THE INFLUENCE FEED COST HAS ON CHANGING BEEF CATTLE GREEN-HOUSE GAS EMISSIONS

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SUMMARY

Genetic trends are presented for estimated greenhouse gas (GHG) emissions of young Angus animals at pasture and in the feedlot, and of Angus cows at pasture for a self-replacing, 100d-finished production system. GHG emissions are predicted to have increased over time, accompanying genetic gains in productivity traits and feed intake. The trends support the need for multiple trait selection that appropriately considers feed intake and the whole production chain. The results show the cost of feed used in the breeding objective impacts on the GHG emissions reductions that can be achieved with selection. Small reductions in GHG emissions can be achieved when feed is expensive, e.g. $130/t, and carbon is priced at $0/t. When feed is inexpensive GHG emissions increase and an $80/t carbon price is needed to make GHG emission changes negligible.

INTRODUCTION

The need to reduce greenhouse gas (GHG) emissions from livestock, especially beef cattle, is the subject of increased societal pressure due to concern about climate change. In the absence of feed efficiency improvement, Walmsley *et al.* (2017) showed that productivity gains in Australian Angus cattle that have occurred through breeding are associated with increases in feed intake. The association between feed intake and GHG emissions was shown by Blaxter and Clapperton (1965). Many studies have examined reducing GHG emissions genetically, but often they inadequately describe feed intake, only examine responses for a particular trait, or do not focus on the whole production chain. This paper examines genetic trends in estimated GHG emissions in Angus cattle and shows how multiple-trait selection strategies can reduce GHG emissions associated with feed intake for the whole production chain.

METHODS

Breeding objectives. Breeding objectives for net return per cow were derived with BreedObject (Barwick *et al.* 2005) for a 100d feedlot-finished (self-replacing cow herd at pasture, steers finished at 640 kg live at 22 months) production system. Traits in the breeding objective were sale weight, dressing %, saleable meat %, rump fat depth, marbling score, feedlot entry weight, weaning weight (direct & maternal), calving ease (direct and maternal), mature cow weight, cow weaning rate, residual feed intake when pasture availability is limited, residual feed intake when pasture availability is greater than required, residual feed intake in the feedlot, and cow condition score. When GHG emissions were part of the breeding objective, the cost of emissions was included in the economic value of each breeding objective trait. Residual GHG emission traits were not included in this paper as EBVs for these are not currently available and little is known about their association with other traits. The general form of the economic value calculated for traits was Δ returns – Δ feed costs – Δ non-feed management costs. The feed requirement associated with a unit change in each objective trait was estimated using the equation systems described by Freer *et al.* (2007).

Trends in methane production. EBVs for the breeding objective traits were predicted from BREEDPLAN EBVs published in January 2017 for 1,895,481 Angus animals born from 1985 through

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2015, and summarised by year of birth. Predictions use the relation $\hat{\mathbf{g}} = \hat{\boldsymbol{\mu}}\, \mathbf{G}_{11}^{-1}\mathbf{G}_{12}$, where $\hat{\mathbf{g}}$ and $\hat{\boldsymbol{\mu}}$ are breeding objective trait EBVs and BREEDPLAN EBVs, respectively, and $\mathbf{G}_{11}$ and $\mathbf{G}_{12}$ are genetic covariances among BREEDPLAN EBVs and between these and the breeding objective traits. Genetic parameters used were derived from industry and literature estimates and are those used for developing Angus indexes in Australia. Genetic trends in estimated total feed intake (excluding any period of surplus feed) per animal were as presented by Walmsley *et al.* (2017). The trends in methane production are derived using the phenotypic relationships between feed intake and methane production of Charmley *et al.* (2017) when animals are at pasture, equation 7 of Johnson *et al.* (2017) when animals are in the feedlot, and the recommended global warming constant for methane (28; Edenhofer *et al.* 2014) for determining kg of CO_2-equivalent.

