A fourth major study is concerned with the internal structure and composition of enzymes. Using the techniques of nuclear spectroscopy and fast reaction kinetics it has been possible to define some of the changes that occur in enzymes as the various enzyme catalyzed reactions are executed.

Through collaboration with the adjuct faculty in the USDA Metabolism and Radiation' Research Laboratory we have probed into the biochemistry of the insect cuticle — the outer surface of insects. Other collaborative studies have reported how plants convert pesticides, especially herbicides, when these are applied in the field and what happens to the pesticides when animals eat treated crops.

The progress and findings in the research studies are best summarized in the 210 technical reports, 25 Doctoral theses and 36 Master's theses that have been prepared over the past two decades. Each of these reports and theses relates some phase of progress on an Experiment Station research project.

The progress in the development of the research and teaching programs in Biochemistry has been achieved through the close cooperation of the Agricultural Experiment Station, the various academic units of the University, including the College of Agriculture, and the United States Department of Agriculture. This close cooperation has made it possible for a sharing of the talents and knowledge of a limited number of scientists who, in turn, share in the use of research and teaching facilities which have been provided jointly by the cooperating units. A large measure of credit for this harmonious working relationship is due to the skillful administrative leadership provided by Dean and Director A. G. Hazen.



BOTANY

H. Goetz, Chairman

One beautiful morning in late June of 1952 a group of nine persons was gathered around a small plot in the middle of a field of grass near the road leading to the Dickinson Experiment Station. Some were kneeling over the plot; others had their heads bent downward in a seeming attitude of reverence; one was speaking quietly and earnestly; all were attentive. Obviously the occasion was one of importance. A car stopped on the road, the door slammed, and a stocky gentleman of youthful but thoroughly competent appearance approached the party through the grass. What he saw when he reached the place where the group was gathered was not a wake for the deceased, but rather a small block of grass enclosed in a 1' x 3' metal frame, and the kneeling individuals were busily counting the number of stalks of grass within the area delineated by the frame. Dean Hazen was witnessing for the first time some of the work of the Botany Department in grass and range management being done at the Dickinson Station. Obviously what Dean Hazen saw that morning so long ago was a student training session in identification and enumeration techniques used in grass and pasture research. His comment as he turned to go back to his vehicle reflected his concern for efficiency in research operations: "I couldn't help but wonder what was responsible for such a large concentration of man power on such a tiny area."

Early Grass and Range Studies:

Almost from the beginning much of the work of the Botany Department in grass and range and pasture management has been centered at and done in close cooperation with the Dickinson Experiment Station. Without this close association the work in western North Dakota would have been essentially impossible to do. The earlier work, prior to the time when Dean Hazen became administratively associated with the Main Station, was mainly concerned with studies defining major range vegetation types in western North Dakota, evaluating grass production on these types, and making preliminary studies on growth characteristics of important native range plants.

This basic research on ranges in western North Dakota, aspects of which have been continued to the present time, has paid off handsomely in terms of contributing to the development of basic concepts of range evaluation and management currently in use by ranchers and farmers, government agencies, and by students of range management throughout the Northern Great Plains.

At the same time that these studies were being conducted a continuing program of grass variety and species testing was carried on at the Dickinson Station. During this period almost every grass species and variety that showed some promise for use as pasture or hay in the Missouri Slope country was tested for yield and hardiness at the Dickinson Station. Farmers and ranchers of the area were able to see these varieties at firsthand and to make their own judgments as to whether they would be useful in their own grassland management programs. The testing and evaluation of grass varieties at the Dickinson Station has been continued to the present time with the latest trial involving over 90 different grasses.

Another phase of the earlier work at the Station was the determination of the chemical composition of major native and introduced grasses with special reference to carotene, protein, and phosphorus. This project was cooperative between the Botany and Animal Science Departments and the Dickinson Station. For many years this study constituted the most definitive work on the potential nutritive value of range and pasture grasses in western North Dakota.

Grazing Trials Begin:

Pasture trials began at the Dickinson Station during the period that Dean Hazen was acting as Assistant to the Director of the Experiment Station, while H. L. Walster was Director. Raymond J. Douglas was Superintendent of the Dickinson Station. The first trials compared crested wheatgrass and crested wheatgrass-alfalfa pastures for early season grazing, with the pastures being seeded in the fall of 1953. The actual trial with yearling steers began in the spring of 1955 and continued through 1961. This trial was watched with a great deal of interest by the farmers and ranchers of the area and demonstrated to many the potential for increased beef production through the use and demonstrated to many the potential for increased beef production through the use of crested wheatgrass pastures for early season grazing and native grass pastures for later season use.

Near the end of this grazing trial initial studies of the use of nitrogen fertilizer on seeded pastures and hay crops were begun. The results of these were so promising that it was apparent that nitrogen fertilizer could have a place in the grassland agriculture of the southwestern part of the state.

Initial Expansion of Grass Work:

By the late 1950's it was clear that the investigation of the use of fertilizers on ranges and pastures and the study of other practices which were showing potential for increasing grassland production in western North Dakota would require some additional personnel other than one part-time professional employee and such student help as could be recruited. To meet the need for increased grass work at the Dickinson Station Dean Hazen approved the appointment of Harold Goetz as Assistant Professor of Botany in 1961 with half-time responsibilities in range and pasture work at the Dickinson Station. A total of one scientific man-year of effort was thus to be directed to the grassland studies in western North Dakota.

The problem of fertilization of native grass ranges immediately became the target of new studies. This initial work with range fertilization clearly brought to the attention of ranchers and farmers of the area that while range fertilization showed much promise as a means of increasing range production, it would not be without its problems.

