 'white sows' without extra energy feed

Swine research is in nutrition. Our goal for all the studies reported here is to improve overall feed efficiency.

We are examining the limiting amino acids in different diets. Our part of a regional cooperative project is finding the protein requirements of finishing pigs, and the differences between barrows and gilts. We are adding up to 25% oats in low-protein diets as a tryptophan source.

In energy research we are refining the feed level for the high productive sow and studying the use of chickpeas in sow diets (late gestation). Chickpeas are a potential farm-grown fat (high energy) source. We are checking the value of extruded soybeans in growing-finishing diets and the possibility of barley as an energy source for finishing pigs, which will require studies of carcass quality and dressing percentage.

"White" sows require no more energy than "colored" females, but are more productive. Four more pigs/sow/year could let us reduce sow herd by 25% with same number of pigs, a cost savings of over $6.8 million/year. Or we could keep all 200,000 sows in state and add millions to the industry.

Sow energy work over the last 3 years has indicated that productive "white" females require no more energy than less productive sows. If those productive females bear four additional pigs/sow/year, the sow herd in the state of South Dakota could be reduced by at least 25% and still produce the same number of pigs.

In feed cost savings alone, this would result in over $6.8 million per year.

Or, if the sow herd stayed the same (200,000 sows), an additional $20 million in gross feeder pig sales and $10 million in gross butcher sales could be realized in the state.

First order of business for sheep: get production to a 180% lamb crop

It's just possible sheep don't get the respect they deserve.

Sheep are more efficient than cattle because of greater prolificacy, earlier puberty, shorter gestation period, and shorter growing period. Because there is a shorter time between generations, breeding improvement potential is greater. In addition, the producer can market the wool, one of the most durable and best insulators among the natural fibers.

These double benefits of meat and fiber and the fact that sheep complement other ruminants in their grazing and forage needs make sheep unique.

But productivity isn't what it should be. In 1982, the national lamb crop was only 97 lambs per 100 ewes. In 1985 this had risen to 102. Our goal should be a 180% lamb crop.

South Dakota ranks fourth in stock sheep numbers in the U.S. Sheep numbers had steadily increased in the state from 594,000 head in 1977 to 724,000 stock ewes plus ewe lambs in 1981. In 1986 we dropped back again to 480,000 stock ewes, mostly because of adverse weather conditions for two growing seasons.

Consequently, the goal is to raise production. Our research shows that for every 100 Targhee ewes brought into the breeding flock, 24,400 lb of weaned lamb and 4,360 lb of wool were produced after 6 years. Substituting one half of the genetic base with Suffolk breeding

resulted in a nonsignificant increase of 1,300 lb of weaned lamb and a significant decrease of 488 lb of wool after 6 years. The use of one-half Finnsheep breeding resulted in 6,000 lb more lamb and 800 lb less wool per 100 ewes than for the Targhee ewes.

In short, Finn x Targhee ewes were most prolific, while Targhee ewes produced the most wool in both ranch and farm flocks.

Year of production and breed of sire have significant effects on lifetime productivity. The high nutrition postweaning group weaned more pounds of lamb at 12 months than a moderate-energy postweaning group. Multiple-born ewes had higher conception rates at 24 and 36 months than single-born ewes. Single-born ewes had less health problems.

Sheep productivity is climbing; national average at the beginning of 1987 was 108. South Dakota topped that with an average of 127 lambs per 100 ewes, ranking the state first among states with 400,000 or more ewes. Breaking even in the sheep game is between 100 and 120. Sheep can be either a primary or secondary enterprise and respond well to management.

Meats work concentrates on chuck for most returns from an undervalued cut

The meat research effort concentrates on muscle growth, chemical and physical characteristics, carcass composition, and processing technology. Our first major goal is to increase consumption of meat products by improving composition, palatability, and portion size. The second goal is to increase the value of the carcass and live animal by enhancing the demand for less valuable portions through incorporation into products attractive to modern consumers.

Meat restructuring research has progressed through flaking and forming; chunked, formed, and cured; chunked and formed, fresh and frozen stages; and finally to the best whole muscles of the chuck put back together with a seaweed "glue" (alginate). We concentrate on the chuck, the largest wholesale cut that represents a potential for value-enhanced meat products, since it has muscle mass and a low demand/value profile in today's market.

The meat products of the future must provide the consumer with a source of high-quality animal protein, iron, zinc, vitamins, energy, and other nutrients. At the same time, meat research must develop new products that insure wholesomeness, provide convenience, assure shelf stability, and require minimum preparation time with modern kitchen appliances.

Cooperation with other researchers will continue to have high priority. The meat product is the endpoint of all forage, crop, breeding, and animal nutrition research in the Department of Animal and Range Sciences. □

Compiled and edited by ***Dr. John R. Romans,*** *professor and head, Department of Animal and Range Sciences.*

Biology

Biologists tend to view agriculture as applied biology.

The Department of Biology is a point of departure for specialties in animal, range, and plant sciences, horticulture, pharmacy, nursing, and for all farming and ranching operations and any other disciplines that deal with living creatures, plant or animal.

Hybrid corn and livestock breeding are applications of Mendel's basic biological concepts. Plant nutrition, especially as applied to agriculture, can be tracked back to plant physiologists who hypothesized the existence of essential nutrients required for good plant growth.

These "applied biology" specialties are returning more often to the parent science of biology for the basic data that will help answer numerous agricultural problems. This shift will become more pronounced in the next 20 to 30 years.

'Biotech' not new, includes tissue culture work we've done for years

The primary reason for this re-emphasis on biology is biotechnology.

A general definition of biotechnology is that it is the use of living organisms to create or improve commercially important products or processes. In that light, wine and cheese making are biotechnological processes that have been around for centuries.

Antibiotics, enzymes, and amino acids were early biotechnology products. Plant hybrids, AI, superovulation, embryo transfers, all familiar in "applied biology" fields, are biotechnological offshoots.

Genetic engineering is simply biotechnology at the cellular or molecular level. Manipulating genes may improve the ability, speed, and efficiency of producing desired hereditary traits.

The Biology Department's most significant contribution to this research has been in plant tissue culture.

The Department pioneered tissue culture during the late 1950s and early 60s. It is just starting to have payoffs in horticultural and agricultural applications.

In tissue culture, small pieces are cut from a selected plant and placed on a nutrient gel. By manipulating the nutrient composition of the culture medium, we can induce the plant pieces to form callus, and eventually new shoots and sprouts. These can then be removed from the culture and grown independently in the field.

The shuffling of genes and the new genetic combinations that occur during this culture process can result in rapid genetic improvement of the species.

Early work focused on the culture of native plant species to preserve valuable germ plasm for future ecological and agronomic applications. Many native plants are becoming endangered; tissue culture is able to increase the numbers of individuals of a species rapidly.

More recently, biologists have developed cell and tissue culture techniques for the rapid cloning of forage grasses and hybrid corn lines. The goal is to produce superior synthetic varieties that are genetically modified and adapted to South Dakota conditions.

We have cultured 11 different species of forage grasses at SDSU, including switchgrass, big bluestem, and crested wheatgrass. Combined with conventional breeding programs, this work has vast potential for agronomic applications. It has brought our scientists national and international attention.

Purple coneflower is example of vast gene pool in native prairie

Our researchers are also investigating the biology and agricultural potential of a native prairie plant, the purple coneflower. It's a pretty little plant, but until now it hasn't excited any interest except from people concerned with preserving our prairie heritage and from undergraduate taxonomy students required to memorize what it looks like.

Purple prairie coneflower grows naturally on agriculturally marginal land, is drought and disease resistant, contains a biodegradable insecticide, and produces seed that contains 30% oil that is very similar to sunflower oil. As a bonus, the plant is a perennial.

We hope, through tissue culture, selection, and breeding, to produce a single-headed variety with high oil content and pest resistance. In the future, through genetic engineering, we will try to transfer the pest-resistant properties to sunflower by gene transfer.

Tissue culture is cloning—all new plants are genetically identical. If genes change (or are changed) during culturing, this can have momentous impact in the plant breeding world. One-of-a-kind plants can be increased in weeks instead of the year normally needed.

Certain brain defects may relate to deaths of 50% of pig embryos

While nearly all of the 10 to 20 eggs ovulated by female pigs are fertilized, only 50% of the embryos survive. Implantation, the time when contact is established between mother and embryo, is when most of these embryos die.

Our research so far suggests that infertility is caused by defects in the brain (hypothalamus) and/or the pituitary gland. When we learn more about mammalian implantation, we should be able to control, by proper management, those conditions which aggravate and increase the loss of livestock embryos.

Molecular genetics, cell-molecular biology in research plan for future

In future research we plan to concentrate on developing a strong and nationally competitive research expertise in molecular genetics and cell-molecular biology.

There's much to learn, and it's an exciting field. Waiting to be discovered are fundamental cellular and molecular mechanisms of gene expression and control, plasma membrane function, energetics of cells, and more about cell division and growth and the immune system.

And it all fits into production agriculture. What we learn from these discoveries in biotechnology can be applied to genetic improvement, nutrition, enhanced reproductive rates, elimination or control of diseases, and enhanced growth potential. That benefits us all, in higher quality products at lower cost.

Another benefit of biology research to South Dakotans is the preparation of its citizens for the future. Fewer and fewer of us will be working the land. Spin-off industries, such as plant and animal biotechnology, will keep our highly trained and educated young people in South Dakota.

And biology will never be the same again. □

Compiled and edited by ***Dr. Charles McMullen****, professor and head, Biology Department.*

Dairy Science

The saying goes: use what you have on hand first. It'll probably work, and it's cheaper.

What's on hand in South Dakota for dairy producers are South Dakota produced feeds—not only the usual crops and forages, but also the byproducts of the dairy manufacturing industry.

Over the years, dairy researchers have used this approach, spending more time on applied than on basic research and using South Dakota products. It has paid off handsomely, but it hasn't kept us out of the national and international limelight.

SDSU is, for example, the world leader in whey utilization research.

Whey is a byproduct of cheese production and, in many cases, is discarded. Since about 75 to 80% of the milk produced in South Dakota is processed into cheese, the Department has done extensive research in the use of whey and whey products. It can be turned back into animal diets, and it can be used in new dairy products for human consumption.

Whey, put back into feed, stirs up the microorganisms in rumen

We have concentrated primarily on dairy cow nutrition and dairy manufacturing.

Because we are a small department, we do not conduct extensive research in reproductive physiology or in genetics and breeding, but rely on cooperative efforts with other land-grant universities in these areas, just as they rely on us for our strengths. In the long run, it pays off for South Dakota dairymen and consumers alike.

We know now, through our whey utilization research, that we can replace essentially all the protein supplements and feed grains traditionally fed to growing and fattening cattle or milking dairy cows.

Our basic research has shown that adding whey to the diet will increase rumen microbial protein synthesis. As a result, the cow can use more nonprotein nitrogen products such as urea in her diet. Cows fed dried whey and urea produced as much milk as cows fed corn and soybean meal, and more milk than cows fed corn and urea.

Another way we are working with whey is to incorporate it into cheese to increase cheese yields.

Looks like chickpeas could be home-grown dairy feed in future

Another South Dakota produced crop we have combined with the dairy operation is sunflowers.

We have done extensive research in evaluating sunflower meals in livestock feeds, particularly dairy cattle rations. We have also examined the feeding value of whole-plant sunflower silage, seeds, combine residue, and sunflower hulls.

Much of this research came in response to questions our farmers were asking. It has developed, however, into providing advice and recommendations nationwide.

The future of chickpeas as an economic South Dakota crop is being evaluated by some farmers and several departments at SDSU. Dairy Science is one of them. We have several experiments just completed and some in progress evaluating chickpeas in the rations of growing heifers and lactating dairy cows. Preliminary results indicate that chickpeas may indeed be a future feed source for state farmers.

In cooperation with the Plant Science Department, we are also investigating several new forages such as teff grass and Cicer milkvetch as feeds for cattle.

We concentrate on our strengths—research that's immediately usable

We also have an active leadership role in protein nutrition, especially as it relates to the high producing dairy cow. This has been a large effort nationwide, with particular emphasis on increasing protein utilization in early lactation.

