

# Summary of Some Major Research Projects In The Agricultural Experiment Station

## **Economic Impact of Coal Development**

The prospect of extensive coal development in North Dakota poses many questions to public decision makers and to all citizens of the state. Among the more important considerations are the effect of development on employment, population and income in the development area and the effect on public costs and tax revenues. To help find answers to these questions, the agricultural economics department at NDSU has been engaged in a study of coal development impacts.

A preliminary analysis of the employment and population increases likely to result from coal development has been completed. An analysis of public cost-revenue implications of various types of coal development—gasification plants, electric generating plants and export mines—is underway. The objective is to evaluate the effect of one or a series of these facilities on local public service costs and local tax revenues and also on state government revenues and costs. Results of this analysis will provide a basis for realistic policies regarding taxation of coal conversion facilities.

Coal development may create many additional employment opportunities. However, just as important as the question of how many jobs there will be is the question of who will get the jobs. Will North Dakota residents be able to qualify for the jobs or will they be filled by migrants? These questions are being investigated through a survey of the state's present coal mine and power plant work force.

Construction of a coal gasification plant can be expected to have a substantial effect on the local area and its people. About 3,000 construction workers may be involved at the peak of building activities. Providing housing and public services for these workers will be a challenge to local governments. To obtain a better understanding of the impacts of such a large scale development on community facilities and local residents, the NDSU researchers are conducting a case study of the Anti-Ballistic Missile project in northeastern North Dakota.

## **Sheyenne River Basin**

The first year of a five-year project to identify the costs and benefits of varying pollution control

standards and evaluate alternative water and land use management systems in the Sheyenne River Basin has been completed. This interdisciplinary project involves the departments of agricultural economics, botany, bacteriology, geology and chemistry at NDSU along with the department of sociology at Concordia College and the chemistry department at Moorhead State College.

The study is focusing on the lower Sheyenne River basin, from Bald Hill dam north of Valley City to the river's mouth on the Red River north of Fargo. This portion is about one-third of the river's total length.

During the project's first year, geologic field analysis and mapping were begun, data on the socioeconomic characteristics of the basin were collected, water quality analysis was initiated and the relationship of water quality to land use was studied.

The second phase of the project is now underway. Research during this phase will include continued monitoring of water quality, collecting additional information describing the basin and its economic activity, analyzing specific pollution sources and methods to increase the water quality, and using a simulation model to evaluate alternative futures for the basin.

## **Marketing Irrigation Production**

With irrigation on the increase in North Dakota, farmers and businessmen in the irrigation districts find themselves faced with a new set of marketing and management decisions. It is important that a high level of expertise be available to help producers and businessmen evaluate the unfamiliar alternatives that irrigation will present. A project on evaluating production alternatives and marketing irrigation production is underway at NDSU to help provide this expertise.

This is an interdisciplinary project under the leadership of the agricultural economics department, and involving the departments of agronomy, soils, animal science and horticulture.

To date, much of the initial work of analyzing the production alternatives in the southern project area—the LaMoure-Oakes area—is nearing com-



pletion. Work the first year of the project concentrated on developing model irrigation farms for the project area and determining basic production relationships for crop and livestock enterprises on the model farms.

Based on the analyses of production alternatives, work on market potentials for the highest-profit specialty crops is being initiated. The aggregate effects of irrigated production on the total project area will also be determined to evaluate the impact of the project on markets for farm products and on the level of economic activity in the project area.

At present, preliminary work on production alternatives in the central part of the project area is being started. The central area is composed of the Warwick-McVille, New Rockford and Lincoln Valley sections.

### **Resource Inventory and Monitoring System**

North Dakota is being faced with rapid changes, and the state's citizens face critical management decisions on how resources are to be used.

These important decisions require immediate access to many types of reliable information. NDSU's interdisciplinary RIMS (Resource Inventory and Monitoring System) project is an information bank that will help to meet this need.

RIMS is a user-oriented information system to provide quick and easy access to data. Long-range goals are to provide as complete an inventory as possible of information useful to resource decision makers.

The project has put into operation a special "digitizer" which converts maps into language which a computer can store and print out. Once inside the computer, maps can be recalled, changed in size, laid one upon another and reproduced without copying by hand. A television-type computer terminal is being used to check on soils maps being entered into the computerized data bank.

Two typewriter-type computer terminals are being used to enter and store data. Natural and socioeconomic data are being stored and can be easily recalled by any of the three terminals.

With computerized information readily available from the data bank, it should be possible for researchers and decision makers to approach problems from more than one point of view and study alternative solutions. "What if . . . ?" questions can be answered by simulation and modeling much more easily with relevant information immediately available.

The RIMS system also keeps information available for purposes other than the original one. Collecting information costs money, so the RIMS system will spread collection costs out over more uses, eliminating duplication of effort.

### **Buried Irrigation Pipe**

Pipe materials and pipeline designs for irrigation water distribution systems vary greatly depending upon application. Buried pipe must be capable of withstanding external forces from the surrounding soil as well as internal pressure from water.

Cold winter temperatures in the north central states require placing water lines six to seven feet below the surface to protect them from winter freeze-up. One alternative is to bury the pipe shallow, within the frost zone, but lay the pipe to allow water to drain before freeze-up. The difference in cost between burying pipe three feet deep or seven feet deep is substantial enough to make only the shallow placement economically feasible in North Dakota. The Carrington Irrigation Station has been conducting studies on buried pipeline to gain experience with this type of installation and evaluate its performance under North Dakota conditions.

Approximately 15,000 feet of PVC, asbestos-cement, concrete and vinyl-clad aluminum irrigation pipe have been buried within the frost zone, 30 to 36 inches deep, at the Carrington Station. All lines have been laid to grade to permit water drainage before freeze-up.

These lines have been in use for periods ranging from four to 10 years. During this time various studies have been conducted to evaluate the performance of the various pipe materials under normal field conditions.

Results and observations suggest that the relatively shallow placement of pipelines presents no new or different problems than those encountered in areas of milder temperatures where similar installations have been used. The major precaution required is that pipelines be laid to grade to permit drainage of water from the pipe.

### **Efficient Use of Irrigation Water**

Development of the Garrison Diversion Project is nearing the point where irrigation water will be available on North Dakota farms. The efficient use of irrigation water is important to the success of this project.

