SPREADS – A SYSTEM FOR CONTROLLING THE COSTS AND EFFICIENCY OF MANURE AND SLURRY SPREADING ON FARMS

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ABSTRACT

A decision support system (DSS), SPReader Economic Assessment and Decision Support (SPREADS), capable of assessing the costs and associated performance characteristics of a range of manure and slurry spreading techniques has been developed. The system makes use of published information on machine performance and costs, with gaps in information supplemented by expert knowledge and, in some cases, field performance assessments.

A database contains information on a wide range of application systems, including some of the new, surface placement techniques designed to improve application precision and reduce emissions following slurry application. Umbilical supply systems are also covered, as well as an option for hire or contracting services. The DSS calculates the economics and work rates for manure application and the output is displayed in both graphical and tabular format. The risk of inappropriate system design within SPREADS is minimised by the implementation of extensive logic checks. Limited validation of the model, against an existing Dutch DSS, has shown good agreement of outputs on costs and work rate, where simulations are based on the same assumptions.

"SPREADS" is a potentially valuable aid to improved manure management, allowing farm-specific analyses to be conveniently and rapidly undertaken. It is anticipated that SPREADS will be useful for agricultural contractors, consultants and policy advisors as well as research scientists.

INTRODUCTION

Livestock manures are valuable sources of plant nutrients and organic matter and considerable savings in fertiliser purchases can be made when they are successfully integrated with fertiliser inputs (Smith and Chambers, 1995). However, the potential contribution from manures is often ignored due to uncertainties about nutrient supply, the anticipated difficulties and costs of manure spreading. Equipment prices are provided by manufacturers, but without good technical data on performance, it is difficult to judge which machine type or size is best for the individual unit, or whether to hire. Contractor charge-out rates (Anon, 1999) may be similarly unhelpful and, unless provided with an indication of work-rates, do not allow an assessment of operational costs, in terms of £/tonne of manure or £/ha of land spread.

In the UK, slurries are almost entirely surface broadcast (Smith et al., 2000), but new application techniques are available, e.g. surface banding or shallow injection, which claim to reduce ammonia losses to the atmosphere (and odour) by up to 75% (Huijsmans et al., 1997). These techniques are also claimed to increase precision and allow more efficient utilisation of slurry nitrogen - but can the increased costs be justified by the claimed benefits?

MATERIALS AND METHODS

The SPREADS decision support software has been developed using the Microsoft Visual Basic 6™ development environment and is based on the Multiple Document Interface (MDI) model. The MDI model allows the user to create, save and retrieve any number of independent project windows in which to design their manure spreading operations. Each project window is divided into three panes as shown in Figure 1.

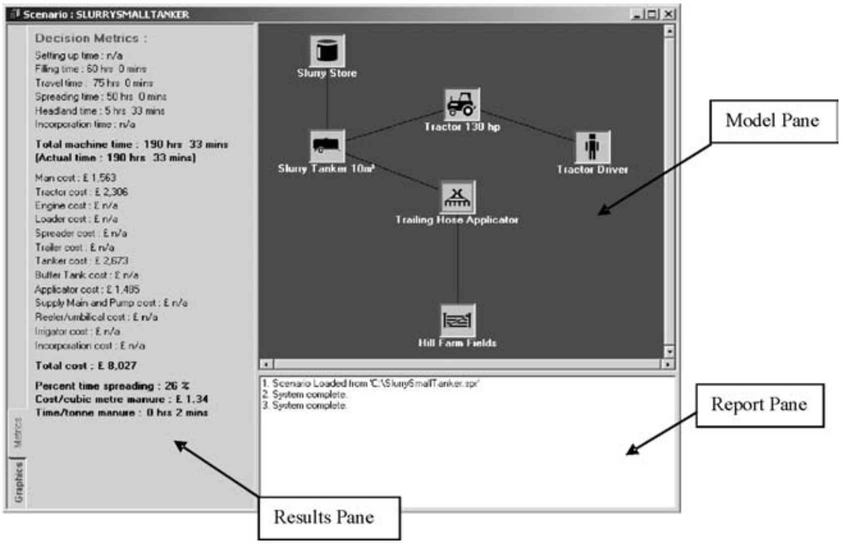


***Figure 1**. Project window for SPREADS DSS in operation.*

Model Pane

The Model pane is used to construct manure spreading systems for analysis. Users add icons representing spreading machinery, personnel and farm attributes and then connect these together to construct a schematic spreading operation. Each component has multiple attributes. For example, spreading machinery is described in terms of capacity, application rate, filling time, working width, and various components of cost. Default values are available but the attributes of any component may be edited. Much of the machinery performance and operational data used to inform the DSS have been provided by experts in the field. Supplementary data for some aspects of performance have also been collected under practical operating conditions on commercial farms.

