



Charles M. Smith, Chairman

SOILS

The last two-plus decades have been a period of major growth for the Soils Department. Reflections on the changes that have occurred could be extensive, but an emphasis will be made on only a few examples. Soil and water are basic to life. The study of these natural resources has grown from efforts by a very few to those of nearly 30 senior and junior professional staff members.

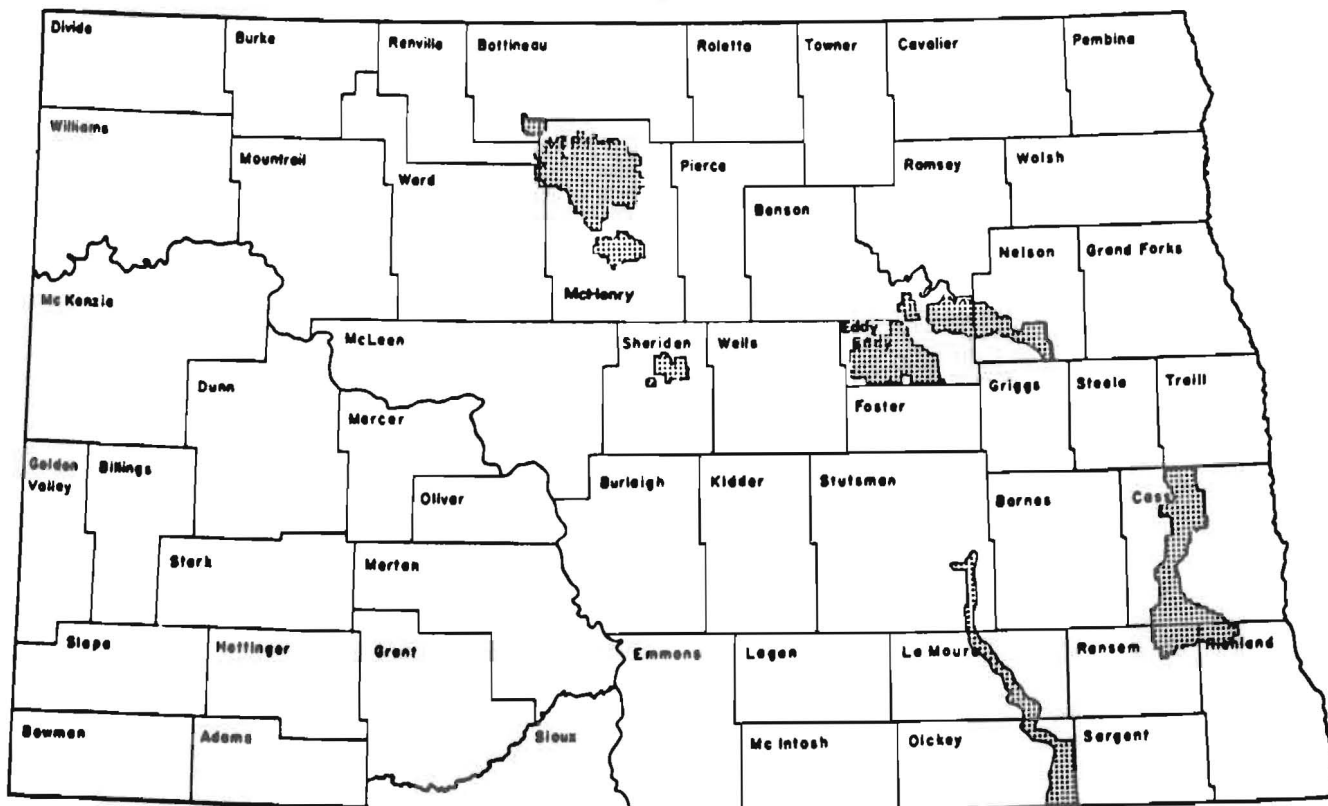
Organization of soil resource information by soil surveys has developed through different stages. In 1953 a reconnaissance soil survey of all North Dakota was requested by the Legislative Research Committee for purposes of improving equalization of taxes among counties. In due time this was completed with cooperation of the USDA Soil Conservation Service, and generalized county maps and a state map have resulted also. Our scientists continue assistance to tax equalization officials on an ongoing basis.

Interest in irrigation was spurred on by apparent potentials of the Garrison Diversion of Missouri River water. Mapping of soils in irrigation districts by Soils Department scientists has moved ahead steadily since 1956.

