TABLE IX. WHO READS THE PUBLICATION

Who Else Reads the Publication	Farm Readers	Non-Farm Readers	Total Respondents
Spouse	679 (34.3%)	53 (13.5%)	732 (30.9%)
Other Family Members	743 (37.6%)	34 (8.7%)	777 (32.8%)
Others	150 (7.6%)	214 (54.6%)	364 (15.4%)
No One Else	405 (20.5%)	91 (23.2%)	496 (20.9%)
Total	1,977 (100.0%)	392 (100.0%)	2,369 (100.0%)

More than one-third (34.3 per cent) of the farm readers who responded indicated their spouses read the bulletin. Since most of the subscribers are male, spouse usually indicates woman. Non-farm respondents indicated 30.9 per cent of their spouses read the bulletin. Just over 20 per cent of the farm respondents and 23.2 per cent of the non-farm respondents indicated they were the only person reading the copy of the bulletin addressed to them.

Conclusions

1. Respondents' attitudes toward the reading level in the **North Dakota Farm Research Bimonthly Bulletin** were distinctly favorable.

2. Respondents' attitudes toward the number of pictures used in the bulletin suggests the bulletin contains about the right number of pictures.

3. About one-third of the respondents indicated their spouses were reading the **North Dakota Farm Research Bimonthly Bulletin.**

Recommendations

The writer recommends that the readers of the **North Dakota Farm Research Bimonthly Bulletin** be questioned about their attitudes toward a sample of articles in the bulletin. This may identify more specifically the attitudes of the readers.

SUMMARY OF SOME MAJOR RESEARCH PROJECTS IN THE AGRICULTURAL EXPERIMENT STATION

Alternative Uses of Wetlands

Benefits associated with the wetlands of North Dakota are both economic and esthetic. Economic benefits include recharge of ground water supplies, flood control and sources of water supply for livestock. Esthetic benefits include providing nesting and staging areas for waterfowl, as well as habitat for other wildlife. Game production provides other economic benefits to the community because of expenditures by hunters to the trade and service sector and, in some cases, to landowners for hunting privileges.

Costs also are associated with preserving wetlands. These include income that could be realized by farmers if they drained the wetlands and converted them to agricultural production. Lands kept out of production also cost the business community through loss of potential sales of farm production inputs. Temporary wetlands may increase production costs because of the nuisance and time loss involved in farming around the wetlands, as well as actual crop loss from excess water during wet years.

Another cost often related to wetlands is crop depredation by wildlife. Most severe depredation losses in North Dakota occur in years when crop harvest operations have been delayed by wet weather, when waterfowl and other migratory birds may damage fields of swathed grain during their fall migration.

A pilot project to evaluate alternative uses of wetlands has been designed to provide data and experience for planning a more detailed study of wetland use, which would include social, economic, biological and ecological aspects. Such research is needed to provide information for decision making regarding choice of resource use among existing and potential alternatives.

Leading the project is the Department of Agricultural Economics. The departments of community and regional planning and zoology are also involved in the study.

The study will involve estimates of gross business volume generated by expenditures by hunters, increased revenues to farmers and the community that would result from drainage of wetlands, and costs of crop depredation losses to wildlife. Other factors that influence decisions to drain wetlands will also be identified.

A realistic approach is needed to most effectively utilize the land and related water resources in the pothole region of North Dakota. The first step in this effort is to determine the benefits and costs of wetlands to farmers and society in general.

Marketing Irrigation Production

Agricultural land irrigation is increasing in North Dakota. With the completion of the Garrison Diversion Project, North Dakota will have an estimated 1.3 million acres of irrigated land.

Substantially increasing acreages of irrigated cropland presents a new set of management and marketing decisions for both farmers and agribusinessmen living in the irrigation districts. Selecting the most economic combination of cropping and livestock enterprises will depend on evaluating a new set of economic and physical production factors.

It is extremely important that the highest level of expertise available is used to evaluate the alternatives that irrigation development will make possible. A project on marketing irrigation production is designed to help provide this expertise.

This interdisciplinary project involves the departments of agricultural economics, agronomy, soils, animal science and horticulture.

Intensification of agriculture in the irrigated area may bring about substantial increases and employment in the agricultural and nonagricultural segments of the economy. Development of optimal combinations of cropping and livestock enterprises under irrigation depends on both production and marketing considerations.

Many intensive agronomic and horticultural crops are possible production alternatives in the irrigation areas. However, market potentials for the new crops must be determined before production can feasibly take place. Many potential specialty crops would require the development of marketing and processing facilities, requiring a community effort to develop facilities. Such development will require detailed feasibility studies to identify their potential economic success.

National market potentials for new cropping alternatives must be studied to identify realistic market prices for new products at different levels of production. Market potentials must be thoroughly investigated before capital is invested in processing and handling facilities to avert possible business failures.

A comprehensive assessment of market and production potentials for irrigation development is needed to provide guidance to farm operators, agribusiness firms and community planning organizations is making decisions during the transition from dryland to irrigated agriculture.

Impact Of Coal Development

Abundant, low-cost energy has been a prime contributor to rapid economic growth in the United States. Now, however, the days of cheap fuel appear to be over, and low-cost, non-polluting energy is becoming a scarce resource. As a result, lignite coal reserves of the Fort Union Formation in western North Dakota are expected to play a major role in supplying national energy needs.

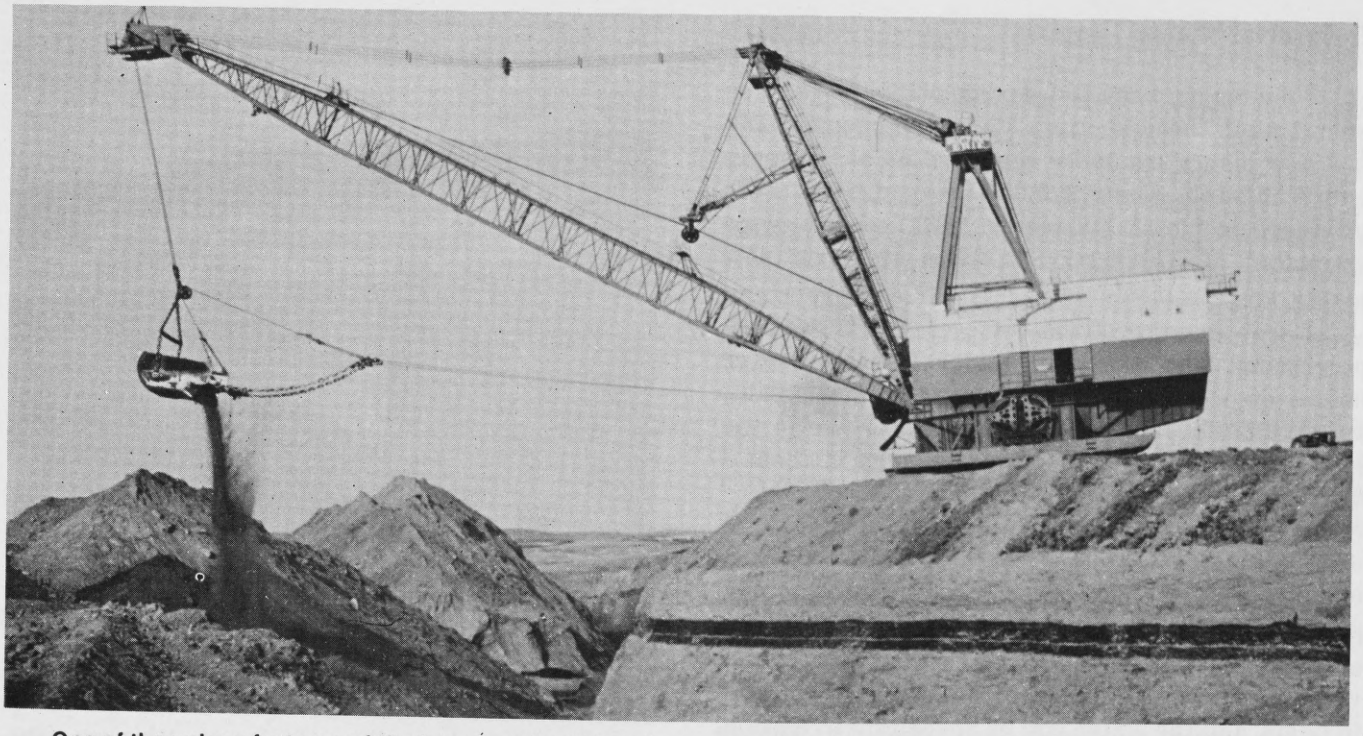
Plans for development of North Dakota's lignite reserves are proceeding rapidly. Lignite production in the state increased from 4.4 million tons in 1968 to 6.8 million tons in 1973, and plans for developing additional power generation facilities and coal conversion plants suggest rapid changes in future production. Intensive mineral rights leasing activity has been observed, and water and surface rights have been subjects of considerable interest.

The prospect of extensive coal-related development poses a number of crucial concerns to public decision makers and area residents. Such concerns include the effect of alternative levels of development on population, employment and income and the level of services demanded from state and local governments, as well as the revenues available to these governmental units. Other concerns include environmental impacts, effects of alternative spoil bank reclamation practices and the pattern of future economic activity once the lignite has been mined.

To help find answers for some of these questions, the Department of Agricultural Economics is conducting a five-year study on the impacts of coal development alternatives.

Objectives of the study are to identify alternative methods of utilizing western North Dakota lignite resources to meet energy needs; identify and evaluate effects of alternative development patterns on local economic activity, resource use and population distribution; and identify the factors that affect the level and pattern of development of North Dakota lignite.

Lignite development in western North Dakota has the potential to transform the character of the area irrevocably. This research effort is designed to provide information that will enable the people and their elected and appointed representatives to make better informed decisions regarding this important question.



One of the unique features of the immense lignite coal reserves of the Fort Union Formation in western North Dakota is that it lies so close to the ground surface for economical strip mining operations. Strip mining, however, causes other environmental impacts that need to be studied and fully reported.

Sheyenne River Basin

The effect of human activity on the environment has been the focus of much discussion in recent years, but little evidence is available on the actual contributions of natural and man-induced sources to water pollution and on reasonable alternatives available to farmers, cities and industry to meet pollution standards. A recently-initiated study at NDSU will attempt to identify the costs and benefits of varying pollution control standards and evaluate alternative water and land use management systems in meeting federal and state standards.

The project will focus on the Sheyenne River Basin and will be one of the first efforts made on a North Dakota river in sufficient intensity and time span to provide solutions for these problems.

The Sheyenne Basin was chosen for several reasons. It is the longest river completely within the state's boundaries. It is a relatively narrow, well-defined basin with characteristics representative of other river valleys in eastern North Dakota in terms of agriculture, municipalities and recreational use. Also, several projects are underway or being planned that will affect the Sheyenne Basin.

The Sheyenne is scheduled to become one of the waterways used in the Garrison Diversion Project. This will augment water flows while probably increasing salt concentrations in the water. Another project affecting the Sheyenne is the proposed Kindred Dam. It is important to begin work in the Sheyenne Basin before starting these projects, so baseline information can be obtained and land-river use alternatives can be evaluated in terms of their socioeconomic and environmental impacts.

The project is interdisciplinary, involving the departments of agricultural economics, botany, bacteriology, geology and chemistry at NDSU; sociology at Concordia College, and chemistry at Moorhead State College.

The project involves four basic areas: (1) developing a computerized simulation model of the basin; (2) compiling information on geological formations, vegetation, cropping patterns, agricultural units, municipalities, recreational areas, etc., in the basin; (3) analyzing the river water chemically and bacteriologically at various locations; and (4) collecting data on the various uses of the river, attitudes toward the river and economic activity in the basin.

The portion of the Sheyenne selected for study is from the Bald Hill Dam north of Valley City to its mouth on the Red River north of Fargo—about one-third of the river's length.

Industrial Waste Disposal

Four sugar beet processing plants have been operating in the Red River Valley for many years, and new plants are under construction at Hillsboro and Wahpeton. About 220,000 acres of beets were produced in North Dakota in 1973, with acreage estimated at 320,000 acres when the two new plants go into production.

Large amounts of water are used in sugar beet processing, and the treatment of waste water before disposal is a problem. At a typical plant, approximately 700,000 gallons of water are in the system, and the total circulated per day is about 8 million gallons.

The Environmental Protection Agency is working toward a goal of no discharge of waste water from sugar beet processing plants. The four plants now operating in the Red River Valley will use vacuum filters to remove solids from waste water from the plants. These solids will be trucked to fields, and the water will be spread by irrigation.

Evaluation of these practices is being conducted by the departments of agricultural engineering, soils and bacteriology.

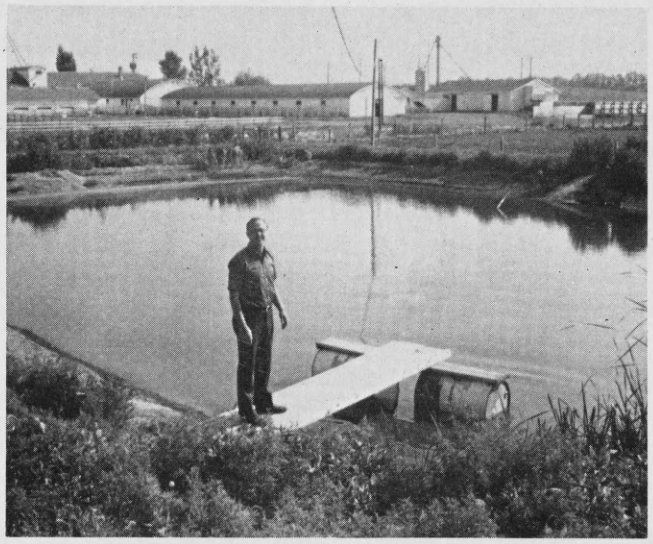
Objectives of the project include determining the factors influencing maximum annual disposal rates, determining the factors influencing long-term utilization of wastes compatible with sustained production, and establishing acceptable management practices for land application of wastes.

Animal Waste Management

Animal waste management, especially in view of the trend toward more concentrated livestock operations and confinement housing, is an increasing problem for the livestock industry. Research at NDSU is designed to further develop animal waste management systems to control odors and toxic materials in the air and organic materials and other pollutants in water and soil, compatible with efficient livestock production.

Departments involved in animal waste research include agricultural engineering, animal science, bacteriology and civil engineering.

Work in the past year has evaluated using evaporation ponds as a method to dispose of animal wastes. The project involves determining if the evaporation rate from a pond containing waste water is slower or higher than the evaporation rates of clean water. The goal is to develop a method to size ponds so all water from a waste disposal system can be disposed of by evaporation.



Dr. George Pratt, professor of agricultural engineering, is taking the leadership in research designed to find answers to the problems of animal waste management systems, including evaporation ponds such as this one at the Main Agricultural Experiment Station, Fargo.

Another project is under way to determine the runoff rate from feedlots during spring thaws and summer rainstorms, the pollution potential of this runoff and the fate of pollutants as feedlot runoff permeates down through the soil. Design criteria for structures suitable for holding feedlot runoff until it can be disposed of without creating a pollution problem are being developed. Use of runoff water on cropland and on trees is also being evaluated.

Another aspect of the waste management research involves an evaluation of the bacteria present in manure from cattle maintained in confinement barns. To determine whether the wastes from animals kept in confinement pose a greater health hazard than those from unconfined animals, effort was made to isolate and identify potential pathogens from the manure samples. As this project continues, the survival potential of human and animal pathogens from waste water in soil and in lagoon sediments will be determined.

Using Center Pivot Irrigation

With irrigation development progressing in North Dakota, many farmers are being faced with a new set of management decisions regarding irrigation systems and equipment.

The objective of one NDSU study is to determine the production and net return potential attainable with center pivot sprinkler systems when they are used to irrigate more than one tract

of land. This study has been conducted at the Carrington Irrigation Branch Station.

Plot irrigators are used in small plot experiments to simulate three investment levels in center pivot equipment. Investment levels are one center pivot per field, one center pivot per two fields, and one system for three-field irrigation.

Irrigations in this study are scheduled by a computerized scheduling model. Weather and irrigation information are supplied to the model once each week and used to predict the crop water use of the previous week. Then, with advance weather information, irrigations are scheduled for each succeeding week.

Production comparisons for the three investment levels in the study are being obtained for alfalfa, corn, pinto beans, potatoes, wheat and oat ensilage crops. The results will be summarized to determine which combinations of soils, system pumping rates, crops and management schemes will provide acceptable net returns for various investment levels in center pivot irrigation systems.

Agricultural engineer Richard Witz examines the heat exchanger unit at the confinement beef barn. In this heat exchanger, a layer of rocks is heated by exhausted warm air, and this heat is then used to warm incoming ventilation air when the flow is reversed.

