THE USE OF A MINICOMPUTER SYSTEM IN OILSEED ANALYSES

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In 1977 the growing of rapeseed in Sweden amounted to 117,000 ha and about 230,000 tons of seeds were harvested. The economic compensation to farmers is based on the quantity delivered as well as the quality of the seed. The quality factors include water-, oil-, and chlorophyll content in the seed and erucic acid content in the oil. However, the chlorophyll content is calculated as ppm in the oil. Our laboratory in the chemical department of the Swedish Seed Association annually receives between 20,000 and 30,000 samples for quality control. The main part of this analysing is carried out during the months of August to October, which implies that the daily capacity must exceed 700 samples or 1,400 analyses as double analyses are carried out on every sample. Erucic acid analysis is carried out on winter- and summer rape and summer turnip rape which is about 90% of the total number of samples. With regard to this analysis the daily capacity of our laboratory must exceed 1,200 analyses. In addition to these we annually perform about 60,000 fatty acid analyses as part of the breeding program of rapeseed.

The short analytical season and the demand for a high daily analytical capacity imply that there is during this period a special requirement for increased manpower and laboratory facilities compared with the demand during the rest of the year. In order to increase the analytical capacity and minimize the cost we have computerized the analyses. Four electronic balances and one colorimeter are directly connected to one minicomputer. Since the analysis of erucic acid was included in the analysis of farmers samples in 1976 we have also attached 17 gas chromatographic columns to a second minicomputer. Eight of the columns are equipped with automatic samplers. Finally, the computers are connected to each other.

The seed sample arrives in a paper bag together with a sealed tube containing seeds for water content determination which is made according to the drying cabinet method. As oil-, chlorophyll- and erucic acid content is to be determined on pure samples, the seed sample is weighed and then sifted before it is introduced to this part of the analysis. The quantity of the waste is weighed and the oil- and chlorophyll content are finally calculated on the original seed sample.

After the sifting, the sample is divided in a sample divider. Two laboratory samples of about five grams are placed in two numbered beakers and are then dried separately overnight. The oil content in the dried samples is determined according to the Svalöv method which is a gravimetric routine method, briefly described in the following items. The seed is weighed and transferred to steel tubes containing three steel balls (ball mill). A fixed amount of solvent (petroleum ether/ethanol) is added, and the sample is extracted during shaking. After centrifugation of the steel tubes an aliquot of the oil-solution is withdrawn. The chlorophyll content in the oil-solution is determined colorimetrically and expressed on oil basis. After evaporation of the solvent, the oil residue is weighed. A small fixed volume of the oil-solution is also used for the gas chromatographic erucic acid determination after being transesterified (Fig. 1).

In a complete analysis besides the erucic acid determination 12 measurements have to be performed on all samples, which implies a daily capacity exceeding 8,500 separate measurements. In addition, all the data obtained must be treated and the result calculated. Due to the large number of measurements it appeared reasonable to rationalize the analysis by computerization.

The base computer consists of a minicomputer with 32 K core memory, a disk memory with a capacity of 2,5 million words, a type writer, terminals connecting the computer with the four balances and the colorimeter, and two communication lines to two other computers.

The disk memory contains the basic program which is used continuously. Mass memory resident programs, tara weight for all beakers, data of samples exceeding previously fixed analytical limits, data of samples for erucic acid analyses and all analytical data are also stored in the disk memory. The mass memory resident programs are the specific programs for each one of the individual operations in the analysis and treatment of the analytical data. They are not continuously used and are collected to the core memory when desired. Through this constellation core memory is saved.

Through each terminal attached to each balance, the operator can communicate with the computer. As soon as the operator starts weighing a series of seed samples for the oil content determination a particular code for this process must be sent to the computer through the terminal. The computer collects from the disk memory the mass memory resident program for this specific operation and asks the operator for some additional data about the first sample in the series. When the weighing of the series is concluded the different weights are stored at the right sample number. All measurements are in principle made in the same way. When the sample first enters the analysis in connection with the weighing of the paper bag the computer stores certain data including the number of the sample, type of oilseed, date and two working numbers per sample. These working numbers are printed on all beakers and tubes used in the oil content determination and they follow the sample throughout the entire analysis. The numbers, beakers and tubes may be refused as soon as the oil content determination is complete.

The typewriter is used for the direct communication with the computer. Every weight figure that is stored is checked against a parameter set which may be changed from the typewriter. The number of samples that are rejected for some reason may be presented on a list for re-analysing. When an individual weighing operation is incorrect an alarm will appear on the balance terminal and in some cases also on the typewriter. Also, samples for erucic acid analysis are presented in a list on the typewriter. Finally, the typewriter is also used for reports during the analytical work and for the final report.