Sprinkler irrigation systems are being planned instead of the less efficient gravity sys-



tems. The agricultural engineering department, in cooperation with the Carrington Irrigation Branch Station, has conducted field and plot studies to develop criteria for management of center pivot irrigation systems. These studies are designed to determine the combinations of pumping rates, soils, crops and management schemes required for the successful application of one center pivot system to two or three fields.

Irrigation scheduling techniques are being developed so sprinkler irrigation systems can attain the optimum efficiency in water application. Center pivot system scheduling methods are being studied at the Carrington and Oakes research sites.

Irrigation scheduling criteria which are based on environmental factors that cause water stress are being investigated. This study involves the use of instruments that provide a measurement of actual plant water stress. These data are then correlated with factors such as soil moisture efficiency and the prevailing daily atmospheric evaporation to predict when to irrigate.

#### **Runoff and Erosion of Mined Areas**

In the summer of 1974, the departments of agricultural engineering and soils at NDSU initiated a project to study reclamation problems related to strip-mined land in western North Dakota.

Specifically, the study is to identify snow melt, rainfall and erosion losses from strip-mined materials, as well as to evaluate the water movement and storage in the top nine feet of the soil profile as affected by surface configuration. The amount of sediment and the amount and type of water soluble constituents from runoff flows are also being determined.

The study plots are located in the Beulah area. These plots will be used to monitor the quantity of erosion and runoff from natural and artificial rainfall. The research site has been prepared and instrumented and is ready for collecting data.

#### **Effect of Grain Drying**

Mechanical grain drying is becoming a more common practice on North Dakota farms. NDSU researchers from the Departments of Agricultural Engineering, Cereal Chemistry and Technology and Agronomy have been conducting a project to determine the effects of forced air velocities and temperatures during drying on the milling and baking qualities of hard red spring wheat.

Laboratory tests were done with durum, using drying temperatures up to 220 degrees F. and durum moisture content up to 20 per cent. Labo-

ratory results showed that durum containing 20 per cent moisture could be dried at air temperatures up to 220 degrees and still produce acceptable spaghetti. Durum at 18 per cent moisture could be dried at even higher temperatures.

To verify the laboratory results, observations were made of durum dried in actual farm dryers. The laboratory predictions agreed well with the actual results.

#### **Crossbreeding Beef Cattle**

The beef cattle crossbreeding research project at NDSU was developed as a total "conception to consumer" approach. Overall objective of the project is to evaluate the reproductive and productive traits of crosses between new European beef breeds, a dairy breed and the conventional beef breeds. Breeds for this project were selected to evaluate and measure various types of cattle for fertility, calving ease, mothering ability, rate and efficiency of gain, carcass quality and composition and characteristics of meat that appeal to the consumer.

Results have shown that breed background does effect performance. Purebred Angus and Hereford calves out of two-year-old heifers delivered with less calving difficulty than comparable calves sired by Charolais and Brown Swiss bulls, with 67 per cent of the crossbred calves born without difficulty compared to 81 per cent of the purebred calves.

Crossbred calves averaged 65 pounds heavier at weaning and 102 pounds heavier as yearlings than purebreds. Cow-weight to calf-weight ratios were greatest for Brown Swiss cross females with Hereford breeding.

Carcass quality has decreased as the percentage of Charolais, Brown Swiss or Simmental breeding increases.

#### **Sheep Breeding Research**

A research project has been underway at NDSU and the Hettinger Experiment Station to determine the potential of various breeds of sheep and their crosses for intensified production.

These crossbreeding trials have used the Border Leicester. This breed is world-renowned for its ability to sire productive commercial ewes, but has not been used to a great extent in the United States. NDSU has been one of the pioneers in introducing the breed to this country.

Results of the breeding trials show that the productivity of crossbred ewes sired by Border Leicester rams from Rambouillet ewes has been



superior to any other cross evaluated. Crossbred ewes sired by North Country Cheviot rams have also been evaluated. These ewes have produced significantly less wool than other crosses.

More recently, the NDSU researchers have begun evaluating crosses with the Finnish Landrace, a breed noted for its fertility.

### Evaluating Feed Grains

A project to determine the importance of variety differences and production variables as factors contributing to variation in feeding value of North Dakota feed grains has been underway at NDSU. The project involves the departments of animal science, agronomy and cereal chemistry.

Chemical analysis indicated considerable differences in feed value among different varieties of oats. Preliminary research to determine if these differences were of any practical value was conducted using rats as experimental animals. Rats

were used because only small amounts of the experimental grain were available, dictating use of laboratory animals rather than livestock. Feeding data from rats, while not directly applicable to farm animals, would provide general information on the feeding value of the varieties of oats.

The results showed considerable differences in the digestible energy of the different varieties.

The varietal differences from these trials feeding rats were significant enough to call for additional research using swine and other farm animals.

It is possible that livestock producers might be able to use pounds of livestock gain per acre as a criterion for selecting a feed grain variety as well as bushels per acre.

### Compensatory Growth

Nutritionists in the NDSU animal science department have demonstrated the potential eco-



Dr. Robert Harrold, Department of Animal Science, uses laboratory animals to determine varietal differences in the feeding value of oats, as part of a project evaluating North Dakota feed grains. Feeding trials involving swine or other livestock are then designed on the basis of general information obtained from feeding rats.



conomic benefits of compensatory growth in both turkeys and swine.

The original work was done with turkeys, attempting to find ways to avoid the structural problems that often develop with fast-growing poults. The researchers found that despite extreme initial growth depression, poults receiving only 70 per cent of recommended protein levels for one-third of the growing period responded when returned to normal rations and converted feed to gain as efficiently as birds fed a higher level of protein throughout the growing period.

A similar study was conducted with swine, with a control group fed a ration containing 16 per cent protein to market weight, another group fed 14 per cent protein for four weeks and then 16 per cent to market weight, and a third group was fed the 14 per cent ration for eight weeks before going on the 16 per cent ration.

The pigs fed the lower protein ration for four weeks put on the most economical gains, with savings in feed cost of \$2 per pig for the feeding period over the pigs fed 16 per cent protein throughout the trial.

