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bST: An assessment of potential response for pasture based dairy farms in New Zealand

P.M.B. EKANAYAKE, C. MATTHEW[1] AND W.C. BAILEY

Department of Agricultural Economics and Business, Massey University, Private Bag 11-222, Palmerston North, New Zealand.

ABSTRACT

Potential response of lactating dairy cows to bovine somatotropin (bST) was estimated *ex ante* for 12 geographically distinct pastoral regions of New Zealand. The estimation process was as follows. First, seasonal pasture growth data were collected or, where such data were unavailable, seasonal pasture growth was estimated from published climate data using the GROW model. The UDDER model was then used to generate, from the pasture growth information and average regional stocking rate, seasonal pasture mass profiles for an "average" season in each region. Second, an econometric model was developed from results of an earlier bST response experiment. To quantify milk production responses to bST, milk fat production (kg/cow/day) was regressed against pregrazing herbage mass (kg DM/ha) for bST treated and control groups of cows. Response to bST so estimated was 1.2 x10^{-4} kg milk fat/cow/day per kg pregrazing herbage mass ($P<0.01$, $r^2 = 0.99$).

Predicted regional responses generally fell into one of three categories. Response to bST was predicted to be high throughout lactation in North Island areas with a reliable summer rainfall but was predicted to occur in early season only in summer-dry North Island areas. For one higher altitude North Island site and in South Island areas with cold winters but high summer rainfall, response was predicted in late season only.

Keywords: bovine somatotropin; potential response; dairy farm; pasture.

INTRODUCTION

Galactopoietic properties of the pituitary hormone now termed bovine somatotropin (bST) have been recognised as early as 1937 (Asimov and Krouze, 1937) and in New Zealand for some 40 years (Brumby and Hancock, 1955) but supply of bST was extremely limited while the compound had to be obtained from pituitary extracts. Relatively recent availability of synthetic recombinantly derived bST has led to extensive testing, culminating in the commercial use of bST in the U.S.A. from February 1994 (Bent *et al.*, 1994).

Milk production increases following bST administration typically range from 10% to 30%, with little or no change in milk composition (Bauman *et al.*, 1985; Peel *et al.*, 1985; Chalupa *et al.*, 1986; Peel and Bauman, 1987; Chilliard, 1989). Treated animals at first exhibit negative energy balance but voluntary intake increases after a few weeks of treatment and in stall-fed animals the response persists while treatment continues, providing adequate dietary intake is maintained (Bauman, 1992). The magnitude of increase in feed intake is in turn related to energy density of the diet and to milk yield response (Chalupa *et al.*, 1986; Chilliard, 1989). The technology therefore offers an avenue for reducing cost and enhancing output on commercial dairy farms. Most research into bST response has been with stall fed animals, but several studies, including Peel *et al.* (1985), Hoogendoorn *et al.* (1990) and Michel *et al.* (1990), have involved cows grazed on pasture. The objective of this *ex ante* study was to estimate potential response to bST use, should this technology be approved for use on New Zealand dairy farms.

MATERIALS AND METHODS

Twelve sites representative of the major dairying regions of New Zealand were selected. Published data on seasonal pasture growth rate were obtained if available (5 sites) or, if unavailable, data were generated (7 sites) from climate records using the GROW model (Butler *et al.*, 1990). To validate GROW predictions, simulations were also conducted for one site for which published pasture growth records were available. Regional average stocking rates were then obtained from New Zealand Dairy Board statistics, and the dairy farm simulation package UDDER used to simulate seasonal pasture mass in an average year for the twelve regions of the study. For one site, the model output was again compared with actual data as a validation.