Confinement Housing Ventilation

Confinement housing for beef cattle has some advantages for the Northern Great Plains, offering potential for controlled environment to provide comfort for both animals and operator as well as possible pollution control. Ventilating buildings in cold northern climates offers some problems, however. At cold temperatures there is not enough heat to provide sufficient ventilation to remove moisture.

NDSU agricultural engineers have designed a unique system that might be the answer for complete confinement livestock systems. This system involves a reversible air flow and rock beds which act as a heat sink to warm incoming air. Outgoing and incoming air passes through a 4-to 5-inch layer of rock, which saves the heat from the building.

Heat exchangers for reclaiming heat from exhaust air have been tested at other stations, encountering problems with heat exchange surfaces that become dirty or corroded and the high cost of installing damper controls. Rocks, on the other hand, are inexpensive and are easily cleaned with detergents and hot water or steam.

The rock sinks have been successful for reclaiming exhaust heat. There have been some problems due to icing up of the rock sinks. Larger rocks, longer ventilation cycles and salt have helped to control the ice at extremely low temperatures, and studies to improve the system are continuing.

Treating Farm Water Supplies

Water in southwestern North Dakota varies considerably in quality. Many farms in that part of the state have well water that contains organic matter and minerals to the extent that the water is marginal for household use and must be treated to be used successfully.

The Department of Agricultural Engineering, in cooperation with textiles and clothing in the College of Home Economics, evaluated a water treatment system known as reverse osmosis. Reverse osmosis units were installed on two farms in the area, one near Dickinson and one near Reeder.

Water on both of the farms was high in dissolved solids and dark in color. Since installing the reverse osmosis units, water quality on both

farms has been improved considerably. It is now possible to do laundry satisfactorily with the well water, and beverages made with the water look and taste better.

This project has demonstrated that reverse osmosis makes it feasible to convert poor quality water into a high quality water, allowing an improved way of life on these farms because of an abundance of quality water.

Hard Red Spring Wheat

Waldron, a 1969 North Dakota State University release, has occupied 53 to 62 per cent of the annual North Dakota wheat acreage during 1971-73. The total added value from yield and quality by growing Waldron wheat since 1969 is an estimated $75,000,000 in North Dakota. Yielding ability, broad stem and leaf rust resistance, excellent straw strength and grain protein content make Waldron an attractive varietal choice. In 1973, the excellent quality of Waldron contributed substantially to the overall milling and baking quality of the North Dakota HRS wheat crop.

A new HRS wheat variety, Olaf, is the first semidwarf wheat released by the North Dakota Agricultural Experiment Station. Though not as high yielding as Era and 0.5 percentage units lower in grain protein than Waldron, Olaf wheat provides the best combination for yield, disease resistance and grain protein of any semidwarf variety grown in North Dakota.

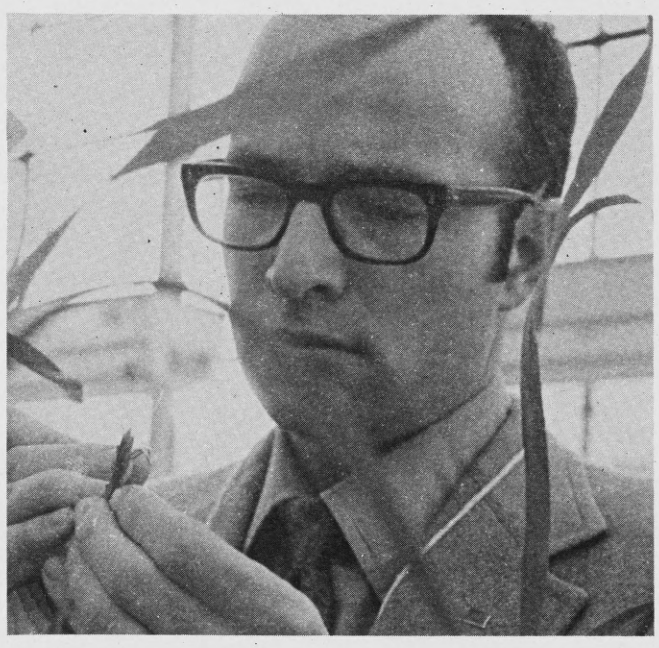
Using diverse genetic sources of rust resistance in the breeding program means reduced genetic vulnerability of future wheat varieties to these important wheat diseases in North Dakota. Discovery of a unique genotype for increased grain protein represents a major step in combining significant improvements in wheat yield and grain protein content. Identification of genotypic differences for nitrogen reduction and translocation within the wheat plant will enable the breeder to more critically choose parents for crosses and eventually to devise more efficient screening techniques for protein and yield of segregating progenies.

New Durum Varieties

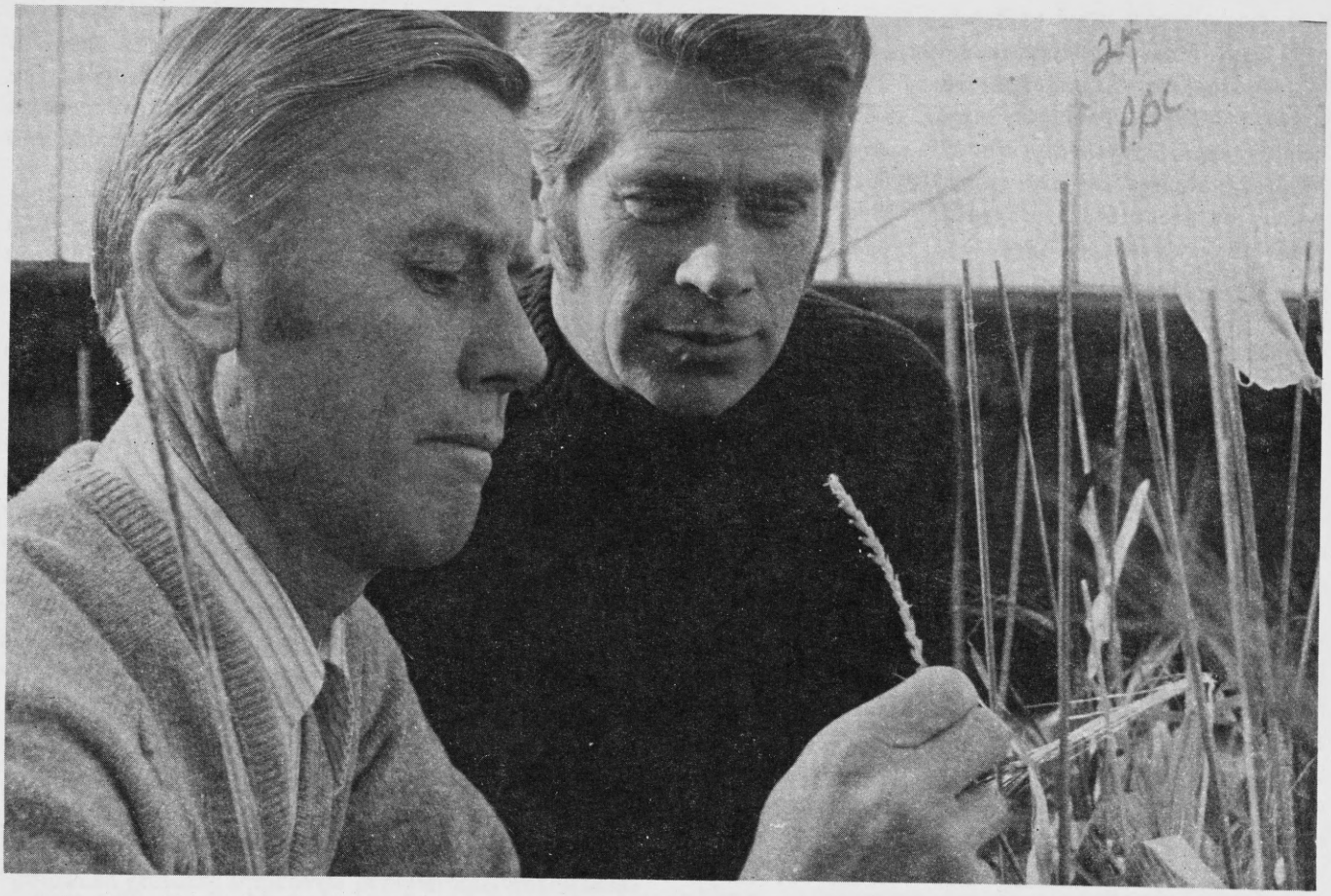
Three new durum varieties, Crosby, Botno and Rugby, were jointly developed and released by the North Dakota Agricultural Experiment Station and the USDA in December, 1973. These new varieties possess increased yielding ability over Leeds, and also have stronger straw, earlier maturity, improved disease resistance and improved spaghetti quality. These varieties join Rolette and Ward, released in 1971 and 1972, respectively, to provide North Dakota farmers five new varieties with several major advantages.

North Dakota-released durum varieties have made up at least 95 per cent of North Dakota and United States production during each of the last 10 years, continuing the dominant position held for many years. When in 1953-54 durum production fell to about **six million** bushels in North Dakota because of stem rust devastation, the varieties Langdon and Ramsey, released in 1956, brought durum production back to normal levels. New races of stem rust attacked Langdon and Ramsey, which were then replaced by the resistant varieties Wells and Lakota, released in 1960. While Wells today is an important variety in North Dakota and still resistant to stem rust, newer varieties such as Leeds, Ward and Rugby have provided progressively higher stem rust resistance levels.

Leeds durum, released in 1966 and possessing greatly improved grain and spaghetti quality over Wells, has occupied more than half of the acreage since 1968. The large seed and excellent yellow semolina and pasta product color of Leeds have been largely responsible for happy domestic durum processors and for holding the large durum export



Dr. James Quick, project leader for durum variety improvement, speeds up the process of new durum variety development with his winter crossing program.



Dr. Glenn Peterson and Dr. Earl Foster inspect a possible new barley variety by checking to see if cytoplasm from different sources affects yield and other characteristics.

market and favorable prices enjoyed the past few years.

Rolette durum, released in 1971, was grown on about 14 per cent of the North Dakota acreage in 1973 and may occupy as much as 40 per cent in 1974. Early maturity, short stiff straw, large kernels and high yield make Rolette an attractive choice for producers.

Ward durum, released in 1972, was grown under seed increase on about 20,000 acres in 1973, and may occupy up to 20 per cent of the North Dakota acreage in 1974. Ward has about a 12 per cent yield advantage over Leeds, and has stronger straw, greater resistance to leaf rust, excellent spaghetti quality and a lower incidence of leaf spotting than current varieties.

Several medium height durum selections, intermediate between Leeds and semidwarf types, are undergoing final evaluation. These lines of a new height class for durums will provide the shorter straw needed in most of the durum area, and allow the stem to carry additional spike weight without lodging. Less effort is being applied to the development of semidwarf durums. Problems of leaf diseases and fertility have largely been overcome among semidwarf durums, and final effort is being made to overcome spaghetti quality deficiencies. Recent improvements have been made in increasing kernel size, broadening disease resistance, stiffening the straw and improving spaghetti quality in experimental lines which are used in hybridization breeding programs. Research just completed indicates several sources of genetic resistance to leaf rust are available and easy to manipulate genetically.

Developing New Barley Varieties

Barley is the third most important cash farm income commodity in the state. In addition, a significant part of the barley crop is marketed indirectly through livestock and does not occur as cash farm income. Last year, North Dakota produced about 2.8 million acres of barley yielding over 100 million bushels. The total value at current prices amounts to about $200,000,000.

Since 1961, five barley varieties have been released from the barley breeding program at North Dakota State University. These include Larker, Trophy, Dickson, Nordic and Beacon. With the exception of Nordic, which is not classified as a malting barley, all are considered dual purpose varieties acceptable for malting and brewing as well as for livestock feed.

Because of disease problems that occur in the major part of the important growing areas in the state, a considerable effort has been made to improve varieties by incorporating disease resistance to the leaf spotting diseases, primarily spot blotch, net blotch and Septoria leaf blotch, along with resistance to loose smut. Dickson, released in 1964, was the first variety to combine resistance to these three leaf spotting diseases. So Dickson has taken over much of the acreage in the eastern part of the state, especially the northeastern part where these leaf diseases are present almost every year and cause considerable damage.

Nordic, released in 1971, is a further improvement over Dickson in resistance to leaf spotting diseases. Beacon, released last year, is the first variety ever accepted as suitable for malting at the time of naming and release. A major accomplishment in Beacon is the incorporation of resistance to the leaf spotting diseases and to loose smut. It is the only variety available to North Dakota growers that has this combination.

Over the past years the varieties developed at NDSU have dominated the acreage not only in the state but in the upper midwest. Annually, at least 80 to 90 per cent of the barley acreage in North Dakota is from varieties that have been developed here.

Because of the wide adaptation of some of the North Dakota varieties, they have contributed considerably to the nation's barley crop. About 35 per cent of the nation's barley acreage was grown to varieties developed here. About 70 per cent of the barley used by the nation's malting industry is of North Dakota developed varieties. At current prices, these varieties contributed over $300 million to the nation's agricultural economy.

The primary goal of the North Dakota breeding program is to develop varieties for the state. However, the production of some varieties in other areas is an added benefit. Last year, 89 per cent of the acreage in Minnesota was grown to North Dakota produced varieties, 57 per cent in South Dakota. Larker was produced on 14 per cent of the Oregon barley acreage, tying for the most popular variety in that state. North Dakota varieties are grown on nearly 10 per cent of the acreage in Washington, and also in states such as Idaho, Wisconsin, Michigan, Iowa, Nebraska and other north central states.

In addition to cropping and evaluation in North Dakota, NDSU barley breeders use greenhouses on the campus as well as southern increases in Mexico and Arizona to speed up varietal development. Through these techniques, they have been able to reduce the time of development from about 14 to 8 years. Short time of development is important. It is possible that if the time of development of a new and improved variety takes too long, unexpected changes in the marketplace or producer needs may have changed; thus, a new variety would be without a use. So, planning a breeding program which anticipates future needs by both producer and consumer and shortening development time is important to have a product that is currently desirable.

Work On Hybrid Wheats

Plant geneticists in the Department of Agronomy continue their research into the intricacies of producing hybrid wheat. The crop is normally self-pollinating. To produce hybrids, techniques and genetic stocks have been developed to convert wheat into cross-pollinating male and female lines which have the capacity to produce hybrids that are again self-pollinated. The genetic stocks to accomplish these changes were derived through complicated transfers of cytoplasmic male sterility and fertility restoration factors from wild and semi-wild Asian species to North Dakota spring wheats.

The main function of the male sterility-fertility restoration systems is to give pollination control. However, in working with these systems, geneticists find that other traits such as plant vigor and growth rate are sometimes strikingly affected. Cytoplasms and genes which alter plant vigor by as much as 100 per cent or more have been identified.

In the past, wheat breeders have not intentionally manipulated cytoplasmic genetic factors in their programs. They were probably not aware that such factors existed. How to manipulate cytoplasms and restorer genes so that their effect on the hybrid is favorable rather than unfavorable is the underlying direction of much of the current research. The effects and use of the various

restorer lines and cytoplasms as aids to breeding regular wheat varieties is also being evaluated.

Some hybrids have been produced and tested to determine what further improvements must be made in hybrid parents. Parents must meet standard agronomic and quality requirements and must also possess some unique traits such as being good pollen producers to facilitate their use in hybrid seed production. During the next few years, many hybrids will be produced and tested to perfect them to the extent that they will become a commercial crop.

Corn Research In North Dakota

To date, North Dakota State University has released 33 inbred lines and 52 male-sterile or fertility-restoring sublines for use in producing corn hybrids adapted to North Dakota.

Emphasis has been placed upon early maturity, adaptability to mechanical harvesting, lodging resistance and yield in developing these inbreds. Present breeding goals include development of inbreds with higher yields, adaptability to irrigated culture, improved protein and nutritional quality while maintaining acceptable agronomic attributes.

A substantial testing program is conducted to evaluate inbred line performance in hybrid combinations. At present six locations, including two irrigated sites, are utilized to test both experimental and commercial hybrids.

One particularly bright spot in the corn research effort has been the performance of corn under irrigation at Oakes. Evaluation of irrigated corn at Sheldon was started in 1958 and expanded in 1970 to include the Oakes site. This research is aimed at determining the potential of irrigated corn, which hybrids respond best to irrigated culture, and which inbred lines might have value in a corn improvement program to develop even better hybrids for irrigation in North Dakota.

Soybean Research

Soybeans grown at Fargo and sprinkler irrigated soybeans grown at Oakes indicate that early planting (May 10-20) with full season varieties generally will give highest yields.

The average frost date for a specific area is a good guide to use to determine the planting date for soybeans. Soybeans which have emerged before the average frost date will have better than a 50 per cent chance of injury due to frost. Delay after that date causes the loss of a part of the growing season.