Our share of this effort has been primarily on heat treating protein supplements to reduce the solubility or rate of protein degradability in the cow's rumen. We have concentrated on soybean meal and sunflower meal, the primary protein supplements available in this area and in many other parts of the U.S. Our practical research has demonstrated that high producing cows fed heat treated soybean meal or soybeans will produce more milk than when fed regular commercially available soybean meal.

Some of our work has been in basic research—studies in which we can rapidly expand our knowledge of the cow's rumen, but which are not immediately practical for on-farm operations.

We have evaluated protein degradability, amino acid composition of products, and other gross changes of feeds as a result of the additional heat treatment. We have inserted cannulas (they would remind you of the neck of a fruit jar with a pop-top lid) into the cow's digestive tract at various points. Through the cannula we can extract partially digested feed and measure rate and site of digestion. We have done some of this type of work, but we have left the bulk of it to other stations. It is very expensive research.

A more practical approach is to supplement proteins with the limiting amino acids. We have begun with methionine, which must be protected to minimize its destruction in the rumen so it can be available in the lower digestive tract.

We study protein nutrition, feeds, limiting amino acids but never forget this, the ultimate utilization of our product. You can smile, too; visit our Dairy Bar on campus where milk, cheeses, butter, and ice creams from our dairy processing and manufacturing programs are sold.

It's a 'natural' to combine and expand protein and energy studies

Our other area of specialty is energy feeds.

The inability of cows to consume enough energy during the first few months of lactation is usually one of the major factors limiting milk production.

Since fat contains over twice as much energy as the same amount of cereal grains, displacing some of the cereal grains in the ration with additional fat can potentially increase energy intake and possibly increase milk production and overall cow health.

We have emphasized natural sources of fat. Sunflower seeds are approximately 40% fat, soybeans contain about 20%.

In general, cattle can utilize more fat in their diet than they normally are fed; however, they cannot use nearly as much as nonruminants such as hogs or humans. We are fine-tuning our recommendations.

A natural follow-up to both protein and energy studies is to combine them. We are beginning work in protein-energy relationships.

We know we can increase production of some cows by feeding a bypass type (heat treated) protein. However, sometimes these diets will reduce rumen microbial protein synthesis. We also know that some sources of carbohydrates are degraded more slowly in the rumen than other sources. For instance, the starch in barley is generally fermented

more rapidly than the starch in corn.

So barley may be a better source of fermentable carbohydrates for improving rumen microbial protein synthesis than other sources. Our researchers are evaluating the proper role of certain crude protein, carbohydrate, and fat sources so that we can ultimately recommend the best rations for South Dakota dairy cattle.

Softer butter and 'blue milk' are two processing projects

Cheese, butter, and ice cream have been our primary emphases in dairy manufacturing research. (Our products are on sale at our ice cream parlor on campus, and we invite you to stop in and enjoy.)

We are trying to find a butter that is more spreadable at refrigerator temperatures. This has turned out to be more than laboratory work, for we have found that what farmers feed their cows may influence not only the composition and flavor of dairy products but also the processing properties of the milk.

When we feed additional fats from soybean and sunflower seeds, we may set up conditions for a milk fat which is more unsaturated in fatty acids. Butter made from this milk may be more spreadable at refrigerator temperatures.

After storage tests are completed, we will know whether the flavor and quality of this butter is maintained throughout a normal storage time.

And we continue our efforts to keep antibiotics out of milk. (Antibiotics are routinely used for treating cows that have mastitis infection in their udders.)

Great strides have been made in developing new, rapid, and more accurate antibiotic tests for milk. We have assisted in developing some of these new tests.

One product that was evaluated extensively in our SDSU dairy herd was a colored dye marker in the antibiotic. The theory is that this dye will be milked out of the udder at the same rate as the antibiotic, so if the milk still has a blue color, chances are that it also still has antibiotics. If the dairyman finds the blue milk, it reminds him that it must not be put in the bulk tank for human consumption. Such products are now being used in New Zealand and in France, but have not been approved for use in the U.S. at this time.

'Strong suit' is dairy processing plant where we check out our work

And now for the big news.

The National Dairy Promotion and Research Board has solicited research proposals for new dairy foods research centers.

Our dairy manufacturing group formed a consortium with the Food Science and Nutrition Department at the University of Minnesota to establish one of these research centers at our two universities. The primary goal of our center will be increase emphasis on biotechnology in the development of new starter cultures and new dairy products. SDSU's strong point in this plan is that we have an excellent dairy processing plant that can be used as a pilot plant for the practical development and final application of any potential products we develop.

Regional research and cooperation among universities will grow stronger. Sharing research results not only saves South Dakota tax dollars; it also shortens the time between the start of research and ultimate recommendations to the farmer. It takes a long time to breed, gestate, drop a calf, and start milking, as any farmer knows, and it takes a lot of animals to obtain meaningful data. When cooperating universities combine their herds and efforts, the process is speeded up.

There will be new products to be evaluated. Bovine somatotropin and isoacids have already been in the news. Some will be developed at universities such as SDSU. Some will be developed by industry, who comes to the land-grant dairy departments for evaluation of their products.

In the long run, the Dairy Science Department will continue to give South Dakotans the most for their dairy research dollars. We may increase our efforts in basic research, but will not forget that basic research must ultimately have practical application for the dairy producer. □

*Compiled and edited by **Dr. John Parsons**, professor and head, Dairy Science Department.*

Economics

The end products of economic research are reports which provide improved understanding of complex problems in the farming economy and contain information, for use by Extension staff and "real-world" decision makers, that will facilitate improved decisions concerning farming and farm related problems and needs.

Our continuing research purpose is to generate information and insights on issues in economic decisions made by private individuals and public officials in South Dakota.

The research is focused on managerial and policy options that offer a prospect of alleviating the financial stress so deeply embedded in South Dakota's agricultural economy. The decision makers of most direct concern are farmers and ranchers, bankers and other agricultural business people, and state and local government policy makers.

During recent years, between 50 and 60 research reports have been published annually by the Economics Department's five to six "full-time equivalent" researchers. Most publications are targeted to "real-world" decision makers in South Dakota. Around 10% are aimed more directly at academic peers in South Dakota and elsewhere in the country.

Economics research centers on farm management and marketing

Our research includes studies in farm management (including "small farm" research), marketing (both grain and livestock), public policy (including agricultural policy), transportation, community development, energy use, resource development, irrigation, and finance and land values. Of those, farm management and marketing (broadly interpreted) are most emphasized.

Livestock production accounts for about 70% of the state's agricultural cash receipts. The organization of the food system greatly affects prices received, marketing costs incurred, and efficiency of the process. Research projects in the Economics Department include not only livestock production but also the movement of the product from the producer to the ultimate consumer.

Livestock prices commonly fluctuate widely. Research on causes of that fluctuation and how to make reliable forecasts is a valuable contribution to producers and the state's economy.

South Dakota corn prices are responding more quickly to price changes in destination markets than they did formerly. Prices in South Dakota have improved relative to those in the Gulf, Minneapolis, and Chicago markets. Research which tracks these changes and helps producers respond to them will continue to benefit the state.

Farm and ranch land represents two thirds of the value of physical assets in South Dakota agriculture. Land markets are very localized, meaning that land use and location variables explain most of the variation in land prices. (Land use

variables are a proxy for agricultural productivity and estimated net returns, the key factors that affect price, in our studies.) Real (inflation adjusted) interest rate changes influence real farmland price changes, but there is little evidence that any individual financial/lender variables systematically explain price variation.

A recent study involved collection of data from commercial banks, the primary source of credit to local business and agriculture. Cost and availability of that credit depend upon the banks' ability to limit their exposure to risk. Deregulation of the credit markets has created new exposure to interest rate risk and new tools for handling risk. Research results indicated that banks are limiting exposure to interest rate risk by matching maturities of groups of assets and liabilities, shortening maturities of assets, and reducing loan-to-deposit ratios.

About 70% of the state's irrigation water is distributed by pressurized sprinklers energized by electricity. Electric rates have been increasing at roughly 20% per year over the past 6-7 years. Recent research on electric rate structures for irrigation shows at what electricity prices irrigators would 1) start to cut back and 2) completely stop using electricity to energize their irrigation pumps.

Both bright side, dark side to support for economics research

The general level of total support for the South Dakota Agricultural Experiment Station is low, relative to that for other experiment stations in the region. For example, the $2.85 expenditure on production-related research per $1,000 of value added in agriculture in 1979 in South Dakota was less than half the average for the 10 Great Plains states and was less than three quarters the amount for the ninth ranking state.

The budget expenditure for agricultural research per scientist-year in 1979 in South Dakota was $61,500. Among the 12 agricultural experiment stations in the North-Central Region, South Dakota ranked 12th, with the $61,500 per scientist being 36% of the average for the 12 states and 63% the amount of the 11th ranked state.

The Economics Department receives about 3.5% of the total South Dakota Agricultural Experiment Station's budget. One reason for this modest level of support is that there is no need for fields or equipment, for livestock or people to care for them, or for out-state experiment farms or on-campus labs.

But no department can do research that will be appropriate for others wihout getting out into South Dakota to find out what clients want and need.

The total budget per research project in the Economics Department for travel, data collection, data analysis, supplies, telephone, and labor is less than $2,750. That is a very low figure compared to other states.

On the bright side, the Department competes well with other universities in recruiting researchers for entry-level positions. However, the turnover rate is high. While that is a problem in all departments, it is more severe in Economics because the demand for qualified ag economists is greater than the available supply.

In future, more economic input will be part of all ag research

Again, on the bright side, there is a growing awareness that economic input is critical in virtually all areas of research conducted at SDSU.

There is a need for greater interdisciplinary and interdepartmental cooperation on research. There will be an ever increasing number of researchers in all agricultural departments working with economists. The final contribution is providing the state's citizens with an improved understanding of complex problems in the agricultural economy and information to help them make sounder economic decisions in their farm and farm-related businesses. □

Compiled and edited by ***Dr. Ardelle Lundeen****, professor and acting head, Economics Department.*

Home Economics

The only department in Home Economics that is supported by funding from the Agricultural Experiment Station is Nutrition and Food Science. Three projects are now in progress that are critical to the well-being of all South Dakotans.

If fatty tissues hold pesticides, what happens when people diet?

Much research has already shown that, as animals eat creatures below them in the food chain, most pesticides which any lower animal ingested will not be excreted but will be passed up through the food chain to the highest animal, which stores these pesticides in body fat.

One of our projects is exploring the level of pesticide storage in South Dakota human adipose tissue. The USD Medical School is cooperating in the collection of fat samples.

Fat stores are one of the last sources the body will tap for energy to carry on normal activity. However, over half the population in a recent six-county study considered themselves overweight and were considering or already dieting. Obviously, they intended to burn up some of their fat stores.

Weight loss in research animals is known to release stored pesticides in much higher levels than our human population. Yet, in humans, a contaminated energy source may also pose a health risk, depending on the amount of pesticides stored.

We will be evaluating diet and dietary alterations on body composition and pesticide metabolism. We would like to enlarge the study to include pesticides in human breast milk from mothers who are reducing their weight at the same time they are breast feeding their infants.

Off-again on-again pounds may be worse than not trying at all

A considerable number of Americans are chronic dieters. While they continually try to lose weight, they frequently have relapses of gaining weight.

There is evidence that this sort of diet cycling may disturb energy metabolism and ultimately result in higher amounts of body fat than that produced by moderate, stable obesity.

