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Predictive use of a pasture production model on commercial farms: some examples

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ABSTRACT

This paper reports on an interactive, user-friendly microcomputer based pasture production model which provides pasture growth rate information for farmers and advisers. The model (GRASS) describes the production of perennial ryegrass and white clover pastures in terms of simplified major processes. The model not only allows for assessments of historic and current (daily) growth rates, but can also make rapid analyses of future pasture growth rates. This predictive ability is of major importance in many management decisions. The model also allows for on-site calibration. It is intended to be used on individual farms and any management can be simulated. This model overcomes the limitations of pasture growth data collected at research stations over a limited number of years using standard cutting techniques at sites which are often not representative of the climate and soil types on a particular farm.

Examples of potential uses for the model are given. It is concluded that an explanatory low resolution model appears to be a promising approach for more sophisticated feed planning and management decisions.

Keywords Simulation model; pasture growth rate; pasture production; validation.

INTRODUCTION

Traditional agronomic methods have not yielded the information required to predict pasture growth rates for an individual farm. There are many cases where a farmer has to make management decisions on stocking rate, lambing date, calving date and weaning date where questions on feed supply and pasture growth rate are involved. Microcomputer based simulation models are now becoming available which make it possible for farmers to simulate pasture production for their own property in their office. This is important as pasture growth rates are more variable than assessments of either standing dry matter or data on animal requirements, in developing a feed plan. There are also large differences in rainfall, soil temperature and soil types between research sites and individual farms so that extrapolation of data from research stations and demonstration farms to individual farms is fraught with difficulties.

A computer model (GRASS, Baars *et al.,* 1987) has been constructed that predicts pasture growth using climatic factors which the farmer can measure himself on his farm. The program runs on all MSDOS IBM compatible microcomputers and has been designed for use in the farm office. Feed plans can then be formulated at home on the basis of present and expected pasture growth rates to evaluate possible management options. Such exercises are helpful in determining the timing of critical decisions like selling stock or feeding supplements, so that decisions can be made before a critical point is reached.

This paper presents an outline of the pasture growth simulation model and describes examples of its possible use. Previous validation results have been reported by Baars *et al.* (1987).

MODEL OUTLINE

Inputs

The model requires daily inputs of soil temperature at 10 cm depth and rainfall as well as monthly averages of 10 cm soil temperature and solar radiation (New Zealand Meteorological Service, 1980). An estimate of available water at the rooting depth of the relevant soil type is also required.

Potential Growth

Monthly solar radiation and 10 cm soil temperature are used to calculate average pasture growth rates and ceiling yields. A basic growth curve consists of an exponential, a linear and a ceiling yield phase.

Actual Growth

Potential growth curve parameters are adjusted for moisture stress, and a daily water balance calculated. A Priestley-Taylor equation is used to calculate evapotranspiration. As air temperature is often not available for farms, regression equations relating air to soil temperature, derived from a sample of adjacent meteorological stations, are used to calculate air temperature from the soil temperature measured on the farm. These regression equations differ for different areas and have to be calculated for each region where the model is used.

Growth takes account of the stubble or post-grazing residual pasture mass, present at the onset of each regrowth period. A regrowth period can be a cutting or grazing interval specified by calendar dates or number of days between cuts, or the interval necessary to reach a specified level of standing dry matter or herbage mass.

MODEL USES

Examples of possible uses for the model would be to derive:—

Standard Rate of Growth Curves

The seasonal pattern of pasture production has been measured extensively throughout New Zealand at about 40 sites. Most of the national trials have been measured with a 2-weekly cutting interval. A constant level of defoliation and regrowth period was used throughout the year over the trial periods (Radcliffe, 1974). By contrast the levels of defoliation and grazing intervals vary during the year on most farms. As a result measurements can not be easily extrapolated to farming conditions. In the Waikato, agreement between simulated and measured pasture growth rates on a number of sites on dairy farms using a standard 4-weekly cutting interval has been good (Baars *et al.,* 1987). Similar agreement between predicted and measured growth rates for 2-weekly cutting was found at Ruakura No. 2 Dairy and on other dairy farms used for model validation (Baars *et al.,* 1987). Some results for the Ruakura No. 2 Dairy are presented in Fig. 1. The differences resulting from 2- and 4-weekly cutting are of similar magnitude to the variation between these cutting regimes in Taranaki (Baars, 1982). Fig. 2 shows the effect of management on the average seasonal pattern of pasture production in the Waikato using GRASS. The seasonal pattern of pasture production for 2-weekly cutting is markedly different from that for either 4-weekly cutting or a typical dairy management system.

