BeefSpecs a tool for the future: On-farm drafting and optimising feedlot profitability

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Abstract: The BeefSpecs fat calculator was conceived as a means of combining data from growth path studies with knowledge contained in animal growth and body composition models to make predictions of cattle body composition using on-farm measurements. This would assist producers to make critical management decisions that affect their ability to meet market specifications. The first phase of BeefSpecs was based on a multiple regression interpolation of the simulation results from an animal growth and body composition model called the Davis Growth Model (DGM). The agreement between observed and predicted P8 fat depths using this approach was relatively high. However, there are certain circumstances where the multiple regression method produces poor agreement with observed P8 fat depths. The second phase of BeefSpecs has involved the departure from the multiple linear regression approach and direct use of an alternative animal growth model (Williams and Jenkins model, WJ). Agreement between observed and predicted P8 fat depths using this model has generally been similar to that experienced in phase one. However, in circumstances where phase one had problems predicting P8 fat depth the WJ model has provided much more robust predictions. Work is progressing to extend BeefSpecs' capabilities by predicting retail meat yield from on-farm measurements. These refinements of the BeefSpecs calculator have allowed the development of other tools that "hang off" BeefSpecs to progress to the preliminary testing stage. A tool for on-farm drafting has been developed that allows producers to explore the effects that management changes have on the ability of groups of animals to meet market specifications. An additional tool has been developed that is targeted at refining how pen allocations occur in feedlots to help reduce the days on feed needed by certain animals and increase overall production-system profit.

Keywords: beef cattle, decision support, body composition, market specifications.

Introduction

The BeefSpecs fat calculator has been developed within the Beef Cooperative Research Centre for Genetic Technologies (Beef CRC) to combine results from past growth-path studies that examined compositional changes in response to changing production environments with proven animal growth and body compositional models (e.g. Davis Growth Model; Oltjen et al., 1986) to predict fatness of beef cattle in the field. The overall aim of this process has been to assist beef producers in making production decisions that allow them to manage their cattle to better meet market specifications for domestic and international markets.

A major challenge has been to develop a tool that combines experimental data with the computational power of animal growth and body compositional models while keeping user interaction with the tool sufficiently simple to allow and even encourage in-field use. The development of BeefSpecs has also allowed other ideas for refined animal management such as on-farm assisted-drafting and feedlot pen-assignment to develop to conceptual stages ready for testing in production systems. This paper describes the evolution of the BeefSpecs calculator from the conceptual stage to the current working version. Other tools that use the WJ model behind BeefSpecs as the foundation of their operation and have been developed to the testing stage are also described.

Background

Beef producers continually make management decisions that impact on both the capacity of their cattle to meet market specifications and the profitability of their beef businesses. A recent study has demonstrated that non-compliance of beef cattle to market specifications in the Australian beef industry is high. Analysis of 20,000 feedlot records for short-fed cattle showed that 28% missed weight specifications costing $5.50/head, and 16% missed P8 fat specifications costing $17.50/head (Slack-Smith et al. 2009). In addition, 20,000 records for long-fed cattle showed that 29% missed weight specifications costing $11/head and 70% missed the marbling specification of score 3 or better costing an estimated $105/head (Slack-Smith et al. 2009).

BeefSpecs was developed to assist producers to address this issue of non-compliance (McKiernan et al. 2008). BeefSpecs combines the predictive power of animal growth and compositional models that have been developed both in Australia and overseas with information relating to animal growth and fatness in response to changes in the production environment. It makes good use of data collected in all the Beef Cooperative Research Centre experiments (1996-2004). BeefSpecs has the ability to be highly

functional across a wide range of production environments whilst maintaining sufficiently simple input options to make it user-friendly for on-farm use. Combining the demands of complex research models and simple user interactions has presented some challenges during development. In solving these problems we have created some new opportunities including the possibility of developing higher level animal management systems that flow from the BeefSpecs fat calculator e.g. on-farm assisted drafting, optimisation of cattle allocation during feedlot induction and prediction of retail meat yield using on-farm measures.

