Proceedings of the New Zealand Grassland Association 53: 137-140 (1991)

Stockpol: A decision support model for livestock farms

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Abstract

A computer program called Stockpol is described. It is a biological model designed for decision-support applications on pastoral farms. Individual farm scenarios are defined in terms of component subfiles which define stock (numbers and performance), land (area, pasture growth rates and land use), prices and constants. Physical and financial reports are available for individual scenarios, and for comparisons among scenarios. Once defined, scenarios are tested for biological feasibility by calculating if there is enough pasture cover on the farm at all times to meet animal requirements for targetperformance levels. Policies for biologically unfeasible farms can be automatically modified if necessary. Stockpol can be used to analyse long-term policy changes or short-term feed budgets, but it is not suitable for paddock-level feed budgeting.

Keywords sheep, beef, pasture growth, pasture cover, feed budget, biological feasibility, prices, profits, computer model

Introduction

Stockpol is a computer program which models the biology of a pastoral farm. It has been developed by the modelling group at Whatawhata Research Centre over the last 3 years, in response to requests for such a model from both scientists and consultants, The program has been designed to help consultants to compare the profitability of different management options. It can be seen as a *means* of making research results available in a usable form.

Objectives and specifications

Objectives for Stockpol were defined after a series of workshops in which MAFTechnology farm consultants were asked what they wanted. Further meetings with selected consultants after the first versions of Stockpol had been written enabled these objectives to be refined. A tool was required to analyse the profit of various stock policy options for a farm (e.g. should I increase the ratio of finishing cattle on my farm?). Given this purpose, priority was given to biological accuracy, ease of use and speed of calculation.

An important design consideration in any programming project is the balance between simplicity anddepth. Aprogrammay be technicallyverypowerful, but is worthless if no one can use it. Stockpol has been designed to be usable at different levels. The design and order of editing *screens,* and the supply of meaningfuldefaults make acomplete analysis possible using only five or six screens and very few inputs, while the program still meets the demands of more complex use.

Stockpol has been developed in Turbo Pascal for MS-DOS machines, and has a graphic user interface. Pull-down menus, dialog boxes and spreadsheet-like data entry cells have all been used to make an intuitive, easy-to-learn interface (but without mouse support). There are about 40 000 lines of code, 45 data entry and editing screens, and 30 reports, including both tables and graphs.

Files

Information on a complete farm strategy (including prices) is stored in one file by Stockpol, referred to as a "Farm". Farms can individually defined, duplicated, modified and tested for biological feasibility. Various reports, including financial summaries and enterprise margins can be generated for each farm. It is also possible to generatereports in which up to five farms can be compared on one screen, which will usually be a comparison if different scenarios for the same physical farm. The "farm" can alternatively be thought of as a strategy or a scenario.

The farm is made up of up to 26 "subfiles", most of which define a mob of animals, a block of land or a unit of bought-in feed. Special subfiles also exist to define prices, biological constants, feeding-out patterns and user notes. This modular approach to farm definition allows flexibility in that a simple farm can be analysed quickly using just *one* stock and one land subfile, but for more complex systems, several subfiles can be used, with stock being transferred from one to another if necessary. These subfiles are laid out on the main screen of Stockpol in a spreadsheet format (Figure 1).

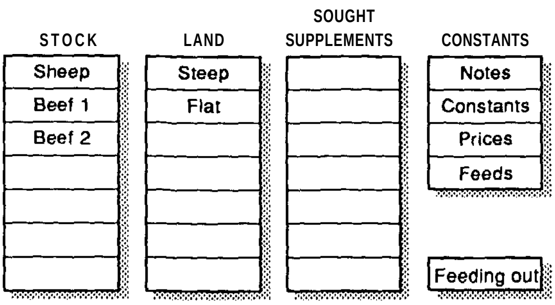

Figure 1 The main screen of Stockpol. In this example, three stock subfiles and two land subfiles have been defined.