### Barley Variety Development

Barley variety development research formally started at NDSU in 1945 with research effort concentrated on six-rowed white aleurone dual-purpose (malting and/or feed) barleys. In 1958, the research program was expanded to include a minor effort on blue aleurone barleys. Such barleys presently make up about 10 per cent of the malting barley varieties sold in North Dakota. In 1968, a breeding program was started on two-rowed barley. Initial variety tests indicated that two-rowed varieties performed extremely well in the western part of North Dakota. Dr. Melvern Anderson is in charge of two-rowed barley research, while Dr. Earl Foster continues research with six-rowed barley.

Two-rowed barleys have the potential for high yields in eastern North Dakota also, if resistance to stem rust and major leaf spotting diseases can be incorporated into them. In the NDSU testing program for advanced barley breeding lines, several two-rowed lines have shown real yield potential. These two-rowed selections showed substantially higher yields than Larker, a six-rowed dual-purpose variety released by NDSU in 1961, at the Langdon and Williston branch station tests while equal or slightly less in yield at the Fargo and Carrington stations, respectively. It would seem illogical that two-rowed barleys have a high yield potential since they have long slender heads with



Dr. Earl Foster, left, and Dr. Mel Anderson, Department of Agronomy, look at two experimental barley lines. Foster is in charge of six-rowed barley breeding, while Anderson is expanding a program in two-rowed barley research.

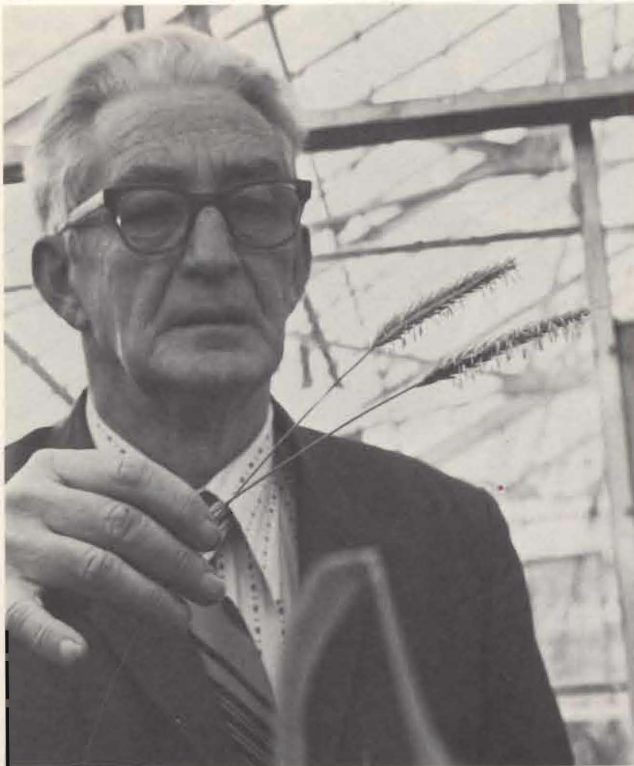
two instead of six rows of kernels. But the two-rowed barleys also have a high tillering capacity which accounts for much of their high yield potential.

NDSU's six-rowed barley program has been outstandingly successful. The North Dakota Experiment Station has released barley varieties Trophy, Larker, Dickson, Nordic and Beacon which have occupied 85 to 92 per cent of the state's acreage from 1968 to 1974, a similar amount in Minnesota and more than 50 per cent in South Dakota. Estimated annual benefits to North Dakota producers over the next best variety of \$6.6 million for production of Larker and Trophy released in 1961 and \$6 million for Dickson released in 1964 can be projected into the 1968 to 1974 period. Using an annual cost estimate of \$172,000 for all malting barley research at NDSU, a cost: benefit ratio of 1:73 is obtained.

Larker, Dickson and Beacon barley together account for 85,000,000 bushels (about 75 per cent) of all barley used by the malting industry in the United States.

Beacon barley, released in 1973, is the first white aleurone barley with acceptable malting quality and **loose smut resistance** released from the NDSU Agricultural Experiment Station. Beacon was grown on 17 per cent of North Dakota barley acreage—386,000 acres—in 1974. The loose smut resistance alone produced an extra \$650,000





Dr. Arnold Schooler, Department of Agronomy, uses wild species of barley such as this to develop disease resistance and added straw strength in new barleys.

income to North Dakota farmers, as loose smut damage is a direct economic loss not compensated for by the barley plant. Beacon also is early maturing with strong straw which had considerable significance in the late 1974 season.

Breeding for resistance to barley diseases has resulted in the availability to producers of a barley with combined field resistance to stem rust and three important leaf spotting diseases: spot blotch, net blotch and Septoria leaf blotch. In addition to Beacon, resistance to loose smut also has been incorporated into advanced breeding lines in the barley program.

Successful research in barley cytogenetics has resulted in the transfer of several sources of barley foliage disease resistance from "wild barley" types to common barley. These "wild common" barley hybrids are being further improved for quality, yield and other desirable agronomic characteristics in the barley breeding project.

Semidwarf barley lines obtained from crosses of a wild barley (*Hordeum bulbosum*) x common barley (*H. vulgare*) have been crossed with Larker, Trophy and Kindred to produce semidwarf common barley having shorter and stronger straw than present commercial varieties. Both facets of "wild barley" research are under the direction of Dr. Arnold Schooler.

### New Varieties in Seedstocks Program

The policy of the North Dakota State University seedstocks program has been to make rapid increases of potential varieties produced by NDSU and new varieties from NDSU, other states and Canada of usefulness to North Dakota producers.

The program provides new varieties rapidly to North Dakota farmers. By use of southern and North Dakota increases, a new variety may be increased from one bushel to one million bushels in less than two calendar years. Three consecutive crops can be grown in the field in North Dakota, California and Arizona from August to August of a 12-month period. Such an increase of Waldron wheat resulted in increased benefit to North Dakota growers of \$14 million in 1971, and of Ward durum at least \$1.3 million in 1973, over the benefit resulting from increase only in North Dakota or southern winter increase at a later time.

Arizona increases of our daylight-sensitive cereals usually are returned about the third week in May. NDSU has done research to determine the economic feasibility of maturing the crops 30 days earlier by use of night (dark period) interruption. Research from date-of-planting studies indicates that the month gain in seeding date in North Dakota has resulted in 13 to 40 per cent yield gains over the same crop variety seeded one month later.