The BeefSpecs tool

The first phase of the BeefSpecs fat calculator (Figure 1) was based on a dynamic steer growth model called the Davis Growth Model (DGM) (Oltjen et al. 1986). The DGM describes the deposition of muscle and fat tissue in response to nutrient intake during an animal's growth (Oltjen et al. 1986) and partitioning of fat between fat depots in the body (e.g. subcutaneous, intermuscular, visceral and intramuscular) (McPhee 2006; Sainz and Hasting 2000). To make predictions of fat deposition from the DGM industry-relevant, the quantity of total subcutaneous fat in kilograms is converted to millimetres of fat at the 12/13th rib site (McPhee et al. 2008) and then subsequently to millimetres of fat at the P8 site while taking sex, breed type and weight into consideration (Walmsley et al. 2010). The DGM uses simple-to-obtain user inputs to initialise the growth model. These are frame score (height at the hips relative to age - as a measure of animal type), initial fatness and initial live weight (an assessment of current phenotypic status), expected rate of weight gain (the realised outcome of amount, type and quality of feed eaten) along with implant (hormonal growth promotant, HGP) status, days on feed, sex and breed type. Some inputs are demonstrated in Figure 1.

The objective of maintaining sufficiently simple user interaction with the BeefSpecs calculator caused problems relating to the direct use of the DGM, which requires an estimate of feed intake to run. To overcome this issue a series of simulations were run with the DGM to produce a matrix of inputs and outputs that covered a range of initial weights, frame scores, initial fat depths, implant status, days on feed, and metabolisable energy content of the feed and intake (pseudos for expected weight gain and production system). A multiple linear regression was then developed from this large matrix of inputs and outputs that operates directly behind the BeefSpecs calculator to predict P8 fat depth in response

to the inputs entered into the calculator (McKiernan et al. 2008). The metabolisable energy content of the feed was replaced in the multiple regression with a description of the production system in terms of quality of feed, distance to water and surrounding terrain on the scale 1 to 4 (e.g. 1: feedlot/strip grazing vs. 4: large paddocks, native pasture, hilly terrain). The inputs entered into and outputs obtained from the BeefSpecs fat calculator are group averages as opposed to individual animal measures.

The second phase of the development of BeefSpecs (Figure 2) has been conducted in response to shortcomings of predictions arising from calculations using regressions derived from the DGM. These shortcomings are discussed below. The second phase of BeefSpecs has moved from using a multiple regression interpretation of the DGM outputs to applying a growth model directly behind the calculator. Because producers don't know the feed intakes of their animals, a more suitable model was chosen to generate the predictions required. This model was originally developed by Keele et al. (1992) and subsequently refined by Williams and Jenkins (1998) (WJ). This model predicts the composition of empty body weight from animal growth (kg/day) given a description of animal type (frame score, sex and breed type), prevailing production conditions (growth hormone treatment, days on feed and feed type [grass vs. grain]) and initial conditions (initial weight and P8 fat). The WJ model is based on the assumption that an animal of a given type will have a defined body composition (fat and lean) when it is treated in a specified manner and is achieving a nominated growth rate. The WJ model predicts rib fat depth from its prediction of total body fat which is then used to predict P8 fat depth using sex, breed type and weight (Walmsley et al. 2010).

The WJ model as applied in BeefSpecs uses lag phases (Keele et al. 1992) to model the transition in growth and body composition changes of animals as they grow from young to more mature animals. The lagged response in growth and body composition to HGPs has also been implemented in the WJ model to reflect sensible production responses (Oltjen et al. 1986). The effect that feed type (grass vs. grain) has on body composition when animals are grown at the same rate (Tudor 1992) has also been implemented in the WJ model to reflect leaner animals coming off pasture systems.

The user-friendly attributes of BeefSpecs have been maintained in the second phase of development with similar inputs being used and only minor changes occurring. The specification of a production system has been removed, and feed quality is accounted for by

the growth rate and feed type (grass vs. grain) inputs. The breed type description has been expanded from the Bos indicus vs. Bos taurus breed description used in phase 1 to now include Bos indicus, British and European breed type options. A prediction of boning room meat yield is also under development. Some re-arrangement of the BeefSpecs interface has also occurred which now places inputs under the categories of 'Animal Type', 'Management' and 'Performance' to better reflect the impacts they have on animal growth and composition (Figure 2). 'Animal Type' is a description that sets the production potential of the animal given ideal conditions. 'Management' refers to how this potential can be manipulated by altering aspects of the production system. 'Performance' is a description of where the animal starts (e.g. initial weight and fat) and the performance it exhibits (e.g. growth rate, days on feed).

How do they compare?

