

**THE USE OF COMPUTERS IN AGRICULTURAL
RESEARCH AND MANAGEMENT**

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INTRODUCTION

The development of the computer is another milestone in the history of mankind. All computers operate on one of two basic principles, analog or digital. Analog computers measure continuous quantities by monitoring a given medium as changes in proportion to the actual entity being measured. An example of analog computers are thermometers where the liquid expands or contracts with temperature. On the other hand digital computers operate by counting discrete ones. Most of the computers which are in use at present are digital computers. A calculator is a limited class of digital computer. It processes a particular set of symbols - the digits - that form the numbers - according to the rules of arithmetic. Unlike, a calculator, which must be spoonfed and where instructions disappear as they are executed, a computer has a memory and can carry out a specified sequence of instructions called a program. Because of its memory and decision making power, the digital computer is a symbol processing machine.

COMPONENTS OF A COMPUTER

The principal parts of a digital computer are shown in Fig. 1. A computer system consists of physical machinery called hardware and the programs that control the hardware are called software. The schematic view of the computer is given in Fig. 2. Each box represents a part of a hardware. A software gives the logical process needed to direct the computer to process information. Individual units of software that accomplish specific tasks are called programs. The people who write the programs are called programmers. The information processed by the computers are called data.

The principal part of a digital computer is the central processing unit (CPU), inside which is a control unit that processes numbers one by one and decides what to do with them. The numbers that the control unit recognizes as data are sent to the arithmetic and logic unit (ALU) where they are subjected to some form of arithmetic operation. Those numbers that the control unit recognizes as coded instructions are sent to the instruction decoding unit (IDU) where they are decoded and interpreted. The box marked input represents all the devices that can be used to enter the instructions or data for manipulation by the computer e.g. Key Board, Mouse, etc. The box marked output represents all the devices that can be used to make the results known to the outside world e.g. Video Monitor, Plotter, Printer, etc.

During the course of processing, the CPU may be directed to save certain numbers to be recalled later. The storage space consisting of cells is called the memory of the computer. Each computer memory cell has an address and