When we decided to computerize the determination of fatty acids on gas chromatography we had available five gas chromatographs with nine columns, one autosampler and four integrators. The breeding program made it necessary to increase the capacity especially in view of the fact that determination of erucic acid was also included in the analysis of the farmers' samples.A total number of 17 gas chromatographic columns and 8 autosamplers were installed, which made a second computer system necessary for this specific analysis with a capacity of 20 gas chromatographic columns.

The base computer consists of a minicomputer with a 32 K core memory, a disk memory with a capacity of 2,5 million words, a casette tape unit, two typewriters, gc-terminals, and a communication line to the earlier mentioned computer.

In the disk memory the basic program, mass memory resident programs, parameters for the handling of gas chromatograms, erucic acid content in the farmers' samples, and complete data of gas chromatograms in the breeding program are stored.

Before injection of the first sample of a particular series the operator must choose action schedule which contains all data needed for the computing process. Through the gc-terminal the operator informs the computer that the first sample is injected. The chromatogram is then automatically handled by the computer and after integration, calculation of concentrations and identification of the individual components the final report is presented on the typewriter and stored in the disk memory. Through the choice of a special action schedule the erucic acid content of the farmers' samples is stored together with the sample number on a file in the disk memory. As in the final report, the erucic acid contents shall be reported together with the data from the oil content determination, the erucic acid values are transferred via the communication line to the computer used for the oil content determination and are then stored on the disk memory in this computer.

The complete gas chromatographic data of the samples of the breeding program are stored in a special file in the disk memory connected to the gas chromatographic computer. From this file it is possible to copy a selected number of gas chromatograms to a casette tape for external treatment in a third minicomputer. This minicomputer which is equipped with a 24 K core memory, a tape reader, two casette tape units, a card reader and a typewriter, is used for statistical analyses of experimental data including the gas chromatograms. Finally, this computer is also connected through a communication line to the computer used for the weighing operations and through this to the gc-computer. The statistical unit works with the programming language Basic which implies that for external treatment of gas chromatograms we can write our own programs. This computer is used for the reporting of the fatty acid pattern in a tabulated form. We also plan to store these tables on another casette tape and later on to use this cassette tape for the selection in the breeding program.

As an example of external use of this minicomputer it can be mentioned that samples from the field trials performed by the Swedish Oilseed Growers' Association are analysed at Svalöv. These analytical values are combined with the agronomic data including yield, stalk stiffness, winter hardiness, time of maturity, and all these figures are treated, stored, evaluated and tabulated in the statistical minicomputer.

The advantages of the computer system for the weighing operations are: the efficiency of the laboratory has been doubled, the calculations are obtained automatically, and the risks of mistakes are minimized. The speed of the analytical work has been increased and the requirement for laboratory area has diminished.

The gas chromatographical computer system has replaced the purchase of 20 integrators and the treatment of data has been simplified. It has also been possible to treat gas chromatographical and other analytical data on the third minicomputer. The entire computer system has been very versatile due to the connection of the three minicomputers through the communication lines.

The entire minicomputer system designed by Altema AB, Solna (hardware), and Altema Dator AB, Västerås (software) is schematically shown in Fig. 2.