These areas are shown on the map in Figure 1. Surveys include the Tri-County area of Cass, Ransom, and Richland counties (1956-58) comprising 274,000 acres; the LaMoure section of the Garrison Diversion project (1958-60) in LaMoure and Stutsman counties with about 42,000 acres; Warwick-McVile areas (1959-60) in Eddy, Benson, and Nelson counties of 133,000 acres; the 85,000-acre Oakes Section of the Garrison project in Dickey County from 1961 to 1963; the New Rockford and the Warwick-McVile addition in Eddy and Benson counties (1964-69) of about 168,000 acres; the Lincoln Valley District of some 29,000 acres in Sheridan County (1970); the approximately 48,000-acre Karlsruhe District in McHenry County (1971-72); and currently about 115,000 acres is completed in the Middle Souris and Mouse River Irrigation Districts in McHenry County.

All of these surveys are accompanied by appropriate soil classification and analysis of chemical and physical properties. Many critical irrigation management decisions cannot be made without the details furnished in these high intensity surveys.

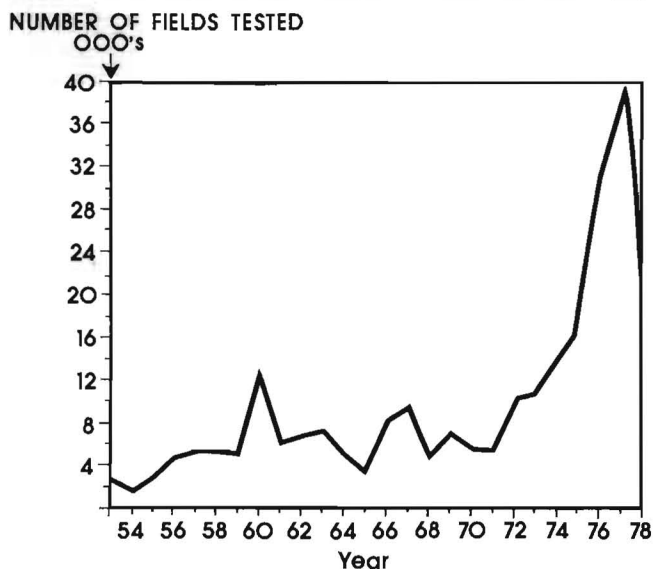
Figure 1: Mapping of soils in irrigation districts by Soils Department scientists has moved ahead steadily since 1956.



In addition to the surveys and associated research a highly significant multi-departmental effort labeled RIMS (resource inventory management system) has been developed. This system utilizes the storage of data into a computer system for later retrieval for land resource management decision making. Cooperative research efforts like this one involving Agricultural Economics, Soils and Botany have been encouraged by Director Hazen's office.

The kinds of research problems in soil fertility and plant nutrition and the use of information by farmers has changed markedly since the mid-'50s. The Soil Testing Laboratory was begun in 1953 by the Soils Department and use of this service grew slowly until 1972 as is shown in Figure 2. This graph of fields sampled shows a doubling of number in 1960, but it dropped back to a steady rate of change the following year. Extremely rapid growth began in 1972 when the acceptance of the nitrate nitrogen soil test became clear. Numbers of fields tested soared to nearly 40,000 in 1977, with approximately two samples being analyzed per field. The successful and popular test for nitrate nitrogen was introduced by the Soil Testing Laboratory in 1968. This decision was based on numerous experiments over a period of years, testing rates of nitrogen fertilizer and time and methods of N-fertilizer application. A drop in fields tested occurred in the year ending June 30, 1978, because of a wet fall in 1977, early snow, and a relatively late spring. This fall sample numbers are moving up again.

Figure 2: Use of the Soil Testing Laboratory.



Soil fertility research to the mid-'50s centered around the evaluation of phosphorus fertilizers for various crops, particularly on fallow, and on methods of predicting the need for phosphorus fertilizer. Besides research on small grain, such crops as corn, potatoes and flax were shown to respond to fertilizer additions. However, it was also shown that germination injury could be caused by too much fertilizer placed in the row, especially using materials containing nitrogen, with the greatest problems being with flax.

In the 1960's nitrogen status of soils and date of seed-

ing were shown to be key factors in determining acceptable or excessive protein percentages in malting barley. Soils Department research also showed that potassium (K) fertilizers improved barley kernel plumpness and yield, when the plant available soil supply was low. Currently, K deficiency has been shown as the causal factor for a leaf scorch affecting older leaves of sugarbeets.

