USE OF COMPUTERS ON THE CANE FARM

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Abstract

The current use of a micro-computer on a sugarcane farm is discussed. The use of application programs written especially for sugarcane farming as well as the use of general purpose commercial programs is described. Some benefits and disadvantages of computerization are listed. The current use of computers is then classified according to a computer systems taxonomy. Two system types are identified which lend themselves to cane farm computerization. A feasible scenario describing an information flow on a cane farm, using current computer technology, is described. An aid to the decision on purchase of a micro-computer is included.

Introduction

The current explosion in micro-computer technology and the level of interest among the public in computerization of businesses suggest that a review should be made on the applicability of computerized management systems to cane farming. Some computer programs and models that are currently being used on Schmidt Estates (Pty) Ltd will be described and analysed. Two program types are discussed, one being general purpose commercial programs and the other are programs written specifically for sugarcane farm management. The general purpose programs include Visicalc,[8] Multiplan,[3] Superscripsit[7] and a General Ledger program. The specifically written programs are included in the Sugar Farm System.[6] A second part of the paper attempts to distinguish between the levels of sophistication of various computer systems and to relate them to practical applications. A computerized information flow from field to industrial centre, which is within the scope of current computer technology, will be described.

Terminology

For the layman to understand the following discussion of computer usage and concepts, it is probably necessary to review briefly the terminology used.

Computer technology is of two kinds, the "hardware" and the "software". Hardware consists of the physical, tangible components of a computer is best described by the functions they perform which are:

Input function

This is the introduction of items or data into the computer for processing and is called "data entry". It is usually performed by an operator on a "keyboard", similar to a typewriter keyboard. This may be attached to the computer as in the case of a micro-computer or it may be remote from the computer as in the case of a "terminal", which consists of a keyboard and a "video display unit" (VDU) similar in most cases to a television screen. Other methods of input include card readers, barcode readers and in developmental stages, voice input.

Transformation function

This is the processing of the input items by the "central processing unit" (CPU). The CPU comprises three components, the control unit (CU), an arithmetic-logic unit (ALU) and a primary memory (PM) or primary storage area.

Storage function

Input items, processed information and programs may be stored for future reference in secondary storage devices. These may be drums, disks or tapes; micro-computers commonly use either disks or tapes.

Output function

The components that perform this function are the "printer" and the VDU. Both present the information to the operator in legible form.

Communication function

The communication of data is performed by communication lines and equipment. The lines may be normal or "dedicated" telephone lines, the latter being used exclusively for the purpose. Other hardware equipment may include a control unit to relieve the CPU of the extra processing required and a "modem" which transforms the information to audible sound waves.

Software comprises the set of instructions, known as the "program", that are carried out one at a time by the CPU. The program and the data are located in the "primary memory" Some software definitions follow:

- **System software**

  This is the software that controls the functions of the hardware. These are operating instructions which facilitate the scheduling and execution of other programs, allocate processing resources and control the flow of data through the executing programs and the hardware devices.

- **Application software**

  These are the programs that perform the functions required of the computer by the business. These programs will effectively control the interaction between the operator (user) and the computer, determine what information is to be input, what processes that information is to be subjected to, as well as its storage and presentation to the user.

Programs are "interactive" when the user can change or modify the program in order to achieve a particular objective. A subset of interactive programs are "menu-driven" when the user responds to a sequence of prompts to achieve an objective. Menu-driven programs are generally easier to use although commonly less flexible.

Spreadsheet programs are interactive programs and consist of an electronic worksheet of rows and columns. A spreadsheet program can comprise a large number of worksheets and will allow the transfer of information between sheets. A sheet containing a series of formulae for the calculation of a particular result is known as a "model". Each sheet or model may be stored on the disks electronically for future reference or use, and the procedure is known as "saving to disk", while retrieving that sheet is known as "loading from disk".

