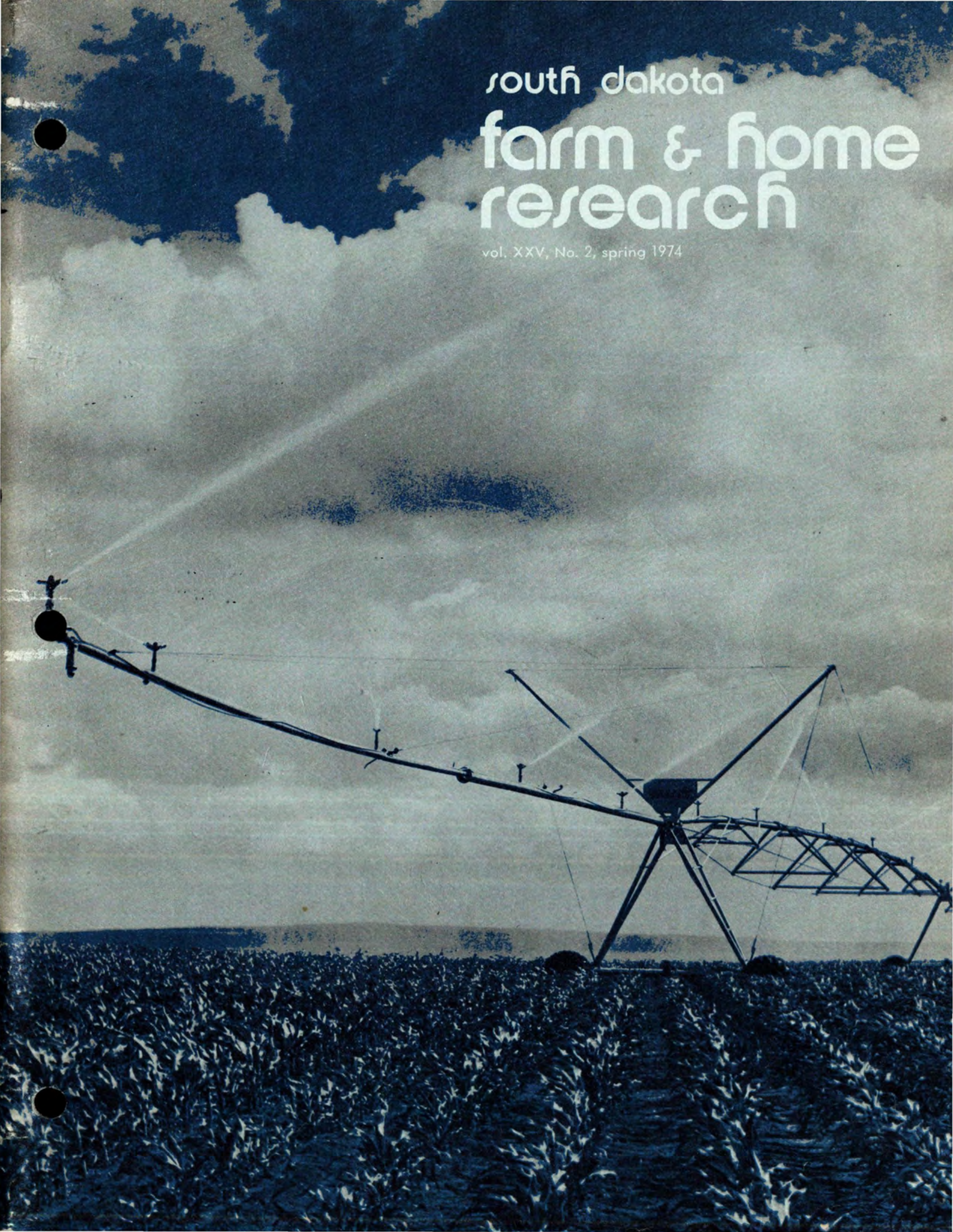
Spring 1974

South Dakota Farm and Home Research

Agricultural Experiment Station, South Dakota State University

south dakota farm & home research

vol. XXV, No. 2, spring 1974



South Dakota State University
College of Agriculture and Biological Sciences

Delwyn Dearborn, Dean

B. L. Brage, Director, Resident Instruction

R. A. Moore, Director, Experiment Station

J. O. Young, Director, Extension Service

Farm and Home Research

Mary Brashier, Editor

Virginia Coudron, Artist

south dakota farm & home research

Serving the people of South Dakota through Teaching, Research, Extension

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

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

vol. XXV, No. 2, spring 1974

Cover photo from Valmont Industries.

The shrinking public support for ag research, Oahe, and South Dakota's role in international trade are major concerns of Dearborn in

an interview with the dean

He's a particularly busy man these days, but Del Dearborn, new Dean of the College of Agriculture and Biological Sciences, found time to be interviewed by Lee Jorgensen, SDSU agricultural news and features editor, for Farm & Home Research.

Dearborn, a Miller native, holds B.S. and M.S. degrees from SDSU and received his Ph.D. from the University of Nebraska in 1971. He worked in the Cooperative Extension Service in Brookings County, as a livestock specialist at Rapid City and in Nebraska, and was in commercial agriculture as a geneticist before returning to SDSU as head of the Animal Science Department.

He is a firm believer in face-to-face communication. It shouldn't surprise you in the future if he comes wheeling into your driveway some day to talk with you about your particular opinions on South Dakota agriculture.

Interviewer: If you could start from scratch and build your own programs for the Cooperative Extension Service, the College of Agriculture, and the Experiment Station at South Dakota State University, where would you place priorities?

Dearborn: It's an interesting question, but more academic than practical because you're bound by the situation in which you find yourself by staff capabilities, support, and tradition. However, if we could start all over, we'd probably point our staff toward more joint appointments. I feel the fellow who knows the most about wheat breeding from his own research, for example, ought to be able to contribute to Extension by making some of the variety recommendations. And I would like to have all of our undergraduate students, when they graduate from this campus with a B.S. degree, to be on a first-name basis with our Extension specialists. I'd like the graduates to be well versed in what kind of expertise our specialists and researchers can provide.

With 25 to 35 percent of the graduates from SDSU's College of Agriculture and Biological Sciences returning to production agriculture

in this state, this communication is, I think, important. The other ag graduates will be in agribusiness or government agencies. We would like all of them to be able to pick up the telephone and give us a call and know who they are talking to. I also hope that these graduates will provide input ideas for our research.

Interviewer: This was a stock question. We realize that you have to adhere to existing policies, structures, and convention. However, do we have crying needs in South Dakota agriculture?

'we need greater emphasis on research'

Dearborn: We need greater emphasis on research than we have ever had in history. We need this new knowledge because of this country's present situation regarding food reserves and because of our position in world trade. We may see more of the research formerly done by agricultural college Experiment Stations assumed by private concerns in the future, but there also is a need for a balance between public and private research. For example, a news release recently said that 10 percent of the USDA budget in 1960 was for research. Today, only 2½ percent of USDA's budget goes for research. You'll probably find the federal contribution to the SDSU Experiment Station also is smaller in proportion to what it was 20 years ago.

Even though I like government "close to home," the trend to less federal support for agricultural research bothers me, because one of the historic benefactors of agricultural research has been the American consumer. I hope that city and urban consumers recognize this and recognize their responsibility to see to it that research funds for agriculture are adequate.

Interviewer: This leads into my next question. SDSU has a total of 30 staff members in animal science. This is actually fewer than a decade ago. At the same time, we are getting a new $4.6 million animal science facility, something we have sorely needed for a long time. The total dollar support for animal science research and teaching in 1973 was about the same as in 1965. Last year the total Animal Science Department budget was $650,000, with $225,000 as the federal share and $450,000 from the state. But the college returned $350,000 of this amount from revenues it collected from tuition, sale of animals, etc., to the state general fund. That means that the state actually invested only $100,000 in research for livestock at SDSU in 1973. Livestock is a billion dollar industry in this state. Put another way, the amount the state spent on Animal Science represents one ten thousandths of 1 percent. You worked with industry prior to your appointment as head of SDSU's Animal Science Department. Industry provides 5 to 10 percent of their gross income for research. Is SDSU shaved too thin?

Dearborn: Of course as dean of a college of agriculture I think it is too small. Let me straighten out one figure—$3 million for the animal science complex was a direct state appropriation and $1.6 million came from the state building authority.

Otherwise, I think that your figures are essentially right on the operating budget. I think I should point out, however, that the figure represents only the support of research in animal science. In addition, we are funded for research in animal diseases, feed production, product development in home economics and agricultural engineering. Adding that on, however, still wouldn't greatly improve that one ten thousandths of 1 per cent.

You are right about that 5 to 10 cents on the dollar spent by industry for research. Before I came back to SDSU, I was associated with a large private organization that prided itself on the fact that it spent 13 cents on the dollar for product development and research. They developed their 10-year plans with the assumption that even though they were making expenditures, they expected to return profits to the company. That's why they are in business—to make a profit.

We'd have to submit that the public also has had similar benefits from public research in many ways; the fact that we only spend 16 percent of our take-home pay for food as compared to countries with expenditures 2 to 3 times that should tell us something. More importantly, however, I think that our agricultural research has helped us in international relations. It has helped to reverse the extreme deficits in this nation's balance of payments. It also has cooled off the hostilities between our country and nations like China and Russia. I hope that we can continue to trade and increase these lines of communications. I think agriculture is the basis of our life essentials.

Interviewer: Didn't some of our food giveaway programs a few years ago cause more problems than they solved?

Dearborn: That is probably true, yet, I would say there are cases where we have a moral obligation to make foods available. Though I am sold on my state of South Dakota, I hope that I don't become so engrossed with it that I forget that many of the things that we do here have an effect outside our borders.

Interviewer: In addition to bountiful cropland, American agriculture in the past has been blessed with an abundance of cheap energy. A recent report from Cornell University, however, indicates that because of the world's demand for fossil fuels the U. S. farmer may be headed for trouble. The farmer uses an equivalent of 80 gallons of gasoline to produce an acre of corn (this includes preparing the seedbed, planting, chemical fertilizing, pesticides, harvesting and crop drying). Machinery fuel consumption alone rose from 15 gallons per acre in 1945 to 22 gallons in 1970. If fuel costs continue to climb, can America afford this type of agriculture?

Dearborn: It depends on how we define the word "efficiency." It is true that this country has been in the habit of talking about bushels per acre or pounds per day gained without fully analyzing all of the inputs. They were good measures of efficiency in their day, but they might not tell everything we need to know today. We have to go beyond that now. Even trying to figure a dollar's return per dollar invested may not be enough, because it can be a very temporary

measure. For example, who would have guessed $5 wheat two years ago? But what can we project for next fall?

If I may rephrase your question, I think you really were asking if we need to be concerned about caloric efficiency. The answer is yes. I say this, recognizing that we could talk ourselves out of livestock production into other types of production that do not require as many input calories. This involves a question of quality of life. Many of us enjoy eating meat.

On the other hand, we have to recognize that the cost in caloric input for meat or corn might be robbing our future resources. With computers we ought to be able to develop some revealing evaluations that not only tell us about the economies of production, but which also give us some insight into energy use and returns.

Agriculture uses only about 3 percent of the nation's fuel supply as opposed to 12 percent for processing and marketing of food. Agriculture has for a long time been concentrating on fuel conservation, doing research on such things as minimum tillage, high moisture corn storage and other fuel-conserving practices. But all of us as consumers had better take a look. I notice quite a few people would like to return to the 70 mile per hour speed limit, because they feel it gives them mobility and that is related to quality of life. Faster speeds also require higher caloric inputs.

Interviewer: What must South Dakota do to keep its agriculture competitive?

Dearborn: We might work on further specializing production, perhaps concentrating on local processing and product development. In other words, if we intend to produce a few acres of edible beans and send them far away to be packaged, we are at a disadvantage. Maybe we should think about processing them locally. The same thing might be said for livestock and livestock products, cheese and cereal crops, depending on the economic feasibility of local processing.

Interviewer: You grew up on a farm in Hand County and saw the boom and bust times of agriculture. Doesn't the College of Agriculture need more production economists, the type who would go out and talk "farming and ranching?" He could tell producers whether they would be better off using oat silage rather than corn silage; he'd be the type of specialist who could talk about the effects of plowing up 500,000 acres of grassland in this state on cattle production.

Dearborn: The "10 Steps Farm and Ranch Management Program" used in this state does this to some degree, but I admit that the farm management agents' recommendations are probably going to become more specialized to individual operations as time goes on. We know there are four major resources that may be manipulated for agriculture enterprises—land, labor, capital and management. To a degree we can substitute one for another according to individual management talents. I think we are going to see future development of computer pools that can tell us more what we can do with these inputs.

Interviewer: There are some who did not like the idea of our closing substations. Did we actually cut back or expand our capabilities?

Dearborn: Our efforts in the field have actually increased, though this may be difficult for the people at Eureka or Presho to see. We have now centralized a staff of 10 specialists and researchers at the Rapid City Research and Development Center.

Often research at substations become one-man operations. If we can work with cooperators and provide professional research in problem areas in more than one location and in several disciplines, I think we become more effective. That's what our plans are. We couldn't afford to staff a dozen different units on a year-around basis, but mobile units will allow us to serve all of the West River area more effectively than before. The fact is, the people out there will probably see more of our professional research people than they did under the previous arrangement.

'west river people will see more of our researchers'

Interviewer: We have quite a turnover of young county Extension agents in South Dakota. The question, I guess, is what is there to keep them in the Extension Service in South Dakota when the pay is better in other jobs requiring similar training?

Dearborn: It is quite a perplexing question. When I was a 4-H member, I looked to the county Extension agent with a considerable amount of admiration. I still hold a considerable amount of admiration for these field faculty members from SDSU. They influence a lot of lives. As a result, I hope that we give them the full amount of credit they deserve.

Both the county Extension agent and the Extension home economist are extremely important positions. They deal with the day-to-day problems of South Dakotans. I hope that we can instill in these young men and women who serve Extension the importance of their job. It's true, we have lost some Extension people to greater financial opportunities elsewhere. I suppose that this always will happen to some degree, but we need to be conscious of this and to work for improved benefits. We will.

There has been an interest in specialization among county staffs. We have a committee of Extension field people studying this.

Interviewer: Some people feel that Extension and the College of Agriculture should take more of a leadership role than they have. For example, they would like to see them more involved in informational programs on water resources planning, pollution, critical areas legislation, constitutional revision, the pros and cons of the Oahe Irrigation Project and other public affairs issues. Will we become more involved in these issues?

Dearborn: There is no question of our responsibility to inform the public about these issues. I recognize that perhaps the Oahe Project is the number one emotional issue in South Dakota at this time. At the same time I think we have a considerable amount of expertise that can provide the answers to some of the specific questions that people have about it. I want us to provide this kind of information, but I also want everyone to be aware that there may be questions that cannot be logically answered at this point.