Stock subfiles (sheep or beef) define stock numbers and target weights for a mob of animals (including males and replacements). Basic information required for a stock subfile includes dates of mating and shearing, stock numbers and monthly target live weights. A spreadsheet-like self-balancing stock reconciliation is used to enter the stock numbers over the year (Figure 2), with a separate screen to record in which months the various sales and purchases occurred. Default live weight targets are supplied (based on a specified mating weight), and these can be edited either as monthly live weights or live weight gains. The performance screens also show a plot of live weights along with predicted fleece weights and lamb (or calf) weaning weight.

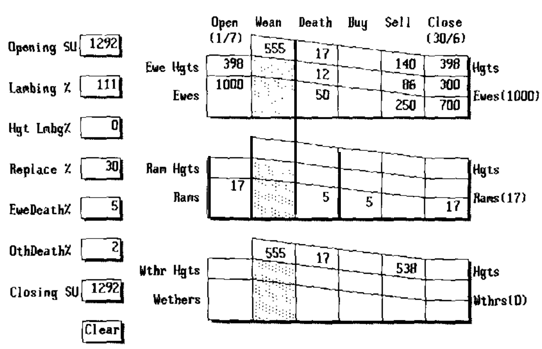

Figure 2 The sheep stock-reconciliation screen. The cells on this screen can be edited like a spreadsheet.

The distribution of weights around the mean of each stock class is also modelled, so that the user can see not only the mean target live weight but also the live weight distribution in any month. This begins as a normal distribution at weaning, but will be modified by stock sales. Sale stock can be drafted from either the top or bottom of the distribution. Drafting screens use this feature to allow the user to predict sale numbers from drafting cut-off weights. These screens also display drafting weights, carcass grading and income, so that the financial implications of a particular drafting strategy are immediately available.

Land subfiles define blocks of land, each of which has an area and monthly pasture growth rates. A block of land for this purpose is any area of land with similar growthrates. It may not be aphysically separate block. A farm might be defined with one block each for steep and flat country, or perhaps one block of pasture and another of luceme. Pasture growth is defined using monthly averages of 14-day cuts. Nitrogen fertiliser can be added here to boost the pasture growth rate in certain months. Conservation and cropping (grain or forage) are defined on other screens for each land subfile to allow integration of cropping and livestock, but crop yields are not modelled and must be supplied by the user.

Abuilt-indatabaseofpasturegrowthat 120pasture sites around New Zealand (with average rainfall and temperature for each site) is useful when defining farms for which actual pasture growth rates have not been measured. A weather simulation is included to simulate the effect of altered rainfall or temperature on pasture growth for these sites (Baars *et al.* 1990).

The feasibility test

The heart of Stockpol is the feasibility test. Stockpol does not model stock performance as a result of pasture availability. Instead, it uses the defined target live weights and production levels to calculate the energy requirements. Pasture intake requirements are then derived, and minimum pasture cover requirements to enable those intakes. A simulation is run to check whether target intakes can be achieved, and to predict actual intake if there is not enough green pasture mass to meet the target intake.

The pasture supply and demand are modelled over a number of years until an equilibrium is reached between opening and closing pasture covers. Actual covers are then generated, and if they fall below the minimum required cover (i.e. required intakes cannot be achieved), the farm is marked as biologically unfeasible (Figure 3).

For short-term feed budgeting exercises, Stockpol can also run a feasibility test over just one year, for which a starting date and starting pasture cover are required inputs.

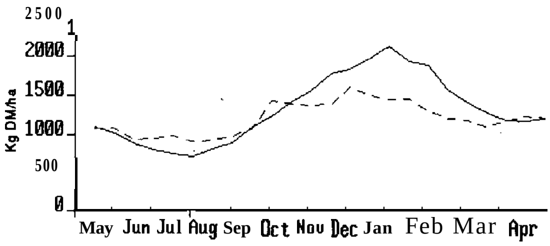

Figure 3 Cover plot for an unfeasible farm. The dotted line shows the minimum cover required to maintain the specified target performances.

The pasture growth itself is modelled by dividing pasture mass into three pools (green leaf, stem and dead), with equations to govern the movement of pasture among these pools, dependent on pasture mass and time of year. Pasture growth is modified by pasture cover, being reduced where insufficient cover exists to intercept all the light, and where excess cover reduces net growth because of senescence and decay.