Some computer programs and models currently being used

Computers were introduced on Schmidt Estates in December 1981. The main programs used are Superscripsit,[7] a General Ledger program, Visicalc,[8] Multiplan[3] and Sugar Farm System.[6] Superscripsit is a word processing program and is primarily used for letter and report writing and is not discussed in this

paper. The General Ledger program is used to write-up Schmidt Estates' books of account up to trial balance stage. This program has been used for three financial years and satisfies Schmidt Estates' auditors' requirements.

Visicalc and Multiplan

The first program used was the spreadsheet program, Visicalc, but since June 1984, a much more powerful spreadsheet program with many additional features, Multiplan, has been used and all new models are developed on it. Visicalc is now only used when the advanced features of Multiplan are not required. The conversion from Visicalc to Multiplan is very simple because Multiplan has the facility to read Visicalc files and therefore the transfer of data does not have to be done manually.

Multiplan is used for budgets, cash flow analysis, costing, stock control and farm planning, that is, the use of fertilizer, herbicides and labour. All basic information required for the budget is entered on the "budget support sheet" (Table 1). This information includes hectares to be harvested per month, expected yield in tons per hectare, expected relative sucrose percent, expected sucrose price, monthly labour requirements, average wage rates, cost of rations per unit and cost of cane transport per ton.

TABLE 1

Description	May	June	July	August	
Budget support sheet					
Days per month	20	24	30	24	
Daily allocation	60	60	60	60	
Tons cane	1 200	1 440	1 800	1440*	
Sucrose %	12	12	12	12	
Sucrose price ton^{-1}	210	210	210	210	
Tons sucrose	144	173	216	173*	
Cane income	0	27 216	32 659	40 284*	(A)
Labour units day^{-1}	45	45	47	50	
Wages unit^{-1} mth^{-1}	150	150	150	150	
Total wages	6 750	6 750	7 050	7 500*	(B)
Rations unit^{-1} mth^{-1}	40	40	40	40	
Total rations	1 800	1 800	1 880	2 000*	(C)
Cane transport ton^{-1}	2	2	2	2	
Transport cost	0	2 400	2 880	3 600*	(D)
Budget dependent sheet (Rands)					
Salaries	1 900	1 900	1 900	1 900	
Wages	6 750	6 750	7 050	7 500	(b)
Rations	1 800	1 800	1 880	2 000	(c)
Electricity	350	350	350	350	
Machinery maintenance	800	800	800	800	
Building maintenance	300	300	300	300	
Fertilizer	0	0	0	9 000	
Chemicals	0	0	0	3 000	
Fuel & lubricants	2 000	300	300	2 000	
General	500	500	500	500	
Cane transport	0	2 400	2 880	3 600	(d)
Administration	600	600	600	600	
Overdraft interest	237	579	333	0	
Total expenses	15 237	16 279	16 893	31 550	
Opening bank balance	-10 520	-25 757	-14 820	946*	
Cane income	0	27 216	32 659	40 824*	(a)
Net flow	-15 237	10 937	15 766	9 274*	
Closing bank balance	-25 757	-14 820	946	10 220*	

Lines (A), (B), (C) and (D) on the support sheet are transferred electronically to (a), (b), (c) and (d) respectively, on the dependent sheet

* Indicates lines calculated by formulae

Formulae are then entered to calculate, for each month, tons of cane harvested, tons of sucrose, total cane income, monthly wages and ration costs and cost of cane transport.

The budget is then entered on the main sheet, known as the "budget dependent sheet" (Table 1). The amounts for the various expense items are entered. For items such as cane income, wages, rations, cane transport, a command instructs the computer to extract the relevant information from the support sheet. Separate formulae are constructed for the cash flow analysis, including automatic calculations of interest payable on overdraft.

It has been found that the time saved, compared with manual budgeting using a calculator and paper, is of the order of days per month. The speed and ease of budget recalculation enables accurate budgeting in the face of rapid changes in the variables such as sucrose percent, sucrose price and yields. Decision-making on cash flows and capital purchases is greatly facilitated.