Good weed control is imperative and may be most critical at the early planting, especially on wild mustard, which can cause up to 40 to 50 per cent reduction in yield. However, early planting may add $25 per acre to soybean profits in the Fargo area and $50 to $100 per acre if in narrow rows under irrigation at Oakes. Therefore, early planting with a full season variety and good control of weeds are prerequisites for maximum profits from soybeans.

High prices of soybeans last year renewed general interest in them as a cash crop in the Red River Valley. Anticipated 1973 yields from 500,000 acres in the valley would net the area about $35,000,000 (22 bushels per acre on 500,000 acres at $5.25 per bushel minus $45 per acre production costs). However, an added benefit may become more apparent with an extended energy crisis. Land preparation for crops following soybeans usually do not require high energy expenditures because the soil is "mellow". Therefore, fuel savings on last year's soybean ground may be more noticeable this year. For example, fuel consumption for tandem disking requires only about one-fourth to three-fourths the gallonage as for moldboard plowing. The energy crisis, also, has influenced the amount of ammonia fertilizer available, because the ammonia is a product of natural gas. Therefore, growers may consider more soybeans as an alternative to those crops requiring substantial amounts of added nitrogen to obtain profitable yields. Well-nodulated soybeans are able to utilize nitrogen from the air in sufficient amounts to yield 30 to 50 bushels per acre if other factors are optimal.

Seed Increase of New Varieties

During late 1972 and 1973, the North Dakota Agricultural Experiment Station released and named four new crop varieties; Ward durum, Beacon barley, Olaf hard red spring wheat and Sundak sunflowers.

Because an aggressive prerelease program is carried on in North Dakota through the cooperation

of the North Dakota Agricultural Experiment Station, the Extension Service, County Crop Improvement Associations and the North Dakota Agricultural Association, approximately 1,250,000 bushels of the new varieties will be available for planting in 1974. In addition, 200,000 to 250,000 pounds of cleaned seed of the rust resistant, high-yielding Sundak sunflowers will be available. The breakdown on the estimated field production is as follows; 600,000 bushels of Ward durum, 575,000 bushels of Beacon barley and 300,000 bushels of Olaf wheat.

If a prerelease increase of D6674 (now Ward) durum had not been made, only about 20,000 bushels would have been available in the fall of 1973 instead of 600,000 bushels. This represents a gain to North Dakota of slightly over $4,000,000.00 on the basis of $7.00 per bushel for commercial durum. Since this production is for seed, the income is still higher. In addition, about 400,000 acres of the superior Ward variety will be produced in 1974 instead of 16,000 acres. Similar comparisons of normal accelerated increase can be made regarding the other varieties mentioned.

In addition to making prerelease and early increases of the foregoing, the Seedstocks Project also provided ND140 (Beacon) barley in carlots for two years prior to release. Beacon is the first variety to have known acceptability for malting at the time of release.

As long as it is of benefit to the taxpayers of North Dakota, new varieties will be increased and released as rapidly and as reasonably as possible.

White Navy Beans — A Coming Crop?

Traditionally, the state of Michigan has been the largest supplier of white navy beans for soup processors. Because of urbanization and mounting production problems, a large supplier for the Stokely and Campbell companies started searching elsewhere for production.

Early in 1972, the Department of Agronomy at North Dakota State University was contacted and tests and planting resulted in the spring of that year. Approximately 1,500 acres were planted under contract. The Seedstocks Project undertook comparative tests of three navy bean varieties along with four pinto bean varieties for comparative checks. With the cooperation of A. H. Berg at Wyndmere and Jerome Holter at Hatton and the NDSU Department of Plant Pathology, the tests were planted at Fargo, Wyndmere and

Edible bean acreage in North Dakota increased to more than 100,000 acres in 1973.

Hatton. The favorable yields have resulted in the expansion of acreages and test plots in 1973.

During 1973, about 3,000 acres were under contract by farmers to the Lakeland Bean Company of Olivia, Minnesota. Performance tests were again carried out, but on a larger scale in several instances and at several more locations. The new locations included the Branch Experiment Stations at Minot, Carrington, Oakes and Langdon (hailed out) and another farmsite trial at Larimore.

All the data have not been analyzed yet, but indications are that the navy beans can compete very well with pinto beans in North Dakota, and both crops, barring a build-up of diseases, should have a very bright future here. Prices paid for navy beans will equal and generally exceed those paid for pinto beans. Thus, both crops, especially in the Red River Valley, merit very serious consideration both in regard to income and good rotations.

Pinto Beans in North Dakota

With increased world demand for foods rich in proteins, processors and producers are looking to North Dakota for help, particularly in the Red River Valley. From recent studies by the North Dakota Agricultural Experiment Station, it appears that field beans can be grown in low rainfall areas as well as under irrigation.

Pinto beans have increased from 30,000 acres in 1968 to 75,000 acres in 1973. Even at $7.00 per hundred weight, pinto beans have been a high income crop with an average yield of 1,200 pounds per acre in 1972. Experienced producers produce 2,000 pounds per acre readily.

Because of precedent, all seed stock until recently has been shipped in from Idaho and other inter-mountain states by contracting companies. The Seedstocks Project considered that production of disease-free seed was feasible in North Dakota and started trial production in 1967. Since then, with cooperation from the NDSU Department of Plant Pathology and the State Seed Department, Foundation bean seed has been produced annually. Today Foundation seed of three pinto bean varieties is available through the Seedstocks Project; namely, U of I 114, Wyo. 166 and Ouray at less expense than shipped-in seed.

The State Seed Department does not allow any tolerance of disease in the Foundation stock. This means that not a single diseased plant can occur in a field that is being grown for production of Foundation seed. Such seed produced and processed in North Dakota should be equal in freedom from disease to any that can be purchased and at a reasonable price.

Simulated Hail Research

Very few research projects have a more direct effect on the producer than the simulated hail projects which are partially funded by the Hail Insurance Adjustment and Research Association (HIARA) and the Crop Insurance Research Bureau (CIRB). Crop damage caused by hail in North Dakota has been estimated near $15,000,000. Obviously, equitable and accurate financial adjustment is beneficial to both farmers and hail insurance companies by keeping rates at a reasonable level and by paying actual losses.

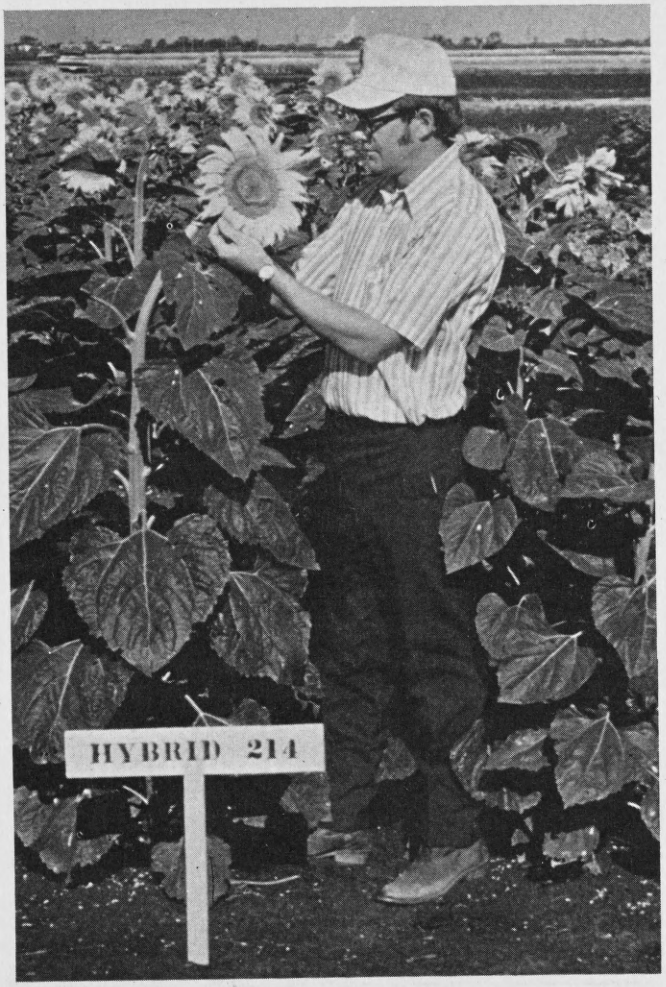
Small grain loss charts developed from simulated hail research data have been used by hail adjustors for about five years. These charts are being improved as more research results are obtained. Loss charts used in North Dakota previously were based predominantly on Oklahoma data. The effects of hail on winter wheat in Oklahoma may be quite different than the effects on spring wheat or barley in North Dakota.

Simulated hail studies on both spring wheat and barley have been conducted across North Dakota in order to sample as many different environments as possible within the financial limits of the studies. These results have allowed the development of more accurate loss charts for adjusting hail damage to wheat and barley in North Dakota.

Hail damage at various stages of growth can be predicted by using accurate loss charts if weather conditions are normal. Because weather is rarely normal, trained and informed adjustors are a **must** to compensate for the unreliability of the weather. Hail adjustor workshops have been held at NDSU to help supply the need for continued information required by hail adjustors to do an adequate job of accurately adjusting individual losses.

Perennial Weed Control

The research program for control of perennial weeds was started in 1971. The greatest emphasis



Dr. G. N. Fick looks over one of the hybrid sunflower varieties that he is studying.

is for control of leafy spurge and field bindweed (commonly known as creeping jenny). Other perennial weeds being studied are Canada thistle, perennial sowthistle and quackgrass.

Postemergence herbicides such as 2,4-D and dicamba applied in September have been more effective than June or July treatment on leafy spurge, field bindweed and Canada thistle. In some cases, the fall herbicide application has been twice as effective as the spring treatments and more than 95 per cent of the established perennial plants have been killed. Rates of fall applied 2,4-D that have effectively controlled field bindweed are 1.5 to 2 pounds per acre; this is a six-fold to eight-fold increase over the 1/4 per acre rate that farmers use for general weed control. The cost of the 2,4-D treatment at $2 to $3 per acre including application is economical considering that only low yields of grain are obtained where field bindweed patches grow.

Picloram (Tordon) is an effective chemical for leafy spurge control in pastures, but the chemical is water soluble, degrades slowly in soil and is toxic at very low concentrations to broadleaf plants like alfalfa, sunflowers and garden vegetables. Studies are in progress to determine whether more extensive use of picloram in North Dakota would be environmentally unacceptable due to leaching into ground water or runoff into waterways, ponds or untreated fields.

Work On Complete Weed Control

Weeds affect everyone. They may poison or seriously affect the growth of livestock. They cause allergies such as poison ivy and hay fever, resulting in high absenteeism from jobs and school. They infest home lawns and gardens. They create problems in recreation areas such as golf courses, parks, boating and fishing areas; they are

Dr. John Nalewaja and colleagues study controls for wild oats, the state's worst weed pest that cost North Dakota farmers nearly $200 million last year.

pernicious along roadways, railroads, in industrial areas and near airport landing fields. They choke irrigation and drainage systems, and their control is one of the most expensive steps in the production of food and fiber.

For North Dakota farmers, weeds are a yearly foe which must be dealt with seriously, and efforts to keep crop yield losses from weeds to a minimum "pay off" well. Further, harvesting interference, dockage in grain, tainting of milk and flour are also manifestations of weeds in agricultural fields.

The Department of Agronomy weed control research group has contributed a tremendous amount of beneficial information to help farmers minimize their economic loss from weed infestation. Weed control research is directed at recognizing and evaluating weed problems and potential weed problems in the state and at resolving these problems by various research methods.

Research involves a study of weed biology, herbicide screening, advanced testing and development of herbicides; crop response to herbicides, edaphic and climatic factors influencing herbicide action, and physiological factors of herbicide action; and systems of weed control which includes tillage practices and competitive ability of various crops with weeds. The research is conducted mainly at Fargo and Casselton with advanced testing at most of the Branch experiment stations in the state.

Weed control research is a coordinated effort involving field, greenhouse and laboratory type experiments. Some experiments are conducted in cooperation with various plant breeding and plant physiology projects and with staff of the USDA Metabolism and Radiation Laboratory on the NDSU campus.

The major weed control effort has been directed toward wild oats control. However, general weed control research in small grains, sugar beets, sunflowers, soybeans, flax, corn and potatoes also has been pursued as well as perennial weed control on rangeland and in non-crop areas.

Research is conducted on environmental conditions as they influence the performance and uptake of herbicides with the goal of obtaining more consistent weed control or for a possible reduction in the amount of a herbicide needed to obtain control. Research with additives to sprays is conducted to increase the retention and uptake by target plants and thus also possibly reducing the amount of herbicide needed for effective control.

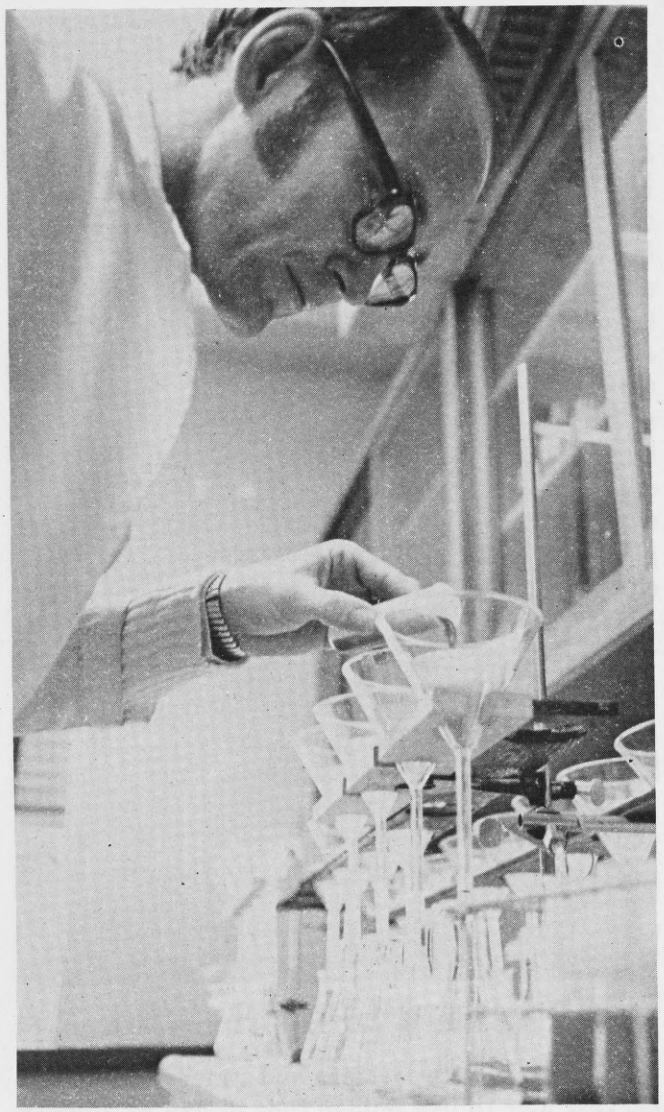
Weed control research involves an effort to develop a complete system of weed control involving cropping practices, tillage methods and the use of herbicides as related to a crop-weed interaction. For example, research found that wild mustard which emerged eight days before soybeans caused twice the yield loss as wild mustard emerging with the soybeans. Further, wild mustard emerges much more rapidly than soybeans with low temperatures. Thus, under these conditions, a harrowing prior to the soybean emergence can reduce losses by controlling the early emerging wild mustard. Preemergence or postemergence harrowing also is necessary when climatic conditions cause herbicide failure.

Another example of relating weed biology to control is that wild oats seed produced under hot dry conditions was found less dormant than seed produced with cold wet conditions. Thus, a shallow post harvest tillage would promote germination and elimination of the seed in the year of production, assuming fall rains. On the other hand, with cool summer temperatures, post harvest tillage would be of no benefit.

Forage Management Research

North Dakota farmers and ranchers annually harvest four to five million tons of hay as a cheap energy source for ruminant livestock. Alfalfa or predominantly alfalfa-grass mixtures constitute about half the total tonnage. Alfalfa hay acreage has increased in recent years as producers recognize its superior forage and protein production potential. Forage management research is designed to enable forage producers to increase their production of a high quality forage to meet the demands of an expanding livestock enterprise. For example, alfalfa management trials indicate that timely harvest and stand rotation every three to five years could increase productivity approximately 50 per cent.