The practice of range interseeding was also brought under initial study on a small plot basis. Native range plots interseeded with alfalfa showed especially good increases in production, with some interseeded plots yielding over twice as much forage as the untreated check plots. The rough surface left after the interseeding treatment proved to be a barrier to the spread of the practice, even though it was demonstrated that substantial increases in yield could be obtained through interseeding.

A series of eight 6-acre pastures were seeded in 1961 and 1962 to provide a grazing trial comparing straight crested wheatgrass, crested wheatgrass and alfalfa mixture, and crested wheatgrass fertilized at 25 and 50 lbs/ acre. Grazing was begun on these pastures in the spring of 1964. Unfortunately, it was impossible to carry this trial to a definitive stage because the land on which it was situated was required for the construction of a new school by the city of Dickinson.

Preparation of a new series of pasture trials designed to evaluate a three-pasture grazing system using crested wheatgrass, native range, and seeded Russian wildrye pastures was begun in 1969, but actual grazing on these pastures was not to begin until 1972. In the meantime a most significant and productive phase of the grassland work of the Botany Department was about to begin.

Sheyenne National Grassland Work:

Following a conference between representatives of the Sheyenne Valley Grazing Association, U.S. Forest Service, and the Experiment Station in the summer of 1968, a cooperative program of grassland research was set up for the Sheyenne National Grassland in the sandhills southwest of Fargo. With the endorsement of Dean Hazen, Dr. William T. Barker was designated to work with the Grazing Association and the Forest Service to develop and implement this program, with actual field work beginning in the summer of 1969.

The Animal Science Department joined the Botany Department in the work on the Sheyenne Grassland in 1972 undertaking the determination of chemical composition and digestibility of different plant species. This work has since been expanded to include other trials both in eastern North Dakota and in the work centered at the Dickinson Station.

The appointment of Dr. Barker to the Experiment Station staff on a part-time basis by Dean Hazen increased the Botany Department's work assignment in the grass and range management area to about 1½ scientific man-years, and greatly enhanced the scope and effectiveness of the work being done.

Grazing Systems:

The potential for extending the grazing period and increasing grazing capacity through the use of different pastures at different times during the season was established in the 1960's, but the experimental work with one or two of these systems did not begin until the early 1970's. The grazing studies of the possibilities of system grazing in the western part of the state took the form of combining seeded pastures and native grass pastures, both fertilized and unfertilized in a season-long system. In the Sheyenne Grasslands the experimental procedure took the form of evaluating the use of three-pasture or four-pasture rest-rotation systems on native grassland.

The need for evaluating grazing trials with the cowcalf combination rather than with yearling steers was stressed by livestock operators, and in 1977 the trials at the Dickinson Station were changed to grazing with cow-calf units.

Another phase of the work at Dickinson recently begun is the evaluation of interseeded range pastures. The emphasis of this work has been on the development of interseeding techniques and equipment which leave the land surface relatively undisturbed while providing the adequate establishment of interseeded species. An integral part of these new trials is the actual evaluation of the interseeded pastures by means of grazing livestock.

Recent Developments:

Farmers and ranchers throughout the state have always shown a lively interest in the grass work, and this was intensified in the last few years by a greater realization of the potentialities for increasing production from ranges and pastures by means of system grazing combined with increased efficiency of overall livestock production operations. Working through the North Dakota Stockmen's Association and with the Experiment Station and Extension Service Consultation Board, livestock interests promoted additional funding and approval for land purchases to make possible expanded grassland and beef cattle research. The State Legislature provided additional funding for these purposes in 1973 and a new phase in range and pasture research operations was started. Under this program a permanent full-time professional grassland researcher was placed at the Dickinson Station and a full-time technician was provided to help him. Plans were made for additional land purchases for the expansion of grazing trials at the Dickinson Station and for the establishment of a grass and beef research station in central North Dakota to be operated primarily by the Department of Animal Science, but with the cooperation of other departments including Botany. Initial land purchases have recently been made looking toward the establishment of this research facility. **Basic Research:**

Basic research has been a part of the Botany Department's activities in grass work throughout its association with the Experiment Station program. This portion of the research program has had the support of Dean Hazen as Director of the Experiment Station and the support of the Superintendents at the Dickinson Station, including especially Raymond J. Douglas and Thomas J. Conlon, the present superintendent at Dickinson. Many graduate students have been involved in this part of the program, and their contribution to the successful completion of these projects has been very great indeed.

These studies have been too numerous to mention individually, but for the most part they have included floristic studies in various parts of the state, studies of the dynamics of range forage production supported in part by the National Science Foundation through the Grassland Biome Project of the International Biological Program, studies of native grass species adaptation and growth patterns in cooperation with other Great Plains States, studies of woody vegetation types and growth characteristics of individual browse species, definition of the characteristics of wetland vegetation and grassland types under the regional Environmental Assessment Program, and most recently in cooperation with the U.S. Forest Service studies of vegetation in ponds on mined land, shrubs for possible use in reclaiming mined lands, and ways of establishing native forbs on these lands.

An inventory of range resources on state lands was begun recently in cooperation with the State Land Department. While this would not qualify as essentially basic research, the evaluation of these lands involves the application of basic grassland evaluation techniques. Looking Back:

Looking back over the 27 years that Dean Hazen has been associated with the administration of the Experiment Station we see a pattern of continuous increase in the scope and support for grassland and grazing research. Obviously he has recognized the importance to our agricultural economy of the state's grassland resource of approximately 13 million acres, and he has been aware of the potential for increasing its production through both applied and basic research. This awareness has led him to allot research resources to this area in increasing amounts as the overall support for agricultural research has increased.

Dean Hazen's strong support for the integrated grassland and beef research program now being developed on an interdisciplinary basis by the Experiment Station has ushered in a new era in the development of the research basis for the more effective and profitable use of North Dakota's many grassland acres.