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HIGH TECH APPLIED TO OLD SYSTEMS

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ABSTRACT

This paper reviews the application of computer models to management in the rangelands. Several models are now available and these have application at the station level for decisions that are primarily financial in their content. The models need improvement in their biological content before they can be confidently applied to decisions on matters such as stocking strategies, where interactions with pastures are of primary consideration.

INTRODUCTION

The production systems in the rangelands have remained static almost from the beginning and seem destined to remain that way. Improvements and changes will occur, particularly around the higher rainfall margins, but they will affect only a small part of the rangelands. For the greater part, restrictions of low rainfall mean that there is little opportunity for introducing new products, or of changing the land use. Production will remain as meat and wool from cattle and sheep, grazing on native pastures. Furthermore the stock numbers on this land will not increase. In some regions they may even decrease if land degradation occurs or there is fear that it may.

The world around however, is changing. The terms of trade for agricultural produce continue to decline when viewed over the long-term. This means simply that costs are rising faster than prices. Therefore continuing effort is needed to raise economic productivity. Gains may be made by saving labour (through more efficient sheep handling or station maintenance) by improving per head productivity, (wool cut, turnoff or product quality), or by improving management in areas such as droughts or finances.

One new area where gains will be made in the nineties will be in the use of integrated management information systems to help the pastoralist make better decisions. The gradual development and refinement of these computer based systems or models, will mean that better decisions will be made and greater returns will accrue from the same basic enterprise. There are many desirable management practices, but there is a problem in putting them all together. Which practices are the most critical for production and how do you extrapolate the consequences of the various alternative strategies into future years? These include the long-term structural decisions, such as best ewe-wether ratios or optimum stocking rates and short-term decisions on matters such as supplements and drought selling. The issue for this address is the extent to which these models can assist with decision making, both now and further into the future. High tech applied to old systems! An associated question is the research needed to make these models much better in the future that they are now.

In this paper I wish to present two points of view. First for the producer, that these models are of value, and that it is an appropriate time to start using them. Second for the research worker, that these models still have a long way to go before they can achieve their ultimate value. I hope that this will be a stimulus for an interchange of views from the floor.

MODEL APPLICATIONS

First we may ask, what are models? There are a whole variety of types, from the deeply mathematical to the simple retrievers of information like the pages of a book. Today I am talking about the moderately mathematical ones that seek to quantitatively mimic the fairly intricate processes of an agricultural system involving land, grass and livestock, or at least the financial inputs and outputs of a station. A stylized example is contained in the diagram that follows (Figure 1).

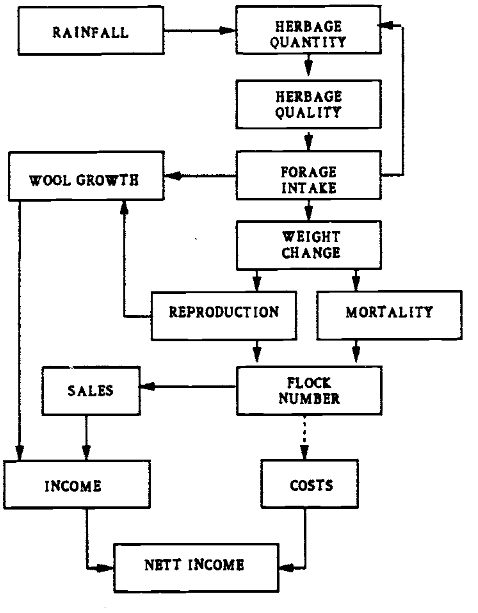

Figure 1. Some components of a rangeland model

Each of the steps involves a number of mathematical functions that have been derived from many years of research. An example is the relationship between wool growth and the amount of green herbage available on the ground, as shown in Figure 2, for a semi-arid woodland in eastern Australia. These are the basic building blocks of any model - a series of such relationships, built up in sequence.

Another essential feature is that they contain the main feed-back loops that we know exist on stations, such as the more stock you have the more forage will be consumed. A model will be of little use without these, since we are often looking for an optimum solution to a management problem such as the input that will achieve the greatest dollar output. Some models, however, which have a more limited scope, such as looking at the consequences of two defined strategies (e.g. sell or agist) and their comparative financial outcomes, may not need the feedback loops.

The reason for developing models for rangelands applications must always be kept to the forefront. It is not possible or desirable to include all the biological information and interactions into the one big model. Even with computers, they become too unwieldy and eventually inaccurate. Hence there will not be just one model, but many, each with a different purpose. The objectives determine the content. Some purposes in the rangelands are:

- To determine the financial outcome of several alternative management strategies.
- To determine the longer term consequences of a current decision, such as selling in a drought or burning a paddock.
- To explore the effects of rainfall variation (including drought) on the enterprise, such as on the most profitable stocking strategy.