Interviewer: Let me elaborate on my question—while one side argues that the Oahe Project offers economic stability for the entire area, the other side talks about people and pollution problems, condemnation proceedings, other painful questions. Specialists from SDSU can easily talk about the economic questions, but are we that sure when we talk about the human problems?

Dearborn: It's real hard to put some kind of objective measure on people problems. I would hope that public projects are not determined on the basis of how they benefit individuals.

That is, I hope that our picture is bigger than just simply considering economic returns. We need to also consider: Will this contribute to the welfare of the public in other areas? How will it affect long term natural resource use in our state?

I also am concerned about what we leave for our sons and daughters.

As to Oahe, I've identified this as the first issue I hope to become better informed about. I have gone to some of the discussion sessions as a spectator. I don't intend to be identified with special interest groups on either side. However, we will provide factual information so that the public can be better informed for making public decisions.

Interviewer: That is a specific answer to a general question, I guess. Covering more ground, should SDSU and Extension field staff become more involved in presenting information about public concerns?

Dearborn: We will. We have been involved. For example, the governmental reorganization information was presented by Extension in 1972. I think this was done in a very objective fashion, where people were left to resolve their own opinions. I think educational programs on public issues like the Oahe Project and land use legislation are our areas of responsibility. Our job is to provide information in the best manner we can without taking sides.

Interviewer: There are natural conflicts between staff members with different specialties, aren't there? What if we come up with opposing information?

Dearborn: It's great that individuals have varying viewpoints. SDSU, however, has the obligation and it is in the interest of public trust that we stick to evidence supported by research. Speaking as Del Dearborn, dean of the College of Agriculture and Biological Sciences at SDSU, I had better speak to things that are based on research. If I share my view publicly beyond that, I have the responsibility to divorce myself from the institution that I represent and say, "I speak as John Q. Citizen." I know that is difficult to do, but I and other staff members have a responsibility not to use our positions to influence other people when it enters the realm of opinion. We are voting citizens, too, but we have an obligation whenever expressing opinion that the public **knows** that it is an opinion.

CES by Congress when it was formed back in 1914.

Interviewer: Urban 4-H has been very effective in the towns. That's where most of its enrollment increases have been in recent years. Will we continue to increase the 4-H emphasis here?

Dearborn: I see no decreased emphasis there. I hope to see further inputs in urban 4-H.

Interviewer: Once the Animal Science building is built, will there still be growing pains?

Dearborn: I am sure that when Agricultural Hall was built at SDSU they did not intend that the old Dairy Building should become the home of Wildlife and Fisheries for the next 20 years or that the Economics Department live in a barracks for 15 to 20 years, but that is what happened. We also will have to gear up for the expanding needs in the Horticulture-Forestry Department. Remodeling or location is very high on our priority list for both wildlife and horticulture. Biology has become crowded in the top floor of Agricultural Hall. The Plant Science Department also is overcrowded. The building planning committee has been working on space reassignment for Agricultural Hall for the time that both the Animal Science Department and the Biochemistry Section move out. The Sociology Department will move out of Agricultural Hall into Scobey Hall as soon as that building is remodeled. At this time the Economics Department also will move into Scobey Hall from their barracks housing.

Before you turn off that tape recorder, I'd like to make a statement to the citizens of South Dakota: I'm honored to be Dean of the College of Agriculture and Biological Sciences at SDSU. I'm grateful to those of you who have expressed your best wishes to me in this new position. I really believe in first-name communication and I hope to meet many of you in the future. □□

'no conflict between production economy and quality of life'

Interviewer: You've talked about quality of life and things that we can't pin down, but the funding of the Cooperative Extension Service from the national level seems to be moving toward production economies of food and fiber production instead of "people" programs. In recent years in South Dakota we have been building expertise in rural development, etc. Are these funds to be cut; will emphasis continue on "people" programs?

Dearborn: You may think I'm talking around in a circle, but I see no conflict between sustained long-term production and things related to quality of life. A readily available food supply is tied directly to quality of life. So is international trade and balance of payments. Rural development in our state will most likely take place if we have the kind of production economy that sustains agribusiness, agriprocessing, and other local developments.

Production agriculture that is truly beneficial on a sustained basis should not rob our natural resources.

For that matter, nationally, the Extension Service has over 600 full-time rural development specialists working with local leaders. The plans are that over the next 5 years the CES will increase the proportion of its resources devoted to rural development by 75 percent. So you see, we're striking a balance in our efforts to "improve the quality of rural life," which was the charge given to the

20 % less water than sprinklers -- more yield; 30 - 40 % less water -- comparable yield

Trickle Irrigation

Delvin D. Brosz*

It hardly seems suited for great acreages in South Dakota, but trickle irrigation may fit your particular water management plans.

It's been tested already on potatoes and corn, and next year vegetables and strawberry beds will be trickle irrigated and studied by SDSU agricultural engineers.

Trickle irrigation has been highly successful for years in other parts of the world, mainly for turfs, orchards, and vineyards. The drip method shows promise for small acreages of specialty crops. The initial investment cost compares favorably with the cost of a solid-set sprinkler system.

Trickle irrigation is characterized by plastic tubing and near zero water pressure. Water "drips" or "trickles" from emitters (or orifices) at selected spacings along the tube. Or the tube itself may be porous, allowing water to "seep" to the outside. The wetting pattern of a trickle system with emitters which has just been started up is shown in Fig. 1.

When the tubes are placed below the soil surface in the root zone area the system is referred to as subsurface irrigation. While a buried system does not interefere with cultivation and a dry soil surface tends to reduce weed germination, the emitters plug easily with plant roots. Plugging is not only difficult to service, but can go undetected until the plants exhibit a water stress. For this reason we are not particularly interested in subsurface irrigation by the trickle method at this time, although new emitter designs will probably alleviate the problem.

Trickle and subsurface irrigation can cut your water use from that of more conventional irrigation systems. Irrigation water losses (the water that is not actually used by the plants) occur through deep percolation or leaching, runoff, and evaporation. You control all three of these problems because theoretically you use only enough water to replace that used by the plant each day. You might use up to 20 percent less water than normally required in sprinkler irrigation, for example.

Maintaining a constant moisture supply in the root zone also may result in more optimum growth of the plants—they may never have to undergo water stress periods between irrigations or in dry spells. Fertilizer use has been claimed to be more efficient; and some operators add nutrients through the water system. The main advantage the trickle method has over other irrigation systems is its reduction of evaporation losses during application.

Fig. 1. Early wetting pattern of a trickle irrigation system.

*Extension and research irrigation engineer, Agricultural Engineering Department, Water Resources Institute (now water resources engineer, Department of Natural Resource Development, Pierre).

Fig. 2. Every row trickle irrigation.

Water used in trickle or subsurface irrigation must be filtered to remove particles that otherwise will clog the emitters. Periodic flushing of the lines with a weak acid or detergent may help reduce salt buildup around the emitters.

As greater demand is put on our water supplies, increased efficiency of water use will become more important. Since trickle and subsurface irrigation do seem to be more efficient methods of water application, we need to know more about how these systems work. The Water Resources Institute at SDSU conducted a 3-year study comparing trickle, subsurface, and sprinkler irrigation systems. The studies were done in 1971, 1972, and 1973 on full-scale field plots located on the Agricultural Engineering Research Farm near Brookings. The Fordville sandy loam soil consisted of a 20 to 24 inch sandy loam surface underlain by sand and gravel.

The irrigation system designs were:

1. Every row trickle (Fig. 2)
2. Every other row trickle (Fig. 3)
3. Every row subsurface
4. Every other row subsurface
5. Solid-set sprinkler (Fig. 4)
6. Conventional sprinkler.

The irrigation systems were designed to accommodate 36-inch row spacings. The solid-set sprinkler system was used to simulate sprinkler systems that apply approximately 1 inch of water per irrigation. When 1 inch of water was depleted in the soil, it was replaced. The conventional sprinkler system simulated sprinkler systems that apply 3 to 4 inches of water per irrigation. so that when 50 percent of the water was removed from the soil, the sprinkler again brought soil water up to field capacity.

Kennebec potatoes were planted in the plots during 1971 and 1973. The average potato yields for the different systems are shown in Table 1. Hybrid corn was planted in 1972, and the average yields are shown in Table 2.

During 1971 and 1972 the irrigation water application on the trickle and subsurface irrigated plots was limited to 80 percent of the amount applied on the sprinkler irrigated plots. A statistical comparison of the average yield of plots irrigated by the four trickle and subsurface irrigation systems to the average yield of plots irrigated by the two sprinkler irrigation systems indicates that higher yields can normally be expected from plots irrigated by trickle and subsurface systems.

During the early part of the 1973 season, approximately 50 percent (60 percent of net) as much water was applied on the trickle and subsurface plots as on the sprinkler plots. Midway through the season the potato plants showed visual signs of moisture stress, so water applications were increased until these signs disappeared. The seasonal application ended at approximately 60 percent of that applied to the sprinkler plots.

We learned that potato and corn production could be increased by 5 to 15 percent with 20 percent less water applied through trickle and subsurface irrigation. A water savings in the neighborhood of 30 to 40 percent could possibly be

Fig. 3. Every other row trickle irrigation.

achieved with trickle and subsurface irrigation with yields that are essentially the same as those obtained with sprinkler irrigation.

A general comparison of the 1971 and 1973 potato yields of the sprinkler irrigated plots indicated a somewhat higher yield for 1971 even though water management was essentially the same. Several factors may have contributed to the yield difference: 1) The certified potato seed was purchased from a different source, 2) the amount of applied potasssium was considerably more in 1971. (Fertilizer applications were in accordance with soil test recommendations.) 3) Seasonal weather conditions do vary from year to year.

The data from the 3 years of study indicate that, using 80 percent as much water, trickle and subsurface irrigated crops of potatoes and corn will show a yield increase over potatoes and corn under sprinkler management. It is doubtful that the quantity of water applied can be less than 80 percent and still increase yields significantly. The study did not substantiate improved crop quality or accelerated plant growth for potato and hybrid corn crops.

The study does indicate a need for continued research on trickle and subsurface irrigation systems. The Water Resources Institute in cooperation with the Agricultural Experiment Station is now examining the effects of trickle irrigation on shallow rooted vegetables and berry crops. □ □

Table 1. Potato yields

	yield, cwt/acre 1971	1973
Every row trickle	496	378
Every other row trickle	448	384
Every row subsurface	474	370
Every other row subsurface	459	346
Solid-set sprinkler	446	389
Conventional sprinkler	413	376

Table 2. Corn yields

	yield, bu/acre
Every row trickle	150
Every other row trickle	149
Every row subsurface	146
Every other row subsurface	150
Solid-set sprinkler	133
Conventional sprinkler	142

Fig. 4. Sprinkler irrigation.

oats: your protein source?

Dale L. Reeves*

Yes, if current breeding is successful and if you have the right combination of variety and fertility.

Off again, on again; oats are back in style again. Is this just a passing fancy or will oats continue to be important to the farmers and ranchers of South Dakota?

New interest in oats started in 1964 when some wild oat types from Israel were found to contain over 30 percent protein. Since these oat types can be easily crossed with our cultivated oats some people thought that within a few years we could raise the protein level in cultivated oats to this level. However, this has not been possible.

Interest in oat protein content has also been stimulated by recent increases in the price of protein supplements. Farmers hoped oats would be a cheaper source of protein. The third factor creating new interest in oats has been the discovery that oat flour can be separated into various fractions, some of which contain up to about 90 percent protein.

*Assistant professor, Plant Science Department

Oats are planted on about 2,500,000 acres in South Dakota each year, with 55 percent of the production being used on the farm. Since South Dakota is one of the three leading oat producing states, we need to fully utilize the potential value of this crop.

Some nutritionists believe that we underestimate the true feeding value of oats. Oats are not high in energy like corn, therefore nutritional value is largely related to protein content.

Oat protein from a quality viewpoint is equal to soybean protein. Therefore, farmers who grow oats have one of the best grain sources of protein. Oat protein is also the cheapest source of grain protein when figuring cost per pound. The future for protein flour containing 50 to 90 percent protein appears very intriguing and exciting. The oat fractions which are very high in protein will most likely be used for human consumption, but the exact future of such flour is not known at this time. On the other hand, 15 to 20 million bushels of oats from South Dakota are annually milled for human consumption at the present time. For human food, protein from oats is the best of the cereals. Other nutrients are also high because oats do not have the germ or bran removed when milled for human consumption. Since these portions of the grain have the highest concentrations of nutrients, their removal takes away a considerable part of the nutritive value in other grains.

The factor which is most widely used as an indicator of oat quality is test weight because it frequently is the only information available and it is easily obtained. Other factors which influence grain quality are hull percentage and protein percent, but usually these are not known. Oats with high test weight are preferred because they have plump berries and a smaller hull percentage than light oats. If the test weight is low, kernels will usually be thinner and hulls will make up a higher proportion of the grain. Although test weight is a good indicator of oat quality it is not the total measure of quality due to differences in factors such as hull thickness and kernel shape.

Groat percentage (the grain remaining after hull removal) is a more precise measure of feeding value. Oats in South Dakota will usually range from 60 to 70 percent groats. The average groat percentages for 25 oat varieties are listed in Table 1. Two year averages gave a range from 56 to 72 percent and an overall average of 67 percent groats, however most varieties were similar. There are consistent differences between varieties and also considerable differences between locations. Local weather conditions play a major role in determining hull percentage. Average groat percentages were lower in 1973 than in 1972. All locations were slightly lower; however some varieties at Bison and Wall were 20 to 25 percent lower than at other test sites due to unfavorable weather. The average groat percentage for the various locations ranged from 60 to 75 percent in 1972 and 48 to 73 percent in 1973. The lowest groat percentages were 42 percent in 1972 and 33 percent in 1973 with both being the variety Cayuse which was consistently low in all tests.

Average yields of groats per acre for 1972 and 1973 are included in Table 1. In comparing production in this manner it must be kept in mind that some varieties are not well adapted to all locations. Varieties which have lowest yields of groats per acre are either high in hull percent, are not well adapted to all areas where they were grown, or are just lower yielding varieties.

When a farmer grows oats as a major source of protein the factors of greatest interest to him are protein percentage in the grain and pounds of protein produced per acre. In 1972 groat protein varied from 14 to 24 percent. For research purposes most protein is determined as percentage of groat rather than percentage of the entire oat kernel. This is done so differences in hull thickness and percentage will not obscure the real difference in groat protein.

When feeding oats in a livestock ration it is necessary to figure the protein percent of the whole grain. Whole grain oats will average about 3.5 percent lower in protein than the dehulled groats, although this depends somewhat on hull percentage. If, for example, the groat protein is 18.5 percent, then the whole oats will be about 15 percent protein.

