

AGRICULTURE USES UNIVERSITY'S COMPUTER FOR EXTENSIVE DATA ANALYSIS

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The computer is an information machine. It might be compared to a person with a photographic memory, and a fast pencil, but who is incapable of independent thinking. With appropriate and skillful guidance, the computer may become one of agriculture's most significant tools.

A computer consists of input and output devices, arithmetic and control circuits, and a memory. Equally essential to complete the picture is the program of instructions, which must be devised by man, that puts the system to work.

The computer accepts information through input devices. It combines this information according to the rules of the program with machine programmed information that is stored in its memory, and then sends information back through its output devices.

The first computer at North Dakota State University was installed in October, 1961. However, the College of Agriculture had been using data processing equipment since 1958. Utilization of the first computer increased steadily, and although more equipment was added, the capacity of the computer was saturated and research activities were hampered.

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The present Computer Center provides service to the entire University. The Center is administered by a director who is responsible to the President. The President also appoints faculty representatives to a University Computer Center Committee which makes recommendations to the director in areas of operation and future computer requirements of the University. This Committee is composed of representatives from each of the colleges, the Extension Service, Experiment Station, Library and University Administration.

In 1966 this Committee recommended that a proposal be submitted to the National Science Foundation to enlist their aid in financing an expansion of the computer facilities. The NSF awarded NDSU a \$230,000 grant to be used to acquire an IBM 360 computer. This grant was contingent upon the University's ability to furnish matching funds from non-federal sources. The IBM 360/50 computer was installed at NDSU in September, 1968.

Agriculture has used the computer mainly for data analysis, but this is not its only use. In the areas of genetics and animal breeding, computers are used to generate data concerned with specific genetic models. The same is true in agricultural economics where certain economic models are investigated. The U.S. Department of Agriculture is presently developing an information retrieval system which will provide Experiment Station personnel, along with other interested people, a readily available source of information on research being conducted at the land-grant colleges in the United States, along with summaries of the results of this work.

A summary of the Computer Center reports from July, 1969, through July, 1970, indicates that the College of Agriculture and Agricultural Experiment Station used an average of 19 per cent of the total computer time. This amounted to about 70 hours a month out of a total of 380 hours. In July and August, 1969, the Experiment Station used an average of 56 hours, while in July and August, 1970, the reports indicate an average use of 91 hours. This accounted for 24 per cent of the total computer hours. The Experiment Station has steadily increased its use of the computer and the number of hours of computer time required to process experimental data.

Departments in the College of Agriculture utilize the computer for a number of different tasks, with statistical analysis of experimental data of major importance to most departments. Problems which were too complex to be answered a few years ago can now be handled routinely on the presently available equipment. With most agricultural research work, time is very important. The longer it takes to analyze and publish data, the less valuable but more costly the data becomes, which makes the computer a very important tool.

A number of statistical programs are available to University personnel with faculty in a number of departments using the same programs. Other uses of the computer are unique to a particular department or area. Complex programs are often exchanged between universities, facilitating exchange of ideas, lower costs, and increased efficiency.

Computer usage by some of the departments in the Agricultural Experiment Station are presented in the following discussions.

Agricultural Economics

The IBM 360 computer has been used by Agricultural Economics at NDSU for a variety of research applications. One such application is the statistical measurement of demand for the transportation of hard red spring wheat and the demand for all classes of wheat in both domestic and foreign markets. Another application has been an extremely complex transportation analysis in which least-cost flow patterns have been identified for hard red spring, durum, and hard red winter wheat in United States domestic and export markets. Another study is now under way to analyze truck shipments of nonagricultural products to and from North Dakota.

Linear programming assists managers in determining how best to use the resources available to achieve specific objectives, such as maximum profit or minimum cost when the resources have alternative uses. Linear programming has been utilized

to obtain solutions to and analyze problems in four general areas: (1) farm reorganizations and adjustments profitable for farmers to make when faced with changing product and input prices, levels of technology, and institutional arrangements; (2) farm enterprise analyses, including selection of farm program alternatives, least-cost livestock rations, and machinery replacement decisions; (3) agricultural policy, analyzing the impact of alternative government farm programs on the income and resource use of individual farms as well as the impact on an area or the state's economy; and (4) resource economics, to determine the profitability of and economic justification for irrigation development.