Aggressive prerelease production and early release of Sundak sunflowers greatly benefited



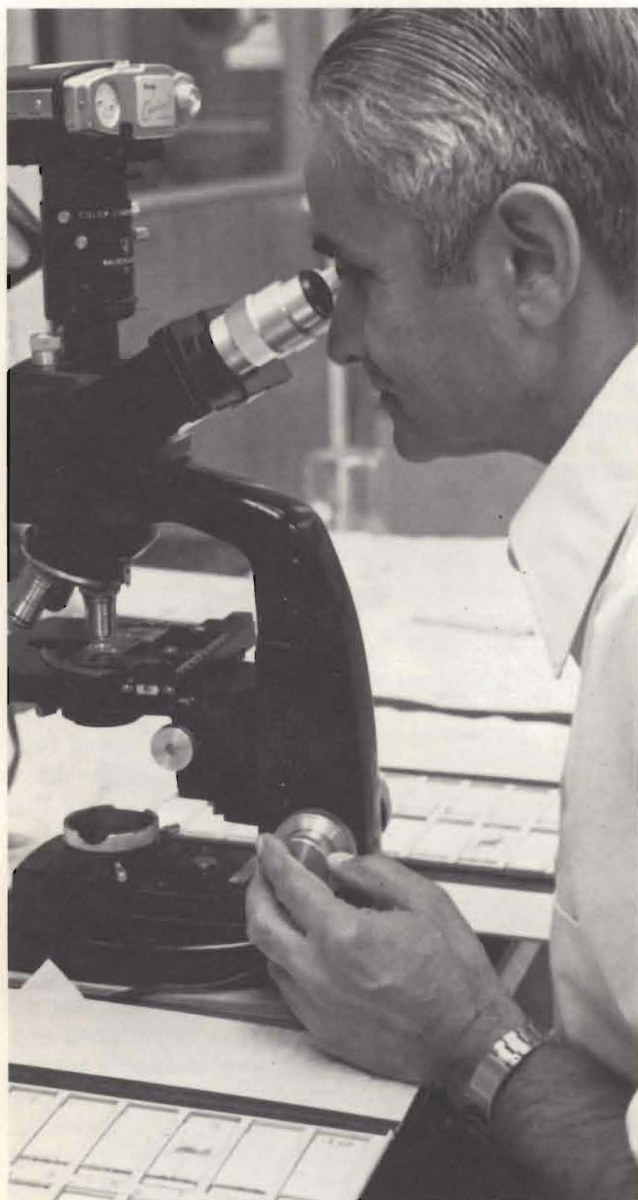
Dramatic seed increases are possible using present techniques in the Seedstocks project. Superintendent LeRoy Spilde and David Ebeltoft, Department of Agronomy, inspect some freshly cleaned seed at the Agronomy Seed Farm.



North Dakota. Because of serious rust losses to other varieties in 1973, some 80 per cent (200,000 acres) of the confectionary type grown in 1974 was Sundak. An estimated yield increase of 10 per cent at 15 cents per pound would result in an additional \$2 million to farmers in North Dakota and Minnesota.

### Wheat Genetics, Breeding and Cytogenetics

The great research competence and facilities in wheat genetics and breeding, as well as cytogenetics, at NDSU are recognized nationally and internationally. In 1972, two D. F. Jones post-doctoral fellowships worth \$19,200 were awarded to NDSU for research in wheat cytogenetics with Dr. S. S. Maan, in 1973 a graduate fellowship for



Dr. S. S. Maan, internationally-known cytogeneticist, studies wheat chromosomes in his work on wheat cytogenetics.

doctorate study, and in 1974 two more postdoctoral fellowships funded at \$14,000 and \$12,000. These five awards were of a total of less than 10 awarded nationally each year for additional research in cytogenetics of important food crops.

In 1973, about 50 wheat geneticists from around the world came to the NDSU campus to see and discuss wheat improvement research including that of Dr. Maan. In early 1974, Drs. Maan and James Quick were invited to an international conference on wheat genetics to present and discuss NDSU research on wheat genetics, breeding and cytogenetics.

The breeding program on hybrid wheat of Maan and Dr. Carl Lucken has developed extensive male and female parental stocks for hybrid production that now would require five to 10 years of breeding at a cost of at least one million dollars to duplicate. Unique nuclear genes and cytoplasm from wild and semi-wild wheat relatives have been incorporated into a wide array of adapted North Dakota wheats. Striking genetic control of the plant has been demonstrated with these materials. Procedures for using this control of plant vigor represent major contributions to both conventional and hybrid breeding of wheat and other crops which should be of great value in future wheat improvement.

Research in hard red spring and durum wheat has meant added millions of dollars to North Dakota farmers, and development of hard red winter wheats suitable for growing in the state has great potential usefulness and economic benefit.

Waldron wheat has yielded three bushels per acre more than the next best conventional height variety. Grown on three million acres in 1973 and 1974 and assuming \$4 per bushel, this variety has meant \$72 million of added income for North Dakota farmers in these two years.

Olaf wheat, a 1973 release, having longer straw than other semidwarf wheats, yielded two bushels more than the next best semidwarf spring wheat variety of comparable quality. At present wheat prices, it meant \$2,400,000 of increased crop income in 1974 as it was grown on 300,000 acres. Olaf has wide adaptation and maintains good protein content and protein price premiums for the producer.

### Hard Red Spring Wheat Development

NDSU developed and released Tioga hard red spring wheat, resistant to sawfly and superior to Fortuna in "block chaff" resistance and in milling-baking quality. Two new solid-stemmed medium height wheat experimental lines appear very





Greenhouse work is an important phase of the year-around spring wheat research program. Dr. Richard Frohberg, Department of Agronomy, emasculates a wheat spikelet as a part of that program.

promising and are advanced into uniform regional tests. One is superior to Tioga in straw strength and leaf rust resistance and the other is a semi-dwarf line superior to Tioga in yield.

NDSU released Rolette durum in 1971. It is currently grown on 1,224,00 acres. In 1973 Rolette outyielded Leeds by an average of 3.7 bushels per acre. The same increase in 1974 would have meant over \$27 million this year, figuring durum prices of \$6.00 per bushel.

NDSU released Ward durum in 1972. It was seeded on 407,000 acres in 1974. Ward yields significantly more than Rolette. A 15 per cent increased yield over Leeds would mean an increased gross return to North Dakota farmers of over \$12 million.