From the table it will be noted that there are considerable differences in groat protein per acre. For farmers who are planning to use oats as a protein source the ability to produce protein

should be considered in addition to such things as straw strength, maturity and rust resistance.

It is difficult to predict exactly what protein level you will get in your oats, but you can alter the expected value because three primary factors determine protein percent. These are variety, fertility level (especially nitrogen), and weather. Of these three factors the grower determines all except the weather so he does have considerable control over the protein level of his oat crop.

The exact protein percent is impossible to predict in advance. However, varieties can be grouped into the relative protein classes of high, medium and low. The varieties classified as high protein will usually be in the top group at all locations regardless of fertilizer levels. On the other hand, the varieties in the low and medium protein classes can have a higher than average protein content if grown under very high nitrogen levels.

The current varieties which would fall in the highest protein group are Dal, Diana, Otee and the Iowa multilines. Chief will average about the same to perhaps 1 percent lower groat protein.

The interest in protein is reflected in some of the newer oat varieties. Some varieties have been primarily bred for high protein level. All new varieties will be tested for protein content, although not all will be high. Yield, straw strength, and disease resistance must be considered. Growers who want oats with maximum protein levels may now have to be satisfied with slightly lower yields, but in the future high protein varieties will probably yield the same as other varieties.

One high protein selection which is being considered for release has been tested under the number SD955. It is a midseason selection with stiff straw and was developed from a Neal x Clintland 64 cross. Under good fertility conditions this selection will usually contain 20 percent groat protein, which is about 1 to 1½ percent higher than Chief. Yields of SD955 across South Dakota have been about the same as Chief.

Other high protein selections which have a groat protein range from 19 to 23 percent are being thoroughly tested. It remains to be seen if they yield enough and are good enough in the other necessary characteristics to warrant release. The biggest problem with very high protein lines is that they are often low in yield.

When all factors are considered oats should continue to be important in South Dakota, especially if protein content and quality can be improved by effective breeding research. However, this means that producers need to pay attention to variety selection, proper fertilization and efficient production. At the same time, livestock producers who feed oats need to take a closer look at the exact quality of the grain they are feeding, especially if the oats are being used as a primary source of protein. □ □

Table 1. Average protein and groat yields from Standard Variety Oat Trials in South Dakota. (Data from 6 locations in 1972 and 7 in 1973.)

Variety	1972-1973 Groat Percentage	1972-1973 Yield of Groats (lbs/A)	1972 Groat Protein (lbs/A)
Brave	66	1515	260
Burnett	69	1560	253
Cayuse	56	1426	218
Chief	72	1742	363
Clintland 64	68	1321	304
Dal	69	1537	365
Diana	68	1613	340
Dupree	69	1568	277
Froker	70	1691	349
Garland	69	1658	308
Grundy	69	1848	305
Holden	68	1567	282
Kelsey	65	1602	242
Kota	63	1500	273
Lodi	64	1470	283
M-73	69	1567	373
McCurdy 3306	65	1454	303
Nodaway 70	72	1645	292
Otee	66	1446	326
Otter	66	1651	259
Pettis	69	1402	266
Portal	69	1614	309
Random	62	1525	260
SD955	67	1678	370
Trio	67	1598	294

does her first-winter nutrition affect her lifetime performance?

replacement beef heifers

Gene H. Deutscher and J. A. Minyard*

It's been estimated that 300,000 heifer calves are retained each year as herd replacements by South Dakota ranchers, but about 60,000 (or 20%) don't breed the first year. Another 20% of the heifers that do breed don't conceive as early in the breeding season as they should. These heifers are free loading and the question is: can you afford that, at any feed prices?

Proper nutritional programs and improved methods of management are primary areas where a rancher can enhance the reproductive performance of replacement heifers. Research results from Montana, for example, indicate the level of feed available to heifers during the first winter after weaning has a great influence on their subsequent reproductive performance and lifetime production. So, would it be possible to program a heifer to be a high or low lifetime beef producer simply by adjusting her level of nutrition during her first winter?

SDSU beef cattle researchers at the West River Agricultural Research and Extension Center, Rapid City, initiated a study in the fall of 1972 to evaluate the effects of winter nutrition of replacement heifer calves on subsequent breeding performance and lifetime productivity.

It involved 117 Hereford heifer calves obtained from two cooperating Harding County ranchers. The heifers were high quality herd replacements and averaged 441 pounds at the beginning of the winter feeding trial on December 5. The wintering trial was conducted at the Cottonwood Range and Livestock Field Station. Heifers from each ranch were randomly allotted according to weight and age into three wintering groups (high, medium and low) to gain 1.5, 1.0 and 0.5 pounds per head per day, respectively, for a 150-day feeding period. All groups were fed a mixed alfalfa-grass hay plus grain at a rate calculated to obtain the expected gain. Table 1 shows the ration fed to each group during the wintering period. The heifers were weighed at 28-day intervals and rations were adjusted periodically to achieve the desired gains. A 50:50 mixture of trace mineralized salt and dicalcium phosphate was available free choice.

During the wintering trial, the heifers were vaccinated for brucellosis, leptospirosis, vibriosis and IBR and given an injection of vitamins A, D and E. Heifers were observed for

*Assistant professor, Animal Science; and Extension livestock specialist

estrus during a 30-day period when they averaged 12 months of age. Internal and external pelvic measurements were taken as yearlings and were taken again before calving, at 2 years of age, to evaluate the relationship of pelvic measurements to calving difficulty.

After the winter feeding period was terminated on May 4, the heifer groups were combined and moved to summer pasture at Fort Meade. They were artificially bred as yearlings for a 50-day period beginning May 29 using semen from Angus bulls. In October, all heifers were pregnancy checked by rectal palpation and conception rates calculated for each wintering group. The bred heifers were then returned to their respective owners as herd replacements and the open heifers were sold.

These bred heifers (cows) will be treated as a group on each ranch and as similarly as possible during their productive lifetime. Production records will be taken to evaluate subsequent performance and productivity as affected by the level of winter nutrition they received as weaner calves. Reproductive performance, including calving dates, calving losses and rebreeding dates, as well as calf weaning weights will be obtained.

Results

Only the first year results are available on this long term study (Table 2). (Further reports will be made in Farm and Home Research as the study progresses.) This table shows the results for the three winter feeding groups from each ranch separately. The winter weight gains were quite similar between the two ranches with the high level groups gaining about 1.35 lb/hd/day, the medium level gaining 0.75 and the low level groups gaining 0.45 lb/hd/day. These gains were slightly lower than desired because of poor gains early in the wintering period. However, there was a substantial difference in the average weight of the groups before breeding so a comparison of the breeding performance of different weights of heifers could be made.

Conception Rate. The results from Ranch A show only 53 percent of the heifers in the low level group conceived during the 50-day breeding season while 80 percent conceived in the high level group and 67 percent conceived in the medium level group. These results support previous research reported from other stations that an increase in the level of nutrition tends to increase the conception rate.

In contrast, the high level group from Ranch B responded with a lower percent conception and the medium level group had the highest conception. Results from Ranch B were 79 percent conception in 50 days for the medium level, 75 percent conception for the low level and 63 percent for the high level.

Conception Date. The high level group of heifers from both ranches had an earlier onset of puberty and a larger percent conception during the first 21 days of breeding. This early breeding is reflected in the 7 to 9 day earlier average conception date for the high level groups. This suggests heifers should be fed well during the winter period to achieve early puberty and conception. The results on the low level groups suggest that even though heifers gain rapidly on lush pasture in the spring after being roughed through the winter, they still won't conceive early in the breeding season. Therefore, winter gains appear important for early conception.

Research has shown that getting heifers bred during the early part of the breeding season is very advantageous and profitable. In fact, selection of heifers according to date of conception

is recommended by some researchers. When heifers reach puberty early and conceive early in the breeding season, they will consequently calve early the next spring. This early calving will allow them to rebreed early that year and therefore to breed early every year. Early calvers will also wean heavier calves in the fall and probably have a higher lifetime production.

A related observation in this study was that young ages as well as light weights in the lower level feed groups apparently contributed to poor conception. It is known that within a breed a combination of both age and weight influences the onset of puberty and either can be the limiting factor. If young heifers are managed so they don't reach puberty before or early in the breeding season, they can't conceive until late in the season and may not conceive at all during a limited breeding season.

Recommendations

The preliminary results from this study and others support the following recommendations.

1. Hereford heifers should be fed to weigh 625 to 650 pounds before breeding for high conception. The level of nutrition required to accomplish this weight will be influenced by age, weight and condition of the heifers at weaning. Ideally, heifers should be fed in two separate groups with the older, heavier, and higher conditioned ones fed to gain from .75 to 1 lb per head daily, and the younger, lighter heifers fed to gain 1.2 to 1.4 lb per head daily. Since many ranchers do not have facilities for managing and feeding two groups of heifer calves, they will need to choose the feeding program that most nearly fits their age and weight of heifers.
2. When selecting replacement heifer calves at weaning, actual weights and ages should be considered in addition to performance indexes. Because a heifer must reach a sufficient weight and age before she will conceive, setting lower limits on weight and age appears to be justified even though a heifer has a high performance index. A high-indexing heifer that is open after breeding is of little benefit to the breeding herd.
3. The available feed and intended feeding program should also be considered when selecting replacement heifers at weaning. If the feeding program involves roughing heifers through the winter at a low rate of gain, selection of older and heavier heifers will be very advantageous.
4. To get an early onset of puberty and possible early conception, a high level of nutrition should be fed during the first winter. Early conception during the first breeding season may be the most important factor in determining subsequent reproductive performance and lifetime productivity. □ □

Table 1. Winter feed rations for replacement heifers

Avg Daily Feed (per head)	Winter nutrition level (high)*	(medium)*	(low)*
Hay,† lb	10.1	10.3	11.9
Gain,‡ lb	6.8	3.4	1.2
Mineral supplement¶	—free choice—		

*High level group in drylot, medium and low level groups on winter pasture.
†Mixture of 30 % alfalfa and 70% native grass hay.
‡Mixture of ⅓ whole oats and ⅔ rolled corn.
¶A 50:50 mixture of trace mineral salt and dicalcium phosphate.

Table 2. First-year summary of replacement heifer study

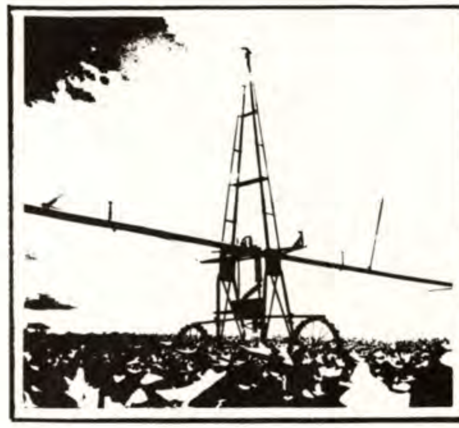
Data	Ranch A (Winter Nutrition Level) high	medium	low	Ranch B (Winter Nutrition Level) high	medium	low
No heifers	15	15	15	24	24	24
Beginning wt, lb (12/05/72)	437	437	437	443	443	443
Winter gain (lb/day)	1.30	0.69	0.40	1.38	0.77	0.49
Wt before breeding,* lb (5/24)	658	604	564	670	621	583
Age before breeding, days (5/24)	406	406	406	411	411	411
Gain on grass,† (lb/day)	1.15	1.92	2.12	1.00	1.79	1.88
% showing estrus by 12 mo of age	66.7	6.7	0	54.2	8.3	8.3
% showing estrus by 15 mo of age	100.0	80.0	73.3	91.7	87.5	91.7
% settled first 21 days of breeding	53.3	13.3	20.0	50.0	41.7	33.3
% settled second 21 days of breeding	20.0	46.7	20.0	12.5	29.2	29.2
% settled during 50-day season	80.0	66.7	53.3	62.5	79.2	75.0
Avg conception date (day of year)	166	175	177	164	171	172
Wt in fall, lb (10/11/73)	833	803	781	843	812	778

*Weight taken 5 days before beginning of breeding season.
†Gain period was 75 days—from 25 days before breeding through 50 days of breeding.

field day is July 23

ONE-STOP IRRIGATION CENTER

Dennis Moe and Ray Ward*



So there have been too many summers with too little water, and your yield has hardly seemed worth greasing up the combine for?

You think that you could irrigate —your soil will accept and hold supplemental water, you could find an adequate water source, your land is level or at least fairly so and the venture could be economically feasible.

But you may be skeptical of all the claims of the manufacturers. You want to compare different systems of irrigation in actual operation before you make this sizable capital investment.

There's a "one-stop" public demonstration of irrigation equipment under operating field conditions in South Dakota designed to help you. This is the James Valley Agricultural Research and Extension Center 6 miles east and ½ mile north of Redfield. Here irrigation systems and related equipment are demonstrated and evaluated for operation, practicality, and compatability with existing systems.

Here you can see a tow line, a big gun, center pivots, and gravity irrigation in operation. You can compare open ditches, concrete-lined ditches, and gated pipe. There are different delivery and reuse systems.

The problem for potential irrigators is the flood of new manufacturers and new products on the market. There's little standardization and/or evaluation by the manufacturer or by farmers who buy the systems.

Although South Dakota has a 2 to 3 million acre irrigation potential, expansion is slow, and it's difficult to see an operation that you might be interested in without driving several hundred miles to neighboring states.

Unless you go to Redfield. Its Field Day is scheduled for July 23; put it on your calendar because the systems will be in operation.

The first irrigation project in South Dakota was established approximately 70 years ago, but minimum interest in irrigation of large acreages prevailed until the Pick-Sloan Missouri River Development Project was initiated 30 years ago.

In 1946, a 200-acre irrigation demonstration and research farm at Redfield was leased by the Bureau of Reclamation for investigation as part of the Bureau's study of the irrigation potential and feasibility of the Oahe Unit. The Agricultural Experiment Station had been a cooperator in the establishment of the farm, and gradually took over the entire operation as the Bureau phased out its active work at the site.

The original irrigation system installed in 1946 was laid out entirely for gravity irrigation with siphon tubes. The farm was gradually made more versatile so that both research investigations and Extension demonstrations could be conducted simultaneously. The sprinklers were added in 1972. The James River, irrigation water source for the station, was too low in 1973 to permit irrigation throughout the entire summer, so evaluation of these systems has been delayed a year.

The following covers most of the installations at Redfield. You can visit the farm and talk to Ray about the installations and your problems at any time.

Underground Distribution Systems

Since at least 5 percent of a field's acreage may be taken up by the average ditch system, you could save a lot of valuable crop production land by using underground pipe for water distribution. Properly installed, it has a long life expectancy, low labor requirements, and no evaporation or seepage losses. It's permanent, however; it's difficult to switch to another irrigation system and reclaim your losses.