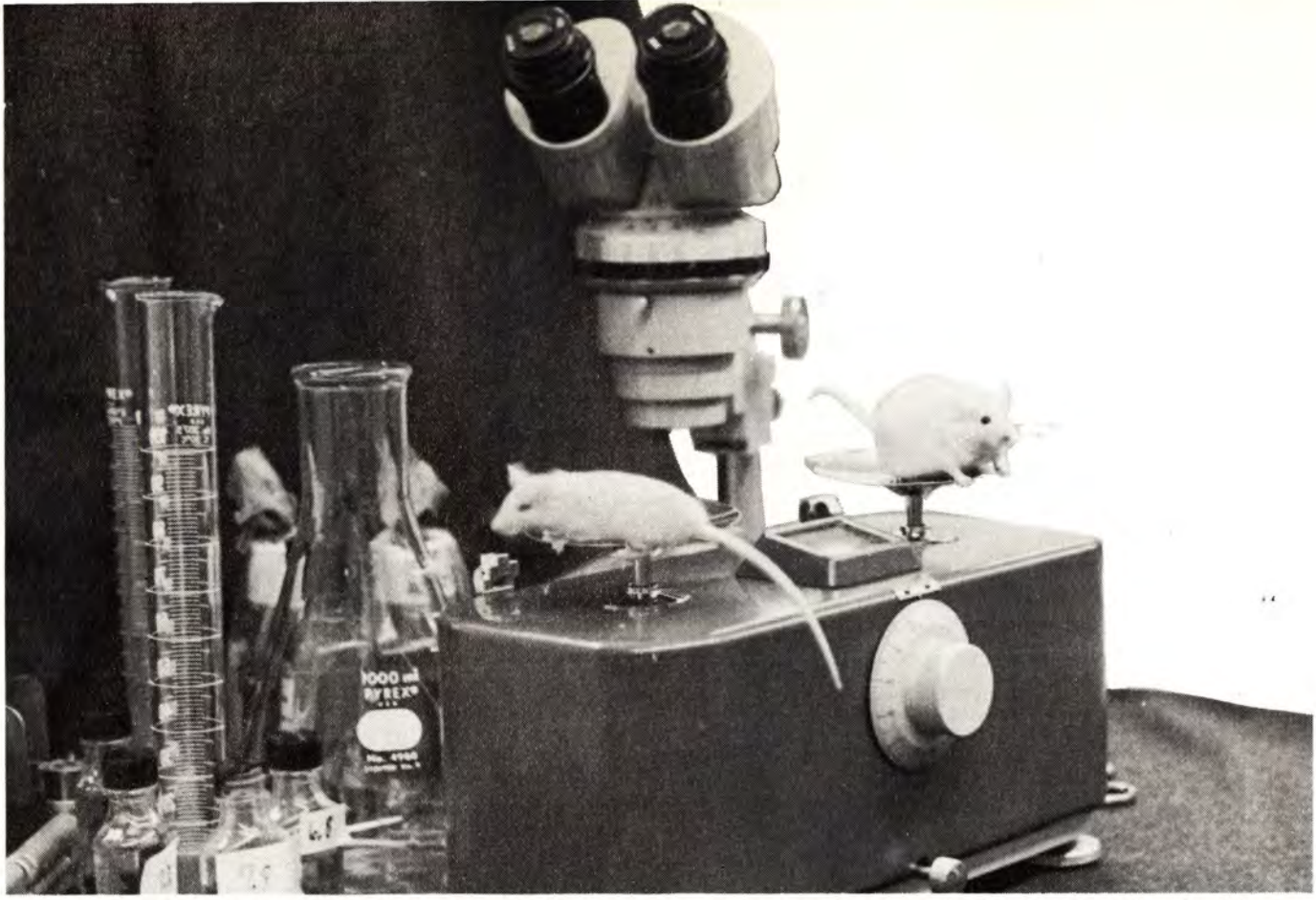
There's a particular strain of mouse that has even more trouble losing weight than do must humans. It is genetically programmed to be obese. On the equivalent of a "bread and water" diet it will still get fat while other strains of mice stay lean.

We are continuing to study these two types of mice, focusing on type and amount of tissue lost or altered on a calorically restricted diet, comparing their energy efficiency during calorie restriction and subsequent refeeding over several cycles.

The project has direct implications for weight loss in humans with certain genetic predispositions for body type.

Are repartitioning agents truly wonder drugs? Is there a catch?

Certain drugs, called repartitioning agents, have been shown to increase lean



The one on the left is young; leave him to himself and in time he'll weigh up to 30% more than normal mice. The "fat yellow mouse" is special; the color of the fur is genetically linked to a propensity for fat. Repartitioning agents change his body mass to more lean muscle and less fat, but of course he's only a lab mouse and not a pig or steer where this drug would really benefit the industry—if it works. It's far too early to tell whether repartitioning agents are safe for humans.

muscle mass in many animals while reducing proportions of body fat. These drugs have been proposed as feed additives to improve efficiency in meat animals, giving more lean carcass with less waste. Others have suggested they may be used as weight reduction agents for humans.

We are testing the drugs on both genetically lean and obese mice, examining the mice for total protein and fat and muscle and organ weights.

Recommendations will be made, favorably or unfavorably, only after very long and exhaustive research. We do not blithely suggest use of drugs without solid supporting evidence.

Other critical nutrition and home ec studies need support

The Nutrition and Food Science Department is conducting other research which fits the goals of the Agricultural Experiment Station but funded from other sources. We would be able to enlarge these studies and contribute to the health of South Dakotans more quickly with additional funding.

A diabetes project focuses on nutrition knowledge and control of the disease process. We are studying prenatal nutrition and preganancy outcome in minorities in South Dakota. Dietary patterns and their relationship to degenerative disease patterns are also being investigated.

There are other projects in the College of Home Economics for which extra funding is needed. The last support for Clothing and Textiles was for a North-Central regional cooperative project on burn injuries and clothing type that was completed in 1982. There is a history of no support for Child Development, Family Relations, Family Economics, Consumer Education, Housing/Interior Design, or Home Economics Education. □

Compiled and edited by ***Dr. Edna Page Anderson****, professor and Dean, College of Home Economics.*

Horticulture, Forestry, Landscape and Parks

To readers of *Farm & Home Research*, we are the "Hort-Forestry Department." We **do** have a longer title. It is the "Horticulture, Forestry, Landscape, and Parks Department.

You know us by the former name because, since 1983, we have conducted research only in areas of horticulture and forestry.

Our existing horticultural research incorporates fruit and vegetable breeding and variety testing, a greenhouse crops production evaluation program, and a selection and propagation study of superior native and introduced trees and shrubs for South Dakota.

South Dakota is seeing a rapid increase in commercial horticultural crop production. Research in our Department will assist those new owner/operators in producing plant varieties that will show higher yields and quality.

Our forestry research is involved in the genetic improvement of our tree species for utilization in windbreaks and shelterbelts. We have looked at the physiological characteristics of conifers used in our windbreaks and shelterbelts. This study was essential for determining the causes behind lack of success in growing conifers in the eastern two thirds of the state.

Truck gardening is 'old as the Hills,' department is giving it a new boost

Commercial horticultural cropping has caught the interest of many South Dakotans as they seek alternative enterprises to more traditional crops.

Truck gardening and "pay and pick" operations are not totally new in the state. Certain areas in the Black Hills, for example, were specializing in "wagon" or "horse" gardening in the days of the 1874 gold rush, when some entrepreneurs grew rich supplying vegetables to miners too busy to grow their own.

When the Experiment Station was opened in 1887, a horticulturalist was one of the first five scientists hired. His duty was to "ascertain what . . . fruit trees will grow best, and what kinds of garden vegetables can be easily cultivated to add variety to the farmer's bill of fare and to increase his profits."

The Department since then has continued to provide new varieties to the public. The names of some bear an obvious South Dakota origin—Siouxann and Rushmore tomatoes, for example. Other vegetable and tree varieties hide their roots, but you have come to depend upon them in preference to other sources because they have been developed specifically for our state's planting zones.

The Department continues to pursue the breeding of high quality cultivars of fruits, vegetables, and woody ornamentals adapted to South Dakota. Among these are new pot species that can be produced in 3 to 4 months at low, fuel-saving temperatures and without costly cultural practices such as pinching and disbudding. If they pass the test of consumer acceptance, commercial greenhouse operators and the public will benefit.

We also plan to develop economic methods of propagating horticultural crops, with special emphasis on micro propagation.

Breeding is only part of the effort in attaining commercial success. The other part is the care the plant receives. We are concentrating more effort in determining

An experimental pepper field will produce an amazing variety of shapes and sizes and colors. Such traditional breeding is complemented by cultural practice research with both new and existing cultivars of trees, ornamental flowers, and shrubs.

superior cultural techniques for horticultural crops to increase their commercial and/or aesthetic value.

These techniques include drip irrigation, root stock/scion relationships, nursery container growing systems, soil modifications, and integrated pest management.

New technologies in computer control of plant production and crop modeling are "naturals" to adapt into our research.

Scattered double lines of trees are shelterbelts of the future

Even before the extensive federal shelterbelt program (systematic planting of trees to protect fields) began in South Dakota in the mid 1930s, the state's landowners knew the value of trees.

They had planted a 600-ft-long shelterbelt on the Webber demonstration farm near Pierre. By the time the federal program began, the planting was showing vigorous growth despite severe drought and grasshoppers.

By 1955, shelterbelts were more than paying for the land they occupied in increasing yield on the portions of fields that were protected, increasing sale value of the property, reducing soil blowing, and controlling drifting snow. Yield increases were 8 to 9 bu more corn and 3 to 4 bu more wheat, farmers said.

Another study showed that farmhouses protected on the north by windbreaks had fuel savings up to 20%. Exposed cattle lost an average 30 lb more than those protected by tree and shrub cover in a 3-day blizzard.

Despite the unquestioned good that shelterbelts and windbreaks have contributed to the South Dakota economy and quality of life, most have received minimal or no care. They are aging and dying.

It is the rare tree planting of the 30s that is healthy in the 80s, as we have reported to you in earlier *Farm & Home Research* articles.

Undoubtedly, some of this decline has been due to neglect. People tend to plant a tree and expect it to thrive under conditions they would never subject a row crop or small grain to. Some decline is also due to the extreme difficulty of regular maintenance; tree rows in early shelterbelts were planted too close to permit tillage or the replacement of unthrifty trees.

Researchers in our Department have designed a new plan, the twin row-high density plan. Such shelterbelts are very distinctive when planted out. The trees are young yet, but early returns indicate they are effective and attractive alternatives.

The 'breed' of a tree will tell; we are improving superior stock

One reason for the vigor of the new shelterbelts is the better breeding of the trees. The Department is seeking superior sources of seed from tree species that are important for rural and urban plantings. We have initiated a breeding program to improve on these traits for cold, drought and pest tolerance, growth rate, and form.

There is a link between the health, vigor, and survivability of trees and levels of foliage carbohydrates (sugars). We have also investigated that link.

Silvicultural research in the Black Hills is needed. Much of the ponderosa pine requires thinning, but research must tell us what stocking level of the pine will maximize volume growth in the trees and maintain high production of herbage for grazing. Determining the effects of slash pile burning on soil chemical and physical properties also requires a research project. □

Compiled and edited by ***Dr. Thomas D. Warner****, professor and head, Department of Horticulture, Forestry, Landscape, and Parks.*

Microbiology

Research in the Microbiology Department is designed to provide an integrated understanding of the role microorganisms play in the agricultural community. With this approach, we can make advances in agricultural productivity by incorporating or taking advantage of certain microbial processes. Our part in this research is of fairly recent origin. It will be some time before our results are turned into management recommendations.

Farmers could cut annual $155 million fertilizer bill if bacteria helped out

South Dakota farmers spent over $155 million last year on fertilizer. Most of that was for nitrogen. And most of that nitrogen (10-90%, our research shows) is lost back to the atmosphere under certain climatic conditions or farming practices.

If crop plants could capture nitrogen from the air and turn it into amino acids and proteins, high fertilizer bills would be a thing of the past.

Alfalfa, soybeans, and other leguminous plants use some of that nitrogen (it makes up 79% of the earth's atmosphere). They have a living arrangement with certain bacteria—the crops provide nodular "homes" in their roots and the bacteria respond with plant-available nitrogen compounds the crops use to grow.

Only certain bacteria and blue-green algae have the capability of "fixing" nitrogen. Some require a specific host plant, like the Rhizobia strains with the alfalfa. Some bacteria live free in the soil and fix nitrogen, thus enhancing fertility in their immediate area. Other bacteria infect many different kinds of nonleguminous trees and shrubs and contribute significant amounts of nitrogen in some forested areas.

Microbiologists aren't yet sure of the chemical pathways that these bacteria use; the Microbiology Department is one of many departments nationwide applying basic research to these questions.