The value of nitrogen (N) fertilization on tamegrass productivity has been well documented. An old bromegrass sod fertilized annually since 1954 at rates up to 266 pounds of nitrogen per acre has shown that 66 pounds of nitrogen per acre doubled the forage and protein production of nonfertilized bromegrass. Soil samples at six-inch intervals indicated that little nitrate-nitrogen had



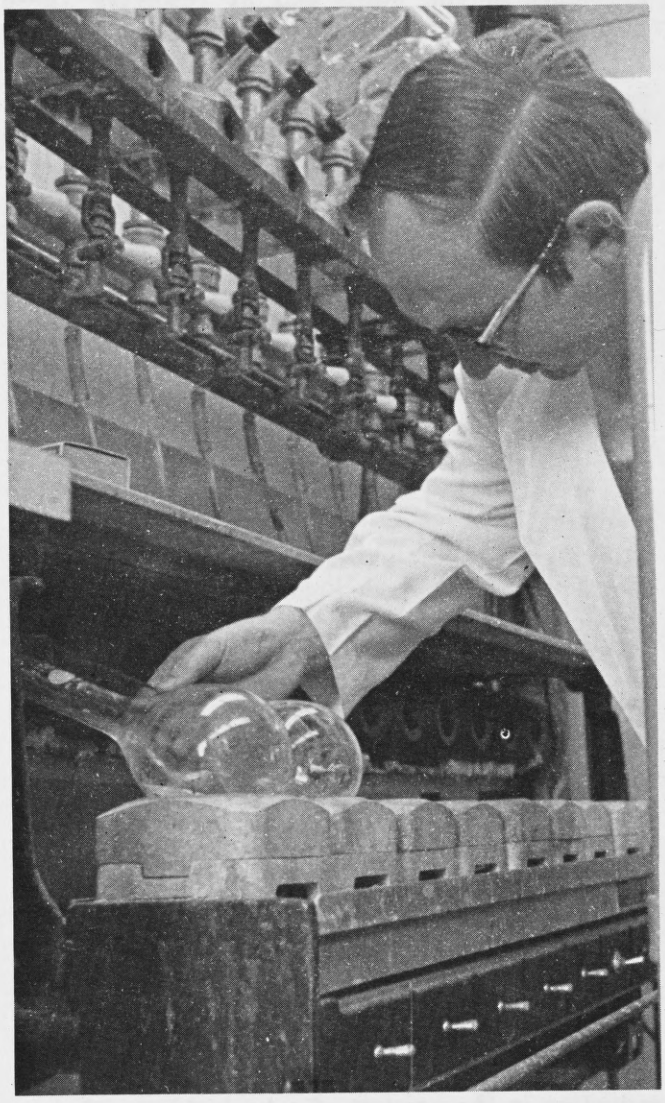
Dr. Dwain Meyer filters a forage sample to determine its digestibility.

accumulated in the top four feet of soil under the 66 pounds of nitrogen per acre treatments, but substantial nitrate - nitrogen accumulation had occurred under 200 or 266 pounds of nitrogen per acre treatments. No apparent accumulation was found below the rooting depth in the fine-textured, Fargo clay soil. The influence that long-term fertilization at high rates may have on micro-nutrient concentration, nitrate content and digestibility of the forage are areas of current research efforts.

Another phase of forage management research has been in determining the influence that management has on forage quality. Forage quality is being determined by the **in vitro** dry matter digestibility (IVDMD) technique, in which the rumen digestive action is simulated in a test tube to estimate the energy fraction, and by important nutrient constituents such as protein content. Such trials have indicated, for example, that alfalfa harvested three times annually at one-tenth bloom had a 10 per cent greater IVDMD and produced 230 pounds more protein per acre (valued at $30 per acre when soybean oil meal cost $260 per ton) as compared to alfalfa harvested twice at full bloom.

Feed Value Of Grains

Many factors contribute to the variations in feeding value of grains that livestock producers often notice. Differences in grain varieties and in production practices may influence feeding value, but there has not been much information concerning these variations.



Dr. Robert Harrold chemically digests feed grain samples to determine their protein content.

A project has been underway at NDSU, involving animal science, agronomy and cereal chemistry and technology, to determine the importance of variety and production variables as factors contributing to variation in feed value of feed grains.

The highly favorable 1972 crop year produced oats and barley samples which had nutrient values greatly in excess of published values of nutrient composition. Conditions in 1972 were highly conducive to production of high quality grain, and analysis of North Dakota oats and barley produced that year indicate these grains were considerably more valuable as feed than is commonly recognized.

Considerable variation was found in protein content of oats. This variation could be attributed to where they were produced and variety. There was also variation in protein content of barley samples, but these were associated primarily with production location. The practical value of the differences in oats varieties is being determined by feeding laboratory animals.

Varietal differences in nutrient composition could be important to producers in deciding varieties to plant and to plant breeders with the possibility of developing grain varieties with higher feeding value.

Feed grain evaluation is a continuing project, and grain from the 1973 crop year is now being analyzed.

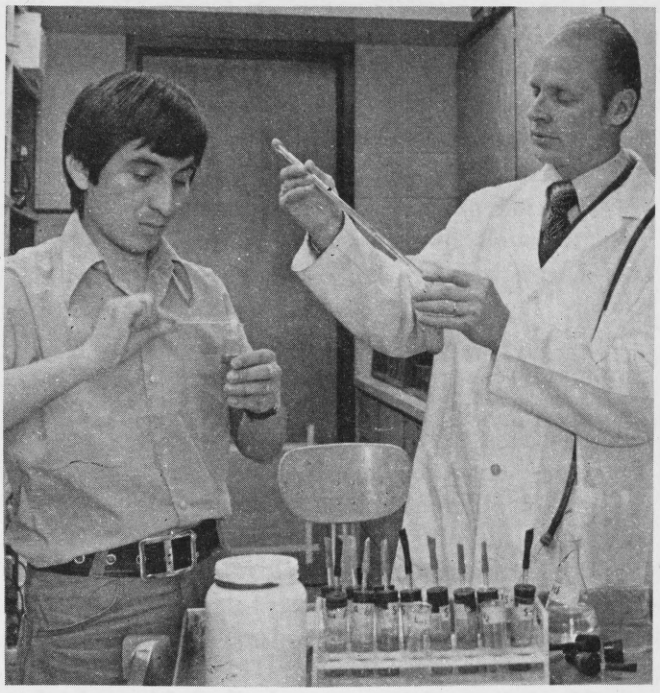
Evaluating North Dakota Forages

Producing forage for ruminant animals—beef cattle, dairy cattle and sheep forms a large part of North Dakota's agriculture. Forages of many types are produced, harvested and processed in many different ways. Researchers at NDSU are involved in evaluating these forages and determining differences in species and production practices.

This is a continuing cooperative project involving animal science, soils, agronomy and botany.

One aspect of the project involves analysis of several native species from the Sheyenne Grasslands, as well as several range management techniques.

Several thousand samples, both native and tame species, are analyzed in the animal science laboratories each year. This forage analysis, coordinated with forage production and range management factors, should help provide information on optimum management to produce both tonnage and quality of forage.



Gilberto Tenesaca, animal science graduate student from Ecuador, and Dr. Duane Erickson run laboratory measures of forage digestibility as part of forage evaluation research.

Protein Levels For Swine

Utilizing home-grown feed grains for growing-finishing swine in most cases is a practical way to raise hogs. Most cereal grains need to be supplemented with some protein source to bring the protein content of the ration up to the level necessary for efficient performance. With protein supplements currently very expensive, however, there may be a natural tendency on the part of many producers to skimp on protein levels.

Swine nutrition trials at NDSU have been conducted to establish the cheapest and quickest way to raise a 40-pound feeder pig to a 220-pound butcher hog and best utilize North Dakota feed grains.

One project was undertaken to determine to what weight various feeds should be fed. It is generally recommended that a 16 per cent protein ration be fed to 80-100 pounds, then a 13.5 to 14 per cent ration to market weight. However, if protein levels could be cut without impairing the growth rate of the pig, some savings in feed costs

might be achieved. This project also evaluates the addition of supplemental lysine, the major limiting amino acid in cereal grains, to barley rations. None of the treatments limiting protein performed as well as the recommended levels in either growth rate or cost of gain.

Another project is being conducted comparing various levels of commercial protein supplement added to a basal ration of corn, oats and barley. Results should demonstrate what happens when producers cut back on recommended levels of supplementation.

Another project now underway is designed to evaluate oats, barley and alfalfa in gestation rations for sows; study the levels of protein in gestation rations for efficient and profitable production; and measure the effects of methods and levels of feeding on reproductive performance.

Composition of Pork Muscle

Nutritionists have generally assumed that ration composition has minor effects on the amino acid content of muscle, and that the nutritional value of two similar-appearing roasts or chops was essentially the same. Recent evidence obtained from laboratory animals and swine, however, suggests that this might not be completely true.

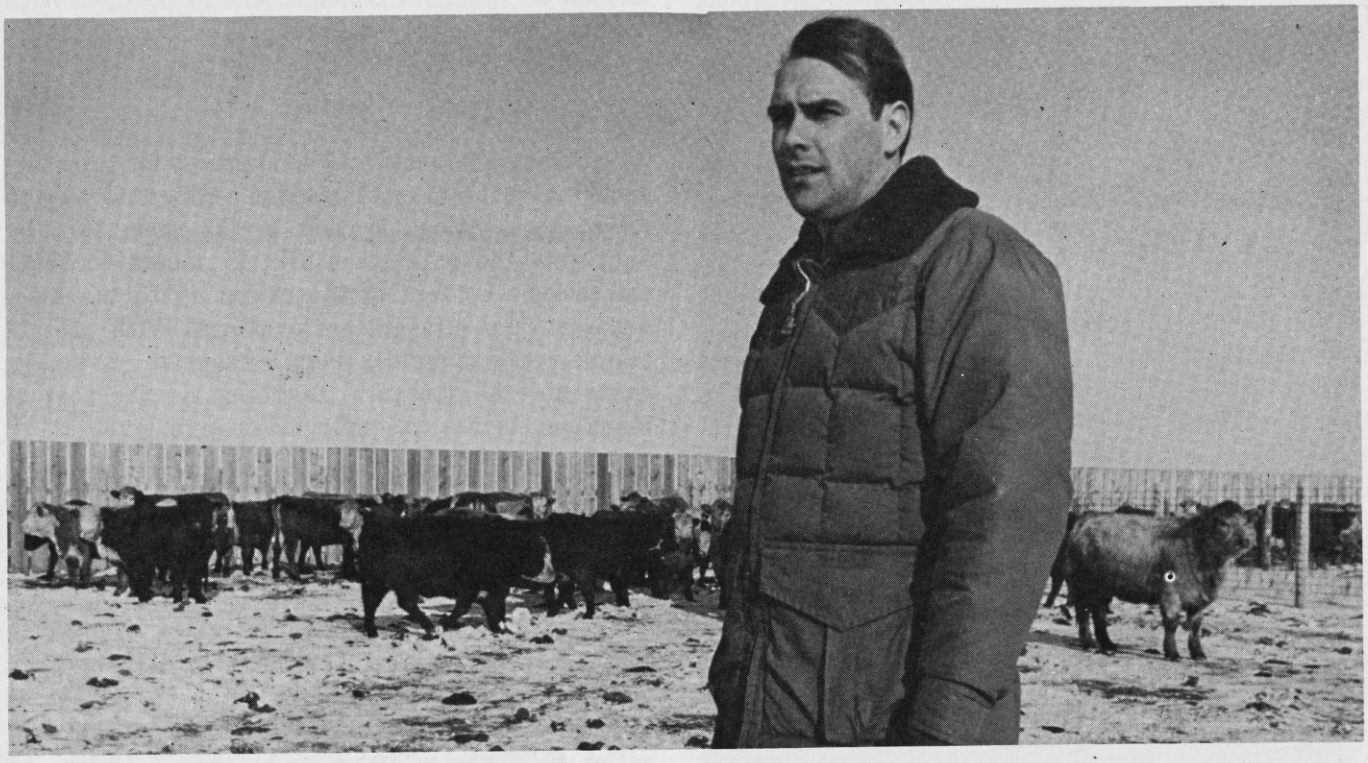
This evidence led to an animal science project to determine if imbalances in dietary protein and amino acid levels fed to swine will alter the amino acid composition of pork muscle tissue.

Rations formulated to be deficient in single amino acids as well as diets involving multiple amino acid deficiencies are being fed. Animals will be started on the experiment at about 50 pounds and will be removed at individual weights of 210 pounds. Carcass data is collected at slaughter, and tissue samples collected for analysis of amino acid composition.

Results of this project, in conjunction with other research in progress, are demonstrating that producers following recommended feeding practices are producing a superior product more economically. Evidence that nutrition can alter the amino acid composition of muscle could have wide-ranging implications for both animal and human nutritionists.

Crossbreeding In Beef Cattle

Consumer demand and increased production costs have caused a shift in the type of cattle demanded by various segments of the beef industry to improve production efficiency.



Russell Danielson, animal scientist, looks over a group of crossbred heifers in the NDSU beef cattle crossbreeding program designed to evaluate the productive and reproductive traits of crosses between exotic, dairy and the conventional beef breeds.

The cow-calf operation must produce a fast-growing, heavy-weaning calf that will finish rapidly and efficiently in the feedlot, allowing a profit to the producer. The animal must yield a carcass with a high percentage of red meat with acceptable quality at the desired weight to provide a profit to the packing industry. Most important, this product must satisfy consumer demands.

The NDSU Animal Science Department is now in the fifth year of a beef cattle crossbreeding program to evaluate the reproductive and productive traits of crosses between new European ("exotic") beef breeds, a dairy breed and the conventional, established beef breeds.

Angus and Hereford cows from the NDSU beef herd are being used to establish breeding groups of crossbred cows. Charolais and Brown Swiss sires have been mated to these cows to produce crossbred females, and a group of Angus cows is being bred to Hereford bulls to produce the black-white face cross to be used as a trial control.

Each first-cross breeding group is being mated to sires from both foundation breeds to establish backcross breeding groups, which are being mated to a third breed as a terminal cross. The Simmental breed will be used as the third breed when a 7/8 blood Simmental bull reaches breeding age.

All calves are weighed and scored at birth, at weaning and as yearlings. Replacement heifers are weighed and scored at 14 months of age, while steer calves and terminal cross heifers are moved to finishing barns at weaning and fed until slaughter weight or 16 months of age. Feed efficiency and growth rate data will be determined, and carcass data will be obtained at slaughter.

Performance of the cow herd is recorded on all females in each breeding group to estimate relative reproduction efficiency. Information recorded includes type and ease of delivery, calf weight, age at first exposure to the bull, age at first breeding, calving interval, weight of calf and quality score of the calf. Females involved in this study are culled from the experiment only because of injury, disease or reproductive failure.

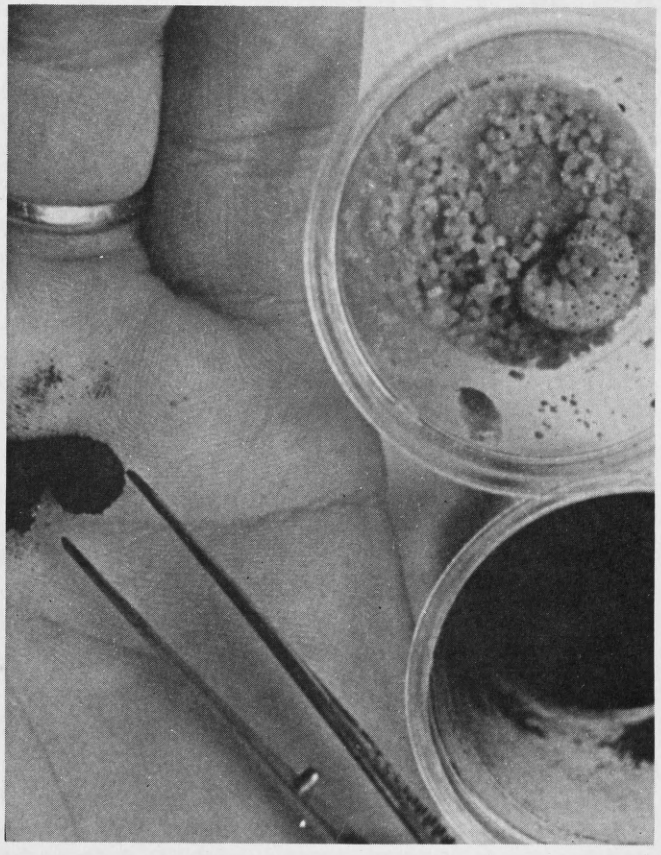
This project is about at its mid-point, so preliminary data only are available to date.

Insect Rearing Molds

Research in methods of controlling insects requires cultivating large numbers of insects under laboratory conditions. The artificial media used are also excellent for mold and bacteria growth. Growth of these contaminants must be controlled while the insect progresses through the stages from egg to larva to pupa to adult. Experts report that a 20 per cent saving in rearing costs would result from determining a cheap and effective control method.

Antibiotics generally are effective to control bacterial growth. Research results in a cooperative project between the Department of Bacteriology and entomologists at the Metabolism and Radiation Laboratory indicate that antibiotics can be used in smaller amounts than in most media recipes. If borne out in further testing, this factor would result in considerable saving.