Redfield has four types of low-head (low pressure) underground pipe materials. These are 1) reinforced plastic mortar, 2) concrete, 3) polyethylene, and 4) polyvinylchloride (PVC). The high-head pipe is solvent weld and gasket PVC.

Selection of pipe size in relation to water supplies, irrigation needs, and friction losses is probably more critical in underground systems than in any other. Up to now, all pipe materials at Redfield have performed satisfactorily. Several leaks were encountered in the concrete pipe which meant re-excavation and reinstallation. The problem was improper seating of the "O" ring at the time of the original installation and may reflect on the installation method.

*Department head, Agricultural Engineering; and Research Manager, James Valley Research and Extension Center

Concrete-lined Ditch

Redfield's concrete-lined ditch with four sets of spiles at different elevations overcomes the high labor requirements of siphon tubes. The lining of the ditch itself prevents seepage losses.

The ditch has a 12-inch bottom, 18-inch depth, and a 4-inch thickness. Four sets of spiles on grade are installed in the side of the ditch. A check dam is used to raise the water level in the ditch, allowing flow out of the spiles. Moving the check dam downstream, for example, drops the water level below the spiles in the top set but allows flow from the lower sets.

Each spile is capped, or plugged. Each plug contains three holes so that the flow may be controlled by varying the number of holes exposed. Rotating the plug and moving the holes toward the top also regulates the flow. Any tube may be shut off by pushing the plug completely into the tube. Once the proper plug setting has been determined, based on the number of spiles per set and pump discharge, no further adjustments need to be made for the duration of the irrigation season.

Although this takes a proportion of land out of production, the concrete ditch has proven to be a practical, labor saving system. It is also relatively less expensive than some other systems.

Gated Pipe

Gated pipe, which has adjustable outlets spaced at row-width intervals, has probably been the greatest single development in improving the efficiency of surface irrigation in the last several decades. Pipe uses less land than ditches; no water is lost to seepage and evaporation in delivery; and labor requirements are low. Since the system is low pressure, water can be supplied from a main ditch by gravity pressure or pump, or from a well.

Before installing a gated pipe system or other furrow method, you must consider field slope, soil intake rate, and the length of run. Obviously, to reduce labor requirements, you want the longest possible stream run. But you've got to wet the entire length of the furrow as quickly as possible. If you don't know your field's soil characteristics you can have deep percolation water losses at the inflow end of the field and either inadequate water or surface runoff at the lower end.

If you use a stream of sufficient size to distribute water evenly throughout the field, you can lose up to 30 or 40 percent of your water through runoff. That's why, with gated pipe and with many other installations, you should consider incorporating a water recovery system into your design.

(Valmont Industries)

(Photo from Valmont Industries)

Reuse Systems

With a recovery and reuse system you can increase your irrigation efficiency and can cut the possibility of polluting streams with chemicals and soil runoff. You can also increase the furrow stream flow up to erosion limits, to ensure that the lower end of your field is well watered.

The basic layout includes drainage ditches across the bottom of the field, a holding reservoir, and a pump and pipeline back to the main irrigation system.

Redfield has two reuse systems. The first features a buried 1800 gallon concrete tank with the turbine pump mounted on top. Runoff water enters the tank through a series of holes in the cover which are covered with hardware cloth and pea gravel.

The second is a turbine pump mounted on a vertical section of 30-inch corrugated metal pipe with slots for water inlet. The pipe is installed in a small reservoir excavated in the field to allow storage in the pump area.

Both pumps are automatically controlled by electric float controls and discharge directly back into the water supply line.

Redfield has several sprinkler systems in operation, and the facilities can handle any system that is available for purchase. The water supply is delivered through the low-head pipe used for gravity irrigation and is fed through a booster pump.

Center Pivots

The station has three center pivots —two are electric and one is self-propelled under its own water pressure. A center pivot is a sprinkler-bearing lateral that moves continuously around a swivel point. The pipeline is supported high enough to clear growing crops by mobile units that are individually propelled at speeds regulated to maintain the lateral in a straight line.

The system is becoming increasingly popular—it has relatively low labor requirements; it can be adapted to fields without extensive land leveling; and it can irrigate high intake rate soils with high efficiency.

Of course, a center pivot generally waters only circles, so it is most practical for square fields. Some dealers offer optional end guns which extend the reach of the lateral in field corners.

If you go into center pivots you will need to have a specialized serviceman for special breakdown problems within reasonable driving distance and a relatively high amount of capital for initial investment. But you are trading capital for labor requirements.

The big advantage of a center pivot is that you get the water on the crop when it needs it. There's no delay in moving pipe, which can cost you dollars in yield reduction.

Solid Set

The solid set, positioned and left in place until the last irrigation before harvest, also reduces labor requirements. You can water critical areas of a field as soon as you determine need; and you can furnish light, frequent applications for seed germination or other situations. Solid sets can be automated, although the one at Redfield is not.

You would need sufficient pipe to sprinkle the entire field without moving the laterals, balancing that against the savings in labor.

Big Gun

The station's model of this high pressure, single-head sprinkler is a traveling big gun. Big guns have also been adapted to handmove, tow, self-propelled, and solid set systems.

Redfield's big gun will water a 200-foot circle, and is winched across the field by a gasoline engine. Such a system is suited for a rectangular field.

A hose that will withstand years of being dragged around a field full of water, pulled around capstans and rolled up on reels and that will be able to carry water under high pressure is an important item when you consider a traveling giant sprinkler. The system lends itself to differing individual layouts and can be automated to various degrees. You still have some labor requirement—the outfit must be moved to new settings.

One of the unique features of the testing and demonstration facility at the station is that practically all sprinkler systems and equipment are provided by cooperating industrial and commercial firms. This results in maximum benefits to South Dakota irrigators and to equipment companies at minimum costs to the Center and the state.

If you are considering going into irrigation, stop in at Redfield. It is your most comprehensive and closest source of help. □□

Tow Line

The tow line system at the station takes advantage of the low operating costs of a hand move system and reduces labor costs. The operator can tow the lateral in one piece on skids with a tractor instead of breaking down and handling the pipe sections individually.

You can lose as much as 10 percent of the field area for center turn rows and pull strips, but total capital investment is low.

field days

Date	Event	Person to Contact
July 17	Pasture Research Center, Norbeck	Charles Krueger
July 23	Irrigation Field Day, James Valley Research Center, Redfield	Ray Ward, Mgr.
Sept. 20	S. E. Experiment Farm Field Day, Beresford	Fred Shubeck
Nov. 1 (tent.)	Cattle Feeders Day, SDSU	
Nov. 1 (tent.)	Poultry Research Day, SDSU	
Nov. 21 (tent.)	Swine Research Day, SDSU	
Jan. 9 and 10, 1975	Farm Managers and Rural Appraisers	
April 1	Agri-Business Day, Brookings	Wallace Aanderud, Ag. Econ.

Is this the year for wheat rust?

Chemical control is second line of defense

Spraying for wheat rust

George Buchenau and Fred Bode*

Chemicals that control wheat rusts have recently become available to the South Dakota wheat producer. Since rusts are microscopic plants called fungi, the chemicals that kill rusts are known as fungicides. Two such fungicides are currently cleared for use on wheat; a fungicide called Zineb, marketed under several trade names, and a maneb derivative, sold under the trade names Dithane M-45 (Rohm & Haas) and Manzate 200 (Du Pont). While the maneb-based fungicides are more effective against wheat rusts, they are also more expensive than the Zineb formulations.

Control of rusts with fungicides is the second line of defense, a backup measure for use when resistant varieties fail. We know from previous experiences that last year's resistant varieties may not be resistant this year. Such breakdowns in resistance are analogous to DDT resistant insects; eventually a rust population (race) develops that overcomes the resistance genes of the wheat variety. The fact that we have not experienced a major rust race shift in nearly 20 years does not provide much security, especially when an increasing acreage of rust resistant winter wheat varieties in the Southern Great Plains places pressure on the rust to change.

Economically, chemical rust control appears more feasible than in recent years. The break-even point for two applications is about 2½ bu/A (yield increase) when wheat sells at $3.00/bu compared with around 6 bu/A needed to pay for spraying $1.35 wheat (Table 1). Rising costs of fertilizer and fuel also point up the need to maximize yield per acre.

*associate professor and assistant, Plant Science Department

Limitations of Chemical Control

Profits depend on the season

Although the investment in chemical rust control is substantial, such an investment sometimes provides handsome profits. For example, even in 1968, a year of record wheat yields in South Dakota, we achieved a return of $2 for every dollar invested in rust control. Even better returns have been obtained in other cases. On the other hand, there are many "light" rust seasons when benefits will not cover the cost of spraying. This erratic response is one of the major barriers to grower acceptance of chemical rust control.

Chemicals are not perfect

Neither of the fungicides listed above will control rust perfectly, some rust will continue to develop even though fields have been sprayed. Further, the control is not immediate, rust that has already penetrated the plant will continue to develop for 7-10 days after spraying. Control is usually better in large fields than in small experimental plots because more rust spores contaminate the small sprayed plots from nearby unsprayed wheat. Thus we expect better control from commercial spraying than we obtain experimentally, even though experimental sprays have provided good yield increases. In addition to these limitations, spray deposits weather away and new growth must be covered, thus one or more additional sprays are usually applied at 7-10 day intervals.

Early sprays are critical

The most common mistake is to apply the first spray too late—after rust has already built up to substantial levels. For example, if a grower sprays when there are 10 stem rust pustules already visible

on each stem, there are probably already another 100 incipient pustules present. These will become visible during the next 7 days whether sprayed or not. The spray would have been applied too late for maximum benefits, and possibly too late to give enough yield increase to pay for spraying.

You can Assess Potential Profits

In 1970 a method was published to help wheat growers make the decision of whether or not to spray for rust. The details of this method are explained in a reprint entitled "Forecasting Profits from Spraying for Wheat Rusts" available through your county Extension agricultural agent or from the Extension plant pathologist, SDSU.

Since 1968 we have been evaluating the accuracy of such forecasts by attempting to determine the actual losses due to rusts in spray plots on several spring and winter wheat varieties at various locations in South Dakota. The varieties used in these tests were those that had known susceptibility to either leaf rust, stem rust, or both rusts. Leaf rust produces small, yellow-orange lesions on the leaf blade or sheath; stem rust produces larger brick-red lesions on all above-ground plant parts.

Results from these supportive tests (Table 2) have shown that the prediction system provides a reliable basis for making spray decisions, in spite of the relatively small "weather input" at the time the prediction is made. Even better predictions of rust loss can be made by applying the following minor adaptations of the original system.

1. Leaf rust alone rarely causes more than 40% loss in South Dakota. Although this rust can completely destroy the crop, it rarely does so. Therefore, if the prediction indicates a loss of more than 40% due to leaf rust, consider a loss of 40% more likely.

2. Even if weather conditions have been favorable for stem rust development, we usually choose to predict a "moderate" rate of increase. This does not hold true for leaf rust where "fast" increases are common.

Summary

Yield increases from spraying have generally been effectively estimated, except when other factors not controlled by the fungicides are operative. Insects, certain other diseases, and hot, dry weather that unduly hastens wheat maturity are examples of such factors.

Much of the uncertainty associated with chemical rust control can be avoided with the aid of individualized rust loss estimates applied to each field. Limitations of season, chemical, variety, and spray timing can be evaluated in advance of spraying, and expected profits can be assessed realistically.

If your wheat variety develops susceptible type rust pustules this summer, you know that your variety is no longer rust resistant. When this occurs, consider the possibility of spraying. □ □

Table 1. Yield increase needed to break even when spraying for rust control.

Number of applications and fungicide used	Break-even point in bu/Acre at wheat price of 1.35/bu.	3.00/bu.	4.00/bu.
Two applications			
Maneb	6.0*	2.7	2.0
Zineb	5.6	2.5	1.9
Three applications			
Maneb	9.0	4.1	3.0
Zineb	8.3	3.8	2.8

*Based on estimated 1974 aerial application costs of $2.25 per acre per application; Dithane M-45 or Manzate 200 at $0.90/lb; Zineb at 0.75/lb.

Table 2. Predicted and actual losses from rusts on Winter (HRW) and Spring (HRS) wheat varieties as determined by spray tests in South Dakota 1968-72.

Year	Location	Variety	Predicted rate of rust increase Stem	Leaf	Predicted loss %	Actual loss %
1968	Pierre	Hume HRW	0	Fast	33	30
1968	Brookings	Nebred HRW	Mod.	Mod.	20	24
1969	Presho	Omaha HRW	0	Slow	0	0
1969	Presho	Lancer HRW	0	Slow	0	0
1969	Brookings	Nebred HRW	Mod.	Mod.	40	41
1969	Brookings	Hume HRW	0	Slow	19	14[2]
1969	Brookings	Ceres HRS	Mod.	Fast	43	55
1969	Brookings	Crim HRS	0	Fast	33	25
1970	Brookings	Nebred HRW	Mod.	Fast	46	45
1970	Brookings	Ceres HRS	Mod.	Fast	71	67
1970	Brookings	Crim HRS	0	Fast	40	36
1971	Presho	Lancer HRW	0	Fast	16	0[1]
1971	Brookings	Nebred HRW	Mod.	Fast	40	29
1971	Brookings	Crim HRS	0	Fast	20	17
1971	Brookings	Ceres HRS	Mod.	Fast	30	25[2]
1972	Brookings	Nebred HRW	Mod.	Fast	47	41
1972	Presho	Lancer HRW	0	Fast	40	17[1]
1972	Brookings	Crim HRS	0	Fast	40	33[2]
1972	Brookings	Ceres HRS	Mod.	Fast	60	38

[1] Lancer winter wheat has not responded well to sprays due to its susceptibility to a bacterial leaf disease.

[2] Yield loss estimated by formula due to uncontrolled variables affecting yield.

can we prolong the blooming period?

FLAX: BREAKING THE YIELD BARRIER

C. Dean Dybing and Richard A. Carsrud*

The "Green Revolution" has made an amazing increase in food production possible in many countries by the introduction of new, high yielding varieties of rice and wheat. If flax is to compete favorably and be maintained as a cash crop in our region, its yield, too, must be increased.

What is the maximum seed yield that can be obtained from a crop of flax? What keeps yields considerably below the best capabilities of the plant? There are three distinct yield levels or "plateaus" for flax. The first level is set by environmental conditions and management practices at 10 to 14 bushels per acre, the average commercial yield in South Dakota. The second level is closer to 40 bushels per acre, the yields sometimes obtained in South Dakota in a very good year and in the best flax area. The third level, the highest possible yield, is even more than 40 bushels; it can only be obtained under irrigation and other special conditions. For example, 65-bushel yields are sometimes obtained in the Imperial Valley of California.