Production system responses to selection. When included in the breeding objective the cost of feed has been shown to have important impacts on index rankings of beef cattle (Walmsley *et al.* 2018). In this paper, feed was costed at \$130/t (expensive) and lowered by 30% (\$91/t; inexpensive) to demonstrate the impact cost of feed has on GHG emissions. The carbon price used in the breeding objective varied with feed price. When feed price was expensive the carbon prices examined were \$0, \$20 and \$40/t. When feed price was inexpensive the carbon prices examined varied between \$0 and \$80/t. More detail can be found in Barwick *et al.* (2019).

Changes in individual traits after a single generation of selection were calculated assuming a selection intensity of $i = 1$, using the MTIndex software of J. van der Werf. These changes were used to determine the changes predicted to occur in feed intake and CO_2-equiv. Changes in total GHG emissions and net return were summed over the breeding objective traits for the young animal at pasture, young animal in the feedlot and the cow. These were also summed to give changes for the whole production system. GHG emissions were also expressed per unit of feed intake and per unit of product for the whole production system.

RESULTS AND DISCUSSION

Figure 1a demonstrates genetic changes that have occurred in the breeding objective liveweight traits (sale weight, feedlot entry weight and weaning weight) based on Australian Angus EBVs. Genetic merit for all these traits increased between 1985 and 2015 with sale weight having the highest rate of increase. Figure 1b shows that predicted GHG emissions have also increased, both at pasture and in the feedlot, from increases in feed intake associated with growth potential increases. The total GHG emissions at pasture are higher because the period of time at pasture is longer than the period in the feedlot. Figure 1c shows that young animal GHG emissions per day are greater in the feedlot than in young animals at pasture. Figure 1d shows the trends in GHG emissions per day for the cow alone and for the cow and calf prior to weaning.

Figure 2a shows that when feed is \$130/t and carbon has a price of \$0/t in the breeding objective a small reduction in total GHG emissions is predicted when selecting for multiple-trait merit. As carbon price increases further reductions in GHG emissions are predicted. In contrast, when feed is inexpensive and carbon is \$0/t in the breeding objective, increases in GHG emissions are predicted as a response to gains in live weight traits. GHG emissions do not become negligible when feed cost is inexpensive until the carbon price reaches \$80/t. Figures 2b, c and d illustrate that GHG emissions per unit feed, per unit product, and net return when the feed cost is inexpensive do not reach levels comparable to that when the feed cost is expensive until the carbon price is \$60-\$80/t.

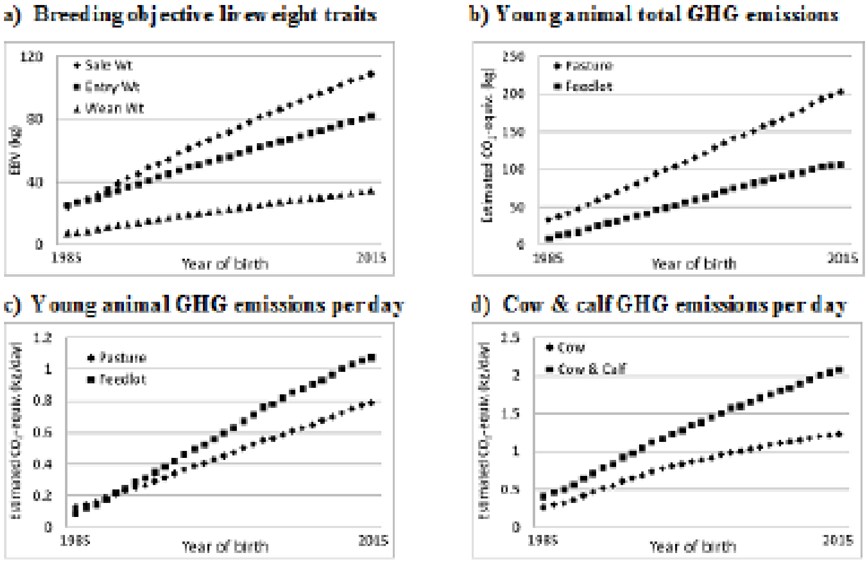

Figure 1. Genetic trends in liveweight traits of the breeding objective, young animal overall and daily estimated GHG emissions at pasture and in the feedlot, and cow and cow/calf emissions at pasture for Angus cattle for a self-replacing cow herd with steers 100-d feedlot finished. Trends exclude any period of surplus feed