Relationships underground are as complex as aboveground. Nitrogen fixation by some bacteria in nonlegume plants is inhibited if the roots of the host plants can't supply enough carbon for the process. Some root fungi, naturally found on plants growing under certain conditions, seem to stimulate carbon production. If we can adjust that combination of host/bacterium/fungus, we may be able to decrease the amount of nitrogen fertilizer a farmer must apply.

Because we have learned that from 10 to 90% of the nitrogen applied as fertilizer may be lost back to the atmosphere and because heavily fertilized soils that are saturated following rainfall or irrigation can lose large amounts of nitrogen, we are establishing rates of denitrification for corn and oats. Then we will be able to develop a management strategy for control of this loss. The potential for denitrification will be a part of fertility recommendations.

Some bacteria get between pesticide and target. That means lower yield

Pesticide application in South Dakota last year cost farmers over $6 million.

Studies underway in the Microbiology Department are determining the turnover or decomposition in soil of selected pesticides. Again, bacteria are involved.

Certain soil bacteria have plasmid DNA which breaks down soil insecticides and herbicides containing carbofuran. When we find those bacteria we examine the

plasmids, using restriction mapping and molecular weights. It's the first step toward providing the actual cost-benefits of pesticide usage and will aid the farmer in selecting the most appropriate pesticide combination for his system.

Pesticides and fertilizers cost farmers nearly $20/acre. If these chemicals fail to reach their target organisms due to decomposition processes, crop losses increase producer costs. Our on-going studies are revealing these bacteria that get between chemical and target. Appropriate management strategies will follow.

BRDC takes a heavy, if unknown, toll in cattle; vaccines are unpredictable

The true economic impact of bovine respiratory tract diseases in South Dakota is unknown. The bovine respiratory disease complex (BRDC) may be implicated in up to 80% of cattle disease, even if not directly responsible.

We do estimate that approximately 5% of yearling feedlot cattle will fall prey directly to BRDC each year. Of these, approximately 20% will die.

Many vaccines are available for immunization against the microorganisms that cause this disease complex, but their success is, at best, unpredictable. Our laboratory has chosen to examine this problem by conducting several basic research investigations into bovine pulmonary immunoreactivity.

Using fiberoptic bronchoscopy, we can assess the development of immunity to various antigens in the lungs of young calves. That will tell us which immunization procedure gives the greatest pulmonary protection. We can then apply this information to either the evaluation of existing vaccines or to the testing of new vaccine preparations.

Results from this basic research will be used by veterinarians to recommend the safest and most effective means of vaccinating against bovine respiratory diseases.

Too dangerous to study Leptospira directly, we put genes in E. coli

Leptospirosis is a disease that results in abortion in cattle and sheep.

This legume and its many wild and tame relatives can do something we're trying to duplicate—using free nitrogen for crop growth because of a symbiotic relationship with certain bacteria. Department's studies of the chemistry of this relationship may help someday to cut farmers' fertilizer bills.

We are investigating a mechanism for the production of a vaccine or diagnostic reagent. Using recombinant DNA, we have transferred the Leptospira genes to another bacterium, *Escherichia coli*. This rapidly growing organism is frequently used in recombinant DNA technology.

Our research will determine if the use of an "alternate" organism for vaccine production is possible. We'd prefer that because the "natural" organism is highly pathogenic and difficult to work with.

New methods and feedstocks edge price of ethanol production down

"Value added" in-state processing plants for South Dakota's agricultural products would provide additional markets for farm produce, additional jobs for state residents, and additional tax revenues from an expanded economic base.

Nationwide fuel ethanol production in 1985 surpassed 5 billion gallons and accounted for over 5% of all automotive fuel sales. South Dakota consumed 3-4 million gallons of ethanol in 1985, with the bulk coming from out-of-state plants.

Although only one plant (in Yankton) was in operation in 1985, interest remains at high pitch. To further encourage in-state production, the 1986 legislature passed a $.30/gal ethanol producer credit

The easy answers are in—that fuel ethanol from local feedstuffs can be made but too expensively. The hard answers are slower to come—that ethanol production costs will edge downward with adjustments in the fermentation process. When the economics matches the technology, South Dakota agriculture will have expanded home markets and more options.

and a $.02/gal pump exemption on ethanol blended fuels.

Research in the Microbiology/Ag Engineering/Economics departments at SDSU has concentrated on the fermentation processes small-scale ethanol plants would use with various South Dakota feedstocks as energy sources.

Previous research with feed grains and cheese whey mixtures showed how to cut ethanol production costs to $1/gal and reduced energy consumption for production by 40%.

Two novel fermentation systems (solid phase and diffusion-fermentation) have allowed us to evaluate ethanol production from new crops—wheat, fodder beets, and sweet sorghum, for example. Preliminary results indicate these feedstocks may be as economical as corn for fuel ethanol and feed byproduct production. If so, South Dakota farmers could diversify their farming operations and produce new cash crops on land that had previously contributed to the surplus of conventional crops.

Another supplemental farming enterprise in South Dakota continues to offer options to traditional agriculture.

Within the last year and a half, nearly 100 mushroom growers produced 30,000 lb of fresh mushrooms per week. This resulted in the employment of over 500 persons, full and part-time, and an estimated economic impact of $10 million per year.

Our part in this was research into production, disease control, harvesting, storage, and marketing of mushrooms. Numerous seminars and workshops were organized and conducted. We will continue to aid this industry when our input is appropriate.

Both basic and applied research end up answering questions you put to us

Last year, all microbiological research was accomplished by just 2.2 faculty and 1.75 graduate research FTEs. There are more than 3.9 people in the Department; they also have teaching and other duties. Results of our research are presented at meetings or published in the popular or scientific press. Publications for the past 3 years averaged 11 scientific and 14 popular articles per year.

Future research in the Microbiology Department will include the incorporation of biotechnology into agricultural production. Techniques will include the latest fermentation technology to produce new products for agriculture, production of monoclonal antibodies for disease detection and prevention, recombinant DNA manipulations to develop new and useful characteristics in microorganisms, and microbial inoculums to improve animal and plant production. The potential for applying these biotechnological methods for increasing productivity is enormous.

Microbiology is a good example of the combination of basic and applied research. Some of our work has immediate application—what we discover in our pilot ethanol fuel plant is an example. Other research projects are pure basic science. Scientists who work in basic research are never sure where their research will lead them. They begin, especially in the Experiment Station and departments like Microbiology, because a need has been expressed by the state's people.

Both the basic and applied research conducted in the Microbiology Department are designed to solve problems—yours, not ours. That gives you the opportunity to get on with your life and find new problems for us to solve. □

Compiled and edited by ***Dr. Robert L. Todd,*** *professor and head, Microbiology Department.*

Plant Science

The Plant Science Department encompasses the disciplines of agronomy, entomology, plant pathology, soils, and weed science. It has an excellent research record, with an emphasis on serving the needs of farmers and ranchers in South Dakota.

The research program has 50 active projects in the Agricultural Experiment Station and 48 grant projects funded by outside sources. To complement the research, the Department operates several service projects including soil and seed testing, seed certification, crop performance testing, foundation seed stocks, and several research farms.

A project or two may be missed in the following summaries. If you have questions, please visit with us. We might already be working on the research you are interested in, or you can acquaint us with your need for such a project.

Breeding programs continue on the old standbys, some brand new crops

Producing new varieties of major crops which are adapted to South Dakota and which perform well under our climatic conditions continues to be an important research area.

Currently, breeding programs are being conducted on 10 crops—alfalfa and forage legumes, chickpeas, corn, flax, forage grasses, oats, rye, spring wheat, winter wheat, and sunflowers.

Briefly, legumes are important sources of protein, vitamins, and minerals for humans and livestock. New varieties of chickpeas may supply home-grown feeds for livestock as well as garbanzo beans for salad bars.

Promising experimental lines of five grass species are being tested, and two annual grasses show great potential for short-term forage production on land suitable for conventional crop production.

Spring wheat yields have increased 100% in the past 50 years, approximately half of that due to improved varieties. We have also built improved yield stability into the newer varieties. The emphasis in the spring wheat program is on early maturity to avoid drought stress and on multiple pest resistance.

Problem isn't bad climate; it's both good and bad which we can't predict

South Dakota is a transition zone for crops and environment between northern and southern growing areas. Rapid swings in weather patterns cause serious stresses for plants, and research on environmental and biological stresses is essential.

Intermittent drought is the most serious obstacle to crop production in South Dakota. Some wheat cultivars can make temporary cellular adjustments to enhance water uptake during low water availability. We believe the mechanism is genetic in origin and involves specific hydrolases that influence wall extension and also make osmotically active sugars available.

Loss of winter wheat in 1977-78 and 1978-79 amounted to about 400,000 acres, over $30 million each year. Cell membranes are known to be vulnerable to effects of freezing. We have discovered a membrane protein which is present in high amounts in a freeze resistant winter barley.

All pest control projects are integrated, may use biocontrols

Pests always threaten crop production, and a major expense is the cost of herbicides to control weeds. Outbreaks of diseases are frequently related to weather and may be difficult to control.

Canada thistle infests approximately 150,000 acres in South Dakota. We are developing safe, practical methods for control by integrated use of agronomic practices, chemicals, and life cycle information.

Sunflowers are vulnerable to many pathogens, including downy mildew, white mold, leaf spot, black stem, etc. One of the best ways to control these diseases is to build in resistance through selected sources of germ plasm, including some wild species. Control of stem-boring insects significantly reduces stalk rot. Field rotation is necessary to reduce insects and diseases.

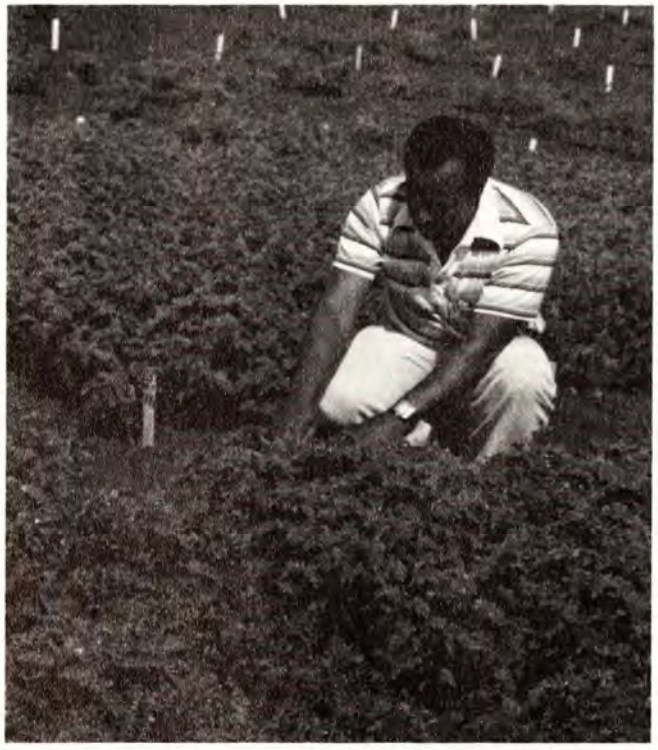
In soybean diseases, our researchers are studying the basic disease resistance mechanisms of the plants. They will be using biotechnology and genetic engineering to identify these sources of resistance and to develop techniques to alter the plants to resist disease, increase yields, or withstand stresses.

Studies in potatoes, an expanding crop in South Dakota, involve tissue-culture plantlets. Soil- and tuber-borne diseases appear to be some of the most important limitations on production.

Controlling corn nematodes will reduce field losses by at least 10%. Chemical control is a temporary solution. Researchers are preparing nematode-resistant varieties.

Biological control is an alternative to expensive chemical pesticides. It mobilizes specific natural enemies of the target organisms, such as we are attempting with common root rot of wheat which causes annual losses of 5-10% in South Dakota.

Reducing this loss by as little as one fifth would provide an additional $3 million to the economy of the state. One approach we are taking is to study the effect of tillage and crop residue management on soil microorganisms and plant health. Scientists are locating soils which suppress these diseases and attempting to isolate biocontrol agents from them.