The hard red winter wheat program started four years ago. It is increasing the winter hardi-

ness, rust resistance and other desirable characteristics. More than 80 per cent of the present hard red winter wheat acreage is being seeded to more winter hardy types, reducing the chances of winterkilling and cost of reseeding. The breeding program has some promising experimentals for consideration.

Different varieties and different seeding techniques for hard red winter wheat have greatly increased survival percentage in eastern North Dakota. Seeding in soybean stubble, seeding in firmer seedbeds and other cultural practices have increased survival in eastern North Dakota enough to cause some interest in commercial production, depending on development of more winter hardiness, greater rust protection and better baking quality. Adapted hard red winter wheat would have higher yield, distribute the work load better and provide another cropping alternative for North Dakota farmers.

#### **Total Weed Control Program**

North Dakota State University weed control research involves field, greenhouse and laboratory type of work integrated into a total program under North Dakota conditions. Field work includes evaluation of herbicides used in the control of weeds in major crops such as small grains, corn, soybeans, flax, dry beans and sugarbeets to provide information to aid farmers in the use of these chemicals. In addition to evaluation, research is conducted to improve the performance of existing herbicides and to develop new weed control practices as well as to study the biology of weeds.

The annual loss from weeds in North Dakota is extremely high. A survey of fields across the state indicated that wild oats alone caused at least \$200 million loss in 1973. Presently, NDSU weed control researchers are developing the use of four new herbicides for wild oats control. Some have excellent potential for substantially reducing this annual loss.

NDSU research leading to the development of triallate (Far-Go) granules applied in fall for wild oats control in wheat and barley permit application under trashy conditions for erosion control. Use has increased and at the same time has reduced possible erosion. The value of reduced erosion is priceless in conservation of valuable topsoil and preventing downstream siltation. Expanded use would be to fields with known infestation. A 30 per cent wheat yield increase is likely or about eight bushels per acre. Figured at \$4.00 per bushel, minus treatment cost of \$8.00 an acre, leaves a net of \$24 per acre on up to 100,000 acres, or a total of



\$2.4 million saving potential to North Dakota farmers.

NDSU research has improved the efficacy of barban (Carbyne) for wild oats control through basic studies which determined the influence of various environments upon barban action. About 500,000 acres have been involved, but use should expand because of improved reliability. A 500,000 acre increase in treatment with a six bushel per acre increase would mean a \$19 net increase, or \$9.5 million of potential added income per year to North Dakota farmers.

Sugarbeet weed control research has replaced about \$10 worth of hand labor per acre above herbicide costs on 165,000 acres in 1974 alone.

Perennial weed control research indicates that improvement in control of field bindweed could easily increase wheat yields five bushels per acre on about 50 per cent of the field bindweed infested area. Field bindweed infests about one million acres in North Dakota and competes vigorously with crops.

#### **Pesticide Residue Studies**

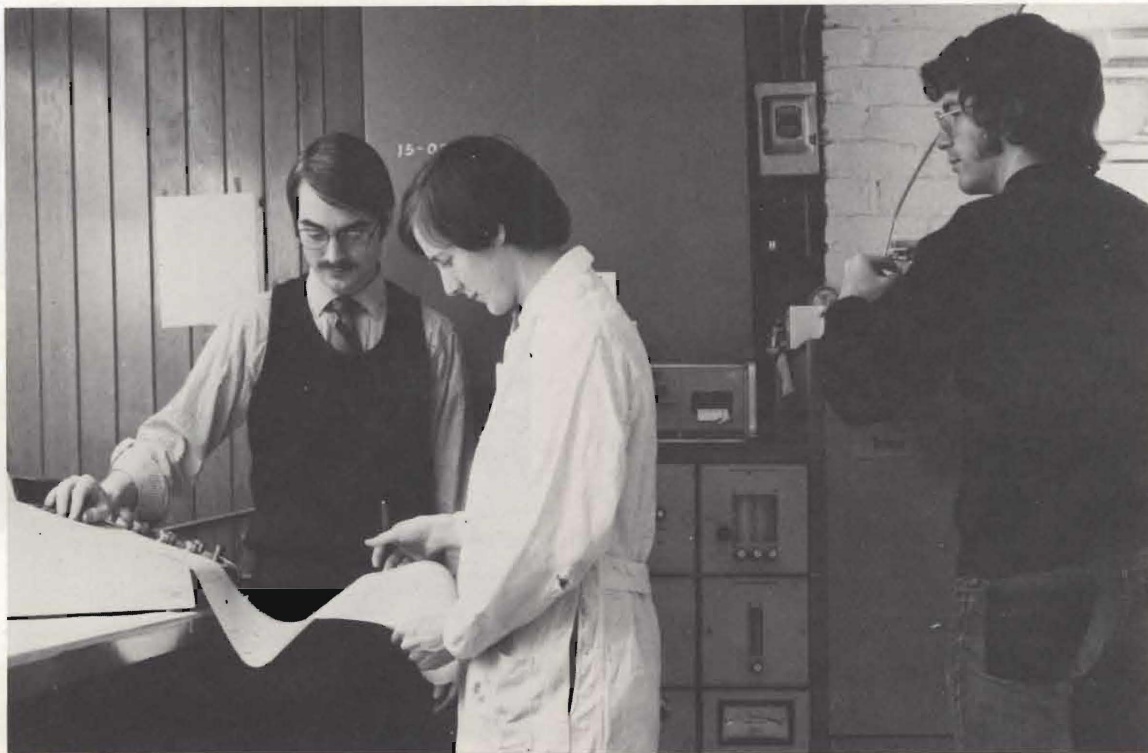
Pesticides play a major part in agriculture's ability to provide sufficient quantities of quality food. In order to insure the proper use of pesticides and to protect consumers, wildlife and the overall environment, new laws and regulations

have been enacted. Such legislation, along with the rising costs encountered by the chemical industry in developing new products, has reduced the number of pesticides available to agriculture.

The Residue Research Laboratory of the Department of Biochemistry was established in 1971 in response to North Dakota's need for pesticide residue studies. The major emphasis of this program is to understand the environmental implications associated with the use of certain pesticides and to obtain data relative to registration of specific pesticides for use on crops grown in this area.