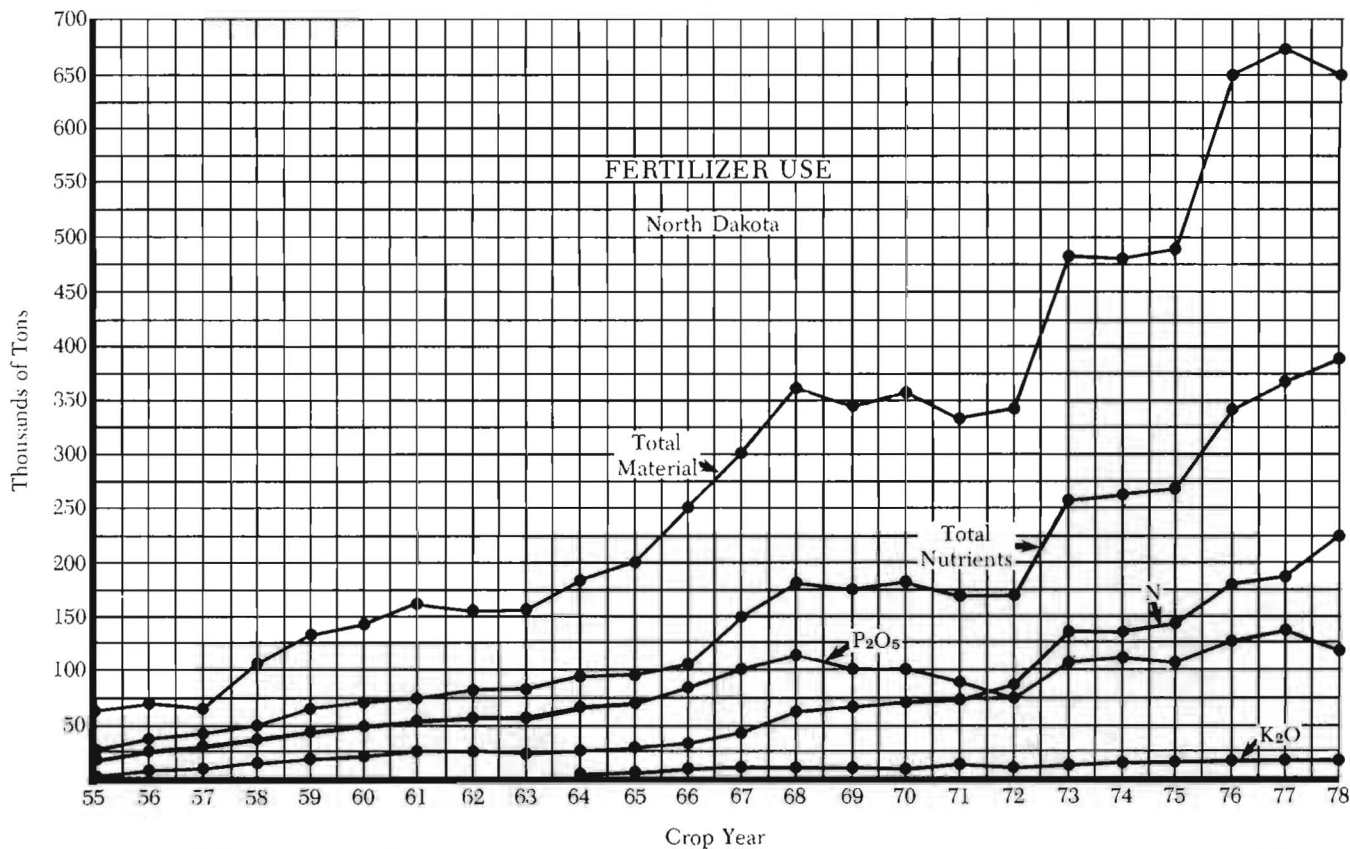
Fertilizer use in North Dakota since the mid-'50s has followed similar trends as soil testing. Much of the improvement in crop yields of the last decade can be attributed to improved soil management with greater and more correct fertilizer use being the most important factor. Figure 3 shows changes in total nutrients and in N, P₂O₅, and K₂O. Note the similarity in shape of curves with the curve in Figure 2. There is a "cause and effect" relationships between soil testing, fertilizer use, and research and educational efforts. Research on soils problems has provided data to substantiate the need for fertilizer, to establish the elements that were deficient, to serve as a basis for Extension educational programs and for fertilizer recommendations based on soil tests.