Poor cultural practices and the use of flax as an emergency crop to be planted very late when all else has failed may be the predominant reasons for low statewide flax yields. Careful attention to the details of good management, such as planting early, using adequate weed control, choosing the proper variety, etc., should help to raise average yields for the state.

But can farmers now producing 20 to 40 bushels reach the next plateau? Before they can break the "yield barrier" we need new knowledge of the mechanisms of flax seed production. The SDSU-USDA cooperative flax program is an attempt to break this yield barrier.

The pot of plants in Fig. 1 was taken from an experiment planted on March 6 and harvested on September 27, 1972. Thus, the growing period was 205 days and the flowering period 163 days. The plants were grown in controlled environment chambers in which temperature, water, light, and nutrient conditions were optimized. They were still growing when harvested; the leaves were green, and the shoots were flowering. A total of 541 flowers was produced by the 10 plants. The total number of seeds produced was 3,637, or an average of 6.7 seeds per boll. A majority of the bolls were borne at the top of the plant, although a number were borne on the lower portion of the main stem.

It's not important that the plant lived for a very long period of time nor that each plant produced 54 bolls and 360 seeds. It is important to note the way the flowers were produced.

Flowers were not produced continuously over a long period of time. Instead, there were four periods of intensive flowering, separated by brief periods of inactivity or rest (Table 1). Each of the first three flowering periods was about 3 weeks in duration, and the two intervening rest

Fig. 1. Flax plants photographed September 27, 1972, at 205 days after planting. Plants had gone through four separate and distinct flowering periods during the 163-day period from first bloom. All bolls remain on the plants.

*Plant physiologist, USDA, Plant Science Department, and Agricultural research technician, USDA

periods about 9 days. The third rest period was 17 days long, and it was followed by the long fourth period of flowering.

The fact that flower production in flax occurs in discrete cycles has been known for some time. This cyclic flowering habit forms the basis for the 65-bushel yield of the Imperial Valley where it grows during the winter and two or even three flowering periods contribute to the final crop. In north central states, however, the plants die immediately upon completion of the first flowering period. We don't know why this happens, but the high light intensity and warm temperatures of late summer and disease appear to be contributing factors. Even if flax in South Dakota did not die in August but lived until first frost, flower production would stop sometime in July and would start again only after a rest period.

What mechanism causes flowering to stop abruptly, to start again only after a period of rest? Could we extend the first flowering period in the north central states by 1, 2 or even 3 weeks, thus increasing yield? This may be the way to surmount the 20 to 40 bushel per acre yield barrier in our area.

Results of SDSU studies so far indicate that the cyclical nature of the flowering habit is not caused by environment. It is not caused by low summer water availability, for example, since plants of Fig. 1 were kept well watered. Other environmental factors that have been considered include light, temperature, and nitrogen. None of these seem to be the key factor that causes flax to flower in cycles. Instead, flowering production appears to be regulated by hormones.

If flax buds between flowering periods are removed from the plants and cultured under sterile conditions, they quickly resume growth and produce flowers until a plant growth hormone is added to the nutrient medium. This helps tell us what happens in the plant in the field, because we know that developing fruits produce hormones. It would appear that hormones produced by developing fruits (the bolls of flax) cause flowering to stop by inhibiting the development of flower buds located at the ends of the branches. When the bolls mature, production of the hormones ceases, and flowering resumes.

If the hypothesis of hormone regulation is correct, practical application of this knowledge should increase yields. One approach would be to spray the plants with a chemical during flowering to counteract the effect of the hormones produced by the developing fruits and allow the plant to flower continuously. A program for evaluating chemicals as foliar sprays is currently in progress. To date, a desirable chemical has not been found. The results are sufficiently encouraging, however, to stimulate the search for other chemicals.

If you check the plants in Fig. 1 again, you'll see that a number of the bolls were borne from short stalks on the main stem below the larger branches. These bolls borne low on the plant do not contribute to economic yield under field conditions, since they can not be recovered

Table 1. Flowering periods for flax plants shown in Fig. 1, as revealed by counting new flowers each day.

Activity	Number of Days From first bloom	Number of Days In period	Number of flowers produced
Flowering Period No. 1	1-26	26	131
Rest No. 1	27-35	9	1
Flowering Period No. 2	36-61	26	118
Rest No. 2	62-70	9	1
Flowering Period No. 3	71-93	23	148
Rest No. 3	94-110	17	6
Flowering Period No. 4	111-163	53	136

Fig. 2. Same plants as shown in Fig. 1. All bolls were removed that formed during the first flowering period (normally the only flowering period in South Dakota). In addition, all bolls were removed that developed on the stem below the main branches and on tillers. The remaining bolls developd on main branches during the second, third, and fourth flowering periods.

during harvest. Most of the bolls on the lower stem were produced during the third and fourth periods of flowering activity. Fig. 2 is a picture of the same plants shown in Fig. 1, but they have been trimmed to remove the bolls formed too low on the stem to be harvested. In addition, all bolls produced by the plant during the first flowering period have been removed. Only those bolls produced on the main branches of the plant during the second, third, and fourth flowering periods are shown. Fig. 2, then, shows the extra bolls that the plant can produce which could contribute to the economic yield if there were time in the growing season for more than one flowering period. In the first flowering period, 1,250 seeds were produced by the 10 plants. An additional 1,044 seeds were borne on the panicle branches in the later stages of flowering, and 1,343 seeds were borne too low on the stem for harvesting. Economic yield, then, was approximately doubled and total yield tripled by late flowering.

Some buds never flower, as shown in Fig. 3. The buds marked "terminal" are located at the end of the panicle branches; these are the buds that normally produce flowers in cycles as described above. Buds marked "alternate" are located farther down the panicle branches at the angle between the stem and small leaves. On each panicle branch there are usually as many, and sometimes more, alternate (non-flower producing) buds as there are flower producing buds. Thus, of all the buds that are formed in a panicle of a flax plant no more than half contribute to the production of fruits and seeds or to economic yield. An additional objective of our research will be to seek hormone sprays which will stimulate the production of bolls from alternate buds as well as from the terminal buds.

These studies have helped us to see the flowering process in flax in a new perspective. Flowering is not continuous but is a process of sudden starts and stops. Many buds that could flower and produce bolls fail completely to do so. Increased knowledge of factors involved in flowering should help us to understand present yield limitations in flax, especially if the regulating mechanism is one of hormonal control that can be overcome by application of the proper chemical spray. In addition, it can be anticipated that the new knowledge gained in work with flax will have other applications, since fundamental studies on one crop often lead to broad applications in many crops. □□

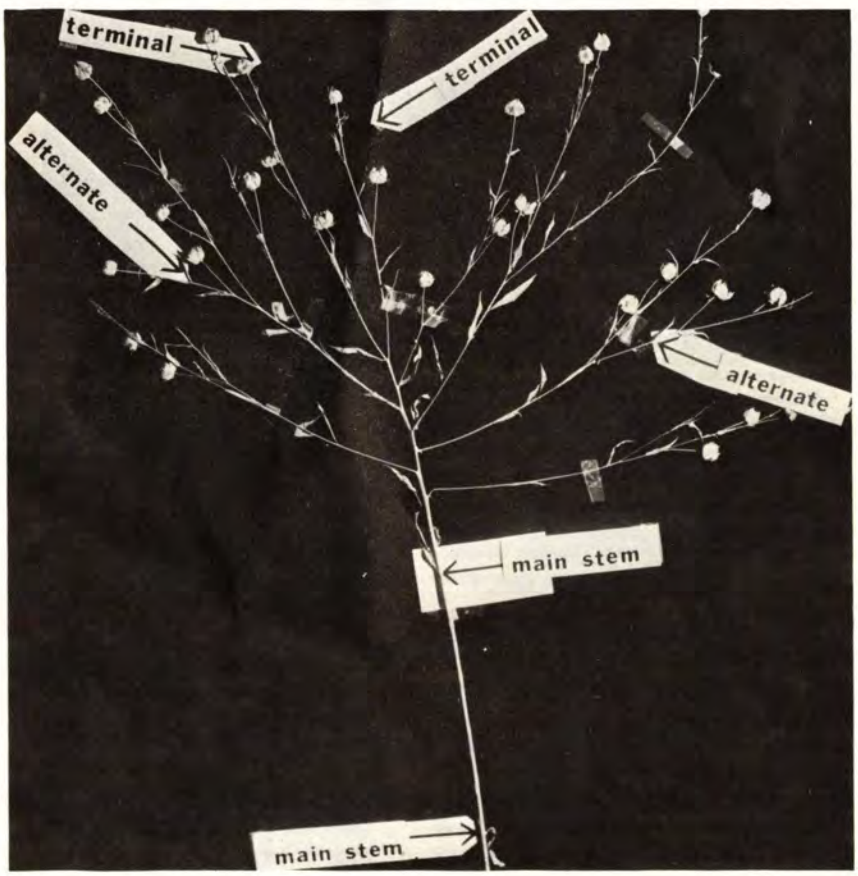


Fig. 3. Typical flax plant, showing three different types of buds." Terminal" buds are borne at the ends of each branch. "Alternate" buds are located on branches near each leaf having no adjacent boll. These buds never develop into flowers unless the terminal portion of the branch is removed. "Main-stem" buds are located in the angle between the stem and each leaf. Only the uppermost mainstem buds develop into branches.

Cooperators and engineers work together in movable center pivot study

away from 'real trouble'

Darrell DeBoer and S. T. Chu*

It's annoying if you put on 2 inches of irrigation water one day and the thunderheads roll up and give you a free 2-inch rainfall the next day. But it's more annoying if you regularly irrigate through the summer and don't get the yield increase you expect.

Maybe the problem is that you haven't figured out just how much water your soil can store for crop use. Engineers in the Department of Agricultural Engineering at SDSU have solved this problem for cooperators in their study of movable center pivot irrigation machines. These cooperators are located throughout the state, as shown in Fig. 1.

Another larger problem is being solved by the cooperation of these irrigators and engineers. It concerns "legitimizing" research. Researchers bring their work out from the campus, not to experiment farms or substations, but to commercial farms and ranches. The researchers see the actual problems of the irrigators; the irrigators and their neighbors see that research can help them in their own particular situations. First-name communication is established, and both parties benefit (Fig. 2).

Here's how this movable center pivot cooperative study works:

The cooperators are asked to keep a record of all the irrigation water and rainfall that is applied to their fields. They also keep a record of their cultural practices and make estimates of their crop yields. The engineers visit the irrigated fields periodically during the growing season to collect soil moisture samples. These are used to monitor the water in the soil profile that is available for crop use. Established research procedures are used to estimate what happens to the soil moisture between the sampling dates.

Fig. 3 illustrates how the soil water or moisture can vary during the growing season. It also shows the frequency and amount of irrigation water and rainfall applied to the field. The soil profile represented in Fig. 3 can store a total of 8 inches of water in the top 4 feet for crop use. This 8-inch moisture storage capacity is divided into three ranges: the upper one-half or the "good" range, the lower one-fourth or the "real trouble" range, and the remaining region called the "trouble" range. If the irrigator keeps the soil moisture level in the "good" range at all times, soil moisture will not be the determining factor for crop yields. However, if the soil dries out to the point where it gets down to the "real trouble" range during

*Associate professor and Assistant professor, Agricultural Engineering Department (Valmont Industries Photo)

the heart of the growing season, crop yields can be seriously reduced because of dry soil conditions. The fluctuation or change in soil moisture, as shown in Fig. 3, is basically caused by crop use of soil water, which will dry the soil or make the soil moisture line drop, and by rainfall and irrigation water, which will wet the soil or cause the soil moisture line to rise.

As was mentioned before, this example soil can store a total of 8 inches but no more. Therefore, it is possible to apply more water than the soil can hold for crop use. This is illustrated in Fig. 3 near the first part of July when there was a 2-inch irrigation followed by a 2-inch rainfall. This rainfall raised the soil moisture above the 8-inch level, but since the soil can only store 8 inches, approximately 1 inch of water drained out the bottom of the soil profile and was lost. This loss is represented by the vertical line above the 8-inch soil water line in Fig. 3. Such a loss can also occur when an irrigator applies more irrigation water than his soil can store.

A 1973 soil moisture and irrigation summary of one cooperator will be presented as an example of how successful the operation of a movable center pivot machine can be. Fig. 4 shows the arrangement of three small (27 acre) circles in one field. The circles are irrigated with a six-tower machine that can apply 0.9 inches of water to one circle in a day. An irrigation well is located near the center of circle B. Circles A and B were in corn and circle C was in sorghum during 1973. The soil is a shallow loam with 2 feet of topsoil which is underlain with gravel. Only 3 inches of crop water can be stored in this particular profile, which makes the soil very susceptible to drought conditions.

A graphic summary of the soil water content for the three circles is shown in Fig. 5. The cooperator tended to favor circles A and B and kept the soil water level in the "good" range most of the time. Circle A got a little dry during the first part and last half of August. Circle C got very dry in August. Since the "good" range is small for this soil, it is very easy to overirrigate at times or to get in the "trouble" range. The vertical lines above the "good" range represent water lost because of overirrigation or excess rainfall.

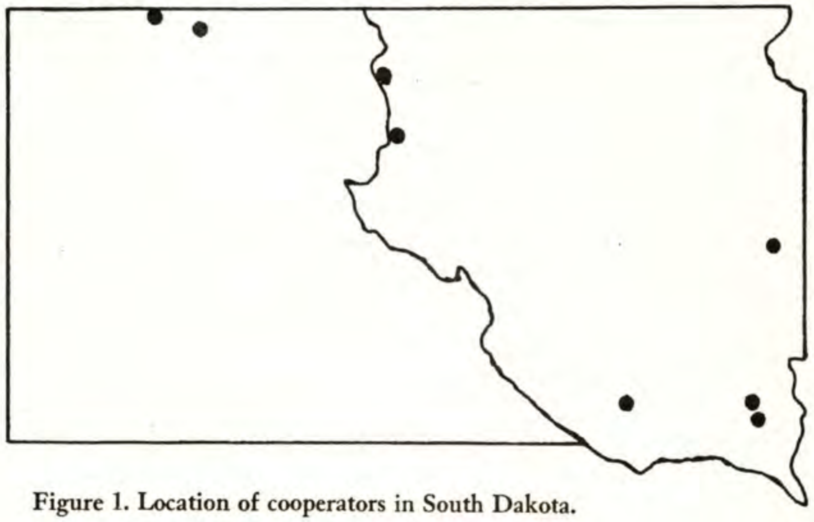


Figure 1. Location of cooperators in South Dakota.

Fig. 2. Clarence Archibald, cooperator near Lodgepole, with his center pivot irrigation machine.