Chickpeas are in the pulse family, one of the most important sources of nutrients, especially protein, for people throughout the world. New lines are being found for South Dakota (chickpeas actually grow better in a little drought); farmers will have an alternative high-energy, high-protein, homegrown livestock feed.

Insects are generally considered as destructive; however, some are beneficial to crops.

Identification of the harmful insects and determination of the level of infestation at which control measures should be initiated are important parts of crop production. Another technique is crop rotation, which helps prevent build-up of insect populations. Timeliness in initiation of control measures and integrated control methods are important aspects of insect pest control.

Estimated economic losses to corn rootworm range from $10 to $35 million annually. Insecticide expenditures range from $5 to $7.5 million each year. Our researchers feel that research results, when applied, will reduce losses and expenditures by 30%.

A fungus may serve as a biological control agent for grasshoppers.

The fungus has an extremely efficient means of dispersing itself from infected

to uninfected grasshoppers and tends to establish itself permanently via resting spores which overwinter in South Dakota soils. Research is now focused on determining the amount of inoculum necessary to kill grasshoppers in areas not previously known to be infected with the fungus. A sidelight is that the fungus itself has a predator which may dampen its effectiveness against grasshoppers. That, too, is being investigated.

We also have projects on livestock insects.

Stable flies decrease weight gain of beef cattle by as much as .5 lb/day and beef efficiency by 10-13%. In the absence of sanitation, keeping the flies below the economic threshold requires many chemical applications.

One control measure for horse and deer flies in western South Dakota is to cut vegetation around farm ponds and dugouts, reducing the emergent vegetation upon which the flies lay their eggs. Another simple method is to permit cattle access to the pond; their trampling also decreases plant growth.

The most promising natural control agent for grasshoppers may be a fungus disease, noted as early as 1895. The fungus has two major advantages—the grasshopper doesn't have to eat it and its spores can overwinter in South Dakota. A researcher can now move the spores to land that has never supported the fungus.

Ripping increases water intake; goal is to keep path open for several years

Soil tillage and other production practices are key factors in developing sound farming systems. Water—its supply and management—is especially important in a sub-humid region like South Dakota.

Our Department is cooperating in a regional project relating soil morphology to soil wetness and to duration of the wet condition.

Projects have documented that reduced or conservation tillage methods can save $3 to $12/A in fuel costs and time, depending on methods. The problems that are incurred include adverse soil temperature, soil compaction, nutrient availability, and slow crop growth. Advantages of reduced tillage are lower labor and fuel requirements. Nitrogen and phosphorus availabilities vary with the intensity of cultivation. Crop growth and yield can be affected.

Runoff is greater from rough surfaces than smooth, if the roughness is random or oriented in ridges up and down slopes. Runoff is least if ridges are on the contour.

Ripping of oats, corn, and soybeans on the contour after planting increased water intake, did not affect yields, and created a path where a crack formed as the crop dried the soil. Our scientists are working on stabilizing the ripper path so it will remain open for several years.

Mixed bag: flush saline soils but keep ag chemicals in place

The soil is a basic resource in crop production. Soil properties, nutrient status, and erosion rates are important factors in determining crop productivity potential.

The ultimate fate of the soluble salts in irrigation water is always a concern. The controversy over the Oahe project was centered on this salinity problem. Salinization of land in Butte County has resulted from 80 years of irrigation out of the Belle Fourche reservoir.

Contamination of groundwater aquifers with agricultural chemicals is another concern of scientists in the Station. Here we would like for the soluble salts to not move, whereas with a salinity problem, we want them to flush out of the soil. By calculating the net volume of water which

The Plant Science Department also provides testing services—seeds, soils, crop performance—for farmers and ranchers. Nutrient levels can be determined in soil samples, and the fertilizer recommendations will be based on crop needs and producer yield expectations.

moves through some test subsoils and the amount of salt this water contains, our researchers will be able to evaluate the long-term salinity effects of irrigation on soils with questionable subsurface drainage capacity. The end result will be an estimation of the future impact of fertilizers and pesticides on groundwater quality.

Challenge ahead is to cut input costs to gain higher efficiency

These descriptions of individual research projects do not show the cooperation that exists between scientists. Project leaders share equipment and labor, pool travel, and communicate ideas or research results with each other.

An immediate challenge in crop production is to increase efficiency by reducing the cost of producing each bushel of grain or other unit of production.

To meet this challenge requires the integration of knowledge about the soil, crop to be grown, and control of pests.

One of the tools that will improve our ability to manage complex cropping systems is the computer. We anticipate that computer modeling of farming systems will utilize a research data base on crops, soils, fertilizers, etc, to develop the most efficient system for an individual producer and his unique resources.

The Plant Science Department is actively engaged in crop breeding and research to develop new crops and new varieties with superior performance characteristics under South Dakota conditions. We anticipate more rapid progress through biotechnology in development of cultivars with built-in resistance to insects and diseases.

New crops with potential for production in South Dakota include chickpeas, crambe, milkvetch, rapeseed, teff, and perennial grain crops.

Production of food and fiber in the future will require a sound scientific research base. Farms in the future will integrate research results into production systems with options based upon individual soils and resources in a given environment. □

Compiled and edited by ***Dr. Maurice L. Horton****, professor and head, Plant Science Department.*

Rural Sociology

State an opinion, and somebody will surely challenge you: Where'd you get **that** idea?

The idea is your own. The facts that support it probably came originally from the Census Data Center (CDC) in the Rural Sociology Department if your opinion deals with certain "people" subjects.

The CDC was established in 1981 as a repository of census information (publications, micro-fiche, maps, and computer tapes) on population, housing, and agricultural statistics.

And, in addition to our other duties, we are now gearing up to store and handle the 1987 agricultural census, which will be released in early or mid 1988. One comprehensive "facts" bulletin and several "trends in agriculture" publications are anticipated.

We will also be using that information, along with all the rest of our data, to answer your individual questions about these subjects. All you have to do is call.

Data is original, undigested; you can even get it at township level

A joint agreement between the U.S. Bureau of the Census and the state of South Dakota in 1981 established the CDC at SDSU. As a part of the agreement, we are provided with all printed materials, micro-fiche, and computer tapes that allow us to serve as a repository of census data pertinent to South Dakota and surrounding states.

The great advantage of all this information is that it is raw data, not "pre-digested" information. Consequently, we can search the original collection for precisely the facts that you need.

Our CDC library presently holds over 2,000 volumes of past and present census data publications. Our personnel have responded to 216 specific requests for research information during the past year, produced 11 publications relating to migration, agriculture, aging, and age and sex distribution by county and the state, and have released our tenth in a series of monthly newsletters. We have conducted a "data users workshop." And we maintain a mailing list consisting of 949 private and public agencies, all legislators, elected and appointed state, county, and city officials, and 159 media outlets.

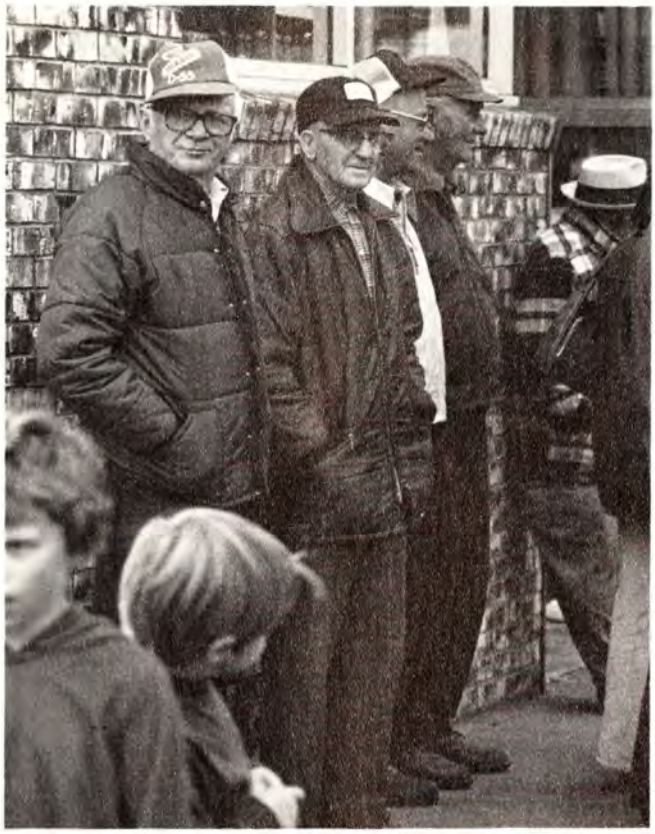
Because our data is complete and unsifted, we can analyze any part of the census material to fit particular requests. We can focus on particular issues related to the state as a whole, a township, or anything in between.

These data allow educated decision making by private and public officials in such areas as distribution of revenue sharing, block grants, poverty programs, minority requirements, etc. Projections and estimates of population allow for more accurate planning efforts, while analyses of the composition of the population (age and sex) provide bases for decisions on school reorganization, business expansion, and economic development.

In the past, communities and businesses were forced to go to private out-of-state consulting firms for these analyses. Now such data is available free of charge through the CDC.

These gleanings are only samples; much more data await your request

We don't tell you what to do with these facts. But many of you have already used



Rural small towns have an average 23 elderly per 100 people of working age. Older people need **local** services—health care, banking, transportation, housing, and often welfare. The children need schools. How is the small community to apportion its limited resources?

them and know you can't make decisions that will affect people in your community without them. There are some gleanings from publications we have put out just this year.

Some may seem obvious to you, but remember that if you are applying for a federal grant, "everybody knows that" is not enough. Your grant must be supported by firm statistical evidence.

If we round figures off below, it is for ease of reading.

* As of Janauary 1, 1987, Custer County had the highest percentage of population gain (+19.7%) since 1980. Bon Homme had the biggest percentage loss (-18.9%). The state had increased to 715,088 by 1987 (+3.5%).

* South Dakota lost a net 20,505 people between 1975 and 1980. Most of them went to Wyoming.

* Thirty percent of people over 65 in our state live in poverty.

* Families still make up 73% of all South Dakota households. From 1960 to 1980, 13 counties did **not** have increases in the proportion of single-parent households.

* South Dakota has the fifth highest percentage in the nation of women working outside the home. That's nearly half (49.3% in 1980) of women in the state. The highest county percentage is in Hughes.

* In 1970, the median years of school completed for the total South Dakota population was 12.1. For American Indians in the state it was 9.4. They have since played "catch-up." In 1980, total population had attended 12.5 median years of school, American Indians completed 11.7 years.

If you don't see something here that interests you, contact us. We have lots more!

The ag census comes this year; we will be releasing new publications

In the coming year we plan to publish a series of agricultural census bulletins for the period 1982-1987. We expect to respond to requests for data and analyses from 200-plus people who must make decisions on such issues as block grants, reapportionment, nursing home and school construction, agricultural changes and trends, minority representation, and poverty status.

And we propose that we expand our role in community development and assessment projects. We have already played a major role in the Sioux Falls needs assessment project, the Brookings employment survey, the Ford Foundation reservation development program, and the recent Super Conducting Super Collider project.

All this information is available to you. It's there for you to use in making South Dakota a better place to live. □

*Compiled and edited by **Dr. Jim Satterlee**, professor and head, Department of Rural Sociology and SDSU Census Data Center.*

Station Biochemistry

Research in Station Biochemistry is one step removed from you. More, perhaps, if you feel uncomfortable with chemistry; we work at the atomic, molecular, and cellular level.

Our research is at this very basic level of reproduction, growth, and regulatory processes in plants, animals, and the environment. It forms the base on which researchers in other departments on this and other campuses build their work. Last year, for example, we cooperated with scientists in Animal and Range Sciences, Microbiology, Plant Science, and the Veterinary Diagnostic Lab.

Our projects divide into three groups: trace substance, environmental, and plant related biochemical research.

What happens to pesticides in soil is still largely a mystery

We are well into work that may change both the livestock industry and the medical profession. Since our department has gained a flow cytometer, we can determine the effects of toxic substances on male fertility.