Datasets (n = 11) have been collected from a variety of production scenarios with the purpose of testing the accuracy of the P8 fat predictions made by BeefSpecs. These datasets range from animals grown in feedlot conditions under experimental protocols to those grown in feedlots under commercial conditions to animals grown and fattened on pasture under standard industry practices. The BeefSpecs version based on the DGM regression (BeefSpecs1) has been demonstrated to generally display close agreement between predicted and measured P8 fat depths (Table 1). However, there are a few notable exceptions. When animals are grown at low growth rates (below ~0.5 kg/day) BeefSpecs1 had a tendency to make large under-predictions of P8 fat depth (e.g. Werribee – March to May) whereas when growth rates were higher (above ~0.5 kg/day) predictions were more accurate (e.g. Werribee – January to March). When used with certain breed type combinations (Simmental and Simmental x Brahman) BeefSpecs1 had a tendency to grossly over predict P8 fat depth (e.g. Moorehead).

The datasets above, used for testing BeefSpecs1, have also been used for testing the second phase of BeefSpecs (BeefSpecs2) that is based on the WJ model. The predictions of P8 fat depth made by BeefSpecs2 also display close agreement with the measured P8 fat depths in these datasets (Table 2). Two points of interest, however, are that when animals are grown with low growth rates, the tendency to under-predict fatness no longer exists and the tendency to over predict P8 fat depth for Simmental and Simmental x Brahman breeds is greatly reduced. Also, it needs to be highlighted that there is close agreement between BeefSpecs1

and BeefSpecs2 predictions in most of the other datasets used for testing and in some cases BeefSpecs1 had higher accuracies of prediction than BeefSpecs2.

Future direction of BeefSpecs

The discussion above simply illustrates that continuous improvement happens during the evolution of a product like BeefSpecs. This process is expected to continue with the development of other management tools that use the WJ model behind BeefSpecs.

Currently, a tool is being developed that will move the BeefSpecs framework from generating average P8 fat depth predictions for groups of animals to drafting animals into management groups based on predictions of individual P8 fat depths given assumed growth rates and production conditions (Figure 3). It is envisaged that the tool will allow producers to look at the consequences of a management change on sub-groups of animals rather than the impact on the whole group average. The tool also has strong synergies with the Livestock Data Link (LDL) project that is currently being developed by a group under the auspices of the Primary Industries Innovation Centre at Armidale and funded by MLA. This will allow extension of the tool to explore the final impact that alternative management options have on outcomes in the carcass when feedback data are available following slaughter.

Mayer et al. (2007) used BeefSpecs1 in conjunction with an optimisation engine to allocate animals to feedlot pens based on when and how well they met market specifications. The optimisation was compared to a base scenario involving a single cohort of 306 steers from the Beef CRC 'Regional Combinations' experiment (McKiernan et al. 2005), a scenario where animals were penned by breed and a scenario where animals were penned by initial live weight. The optimisation indicated that penning animals based on how well and when they met market specifications increased feedlot gross margin by $2,200 or 3.0% compared to the base scenario. This increase in gross margin was greater than that experienced when grouping animals by breed or initial live weight. This illustration that BeefSpecs could improve profit resulted in the development of an additional tool. This tool generates allocations of animals to different pens based on predictions of individual P8 fat levels following nominated growth and management conditions. The aim is to refine pen allocations to allow optimal time on feed required to reach defined market specifications and thereby minimise production costs and maximise profit (Figure 4). While the increase in profit predicted by

the initial study (Mayer et al. 2007) was rather modest, much greater potential was shown in subsequent development of the tool.

The two tools following BeefSpecs are at preliminary stages of development, but they clearly demonstrate the potential of using information from individual animals in a dynamic nature to make decisions concerning sub-groups of animals and thus benefit the whole production system. Both tools also have the capacity to link to the automatic laser capture system for recording hip heights and thus frame scores that has been previously described by Wilkins et al. (2009; 2008) to increase the efficiency with which animals can be processed and decisions made regarding their management.

Conclusions

The BeefSpecs fat calculator was initiated as a means of combining the knowledge obtained from growth path experiments and that contained in animal growth and body composition models to assist beef producers make production decisions that allow them to manage their cattle to better meet market specifications. BeefSpecs has undergone two stages of development in which there have been improvements in the prediction of P8 fat depths under different production circumstances. These improvements have also facilitated the development of other tools that "hang off" BeefSpecs and extend the capability of this technology to allow individual animal performance to be utilised to form sub-groups for management purposes where appropriate rather than using average group inputs and outputs. These types of developments are expected to continue as BeefSpecs and other such tools are used under commercial production conditions to allow refinements to maintain/optimise productivity and economic viability.