Table 1 summarizes the total amounts of rainfall and irrigation water applied to the circles as well as the water lost from the bottom of the soil profile for the summer of 1973. The area received only 6 inches of rainfall during the summer, which is not enough for a good corn crop. You can also see that the corn circles received more irrigation water than the sorghum circle. Approximately 4 inches of water from circles A and B were lost to the ground water table.

The operation of a movable center pivot irrigation system requires a high level of

Table 1. Rainfall, irrigation water and water lost to the water table from June 1 to September 5, 1973

Circle	Crop	Rainfall (inches)	Irrigation (inches)	Lost Water (inches)
A	Corn	6.1	13.5	4.1
B	Corn	6.1	11.7	3.7
C	Sorghum	6.1	6.3	1.7

management and timely labor requirements when the machine must be moved. This center pivot machine was moved 16 times during the 1973 growing season. However, the cooperator got 118 bushels of corn and 108 bushels of sorghum per acre for his efforts.

Lost water doesn't do you any good. But not enough applied water can drop your soil's water level down into the "real trouble" zone with resulting crop stress. If you're curious about the water-holding capacity of your soil, contact your local SCS man.

Our work with the cooperators in South Dakota has been very beneficial. Research people can get an appreciation of some of the problems and limitations an irrigator faces which often cause him to fall short of his irrigation goals. We must be aware of these potential irrigator limitations when applying research results to field situations. □□

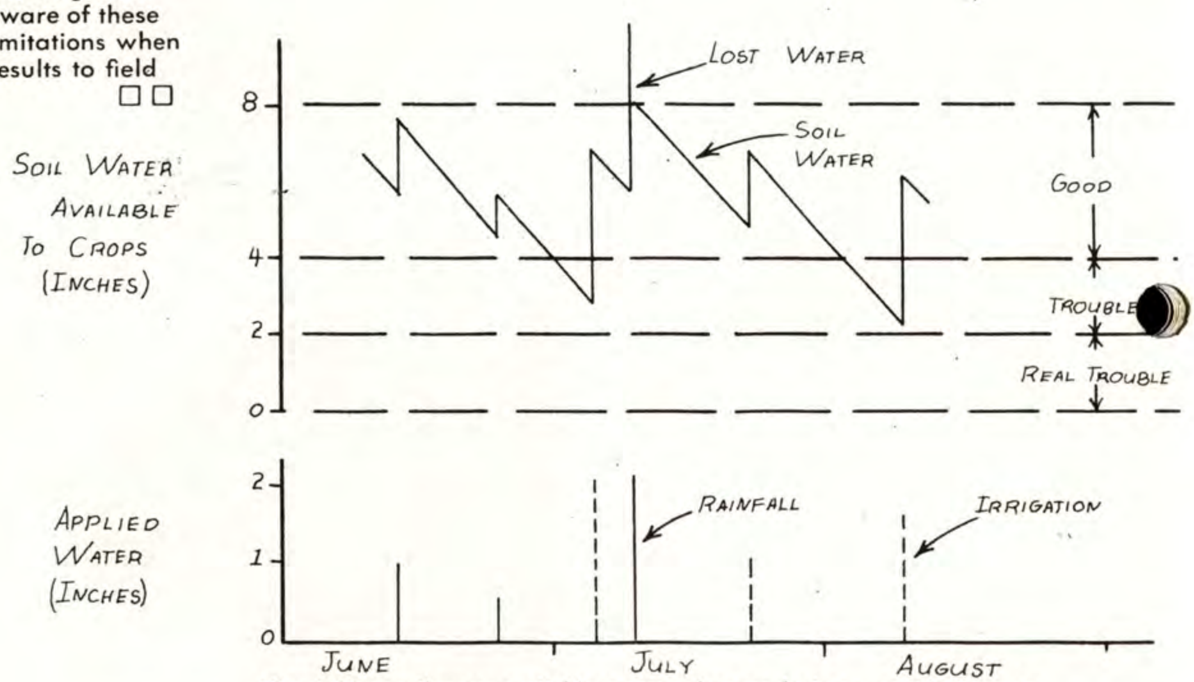


Fig. 3. How soil water available to crops changes during a growing season.

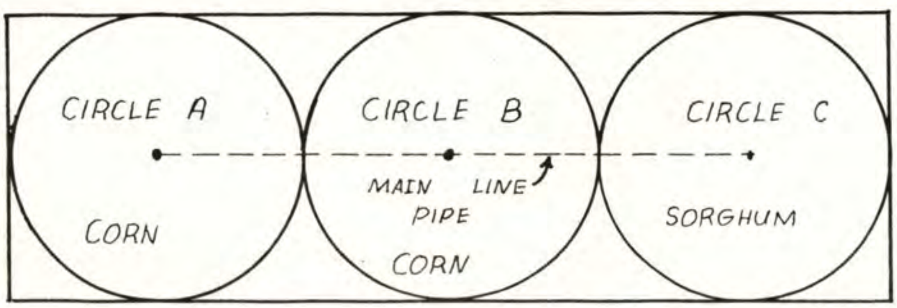


Fig. 4. The arrangement of the three circles in the cooperator's field.

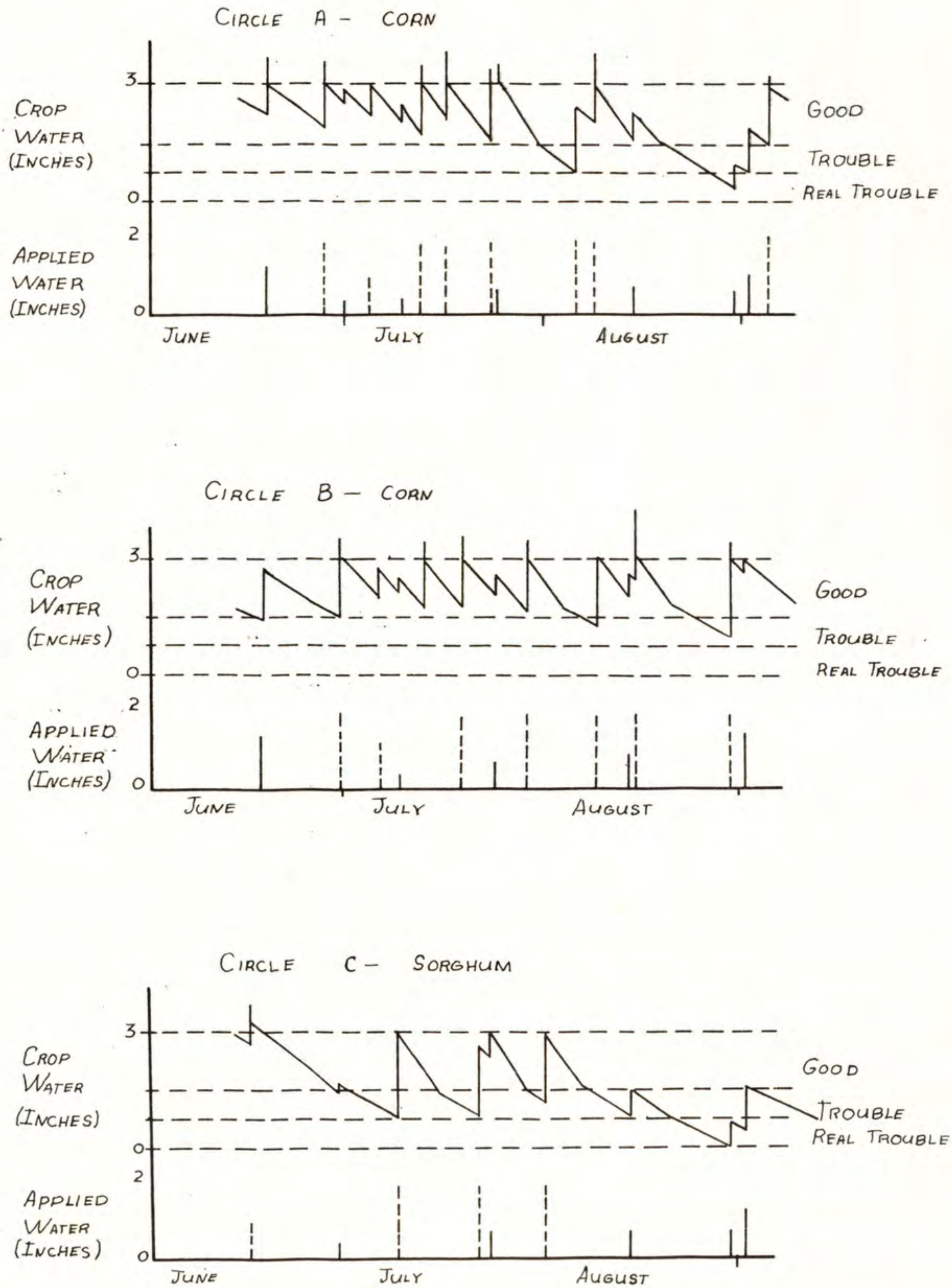
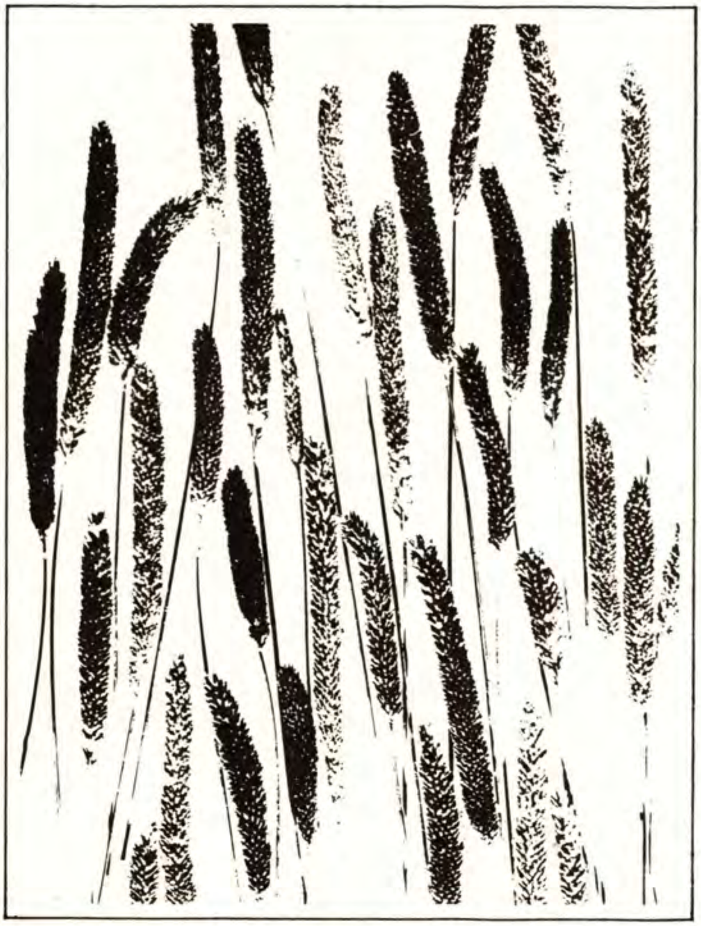


Fig. 5. Soil water variations for three circles irrigated with one center pivot machine.



ideal for grassed waterways

Garrison creeping meadow foxtail

R. C. Kinch and R. C. Ward*

Garrison creeping meadow foxtail is a vigorous, sodforming cool season grass that is relatively new in South Dakota. It is especially well adapted in low meadows and pastures and survives extended periods of standing or running water. It develops a dense, very competitive sod and in many places is planted as a replacement for the taller but coarser reed canarygrass. It has dark green leaves and produces an erect seed stalk 2½ to 4½ feet tall.

Garrison creeping meadow foxtail is an ideal grass for waterways where its vigorous creeping rootstock quickly fills in ungrassed and eroded areas with a dense network ot fibrous roots.

Upon ripening, the immature, very light, chaffy seeds turn from an almost white color through varying intensities of gray to black, fully matured seeds. Shattering starts almost immediately after ripening. The black seeds at the top of the head may drop off while seeds at the base of the head are still gray.

*Professor and assistant professor of Plant Science

Hay Production

The dense, vigorous sod of Garrison creeping meadow foxtail produces a rank growth of forage if growing conditions are favorable. Soil moisture in low meadows, pastures, and grassed waterways is usually not a limiting factor in the growth of this cool season grass that makes most of its growth early in the spring. However, in such cool, moist soil conditions the release of nitrogen proceeds at a slow rate, and the addition of plant food—particularly nitrogen—usually results in increased plant growth that can be measured by hay yields.

An experiment on response of this grass to fertilizer applications was made on a farm in Brookings County. The land had a well established stand of Garrison creeping meadow foxtail located in a low area that received extra water in early spring runoff. Hay and seed yields were very low because of the very sod-bound condition where the extensive root system of this grass had utilized most of the available plant food in the soil.

Fertilizer applications of nitrogen, phosphorus, and potassium were made in the fall for 2

successive years. Forage harvests were made the first of July and are shown in Table 1.

The low yield of the check plot (.35 ton/A in 1968) demonstrates the severity of the sod-bound condition. The first application of nitrogen greatly improved the growth of the grass. The small yield responses to the 30 to 60 lb rates of N and the large increase for the 120 lb rate indicated that the initial application must be large to obtain the most benefit from nitrogen.

When the fertilizer application was repeated the next year, the response pattern was different. Maximum yields were harvested from the 120 lb rate of nitrogen. The 60 lb rate was much more effective in increasing yields in 1969 than in 1968. The reduced yields at the 240 lb rate were caused from lodging of the lush growth. The larger yield responses to lower rates of nitrogen in 1969 were probably due in part to better rainfall distribution during the growing season.

There was very little response to applied phosphorus or potassium.

Protein Concentration

One added benefit from fertilizing Garrison creeping meadow foxtail is increasing protein in the hay (Table 2). In 1968, protein concentrations increased from 7 to 10 percent with an application of 240 lbs of actual nitrogen per acre. The trend held true for 1969 although protein concentration averaged about 1 percent lower. Table 2 shows that applied nitrogen increased the protein content after maximum hay yields are obtained.

Seed Yield

Seed yields were harvested when the first seed heads ripened. Fig. 1 shows seed yield results for 1968. Nitrogen fertilizer increased seed yields from 2 to 245 lbs per acre. Addition of 40 lbs of P_2O_5 increased seed yield about 60 lbs per acre at the 240 lb rate of nitrogen. Potassium in combination with nitrogen and phosphorus produced additional increases in seed yield, especially at the 240 lb rate of nitrogen.

Seed yields were highest in 1969 with an application of 120 lbs of actual nitrogen and 40 lbs of P_2O_5, as shown in Fig. 2. Decreased yields at 240 lbs of nitrogen were due to lodging of the lush growth. Seed germination was measured in 1969 to determine the effects of fertilizer on maturity of the seed. Fertilizer had little effect on percentage of seed germination.

From this experiment it appears that approximately 120 lbs of actual nitrogen and 40 lbs of P_2O_5 should be applied annually (after an initial higher rate of N) to obtain highest seed yields in eastern South Dakota.