Soils Department research, especially in the last decade, has shown a much greater need for N fertilizers and a reduced need for P fertilizer in many soils. Educational programs and recommendations have reflected these results, which were caused by effective fertilization programs using ammonium phosphates and other high P fertilizers for periods of many years. This is the cause of only a small increase in use of P (P₂O₅) since 1972, whereas the N consumption has increased sharply during the same general period. The types of N fertilizers have changed markedly. Ammonium nitrate, which has been the standard for N fertilizers for many decades, reached a peak of 83,155 tons in 1975 but has dropped to one-third that tonnage in the year ending June 30, 1978. Nitrogen solutions had a steady growth until 1973 with a leveling since then. But the striking increases have been in urea and anhydrous ammonia causing a change in research emphasis. Urea use has shot upward by about 60 times since 1971 while anhydrous ammonia tonnage increased by 15 times. These changes were largely caused by availability and prices of product and are related to energy requirements in manufacturing along with lower atmospheric pollution.

Reduced tillage potentials for various crops have pointed to changes in emphasis on researching the influences of residues on storage and losses of water, soil temperature, wind speed at the ground surface, fertilizer use efficiency, the need for summerfallow, and ultimately the yields of crops. Residue management with snow trapping as a goal is a new area of research related to successful solution to a complex problem of saline seeps in many dryland areas. This research is on a problem of seepage of salty water from footslopes and other seep areas caused by water moving through the soil beyond the root zone in upslope recharge areas. Changed cropping practices to have crops growing on the recharge areas a greater amount of time than the 50% in crop of summerfallow are being investigated. The past two decades have seen a rapid increase in the seep problem and in the last ten years a change in our research emphasis.

Other changes in research emphasis in recent years include the beginning of a new effort to gain a better

Figure 3: Fertilizer in North Dakota



understanding of the crusting and compaction problems of soils, especially in the Red River Valley, with crops of first concern being sugarbeets and potatoes. Concerns about water and fertilizer management under irrigation have received much attention in the last decade. Studies at Oakes and other locations have concentrated on movement of nutrients beyond the root zone of crops and the efficiency of water and nutrient use as influenced by irrigation rates and time of application of water or fertilizer nutrients to different crops.

Much progress has been made in gaining a better understanding of irrigation and fertilization for different crops. This information helps minimize nutrient losses which might degrade ground water quality. Other aspects of irrigation include the beginning of efforts to evaluate the compatibility of irrigation water from ground water wells and soils having different physical and chemical properties. With irrigation from wells expanding, this problem is becoming even more urgent.

Agricultural climatology became an integral part of the Soils Department in 1969 when a staff position was created. Research has been toward cooperative efforts with other researchers both within and outside the department. Both microclimatic and larger scale problems are investigated including residue effects on water availability and soil temperature, other factors affecting evapotranspiration, and the providing of complete and current climatic data to researchers and the public.

Lysimeters with the capability of weighing water additions to, and losses from, the soil/plant system have been installed in central North Dakota to evaluate differences between nondisturbed and mixed materials as a

plant growth medium. These are a part of Soils Department efforts in mined land reclamation. The changes in evapotranspiration caused by strip mining reclamation procedures are important for an understanding of water balances for growing plants. During the early '70s an updated climatic station became operational at NDSU with a goal to provide needed base line data to support research on soils, plants, animals, insects, diseases, or other areas where such data are useful.

The impacts of soils, soil management, and air quality of strip mining and reclamation were accepted as research problems by the Soils Department in the early '70s. Several research efforts were undertaken with some funded mostly from outside grants. This work has continued with a major program now underway with a combination of State and grant funding including chemical and physical characterization of overburden materials, water recharge and availability, erosion and water runoff, crop and grass production, and many other problem areas.

The Soils Department has undergone gradual but highly significant changes since the mid-'50s. These include growth in numbers, occupying new quarters, expansion into new and always more challenging areas of research, providing more and better service to farmers and to the public in general. The difficulty of problem solving increases as new practices and higher goals are adopted by producers of crops or the users of soil, water, and climate information. Despite the phenomenal changes that have occurred in the recent past, many more exciting ones will surely appear in the future.