Multiplan is also extensively used for developing the annual farm plan. A support sheet containing field numbers and areas is stored on disk as a long term information base. Relevant information concerning fields that are to be harvested in the forthcoming season is then electronically copied from the support sheet to a second worksheet and sorted into order of harvest.

The estimated yield in tons and appropriate formulae are then entered for each field and days taken to harvest can then be computed for each field, as well as cumulative number of days since the first day of harvest of the season, using the expected allocation of tons harvested per day. A separate program is used to determine the date of each working day number. This program asks for the date of the first day that an operation is to begin, the number of working days per week and the dates of public holidays. The program then prints a list of working days and their respective dates. This information is then graphically represented on the farm plan chart, where field numbers are plotted on the Y-axis and months, weeks and dates are plotted on the X-axis.

The same field support sheet is also used for the fertilizer and herbicide physical plan. Formulae are entered to compute the number of days required to apply fertilizer or herbicide to each field and the cumulative number of days from the first day, as above. Another formula computes the total fertilizer and herbicide required per field. The opening stock on hand is then entered and the computer calculates the balances on hand, after completion of each field. It is now a simple matter to insert amounts of fertilizer or herbicide to be delivered at appropriate times to avoid shortages or excess stocks. This information is then also graphically depicted on the farm plan chart.

This system has ensured that stock never runs out at critical periods. It has also made possible planning the entire fertilizer and herbicide order in May, specifying exactly when delivery is required. The accuracy of the advance order is within 5%.

Consideration is being given to enhancing further the budget model by using the farm plan data as a support sheet for the budget data sheet and thus linking the farm plan directly to the budget. This enhancement is well within the scope of Multiplan with its superior file consolidation facilities.

Sugar Farm System

Sugar Farm System is a set of two menu-driven programs, especially written for sugarcane farmers. One of the programs is a bonus and wages program while the other is a field records program. The latter incorporates records and anlaysis of fields, rainfall and cane estimate.

The basic field information (field number, area, ratoon, age, variety, soil code, total nutrients last applied) is stored at the outset in a "field records file", while historic rainfall records are also stored in a "rainfall records file". These two files are used by the program for all subsequent recording and analysis functions.

The field records are updated on a monthly basis by field. The information shown in Table 2 is entered.

TABLE 2

Monthly input information

Tons cut	Sucrose %
Number of labourers	Fertilizer type and number of bags
Herbicide application	Crop re-establishment information

The program prompts for the information to be entered and is pre-programmed to perform the various calculations and to store the relevant data on disk. The information can be displayed on the VDU whenever required or alternatively printouts, of the information shown in Table 3, may be made.

TABLE 3

Output information

Field number	Area
Ratoon	Variety
Soil code	kg of N, P, K applied since harvest
Current age	Rainfall since harvest
Age last harvest	Total yield in tons ha^{-1}
Tons ha^{-1} mth^{-1}	Tons ha^{-1} 100 mm^{-1} of rain
Sucrose %	Tons sucrose ha^{-1} mth^{-1}
Average harvest age	Average yield in tons
Average sucrose	Average tons ha^{-1} mth^{-1}
Tons ha^{-1} 100 mm^{-1}	Sucrose ha^{-1} mth^{-1}
Total ha harvested	tons cut at any given month-end

Whenever the information is updated for a new month, the computer automatically updates the age of each field and sets to zero the ages of all those fields that are harvested during that month.

The printouts also give an analysis of crop disposition, that is, a breakdown of the ratoons by areas and as a percentage of the whole farm (Table 4). This is followed by a list of all fields that have not been topdressed since last harvest as well as all fields that have not had more than 100 kg nitrogen. This serves as a useful indicator of fields that need a second application of fertilizer.