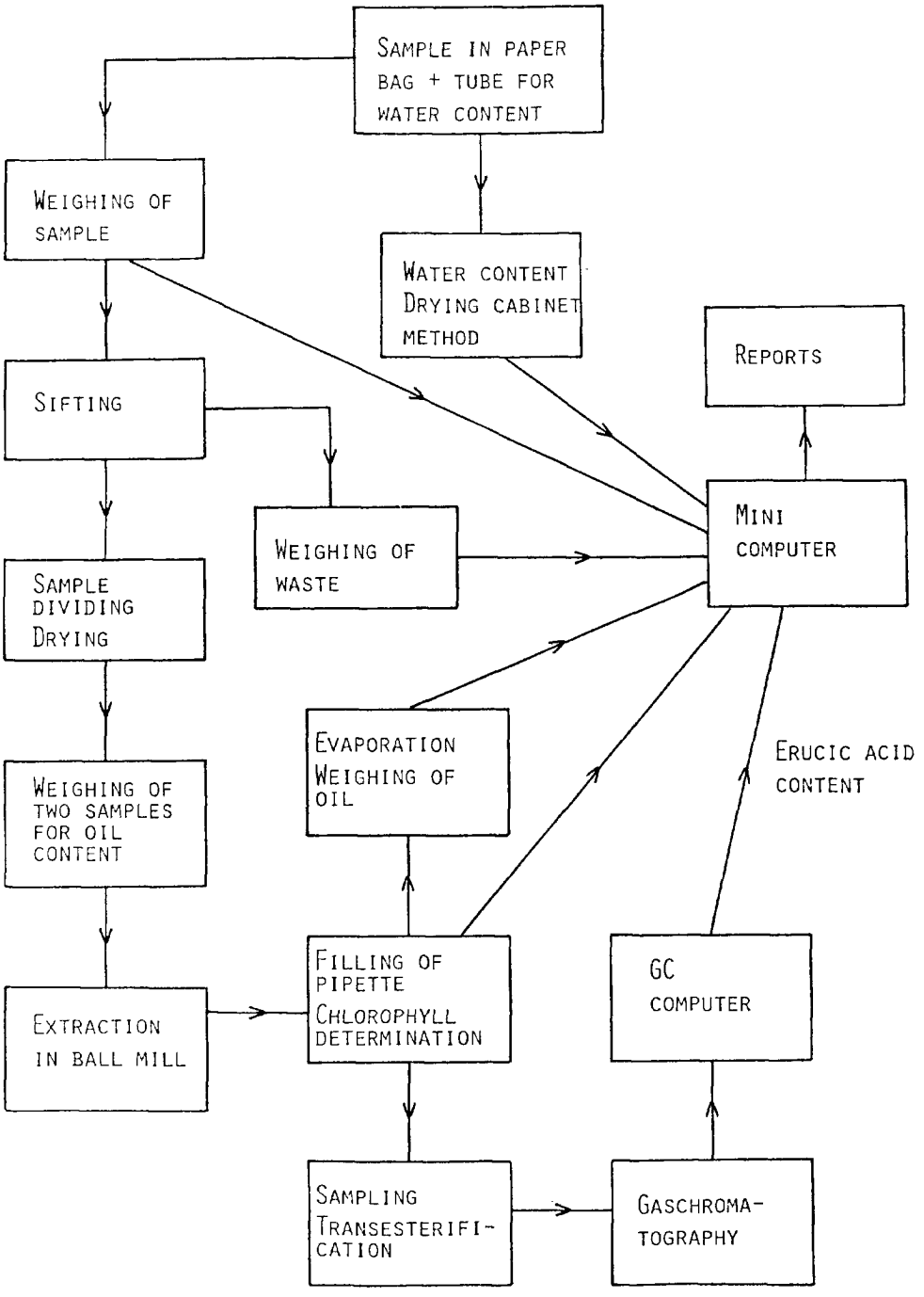

FIG 1.

SCHEMATIC PRESENTATION OF QUALITY ANALYSIS OF SAMPLES FROM FARMERS' SEED LOTS

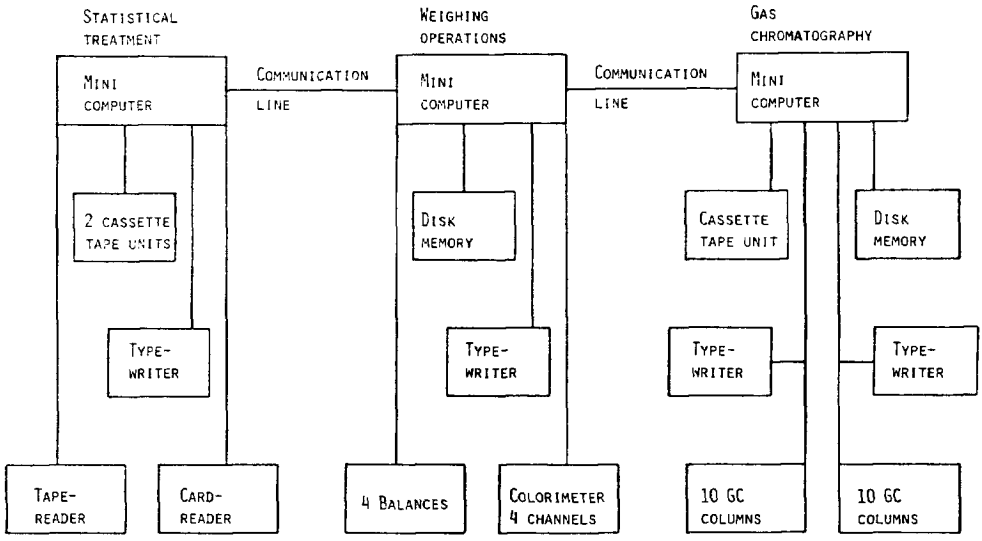

FIG. 2.

SCHEMATIC PRESENTATION OF THE MINICOMPUTER SYSTEM AT THE SWEDISH SEED ASSOCIATION