Since its establishment, the Residue Laboratory has conducted studies involving several pesticides. Residue and metabolism data obtained in a cooperative project with the Department of Horticulture resulted in the permanent clearance of 2,4-D for use as a foliar spray on potatoes. This research effort involved the resources of the Agricultural Experiment Station, the Red River Valley Potato Growers' Association and Dow Chemical Company, as well as USDA.

A similar study being conducted with the Department of Entomology is directed at obtaining residue data needed to clear toxaphene for use on sunflowers. Another study in cooperation with the Department of Plant Pathology is directed at clearing specific fungicides for use on safflower. This minor crop may increase in import-



**Dr. Douglas Bristol, Department of Biochemistry, and Technician Leonard Cook examine results as Technician Ron Icenogle operates a gas chromatograph in the Pesticide Residue Laboratory.**



ance, as it shows promise for controlling saline seep problems in western North Dakota.

The Residue Laboratory is conducting basic research studies on the metabolism of 2,4-D, North Dakota's most widely used herbicide, in wheat and potatoes.

In addition, the laboratory helped develop a very sensitive analytical method for determining mercury residues in environmental samples. This method is used by the Department of Animal Science at NDSU to determine that the environment and food chains in North Dakota have not been contaminated by years of mercurial fungicides use.



The Department of Cereal Chemistry and Technology is working to develop a high-protein pasta product under a National Wheat Institute grant. Technician Candace Brassard and Dr. Abdelmonem Seyam inspect one of the products.

### Wheat and Barley Quality

The requirement by industry for high quality durum and hard red spring wheat and acceptable malting barley is still a major consideration in developing new varieties for North Dakota. During the past two years, price and demand for cereal grains has caused processors to utilize what they can get. However, the need for high quality in these three cereal grains continues to increase. North Dakota has to maintain its unique position as a major supplier of high quality spring wheat and barley.

Much of the research being done in the Department of Cereal Chemistry and Technology is designed to maintain these objectives. An expanded durum wheat and pasta research program was initiated last year through a \$230,000 grant received from the National Wheat Institute and the North Dakota State Wheat Commission. The grant provided for the study of the various unique physical and chemical properties of durum wheat and its products. One of the major objectives of this research was to develop an acceptable pasta product in appearance, taste and texture that would have improved nutritional value over present products. This objective nearly has been reached through a formulation containing durum wheat semolina and concentrated soya protein. A number of other formulations have shown promise. The use of durum wheat semolina as a snack food ingredient is being investigated and has good promise of being accepted by the food processing industry. New uses for durum and hard red spring



Dr. Tadeusz Habar, first post-doctoral fellow in the Department of Cereal Chemistry and Technology, studies the effect of protein differences on wheat processing qualities.



wheat will insure a continuous demand for high quality North Dakota wheat.

Special studies are being conducted to improve the nutritional properties of bread by incorporating proteins obtained from beans, peas and sunflowers with hard red spring wheat flours. Most of the amino acids that are deficient in wheat are found in these crops.

The pentosans are being studied for the role they play in bread baking. It appears that these carbohydrate components and others play a significant part in water-binding capacity of bread doughs.

A new method has been developed for the machine color-grading of barley. At the present time, color-grading of malting barley is done by a visual examination. The method, if adopted by federal grain inspectors, will eliminate the inconsistencies of the visual method.

Several new procedures have been developed to improve the quality evaluation of properties of durum wheat. A micro-milling and semolina purification system has been devised to increase the speed and efficiency of processing nursery durum samples. In addition, a 20-gram milling procedure is being used to obtain enough semolina to select high color lines of new durums.

Several manual procedures currently in use in the barley program are being adapted to an automated system of analysis. This should increase the accuracy and speed of determinations.

A number of research problems involve basic studies on the lipids of durum wheat and the role they play in the destruction of colored pigments in durum wheat. Special studies are being conducted on the development of durum wheats having more desirable protein properties for taste and texture of pasta products. The structure of grains is being examined microscopically for their relationship to milling and processing properties.

#### Alternatives for Insect Control

With increasing concern about the effects of hard pesticides on the total environment, it is imperative that considerable emphasis be placed on the development of controls which are less harmful when placed in the field to control pest populations, and at the same time help manage these populations to the satisfaction of all concerned.

Control of insect pests with diseases is an alternative method under investigation at the North Dakota Agricultural Experiment Station. In the future, major portions of the effort will



Healthy tent caterpillars (above) contrasted with one infected with *Bacillus thuringiensis* (below) in Department of Entomology research.

involve screening diseases for insect control, establishing procedures to produce pathogenic microorganisms for large scale field tests, studying problems inherent in the use of pathogens for insect control, including the effect of the environment on disease-causing organisms when they are applied in the field, and testing application procedures for dispersing pathogens for pest control.

Since time and other resources do not permit intensive efforts on all problems, investigations will involve primarily a screening program for microbial insecticides and pathogens which might be used alone or in conjunction with other insect controls, a search for efficient procedures for the application and dispersal of microbial insecticides, and a study of resistance to microbial control agents which might be acquired by insect pests.

Several types of insect diseases occur in the fields in North Dakota. These included fungi, bacteria and viruses. The bacterium, *Bacillus thuringiensis*, has been used for insect control for



several years, and is effective against a number of pests. Formulations of the bacterium are available commercially. Resting spores of several fungi which infect insects can now be produced in quantity on artificial media. Because of this, the potential for reliable insect control with these fungi is much greater. Examples of fungi which occur in insect populations in North Dakota, and which might be used for control, are species infecting grasshoppers, flies and the forest tent caterpillar.

Other types of insect control which will receive continuing and increased investigation include resistance to pests in host (crop) plants and practices involved in crop culture. Changing or modifying certain practices, for example planting time, crop rotation and tillage practices, can help crop plants tolerate or evade attack by pests. Also included in other control methods will be the use of growth regulators and hormones which upset the normal development of an insect.

The ultimate goal is to develop programs for integrated control and pest management which use combinations of the above and other controls, including conventional chemical insecticides when needed, to maintain pest populations at or below a predetermined non-economic level.

### The NDSU Insect Collection

No one can possibly know by sight the more than 12,000 different species of insects which probably exist in North Dakota. The Department of Entomology insect collection serves the entomologists in somewhat the same manner as a dictionary in the definition of words. A reference collection of authentically determined insects is essential for the entomologists of the North Dakota State University so that they may identify the many insects being constantly sent to them for identification. There are several reasons why the department needs such a reference collection.