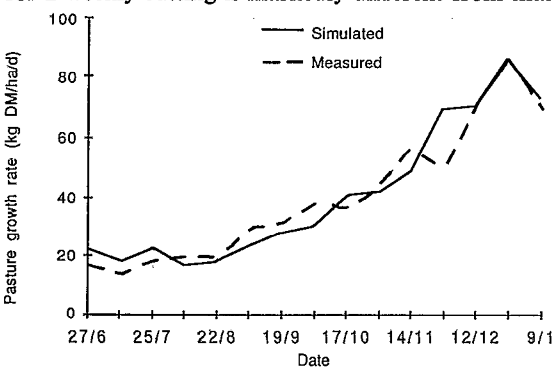

FIG. 1 Simulated and measured pasture growth rates at Ruakura No. 2 Dairy with a 2-weekly cutting interval during 1985.

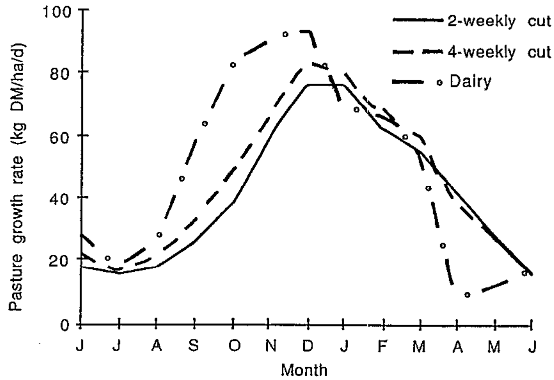

FIG. 2 Effect of different management procedures on the average seasonal pattern of pasture growth in the Waikato simulated by 2- and 4-weekly cutting intervals with post-mowing masses ranging from 500 kg DM/ha in winter to 1000 kg DM/ha in summer, and a dairy management system with a 15 d rotation in mid-spring, increasing to a 35 d rotation in late autumn and post-grazing pasture masses of 1800 kgDM/ha in spring and 2200 kg DM/ha in summer.

Daily Pasture Growth Rates and Forecasting

In most industries a manager controls or knows his raw material supply situation. Farmers can only speculate. A model using up-to-date information on pasture growth can assist in reducing the risk associated with feed planning (Probine, 1977). The present model can calculate the raw material supply as daily pasture growth for any cover on the farm. This can be the average farm cover or the cover of individual paddocks. For example simulated and measured pasture growth rates using the rate of growth technique and corresponding current pasture growth rates during September and October 1986 for the Ruakura No. 2 Dairy are given in Table 1. The importance of daily information on pasture growth rates for different amounts of pasture mass is obvious. It is very difficult for a farmer to get this

TABLE 1 Simulated and measured (in parentheses) pasture growth rates (kg DM/ha/d) at Ruakura No. 2 Dairy with 2-weekly and 4-weekly cutting intervals and simulated pasture growth rates for 4 different levels of herbage mass (kg DM/ha) on 4 cutting dates during the spring of 1986.

Cutting date	Cutting interval 2-weekly	4-weekly	Standing herbage mass 500	1000	1500	2000
4 Sept	39.9(44.4)	—	18.2	36.4	54.7	54.9
18 Sept	52.8(47.8)	65.9(59.5)	21.3	42.7	64.0	75.0
16 Oct	63.2(64.1)	—	23.7	47.4	71.1	84.4
30 Oct	60.4(69.9)	77.6(89.5)	24.3	48.6	72.9	86.1

up-to-date information on pasture growth rates from research stations.

With a microcomputer model a farmer can be more aware of changes in growth rate and ascertain when supply exceeds or falls short of demand. For instance, in spring current pasture growth rates over the farm are required to calculate the number of paddocks which can be closed up for conservation. Table 1 shows the rapid changes in daily pasture growth due to level of herbage mass and time. GRASS also makes it possible to assess when silage paddocks will be ready for cutting. This is facilitated by an option which gives the user the opportunity to see what happens to cover on the farm in relation to a weather forecast consisting of estimates of soil temperature and rainfall. The user can quickly ascertain what happens to cover under any forecast and over any period. This makes it feasible to compare daily feed requirements and future pasture growth.