Acknowledgements

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Appendix

Table 1**.** Comparison of predicted and observed P8 fats presented with mean bias (predicted − observed) for phase one of BeefSpecs.

Dataset	Predicted, mm	Observed, mm	Mean Bias
Glen Innes	11.84	9.68	2.16
Gordon	10.09	6.06	4.03
Jorgensen	13.68	10.90	2.78
Mitchell	6.29	7.44	-1.15
Moorehead	15.45	6.49	8.96
Orange	13.90	16.96	-3.06
Willowtree	7.63	8.84	-1.21
Yulgilbar	15.90	13.75	2.15
Werribee			
- Jan to Mar	4.17	4.85	-0.68
- Mar to May	2.35	5.57	-3.23
- Jan to May	6.09	5.57	0.52

Table 2. Comparison of predicted and observed P8 fats presented with mean bias (predicted − observed) for phase two of BeefSpecs.

Dataset	Predicted, mm	Observed, mm	Mean Bias
Glen Innes	11.71	9.68	2.04
Gordon	9.28	6.06	3.23
Jorgensen	16.12	10.90	5.22
Mitchell	6.46	7.44	-0.98
Moorehead	10.43	6.49	3.94
Orange	12.79	16.96	-4.18
Willowtree	9.52	8.84	0.68
Yulgilbar	16.32	13.75	2.57
Werribee			
- Jan to Mar	5.27	4.85	0.42
- Mar to May	5.97	5.57	0.40
- Jan to May	6.27	5.57	0.70

Figure 1. The BeefSpecs user interface developed during phase one that shows the inputs for frame score, sex, breed, initial weight and P8 fat as well as the predicted outputs (under results heading).

Figure 2. The BeefSpecs user interface developed during phase two that illustrates how sex, initial weight and P8 fat have been reshuffled to be included on the 'Performance' tab along with growth rate, days on feed and expected dressing percentage.

Figure 3. On-farm drafting tool interface demonstrating P8 fat and hot standard carcass weight predictions for individual animals (left) and how these compare to market specifications (right) which can be used to draft animals into sub groups for management purposes.
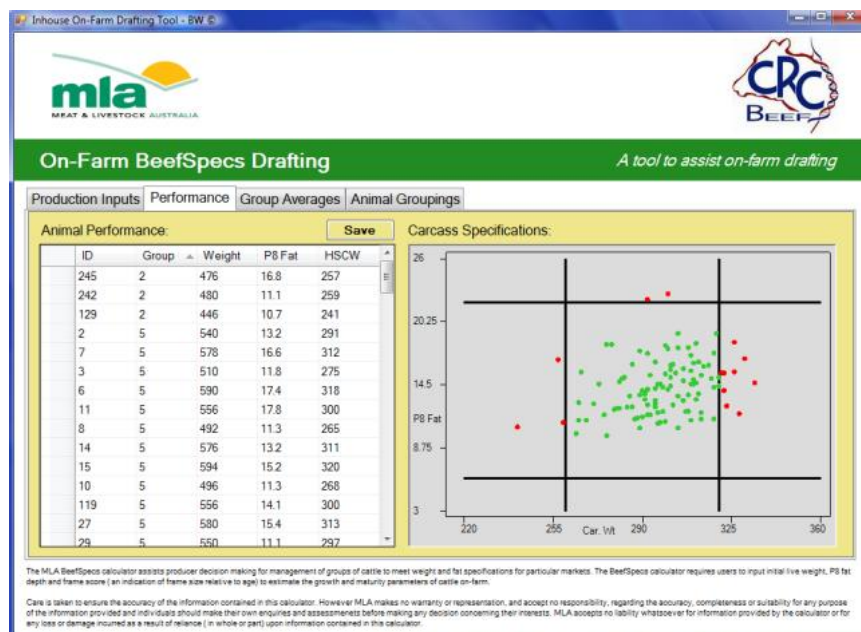

Figure 4. The economic comparison of conventional vs. optimised pen allocation of animals from the tool designed to assist feedlots to optimise pen allocation to reduce days on feed.

http://www.csu.edu.au/faculty/science/saws/afbmnetwork/