The following conclusions were made from the response of Garrison creeping meadow foxtail to fertilizer applications.

Table 1. Effect of added fertilizer on hay yield Garrison creeping meadow foxtail.

Treatment* lbs/A $N+P_2O_5+K_2O$	Hay yield, Tons/A (12% moisture basis) 1968	1969
0+ 0+ 0	.35	.57
30+ 0+ 0	.58	1.12
60+ 0+ 0	.97	1.95
120+ 0+ 0	1.79	2.61
240+ 0+ 0	2.65	2.73
0+40+ 0	.36	.55
30+40+ 0	.56	1.30
60+40+ 0	.92	2.71
120+40+ 0	1.97	3.12
240+40+ 0	2.47	2.28
0+ 0+50	.48	.61
30+ 0+50	.63	1.38
60+ 0+50	1.08	2.38
120+ 0+50	1.76	2.76
240+ 0+50	2.56	2.88
0+40+50	.44	.62
30+40+50	.53	1.30
60+40+50	1.00	2.28
120+40+50	2.14	2.67
240+40+50	2.71	2.50

*Fertilizer treatment applied Sept. 1967 and Nov., 1968.

Table 2. Effect of added fertilizer on protein concentration of Garrison creeping meadow foxtail.

Treatment* lbs/A $N+P_2O_5+K_2O$	Protein content % (12% moisture basis) 1968	1969
0+ 0+ 0	7.0	6.4
30+ 0+ 0	6.6	5.6
60+ 0+ 0	6.6	5.6
120+ 0+ 0	7.3	6.6
240+ 0+ 0	9.3	10.7
0+40+ 0	7.5	6.6
30+40+ 0	6.8	5.1
60+40+ 0	7.0	5.3
120+40+ 0	7.3	6.0
240+40+ 0	10.4	7.7
0+ 0+50	7.5	6.3
30+ 0+50	6.6	4.9
60+ 0+50	6.4	4.9
120+ 0+50	7.5	6.6
240+ 0+50	10.3	10.4
0+40+50	7.0	5.8
30+40+50	6.9	4.8
60+40+50	6.3	4.8
120+40+50	7.6	5.5
240+40+50	9.2	7.5

*Fertilizer treatment applied Sept. 1967 and Nov. 1968.

Table 3. Effect of harvest dates on seed yield and germination of Garrison creeping meadow foxtail

	Pounds/Acre*	Germ	Pounds/Acre of Germinable Seed
6-22-70	408.63	41.3	168.7
6-25-70	298.48	56.3	168.0
6-28-70†	238.07	72.3	172.1
7- 1-70†	198.99	75.0	149.2
7- 5-70†	167.01	80.0	133.6
6-21-71	365.33	62.3	215.6
6-23-71	486.81	73.0	349.4
6-25-71	557.87	72.0	400.5
6-28-71†	280.71	73.6	206.3
6-30-71†	248.73	66.3	161.5
7- 1-71†	213.20	63.6	135.1
7- 3-71†	241.63	71.3	172.6
7- 7-71†	88.83	68.6	61.1

*Average of three plots
†Viable quackgrass seeds found

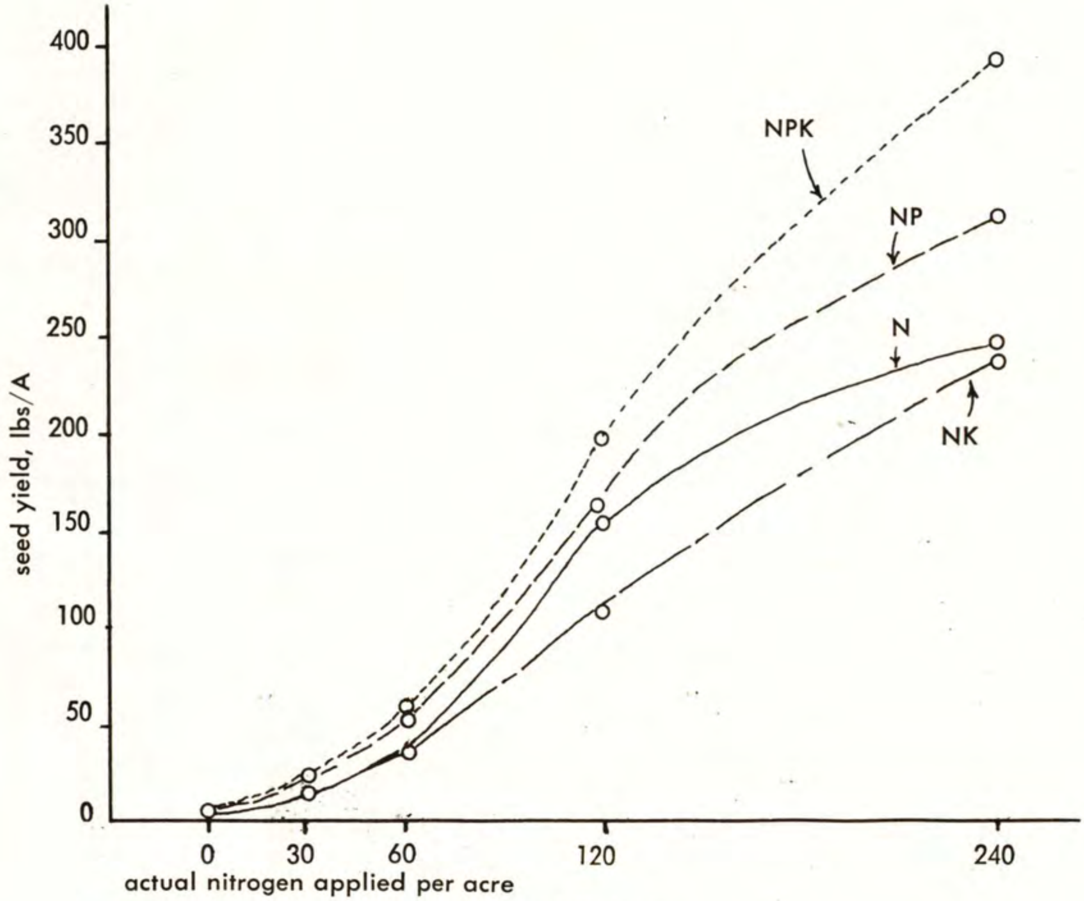


Figure 1. Influence of applied N, P_2O_5, and K_2O on seed yield of Garrison creeping meadow foxtail, 1968

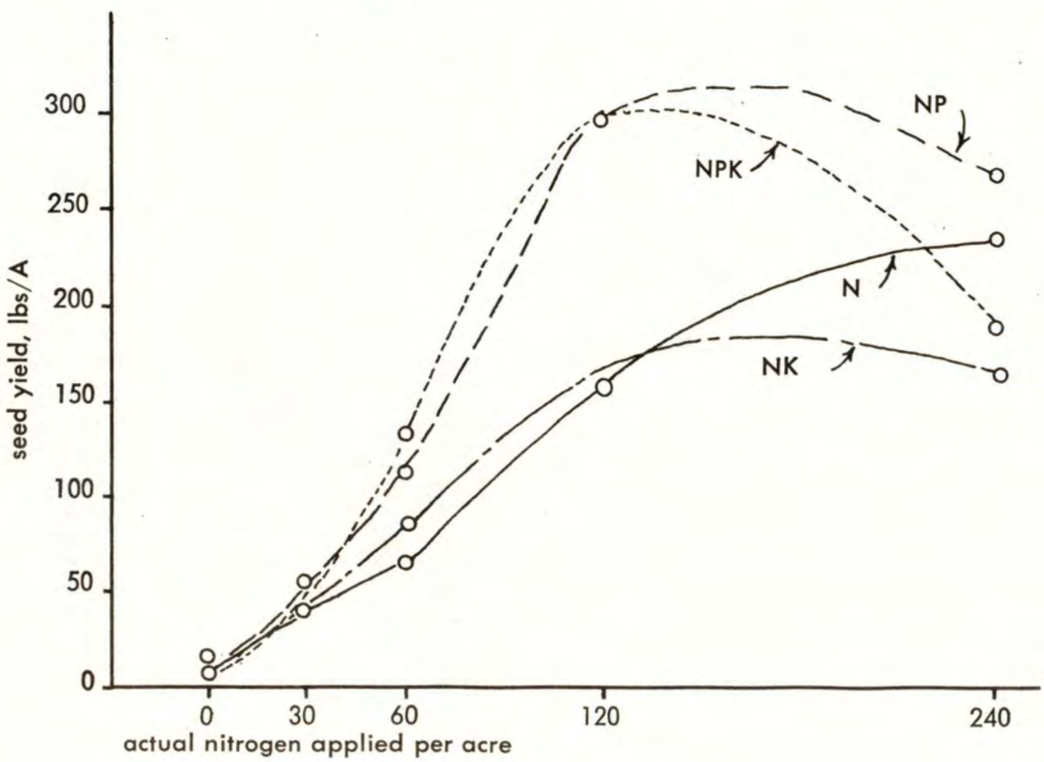


Figure 2. Influence of 2 years of applied N, P_2O_5, and K_2O on seed yield of Garrison creeping meadow foxtail, 1969

1. All nitrogen applications significantly increased forage production. Indications were that annual applications of 120 lbs of nitrogen per acre will produce the most forage.
2. Potassium and phosphorus applications did not increase forage production.
3. Applications of nitrogen above 120 lbs per acre increased the protein content of the hay.
4. Seed production was dramatically increased by nitrogen applications. It appeared that an annual rate of 120 lbs of nitrogen and 40 lbs of P_2O_5 per acre will produce maximum seed yield.

Seed Production

Most Garrison creeping meadow foxtail fields in Brookings County were found to have patches of the noxious weed quackgrass. Seed harvested about the first of July contained quackgrass seeds and could not be sold or used for planting. Quackgrass seeds in the very light, chaffy Garrison creeping meadow foxtail seed could not be completely removed by any known cleaning process, so one possibility for the production of usable seed is to harvest the seed before the quackgrass seeds have developed far enough be able to germinate.

An experiment on dates of harvesting seed was designed to determine if good seed of Garrison creeping meadow foxtail could be obtained at a time that quackgrass seeds were not developed sufficiently to germinate.

A well established heavily fertilized field in Brookings County was selected that had some quackgrass sods intermixed. Three plots from poor to well drained areas of the field were staked and harvested every 2 to 3 days starting June 22, 1970, and June 21, 1971. Seed yields and germinations were determined. All quackgrass seeds were tested for germination. Photographs were taken of Garrison creeping meadow foxtail seed at each of the 5 harvest dates in 1970.

The following conclusions were made from the harvesting of Garrison creeping meadow foxtail seed at different dates from a quackgrass infested field.

1. Seed maturity was variable and many heads had matured and were shattering while adjoining heads were still developing.
2. Seed yields decreased after June 25 both years, because wind and/or rain and hail storms occurred both years, causing extensive shattering.
3. Germinable seed was harvested at all dates.
4. Pounds of germinable seed is perhaps the best single measure of seed production quality. The highest yield of germinable seed occurred June 28, 1970, and June 25, 1971.
5. Mature Garrison creeping meadow foxtail seed is black in color, but the highest yields were obtained when most of the seeds were light gray.
6. No viable quackgrass seeds were found in either of the June 25th harvests.


June 22, 1970


June 28, 1970


July 1, 1970

7. One viable quackgrass seed was found in the June 28, 1970, harvest and four viable seeds were found in the June 28, 1971, harvest. Succeeding harvests had increasing numbers of viable quackgrass seeds.
8. The highest seed yields of quackgrass-free Garrison creeping meadow foxtail were obtained before the June 28 harvest date.☐ ☐

looking for a new variety

a bromegrass that doesn't quit

D. F. Gross and J. G. Ross*

What good is a forage plant if it goes dormant in the summer? It it's smooth bromegrass, it's still good. It produces abundant forage in the cool seasons of early spring and fall. It's highly palatable, nutritious and digestible, and produces a high yield of beef per acre.

But it will take a summer siesta even if moisture and fertilizer conditions are optimum. About the same amount of moisture is lost from the soil whether bromegrass is growing well or not. Water use efficiency is commonly expressed as the amount of forage produced per acre per unit of water used. So the bromegrass planted in South Dakota would have to be termed an inefficient water user. That's wasting water.

What South Dakota ranchers and farmers need is a smooth bromegrass that will produce regrowth in the summer. On irrigated pastures where the water is available, our present varieties go dormant and prevent production over the whole season. A variety with good regrowth would be very important to our irrigated pasture economy. On dryland, a regrowth variety would produce well in the spring and make use of rainfall during the summer. Under either system, a regrowth variety would enable the producer to more efficiently utilize available moisture.

Two source nurseries were established under irrigation, one at Redfield and the other at Brookings. At Redfield, spaced plants were seeded in check rows 40 inches apart each way in late August 1969 and seeded over with alfalfa in the following spring. Outstanding grass plants able to compete with the alfalfa under intense cutting management were identified during 1971, 1972, and 1973 growing seasons. These plants can be used to develop a variety capable of competing well with alfalfa in a mixed pasture.

At Brookings plants were started in the greenhouse from seed and placed in the field, 40 inches each way, in the fall of 1970. No alfalfa was seeded in this nursery. In 1971 optimum fertility was maintained in this nursery by application of fertilizer following each harvest, and moisture levels were maintained by sprinkler irrigation. Plants which had produced the greatest amount of regrowth were marked prior to each harvest. Three harvests were taken in 1971 with a flail forage harvester. In the fall of 1971 pieces of each of 73 outstanding plants were dug up and brought into the greenhouse. Three cuttings were taken in a greenhouse experiment, and the best 34 of the 73 plants were taken to the field and further tested during the summers of 1972 and 1973.

Three varieties were developed, using 14 different plants as parents. These were developed to determine if selection progress for yield and water use efficiency had been made. These varieties were produced in isolated crossing blocks and seed was obtained in July of 1972. In August 1972, seed harvested from these isolations was planted at the Agricultural Engineering Farm at SDSU. The three varieties were designated early, late, and day neutral. This indicated early, late, and intermediate heading dates under greenhouse conditions. Other entries in the experiment included South Dakota 7, a non-regrowth bromegrass with good seed production and disease resistance developed at the South Dakota State Experiment Station, Saratoga, orchardgrass and reed canarygrass. The latter two grasses have a good regrowth capability and were used as comparisons.

In the spring of 1973 pipes were installed in the middle of each block of this experiment. Soil moisture was monitored in 1973 with the use of a portable neutron probe which was inserted into each pipe to various depths. Three harvests were taken from the experiment in 1973 on June 5, July 12, and August 17. Fertility was maintained through application of 50 lb actual nitrogen following each harvest, and moisture was kept at an optimum through use of a sprinkler irrigation system.