Molds, however, are a more difficult microorganism to control than bacteria. Molds are not affected by the same antibiotics which inhibit bacterial growth. Chemicals such as are used to control molds in food are most often used, and they are expensive. The problem mold in most laboratories is **Aspergillus niger.** This is a common



Normal, uncontaminated larva grows on nutrient media at top. Larva contaiminated with mold (at end of tweezers) was grown in the bottom container.

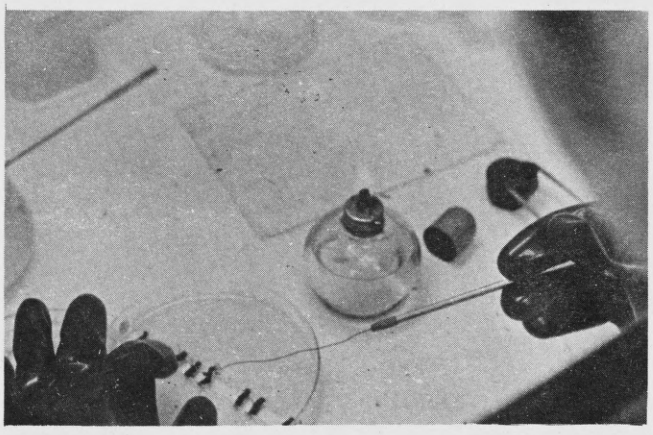
mold, but the isolates found in rearing laboratories are more resistant to the chemicals usually used than the wild types of this species.

About 30 antifungal agents were obtained for testing against this resistant strain of **A. niger.** Six drugs survived initial screening and then were tested to determine if they were still effective while larvae were being reared on the media containing them or whether they adversely affected the larvae themselves. Chemicals currently used in insect rearing media are completely effective until the larvae are present. Apparently the larvae consume and alter the antifungal chemicals. The molds usually are observed growing on their feces.

The test insects in the mold research are the tobacco budworm and the cabbage looper. The larvae are grown in small plastic cups with caps where they are incubated. The antifungal chemical must not interfere with any of the stages as the insect matures. At least one of the chemicals tested so far has proved highly effective and work is continuing on this and others.

Controlling Leafy Spurge

Leafy spurge (**Euphorbia esula** L.) is a perennial dicotyledonous weed that occurs in North Dakota fields, pastures, roadsides, and other waste areas. It is widely distributed in the northern United States from Maine to Washington and as far south as Nebraska and Colorado. Leafy spurge often spreads slowly, but is difficult to eradicate once established since its deep and extensive root system bears numerous underground vegetative buds. Upon removal or death of the shoot system, root buds are generally released to produce several new and more extensive shoot systems.



Botanist Dr. Murray Duysen checks root sections of leafy spurge in a sterile hood which have been treated with various levels of plant hormones. Researchers hope to break down inhibiting factor of hormones, allowing fall control of leafy spurge.

Limited research on leafy spurge in the Department of Botany at North Dakota State University has been concerned with developing a better understanding of controlling the start and then restricting growth of buds that develop on the root system. Strong herbicide treatment often kills leafy spurge, but many times harms desirable plant species as well. Some herbicide applications kill the spurge shoot system but not the root system, nor the root buds, and could contribute to spread of the weed if a repeated herbicide treatment program were not established.

At present, preliminary studies are underway in the Department of Botany by plant physiologists to determine the feasibility of developing a research program on the hormonal control in the initiation and restriction of leafy spurge root bud growth and shoot development. Of particular interest are studies emphasizing the role of natural hormones and the change in hormone balance in restricted and growing root buds. These physiologists have found and described seasonal changes in levels of bud activity arising from the roots which constitutes the large potential for regeneration of spurge infestation.

It is desired that these studies lead to the development of methods whereby the natural spurge homonal balance might be manipulated to release the normal growth restricted root buds. Death of the subsequent developed shoot system would then be accomplished by herbicide treatment, shoot removal, or perhaps frost.

Grain Quality Studies

Much work in the Department of Cereal Chemistry and Technology is devoted to cooperative investigations with the Departments of Agronomy and Soils in the development of new wheat and barley varieties for North Dakota. During this past year, new varieties of hard red spring wheat, durum and barley were released as a result of this program.

Hard Red Spring wheat grown in North Dakota is of the highest quality and is in demand by customers not only in the United States but throughout the world as well. North Dakota usually produces 50 to 55 per cent of the entire United States HRS wheat crop. The 1973 North Dakota

production has been estimated at 174 million bushels, an increase of about 25 million bushels from last year. It is imperative that a program be maintained for the development of high quality varieties. It is anticipated that when a surplus of all wheats develops, the high quality wheats will again demand a premium in the market place.

Export and domestic demand for high quality durum wheat has shown a continuous growth over the last 10 years. Although the potential for durum usage appears to be even better as food shortages from other sources develop, there is still a sharp competition among the world producers to supply durum wheat to the world market. Therefore, in addition to studies designed to develop high quality durum varieties to maintain North Dakota's position in the market, a study was recently initiated to seek new uses of durum wheat.

Through a $230,000 two-and-a-half year grant made available by the National Wheat Institute, Washington, D.C. and the North Dakota Wheat Commission, the Department of Cereal Chemistry and Technology will attempt to develop new pasta products. Funds provided will permit the hiring of several scientists to help conduct the research, and the purchase of a number of equipment items for food processing studies. Equipment of this kind can be utilized for future wheat quality studies.

Part of the work on high protein macaroni products is conducted through a grant from the National Wheat Institute and the North Dakota State Wheat Commission. The project in the Department of Cereal Chemistry and Technology seeks to expand foreign markets for durum. Technician JoAnn Bell readies high protein spaghetti for the dryer.

The research also is aimed at devising processes for the production of acceptable pasta products having higher nutritional value and better eating properties than those presently on the market. A number of manufacturers presently are producing a high-protein macaroni product for use in the school lunch program. These products are usually made with corn and soy flour and are inferior in cooking quality, texture and general consumer acceptance to conventional durum wheat macaroni.

Research is being conducted to determine the role of durum wheat protein in pasta (spaghetti) cooking quality. For many years, the mixing properties of durum gluten has been measured as an indication of the firmness or resistance to "bite" of the cooked product. Currently, research is being conducted to study the relation of durum protein composition and mixing characteristics. The results indicate that protein content may have a greater influence on the cooking characteristics of pasta than mixing properties or protein composition.

In cooperation with the North Dakota State Wheat Commission and the North Dakota Cooperative Extension Service, the Department of Cereal Chemistry and Technology conducted a HRS and durum wheat quality survey of the 1973 crop. The overall quality of HRS wheat was considered to be very good to excellent. It was estimated that 84 per cent of the crop should grade U.S. No. 2 Dark Northern Spring or better. The average wheat protein content was 14.6 per cent, which was 0.6 per cent higher than the 1972 crop. The wheat milled satisfactorily with a high flour yield. The baking and mixing properties of the flour were considered to be excellent. In general, the quality of the 1973 durum crop was considered very good. However, an estimated 2.6 per cent of the total crop showed sprouting. An estimated 66 per cent of the crop will grade U. S. No. 2 Hard Amber Durum or better. On the average, the crop will produce spaghetti slightly lower in color than the 1972 crop, but will show improved cooking properties.

Triticale is a man-made cereal that is produced from durum wheat crossed with rye. Triticale grain is reported to be a good source of protein with fairly high lysine content. Bread of acceptable quality has been produced from blends of triticale flour with wheat flour. Recently several workers have reported producing bread with 100 per cent

triticale flour when using modified baking procedures.

Spring triticale varieties that may be grown in North Dakota were milled into flour, bran and shorts. The yield of flour was lower than for wheat. Flour protein content was similar to wheat and flour ash a little higher. Grain and flour protein was found to be of a higher nutritional quality than wheat protein. Triticale bran and shorts mill fractions were high in protein content and the protein was of a high nutritional value. However, triticale flour dough had weak mixing properties and low water absorption. Reasonably good bread was baked from 50:50 triticale-wheat flour blends.

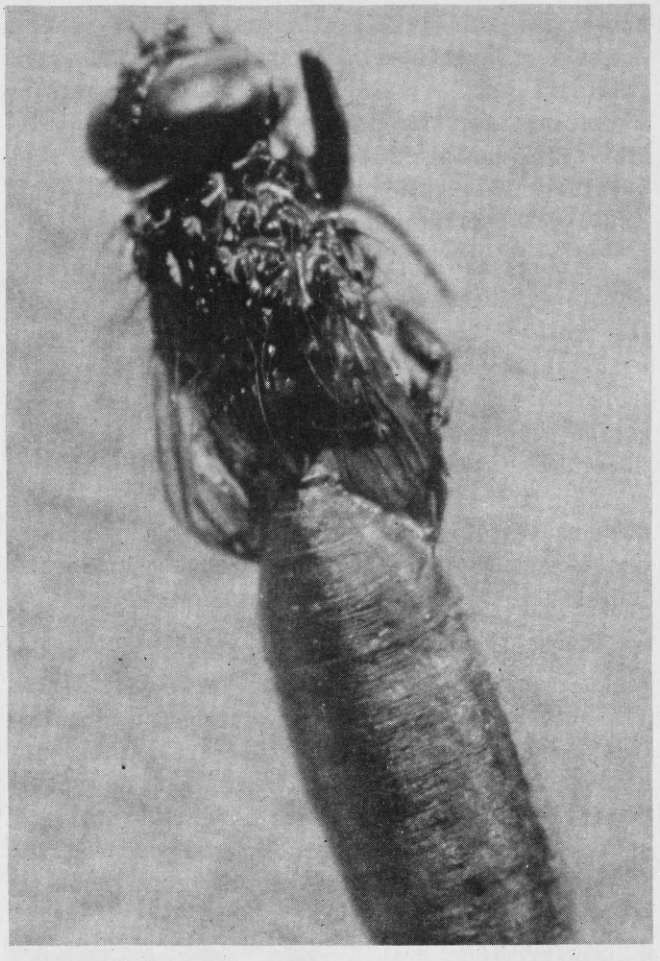
Basic research studies are conducted on grain components to learn how these various fractions affect the eventual use of the grain. A number of research projects involved the major component of wheat, the carbohydrates. Although the amounts of pentosans found in wheat flour (2 to 3 per cent) is retatively small, considerable work has been devoted in the department to investigate this carbohydrate component. This particular poly-saccharide material is able to absorb high amounts of water resulting in extremely viscous solutions. Such a property may result in this constituent having a definite effect on dough properties and baking characteristics. The effect of pentosans in baking, an investigation of the pentosans associated with gluten, a comparison of pentosans extracted from conventional and continuous bread, and changes in pentosans as a result of durum processing are some of the areas that have been examined.

Starch, the major carbohydrate component present in wheat flour, also has been the subject of several studies. The effect of various starches in baking as well as the affect of bread ingredients on starch gelatinization properties and the effect of bread ingredients on bread crumb characteristics have been studied.

A study also conducted during the past year involved a comparison of the carbohydrates present in conventional height wheats with those present in semidwarf wheats.

Non-Toxic Insect Control

Though synthetic organic insecticides have found an established place in world economy, their continued extensive use is posing ecological threats which could not be foreseen earlier. Efforts are now being made to develop highly selective non-toxic



Alternative approaches to insect control include non-toxic materials that disrupt the life cycle of the insect, such as this fly which cannot escape from the pupal case.

materials which interfere with the development and behavior of insects. This type of research which was started by Dr. M. Sayeed Quraishi in the early '60's has been well received in scientific literature.

The New Scientist of London, England in 1965 commented,

> *"The workers conclude that the search for insecticidal compounds, hitherto centered around highly toxic substances, should become more sophisticated biologically. We should look for compounds, which though not toxic against some stages of specific pests, may upset the balance of certain processes, either being lethal or sterilizing any survivors."*

One such chemical being tested is 4-nonanol. When house fly larvae are treated with this chemical they are not killed and the development proceeds apparently normally until the fly starts emerging. The emergence is not completed and the adult fly is unable to escape from the pupal case. This indicated that chemical **per se** is non-toxic to

life in the sense that death is not brought about as a result of the toxic action of the chemical, but because the adult is unable to free itself.

Olethreutid Moth Studies

Insects infesting sunflowers have become economically important with increased production of sunflowers as a cash crop in Eastern North Dakota.

One of the insects of potential economic importance on sunflowers is a small grayish moth, **Suleima helianthana,** commonly referred to as an Olethreutid moth. Larval damage caused by this moth is easily recognized since the larva deposits large amounts of black frass at the entrance hole into the sunflower plant. Infestations usually occur in young plants by mid-June and larva generally enter plants at the leaf axils or through terminal buds. Sunflower plants often outgrow the damage; however, infestations of terminals may cause reduced yields.

Graduate student Bob Ehart, who conducted research on the Olethreutid moth, observes damage in research plot. Such damage strikes about 16 per cent of the plants where the moth is present.

Although populations of this Olethreutid moth are not yet significant enough to merit control programs, North Dakota State University entomologists have been studying the seasonal history and economic importance of this insect. Hopefully, control practices can be established before economic infestation levels are reached.

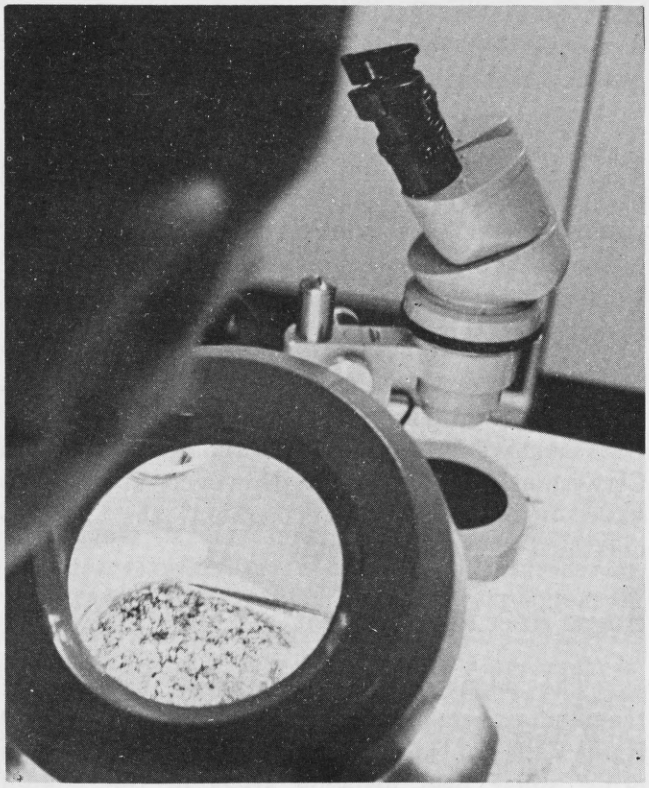
The most significant populations of this Olethreutid moth have been observed in Traill and Cass counties in North Dakota and in Norman and Clay counties in Minnesota. However, infestations have been recorded throughout the eastern one-third of North Dakota.

Sugar Beet Root Maggot

The sugar beet root maggot has caused tremendous economic losses to growers in the Red River Valley of North Dakota and Minnesota and in other sugar beet growing areas of the United States and Canada. At present, producers are relying entirely on insecticides for control. The probability of resistance developing in the insect, future regulations regarding toxic materials and manpower, and the high cost of some of these materials suggest that other avenues of control should be investigated.

In North Dakota and Minnesota, three new beet processing plants are presently under construction, which will service in excess of 100,000 additional beet acres. Much of the new acreage is composed of the lighter soil types into which the maggot easily adapts. Extensive laboratory research is being conducted on all phases of the insect's biology, physiology and life cycle to develop the basic knowledge necessary for a successful control program.

Artificial diets for the maggot are being modified and improved to produce normal, healthy insects. This has been the most difficult phase of the research because this insect has very specific nutritional and physical requirements which must be provided for optimal development. Procedures and equipment for adult handling, adult feeding and egg deposition have been developed. This enables NDSU researchers to have large numbers of adults, eggs and young larvae available on a year-around basis for experimentation and for further diet work.



A larval rearing medium for sugar beet root maggot has been developed. Synthetic insect rearing broadens the scope of research.

Preliminary studies on adult development under varied environmental conditions indicate that accurate predictions of adult emergence in the field can be made. The physiological stimuli which aid the insect in locating a suitable host, and the conditions necessary for eggs to survive and hatch are other aspects of the insect's life cycle which, when understood, may lead to more efficient and economical control practices. Laboratory research on the structure and function of the endocrine system should provide a fertile field of investigation for future control possibilities.

