FARMWI$E: A FLEXIBLE DECISION SUPPORT TOOL FOR GRAZING SYSTEMS MANAGEMENT

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Abstract

CSIRO's new *FarmWi$e* decision support tool provides a framework that permits pasture-livestock systems and management policies of any level of complexity to be simulated. An underlying "modelling protocol" permits other simulation models to be added, further extending its domain of applicability. Management policies are specified in *FarmWi$e* by means of rules that govern when, whether and how management events take place. An example of the use of *FarmWi$e* to study lamb production is given.

Keywords: *FarmWi$e*, decision support, simulation modelling, rule-based management

Introduction

Over the last decade, CSIRO's GRAZPLAN project has produced a number of decision support (DS) tools for the Australian grazing industries (Donnelly and Moore 1999). The most recent of these, *GrassGro*™, has demonstrated that the power inherent in daily-time step simulation models can be utilized successfully in a grassland DS tool (Moore *et al*. 1997; Salmon & Moore 2001). However there are a number of issues in Australian grassland agriculture that require more flexibility than the *GrassGro* tool, with its emphasis on fixed

yearly management schedules, can provide. Examples include management policies that are responsive to seasonal conditions, for example livestock trading and forage conservation, and exploratory studies of novel livestock production systems as a precursor to expensive real-world trials. Also, the analysis of some issues requires a broader set of sub-models than the water, pasture and livestock models found in *GrassGro* (for example sequences of pastures with crops and predicting rates of soil acidification). CSIRO's new *FarmWi$e* DS tool is specifically designed to meet these needs.

Features of *FarmWi$e*

Extendibility. *FarmWi$e* implements the climate, soil moisture, pasture, livestock and economic sub-models that are used in other GRAZPLAN DS tools. However further models can be added to *FarmWi$e*, because the sub-models are implemented within a "modelling protocol" (Wright *et al.* 1997) that handles information exchange between them. This facility goes one step beyond other object-oriented modelling systems (e.g. van Evert and Campbell 1994) by permitting models from different sources, implemented in different languages, to be used together.

Configurability. *FarmWi$e* supports the modelling of systems with multiple instances of each sub-model, for example multiple paddocks each containing a water balance and one or more pasture species, or a multi-location simulation with several different climate components. Relationships between sub-models in a simulation are denoted by arranging them into a tree structure (Figure 1).

Rule-based management. To meet its intended purposes, *FarmWi$e* must represent a wide variety of different management regimes. This is achieved by conceptualizing the management process as a set of simple "events" (e.g. the application of fertilizer, or the movement of stock from one place to another); each event type alters the state of one of the sub-models. The user then specifies which events will occur and when by means of a series

of rules, i.e. logical statements about the conditions under which management events will happen. These rules can use the state variables of the model, so that the system state can feed back into the management regime. There is effectively no limit on the variety of management regimes that can be specified in this way. Conditional statements ("if/then"), iteration, and user-defined variables are built into the rule language, further increasing its flexibility. (See also McCown *et al*. 1996 for a simpler, independently-developed rule language).

User interface. *FarmWi$e* is intended for use by skilled advisors as well as researchers. The software package therefore provides a user interface that makes setting up simulations as straightforward as possible (Figure 1). The set of available models is stored in a "palette", from which the user drags model instances in order to configure a particular simulation. Initial conditions can be input through dialogs or through a tabular interface. Management rules are entered using an editor that guides the user in the syntax of the rule language. Frequently-used setup information and management rules can be stored in a "repository". Simulation output variables can be selected for storage and then graphed or tabulated for export. Outputs can be summarised using a range of techniques, including computation of frequency distributions for risk analysis purposes.

A case study: contract lamb production

As an example of the use of *FarmWi$e*, consider a novel production system for the production of a year-round supply of lambs that meet a market specification (25 kg carcass weight). One option under consideration was to buy lambs at three-monthly intervals and finish them at Kyabram, Victoria (36ºS, 145ºE) on a combination of irrigated perennial ryegrass-white clover pastures and grain. The question requiring analysis was how much grain would be required to ensure that each cohort of lambs reached market weight, and the year-to-year variability in supplement use, as part of costing the overall production system; this information could then be used to establish prices for the purchased lambs.