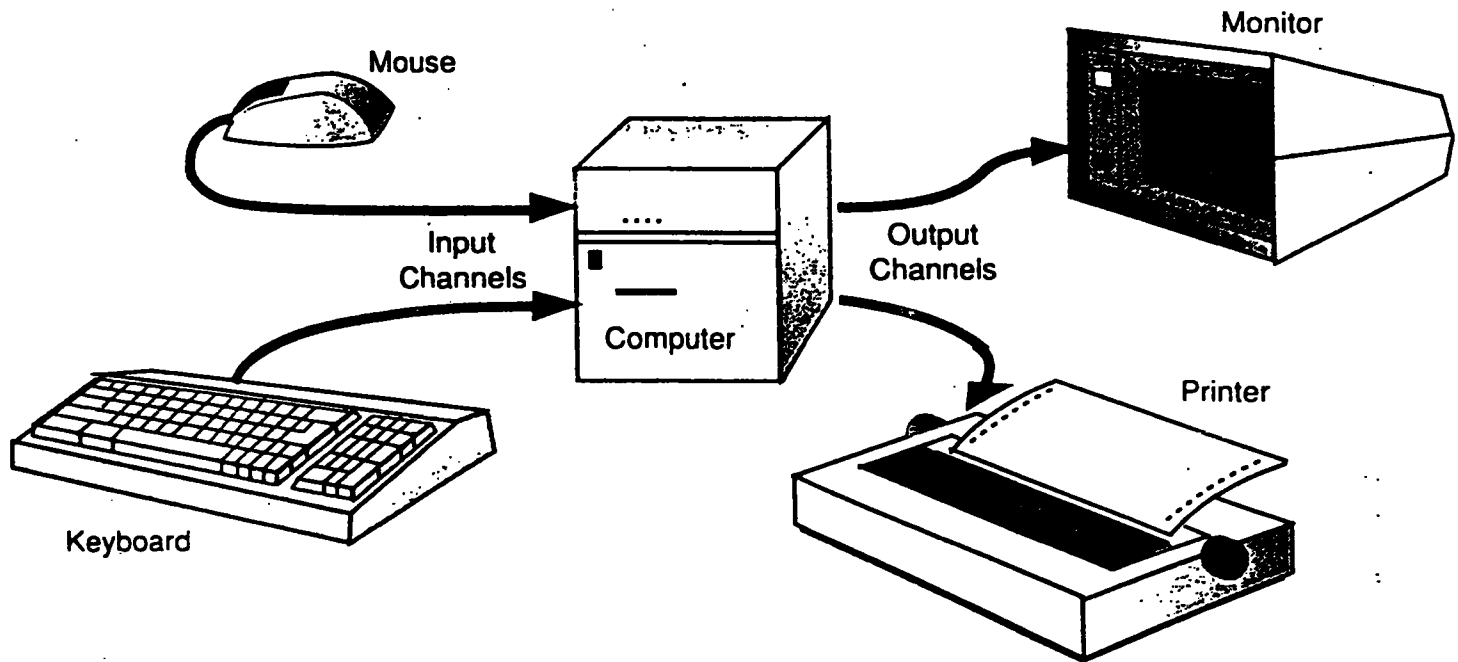


Fig. 1 - The principal parts of a digital computer

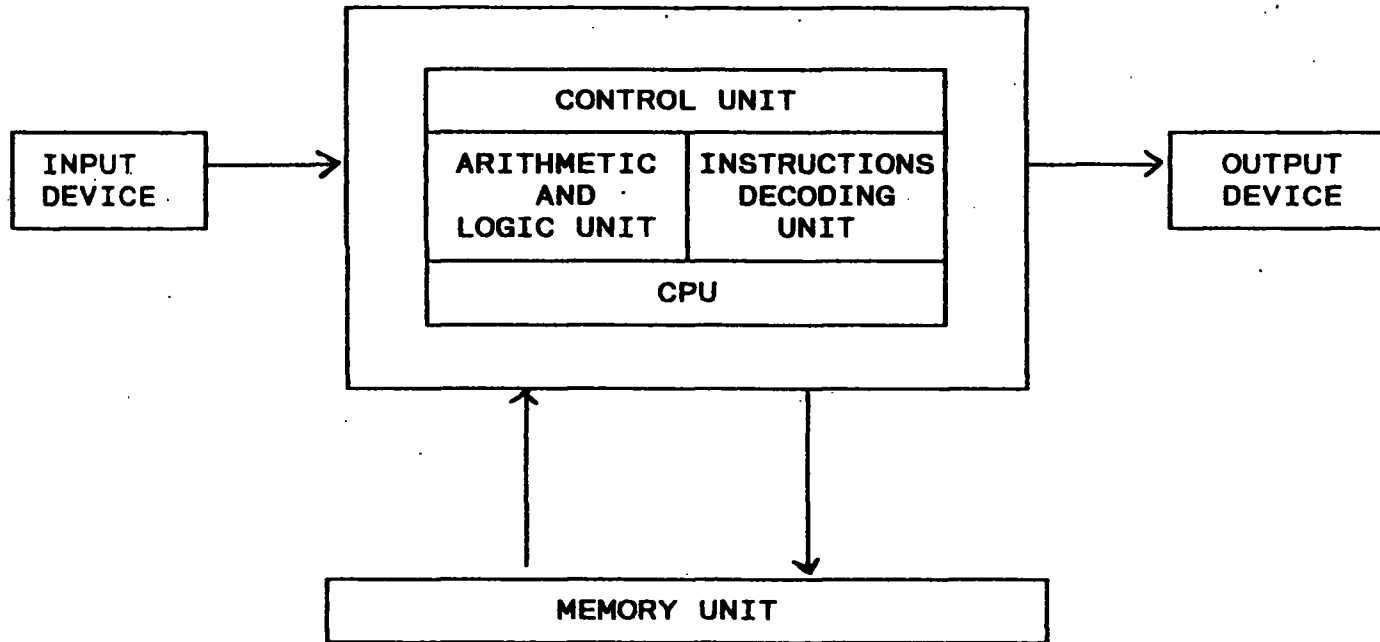


Fig. 2 - Schematic view of a computer

its contents. Memory can be volatile or non-volatile.