1. In plant regulatory and nursery inspection work, a lack of knowledge may permit entry of insect pests into new territory, or inspectors may condemn a shipment which contains only harmless insects. For example, California requires the examination and certification of shipments of grain into that state to be free from the cereal leaf beetle.

2. Certain insects transmit diseases of man and livestock, while other insects are only annoying. Two species of mosquitoes are especially involved in transmitting encephalitis, yet to the layman they are similar to the several simply annoying species. A reference collection helps to identify the culprits.



Dr. Richard L. Post, curator of the insect reference collection in the Department of Entomology, inspects some of the specimens in the immature insect reference collection.

3. Much money may be spent in an attempt to control harmless insects which may superficially resemble injurious species. The closely-related European corn borer and sugarbeet webworm look alike, but have different life histories and control measures.

4. With the introduction of the highly specialized new insecticides it is becoming increasingly important to determine species. For example, barley thrips are hidden between the leaf sheaths of barley and durum and are safe from contact residual insecticides, thus only an insecticide with penetrating and fumigating action is effective against them.

5. Many times during the year, specimens are received with the statement that they are causing injury. Often they are beneficial and are actually preying upon injurious species. Following seasons of aphid abundance, many light cocoons of the predatory aphid lions and Hymenopterous parasites will be found on top of grain in trucks and storage bins.

North Dakota is of special interest to taxonomists due to its being a transition zone where eastern and western, northern and southern species reach their limits of distribution. In 1974, a total of 37 shipments totaling 12,596 specimens were sent to authorities for identification, and 17 lots containing 6,398 specimens were returned

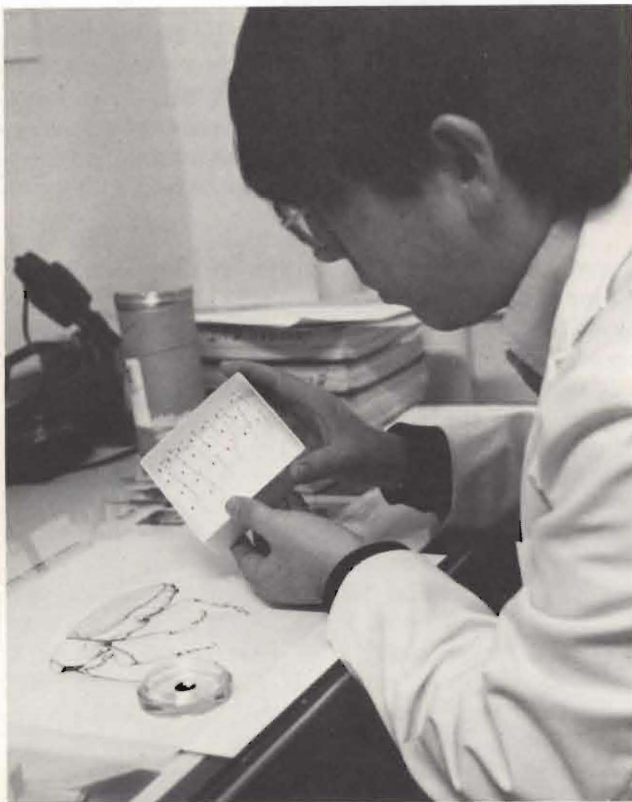


from specialists bearing their determination labels. Six loans totaling 2,125 specimens were sent to specialists and two lots totaling 47 specimens were returned.

Eighteen groups of Minnesota Wildlife FFA participants totaling 130 students studied special displays, with 150 competing in the district finals held at NDSU. Fourteen groups from Minnesota and North Dakota schools viewed special insect exhibits in Morrill Hall.

When Dr. R. L. Post was appointed the first curator in 1946, there was a total of 29,600 insects in the collection. In 1973 alone, more than 20,000 specimens were added to the insect collection which now contains 220,000 pinned or preserved insects, 7,000 microscope slides and 233 Riker display mounters. The insect collection is housed in 20 wooden cabinets containing 762 glass-topped Cornell University-type drawers and nine cabinets for housing the 19,800 vials and jars in the preserved storage system. The tops of the insect cabinets have illuminated display areas to show 31 exhibits of either showy insects, insects of seasonal interest or classroom reference review specimens.

The total original cost value of the insect collection is \$62,000, with a current replacement value of \$150,000.



Dr. Christian Oseto, Department of Entomology, is working on control of a weevil complex currently attacking sunflowers.

### Seed Weevil Studies

The increased domestic and world demand for vegetable oils has prompted many growers to include sunflowers as a part of the crop rotation. However, during the 1974 growing season, a new sunflower pest complex was discovered in North Dakota which has the potential to severely limit sunflower production.

The pests, *Smicronyx fulvus* and *S. constrictus*, are commonly known as seed weevils. These small beetles, approximately 2.8 mm in length, are characterized by a long snout. The two species are easily distinguished on the basis of color. *S. fulvus* is reddish-brown and *S. constrictus* is grayish-black. These weevils are not unique to North Dakota and have been collected from New Jersey to California.

The adult weevil appears in midsummer, punctures the soft hull of the sunflower and feeds on the kernel. When egg laying occurs, the female weevil lays a single egg in the feeding puncture. The egg hatches into a white, legless larva that feeds within the seed. It is this feeding which causes loss to the grower. After feeding, most of the larvae chew an exit hole, burrow into the soil and build earthen cells. Mature larvae overwinter in these cells. Pupation occurs in the soil and requires about eight days to complete. Other larvae may overwinter and complete development within the seed.

Both species appear to be confined to light, sandy soils in southeastern and south-central North Dakota. Infestations as high as 50 per cent have been recorded, with 80 per cent of the seeds infested in a single head.

Research is underway to investigate and evaluate seed weevil control techniques as well as basic biological studies. In addition to chemical control, cultural practices and the use of biological agents will be tested and evaluated.

### Horticulture and Forestry Research Farm

On January 31, 1974, final papers were signed for the purchase of 80 acres of land one and one-half miles east and one mile north of Absaraka, North Dakota. This land was purchased basically for a horticultural and forestry research site.

The legal description of the land is the west one-half of the northeast one-fourth Section 35, Township 141 North, Range 53 West of the 5th Principal Meridian, Cass county, North Dakota. The soil type is Spottswood sandy loam underlain by a water-bearing gravel layer. Under this gravel layer which extends from two to five feet below the soil surface is a deep layer of medium loam. This research land provides ideal horticultural



soil for evaluation and breeding projects for North Dakota.