TABLE 4

Crop disposition

Record of areas by ratoon

Plant	4,7	5,0%
Ratoon 1	6,0	6,3%
Ratoon 2	18,4	19,4%
Ratoon 3	20,5	21,7%
Ratoon 4	21,1	22,3%
Ratoon 5	11,2	11,8%
Ratoon 6	9,0	9,5%
Ratoon 7	0,0	0,0%
Ratoon 8	2,3	2,4%
Fallow	1,2	1,3%
Total area		94,4

Fields still to be topdressed

Field number	Area in ha
2	4,5
5	4,6
11,2	3,6
13	7,5
Total area	20,2

Fields which have less than 100 kg nitrogen applied

Field number	Area in ha
10	2,1

The information on a particular field can be changed at any time, if an error is found or if boundaries of fields are changed by consolidation or for whatever other reason.

At the end of the season, a comparison of each field's growth rate with the average farm growth rate is given. If the average growth rate of the farm is, for example, 6,0 tons ha^{-1} mth^{-1}, then a field with a growth rate of 6,6 would be assigned a factor of 1,1 (6,6 ÷ 6,0) and a field with a growth rate of 5,4 would be assigned a factor of 0,9 (5,4 ÷ 6,0). This information can be printed out for each field, together with the same information for the past ten years. Printouts can also be made listing all the herbicides applied to a field in the previous season as well as any re-establishment details.

The total rainfall, for a given month, is entered and rainfall figures for each field and the yearly figures are then updated. Rainfall records are recorded for 50 years.

An analysis can be displayed on the VDU or printed, giving the total rainfall that fields, at various ages from one month to 30 months, have received. A comparison is made with the amount of rain a field would have had, the field had received average rain for each month, expressed in millimetres as well as a percentage of actual rainfall recorded.

At the beginning of the season, the cane estimate is made by specifying the minimum age, as at 30 April, of any field, that will be considered for the estimate. The program then accesses the field records file and displays the fields one by one starting with the oldest, prompting for estimated yield in tons per hectare.

It is at this point that the performance factor of each field is used. The average growth rate of all fields on the farm is estimated using computer models that calculate the amount of rain that a field has had and projecting the amount of rain for the remaining months until harvest, based on long term rainfall per age group discussed earlier. The growth rate is then multiplied by the calculated performance factor of the particular field, based on historic performance factors. This adjusted growth rate is then multiplied by the expected age of the field at the time of harvest, to obtain yield in tons per hectare. The estimated yield is then entered for each field.

The wages and bonus program is used to prepare all paysheets. Details of the labourers, such as name, identity number, wage rate and total wages paid during the season, can be viewed or printed at any time. The program caters for a 30-day-ticket pay system or a calendar month system.

To prepare for payment, the days worked, deductions and PAYE are entered for each employee to be paid. Total cash payable to each employee is then computed. The cash on hand is entered and the total amounts required for each monetary denomination, are displayed along with the quantity on hand. At this stage the amount required from the bank is entered ensuring that there is enough of each denomination for the payment of wages. Amounts, by denomination, that should be left over after payment, are displayed and this is used for balancing purposes after the pay envelopes have been prepared.

A complete coinage analysis is done by the program and may be printed at any time. Pay envelopes are printed on special wage envelopes, displaying details of deductions and total cash paid.

Bonuses are paid on a weekly basis and may be defined on a "cut and stack" basis or a "cut only" basis as required. The procedure is very similar to the payment of wages.

Advantages and disadvantages of using computers on a cane farm

The advantages include the following:

- quick and easy data analysis and rapid response to changing conditions using spreadsheet programs

- cane estimates tend to be more accurate because they are based on rainfall received and historic growth performance
- time savings of up to 70% for preparation of estimates, farm planning, wages and bonuses
- computers are cheaper than additional clerical staff
- time saved by computerization can be used for more effective management of other aspects of farming
- the availability of greater amounts of more accurate information contributes to more successful decision-making.

The disadvantages of computerization include:

- electricity supply voltage fluctuations or failures can be disruptive to the work process, eg when preparing wages
- some training in computer operation is required for new users.