• To extrapolate research information to neighbouring regions and scale it up to the property level.

To achieve these objectives they require the inclusion of:
• The main interactions that affect production.
• The effects of rainfall variation.
• The longer-term consequences of a decision.
• The economic outcome.

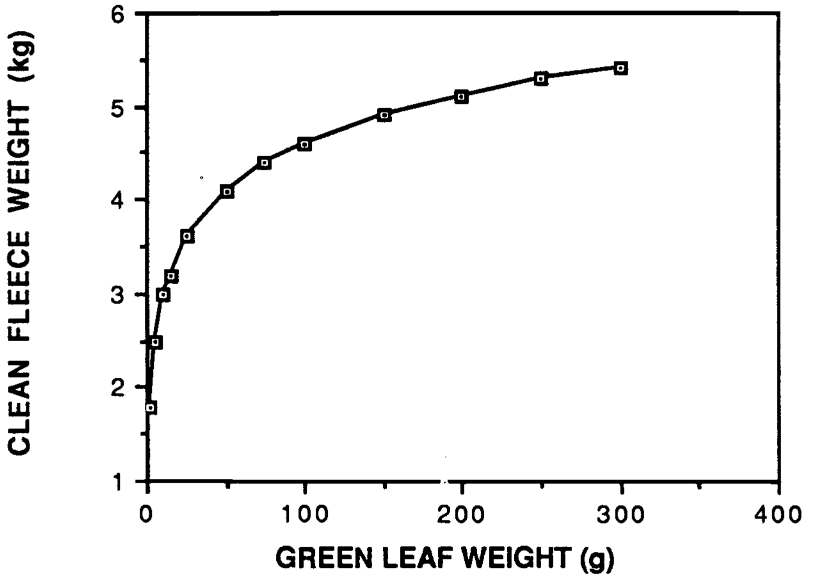

Figure 2. Relationship between wool weight and forage yield for a semi-arid woodland.

EXAMPLES

It is informative to look at what current models are around now and what they are being used for. The following list is not complete, but tells us the type of product that we can expect.

<u>Beefman</u>
This is a herd structure and income model for cattle in Queensland (1). The authors have used the model to conclude that the greatest gain in management comes from increasing the liveweight of cattle at sale. Reducing sale age gives a similar response, but increases drought susceptibility because of a change in herd composition towards more lactating and younger cattle. Improvements in reproduction rate is of lesser importance unless a premium is paid for young animals.

<u>Sheepo</u>
This is a wool production model developed for improved annual pastures (2). It is based on the known energy digestion and production relationships in sheep. It has been used to determine optimal stocking rates and to explore the relative advantages of improving forage growth at different times of the year. An increase in dry season growth or greenness is worth more than an increase in wet season growth. The model is not currently suitable for the rangelands because it is set for annual sward pastures, not tussock and mixed pastures as in the semi-arid, but it could be so adapted in future.

<u>Merino</u>
A spreadsheet flock structure and income model of a sheep enterprise (3). A conclusion from this model is that improving the lambing rate of sheep is not as advantageous as suggested by conventional wisdom. An increase of 10% in weaning may increase gross margins by only 5%, because most of the income from sheep comes from wool, not sheep sales.

Pastor and Wired
Cash flow models of properties in Western Australia which examine the on property financial consequences of changing management, such as flock structures.

Rangepak (Herdecon)
A model that mimics the production and economic returns from selected cattle and sheep properties by including their existing production levels. It presents the financial consequences of various management options (4). It has been used to compare the outcome of various development strategies for properties in the Katherine region, with the conclusion that adopting new supplementation strategies is likely to be more profitable than pasture improvement (5).

Some of these conclusions are perhaps predictable - for instance that an increase in dry season growth is worth more than an increase in wet season growth. Others are not. The poor gains in economic returns from improvements in reproduction rate (at least for regions where it is sufficient for normal flock replacement) is surprising. To what extent does it apply in the Rangelands? The conclusion on which technology to adopt first, for cattle stations at Katherine, will be of considerable value for planning station development. Perhaps more important is that such advice can now be tailor-made to the individual property, hence allowing for the inevitable property differences in land, animal and management characteristics.

EVALUATION OF CURRENT MODELS

In terms of the purposes of models outlined above, these models are generally strong on their coverage of economic outcomes. The more general and useful conclusions come from comparison of alternative strategies, where one is seeking the better strategy rather than a specific prediction of the profit from that strategy. In this case it is not so important that the underlying biological relationships are exactly correct. For instance, the comparative outcomes of alternative flock structures or development strategies are immediately useful to the pastoralist.

