COMPUTERISATION OF FIELD RECORDS SYSTEMS: REQUIREMENTS AND LIMITATIONS

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Abstract

The feasibility of creating a computerised agronomic field record system is discussed. Particular emphasis is laid on its limitations, and on the means whereby they may be kept to a minimum. This type of flexible, scientific, records system has considerable software requirements and is only justified on large estates.

Introduction

Mhlume's estates cover an area of approximately 4 800 hectares of surface and overhead irrigated sugar cane. Soil quality varies considerably, and significant areas of the plantation are the subject of amelioration programmes (Workman *et al*[3]). A computerised field records system is being developed to handle the large quantities of agronomic data describing conditions in the 420 fields. The aim is to improve the agronomic control of the estate, by routine reporting and summarizing of the field data, by section, by year, ratoon, variety, or any other criteria chosen by the operator. Specific interactive enquiries are also possible. Thus the system is an extension of the traditional field record card system, but it will allow collection of more information, and can make its own summaries of agronomic events, for example, the mean response to ripeners over a given period, or long term yield trends by soil type. This type of facility is already provided for growers in South Africa, by the South African Sugar Association Extension Service. Data can be summarized for individual farms, or for whole extension areas (Culverwell,[1] Hulbert *et al*[2]). This paper considers the specifications required for a similar system, applied to an individual large estate. It considers, especially, limitations in the use of computerised field records; limitations that may be caused both by the software itself, and by the layout of the estate. (These latter limitations also apply to traditional manual field record cards).

Choice of data to be stored

The individual parameters

43 parameters were chosen for the database. (Table 1). They are considered to be the minimum requirement for a useful understanding of the estate, but not so many that the system becomes cumbersome, or the availability and cost of computer memory prohibitive. Even so, these parameters require 82 individual entries of information, per field, annually, because items such as dates of sampling and the level of each leaf nutrient all have to be recorded separately. Derived data, such as tc ha^{-1} mth^{-1} is omitted since it is more economical of computer time and space to re-calculate such values as required. Also, perhaps controversially, herbicides have been omitted, because Mhlume's fields are usually clean, and weeds do not hinder growth. If there is a weed problem, or any other exceptional growth limiting condition, such as lodging, these are noted under the final parameter, "Reasons for ignoring data". Anything entered under this heading can be used to make the machine overlook data from that cane field for that season.

Limitations of information that may be stored

It is not possible to satisfactorily quantify events, however important, that have taken place in only a fraction of a field, such as drainage or gypsum application. The system can record that such an event took place, and for some parameters, can give the percentage of the field that was treated. But the details of these "within-field" treatments have to be stored, separately. A further limitation of the usefulness of the data occurs where field boundaries do not coincide with soil type boundaries. For example, there may be 2 or more total available moisture (T.A.M.) contents or soil types within a field. To cater for this, if the T.A.M. or soil type occupies less than say, 70 % of the field area, the item can be entered

Table 1

List of parameters chosen for agronomic field records system

		Parameter	Notes
Field identity	1	Section	
	2	Block/Field	
	3	Co-ordinates	- a grid system to allow spatial presentation of data
Fixed field information	4	Land class	- a soil grouping into areas having similar management requirements (Nixon *et al*)[3]
	5	Irrigation type	- syphon; spile; dragline; solid set or drip.
	6	Maximum arable area	- area including headlands, etc.
	7	T.A.M.	
Current field status	8	Growing season	
	9	Ratoon No.	
	10	Actual cultivated area	
	11	Status	- commercial, nursery or fallow
	12	Variety	
	13	Seed cane source	
	14	Seed treatment	- fungicide, temperature and dipping time
Planting and ratooning data	15	Burn/Plant Date	
	16	Date of first irrigation	
	17	Dieldrin rate	
	18	Furrow conversion	- i e ridging up after plant crop
	19	Trash removal	
	20	Cover crop	- type, quality and % of field planted
	21	Deep cultivation	- type, and % of field treated
	22	Filtercake	- % of field treated at 150 t/ha
	23	Gypsum	- tonnes per treated ha and % of field treated
	24	Additional drainage	- yes/no
	25	Soil data	- pH, P, K, Mg, Ca, S, Zn