Data from a previous trial which evaluated bST response of pasture-fed dairy cows (Hoogendoorn *et al.*, 1990) were used to quantify bST response. Specifically an econometric regression model was constructed, whereby dummy variables were used to remove 'stage of lactation' effects and to test for difference in slope between control and bST treated groups of cows when milk fat per cow per day was regressed on pregrazing herbage mass. The regression model was as follows:

$$Y = f(X_1, X_2, D_1, \ .. \ D_{10}, T)$$

where Y is milk fat yield (kg/cow/day), X_1 is pregrazing pasture mass for control and bST-treated groups and X_2 is

[1]Department of Plant Science, Massey University, Private Bag 11-222, Palmerston North, New Zealand.

pregrazing mass for the treated group only (Control group = 0; to test difference in slope); D_1 .. D_{10} are dummy variables for stage of lactation effects and T tests for difference in intercept between treated and control cows (treated = 1; control = 0). Under this model, the coefficient for the parameter X_2 quantifies response to bST as a linear function of pre-grazing herbage mass. A quadratic term was tested, but discarded when found to be non-significant. This linear coefficient for X_2 obtained from the econometric regression model and the seasonal herbage mass data for the 12 selected regions were then combined in a spreadsheet to estimate milk fat response in bST-treated cows for five 30-day subperiods of an assumed 150-day bST treatment period in a lactation season. The responses presented are therefore "potential" responses in that they do not take account of any reduction in herbage mass arising from increase in intake of bST-treated animals. Partial budgets were also drawn up to determine profitability of predicted responses and these findings will be reported elsewhere.

RESULTS

For the validation exercises, observed and simulated pasture growth differed on average by 2.3 (s.e. ± 4.4) kg DM/ha/day. In only one month was the discrepancy between observed and predicted monthly pasture growth rate greater than 3 kg DM/ha/day. When Fourier equations (Lambert *et al.*, 1986) were fitted to predicted and observed seasonal pasture mass data, the largest difference in herbage mass noted was 150 kg DM/ha and none of the parameters of the Fourier curve differed significantly for the two curves. The "X_2" coefficient from the econometric regression model, indicating response of bST-treated cows (kg milk fat/cow/day) to pre-grazing pasture mass (kg DM/ha), was 1.2 $x10^{-4}$ (s.e. ± 3.6 $x10^{-5}$, $P<0.01$). The "T" coefficient was -0.23 (s.e. ± 0.09, $P<0.05$). The final model output for one site, Hamilton, is shown (Fig. 1). Table 1 gives details of the potential seasonal responses (kg milk fat/cow/day) for the twelve sites modelled.

FIGURE 1: Comparison of potential seasonal pattern of milk fat production (kg MF/cow/day) in bST treated (solid line) and control groups of dairy cows (dashed line), with pre-grazing herbage mass (kg DM/ha, dotted line), based on data for the Hamilton site.

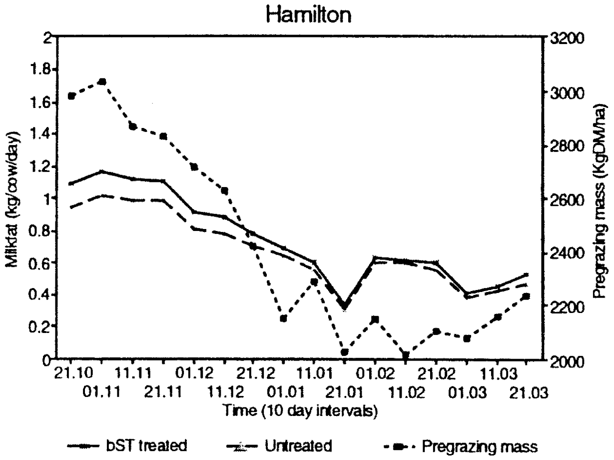

TABLE 1: Predicted bST response (kg milk fat/cow/day) for twelve sites over successive 30 day intervals in the lactation cycle. For the Winchmore site, predictions are given for dryland and irrigated pasture. Note that site response can be categorised according to regional climate; Warkworth, Te Puke, Manaia - summer moist, whole season; Hamilton, Masterton, Palmerston North, Wanganui - summer dry, early season; Stratford (higher altitude), Gore, Greymouth, Invermay, Winchmore (irrigated) - winter cold, late season).