When set up in ***FarmWi$e***, this problem required the configuration of sub-models shown in Figure 1, together with management rules describing irrigation, purchase and sale of lambs at different stocking rates through the year, and grain feeding. In the feeding scheme, the difference between the lambs' current and required growth weight was used to vary the daily grain amount. Sample outputs are shown in Figure 2. The simulations show that spring pastures could support the necessary lamb growth rates with low grain inputs, but that at other times of year substantial, and rather variable, amounts of grain would be required.

Discussion

The example above is relatively simple; the ***FarmWi$e*** software provides the flexibility required to simulate a range of farming enterprises with any level of complexity in management, and to analyze them with respect to profit, business risks and sustainability. The underlying modelling protocol is language-independent, opening the tool to use with any set of simulation models; the ***FarmWi$e*** software could be used with a completely different suite of models. We plan to further increase the power of ***FarmWi$e*** by adding a general optimization facility.

Framing management policies as rules is a much more powerful modelling scheme than fixed schedules. It is also approaches the mind-set of real farm managers more closely. With power, however, comes an irreducible level of complexity in the systems under study and their model representations. Also, learning to use rule-based management requires users to learn to think explicitly about management as a series of events responding to circumstances, rather than as the execution of a pre-arranged plan. As a result, we expect that the successful deployment of ***FarmWi$e*** will depend on developing a user base for simpler simulation-based DS tools such as ***GrassGro***, and on an effective training programme.

