26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

Modelling the whole farm effects of livestock selection: opportunities and limitations

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Abstract: Selectively breeding livestock for desirable characteristics is assumed to translate readily into economic benefit; however, the whole-farm effects of changes to livestock genetics are rarely reported. This research investigated approaches to represent changes to various livestock characteristics within whole-farm models discovering some key limitations and opportunities for future development.

Keywords: *Farm system, genetics, simulation, AusFarm, traits*

1. INTRODUCTION

Modelling the economic value of trait selection typically represents the expression of the trait in average environmental conditions, with a pasture supply unaffected by the impacts of increased livestock productivity and associated changes in grazing management. Whole-farm models may offer a better way to assess the overall implications of genetic selection in a variable environment whilst accounting for the interactions between grazing livestock and pasture supply. Within whole-farm models, livestock are defined by their maximum production potential, which is rarely measured in reality because it is constrained by limited and variable farm inputs (e.g. pasture supply and available supplements). This means that measured animal data is not directly transferable to inform changes to animal characteristics in whole-farm models. Irrespective, long term selection experiments may provide the insight necessary to incorporate some of the expected physiological changes resulting from selection.

Selecting livestock for faster growth leads to heavier mature weights and an altered pattern of feed intake (Herd and Oddy 2023). Similarly, selecting for increased fat deposition also alters feed intake; the ensuing differences in body composition can be entirely explained by increased total energy consumption (Lines et al. 2018). Wool growth can be increased independent of liveweight (**LW**) and voluntary feed intake, but is associated with reduced fatness and decreased reproductive rate (Masters and Fergusson 2019); these changes are generally exacerbated by selecting for lower fibre diameter. The success of selecting for milk yield in dairy cows is apparent but typically leads to lower body condition scores, reduced fertility and poorer survival (Dillon et al. 2006).

The aim of the current research was to explore methods to represent various changes to livestock characteristics in a whole-farm system model (AusFarm®, Hermann et al, 2024) and identify opportunities for model development that would facilitate an improved understanding of the effects of livestock selection.

2. METHODS

A description of the AusFarm livestock model and the modified sheep and cattle parameters explored in the current research are detailed in Freer et al. (2012). The equations of Freer et al. (2012) were reproduced in Microsoft Excel to visualise the effects of parameter changes from birth to maturity for cattle and sheep. Self-replacing beef cattle and dual-purpose sheep enterprises were characterised for the South-West Slopes region of New South Wales in AusFarm to further analyse the effects of altered characteristics on livestock productivity and supplementary feeding requirements.

3. RESULTS AND DISCUSSION

Livestock with an increased mature size (standard reference weight, **SRW**) were less mature at an equivalent LW resulting in lower energy requirements per unit of gain and faster growth per unit of feed intake. Potential intake increased, and maintenance requirements decreased marginally at equivalent LW as both of these are calculated as a function of SRW. While there is limited evidence that maintenance requirements vary per kg in livestock with different SRW (Herd and Oddy 2023), the effects are small and selection for faster growth rates via changes to SRW were otherwise well represented within the model.

Increasing the potential intake increased energy available for liveweight gain and higher condition score. Due to increased intake, maintenance energy requirements were also slightly increased, but this didn't offset the extra energy consumed. Selecting for fat deposition was therefore well represented by increasing potential intake; however, predictions of the changes to maintenance requirements may be improved with a model that tracks body composition and includes predictions of the viscera mass and energy consumption (Oddy et al. 2024).

Energy available for growth is calculated from the energy remaining after the demands of lactation; therefore, increasing milk yield resulted in livestock that were more often in poorer condition as a greater proportion of energy was directed to milk production than growth. At the whole-farm scale, increasing milk yield was detrimental due to a reduction in mature condition and reproductive rate.

Heavier standard fleece weights increased energy requirements for wool growth, resulting in reduced condition score, reduced fertility and increased supplementary feeding. Lowering fibre diameter alone had no effect on energy requirements within the model; however, the proportion of wool growth included in maintenance requirements was reduced by adjusting the basal clean wool growth parameter which increased energy requirements for wool growth.

Increasing the energy value and protein content of gain to represent selection for greater muscle deposition, resulted in faster growth rates, increased conception rates and reduced need for supplementary feeding. Conception rates were increased because livestock were in better condition which is calculated using liveweight rather than relying on predictions of body composition. It is more likely that selecting for increased muscle deposition would lead to lower condition score due to reduced fat deposition and consequently, lower conception rates. Selecting for muscle deposition would therefore be better represented using a model that tracks body composition and predicts conception rates from the empty body fat content.

Increasing the growth rate constant to represent livestock that mature more quickly increased supplementary feeding requirements because they were typically in poorer condition. This somewhat represents the reality as faster maturing animals would be depositing more muscle in early stages of growth. However, within the model, the energy value of liveweight gain was calculated from the animal's stage of maturity rather than current and target body composition which means the shift in the prioritisation of muscle deposition was not represented. A model that tracks body composition would therefore better represent the selection of livestock that mature more quickly.

4. CONCLUSIONS

The on-farm implications of livestock selection can be determined by whole-farm models allowing a more comprehensive analysis of the economic value of certain livestock characteristics in various environments. The development of a model that tracks body composition, rather than liveweight alone, would provide greater utility for this purpose and should be a priority for future research.

ACKNOWLEDGEMENTS

This work forms part of the 'Decide and Thrive' project that received funding from the Australian Government's Future Drought Fund.

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