Day	1-30	31-60	61-90	91-120	121-150
Warkworth	0.14	0.14	0.14	0.14	0.14
Te Puke	0.12	0.07	0.14	0.11	0.14
Hamilton	0.14	0.11	0.06	0.03	0.05
Manaia	0.10	0.14	0.13	0.07	0.14
Stratford	0.04	0.08	0.12	0.10	0.09
Wanganui	0.11	0.09	0.06	0.04	0.03
Palmerston North	0.11	0.10	0.06	0.02	0.04
Masterton	0.12	0.11	0.04	0.00	0.01
Winchmore (dry)	0.03	0.01	0.00	0.00	0.00
(irrig.)	0.02	0.00	0.02	0.08	0.12
Invermay	0.05	0.08	0.09	0.08	0.11
Gore	0.00	0.05	0.13	0.14	0.14
Greymouth	0.00	0.05	0.11	0.12	0.11

DISCUSSION

Some limitations of these predictions need to be acknowledged. bST response is estimated from the results of a single trial, that of Hoogendoorn *et al.* (1990). We have not modelled year to year variation in regional response. Use of regional average stocking rates in the models is not necessarily indicative of response for individual farms which may be carrying a higher or lower stocking rate than the regional average. The negative intercept as indicated by the T coefficient of -0.23 does not necessarily indicate a negative response at low levels of pasture supply, but rather a zero response at the lowest level of pasture supply in this experiment.

A logical consequence of modelling bST response as a linear function of pre-grazing herbage mass is that bST response is predicted to be high at times when seasonal pasture growth is expected to exceed animal demand in a particular region. With the exception of the Winchmore site under dryland conditions, bST responses for the twelve sites modelled could be categorised according to regional climate. There is potential for bST response throughout the season in Northern areas with early spring growth and higher summer rainfall (Warkworth, Te Puke, and Manaia sites, Table 1). There is a potential for response only in the early season in summer-dry Northern areas (Hamilton, Wanganui, Palmerston North and Masterton sites, Table 1). For areas with colder winters but high summer rainfall, potential for bST response occurs only in the late season (the higher altitude North Island site, Stratford, Winchmore under irrigation, and all other South Island sites, Table 1).

This *ex-ante* study is intended to provide a basis for surveying farmer and processor interest in use of bST if the technology were available. However, further modelling work to more fully define the implications of bST use in New Zealand pastoral dairy farming would be very helpful. It would be of interest to modify the equation in UDDER relating herbage mass on offer and herbage intake of animals, thus taking account of effect on herbage mass of bST-induced increase in animal intake. The likely effect of this modification is that early season responses would tail off sooner than indicated in Table 1, while late season responses would be largely unaffected. It would also be of interest to model the year-to-year variation in predicted bST response, since summer pasture production is highly dependent on rainfall. For example, for the Palmerston North site, over the 22 years for which records are available, recorded January pasture growth rates range from 5 to 51 kg DM/ha/day (mean = 24, s.e. ± 11.9 kg DM/ha/day). Finally, it would be of interest to conduct a series of iterations, so as to predict optimum stocking rate for bST-treated herds, given the increased intake.

With respect to future adoption of this technology by the industry, additional considerations are the effect of bST on the treated animal and the potential for harmful residues in animal products. Public concerns in these two areas have led to a moratorium on bST use in the European Union (Bent *et al.,* 1994). However, Peel and Bauman (1987) argue that there is no logical basis for concern about either animal welfare or human safety. These authors note that bST operates as a homeorhetic control, producing a coordinated response in physiological processes parallel with differences between genetically high and low yielding cows. Indeed, study has shown that bST responses are greater in cows of low genetic merit than in cows of high genetic merit (Michel *et al.,* 1990). Also, bST can reduce the late lactation decline in milk production (Bauman, 1992), correction of which has recently been identified by milk processors as an opportunity to reduce processing costs through improved utilisation of capital plant.

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