		Parameter	Notes
Fertilizers	26	1st application	- dates and rates of N, P, K, S and Zn applied
	27	2nd application	
	28	3rd application	
	29	Leaf analysis	- date and levels of N, P, K, Mg, Ca
Pests & diseases	30	White grubs	
	31	Eldana	date and level of infestation
	32	Smut	
	33	"Other"	
Ripeners	34	1st application	date and level of application
	35	2nd application	
Irrigation	36	Dry-off	- date and dryoff deficit
	37	Water used	- total effective water during crop cycle
	38	Annual deficit	- (excludes dryoff deficit)
Yields	39	Tonnes cane	
	40	% Sucrose	
	41	Harvest method	- hand or chopper
Comments	42	General	
	43	Data cancel	- reasons for ignoring data

in the database as "Mixed". The computer is then programmed to omit data from such fields, when doing selections based on these parameters. Clearly this is not very efficient, and will lead to rejection of a lot of data from an estate where the soils are very variable. The long-term solution is to re-lay out fields so that they follow soil boundaries (which may also lead to more efficient farming). Collection of soil-based data can be provided for by setting up specific agronomic "stations" over the estate, covering the full range of soils, varieties, and crop ages.

Maintenance of such "stations" would be highly demanding of management, however, and data from them would need to be stored in a second database. If changes in layout are contemplated, the use of agronomic "stations" may be preferable to the use of data from whole fields, because, once a field changes shape, much of the historical information associated with it becomes meaningless.

Choice of software

The types of software required

A database (Figure 1) that has to be large enough to store the chosen parameters, for all fields on the estate, and over as many years as are considered necessary to show long-term trends, is fundamental to the system. The database must be fully flexible (i e relational rather than transactional), being able to select information according to any limits set by the operator. For example, a monthly smut report would need selection of all smut levels recorded in, say, January 1986 in all sections, and perhaps further broken down by sugarcane variety. Fields with more than 5 % smut might need to be highlighted as potentially in line to be ploughed out. Such a list of information could be made much more satisfactory if it were summarized, especially on an estate with many fields. This necessitates the combination of the database with a spreadsheet. For the smut report, the selected smut data, with associated field areas, would be copied across from the database onto a spreadsheet, where weighted means could be calculated for each section and variety. Then, in order to show how reliable the calculated means are, the database and spreadsheet must also provide such information as the number of items of data contributing to the mean, their coefficient of variation, and range.

On a large estate, with a well established fields records system, two types of data entry will be required; batch direct data entry for information already entered on the record cards, and user defined masks for current data. These latter would show the forms on which the data is initially recorded in the field or laboratory. Batch data capture from record cards may necessitate the redesign of the card to present its data as a long string of information. The design of current data capture forms will be a compromise between computing, and manual recording requirements. A procedure for validating the entered data is then necessary, before it is finally copied into the database.

Finally a report formatter is required, so that summaries of data from the spreadsheet are channelled into understandable, tailor-made reports. Facilities for graphics would also help.

For ease of use, all these elements of the software, for recording, storing, selecting, summarizing, and reporting of data, need to be driven from a menu, so that non-specialist operators can use the system. This involves entering into files all the likely different sequences of use of the system, so the novice can run the system simply by using the relevant file.

Limitations of the software

Despite the wide availability of software, a scientific application such as this may reveal shortcomings in some data processing packages.

Some will necessitate the writing of additional, peripheral programmes. Software must be tested before purchase, by creating a "model" estate. The software is then made to manipulate these few items of data through all the stages that would be required of a larger system. One particular requirement of the software is that it can distinguish between a null entry, and a real entry of zero.

Discussion and Conclusion

The creation of a computerised field records system requires diverse computing techniques, including not only a database, but also facilities for batch and mask data entry; validation; spreadsheet; report formatter; and preferably graphics facilities, all of which must be menu driven if the system is to be used by non-computer specialists. These requirements, plus the high volume of data to be recorded, need considerable soft-and hardware input. The Mhlume system needs at least 17 Mbytes of hard disc storage.

The parameters required by an estate will depend on its unique agronomic situation and on its organisational structure. Thus, any comprehensive agronomic database has to be created individually for the estate. The value of the system further depends on the choice of relevant parameters, and on whether criteria, such as soil type, have been taken into account in the layout of the estate. It is also required that the collection of the data itself is highly reliable.