Two basic types of system may be constructed. The first has spreaders returning to the farm for refilling. The second adds a tanker or trailer for transporting manure from the farm to the fields, allowing the spreaders to refill in the field. Both systems may be further modified, for example, the addition of more spreaders and tractors in order to spread the manure more rapidly. The software makes use of extensive logic checks to advise the user of "illegal" links in the operation schematic, such as the connection of machinery types designed to handle incompatible types of manure.

Report Pane

The Report pane continually reports the additions, deletions and connections made to the operation schematic in the Model pane. The Report pane also advises the user of incomplete aspects of the selected operation schematic, such as a tractor without a man assigned to drive it.

Results Pane

When the user selects an object on the Model pane, the software determines whether it is part of a completed schematic. If the system is complete, the software calculates the total costs and time required to spread the manure. The results are displayed in the Results pane in both graphical form (as pie charts) and in tabular format. The total time is broken down into that spent on the major activities, including filling (spreaders), travelling (store to fields) and spreading. Costs are broken down by machine type and labour.

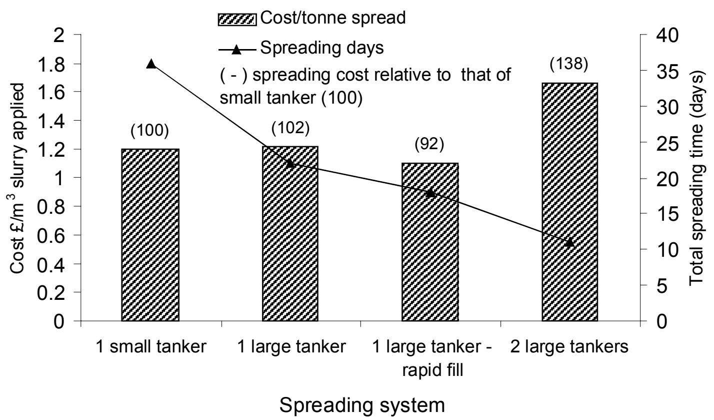
To simplify the operation of the software, a number of 'model' systems have been incorporated which allow the user to select one closest in detail to the one of interest and to then modify components as appropriate. To avoid excessive complexity, the choice of model systems has been limited to four primary systems, enabling a total of 12 secondary models to be presented. Based on these models the user can make more specific machine configurations and system variations as further adjustments and sensitivity assessments are carried out.

Sensitivity Analysis

A sensitivity analysis can be carried out on each machine type or component to investigate its impact and importance on costs and work rate. This should guide farmers who wish to optimise the recycling and efficient utilisation of organic manures.

RESULTS AND DISCUSSION

Using the model, many different scenarios can be simulated and the costs, time and labour requirements rapidly calculated. This facility allows the user to make informed choices about, not only the costs of new machinery or contractor spreading options, but also the time implications – e.g. are there likely to be enough dry days during the spring to undertake the necessary work? An example is shown in Figure 2, which covers a few options for slurry application by tanker and splashplate, on a large dairy unit. Here the slurry is to be spread on fields at an average distance of 500 m from the store. Options for increased work rate include increasing the size of the tanker which, in this case, has minimal impact on cost/m^3 of slurry spread. However, rather greater impact is achieved by reducing the time necessary to fill the tanker, by fitting a larger pump. The combination of two large tankers greatly reduces the time needed for spreading but increases cost by almost 40%.



Notes:
1 Based on estimated slurry output for a 300 cow herd (6000 m3 dilute slurry, 6-month winter)
2 Small tanker - 5 m3 (1100 gallon) tanker, filling time 3 minutes
3 Large tanker - 10 m3 (2200 gallon) tanker, filling time 6 minutes
4 Large tanker rapid fill - 10 m3 (2200 gallon) tanker, filling time 3 minutes

***Figure 2**. Efficiency and costing calculations for slurry spreading on a large dairy unit[1].*

Some validation is of course required before the model can be applied with confidence. This has been done against outputs from another similar model and by comparison with some specific examples on commercial farms. The simulation model CAESAR (**C**omputer simulation of the **A**mmonia **E**mission of **S**lurry application and incorporation on **AR**able land) has been successfully used to evaluate the costs of slurry application (Huijsmans & de Mol, 1999). SPREADS was run using input data and settings, as far as possible, identical to those used in the published examples of Huijsmans & de Mol (1999). Close comparison of the outputs indicated that the two models will give similar answers for simulations where the base information and assumptions are the same.

CONCLUSIONS

Costs and work rates of manure spreading are very sensitive to factors which can vary considerably between farms and different locations. Therefore, SPREADS is a potentially important tool allowing a farm-specific analysis to be conveniently and rapidly undertaken. To date, some limited validation of the software has been provided by comparison against a similar Dutch model, the latter designed only for evaluating the costs of slurry application. Close agreement between the models encourages confidence and suggests that, given reliable information on costs and machinery performance, the model can be expected to provide a reliable analysis of economic and logistical performance of manure application systems. Further detailed validation against a range of spreading systems under practical commercial farming conditions should be undertaken and would add to the confidence in the results now available from SPREADS. A limited issue of the completed software was made available for distribution on CD, early in 2004.

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