References

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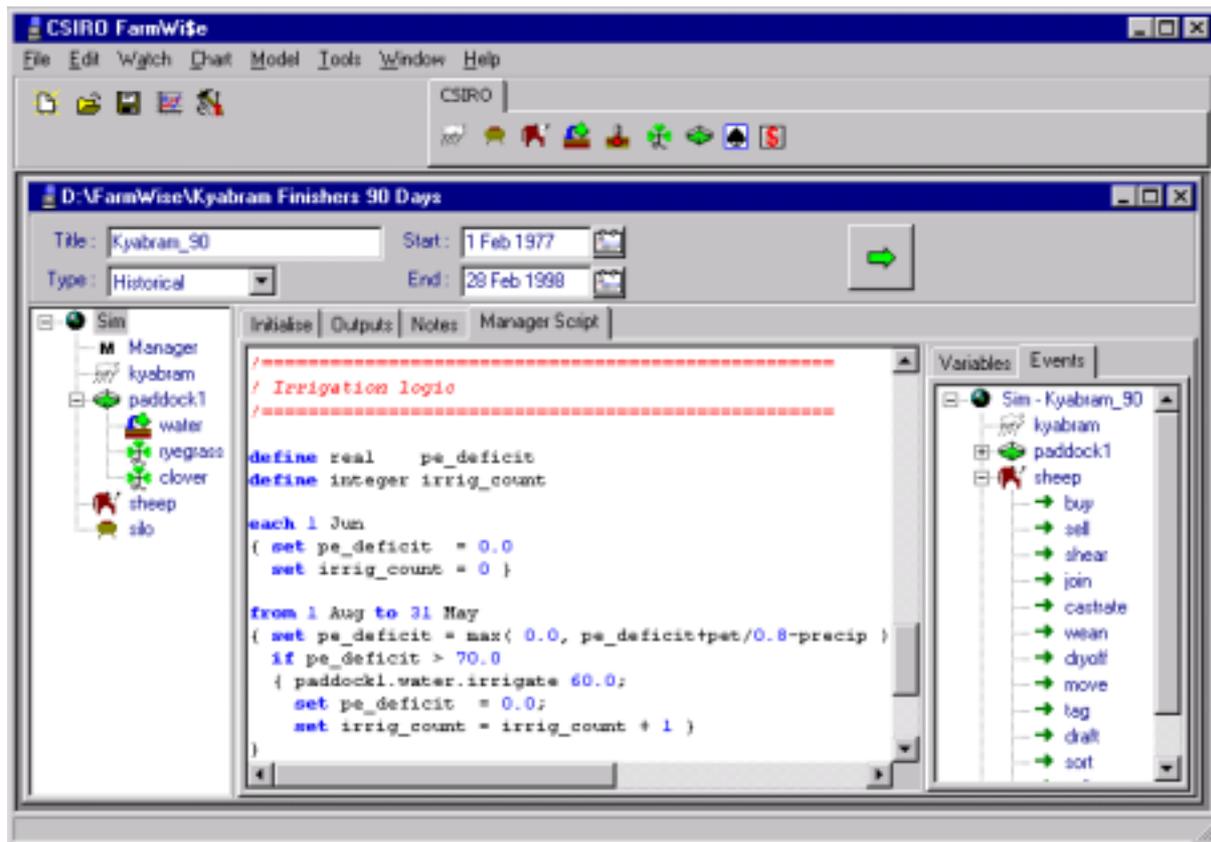
Figure 1 - The user interface for specifying a simulation in *FarmWi$e*. Note the "palette" of sub-models (top); the model configuration pane where the relationships between sub-models are set out in a tree structure (left); and the management rules governing irrigation policy. Icons represent the sub-models, e.g. ⌨ for weather, 🔶 for soil water, ✿ for pasture and 🐐 for livestock.
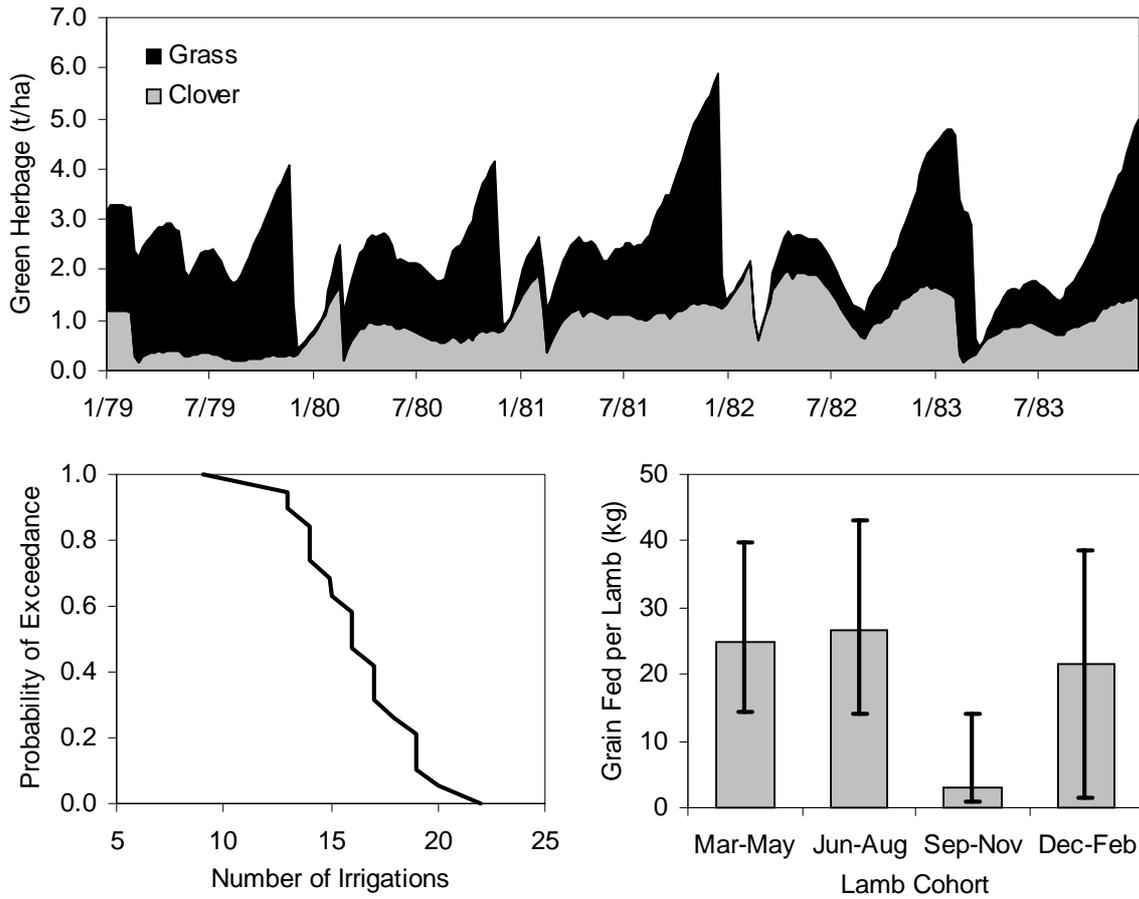
Figure 2 - Results from a *FarmWi$e* simulation of a novel production system for finishing cohorts of lambs on irrigated pasture, showing the effects of climatic variability. (a) Green pasture mass over five of the 20 years. (b) Frequency distribution of the number of irrigations required each summer. (c) Median grain feeding requirements for each of the four lamb cohorts; bars show the first and ninth deciles.