The trends in Figure 1 illustrate that greenhouse gas emissions have increased as a result of genetic change in productivity traits and feed intake. Compared to 1985, the young animal at pasture in 2015 produces an extra 0.66 kg CO_2-e per day which equates to ~170 kg CO_2-e over the pasture period. The animal in the feedlot is producing an extra 0.98 kg CO_2-e per day or 98 kg CO_2-e during the 100 days in the feedlot. The cow in 2015 is producing 0.97 kg CO_2-e per day extra and when combined with her calf to weaning they produce an extra 1.67 kg CO_2-e per day. When viewed in association with the unfavourable trend in feed efficiency shown by Walmsley *et al.* (2017) these GHG emissions trends illustrate that there is a need to focus on multiple trait selection to improve feed efficiency and GHG emissions along with productivity. The association between feed intake and GHG emissions means that either trait can be recorded and this will be expected to provide useful information on the other trait that can be used in selection.

CONCLUSION

The production system responses in Figure 2 illustrate that feed price and carbon price have important impacts on GHG emissions changes under multiple-trait selection. When feed is \$130/t, decreases in GHG emissions are predicted even with a \$0/t carbon price. When feed is considered cheap and carbon is not costed, increases in GHG emissions are predicted to occur in response to liveweight and feed intake increases. GHG emission reductions are not predicted unless carbon is priced at ~\$80/t. These results further support that animal genetic improvement and pasture stocking rate management need to be considered jointly. When stocking rates are low and genetic improvement has the extra benefit of improving pasture utilisation by increasing growth potential, GHG emissions are likely to increase. At high stocking rates, when pasture utilisation and the cost of feed are inherently higher, multiple-trait selection can drive genetic change and limit feed intake and GHG emissions increases across the whole production system.

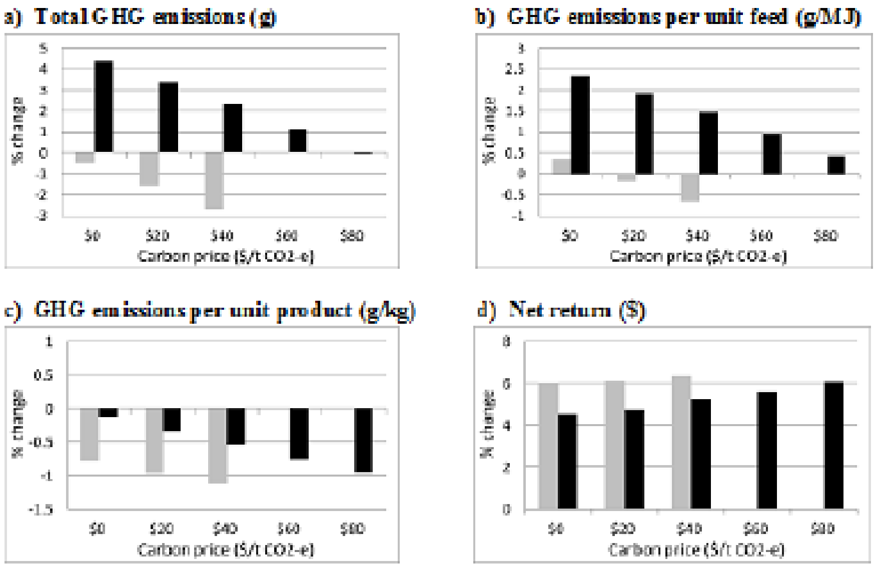

Figure 2. The effect of carbon price on production system responses to selection when feed price is expensive ($130/t; grey bars) or inexpensive (30% lower; solid bars) for Angus cattle from a self-replacing cow herd with steers 100-d feedlot finished

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