PROPORTIONAL REACTOR STRATEGY FOR MANAGING PASTORAL PROPERTIES

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BACKGROUND

For decades pastoralists and researchers have been trying to find better ways of matching stock numbers to rangeland conditions, where rainfall and grass production are more variable and less predictable than agricultural areas of Australia. This paper reports on the continuous development of a model for simulating cattle production in the arid zone. We aim to create and test simple strategies that reproduce realistic management decisions when run over simulations spanning large time periods. We can then use these strategies to better understand what impacts changes to a property's running conditions (eg. animal prices, transaction costs, weather and weeds) are likely to have on production, cash flow and impact on the land. This study builds on the RISKHerd (Stafford Smith *et al.* 2001) modelling study.

Previous studies focused on two representative strategies, *Reactor* (adjusting stock numbers to suit the amount of feed available) and *Constant* (keeping a constant level of stock on the property at all times). Although *Reactor* matches stock numbers to rangeland conditions, it is not always practicable and transaction costs could make it a less desirable option. Reacting perfectly in the variable climate of the rangelands requires extreme stock adjustments in some years. Making large stock adjustments just before an unanticipated good or bad year can cause high financial losses. Large stock reductions can limit the herd's ability to recover numbers within an acceptable time frame, forcing the producer to buy in breeding stock. In practice pastoralists do not use such extreme strategies as pure *Reactor* or *Constant.*

To better match reality we created a new strategy based on *Reactor*. *Proportional Reactor* also matches stock numbers to available feed but reduces the reaction that this matching dictates, cutting down on the transaction costs, reducing the impact on the herd and dampening some of the extreme responses arising from *Reactor*. After making regular sales and purchases the producer uses a utilisation target of available feed to determine how many extra animals to buy or sell to match their target. The producer then applies their responsiveness (the proportion which they react to their available feed) to these sales or purchases. The feed utilisation target and the responsiveness are worked out by repeatedly running the property scenario with various management targets to find the optimum cash flow. This is a formalisation of the reality that many producers who vary their stock numbers over time dampen these buying and selling decisions according to their perceptions of risk. Our study explores whether this approach improves on the simplistic *Constant* and *Reactor* strategies.

APPROACH

The purpose of the study is to explore the benefits of *Proportional Reactor*, and examine how different pricing regimes and changing natural conditions affect responsiveness. This study uses the same buying and selling set-up as used with the *Reactor* strategy but with the added responsiveness limiting the extra sales and purchases. To gain a better understanding of responsiveness the producer's target utilisation has been kept constant. Due to time limitations on running the optimisation, the buying and selling rules are maintained as they are for the original property setup and are not recreated to suit the changing conditions. This may not produce the financial optimum, however it should demonstrate the benefits of *Proportional Reactor.*

MODELS

The program GRASP (McKeon *et al.* 1990) is used to simulate pasture growth on the property. The growth data from GRASP are input into the HerdEcon model (Stafford Smith and Foran 1988).

HerdEcon is a livestock management program originally designed to help producers manage their properties and to run simple "what if" simulations based on their past records. A cut back version, for faster simulations, was created which determines the growth, reproduction and death rate of animals using a series of animal growth equations created from historical data (Stafford Smith *et al.* 2001).

To get the best setup for each property we created an optimisation program within Microsoft Excel based on an evolutionary strategy algorithm (Schwefel 1981). The algorithm takes a starting point of management targets and limits within which these targets can move. It then selects a series of new starting points and runs these through the HerdEcon model, collecting the results (in this case cash flow). These results are used to create a new series of starting points. This process continues until the incremental improvements in results are within set limits. These limits are set so as to get sensible results from the optimiser within a reasonable time frame. The starting point with the best result is then rerun to get the complete set of outcomes (including cash flow, animal numbers and sales statistics) from the property.

To examine the effect that changes in natural conditions have on the producer's optimum behaviour the following steps were taken. First the real 108-year climate sequence was artificially modified to create climates that were more and less variable but produced the same seasonal average. Secondly the climate sequence was changed to move the average up and down, maintaining variability, as a substitute for changes that affect productivity, such as the impact of weeds or different soils. This is possible due to the way the HerdEcon model is set up. Weather data are used as an input to the GRASP program, which generates a productivity measure that in turn feeds into HerdEcon.

RESULTS

Proportional Reactor simulates a more realistic management strategy than others previously explored. It responds as expected to changing prices (it is worth being more responsive as prices improve) but did not respond intuitively to changing climate variability. We found that as the financial conditions became more favourable to the producer, his responsiveness increased. Change in responsiveness was small until the price changes approached 10%. With extremely favourable conditions the responsiveness was at 100%, equivalent to the *Reactor* strategy. When the financial conditions were approaching their worst, responsiveness was reduced to around 20%.

To get the full benefits of *Proportional Reactor*, utilisation targets should be changed as the weather or productivity changes. When utilisation was unchanged, responsiveness moved to 100% as the weather and productivity changed in either direction. There was no significant change until the productivity change became very large. As weather variability increased (and the producer can be less certain of the rain he will get) and utilisation was allowed to change, responsiveness increased to 100%. Under this scenario, utilisation decreased (causing a smaller herd to be kept on the property). When the variability of weather decreased, responsiveness remained constant while the utilisation target increased.

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