The surface of the area is relatively flat as indicated from a topographical survey made by the agricultural engineers. The slope of the land is from the northwest corner to the southwest amounting to about five feet.

The area has excellent windbreak protection from the north, west and south.

Plans for the area are to develop a continuous roadway about 330 feet in from the outer boundaries. Placing the road in this manner will allow for the same maximum depth for all plots. Access to this road will be from the township road from the north, and about 800 feet from the west corner.

A multiple-purpose work and storage building is anticipated. Since electricity is accessible, it is hoped that a small office section could also be constructed.

Other future plans include irrigation development. Shallow wells (20 to 30 feet deep) are presently located north and south of the area. This indicates that a water supply may be available.

Planting plans are being developed to establish permanent plantings of ornamentals and fruits. Annual crop areas are not yet stabilized, since these can be planted in areas not filled with permanent plantings.

### The Birth of an Arboretum

Approximately 35 acres of the new Horticulture Farm at Absaraka, North Dakota, will be used for evaluation and selection research on woody ornamentals, particularly trees and shrubs. Vines and ground cover plants may be added in the future.

An excellent start was made in getting an arboretum off the ground (or into the ground) in North Dakota when some 260 accessions of woody plants were transplanted to the new site in 1974. The main planting is being laid out in an informal or naturalistic manner, rather than in an unnatural or formal row-type planting. Trees will be grouped according to genera and surrounded on all sides by similar groupings of shrub genera. This will permit ease of viewing because the shorter materials will be located near the edges of the planting and are being arranged in alphabetical sequence which will also make the arboretum much more valuable for systematic tours and student teaching purposes. For example, **Acer** (Maples) will be planted before **Betula** (Birch) and **Rhus** (Sumac) before **Spiraea** (Spirea).

By alphabetizing the genera and including both evergreens and deciduous plants, a mixture of deciduous materials interspersed with evergreens will result which will add much to the natural aesthetics of the arboretum. As the various tree groupings grow in size, micro-climates will be produced due to the protection and shade afforded. This will permit trial plantings of a number of materials which would normally fail under open, exposed field conditions.

Until 1974, land acreage for woody plant research was critical. Only small plots were available at NDSU branch stations, and the heavy, poorly drained and aerated clay soil at Fargo is not satisfactory for long-term woody plant research. The Spottswood sandy loam which characterizes the new Horticulture Farm should prove excellent for trees.

There is a real need for increased research on woody plants. Such diseases as Dutch elm, apple scab and fireblight are taking an increasing toll, annually. In the past five to 10 years, dozens of new cultivars of trees, not to mention shrubs, have been introduced that need to be evaluated in North Dakota. Interest in ornamental plants, landscaping and beautification has increased markedly, and nurserymen cannot keep up with the tremendous increase in demand for nursery stock.

Establishing an arboretum in North Dakota will benefit anyone wanting to learn more about landscape materials. Such a planting will be a real asset to students and the nursery industry, and should help to promote propagation of nursery stock locally rather than all out-of-state.

Research presently includes selecting improved trees for the Northern Plains. In 1974, a major planting of **Fraxinus** (ash) was made at the new Horticulture Farm, covering more than three acres. This planting includes 41 selections of green ash which were propagated by budding or grafting to keep the superior growth habit characteristics of the original tree. Four named cultivars and four species of ash were also included.

Four trees of each green ash selection were transplanted, two deeply in order to bury the graft below soil level and two shallow to maintain the graft above soil level. By planting in this manner it is possible to study the effect of the rootstock upon the scion selection. If the graft is planted below soil level, the scion selection should go on its own roots, whereas trees planted shallow will continue to be dependent upon the rootstock. Selections of other trees in addition to green ash have been made and are being incorporated into field evaluations at the new Horticulture Farm.



### Look for Flax Rust Resistance

The major objectives of the flax rust project include selfing and crossing the fungus (*Melamp-sora lini*) to investigate the inheritance of virulence and to produce rust cultures with virulence combinations useful in testing flax varieties for specific resistance genotypes. These tests will aid the development of flax varieties with multiple genes conditioning resistance to flax rust. This work carried out in cooperation with Dr. David Zimmer, ARS, USDA will provide plant breeders Drs. J. Thompson, ARS, USDA and J. Hammond important tester materials since flax varieties multigenic for resistance to rust should provide more stable long-term protection than varieties containing single genes for resistance. Selfing studies provide a better understanding of the virulence potential of the natural flax rust population. Selfing and crossing the fungus also provides information about the inheritance of virulence of *M. lini* so that a more intelligent choice of genes for resistance can be made. Resistance to flax rust is one of the most important factors in flax culture and of great economic value to growers in North Dakota.

Spray trials have demonstrated the potential destructiveness of wheat leaf rust to be as high as 33 per cent, or up to 14 bushels per acre. Studies into the biochemical nature of resistance coupled with other research into the genetic nature of resistance allows plant pathologists to evaluate resistance more intelligently. The development of leaf rust resistant wheat varieties by plant breeders in cooperation with pathologists saves North Dakota growers millions of dollars annually from losses due to leaf rust.

### Veterinary Diagnostic Lab

The Veterinary Diagnostic Laboratory at NDSU does not conduct research as such, but is involved in day-to-day evaluation of animal disease, providing diagnostic and laboratory support to practicing veterinarians.



Graduate student Glenn Wehtje seals ampules of wheat leaf rust used in plant pathology research work.



Dr. Glen Statler, Department of Plant Pathology, stores the ampules of wheat leaf rust in liquid nitrogen to preserve them for use when needed.

In 1974, the diagnostic lab handled over 3,400 cases by a variety of diagnostic procedures, including gross and microscopic pathology, bacteriology, virology, serology and toxicology, as deemed necessary by the pathologist in charge in consultation with the practicing veterinarian.

New procedures recently initiated at the NDSU lab include microagglutination procedures for diagnosing leptospirosis, expanded analytical capabilities in veterinary toxicology and an original rapid method for measuring mercury, copper and zinc in liver tissue.

The case load at the diagnostic laboratory has increased dramatically in recent years. The number of cases processed annually now is nearly double that of the late 1960's.