Release Three New Vegetables

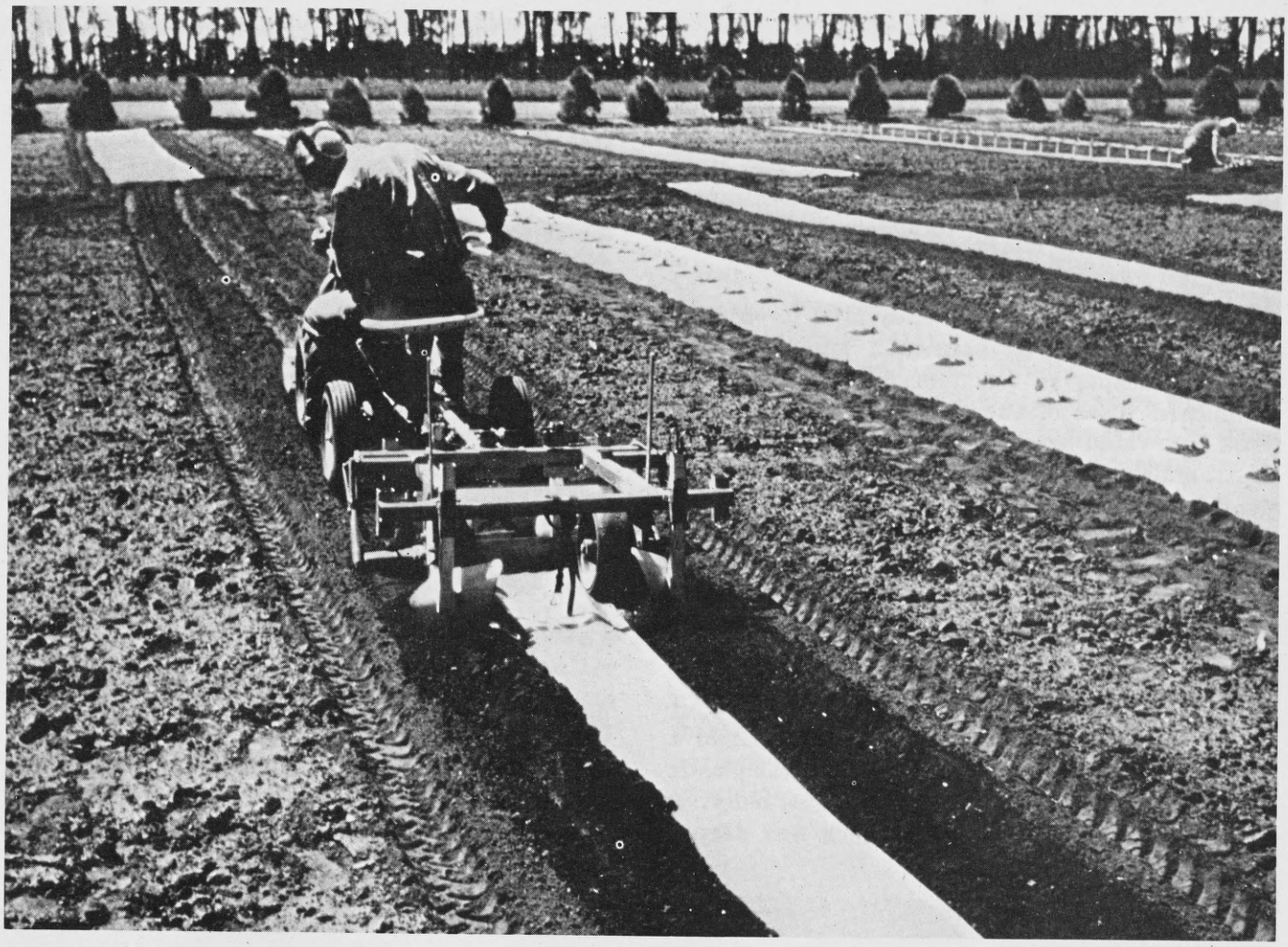
In 1973, the Department of Horticulture announced the introduction of three new vegetable varieties: Lark and Cannonball tomatoes and Emerald squash. The two tomatoes are the 18th and 19th varieties introduced from the tomato breeding program started in 1920. The three varieties are the result of 13 or more years of crossing, selecting and testing.

Lark was derived from a cross of Cavalier with Immune Prior Beta II (a small fruit German variety) and backcrossed three times to Cavalier. It is an early maturing determinate tomato with a very prostrate plant habit. Based on three years trials (1970, 1971, 1972), Lark fruits averaged 3.0 ounces compared to Early Chatham with 2.3 ounces per fruit.

Cannonball resulted from a cross of Sheyenne with a very late, large, rough-fruited tomato from Italy (seed was brought from Europe by a returning World War II serviceman). Cannonball has a determinate plant habit and matures its fruit about five days later than Sheyenne. The fruits are deep, globe-shaped and very large. Based on three years of trials, Cannonball fruits averaged 6.4 ounces compared to Sheyenne with 4.0 ounces per fruit. Both varieties are recommended for home garden and market garden uses.

Cannonball tomato was one of three vegetable varieties introduced in 1973 by the NDSU Department of Horticulture. This large-fruited tomato is adapted to the northern plains area.

Emerald squash was derived from a cross of Bush Buttercup with a small fruited, green-skinned selection having the bush plant habit. The bush plant habit of Emerald enables it to be grown in very limited space and eliminates the 20-foot vines common to squash plants. Emerald fruits are attractive grey-green and shaped like Buttercup (may have a turban). The thick orange flesh has very high quality and the seed cavity is small. Emerald has a storage life longer than Buttercup and each fruit provides four to six servings.

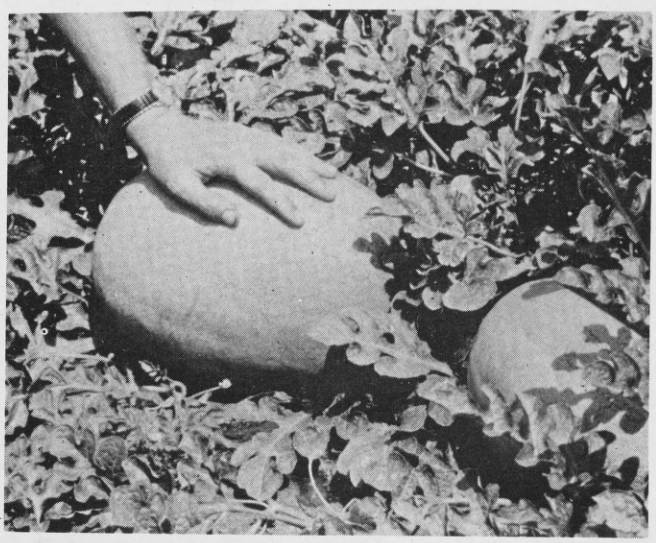


Polyethylene sheeting is being laid as a mulch in watermelon tests at the NDSU horticulture plots at Oakes. Tests are in progress to determine the most desirable width of plastic mulch for use under watermelons. Dr. Earl Scholz is in charge of the research.

Using Plastic Mulch In Gardens

Market gardeners at Oakes and Wahpeton are finding profit in producing watermelons with methods developed by the Department of Horticulture at North Dakota State University. Previous success in watermelon growing was limited because watermelon plants could not be grown to mature size by early July, the only period when temperatures are high enough for effective pollination.

Cold soils cause watermelon vines to grow slowly and thus prevent early planting. A solution to the problem was to cover the soil with clear plastic which helps the sunlight warm the soil. Additional time is gained by growing seedlings for 18 days in the greenhouse before transplanting to the mulched field. Watermelons aided in this way mature in early August; sometimes a second set of fruit matures in September and doubles the yield.



Top Yield, a Japanese Hybrid, is the basis of a developing watermelon industry in North Dakota. In August 1973, mature watermelons weighing 28 pounds were a common sight at the NDSU test plots, Oakes.

Plastic Mulched Trees

In Department of Horticulture research, trees mulched with plastic showed superior growth the first couple of years. However, beyond that time the trees did no better than any other treatment. The plastic mulch seemed to waterproof the area during heavy rains.

Some of the trees were excavated to observe the root growth. The excavated mulched trees showed a deeper root system, as compared with unmulched trees of the same species. The first trees excavated were Green Ash No. 50, with plastic mulch treatment and tree No. 44, cultivated and dry treatment (no additional water except for rain and snow melt). American elms with a rather shallow root system were excavated to observe root growth: tree No. 264, plastic mulch treatment and tree No. 266 cultivated and watered treatment (watered with about 20 gallons whenever the site appeared dry).

Green Ash No. 50 with plastic mulch had a good root system near the surface where the plastic conserved moisture. As the tree got older, a deeper root system developed which was deeper and more fibrous than tree No. 44, with a cultivated and dry treatment.

American Elm No. 264 with the plastic mulch treatment showed a very shallow fibrous root system and a deeper root system that probably developed after the moisture conserved by the mulch was depleted. The check tree No. 266 with a cultivated and watered treatment, showed a root system that was not as shallow as No. 264 nor as deep. The roots of No. 266 started growing below the root collar and did not penetrate as deeply as No. 264.

Plastic mulch conserves available moisture for tree growth. Even if some natural moisture is lost due to heavy rains and the waterproofing effect of the plastic the tree will develop a secondary root system which is deeper than normal.

Potential New Potato Varieties

Several new North Dakota potato clones or lines look promising.

ND7196-18 a cross between a red and white selection continues to perform well and probably will be released soon as a named variety. This

New NDSU potato selections undergoing tests for spindle tuber and virus X are inspected by Dr. Robert Johansen, professor of horticulture, and Dr. Joseph Huguelet, associate professor of plant pathology. Virus diseases reduce yield and quality, and virtually eliminate a variety from certified potato seed production.

particular selection has been increased as a numbered selection for several years and would probably have been released last year if additional information or data were available on it.

ND7196-18 has late blight resistance and chips about like Norchip. Its shape is somewhat longer than Norchip which should made it satisfactory for processing into frozen french fries. The disadvantage of ND7196-18 is the high set or large number of tubers it produces. Under dryland conditions and grown in a dry year, this particular selection could produce many undersized tubers. It seems to be best adapted when grown in the south and particularly Alabama.

ND6634-2R is a red that looks very promising. It has good color and type and chips fairly well early in the season. This particular selection, with its good color, should make a good fresh wash potato for the Red River Valley.

Two other selections that show promise are ND7878-1 and ND8947-2 Russ. ND7878-1 is an excellent white skinned selection that chips fairly well out of storage 40 to 45 degrees F. It is blocky and has good type. This particular selection shows much promise as a processing variety. The other selection, ND8947-2 Russ, is a cross between the White Rose variety and a numbered North Dakota russet selection. It has very long type and russet skin.

With the projection made that the majority of the potatoes consumed in 1982 will be in the form of frozen french fries, the breeding program will probably be geared to develop a french fry and processing variety for the Red River Valley. Breeding lines with such characteristics are presently being worked on.

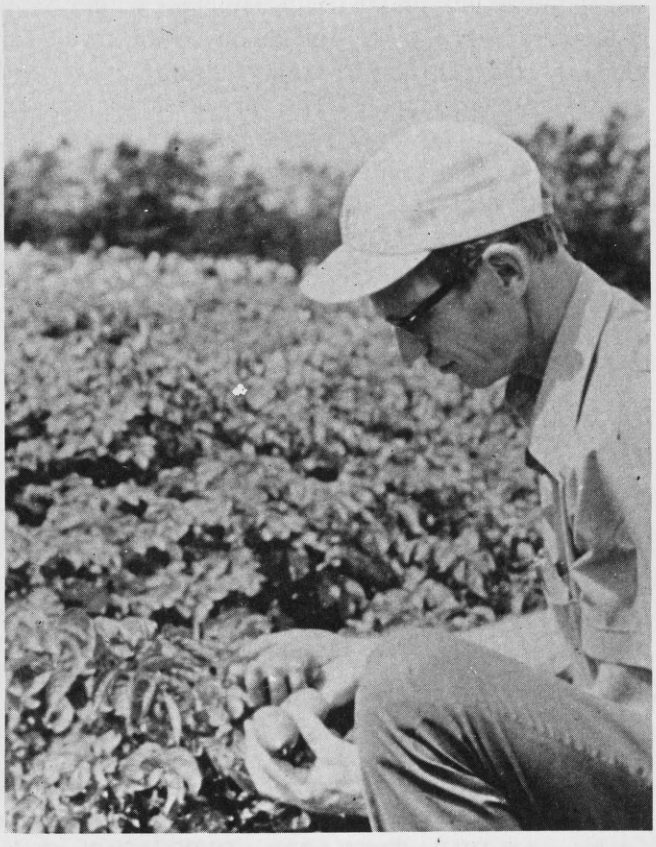
Potato Cultural Studies

Cultural studies with potatoes are conducted to find answers to problems that develop in a constantly changing industry. Over a period of years, there are changes in varieties, agricultural chemicals and technology. It is therefore necessary to generate new information and re-evaluate old cultural recommendations in terms of these changes. Also, interest in irrigated potato production has stimulated research in this area.

Studies in the cultural area have included work on irrigation, seed piece decay, hollow heart, fertilizer rates and ratios, effects of various agricultural chemicals (growth regulators, vine killers, herbicides and sprout inhibitors) and advanced testing of new selections. Much of this work involves cooperative studies with many other departments and other research groups including the Potato Processing Laboratory, Plant Pathology, Soils, Agricultural Biochemistry and Agricultural Engineering.

Currently there is considerable interest in the possibility of expanded production under irrigation. Irrigated potatoes currently account for only about 1 per cent of the total acreage in North Dakota with production located near Englevale, Oakes and Bismarck. An increase in irrigated acres will mean that high value crops will have to be grown in these areas, and potatoes are among these possible crops.

The longest term comparisons between dryland and irrigated potato production have been potato variety trials conducted at the Carrington Irrigation Station. Over eight years, marketable yields have averaged 183 hundred weight per acre under dryland and 335 cwt. per acre when irrigated. In these same trials, average yearly marketable yields have ranged from 106 to 258 cwt. per acre under dryland and 236 to 406 cwt. under irrigation. Total yields at Carrington for this period



Dr. Don Nelson, horticulturist, studies cultural practices of potatoes at the Oakes Irrigation Site.

averaged 213 cwt. (dryland) and 372 cwt. (irrigation).

At the Oakes Irrigation Site over a two-year period, marketable yields have averaged 350 cwt. per acre by late September, with individual treatments ranging up to 510 cwt. Yields from small plots, however, typically average more than those averaged over extensive areas because of more intensive care and the selection of good land.

The eight-year average yield of salable potatoes under irrigation for Idaho's dominant area is 250 cwt. per acre, Colorado, 245 and Nebraska, 220. It appears reasonable that potatoes grown under irrigation in North Dakota can easily match or exceed the production levels in Idaho and Colorado.

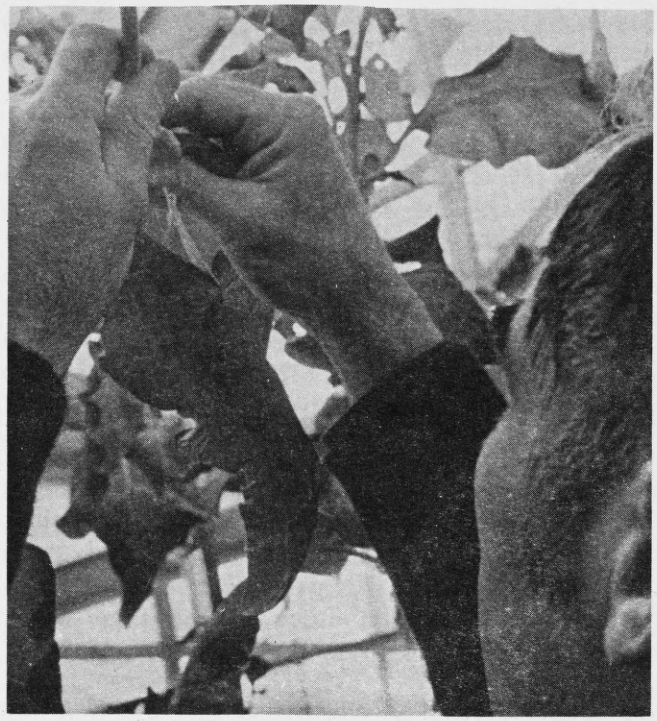
The percentage of potatoes making a marketable grade has equaled or slightly exceeded those grown under comparable dryland conditions. At Carrington, dryland grown potatoes produced 86 per cent U. S. No. 1 tubers compared to 90 per cent for those under irrigation, based on eight-year averages.

The total solids or dry matter content has been consistently less under irrigation. This would be of some importance in producing potatoes for processing (chips, frozen french fries and dehydrated products). The processing industry generally desires high solids potatoes; however, the reduction in solids from irrigation is not great enough to eliminate the production of processing potatoes under irrigation. The solids content under irrigation is high enough for table potatoes and is of no importance in the production of seed potatoes.