We now have the procedures in place. We are ready to discover to what degree any exposure to hazardous substances in their workplaces will alter the chromosomes of human males. We are also measuring unstable chromosomes which we expect to be more common in less fertile bulls.

We have also developed procedures that we can use in detecting pesticide residues in diagnostic studies.

Related to this is our work with pesticides in the soil. Rapid breakdown of pesticides in the soil is environmentally desirable, there is then no carryover to damage possibly susceptible crops. While chemical reactions bring this about in many cases, microbial action is important in others.

Whatever happens between pesticides and the resident bacteria and fungi in the soil sometimes changes the activity of other agricultural chemicals. It may also shift the soil microbial population to something that may (or may not) be desirable to the crop producer.

Pesticide combinations have been much less intensively studied than single chemical applications; we are looking at how these combinations change soil enzyme activities, persistence, and our predictions of pesticide effectiveness.

Two elements require far more study than 'trace' title implies

Silica urinary calculi causing urinary tract blockage is one of the more important causes of livestock losses on the western ranges of the U.S. and Canada. Losses of 3-10% are common in bulls, steers, and sheep in western South Dakota.

Farmers save a possible $2,000,000 per year because of analyses and recommendations from Station Biochemistry. Feed analyses lead to better ration formulation; toxicological analyses (including nitrates and prussic acid) prevent livestock losses. The lab also works with other agencies and with veterinarians in meat inspection and animal health.

We have identified the causes and protective factors of silica urinary calculi and are now drawing up recommendations that will help the producer prevent occurrence.

Another animal disease is selenium toxicity. Selenium is essential for good nutrition, but an excess causes "alkali disease," characterized by unthrifty growth, loss of hair, abnormal hoof formation, reproductive failure, and general emaciation.

Selenium occurs in relatively high concentrations in certain areas of the state. It enters animals through the vegetation. Our scientists were among the first to pinpoint selenium as the cause of alkali disease, and we are one of the few groups that have remained continuously active in the field of selenium toxicity.

Progress is continuing on identification of selenium metabolites. We may soon find out why and how selenium is essential in nutrition and find the ways we can moderate its toxicity. We have provided data on the selenium content of South Dakota foods and feeds and on the daily intakes of selenium by South Dakotans.

We have recently isolated and identified factors in linseed meal (flax) that are protective against selenium toxicity.

Our analytical method for selenium is used worldwide. It also serves as an aid to veterinarians in diagnosing selenium-related problems.

Our work in this area is important because federal agency guidelines have been overly restrictive for selenium dietary intake. There is a potential discrimination against South Dakota produced grains in these guidelines.

If leaves stayed green longer, soybean pods might be fuller

The seeds developing in the pods of soybeans need nutrients produced by photosynthesis in the leaves just about the time that photosynthesis is shutting down and the leaves are turning brown. If we could keep the leaves working a little longer during pod filling, we could increase yields.

A major factor in loss of photosynthetic activity is the decrease in amount or activity of the enzyme RuBP carboxylase. We are now able to study the chemistry of this and other enzymes at concentrations actually present in plants.

This accomplishment also allows us to understand some of the chemical differences between hardy and non-hardy plants. Soon we will try to select or alter genes in the plants to keep desirable characteristics.

Genetic engineering and toxicity, links to other projects in future

Biochemical research in the future will be highly "biotech" oriented. We will put an even greater emphasis on understanding the chemical basis of genetic engineering and toxicity. As in the past, our work will be closely matched with that of other departments working on problems of crop and livestock producers in South Dakota. □

Compiled and edited by ***Dr. Royce Emerick****, professor and acting head, Station Biochemistry.*

Veterinary Science

South Dakota is predominantly a young-animal producing state.

With production of young cattle, sheep, and pigs, we see a high incidence of enteric and reproductive disease; therefore, we have tailored our research toward those diseases.

The Animal Disease Research and Diagnostic Laboratory and the Veterinary Science Department at SDSU are integrated into one unit that provides service, research, teaching, and Extension functions. We have concentrated on the major health problems contributing to death and economic loss in young-animal production systems that relate to infertility, abortion, and diarrhea.

Enteric (intestinal) and reproductive research has a long and productive history in our department. Our researchers are nationally and internationally recognized as experts in the fields, and have developed their reputations to the point that competitive grant applications are now being successfully submitted and funded.

Enteric organisms are choosy. Why and how do they pick certain sites?

Specific enteric projects include studies of rotavirus, coronavirus, and *E. coli*, the major agents causing diarrhea in calves, sheep, and piglets.

E. coli, rotavirus, and transmissible gastroenteritis (TGE) cause neonatal diarrhea, which results in an annual loss of approximately $200 million to pork producers. Economic loss results from increased mortality, treatment costs, and reduced growth among survivors. There is no practical or effective treatment for viral enteritis, and herd infection is difficult to prevent. Commercial vaccines have been only partially effective.

The enteric organisms attach to particular sites on the epithelial cells of the small intestine. We want to know why they choose particular places, what the attraction is between organism and binding site, and if different strains of organisms attach to different sites.

When we understand how organisms attach to or invade tissues, we should be able to shed some light on how these organisms produce disease, how we can decrease the incidence of disease by interfering with attachment or invasion, and how toxin production may be shut down or neutralized. Knowledge of organism structure may allow us to make more effective vaccines and more accurately diagnose the various diseases.

What works in lab may not work in animal. We are narrowing the gap

Reproductive projects have dealt with abortion and infertility in cattle, pigs, and sheep.

The first step in controlling diseases that interfere with reproduction is accurate diagnosis. Each year we examine 800-1,200 bovine and 150-300 ovine abortions. Over the years, diagnostic testing procedures have greatly improved.

New causes of abortion and infertility have been identified, and methods of control have been established. An organism previously unidentified as a cause of abortion has been found in sheep.

Other projects in progress deal with parvovirus abortion in pigs. Parvovirus caused over 13% of the 2,021 porcine abortions examined in the last 5 years. More than 25% of these abortions occurred in herds that had been

A pig in this litter, born in a plastic bubble, will grow up in another with no natural immunities. When a germ is then introduced, the disease process will not be complicated or masked by other germs and the pig develops antibodies to only that germ. Pure antibody is a diagnostic tool.

vaccinated for parvovirus. Infected boars are known to shed parvovirus in their semen. Presently, experiments are being conducted to determine whether the present methods of vaccination produce immunity that will protect against intrauterine infection.

An estimated $745,000,000 is lost by the swine industry annually to infectious diseases, among them bacterial enteritis, pneumonia, and septicemia. Preventive measures have greatly improved, but the swine producer still relies heavily on antibiotics to treat disease outbreaks.

Antibiotics which appear to be effective in the lab (*in vitro*) may not be effective in the animal (*in vivo*). One of our reseach projects is designed to define serum and tissue levels of antibiotics in animals and correlate them with antibiotic levels deemed effective in the lab.

That research is gaining stature and national interest as the project progresses. Staffing is excellent, and the specialized equipment that helps us determine minimal inhibitory concentration is one of the few in use in animal diagnostic labs in the U.S.

Healthy animals are the start of a healthy economy in South Dakota

A major piece of equipment necessary to our research programs is a functioning gnotobiotic (germ-free) unit. It allows us to study one infectious disease process at a time, totally excluding contamination from other infectious diseases or environmental factors.

It also allows us to produce purified antibodies which function more specifically and accurately in many of our diagnostic tests, decreasing the time necessary to obtain results.

The unit was made locally, at a fraction of the cost of commercial units, and is almost constantly in use.

Scanning and transmission electron microscopes are housed in the Veterinary Science facility and are used by us and other researchers on campus. These instruments greatly magnify objects, allowing us to see and photograph images we were previously unable to visualize, thus adding a new dimension to research.

If the Veterinary Science Department is to continue to compete for funding on a regional and national basis, we will need more office and laboratory space very soon. To be competitive for NIH or NSF funds, laboratory animal facilities which comply with federal standards are a necessity.

The challenges we find in our diagnostic and veterinary research help to keep our staff on the "cutting edge" of their field. They look forward to continuing their work with South Dakota veterinarians and livestock producers. Healthy animals are a major link in the chain of a healthy economy for South Dakota. □

Compiled and edited by ***Darrell D. Johnson***, *DVM, PhD, acting head, Veterinary Science Department.*

Wildlife and Fisheries Sciences

The Department of Wildlife and Fisheries Sciences is the only program of its kind in higher education in South Dakota.

Of all departments in the College of Agriculture and Biological Sciences, Wildlife and Fisheries ranks third in the number of undergraduate and graduate majors. Over 800 undergraduate and 150 graduate students have completed the program. The research component in the Department draws many of these students.

In FY 1985, of the 12 academic department research programs in the College, Wildlife and Fisheries ranked 10th in Agricultural Experiment Station funding but fourth in total research funding.

Support from the Experiment Station is not large, when compared to most other departments, but it is magnified because of the way it is used.

Many of our projects involve matching funds from other sources; without Station support these other funds would be unavailable.

A good example of the fund matching process involves research projects contracted with the South Dakota Department of Game, Fish and Parks.

For every $1 in Station funds, we can obtain $3 in matching funds. The good thing about this is that the Station gets $4 worth of results for a $1 investment. The bad thing about it is that when we lose $1 in Station funding, we actually lose $4 in research support.

Keep soil and water in place, and you will likely have wildlife too

South Dakota has some of the finest wildlife and fish resources in the country. Few states can make the claim that over 40% of its residents hunt or fish. South Dakotans who travel and out-of-state sportsmen who return season after season have seen wildlife in other states and can make the comparison. South Dakota comes out looking good.

In addition to the income from licenses, gear, food, and lodging from sportsmen, there is a lot of resident and non-resident non-consumptive use of this resource in the state (boating, bird watching, etc.) For a minimal outlay, and sometimes for free, our South Dakota wildlife provides a wealth of both real and intangible rewards.

The credit for such bounty must be passed around. We in the Department of Wildlife and Fisheries Sciences are happy to take our share, but most of it must properly go to individual farmers and ranchers.

Most of the land in South Dakota is in private ownership. A large percentage of the state's fish and wildlife resource is found on this private land, and almost all of this land is used for some form of agricultural production. In South Dakota, agriculture, wildlife, and fish are closely related. This ranges from aquaculture (the raising of fish for commercial purposes), which is just a form of production

agriculture, to wildlife habitat management.

Sound agricultural practices that keep soil and water in place are the same sound environmental practices that keep wildlife on the land.

Fish farming (small-scale) may diversify operation, add income

All of our Experiment Station projects have one of two common threads. The first is the interaction of agriculture, wildlife, and fish. The second is wetlands management, which actually aligns well with the first emphasis. These break down into different studies, and the following are some of our current and recently completed projects.

Many South Dakota farm and ranch ponds and lakes are plagued with excess aquatic weeds. Chemical control is costly and short-term; mechanical control is costly, short-term, and labor intensive.

The right kind of plant-eating fish could take this problem off our hands.

We are looking at the triploid grass carp. It cannot reproduce because of its genetic makeup. And it can eat 75% of its body weight or more per day of aquatic vegetation. It could make our ponds and lakes far better for fish, fishermen, stockmen, canoeists, swimmers, and everybody who uses this resource.

We are also working on pond fish stocking. There are over 100,000 ponds in the state; most don't produce fish as they should or could. By manipulating stocking combinations and timing and and harvest, we hope to make this resource produce closer to its potential.

Another fisheries project involved the raising of rainbow trout in dugouts, the small excavated ponds found primarily in eastern South Dakota pastures. We have raised rainbows very successfully in these ponds.

Even though growth and survival were excellent, our growing season was too short to get the fish to a large size—hot days and warm water temperatures set in when the trout still had growing to do.

For the time, we are putting this one on hold. There are genetic strains of rainbow trout being developed which can withstand higher water temperatures. When these strains become available, we will give it another try.

Small impoundments in South Dakota may support fish farming. With the right pond, management, and fish, and with the right market, existing waters can produce up to 1,000 lb of fish per surface acre. Fish farming could be a profitable add-on enterprise to your normal farming operation.

The ability of landowners to use an existing water body to produce fish for family food and recreation or for sale is a research area we will continue to explore. In fact, this potential was recognized by the Citizens' Review Committee for Extension. They recommended, and we have hired, an Extension aquaculture specialist to provide aquacultural information to farmers, ranchers, and others. This represents an area of potential farm and ranch diversification.

