EFFECTS OF CLIMATE CHANGE ON PASTURE GROWTH USING A MECHANISTIC SIMULATION MODEL

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A mechanistic model of pasture production (McCall, 1984), developed for grazed hill country pasture ecosystems, has been altered to allow simulation of impacts climate change. The model uses daily meteorological records (rainfall, temperature, radiation) and site specific information (soil moisture holding capacity, soil fertility index) as inputs.

Functions in the model allow prediction of impacts of changed rainfall, temperature and radiation on pasture production. A function was added so that impacts of increased atmospheric $C0_2$ could be assessed (Figure 1). The function was based on a mean response of 30-40% to a doubling in $C0_2$ (Kimball, 1983), with the response being greater in summer than winter (Overdieck & Bossemeyer, 1985).

Simulations were carried out for dairy pasture at the Taranaki Agricultural Research Station (Hawera), with pasture mown every four weeks. The soil fertility factor for the site was obtained by optimising the goodness of fit between measured and simulated pasture yields over eight years. Simulations were carried out with climate scenarios from Salinger & Hicks (1988), and with enhanced $C0_2$ levels (600 ppm).

Mean annual yields (for eight years of simulation) are shown in Table 1, and seasonal distributions in Figure 2. The results show that the direct effect of enhanced $C0_2$ levels is considerably greater than the impact of changed climate (temperature, rainfall, radiation). Both changed climate and enhanced $C0_2$ resulted in an altered seasonal pattern of pasture growth. The predicted changes in pasture growth would undoubtedly allow increased animal production, but provide new grazing management problems because of a more skewed seasonal pattern of production.

Table 1 Effect of $C0_2$ level and climate change scenarios on mean annual yield (tonnes DM/ha)

$C0_2$ Level	*Base*	*Enhanced*
Base Climate	12.0	19.2
Scenario 1	12.2	19.4
Scenario 2	13.9	21.9

It was concluded that the direct effects of enhanced $C0_2$ levels on pasture growth could be large. However relevant biological information is limited, and actual responses to $C0_2$ could be reduced by lack of plant nutrients or water stress, and affected by major changes in botanical composition. Research is urgently required to improve biological information for New Zealand's agricultural systems so this model, and others, can be validated. In particular, pasture responses to enhanced CO_2 levels are urgently required.

References

Kimball, B.A. 1983. Carbon dioxide and agricultural yield; an assemblage and analysis of 430 prior observations. *Agronomy Journal 75*: 779-788.

McCall, D.G. 1984. A systems approach to research planning for North Island hill country. Unpublished PhD Thesis, Massey University.

Overdieck, D.; Bossemeyer, D. 1985. The long term effects of an increased supply of CO_2 on the CO_2 gas exchange of a model ecosystem. *Angewandte Botanik 59*: 179-198.

Salinger, M.J.; Hicks D.M. 1988. Regional Climate Change Scenarios. In *Climate Change in New Zealand*, Royal Society.

Figure 1
Carbon dioxide enhancement factor. Pasture growth is multiplied by the plotted factor where CO_2 enrichment is specified in model runs.

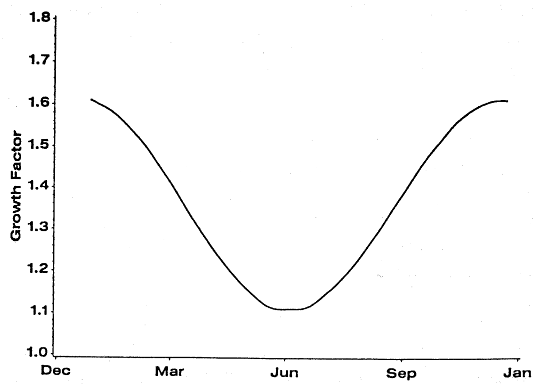

Figure 2
Pasture growth rates (kg DM/ha/day) with base climate and CO_2 levels.