Volatile memory loses the information when electrical power is turned off whereas non-volatile memory does not lose information. Most computers have three distinct kinds of memory. They are main memory, a small number of registers and an auxiliary memory. The main memory holds the data and software that are currently in use. The registers are used by the control unit as a way station to hold information that is being processed or being moved to or from the main memory. Auxiliary memory is used to hold software and data over long periods of time. An example of auxiliary memory is floppy diskettes. The term random access memory (RAM) is used to indicate that the computer memory cell can be accessed in any sequence and access time is the same for each cell. Sometimes computers have a second type of memory called read-only-memory (ROM) a special type of RAM - where the contents of the cell can be read in the normal manner but a special apparatus is required to store a new value in a cell. A computer memory capacity is usually measured in bytes. A thousand byte is called a kilobyte. In this instance a thousand actually means 1024 and not 1000; memory is ordinarily built and sold in sizes that are powers of 2 rather than powers of 10 ($1024 = 2^{10}$).

TYPE OF COMPUTERS

The computers may be classified into 3 types, based on cost, memory capacity and processing speed. They are micro-computers, mini-computers and mainframes. The mainframe computers are large general purpose computers with large number of terminals and extensive processing storage and input output capabilities. Minicomputers are relatively

smaller version of mainframe computers. The largest research oriented computer is called the supercomputer. Micro-computers are often called personal computers which are widely used.

COMPUTERS AT RESEARCH

Computers are used as a research tool in research institutions. They are used for a wide variety of purposes. Software packages are now available for the researchers to handle and manipulate the data. Some of them are given below.

Electronic spreadsheets

In a research institute, researchers tend to collect mountains of raw data which needs refinement for data analysis. The spreadsheet allows one to quickly analyze and graph the result and to look at the relationship which remain hidden in a cursory look at the data. Electronic spreadsheets help the researchers by saving time and aiding analytical skill.

Statistical Analyses Designs

When a field trial is designed and carried out, the experimenter collects data either weekly, monthly or annually and interprets his results by doing statistical analyses. For instance take a simple design (the randomised block design) with 5 treatments and 3 blocks.

The above analysis of variance can be done within 5-10 minutes by using a computer compared to two or more hours on an electronic calculator.

The advantages of a computer are:

1. Correction of data can be done at any time.
2. Vast number of calculations could be done within a very short period of time.
3. Important data can be stored for future reference.
4. Results can be viewed on the screen or can be printed on a sheet of paper (hard copy) soon after the analysis.

All these cannot be done in an electronic calculator. Hence, in a research station where a large amount of data is handled for different statistical designs, it needs about 5-6 officers to complete that job in the conventional manner, whereas it can be easily handled by just one officer using a computer program, developed for the above job. As long as the program is correct there is hardly a chance of making a mistake.

SAS (Statistical Analysis System)

The SAS is a software system for data analysis. The goal of SAS is to provide data analysts one system to meet all their computing needs. If you learn only the SAS system there is no need to learn programming languages, statistical packages or utility programs.

The SAS software provides tools for:

1. Information storage and retrieval.
2. Data modification and programming.
3. Report writing.
4. Statistical analysis.
5. File handling.

The statistical analysis procedures in the SAS system are among the finest available. They range from simple descriptive statistics to complex techniques. Their designs are based in such a way that the SAS system can figure out the sort of work it has to be without being instructed by the user. Statistical integrity is thus accompanied by ease of use.