Through use of the neutron probe and measurements of rainfall and irrigation water, it was possible to determine how much water was used per cutting by each of the varieties in the experiment. Table 1 indicates that each of the three experimental varieties exceeded the Saratoga standard in average forage yield over three cuttings. These yields are actually on the basis of 0 percent moisture, and 10-12 percent would have to be added to convert to a hay basis.

Table 1 also indicates the water use efficiency of each of the varieties. This can be obtained by dividing the yield in pounds per acre by the inches of moisture which disappeared from the soil during the growing period. These figures are also the average of three cuttings. They indicate that each of the three experimental varieties as well as the orchardgrass exceeded the Saratoga in water use efficiency.

Orchardgrass has a great ability to produce regrowth but has shown winter injury in other experiments. For this reason it is recommended only for irrigated, well-drained

*Plant Science Department. This research was a joint project with the Water Resources Institute.

soils in particular areas of South Dakota. This grass is not ordinarily sufficiently winter hardy to be grown in South Dakota.

In this experiment the smooth bromegrass experimental varieties exceeded reed canarygrass in both yield and water use efficiency. In addition to its regrowth ability, reed canarygrass is also flood tolerant and somewhat drought resistant. It is often used in low areas of the state where other grasses flood out.

So there is promising evidence that South Dakota farmers and ranchers will in the future have a bromegrass that keeps on producing forage through the summer months. Seven plants have been selected for use as parents in two new varieties. These will be compared with standard varieties for yield, seed production, disease reaction, and other agronomic characteristics. Dryland and irrigated plots were seeded in August 1973. If found outstanding, the best of these strains will be released as a new variety. □□

Fig. 1. Illustrating the regrowth characteristics of one plant selected from the nursery of over 39,000.

Fig. 2. Using the portable neutron probe to monitor soil moisture in the field in 1973.

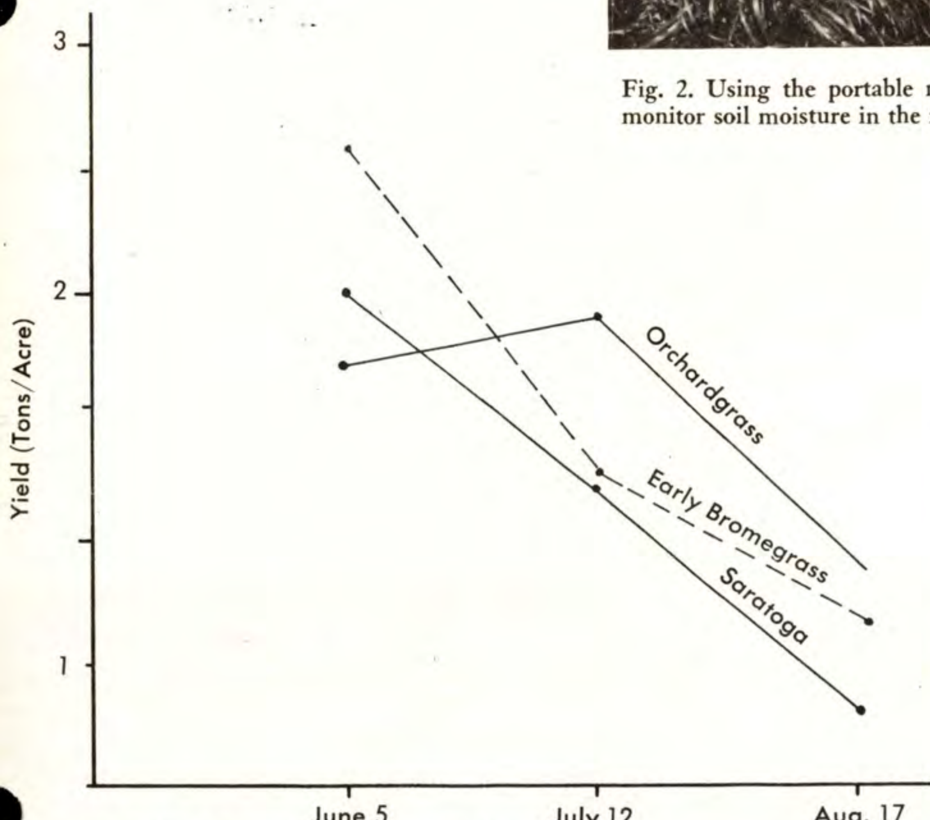


Fig. 3. Yields by date of cutting in 1973 for early bromegrass, Sartaoga, and orchardgrass.

Table 1. Average yields and water use efficiency for three cuttings of experimental varieties and standards in 1973.

Variety or species of grass	Tons/ Acre Yield	Pounds/ Acre/Inch Water Use Efficiency
Early bromegrass	1.49	484
Late bromegrass	1.45	465
Day neutral bromegrass	1.43	481
Saratoga bromegrass	1.19	359
SD 7 bromegrass	1.00	305
Orchardgrass	1.52	477
Reed canarygrass	1.13	348

Steer results were good, but milk production fell off; key was poor fermentation during lactation trial

silage from high-sugar corn

Howard Voelker, Paul Stake, Myers Owens, and David Schingoethe*

Corn cut for silage is no novelty, but planting high-sugar corn is, although some South Dakota dairymen are cropping high-sugar corn. Claims made about it are that it's drought resistant since there's no critical water period during ear set, it's usually more frost resistant than regular dent corn, and it can be planted thicker to give higher silage yields per acre and finer stalks.

Its feeding value for cattle? SDSU researchers have these results from a 2-year test: It's comparatively higher in protein, its feeding value is comparable to that of regular dent corn silage for weight gains. Body weight gains for steers and feed efficiency appear slightly higher for the high-sugar corn. Digestibility of protein and fiber is higher. Milk production was below that of cows fed dent silage because fermentation was more favorable the year the steers were fed than in the year of the cow trial.

Experimental Procedure

Silages. During each of 2 years, high-sugar and regular dent corn silages were grown on similar fields with the same tillage and fertilization. The high-sugar corn, which develops cobs but not kernels unless contaminated, was isolated from other corn so that it would not pollinate. Each year the regular corn was ensiled at the early dent stage of maturity at 62.8% to 63.5% moisture. The high-sugar corn was harvested later after heavy frost had induced a purplish color.

During the first year both dent and high-sugar corn were planted at 18,000 seeds per acre. In the second year the seeding rate of high-sugar corn was increased from 18,000 to 23,900 plants per acre to measure its ability to withstand stress at denser populations and to see if heavier planting might increase silage yield.

The silages were chopped fine with a regular field chopper and ensiled in upright concrete silos.

*Professor, former Research assistant, Extension dairyman, and Associate professor, respectively, Dairy Science Department.

Steer Growth Trial. During the first year, 24 Holstein steers averaging 528 lbs body weight were divided into two groups and fed either high-sugar or regular corn silages free choice for 12 weeks. The steers were weighed 3 consecutive days at the start and end of the trial. A 13.2% crude protein grain supplement was fed at 4 lbs per head daily. Trace mineral salt and dicalcium phosphate were offered free choice, separately.

Digestibilities of the silages were determined using four Holstein steers in a total collection reversal design digestion trial.

Lactation Trial. During the second year, 20 Holstein cows were used in a switchback design trial for a duration of 17 weeks. Silages were fed free choice, and alfalfa hay was limited to 4.4 lbs per cow daily. A 20.1% protein grain mixture was fed at 1 lb for 3 lbs milk produced. Trace mineral salt and dicalcium phosphate were offered free choice. Cows were weighed for 3 consecutive days at the start and end of each experimental period.

Table 1. Planting, harvesting, and yields of high-sugar and dent corn silages.

	First Year		Second Year	
	High-sugar	Dent corn	High-sugar	Dent corn
Plant Information:				
Date planted	May 14	May 14	May 12	May 12
Seeds per acre	18,000	18,000	23,900	18,000
Plants per acre	16,600	17,200	23,000	17,600
Harvesting Information:				
Date harvested	Oct. 8	Oct. 3	Oct. 22	Sept. 15
Dry matter (%)	35.2	37.2	31.9	36.5
Total dry matter (lb/acre)	9,699	10,905	10,454	7,625
Silage dry matter (lb/acre)	9,339	10,585	10,096	7,372
Field dry matter loss (%)	3.7	2.9	3.4	3.3

Table 2. Chemical composition of high-sugar and regular corn silages.

	Steer Growth Trial (First Year)			Lactation Trial (Second Year)			
Silages	High-sugar	Dent	Grain	High-sugar	Dent	Alfalfa	Grain
	Dry Matter Composition %						
Dry matter	33.6	37.3	89.8	33.0	34.8	88.5	88.6
Crude protein	8.62	6.40	13.20	8.56	6.27	18.15	20.15
Crude fiber	19.72	18.76	7.91	21.23	20.56	24.47	4.15
Ether extract	2.52	2.76	3.80	2.17	2.29	1.32	3.00
Ash	4.33	3.70	2.62	3.96	5.00	7.56	5.66
N-free extract	64.81	68.38	72.47	64.08	65.88	48.50	67.04
Calcium	.21	.21		.17	.23		
Phosphorus	.25	.38		.33	.32		

Results

Plant populations, planting, harvesting dates, yields, and losses are given in Table 1. During the second year the planting rate of the high-sugar corn was increased so that there were 30.8% more plants per acre than for the regular corn. This produced a dry matter yield 37.1% greater for the high-sugar corn than regular corn.

There appeared to be greater drought resistance of the high-sugar corn during the second year. It matured later. Rainfall during the critical stage of dent corn ear formation was 49.9% less during the second year than during the first year. This dry weather caused earlier harvest of the regular corn, September 15 in the second year, compared to October 3 the first year. The high-sugar corn silage was made October 8 the first year, and October 22 the second year (Table 1). Field losses from frost damage were not lower for high-sugar corn as sometimes claimed.

The increase in planting rate did not appear to affect the composition of the silage (Table 2). High-sugar corn contained more protein than dent corn, and crude fiber was slightly higher. Nitrogen-free extract was lower in the high-sugar corn.

Table 3 presents the results of the steer feeding trial (year 1). Body weight gains per day and feed efficiency appeared slightly greater for the high sugar silage, but these differences were not significant. The steers fed high-sugar corn silage ate slightly less silage, grain and salt than the steers on regular silage, but they consumed nearly twice as much dicalcium phosphate. We don't know why this happened. Digestibility of protein was considerably higher in the high-sugar silage, and fiber digestibility was slightly higher in the high-sugar silage. The steers

consumed more protein from the high-sugar silage than from the regular silage, since it had a higher protein content.

In Table 4 are presented results of the lactation trial (year 2). Feed intakes were very similar between groups. The cows on high-sugar corn silage gained slightly less weight, although these results were not significant. The cows on regular corn silage produced about 3 lbs more milk daily. This was the opposite of what we had expected since in the first year steers gained more weight on the high-sugar corn silage. Milk composition was similar for cows fed both silage rations.

So why was animal performance better on high-sugar silage the first year but was better on regular corn silage the second year?

In the second year, the high-sugar corn silage contained less lactic acid and less total acid (indicators of silage quality) than the regular corn silage (Table 5). The fermentation results indicate that high-sugar silage was better the first year than the second year. Conversely, the regular corn silage was better in the second year. This corresponds with animal performance, namely faster weight gains and high digestibility on high-sugar corn silage in year 1 and more milk from cows fed regular corn silage in the second year. □□

Table 3. Intake, gains, feed efficiency and digestibilities of high-sugar and regular corn silages (Year 1).

	High-sugar silage	Regular silage
Dry matter intake (lb/100 lb body wt)		
Silages	1.66	1.78
Grain	.56	.59
Trace mineral salt (lb)	.013	.016
Dicalcium phosphate (lb)	.011	.006
Gain (lb/day)	2.24	2.05
Feed Efficiency (Dry matter/lb gain)	5.21	5.88
Digestion coefficients (%)		
Dry matter	70.9	67.2
Protein	63.5	52.2
Fiber	61.9	59.3

Table 4. Feed intakes, milk production, and body weight changes of cows (Year 2).

	High-sugar silage	Regular silage
Dry matter intake: (lb/100 lb body wt)		
Silage	1.52	1.52
Alfalfa hay	.31	.32
Grain	.84	.86
Trace mineral salt	.002	.004
Dicalcium phosphate	.002	.003
Milk production (lb/day):		
Actual	36.4	39.3
Solids—corrected	36.9	39.7
Milk composition (%)		
Milk fat	4.05	4.03
Daily body wt gain (lb)	.70	.90

Table 5. Acids, pH, and sugar contents of silages.

	First Year		Second Year	
Silages	High-sugar	Regular	High-sugar	Regular
Acids:*				
Acetic	1.96	1.59	1.67	1.68
Lactic	6.47	6.65	5.84	7.51
Total acids	8.43	8.24	7.51	9.19
pH	3.90	3.95	3.98	3.92
Total sugars:				
As ensiled	11.02	9.37	11.94	8.83
As fed	3.98	2.16	4.72	1.50
% reduction	63.88	76.95	60.47	83.01

*Percent of dry matter, as fed.

PUBLICATIONS

The Agricultural Experiment Station and the Cooperative Extension Service distribute a large variety of publications to South Dakota citizens. Your county Extension office will have copies. The publications listed here have come off the press since January 1, 1974.

FS 612, Sanitary Landfills—the Situation and Local Requirements
FS 613, Sanitary Landfill Site Selection and Operation
FS 614, Costs and Returns of Solid Waste Disposal in Sanitary Landfills
FS 617, Livestock Theft in South Dakota
FS 618, Maintenance of Irrigation Wells
FS 619, Anthrax
FS 620, Health Services for Rural South Dakota
B 614, Polyester/Cotton for Pillowcases
B 615, Changes in Age Structure, South Dakota Population 1960-1970
B 617, Bronze Wheat
B 618, Luscious, a High Quality Pear for the North
B 619, 1980 Population Projections for South Dakota
C 209, 1973 Corn Performance Trials
C 210, 1973 Grain Sorghum Performance Trials
EC 694, Beef Equipment Catalog
EMC 645, Feeding a Crowd: Do it Safely
EMC 659, Evaluating Nitrogen Recommendations for Corn in Eastern South Dakota
Redfield Progress Reports, Effect of Fertilizing Wheat
West River Progress Reports, Effect of Fertilizing Spring Wheats

COLLEGE OF AGRICULTURE AND BIOLOGICAL SCIENCES
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE UNIVERSITY
BROOKINGS, S. D. 57006
R. A. Moore, Director

Penalty for Private Use, $300

PUBLICATION

Postage Paid
U. S. Department of
Agriculture
AGR 101

Third Class
Bulk Rt.

U.S.MAIL

R. C. Wahlstrom
Animal Science
Ag. Hall