Another fisheries research project which we are just starting involves the genetic manipulation of rainbow trout and walleyes. It is our hope to produce faster growing individuals of these species.

Interaction is key word: deer, beavers, turkeys interact with us and the land

In wildlife, one of our projects is on beavers.

If you think that's inappropriate in South Dakota, guess again. The beaver is the number one damage complaint animal in eastern South Dakota.

Beaver feeding and damming activities can have negative impacts on a variety of things, including agricultural croplands. We hope that our research leads to the solution of some of these problems. Muskrats have been included in the study; since we're out there we don't

A farm that is admired for other characteristics—good soil in place, water soaking in instead of running off, a shelterbelt protecting the buildings from winter winds—will most usually grow at least one extra wildlife crop, too. Good land supports good wildlife, and sound agricultural practices are sound environmental practices. These wildlife resources have both economic and intangible values for all South Dakotans.

have to make a special trip, and they can cause similar problems.

We go to entirely different terrain to study wild turkeys. We have growing populations, and there is a lot of landowner interest in further expansion. We hope that our work with this bird in Gregory County will lead to habitat manipulation practices which coincide with sound agricultural practices. We're looking at habitat, nesting success and brood survival, even the effect of snow cover on home range. Recommendations will result.

We have also recently studied, with Station help, deer and pheasant interactions with agricultural land, shelterbelts, and wetlands.

Cattails don't raise many ducks; they do have forage potential

Included in Department research support from the Station is some funding for the South Dakota Cooperative Fish and Wildlife Research Unit. The Unit has numerous projects; one of the more significant is livestock forage values of various wetland plants.

Another project has to do with the problem of excess cattail growth in wetlands.

They look pretty, but too many cattails can reduce duck production, and it's costly to control them by conventional methods. We have been fencing cattle into wetlands to force cattail removal. While producing more ducks, we will also be capturing the nutritive value of the wetland plants for cattle production.

Biggest benefactor of our wildlife research is not wildlife, it's you

Two of the areas we especially want to expand are aquaculture and wildlife habitat management research.

We do, however, need more support. It's not so much that a large increase is needed, just a return to past support levels.

For example, in FY 1986, operation, maintenance, and labor funding for our Department from the Experiment Station (outside grants and contracts not included) was $46,050; in FY 1978 it was $60,900. The last few years have been difficult.

We also need a new building; our present space was built in 1899. We invite you to come see our current facility.

Our wildlife resources have intangible values. They also have very economic values which may help as much as anything to pull South Dakota out of its current farm slump. We know that wildlife and agriculture are inseparable. It actually turns out that the greatest benefactor of increased wildlife research is every citizen of South Dakota. □

Compiled and edited by ***Dr. Chuck Scalet****, professor and head, Department of Wildlife and Fisheries Sciences.*

99th Annual Report

Agricultural Experiment Station
South Dakota State University

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J.L. Sommerfeldt, PhD, assistant professor
G.S. Torrey, PhD, assistant professor
H.H. Voelker, PhD, professor

Economics

G.E. Murra, professor and acting head
H.R. Allen, PhD, professor
T.L. Dobbs, PhD, professor
M.A. Edelman, PhD, associate professor
W.D. Ellingson, BS, instructor
L.L. Janssen, PhD, associate professor
C.E. Lamberton, PhD, professor
A.A. Lundeen, PhD, professor
B.H. Schmiesing, PhD, assistant professor
D.C. Taylor, PhD, professor

Home Economics

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M.G. Crews, PhD, associate professor
R.A. Shewmake, PhD, associate professor and head
M.N. Rosholt, MS, assistant professor

Horticulture, Forestry, Landscape, & Parks

T.D. Warner, PhD, associate professor and head
N.W. Baer, PhD, assistant professor
M.E. Enevoldson, MS, assistant in
N.P. Evers, BS, instructor
R.M. Peterson, PhD, professor
P.D. Prashar, PhD, professor
P.R. Schaefer, PhD, assistant professor
P.L. Spinski, PhD, assistant professor
J.R. Waples, BS, instructor

Microbiology

R.L. Todd, PhD, professor and head
W.K. Gauger, PhD, associate professor
R.P. Hillam, PhD, associate professor
R.M. Pengra, PhD, professor
C.A. Westby, PhD, professor

Plant Science

M.L. Horton, PhD, professor and head
W.E. Arnold, PhD, professor
D.L. Beck, PhD, assistant professor, supt., James Valley Research & Extension Center
G.R. Benoit, PhD, adjunct professor (USDA/ARS)
A.A. Boe, PhD, assistant professor
J.L. Bonnemann, MS, assistant professor
T.F. Branson, PhD, adjunct associate professor ((USDA/ARS)
G.W. Buchenau, PhD, professor
C.G. Carlson, PhD, assistant professor
M.L. Carson, PhD, assistant professor
W.H. Caskey, PhD, adjunct assistant professor (USDA/ARS)
F.A. Cholick, PhD, associate professor
C.D. Dybing, PhD, adjunct professor (USDA/ARS)
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B.G. Farber, MS, research associate
M.W. Ferguson, PhD, assistant professor
J.R. Fisher, PhD, adjunct assistant professor (USDA/ARS)
P.E. Fixen, PhD, assistant professor
D.J. Gallenberg, PhD, assistant professor
H.A. Geise, MS, assistant professor
R.H. Gelderman, MS, manager, Soil and Plant Analytical Lab
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E.M. Hall, BS, assistant in
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J.A. Ingemansen, MS, research associate
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R.W. Keickhefer, PhD, adjunct associate professor
R.L. Kepner, PhD, research associate
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G.D. Lemme, PhD, associate professor
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D.D. Malo, PhD, associate professor
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R.J. Walstrom, PhD, professor
P.D. Weeldreyer, MS, assistant professor
J.B. Weber, MS, manager, Foundation Seed Stock
E.M. White, PhD, professor
Z.W. Wicks, PhD, assistant professor
M.A. Wrucke, BS, assistant in
R.L. Wynia, BS, assistant in

Rural Sociology

J.L. Satterlee, PhD, professor and head

Station Biochemistry

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B.E. Ballachey, MS, adjunct assistant in
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T.M. Christianson, BS, assistant in
R.J. Emerick, PhD, professor
D.P. Evenson, PhD, professor
R.W. Gesch, BS, assistant in
J.E. Houglum, PhD, associate professor
K.R. Howard, BS, assistant in
F.C. Janca, PhD, research associate
W.P. Jensen, PhD, professor
L.K. Jost, MS, assistant in
D.P. Matthees, PhD, associate professor
L.C. Novotny, BS, assistant in
C.G. Paech, PhD, associate professor
I.S. Palmer, PhD, professor
R.R. Rue, PhD, professor
D.M. Simon, BS, assistant in
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Veterinary Science

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B.M. Carlson, BA, assistant in
J.E. Collins, DVM, assistant professor
D.F. Francis, PhD, associate professor
B.H. Janke, PhD, DVM, assistant professor
D.D. Johnson, PhD, DVM, professor
C.A. Kirkbride, DVM, professor
M.C. Libal, DVM, MS, assistant professor
R.D. Magnus, MS, assistant in
D.T. Nelson, MS, DVM, associate professor
E.A. Nelson, MA, assistant in
M.H. Roller, PhD, DVM, professor
I.J. Stotz, MS, instructor
R.N. Swanson, PhD, DVM, professor
M.L. Vickers, PhD, assistant professor
S.K. Wynia, BS, assistant in

Wildlife and Fisheries Sciences

C.G. Scalet, PhD, professor and head
C.R. Berry, PhD, adjunct associate professor
A.J. Bjugstad, PhD, adjunct professor
L.D. Flake, PhD, professor
K.F. Higgins, PhD, adjunct assistant professor
T.R. McCabe, PhD, assistant professor
T.C. Modde, PhD, associate professor
D.W. Uresk, PhD, adjunct associate professor

Projects

Agricultural Engineering

H045, Heat pumps for livestock building heating and cooling and agricultural processing applications; Julson, Lytle, Froehlich
R062, Irrigation scheduling methods for efficient water and energy use; DeBoer, Lytle, Evenson
H085, Innovative approaches to tillage practices and equipment design; Alcock, Froehlich, Arnold
H123, Seed and chemical placement for conservation tillage; Froehlich, Alcock
H124, Catenary trail tube design for low pressure irrigation; Chu, DeBoer
H134, Improvements of farm chore vehicles and their application; Christianson, Alcock
H144, Engineering aspects of swine production; Froehlich, Christianson
R214, Weather and climate research for agricultural decision making in the North Central Region; Lytle
H303, Compatibility of reduced pressure sprinkler irrigation and conservation tillage; DeBoer, Chu, Stange
H312, Irrigation requirements for South Dakota; DeBoer, Chu, Stange

Animal and Range Sciences

S043, Range and tame pasture production practices in western South Dakota; Johnson, Stymiest
H044, Improving reproductive efficiency of commercial beef production; Pruitt
H073, Improving reproductive performance in the postpartum beef cow; Miller, Pruitt
H084, In vivo measure of microbial contributions to the net protein requirement of growing bovine; Prichard
R093, Beef cattle breeding; McCarty
H104, Preconditioning effects on health and performance of feeder calves; Pritchard
H111, Effect of processing, preservation and storage of feedstuffs on utilization by beef cattle and sheep; Luther, Embry, Kamstra
H153, Reproductive efficiency of sheep; Slyter
H161, Availability of amino acids in feedstuffs for laying hens; Carlson
H175, Improving the utilization of corn-corn silage diets for feedlot cattle; Wagner
H185, Amino acid balance in swine diets and effects on pig growth and nitrogen and mineral metabolism; Wahlstrom, Libal
H195, Nutrient interrelationships affecting performance and body composition of swine; Libal, Wahlstrom
R221, Increased efficiency of sheep production; Slyter
H283, Manipulation of tenderness and other functional properties; Jones, Costello
H293, Enhanced reproductive efficiency in livestock by reducing embryonic mortalities; Granholm
H314, Rangeland resource improvement; Gartner
H444, Grazing management strategies to increase net ranch income; Lewis
H464, Improved grazing management for the mesic mixed-grass prairie of South Dakota; Schlundt
H911, Mineral requirements and nutrient interrelationships of sows; Wahlstrom, Libal

Biology

R055 The development of tissue and cell culture techniques for use in breeding monocotyledonous species; Chen, Boe, Wicks
H065 Plasma progesterone levels of reproductively senescent yello mice, correlated with obesity; Wilkin
H095 Cytology of plant regeneration in tissue cultures of monocotyledonous species; McMullen, Chen
H154 Agricultural potential of the purple coneflower (Echinacea); Holden
H294 Structure and biology of echinacae, the purple coneflower; Myers

Dairy Science

H173 Whey utilization by dairy cattle; Schingoethe
H254 Composition, quality, and consumer acceptance of milk and dairy products; Baer
H262 Dairy cattle breeding with special emphasis on selection; Voelker, Ludens
R382 Optimizing the nutritional utilization of forages by dairy cattle; Clark
S384 Analysis of dairy products; Parsons
R432 Redirecting the nutrient flow in cows for maximum milk production; Schingoethe, Clark
R422 Improving dairy herd management practices; Clark
H454 Improving quality, microbiological safety, and profitability of dairy products; Torrey
H492 Preservation and feeding value of high moisture corn for dairy cattle; Voelker

Economics

H075 Economic analysis of South Dakota farmer experience with reduced tillage systems; Allen
H083 Economics of renewable energy sources in South Dakota agriculture; Dobbs
H113 Livestock price forecasting for South Dakota; Ellingson
H115 Economic analyses of farmland values, rental practices and financing arrangements in South Dakota; Janssen
R125 Effect of changes in transportation on performance of the U. S. agricultural transportation system; Lamberton
R135 Evaluating financial markets for agriculture; Lamberton
H163 The economic impact of alternative electric rate structures on energy and water use in South Dakota; Taylor, Lundeen

H313 Commodity price relationships between South Dakota and major export markets; Schmiesing

