A Model of the New Zealand Beef Value Chain

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Keywords: V*alue chain model; Scenario evaluation; Beef industry*.

EXTENDED ABSTRACT

New Zealand's beef industry produces approximately 580,000 tonnes of beef per year, about 80% of which is exported, with approximately 70% of this beef destined for the North American manufacturing market. Around 65% of beef cattle originate from the dairy industry. Beef cows produce 1.1 million calves (killed as heifers or steers) per year for the prime beef market. In addition, 0.4 to 0.6 million of the 3.3 million calves produced by the dairy industry, predominantly Friesian or beef-sired dairy cross bulls, are retained for the manufacturing beef market. Cull dairy cows also contribute significantly to this market. Improved efficiencies, changing management strategies and better linkages between the dairy and beef industries, have the potential to provide benefits along the whole beef value chain. However, it is difficult to objectively assess and quantify these.

A dynamic simulation model was developed to identify and quantify the impacts of different strategies on efficiency and integration between the dairy and beef sectors for New Zealand's beef producers, processors and exporters. This model can be used to assist with future industry planning at the national level. Expected model outputs are analyses of different scenarios and recommendations based on these analyses for industry strategy and investment.

Industry issues and questions to be answered by the project were defined, and a conceptual model of the beef and dairy industries was developed through workshops with key informants in the industries. A Microsoft Excel spreadsheet model was developed to describe the New Zealand beef industry and its integration with the dairy industry from the farm to the export market. This model runs for 20 years on a quarterly basis to predict long-run changes. The model incorporates 318 classes (age, sex, end-use, breed and feeding system factors) of growing cattle which move though the model in sequential time steps. Standardised liveweight variances were used to describe each cattle class. Five functions were derived to predict the slaughter of each of cows, bulls, steers, heifers and calves. Numbers slaughtered were predicted using numbers on hand, moisture deficit days (a proxy for feed available), time of year and slaughter prices. The heaviest animals in the various classes were drafted for slaughter until a cut-off weight was reached, at a point where the predicted numbers of animals are slaughtered. Meat cuts from these animals were then allocated to the most valuable markets first. Average market prices were calculated and then fed back into the model to help predict slaughter numbers.

The model was validated against historical data, refined and re-run to confirm that it did reflect reality. Several scenarios were then run and presented to industry for feedback, after which the model was further refined. The model was run for several scenarios to study the effects of interactions and feedbacks along the value chain, and to identify those parts of the value chain that were most sensitive to changes.

Three scenarios run were: (1) higher or lower land prices (affecting the cost of feed); (2) more beef x dairy calves (from an increase in artificial insemination with beef semen in the dairy industry leading to retention of more calves from the dairy industry with beef-type attributes); and (3) introgression of a set of genes that lead to better feed conversion efficiency.

Results demonstrated that significant opportunities do exist for the beef industry to improve total returns, while some policies could be quite costly to the industry. Model benefits include: (a) identifying where the greatest impacts for future research and development, and enhanced industry relationships might occur; (b) assisting in assessing future research projects; (c) enhancing learning by model users and industry people through thinking about why particular outcomes might have occurred; and (d) identifying areas where information is inadequate or unavailable.

1. INTRODUCTION

New Zealand's beef industry produces approximately 580,000 tonnes of beef per year. About 80% of this beef is exported, with approximately 70% of this beef destined for the North American manufacturing market. Currently, 35% of cattle slaughtered originate from the beef industry with the remaining 65% coming from the dairy industry (Beeby 2003). Beef cows produce 1.1 million calves per year for the prime beef market. In addition, 0.4 to 0.6 million of the 3.3 million calves produced by the dairy industry, predominantly Friesian or beef-sired dairy cross bulls, are retained for the manufacturing beef market. Cull cows also contribute substantial volumes of beef to this market (Beeby 2003). Improved efficiencies, changing management strategies, and improved linkages between the dairy and beef industries, have the potential to provide benefits along the whole beef value chain.

However, it is difficult to objectively assess and quantify these benefits. A dynamic simulation model was developed to identify and quantify the likely impacts of change on New Zealand's beef producers, processors and exporters. This model can explore the impacts of technologies or practice changes, changes in New Zealand's beef marketplaces and changes to the structure of the beef and dairy industries. This paper will describe the model and its development. Three scenarios will be described to demonstrate the usefulness of the model for evaluating future research or industry changes. The usefulness of the model will be discussed.

2. DEVELOPMENT OF THE MODEL

There were three stages in the development of the model (1) discussion with industry to identify issues that they thought a model cold be used to address; (2) development of a conceptual model; and (3) development of a systems simulation model. Model development has been partly described by McDermott et al. (2005a., 2005b.) but is expanded in this paper.

The first stage of the project defined the range of possible issues, problems and questions that the project sponsors (then Meat and Wool Innovation, now Meat & Wool NZ) wanted answered. These primarily fitted into three categories: the impacts at a national level of changes in (a) technology or practices, (b) markets and (c) industry structure.

Stage 2 was the development of a conceptual model of the beef and dairy industries using three workshops and three interviews with key informants from these industries. This conceptual model formed the basis for progression to Stage 3. A mentor group was involved with the project. Four meetings were held with the mentor group throughout stages 2 and 3 to advise and provide feedback on model development.

Stage 3 was the development and construction of a systems dynamic model in Microsoft Excel, to describe the New Zealand beef industry, including the components of the dairy industry that are integrated with the beef industry. The model includes all aspects of the beef industry, at a national level, from the farm to the export market (Figure 1).