Using Stockpol

Before different management strategies can be compared, a farm must be defined as it is now. If pasture growth rates have been measured, these can be simply entered. Otherwise, these growth rates can be estimated with the help of the pasture sites database. Stock numbers are entered from the farmer's stock reconciliation, along with timing of sales, mating, weaning and shearing.

When the existing farm has been completely defined, Stockpol is used to test for biological feasibility. It may be that the model predicts that the farm scenario is unfeasible (i.e. animal performance targets cannot be met). In this case, the farm definition must be adjusted to make it feasible before any further analysis. Usually, the pasture growth rate estimates are the most uncertain part of the farm's data, so Stockpol can automatically adjust the pasture growth rate values until the farm becomes feasible. This technique is used to calibrate the model.

Reports can now be generated for the farms as with the farmer's own records. Prices may be edited as required. A copy of the farm is then saved on to disk.

New stock and pasture management policies can now be applied to copies of the original farm. Each of these is also tested for feasibility. If a farm is unfeasible, automatic options are available to reduce stocknumbers or performance targets, to conserve feed, buy supplements or add nitrogen fertiliser until the scenario becomes feasible. These automatic options allow Stockpol to go further than a simple 'What-if?' simulation, by optimising certain parameters within the limits of feasibility.

Reports can now be generated for any of the modified farms, and for several farms together giving comparisons of physical and financial summaries. Available reports include a financial summary, gross margins for each of the farm's enterprises (sheep, beef and cropping), a monthly cash flow report including separate income and expense flows for each of the farm's enterprises, monthly stock numbers and feed requirements, production summary tables for lamb, beef and wool production, feed supply and demand curves and farm pasture cover plot.

Financial comparisons (e.g. Figure 4) have been designed to assist with decisions about whether to implement a new policy, but must be interpreted in context. Other considerations are required, such as the riskiness of the new policy to the farmer, given the size of the financial advantage predicted.

If a new policy decision it taken, the monthly feed requirements report can be used to calculate therelative area of the farm required for each stock class. The average farm cover report may also be useful to monitor the implementation of a new policy. If monitored cover deviates from predicted cover, further Stockpol analyses can be used to predict the best course of remedial action (e.g. apply nitrogen in winter, sell stock earlier for a draught or accept reduced stock performance).

FARM	BULLS4	BULLS5	
Description	Nitrogen	Less sheep	DIFFERENCE
status	Feasible	Feasible	
INCOME	$ Total	$ Total	
Sheep	36075	33994	-2081
Wool	38961	36608	-2353
Beef	60861	60861	0
crop	6936	6936	0
Total	142034	138399	-4435
EXPENSES	$ Total	$ Total	
Shearing	6513	6120	-393
Cropping	3468	3468	0
Feed	7200	2000	-5200
Animal health	4656	4467	-189
Interest	3399	3169	-230
Total	25236	19225	-6011
MARGIN	117597	119174	1577

Figure 4 A financial comparison report between two Stockpol farms.

Limitations of Stockpol

Stockpol is useful for testing the viability of long-term farm policy changes, and also has a limited application in short-term feed budgeting. However, it is concerned with balancing feed supply and demand *over the* whole farm and is not useful for paddock-level analysis. It may suggest that a strategy is feasible and profitable without showing how it can be implemented.

It is also difficult to model the transition between policies. Stockpol can do this, but only by the clumsy process of running a series of yearly scenarios, each with a specified starting pasture cover.

At the moment, Stockpol covers only sheep and beef farms, but plans for future expansion include deer, goats and dairy cattle.

Conclusion

The Stockpol project illustrates that it is possible to produce a biologically realistic decisions-support model for a complex farm system. A feature of Stockpol is the careful attention that has been paid to software design and user interfacing. However, the final verdict on whether Stockpol is a practical tool will have to come from its users, the MAFTechnology consultants, and their clients.

Future expansion plans for Stockpol include the addition of more stock classes and a related module for paddock-level feed planning.

REFERENCE

Baars, J.A.; Radcliffe, I.E.; Rollo, M.D. 1990. Climatic change effects on seasonal patterns of pasture production in New Zealand. *Proceedings of the NZ Grassland Association 51: 43-46.*