Use of linear programming was limited until electronic computers were developed. Development of computers with amazing speed and capacity has made linear programming a useful tool for studying the problems of farm decision making.

The computer has been used to measure the income that is generated in the state as a consequence of the "new wealth" that is produced here by agriculture, mining, manufacturing and tourism. Such measurements have been used to evaluate the impact upon local communities and the state's economy of such activities as a new industry in a community and the irrigation that will occur as a part of the Garrison Diversion Project.

Another use of the computer involves processing large quantities of data. An example of such a problem is a research project conducted for the State Outdoor Recreation Agency. Questionnaires were received containing data for more than 13,000 persons and summarized for six age groups, six income groups, five residence groups, and 22 recreation activities for eight state regions. The availability of the computer permitted rapid analysis of these data for use in program planning by the agency.

Summary tapes of 1970 census data will be available from the Bureau of the Census prior to published reports. The summary tapes contain more extensive subject matter and geographic detail than the published reports. The use of the IBM 360/50 computer to handle the census data is a particularly important consideration for users involved in government programs and policies who depend on up-to-date census information about their local areas. The greater geographic detail available on the summary tapes is particularly important for determining legislative districts. The use of the computer enables census data users to broaden the scope of their analysis and application horizons beyond what can be accomplished with the printed reports.

Agronomy

Staff members in the Agronomy Department are using the computer to analyze research data collected from over 300 experiments conducted at Fargo and Branch Experiment Stations each year. Many of these experiments are used to compare the agronomic, pathologic, and quality characteristics of experimental lines compared with check varieties of hard red spring and winter wheat, durum wheat, barley, flax, oats, rye, corn, soybeans and sunflowers. Other experiments are conducted to compare the effects of herbicides on crops, weeds and soil; to measure the effect of various management practices on performance of forages; to evaluate performance of hybrid wheats and barleys; to measure the effect of artificially applied hail treatments; and to evaluate performance of triticale and other new crops, and new practices such as "coating" fall sown spring wheat with plastic. Another important use is for the rapid compilation of data from the hybrid corn performance trials each year. The hybrid corn performance results are immediately printed and disseminated to growers and seedsmen so they can adequately plan their seed needs for the coming year.

In many cases, the computer is used to produce the field randomization and planting plans for the experiments and also to print the books used to record field notes. The speed with which the computer can produce this information is of special help in instances where seed is brought back from Mexico or harvested in the greenhouse and planting must be done as soon as possible.

Special programs have been written to help summarize data collected from several locations for one or more years. The programs are written in such a way that results are printed in the form of tables that can be used directly in reports of various kinds. This direct printing saves time for the experimenter and the secretaries who would otherwise need to compile and type the reports, and also eliminates some chances for errors. Another special program is used to keep track of all the parental material used in the hybrid wheat program. By putting all of the parental information into the computer, the monumental task of keeping track of parents over several years is reduced to routine.

The department also analyzes agronomic experiments which are conducted by the Branch Experiment Station personnel at their stations and at any off-station locations. Results from trials at all experimental sites in the state are used in making recommendations to farmers. Results from specific locations are useful in determining if certain varieties are adapted only to limited areas. In 1970, over 110 experiments from Branch Stations have

been analyzed, resulting in a considerable time saving for them.

Animal Science

The Department of Animal Science was one of the departments utilizing data processing equipment prior to the time a computer was available on the NDSU campus. The computer is a very important tool in animal science, as it is used for analysis of experimental data, for teaching and for administrative duties.

Most experimental data is processed by the Computer Center, using both standard programs and others which have been written for specific purposes of the Animal Science Department.

Chemical analysis of the nutrient composition of feedstuffs is accomplished in the laboratory, with the computer used to solve the necessary mathematical calculations making the information available for applications by the staff.

Record keeping is a necessary but oftentimes time consuming duty of research projects and departmental administration. Special programs have been developed to assist in the administrative record keeping and in summary analysis of many of the research projects.

Special programs have been developed for maintaining records on college livestock, including lifetime production, pedigree information, inbreeding and relationships calculations, carcass data on progeny, type scores and other information necessary for indexing and selecting livestock.