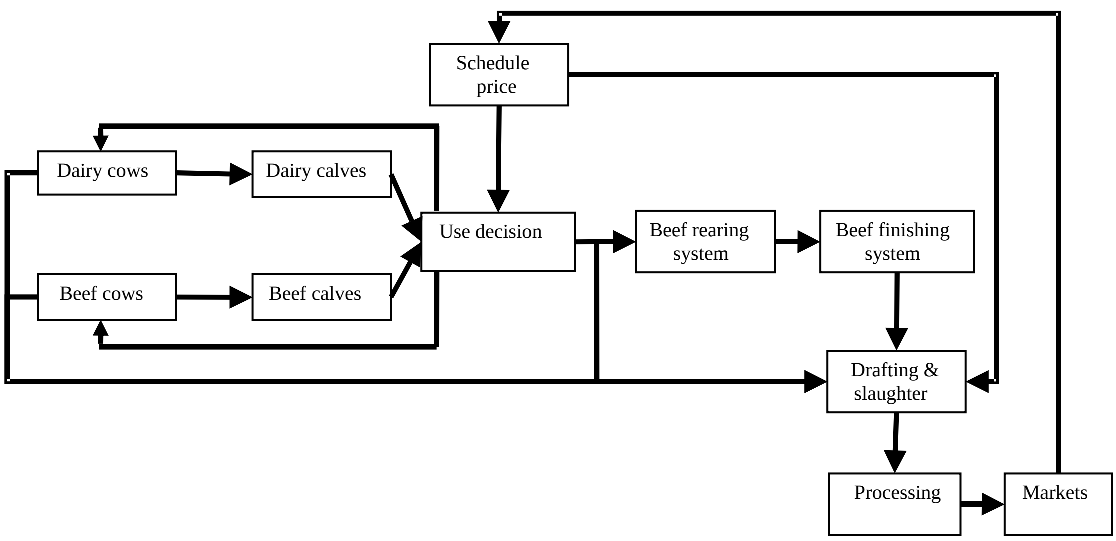

Figure 1. A conceptual model of the New Zealand Beef Industry at a national level (from McDermott et al. 2005b.). This conceptual model shows flows and feedback loops used in the model.

The model runs for 20 years on a quarterly basis to predict long-run changes. The model was parameterised at the national level (see Smeaton et al. (2004) for complete details of the model construction and assumptions). Therefore, all parameters are aggregate or national averages (many parameters are described by means and standardised variances) and as such, no attempt is made to reflect decision making at an individual farmer level. Data for model parameterisation was sourced from industry publications, industry bodies (e.g., Meat New Zealand), and industry experts. A large number of assumptions were made by experts familiar with the industry because published data were often unavailable or considered inaccurate. Any given parameter(s) (e.g. weaning rate, proportion of natural mating used in dairy herds) can be changed for evaluating a scenario.

The model incorporated 318 classes of cattle by age, sex, end-use (e.g., herd replacements, beef finishing), breed, and feeding system – i.e., 27 classes x 3 age groups of steers; 36 classes x 2 age groups of heifers; 39 classes x 3 age groups of bulls; 12 classes x 3 age groups of cows and 12 classes of calves). A closed system was assumed. All animals remained accounted for until they were slaughtered or died otherwise (i.e., losses). This is appropriate at a national level in New Zealand where there are few international animal transfers.

Means and standardised variances in liveweight (Wake et al. 1999) described the weights of the cattle population in each class. Cattle in each class grew at average long-run growth rates (Smeaton 2003) calculated for each quarter. Feed consumption (Geenty & Rattray 1987) was then calculated for each quarter for the different classes of cattle.

The model calculated the number of cattle from each class to slaughter in each period. The five functions used to calculate slaughter numbers (one for the slaughter of each of cows, bulls, steers, heifers and calves) were determined by analysing time series data (for at least 8 years, up to and including 2001) using least squares regression. Numbers of cattle on hand, moisture deficit days (MDD, a proxy for feed available), time of year, milk price, carcass weight and slaughter prices were considered (Table 1). Those variables that were non-significant or did not add to the accuracy or reliability of the predictions were excluded from the functions in the model. The equation was tested against holdout data for 2002 to 2004. Figure 2 shows the prediction on bobby calves killed against actual values, for the fitted model and historical holdout data.

The heaviest animals in the various classes were drafted for slaughter until a cut-off weight was reached such that the calculated numbers (predicted by the least squares regressions described above) were killed (Barr & Sherrill 1989). This is shown diagrammatically in Figure 3.

Table 1. Variables contributing significantly ($P<0.05$) to the slaughter functions (number or proportion of cattle slaughtered within each quarter) for each of the five cattle classes (from McDermott et al. 2005b.). Non-significant variables were excluded from the functions in the model. * $P<0.05$, NS not significant, - not tested.

	Price (NZ$)	Number on hand	Number slaughtered previous period	Feed (MDD)	Feed in previous period (MDD)	Milk price	Carcass weight	Season	R^2
Bulls	NS	*	*	*	NS	NS	NS	NS	0.90
Steers	*	*	NS	*	*	-	NS	NS	0.90
Heifers	NS	NS	NS	*	*	-	NS	NS	0.82
Cows	NS	*	NS	NS	NS	NS	-	*	0.96
Calves	*	*	-	-	-	NS	-	-	0.93