The cost required to set up a computerised field records system is high, and much time and expertise is required to construct the system. But the potential benefits of improved agronomic policies are also considerable if implemented over a great enough area. For these reasons only large plantations are likely to be able to justify implementing such systems.

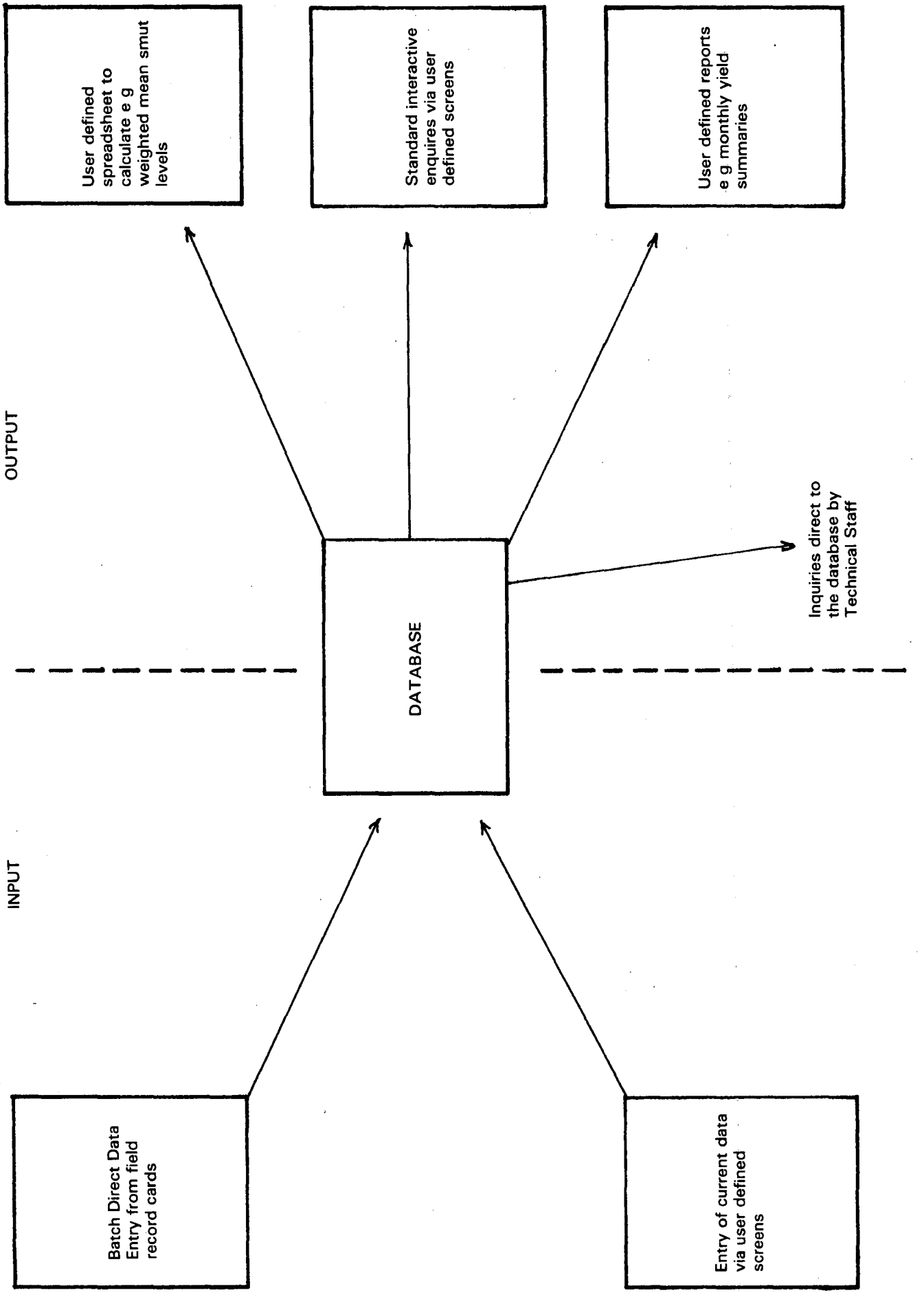

FIGURE 1 Relationship between the various parts of the database

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