However, I believe that they are less than adequate when it come to decisions that involve interactions of land and forage, since few of the models contain any biology. In particular they do not contain the feedback loops of the effects of the stock on the herbage growth or supply. It is therefore difficult for me to believe that they can be used with any confidence to probe issues such as the best stocking strategy or the best drought management procedure, where the longer term models can only guess the possible effects of a lower stocking rate on herd productivity during and post drought. They may record the historical outcome on particular properties, but this is inadequate for predicting the outcome for a different long-term stocking rate on that property, or the outcome on another property.

Another difficulty is that of regional differences. One could say that a sheep is a sheep no matter where it grazes. Wool should be grown at the same rate in response to the same level of nutrition, whether it be in Cunnamulla or Carnarvon. But when it comes to feed, all is not the same. Saltbush is not the same as grass and Mitchell grass is not the same as mulga Mitchell, because there is a matter of quality as well as quantity. In general quality is the greater restriction on production in the north and quantity is the greater restriction on production in the south, but both are involved on every pasture to a greater or lesser extent. Furthermore the consequences of grazing hard may be quite different from one pasture to another. Hence we should not really expect the one relationship, say between the amount of forage and animal performance, to be applicable nationwide. Models that do not account for these basic differences between vegetation types have the potential to be misleading in regions other than where they were developed.

It is important for any user to note the limitations of the model they are using. I may take the comparison of development strategies at Katherine as an example. Whilst the conclusions drawn from the modelling exercise are satisfactory, the authors (Foran *et al.* 1990) note that no account is taken of the effect of supplementation on the utilization of the herbage. This is potentially a serious deficiency, since it has been the experience elsewhere that supplements bring greater pressure on the pasture resource, with the possibility that the model conclusion will not hold up in the long-term.

Another important interaction that must be included in rangeland models is the change in fibre diameter that occurs as wool cut declines. If this relationship is included then overstocking does not show up as deleterious to current production in the same way as it might with cattle. Heavy stocking with sheep will therefore have different consequences to heavy stocking with cattle, where quality accrues to well grown beasts at a younger age.

CONCLUSIONS

For the research worker

My conclusion for the research workers in the audience is that the models need to include more biological relationships, particularly those involving interaction between the stock and the herbage. At present we are including biology mainly by estimating the form of relationships, with the danger that we are simply reinforcing our own biases. It may be appropriate to do this at first, since there is value in producing at least a general conclusion from our limited existing knowledge. But we must be mindful that those estimates (or are they guesses?) require following up with real data in the future. Otherwise there is potential for a false relationship, once incorporated into a model, becoming known as fact.

As I have mentioned, the greatest need is for relationship between livestock performance and pasture variables. In this regard I might also mention that pastures are complex structures, and this requires complex measures of them. For instance I have found from my work in the semi-arid woodlands that the best relationships by far arise not from the measures of total herbage biomass, but from measures of the green leaf of the more palatable herbage species. More work is required to obtain data in this form, but the long-term rewards will justify that work. Grazing trials are expensive, so we must make the most of them. That means measuring the pastures in detail, separating them into species and components, as well as measuring the stock performance, so that we can obtain good relationships for model construction.

A further need is for information on the level of utilization and its effect on pasture deterioration. At present we have little of this data, so the output of our models must stop well short of supplying reliable advice on stocking strategies.

For the pastoralist

I expect that the pastoralist in general will be suspicious of all this activity on computers. To you it has the flavour of engaging many bums at desks, as a means of avoiding doing anything useful. That is perhaps a healthy attitude to new technology, but I would like to convince you that it is now time to try these models for their application to your property. They are now useful, if not yet proficient, for helping you make financial decisions, particularly where there may be longer term outcomes from a current decision. Models are valuable as aids to forward planning, something that managers often fail to do. They also show the value of keeping good records of production and finances, which are rather sparse in the rangelands (Stafford Smith, personal communication). With good records and a model tuned to a property, the manager has an excellent chance of accurately predicting the best long-term strategy (although the actual outcome remains unpredictable since the actual rainfall is not known). Another aspect is that the involvement of pastoralist with models will help to find their strengths and weaknesses, hence aiding the iterative process of making them better in the future.

Models of some form or other are here to stay. It is perhaps difficult for the average pastoralist to understand how they function and hence have confidence in their output. Such confidence and understanding can only come with use, so my advice is for you to get involved, both for your own advantage, and as a means of ensuring that the models do really achieve the dreams of their creators. I expect that by the end of this decade we will have a series of useful working models in use, and that they will be making an impact on the profitability of enterprises and on the maintenance of our land resources. High tech applied to old systems.

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