Detecting Diseases In Potatoes

An important part of the potato pathology research is a continual monitoring of virus diseases found in the potato selections developed at North Dakota State University. Each year 600 to 1,000 new lines are selected at the Langdon Experimental Station and are tested in the greenhouse for potato spindle tuber virus (PSTV) and potato virus X (PVX), in addition to several other diseases.

In order to test these lines, Rutgers tomato is used as an indicator host for PSTV and **Gomphrena globosa** for PVX. The test for PVX is extremely efficient and sensitive while that for PSTV is only about 80 per cent reliable. In addition, the time and space necessary for the tomato test reduces its efficiency considerably.



Dr. Joseph Huguelet works with an introduced plant which may serve as a local lesion indicator for potato spindle tuber virus. The plant would increase accuracy as well as speed up present system of testing for virus.

A new local lesion host, **Scopolia sinensis,** is being tested for use as an indicator for PSTV. Seed production of this species has been limited and therefore hand pollination and rooted cutting methods have been used. If the new test can be developed for North Dakota conditions, it would reduce the index time from 40 days to 14 days and the space required to about one-fourth of that required at the present time.

In addition to virus indexing of all potato selections, advanced selections are evaluated for resistance to late blight, verticillium wilt, common scab, silver scurf, PSTV, PVX, and leaf roll virus.

The bacterial diseases black leg and soft rot, along with the fungal disease dry rot, are the most important potato diseases in the Red River Valley. An extensive research program has been developed to determine the influence each of these diseases has on the others because they are very often found together in nature. The black leg disease generally does not occur unless one or the other diseases is present.

This research attempts to determine what conditions limit or promote black leg development.

Symptons of black leg develop readily under natural conditions, but are much less likely to develop under small plot conditions or in the greenhouse. Thus, methods are being researched which will assure the development of certain levels of the disease so that information may be gathered as to those conditions necessary for disease development or restriction.

Work On Flax Rust

During the past 60 years, flax rust has been controlled effectively through the use of resistant varieties. During this period, six genes have lost their effectiveness in conditioning resistance. However, serious yield losses have been avoided by the timely discovery of new and dangerous races and by the speedy replacement of susceptible cultivars carrying new sources of resistance.

Annual surveys in both Canada and the United States from 1963 to 1972 failed to detect any significant shifts in virulence of the rust population, and all recommended varieties appeared resistant. In August 1973, however, rust was first found in experimental plots at Brookings, South Dakota, and later in commercial fields of Bolley, Nored, Redwood and Summit in the main flax growing areas of Minnesota, South Dakota and North Dakota, and in fields of Redwood 65 and Norland in Canada. All these cultivars except Norland are known to contain resistance gene N1. In November 1973, Races 371 and 372 were discovered in South Dakota.

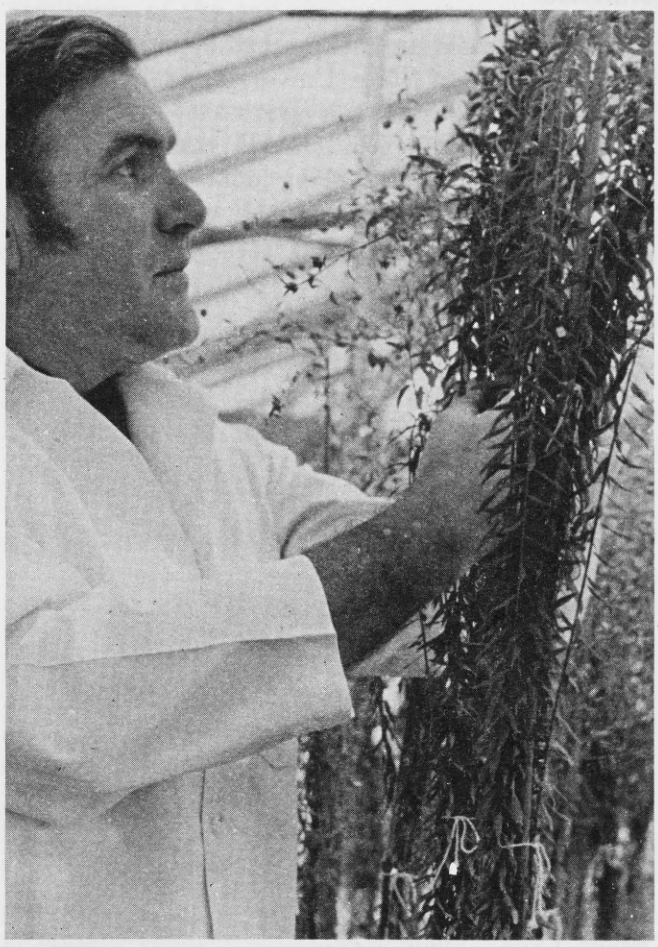
The pathogenicity data collected from selected commercial varieties and 17 flax lines which were inoculated with flax rust clearly establish the existence of the new and dangerous races (370, 371, 372) which possess virulence to varieties whose resistance until now was conditioned by the N1 gene. Race 370 is also virulent on cultivars carrying the L9, M, M1, M4, and P genes. Races 371 and 372, in addition, attack the L gene contained in varieties Marine, Sheyenne and Cree.

Indications are that Race 370 arose as a single, stepwise mutation in the much older Race 238. Races 371 and 372 resulted from recombination of genes via the sexual cycle with other existing North American races.

The implications of the new races are serious. In the United States, more than 85 per cent of the flax acreage is comprised of the newly susceptible cultivars B-5128, Bolley, Nored, Norstar, Redwood, Summit and Windom.

In Canada, the susceptible cultivars Noralta, Norland, Redwood and Redwood 65 comprised almost 93 per cent of the flax acreage in 1973. Fortunately for both countries, the U. S. cultivar Foster, the Canadian cultivars Linott and Raja, as well as a number of advanced breeding lines, are resistant to Race 370. The availability of these cultivars affords the opportunity for substitution in the next few years.

Of the eight genes known to condition resistance to all naturally occurring North American flax rust races prior to the discovery of Race 370, seven remain effective. These genes afford ample opportunity to the flax breeder to develop varieties with multiple types of resistance (where two or more genes are combined). Such varieties are less likely to succumb to a new race arising by spontaneous change, because the frequency of race



Dr. David Zimmer, USDA-ARS plant pathologist at NDSU, evaluates flax lines for resistance to the new race of flax rust, race 370. It attacks most previously rust resistant flax varieties.

development would be the product of the frequencies for spontaneous change for virulence to each resistance gene separately. Flax lines with multiple resistance have been developed but they have not yet been released for commercial production.

A prerequisite for the production of new races is the continued presence of rust-susceptible flax. Both U.S. and Canadian farmers have continued to grow older cultivars which are no longer recommended because they are rust susceptible. In addition, susceptible plants occur as admixtures in resistant cultivars.

The discovery of Races 370, 371 and 372 is a signal for increased emphasis on reducing susceptible admixtures in otherwise resistant cultivars, developing cultivars with multiple rust resistance and searching for additional sources of rust resistance. The ideal way of preventing even the birth of any new rust would be to eliminate growing any rust-susceptible flax in North America.

A flax breeding position has been established at North Dakota State University, supported by Agricultural Research Service funds. The researcher in this position will complement the work in flax already being done at the North Dakota station. The flax breeder will report about April 1, in time to become involved in research work conducted during the 1974 growing season.

Dr. David Zimmer, plant pathologist, ARS-USDA, will work with disease resistance in the host plant to develop rust resistant varieties. Dr. Glen Statler, NDSU plant pathologist, will study the inheritance of virulence of flax rust. Some of his work will include the production of fungal lines to aid in flax rust detection.

Sugar Beet Storage Research

Storage is one of the major problems confronting the sugar beet industry in the Red River Valley. As the industry expands, the importance of storage increases. When the acreage is expanded by the new growers' cooperatives, potential storage losses may be $30 to $35 million during the storage period in the Red River Valley.

The research storage facility built by the Red River Valley Sugar Beet Growers Association is being used by several researchers at North Dakota State University. Primarily, the facility is used by Dr. William Bugbee, plant pathologist, and Dr. Darrell Cole, plant physiologist, of the Agricultural Research Service of the U.S. Department of Agriculture.

Dr. Darrell Cole, USDA-ARS plant physiologist at NDSU, measures the rate of respiration in sugar beets. Beets with slower respiration rates should lose less sugar during storage.

The plant pathologist specializes in storage rots, primarily **Phoma betae.** Phoma is the primary fungi involved in losses in storage piles. Selecting for sugar beet resistance to Phoma rot is a primary objective of the research.

Several roots were selected for resistance and seed was produced from these roots for further selection procedures. Roots which continue to exhibit resistance can be used in a breeding program where resistance to Phoma can be incorporated into new varieties released to the growers.

In addition to selection for resistance to Phoma, other variables which may affect the development of Phoma in the roots and piles are being investigated. These include the effect of nitrogen and various crop rotations on survival of Phoma in the soil and other host species for the fungus.

Other diseases which may affect sugar beet growth in the Red River Valley are cercospora leaf spot, rhizoctonia foliar blight and rhizoctonia root

rot. Viruses and nematodes have not been prevalent in the Red River Valley.

The USDA plant physiologist specializes in factors other than diseases which affect storage losses. Several factors affect storage of beets including storage temperature, humidity, varieties and fertility. Other factors such as moisture, date of harvest, mechanical damage, and other agronomic practices may affect beet quality and root storability.

Different varieties are now under study to determine their storability under different storage conditions including temperature and different topping treatments. Roots are stored for several weeks and are sampled periodically to measure changes in sugar content and impurity levels to determine the best storing varieties.

Sugar is lost primarily through respiration of the beet tissue when diseases are absent. Varieties which exhibit lower rates of respiration should store better than varieties having high rates of respiration. By determining storability of different varieties, processors may be able to reduce the losses in piles by processing those varieties which deteriorate rapidly as fresh beets or early in the storage campaign.

Sugar Beet Research In The Soils Department

The Red River Valley is the most important dryland area for the production of sugar beets in the United States. Research data from the western irrigated sugar beet areas is not always applicable in the Red River Valley with its somewhat irregular precipitation. During the past five years the Department of Soils has studied the influence of soil and nitrogen fertilizer, plant population and date of harvest on sugar production and the general growth of the sugar beet plant. As a result of this research, an effective soil-nitrogen test based on the amount of stored soil nitrate in the upper two feet of soil has been developed. In addition, future avenues of research which may increase sugar yields have been formulated.

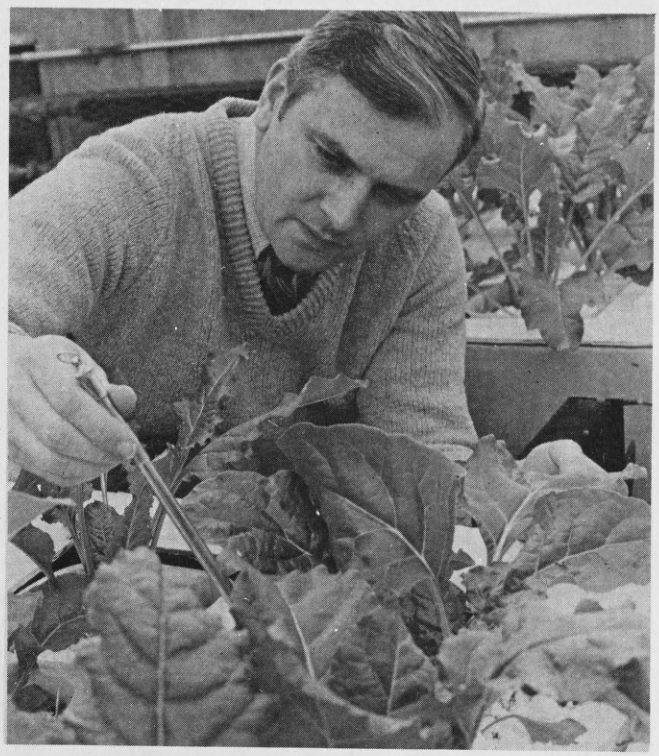
The sugar beet research has provided valuable information about how this crop grows in the Valley. For instance, the fibrous roots of sugar beets were found to exploit soil moisture and presumably soil nitrate to a depth of at least six feet in years of limited precipitation. The ability of sugar beet roots to use this stored soil moisture is undoubtedly the key ingredient in successfully raising sugar beets in the Red River Valley. The research has raised the question whether different sugar beet cultivars differ in their ability to exploit soil moisture in the relatively harsh, low fertility, low temperature environment of the subsoil.

Date of harvest research has shown that sugar yields increase and impurities decrease during September and November. Little storage root sugar accumulation, however, was found to occur until the area of leaf blades was about one and one-half times the area of land on which the beets were growing. This research finding suggests that any production practice which will hasten leaf canopy development will increase sugar yields.

Larger, evenly-spaced sugar beet stands increased both root and sugar yields. An evenly-spaced stand between 80 and 100 plants per 100 feet of row is recommended. The research did not substantiate a European report that higher populations were required in relatively dry years.

The nitrogen fertilizer experiments have demonstrated two advantages to sugar beet producers of the soil-nitrogen test:

(a) it predicts the need for nitrogen fertilizer;
(b) it decreases the possibility of applying excessive nitrogen fertilizer which may decrease the yield of extractable sugar.



Sugar beet studies by Dr. John Moraghan, Department of Soils, help determine nutrient uptake at different soil temperatures.

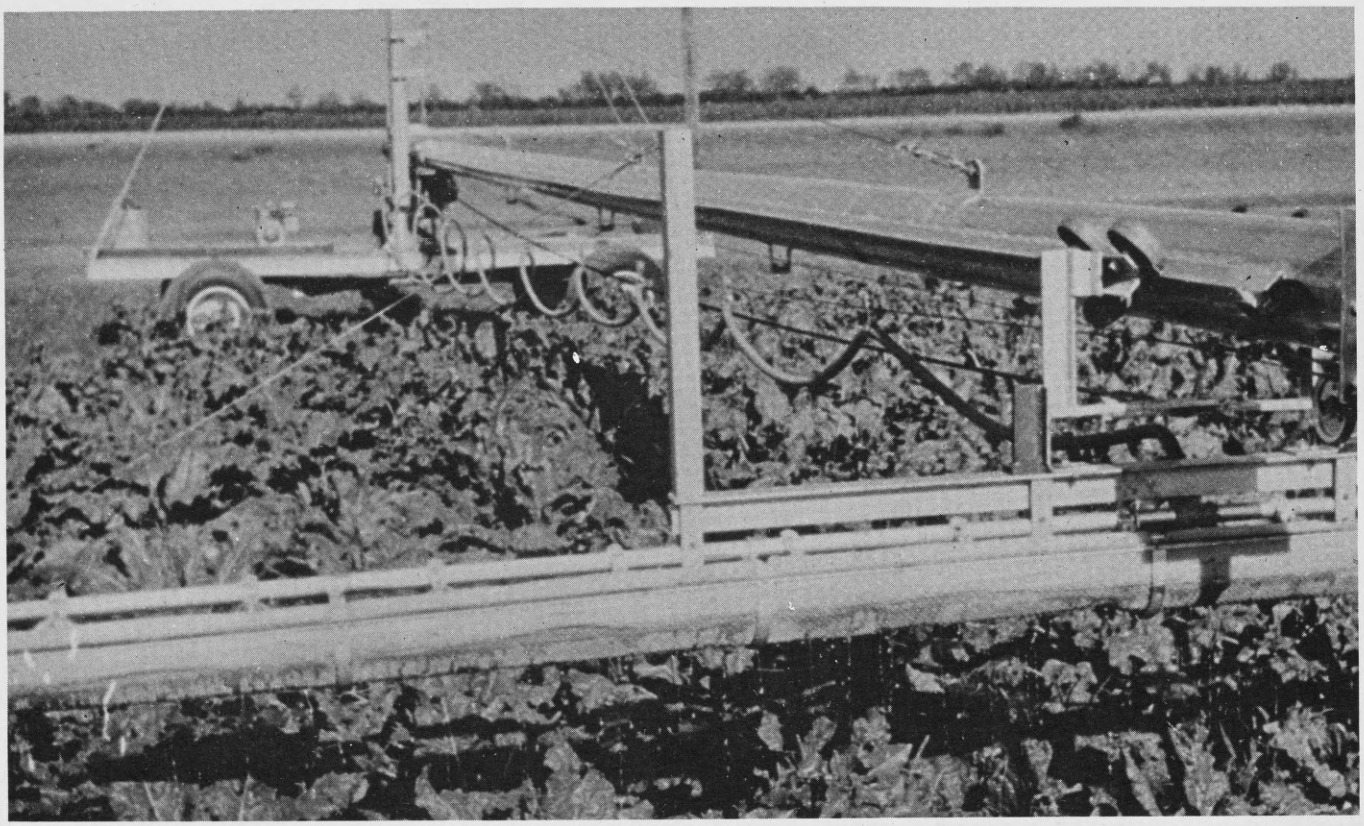
Soil And Water Management

When delivery of irrigation water to the 19,000 acres of the West Oakes Irrigation District from the Garrison Diversion project becomes a reality, irrigators will have information, provided through research by the Department of Soils at the Titus site (Sec. 17 T130N-R57W), about the nutrient and water requirements of crops adapted to the climate of the area.