Linear programming techniques have been used for formulating growing and finishing rations for swine. When compared to basal rations presently used, the computer calculated rations have been very satisfactory.

The department has cooperated with the North Dakota Beef Cattle Improvement Association in developing programs which provide the membership with information on their cattle, along with the calculations and information required in the Certification Program.

Cereal Chemistry and Technology

The Cereal Chemistry and Technology Department is involved in research on barley, hard red spring wheat and durum wheat. Since most of the U.S. supply of these grains is produced in North Dakota, research on the quality and industrial uses of these crops is important to the agricultural economy of the state. Dozens of research projects are conducted, thousands of samples are tested, and tens of thousands of individual pieces of data must be analyzed and interpreted by the computer each year.

For example, at harvest time each year, the department conducts a survey to determine the quality of the hard red spring wheat and durum wheat crops of North Dakota. This involves testing thousands of samples, tabulating and analyzing the data and publishing weekly as well as final reports. These reports are made available to domestic and foreign wheat buyers. Since these buyers plan their purchases in advance, this information must be in their hands as early as possible. To complete these wheat quality surveys and get the information to the buyers on time, fast computer service is essential. If delayed, these reports would be diminished in value and potential customers for North Dakota wheat could be lost.

Another research area where the computer plays an extensive role is in crop quality improvement. The Cereal Chemistry and Technology Department works along with plant breeders to improve the varieties of wheat and barley which are available for production in North Dakota. Most of the wheat and barley varieties currently in production in North Dakota have come through this quality testing program. The recent success in developing new varieties has been due, to some extent, to computer evaluation of quality data. By using special computer programs, thousands of new varieties may be evaluated and those selections having good potential can be identified.

Through the use of computer data processing and better analytical techniques, the time required in developing new varieties has been substantially shortened. Computer evaluation of quality data can be made in time to select the samples having good potential, so that the seed can be grown in Mexico in the winter and sent back in time for planting in North Dakota in the spring. In this way, two crops of experimental varieties are grown each year and the number of years to produce a new, improved variety is substantially reduced.

Research to discover the biochemical basis of quality is an important function of our laboratory. This type of work involves studying the carbohydrates, proteins, lipids, and enzyme systems of cereal grains.

Soils

The Department of Soils has a number of research projects relying very heavily on the fast and accurate handling of voluminous data by an electronic computer.

Daily climatic data from over 150 weather stations in North Dakota have been recorded in the last several years. The weather observations for each day of each year and for each station were

transcribed onto a computer card. However, handling a million-and-a-half computer cards proved to be impractical. For ease of handling and for a more efficient withdrawal of information, the Department of Soils has started to put all the data onto magnetic tapes. To date, 36 stations with the longest records (more than 40 years) have been put onto tape and processed.

Various agroclimatological analyses have been made from this data bank, kept and continuously updated by the department. Climatological summaries for each station have been made and are being prepared for publication. Probability levels of certain threshold temperatures important to agricultural production have also been calculated for each of the 36 stations. Rainfall and snowfall patterns in the state have been drawn from the computer analysis of these data.

More climatological analyses are planned by the department. These include analysis of severe winter temperatures, growing-season precipitation, frequencies of severe storms, drought, and many other climatically - derived parameters affecting crop production in the state.

Intensive measurements of elements making up the microclimate of the soil-plant-atmosphere system are also being made at the Experiment Station by the Department of Soils. These measurements include soil temperatures at various depths; and wind, humidity, and air temperatures within crop canopies. These observations are continuously and automatically recorded onto paper tapes, then transferred onto magnetic tapes. Again, the services of the Computer Center are essential in analyzing the large amount of data involved in this research project.

SUMMARY

Computers have not robbed man of his individuality, but have enabled technology to adapt to human diversity. The uses of computers in science have been in the role of a powerful research instrument and as active participants in the development of scientific theories. In technological applications, computers have been used to execute specific programs of instructions. In many organizations they serve key functions of communication and control. The information processing capacities of computers make it possible to use them to adapt mechanical teaching routines to the needs and the past performance of each individual student. Computers can do such things as set goals, make plans, consider hypotheses and recognize analogies.

The computer is here. Our challenge is to use it to the fullest capacity for our useful work.