DISCUSSION

The above examples confirm the value of a pasture production model. It is important to have a tool which can take account of intensity of defoliation and spelling interval in feed planning exercises. Previously only rate of growth data based on 2-weekly cutting (Baars, 1976) were readily available for feed planning on Waikato dairy farms. For important policy decisions like setting stocking rate, calving date and the likely need for conservation, farm advisers and farmers usually take an average pattern of feed supply and demand. However the standard rate of growth data are based on 2-weekly or 4-weekly cutting. It is therefore necessary to extrapolate to the rotation length and defoliation height a farmer wishes to implement on the property. It is also important to be able to rapidly assess the effect of an extreme year. Here a pasture model is an invaluable tool.

Most pasture production models have only been employed to determine seasonal growth patterns, but GRASS can also be used as a means to supply a daily growth estimate and for predictive purposes. One of the major advantages is that a farmer can anticipate what is likely to happen to his herbage mass before any visual effect can be detected. This means that more timely decisions can be made, as in the case of silage making, allowing opportunities to be capitalised upon, and poor decisions avoided.

The model is empirical, but implicitly includes much of the current understanding of pasture growth. The interaction between weather, pasture cover and pasture growth rate is fully expressed. It is however recognised that these relationships are probably specific for the range of soils and climatic regions within New Zealand. In operational mode the model can take into account the data collected on the farm, which can then be used for calibration by changing the curve parameters interactively. For instance maximum pasture growth rates are strongly dependent on ryegrass content and hence ryegrass growth rate. In spring maximum pasture growth rates range from 135 kg DM/ha/d (Brougham, 1959) down to 70 kg DM/ha/d (Piggot *et al.*, 1986). We think that finetuning of model parameters using data collected on the farm should be allowed for in the design of models for on-farm use. Consequently the design of GRASS makes it very easy to change numerical values of growth curve parameters and study the effect on management. Thus, where the farmer is monitoring pasture growth in indicator paddocks his data can be used for specific site calibration.

The present version of the model does not take account of differences in leafiness or senescence between pastures of the same mass and can therefore be inaccurate in its predictions for swards, which are poorly utilized.

CONCLUSION

We believe simple explanatory models are the most useful approach to pasture growth models in relation to agronomic management. A model employing a minimum of weather information and representing a level where pasture growth is conveniently represented by a modified sigmoid curve, gives useful predictive estimates of pasture growth. Computer models offer considerable scope for sophisticated feed planning on farms.

REFERENCES

Baars J.A. 1976. Seasonal distribution of pasture production in New Zealand. IX. Hamilton. *New Zealand journal of experimental agriculture* **4:** 157-161

Baars J.A. 1982. Variation in grassland production in the North Island with particular reference to Taranaki. *Proceeding of the New Zealand Grassland Association* **43:** 32-43.

Baars J.A.; Rollo M.; Jackson R.G.: McRobbie G. 1987. Use and validation of a pasture yield prediction model on dairy farms in the Waikato (New Zealand). *Proceedings of the 4th Animal Science Congress of the Asian-Australasian Association of Animal Production Societies.* Hamilton. p.451.

Brougham R.W. 1959. The effect of frequency and intensity of grazing on the productivity of a pasture of short-rotation ryegrass and red and white clover. *New Zealand journal of agricultural research.* **3:** 125-136.

Piggot G.J.; Baars J.A.; Waller J.E.; Farrell C.A. 1986. Initial development of the 'potential growth rate' concept for estimating pasture growth on farms across Northland. *Proceedings of the Agronomy Society of New Zealand* **16:** 65-69.

Probine M.C. 1977. The problem of defining production inputs. Management of dynamic systems in New

Zealand agriculture. In *Proceedings of a symposium at Physics and Engineering Laboratory, DSIR,* Lower Hutt. DSIR Information Series **129:** 15-25.

New Zealand Meteorological Service. 1980. Summaries of climatological observations to 1980. Ministry of Transport. *Miscellaneous Publication.* No 177. pp. 172.

Radcliffe J.E. 1974. Seasonal distribution of pasture production in New Zealand. I. Methods of measurement. *New Zealand journal of experimental agriculture* **2:** 337-340.