Home Economics

H035 Effects of repeated caloric restriction on body composition; Rosholt, Dezeeuw
H205 Tissue levels of pesticides in South Dakota residents on normal and calorie-restricted diets; Crews, Shewmake, DeZeeuw
H224 Alteration of muscle and fat deposition using repartitioning agents; Rosholt

Horticulture, Forestry, Landscape, & Parks

M004 Genetic improvement of tall tree species for South Dakota; Schaefer
M164 Selection and propagation of superior native and introduced trees and shrubs for South Dakota; Evers
H204 Breeding fruit cultivars and developing improved fruit cultural practices; Peterson
H412 Production and evaluation of new pot plant species; Spinski
H474 Increasing vegetable yields; Prashar
H494 Renovation of deteriorating windbreaks; Baer
R779 Introduction, multiplication, evaluation, preservation, cataloguing, and utilization of plant germplasm; Peterson
M941 Physiological characteristics of conifers suitable for environmental plantings in South Dakota; Baer

Microbiology

H155 Mycorrhizae and associated nitrogen fixation; Todd
H165 Fuel ethanol and feed byproduct production from alternative feedstocks; Westby
H344 Bovine pulmonay immunoreactivity following localized lung immunization; Hillam
H354 Plasmid-mediated carbamate and organophosphate degradation; Gauger
H364 Denitrification in agricultural soils; Todd
H374 Nitrogen fixation and guanine metabolism in soil bacteria; Westby

Plant Science

H003 Weed control for conservation tillage systems; Arnold
R005 Nutrient management in conservation tillage to improve productivity and environmental quality; White
M014 Soil and forest management influences on understory production in Custer State Park; Lemme
H015 Cell adjustments to drought conditioning in winter wheat; Kenefick, Schumacher, Gellner
H023 Evaluation of germination procedures for crop and forage species common to South Dakota; Schultz
H024 Alternative farming systems; Smolik, Fixen, Hall
H025 Effects of starter fertilization of corn under varying cultural and environmental conditions; Fixen
H033 Soil physical constraints on root system activity; Schumacher
H034 Low pressure irrigation: soil crusting, winddrift and spray evaporation; Kohl, DeBoer, Chu
H053 National Agricultural Pesticide Impact Association Program; Walgenbach, Smolik
H063 Increasing returns from water-related energy inputs in irrigated agriculture; Beck, DeBoer, Kohl
H064 Etiology, epidemiology and resistance to major sunflower pathogens; Carson
R094 Bionomics, vector capabilities, and management strategies for face flies; Easton
CG105 Suppression of stable fly populations in beef cattle through use of sterile insects; Easton
R162 Relating soil wetness to selected and landscape features and to land use decisions; Lemme
H174 Winter wheat improvement; Gellner
H181 Identification and control of soybean diseases; Ferguson
H183 Agronomic investigations of reduced tillage cropping practices in western South Dakota; Stymiest, Jacobson
H184 Use of soil survey information for agrotechnology transfer and soil productivity relationships; Malo
H193 Breeding and genetics of flax and sunflower; Lay, Grady, Ferguson
H194 Development and utilization of oats and rye adapted in South Dakota; Reeves
H203 Corn breeding; Wicks, Carson, Bettendorf
H213 Spring wheat breeding and genetics, Cholick, Buchenau
H223 Management of alfalfa insects; Walstrom
R234 Biological control of soil-borne plant pathogens in integrated crop management systems; Buchenau
H243 Epidemiology and control of wheat, corn, and sorghum virus disease; Gardner
H244 Freeze selection effects on membrane proteins and the cell cycle in winter cereals; Kenefick
H245 Identification, biology and control of potato diseases; Gallenberg
H253 Amelioration of claypan-range-soil properties to increase forage production; White
H263 A test of the winterhardiness of barley populations developed for deep-setting crown characteristics; Gellner
R272 Seed production of breeding lines of insect-pollinated legumes; Boe
H273 Investigations of Entomorphage grylli, a pathogen of grasshoppers; McDaniel
R282 Reduction of corn losses caused by nematodes in the North Central Region; Smolik
R304 Arthropod management and economic losses of insects, mites and ticks on livestock; Easton
H324 Breeding and evaluation of forage grasses; Boe
R333 Soil productivity and erosion; Schumacher, Lemme, Lindstrom
H334 Movement of soil water and soluble salts through till and shale subsoil; Carlson
R343 Management strategies for leafhoppers, spittlebugs, and aphids on alfalfa; Walstrom
H359 Ecology and control of western and northern corn rootworms; Walgenbach
S401 Foundation Seed Stock; Weber
S402 Seed certification; Pollman
S403 Seed testing; Gutormson
S404 Variety testing; Bonnemann
S406 Survey entomologist; Walgenbach
H482 Physiological regulation of individual components of seed yield; Dybing
H484 Establishment and management of forage crops; Holland
R490 Development and evaluation of conservation tillage systems; Shubeck
H502 Chemistry of atmospheric deposition—effects on agriculture, forestry, surface waters and materials; Gardner
H504 Integrating crop culture, chemicals, and life cycles to control persistent weeds; Arnold

Rural Sociology

H212 Socio-economic characteristics of South Dakota population; Satterlee

Station Biochemistry

H131 Structure and functions of ribulose-l.5-bisphosphate car boxylase/oxygenase; Paech
H133 Investigation of chemical equilibria in soil solutions; Rue
H143 Interactions of agricultural chemicals in soil; Matthees
H145 Flow cytometry; Evenson
H394 Mineral nutrition and metabolism in animals; Emerick
H404 Biochemistry of selenium; Palmer
S407 Analytical services; Thiex
R422 Cellular photosynthetic processes and the regulation of photosynthesis; Paech
CG452 Kinetics and in vivo operation of ribulose-1.5-bisphosphate carboxylase/oxygenase; Paech

Veterinary Science

R122 Prevention and control of enteric diseases of swine; Bergeland, Benfield; Francis
AH215 Characterization of monoclonal antibodies to enteric viruses of swine and cattle; Benfield
AH225 Monoclonal antibodies and enzyme-linked immunosorbent assay (elisa) to diagnose bovine viral diarrhea; Vickers
AH235 Ability of humoral antibody to protect the conceptus from infection by parvovirus-contaminated semen; Kirkbride, Leslie-Steen, Vickers
AH264 Serum and/or tissue levels of antibiotics in swine; Libal
AH274 Comparative pathogenesis of porcine rotavirus types I and II in gnotobiotic pigs; Collins
AH284 Basic metabolic and physiologic effects on nitrate and nitrite ions in mammals; Roller, Swanson
R380 Reproductive performance in domestic ruminants; Kirkbride, Johnson

S462 Diagnostic use of enzyme-linked immunosorbent assay for leptospiral antigens; Kirkbride
CG544 Role of cellular receptors in the pathogenesis of porcine enteric viral infections; Benfield

Wildlife and Fisheries Sciences

H013 Fishery development of South Dakota ponds; Scalet, Modde
M514 Relationships of forests and agriculture to management of turkeys in eastern South Dakota; Flake
H534 Assessment of riparian habitat damage caused by aquatic furbearers; McCabe

Articles, publications

Agricultural Engineering

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Chu, S.T. 1985. Hydraulics of perforated irrigation trail tube. Sprinkler Technology, Department of Hydraulic and Electric Technology, China (translated by B.C. Chow) 37(3):53.
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_____. 1986. Determination of Green-Ampt using a sprinkler infiltrometer. Trans ASAE 29(2):501.
Heard, L.R. et al. 1986. Snout cooling effects on sows and litters. Trans ASAE, St. Joseph, MI.
Kohl, R.A. and D.W. DeBoer. 1985. Kinetic energy of low pressure spray sprinklers. Trans ASAE 28(5):1526.

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_____ et al. 1985. Development of an electric, battery powered Skid-Steer loader. ASAE 85-3527, St. Joseph, MI.
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_____. 1985. Generalized Mein-Larson approach and its applications. ASAE 85-2504, St. Joseph, MI.
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Humburg, D.S. et al. 1986. Assemblies and cost analyses of a battery powered Skid-Steer. ASAE 86-1065, St. Joseph, MI.
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Stange, K.W. and D.W. DeBoer. 1985. Field evaluation of sprinkler application patterns. ASAE NCR 85-303, St. Joseph, MI.
Thoreson, B. 1985. Electric Choremaster One: test procedures and results. MS thesis, SDSU.

Animal and Range Sciences

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Gartner, F.R. 1986. Horizontal wells—an economic water development option. Rangelands 8(1):8.
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_____ et al. 1985. Influence of gestation energy on Large White x Landrace sow productivity. SDAES SWINE 85-12:43.
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_____ et al. 1985. Effect of protein level, lysine and oats in diets for growing-finishing pigs. SDAES SWINE 85-10:33.
_____ et al. 1985. Effect of level of barley in finishing diets on swine performance and carcass characteristics. SDAES SWINE 85-3:7.
_____ and G.W. Libal. 1985. Oats for growing-finishing swine. SDAES SWINE 85-2:4.

Biology

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Budget

Agricultural Experiment Station

For period ending June 30, 1986

State appropriation	$ 4,463,342
Federal appropriation	2,126,666
Federal resricted	1,290,799
Other restricted	2,348,295
Total	$10,229,102
Net support from general fund	4,463,342

Director's Comments

Continued from page 2.

agricultural commodities and provide information to improve marketing capability. We are asked to provide information that will assist South Dakotans in developing new businesses, markets, and employment opportunities that will enhance the state's economic and social conditions.

They would like us to do research in family living, communities, and society and to conduct research in fundamental nutrition. The committee encouraged studies that would reduce our dependency on agricultural chemicals, that would safeguard human health, and that would protect our environment and maintain or improve our water resource and its quality.

We should, they said, increase our emphasis on sustaining soil productivity and conduct research that would increase the profitability of agriculture.

That's a tall order, but totally in agreement with the mission of the Station from its inception. It does imply that we will be redirecting funds to intensify research in these areas.

We will still continue to put a large amount of our limited funds into production research that is compatible with soil and water stewardship. We can do that because of the nonproduction research is already being conducted.

The Northern Regional Research Lab at Peoria, IL, is a federally funded unit of approximately 165 scientists engaged in these projects. We do not duplicate any part of their program. They have released some amazing results and much more good, solid information which may not always grab the headlines but which helps us find markets for our crops and livestock.

We have worked directly with them in the past and will cooperate more fully in the future. We will highlight the work at this lab in a future issue of this magazine, but I will give you a hint now: There are new markets for nonfood uses of corn that may be developing.

South Dakotans are truly masters of production agriculture; few people in the world can grow crops and livestock any better than we do. We are devising and trying new methods of marketing. That's still not enough; we must be involved in the ultimate use of our commodities. Not every time will we be able to "count on it being done in Peoria." If it is a South Dakota product and it is not being used to the maximum, we will have to get involved. That is our charge for the future as we move into the second century of the Agricultural Experiment Station. □

Farm & Home Research is printed on campus at the SDSU Printing Laboratory.

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Farm & Home Research
John L. Pates, Department Head
Mary Brashier, Editor
Duane Hanson, Designer

vol 37, no 4, 1986

Published quarterly by the Agricultural Experiment Station, South Dakota State University, Brookings, South Dakota. Sent free to any resident of South Dakota in response to a written request.

College of Agriculture and Biological Sciences
Agricultural Experiment Station
South Dakota State University
Brookings, SD 57007
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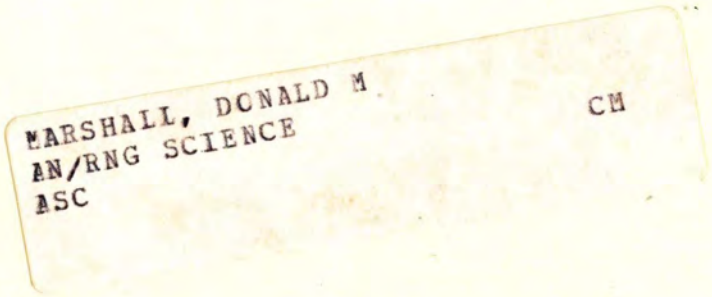

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