Farm computerization and computer based information systems

Three of the various computer based information systems appear to be applicable to cane farm management. These are the Transaction Processing System (TPS), Information Report System (IRS) and Decision Support System (DSS).

Transaction Processing System

This system has its primary role the collection, processing and storage of data describing the transactions of an organisation. An example would be invoices and receipts be stored for later use in a more sophisticated system.

Information Reporting System

This system produces predefined information reports, generated by operations on data previously captured and stored. An income statement generated from the invoices and receipts of a TPS would be such a report. Because the user cannot modify the reports without changing the programs, the interaction between the user and the computer is said to be passive.

Decision Support System

This system facilitates an active interaction between the user and the computer in that it allows a user to specify and to change the format and calculations of a report quickly and easily. A series of analysis models built on a spreadsheet package such as Multiplan[3] would comprise a simple DSS.

The data capture component of the program of the Sugar Farm System (bonus and wages as well as field records) is closely related to the Information Reporting System category. This is illustrated by their ability to produce a number of predefined reports and analyses which the user is unable to modify. The nature of the information generated is historic and tells the user what has already taken place and there are no facilities for simulating the future.

The spreadsheet models designed and used by Schmidt Estates fall mainly into the DSS category. The orientation of the models is to the future and in general are used to simulate the effects of change in any of the variables (eg sucrose price, wages etc). In the same way for example, the financial implication of an impending capital purchase can be simulated rapidly and the effects of a number of alternate repayment schemes on the cash flow can be evaluated. In this way therefore, the system of interactive spreadsheets is used to support numerous decisions.

An advantage of the more flexible Decision Support System is that the user of the information would be able to design the information output in such a way as to be meaningful immediately. The system must also be capable of generating any of the pre-specified reports that are required from the sugarcane farmer from time to time. The monthly estimate is an example of such a requirement.

The value of accurate and historic information should not, however, be underestimated, particularly in cane farming. For example, accurate information regarding the performance of a particular field over the life of the crop will make possible the careful evaluation of the decision whether or not to plough it out.

In a computer system, there is what Sprague and Carlson[5] refer to as the dialogue subsystem. This consists of three parts. The first is the "action language" which refers to what the user can do in communicating with the system. The second is the "display language" being what the user can see of the system (printers, graphics, plotters, etc) and thirdly, the "knowledge base". The last is what the user must understand if the system is to be used effectively. It must be expected that the more interactive the system is with the user, the greater the knowledge base will have to be.

Canning[1] forsees that "integrated packages (for micro-computers) will start to dominate the DSS arena by the end of 1985 and will eventually replace common spreadsheets". It would therefore be a significant advance if Decision Support Systems were to be introduced into the cane farming industry at an early stage in order to avoid the greater learning difficulty if the more sophisticated packages which may be introduced later.

A feasible scenario

This scenario describes an example of a Decision Support System that operates on an integrated package. The system would comprise a database of several interactive data files which store the raw data from the various operations.

Three files of the database would be field records data, rainfall data and labour data. Some of the information that would be stored in each file is listed in Table 5. For space reasons the list is not exhaustive.

TABLE 5

Database file structure

Field records	Rainfall records	Labour records
Year	Year	Year
Field number	Jan	Month
Area	Feb	Name
Plant/ratoon	Mar	ID number
Variety	Apr	Rate of pay
Soil code	May	Deductions
Tons cut	June	Work code
Sucrose %	Jul	Home address
Number of loads	Aug	
Fertilizer	Sep	
Herbicide	Oct	
Planting	Nov	
	Dec	

The following elements of the various files would be used in the following ways:

- tons cane and sucrose percent: in a budget model to update expected income
- tons cane, sucrose percent and rainfall: in a field performance model which would facilitate replanting decisions
- tons cane and rainfall: in a model to check the accuracy of the estimate and to generate the monthly estimate for the Sugar Industry Central Board purposes
- area and field number: in a planning model on fertilizer and herbicide usage and stock levels
- number of loads and work description: in a labour allocation model which would be used to plan the next harvesting cycle
- tons cane, sucrose percent, area and number of loads: together with other information could be transmitted to a central computer for industrial and regional statistical purposes.