Fitting Regression Models

Crop yield is dependent on weather parameters such as rainfall, sunshine, etc and fertilizer inputs such as nitrogen, phosphorus, potassium and micro-elements. Crop yield is a dependent variable while weather parameters and macro-elements are independent variables. If an equation is derived between crop yield and the weather parameters or yield and levels of macro-elements, the crop yield can be predicted under similar types of situations. This fitted equation is called a model. Model fitting is a very difficult task in statistical analyses as it consists of selecting the best parameters among the others and further, each of these selections has to be done after a number of calculations. For example let us look at a simple linear model:

$$Y = b_0 + b_1 X + e$$

Y ----- dependent variable

X ----- independent variable

To fit a linear model using Y (dependent) and X (independent) variable you must estimate the coefficients b_0 and b_1 . A best fitted line can be plotted by using these estimated

values. All these can be done in a computer within a very short period of time.

Now let us take a look on complex models (multiple)

$$Y = a + t_1 X_1 + t_2 X_2 + \dots + t_n X_n$$

This is one of the most complex uses of computers both in respect to computations and the reasoning behind them. In this case there are a number of coefficients to be estimated. A computer program will help you to select the best parameters and also to fit a multiple model in a short time. Use of a computer to analyze complex computations of this nature takes only 1-2 hours depending on the number of parameters to be fitted whereas an electronic calculator may take a day or more.

Simulation Models

The computers are most useful in modeling plant and soil systems. The dynamic simulation models are very useful in answering the queries of Tea Planters such as the magnitude of the yield increase/decrease he can get by increasing/reducing the macro nutrient level.

Graphs

The computer is very helpful when graphs have to be plotted. The user has only to feed the data set through the keyboard and by using 3-5 key strokes the graph can be displayed on the screen or else can be printed on a sheet of paper (hard copy) in whatever form (scatter plot, histogram, line graph or pie chart) the user requires.

Database Management

Information is an important resource. Database management system is a powerful tool for managing information and data. Electronic data processing means that a vast amount of information can be stored, related, manipulated and retrieved with speed and efficiency. You can record your data or display only the data that meets certain criteria. For instance take a series of data on one thousand tea estates where each and every estate name, tea area, extents of seedling and clonal area, seedling and clonal yield, combined yield and nitrogen input for seedling and clonal tea are given separately. Once all this information is fed to the computer, the user is in a position to:

1. Retrieve the estate in alphabetical order
2. Retrieve yield or extents in an ascending order
3. Calculate total tea area under seedling or clonal tea
4. Calculate average yield/ha for seedling or clonal tea
5. Get a hard copy of certain fields or all the fields,

by using only 4-5 key strokes. All this information can be stored in separate files. Any changes made in the master file will automatically lead the computer to mark these changes in the relevant sub files. Further information on any two estates can be compared on the screen whenever the need arises by just pressing 2 or 3 keys. If all this information is handled manually one could imagine how long it would take to select the relevant information on a particular estate among one thousand records. When you consider all these

facts it is no wonder that the computer has outdated all the other machines within the span of a very short period of time.

Word Processing

The next step after completion of data analysis is writing a report. For this purpose word processing is a very useful package. When compared with the electronic typewriter the flexibility and the facilities in word processing is greater. Unlike in an electronic typewriter, corrections of either a character, a word or a sentence could be done on the screen at any time during the process or even after the process. It has the option to move, copy, cut and paste as well as the capability for revising and editing.

USE OF MICRO-COMPUTER IN A TEA ESTATE

Special software are either available or could be written to do estate accounting systems including payroll preparation and inventory management such as fertilizer and chemical stocks. Data-bases could be created to keep information on field history such as chemical properties of soils, pH, organic carbon, nutrient levels and yield. In addition, options are also available in taking management decisions on fertilizer, pruning and pest and disease control programs.

CONCLUSIONS

Considering the enormous advantages in a micro-computer and the present costs, it is certainly not a luxury to have a computer in an institution like a research station where one collects an enormous amount of data for analysis and interpretation from various field and laboratory experiments. Even in a tea estate, computers can help in day to day running of the estate including agricultural decision making. Of course it will help one to carry out the work efficiently, speedily and economically, too.

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