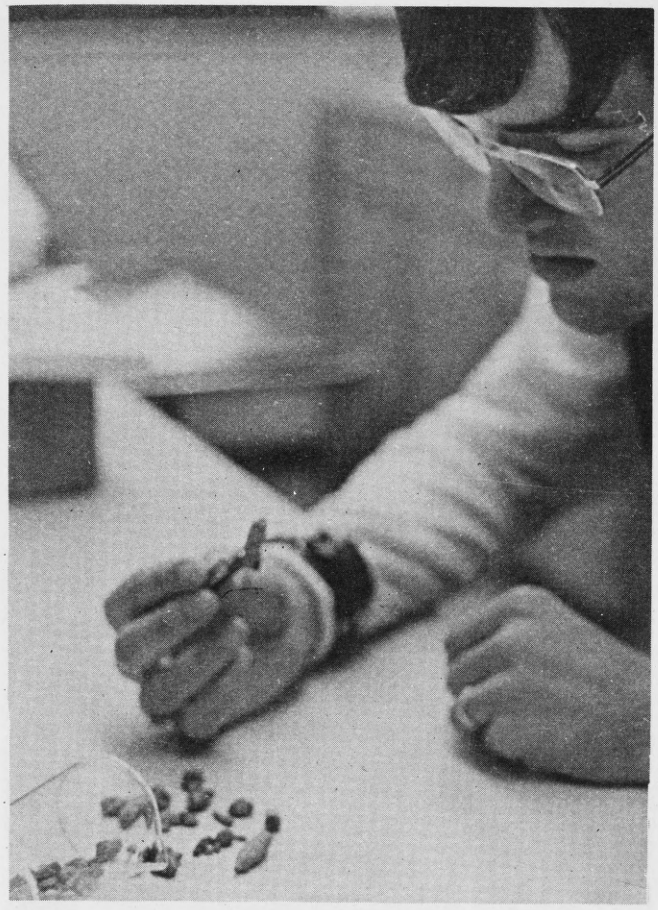
The amount of irrigation water that will need to be applied will depend upon the growing season weather conditions, especially the amount of rainfall and the temperature, and the length of growing season of the crop. Properly scheduling irrigation water is necessary to prevent plant water shortages from occurring, or so they occur as infrequently and at as low an intensity as possible. Improper timing can reduce the effectiveness of the water and reduce the water use efficiency; that is, the yield per acre per inch of water. Not only is low water use efficiency less profitable to the irrigator, but it may have a future bearing on assignment of water from the Garrison Reservoir for use by agriculture. The demand for water from the Garrison Reservoir by industry and municipalities is increasing, and competition for water will intensify. Eventually, a decision on water allocation may become necessary. The basis for judging the value of an inch of water for crop production is in terms of water use efficiency.

Proper nitrogen management provides a two-pronged challenge to the irrigator, (1) because nitrogen is needed in large quantities by plants as well as having a major effect on their nutritional quality, and (2) because nitrogen—the nitrate form—moves with soil water and can contribute to groundwater pollution. The problem faced by the irrigator is to supply an adequate amount of available nitrogen at the right time for the crop, but at the same time manage the quantity of available nitrogen so loss in drainage does not occur. Not enough available nitrogen can reduce yield potential, whether it occurs because of low application rate or through loss by drainage, and then also reduce the water use efficiency.

Correct timing of nitrogen, and other nutrients also, can be scheduled according to crop needs at specific growth stages. Plant analysis to determine nutrient concentrations at specific growth stages in relation to yield is part of the research effort at Oakes.



A small plot irrigator at Oakes Irrigation Site helps researchers study sugar beet water use and fertility uptake, and the effect on sugar beet yields.



Douglas Malo, graduate student, assistant in soils, studies "pipestems", secondary iron-magnesium formations that indicate poor drainage and result in high water tables. Researchers use these samples to evaluate potential soil problems and to help reconstruct past conditions which lead to today's soils.

Soil-Geomorphology Hydrology Research

Research being conducted in this area is concerned with gaining an understanding of the relationships between the natural occurence of soils, the landscapes they occur on and changes in the status of the ground-water. In addition, these studies help determine what has caused our soils and landscapes to appear as they do today.

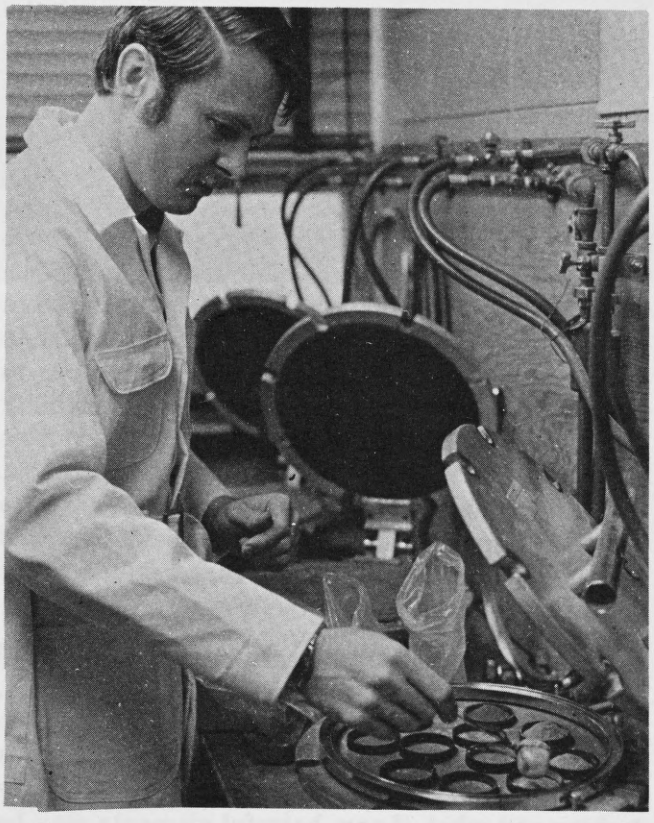
At present, efforts are being directed toward studying the situation which exists in what is commonly called a pothole. In North Dakota there are approximately 660,000 potholes, more than one per person. More than half the state's land area is characterized by potholes. An understanding of how these came to be and what exists today with respect to soils and water is important in management and land use decisions. An understanding of naturally-occuring soils is important to accurately predict how a soil and landscape will react to certain imposed management practices. Fluctuations in the ground-water table often will dictate the best use of a particular pothole; some may be cropped, some not.

Results indicate that crop production may be related to landscape position and depth to the ground-water table. Furthermore, it may be feasible to farm some potholes but not on a regular basis, this being decided by precipitation. An indication of use and management may be accurately gained from the more complete understanding of the soils and direct interpretation of soil survey maps than could be done previously.

Results of this one study have wide application to other potholes in North Dakota. The patterns of soil occurence are essentially similar. The response of the ground-water table to precipitation and cropping are also similar and differ only in the magnitude of response depending on the size of the individual pothole.

Saline Seep Prevention

Saline seep development and growth is related to geologic conditions, cropping practices and climate. A seep is formed when soil water moves



Dr. Lynn Brun, assistant professor of soils, uses pressure plates to determine soil moisture values at which plants would wilt.

vertically beyond the root zone to a layer which transmits the water laterally to a lower elevation where water reappears at the soil surface, depositing soluble salts picked up from the soil and substrata material. Alternate crop fallow, along with recent years of above average annual precipitation, has aggravated the problem in southwestern North Dakota.

Research is under way to evaluate the effect of cropping practices on the use of soil moisture and seep prevention. Preliminary results indicate alfalfa can be used to remove soil moisture that has accumulated under crop production. Relatively large acreages would have to be maintained in alfalfa to prevent seep formation.

Studies Of Coal Overburden Materials And Their Revegetation

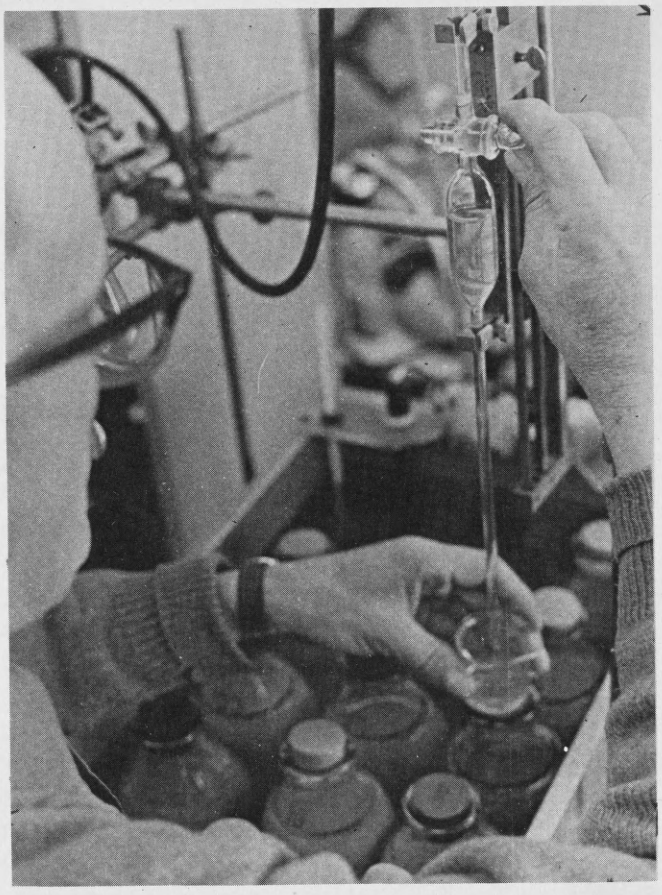
North Dakota's lignite coal reserves will play an important role in providing energy for the future. Mining rights on large acreages of strippable lignite are currently being leased to obtain coal for electric power generation and for gas production.

The soils and botany departments at North Dakota State University are co-operating with the Agricultural Research Service in a project to learn more about the soil materials that must be removed in surface mining of lignite.

Soils experts presently have a good knowledge of the chemical and physical properties of the upper five feet of the most extensively occurring soils in western North Dakota's potential coal areas. Materials to greater depths have been analyzed in only a few locations to date. Researchers need to sample and analyze these deeper overburdens to learn their composition and their variability throughout potential strip mine areas. This knowledge of overburdens is needed so that legislators and agronomists will be able to formulate good plans for the reclamation and management required to get these mined areas back into agricultural use.

Chemical and physical analyses of coal overburdens from the surface to the coal seams, and from the upper five feet of reclaimed fields, are in progress in the Department of Soils. Soils researchers need to know what nutrients are lacking and what, if any, harmful elements may be exposed at the surface by the stripping operations.

The Department of Botany is studying many grass species that have been seeded in reclaimed mine overburdens to determine which species best survive and produce good yields of forage on the reclaimed areas that will be returned to agriculture. Yields on adjacent native range sites are also being studied for comparative purposes.



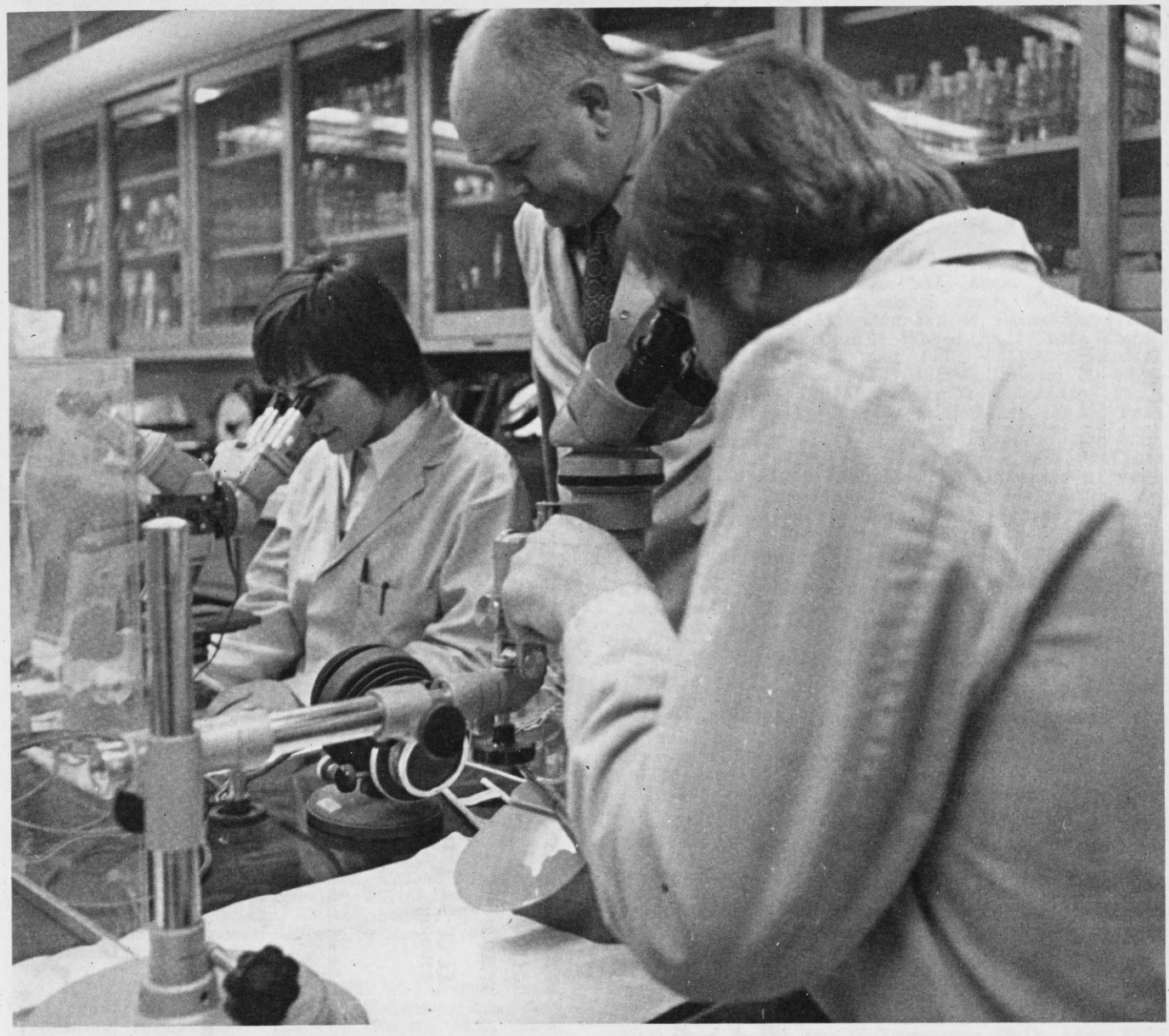
Particle size analysis is conducted on deep probe soil samples taken from an area with mining potential.

Virus Diseases

Virus diseases, notably infectious bovine rhinotracheitis (IBR), are costly to North Dakota livestock producers. Such diseases can be difficult to prevent, treat and even to diagnose accurately. Research in the Department of Veterinary Science is attempting to answer some of the many questions about virus diseases.

Investigations are under way to develop a workable, efficient method of concentrating viruses from animal specimens submitted to the diagnostic laboratory. If such a procedure could be established, a more rapid method of diagnosing viral diseases could be achieved.

The passage of IBR vaccine virus from vaccinated calves to pregnant cows resulting in



Technicians Deloris Dunkin and Clayton Kelling examine specimens in the veterinary science virology laboratory, headed by Dr. I. A. Schipper (center).

abortion, a controversial subject among researchers, producers of vaccine and cattlemen, is under investigation in another project. In research so far, seven IBR-free pregnant cows were kept in continuous association with their vaccinated calves. One cow aborted, and the fetus was positive for IBR. One cow had a weak calf, and both cow and calf developed a titer for IBR. Two other cows failed to produce a calf, indicating the fetus had been reabsorbed.

Investigations are now under way searching for a drug that will effectively counteract the IBR virus. One plant extract has appeared to be of value.

Response to IBR vaccine is also being studied, comparing subcutaneous and intramuscular vaccination and attenuated and killed vaccines.

A new study is investigating whether or not maternal antibodies are transferred to the unborn fetus or to the calf via colostrum milk, if the presence of such antibodies will interfere with response to vaccination, and the youngest age at which satisfactory response to viral vaccination will be obtained. This study is also determining the same things regarding vaccinating for a bacterial disease.