On a monthly basis, the updated estimate model would be transformed into a data file for transmission to a central industrial analysis system via a modem and telephone lines.

There are some program packages available for micro-computers that will support the integration of database, spreadsheet, word processing and communications. Open Access[4] and Lotus Symphony[2] are examples of integrated packages. The advantage of using an integrated package and not a spreadsheet program such as Multiplan, is that the database itself is a powerful tool for generating prescribed reports without the need to design a spreadsheet. Information from a database can be selectively extracted, sorted and displayed or printed. The database can be changed without affecting current analysis models and *vice versa*. Probably one of the greatest advantages of the database of a spreadsheet is that the input function can be so designed that relatively unskilled operators are able to update the basic data. The integrated packages have a further advantage in their ability to be pre-programmed to perform various functions such as extracting the correct data from the database, inserting it into the correct part of the spreadsheet and performing the calculation, thus minimizing the knowledge base required.

Decision-making

The question will arise "how does one go about making a rational decision on the purchase and installation of a computer system?"

The difficulty of quantifying the benefits which may accrue in the future from improved decision-making renders the traditional cost/benefit analysis unsatisfactory. The decision is therefore more influenced by emotion, salesmen and other peripheral impacts.

It is suggested that a methodical and written evaluation of the various criteria for success as well as an enumeration of managerial bottlenecks that are currently encountered, should be made. Such a written evaluation will help to clarify for the individual or oganisation some of the "softer" issues.

A "weight scoring model" (Zmud[9]) may also be used. In this model the first stage is to list a set of criteria (Type A) which are assessed unequivocally (ie Yes/No) for the alternatives. The second stage is to construct a model or table of criteria, which may include some Type A criteria, such as the example given in Table 6. For each criterion, a weighting is allocated according to its relative importance. A number between zero and one would be suitable such that the sum of the weightings equal one. A score is allocated to each criterion in which ten indicates high efficiency and zero indicates non-performance. The list is not exhaustive and each individual will have a different set of evaluation criteria.

TABLE 6

Evaluation of alternatives

Details	Weight	Computerized	Non-computerized
Payroll	W1	S11	S21
Field records	W2	S12	S22
Budget	W3	S13	S23
Replacement decisions	W4	S14	S24
Cash flow	W5	S15	S25
Fertilizer reorders	W6	S16	S26
Herbicide reorders	W7	S17	S27
Labour planning	W8	S18	S28
Estimates (accurate)	W9	S19	S29
Rating	–	R1	R2

The value for the ratings R1 and R2 are calculated as follows:

$$R1 = W1(S11) + W2(S12) + \ldots + W9(S19)$$
$$R2 = W1(S21) + W2(S22) + \ldots + W9(S29)$$

The relative score of the ratings obtained in stage one will indicate which of the alternatives is subjectively preferred. The subjectivity of such an evaluation indicates that the allocation of weights and scores should be done by more than one person in consultation.

Conclusions

The paper has illustrated the current use of a micro-computer and some computer programs on a sugarcane farm in Natal. Extensive and valuable use is made of the interactive programs such as Multiplan for the purposes of decision-making and planning. Word processing and accounting is facilitated by the use of Superscripsit and a general ledger program. Field records are maintained with the use of a specifically written cane farm program which maintains current field records as well as a ten year record of field performance analysis.

Current computer technology will allow a greater degree of data exchange and communications than is generally believed. Integrated software packages available for most well-known micro-computers make possible sophisticated decision support systems, while currently available specific software allow accurate and reliable records to be kept.

Management decisions for sugarcane farmers can be enhanced greatly by accurate records and flexible simulation facilities. The individual management styles of each farmer will influence the decision to computerize as well as the use of the computer itself.

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