Interdisciplinary research raises concerns about selection for production on energy reserves in beef cows

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Introduction

Modern production animals have been selected on output traits and subsequently fitness traits and adaptability have generally declined, potentially leading to reduced overall productivity (Hohenboken *et al.* 2005). In response, the requirement of cattle breeders has shifted from selecting for increased output towards selecting for optimum conversion of available food resources to marketable product across the production system (Jenkins and Ferrell 2007). In forage based systems the quality and quantity of dry matter available varies greatly and periods of low feed availability may inhibit individual animal's ability to express their genetic potential. Jenkins and Ferrell (1994) effectively demonstrated the need for genetic potential to be aligned with production environment. If there is high genetic potential but poor production environment (low or variable nutrition), it is likely biological production efficiency will be reduced due to suboptimal pre-calving energy reserves which are a major determinant of a cow's ability to maintain an annual breeding cycle (Richards *et al.* 1986).

Given the complexity of maternal efficiency, that is, weight of calf weaned per unit of energy consumed by the cow and calf, it is possible that some issues may not be fully captured by routine performance recording and data analysis. Cow efficiency is heavily influenced by management, thus it is important to understand the amount of variation in management and selection criteria used by breeders. This two stage study facilitates the collection and analysis of interview data from 24 breeders as part of an intensive field work component with seedstock producers and also analysis of animal performance data from the Australian Beef CRC Maternal Productivity Project. This paper aims to illustrate the variation in breeder's experiences and perspectives about maternal efficiency and discuss the underlying factors. Furthermore the effect of altered genetic potential for leanness, growth and milk on subcutaneous fat depth on a weight constant basis for Angus and Hereford in southern Australian production systems is quantified. Through the use of an interdisciplinary approach, it is possible to combine the findings of social science and animal science.

Material and methods

Interview analysis. A qualitative research approach comprising 24 in-depth semi-structured interviews with Angus and Hereford seedstock breeders was conducted. The interviews focused on factors breeders perceived as important in contributing to maternal productivity in beef cattle. Sampling was purposeful with all breeders interviewed conducting the full

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range of Breedplan performance recording on both sexes. The interview schedule was internally examined by peers and formally developed in a pilot study. Audio from the interviews was digitally recorded and transcribed in full. The transcripts were analysed using a content analysis approach as described by Miles and Huberman (1994) with the assistance of NVivo™ 8 software providing a database for the arrangement, retrieval and verification of data. Content analysis is multi-staged and involves transcript familiarisation, data coding, and within and across interview analysis. Coding of data involved both data reduction; by arranging large texts into small analytic units (codes) which acted as labels for assigning meaning to descriptive information compiled from interviews; and analytical categorisation of the data (Neuman 2003). First level coding of each transcript in its entirety was conducted and involved placing segments of text to the appropriate code. Secondary coding was performed to cluster codes together and examine interactions between initial codes and to form an initial conceptual order to indicate the nature of relationships between categories. Secondary coding was used to demonstrate interactions between codes, to show how concepts cluster together and how codes relate to each other under different circumstances.

Data within code for each interview was compared to ensure consistency of message on a particular topic, and identify underlying factors if content was not consistent. Data within code and between interviewees were then compared to determine if common themes or messages, or contrasting information was emerging for a particular code. Cross case analysis involved comparing comments on the theme, 'production potential and energy reserves' across interviews and provided an insight into how applicable the findings of the project would be across multiple sites or similar circumstances (Miles and Huberman 1994).

Animal Performance Data Analysis. Body composition traits including weight and ultrasound rump P8 fat depth (P8) were collected on 4604 Breedplan performance Angus and Hereford cows at pre-calving (PC) and weaning (W) over their first two parities (1 and 2). P8 fat depth was used as an indicator of body fatness (energy reserves). Unadjusted P8 fat depth (mm) means at PC1, W1, PC2, W2 were 5.8, 5.8. 6.5 and 8.2 for Angus and 6.6, 6.3, 8.6 and 10.5 for Hereford. P8 fat depth was log-transformed and analysed with a linear mixed model (Genstat 11th ed.) with live weight included as covariate. Specifically, fixed effects fitted included measurement (PC1, W1, PC2, W2), breed, age at each measurement, weight at each measurement and the cow's estimated breeding values (EBVs) for 600d weight (kg), P8 fat (mm), milk (kg of calf) and loin Eye Muscle Area (EMA cm^2) (Graser *et al.* 2005). EBVs were fitted within breed and interactions with measurement were included. Cow and management group were fitted as random effects. EBVs that accounted for greater than 1% of model variation in P8 fat depth are reported. The effect of altered genetic potential for P8 fat depth, 600d weight and milk EBVs on observed P8 fat depth was quantified at each time point for each breed.

Results and discussion

Qualitative content analysis of interview data demonstrated a considerable divergence in attitudes to management of the cow with regards grazing management, energy reserve fluctuation and the utilisation of body fat reserves that appeared independent of breed, calving season, average genetic potential and production environment (location). Breeders managing cattle with systems characterised by relatively stable energy supply and lower cow energy reserve fluctuation (controlled input approach) generally perceived negligible association between increased genetic production potential and cow energy reserves. Conversely, breeders managing cattle using an adaptation model approach characterised by variable feed availability and greater fluctuation in cow energy reserves perceived strong associations between increased genetic production potential and reduced energy reserves. Breeders using an adaptation model animal management approach believed selection for leanness, growth and milk reduced the ability for cows, particularly those in early parities, to attain sufficient energy reserves at critical times of the production cycle such as pre-calving.

Many seedstock breeders detailed production systems characterised by large inter- and intra-annual variability in pasture growth, and animal management aimed at minimised supplementary feeding. Breeders outlined the requirement for cows that could maintain sufficient productivity, namely an annual calving cycle whilst meeting the challenges of such production systems by successfully fluctuating in energy reserves, namely rapid accumulation of lipid (energy reserve) during times of high feed availability and moderated mobilisation of lipid when feed availability was reduced. Breeders believed cows with high genetic potential for leanness, growth and milk were often unable to meet the requirements of the system with regards energy reserve fluctuation and subsequently suffered reduced productivity. The following quotes demonstrate the management implied and perceptions about high genetic potential for production impacting on energy reserves and fertility.
'The cows that have stayed in the system obviously after about three calves have this ability where they can put weight on quickly in spring when there is compensatory growth and they can draw down on those reserves when things are tougher and then gain weight quickly when the feed is available. We see a real advantage in that.'
'The cow with more positive fat is likely to hang in there better as things go down, and she will also be the cow that uses spring.'
'*The cows here that are high growth and high milking cows, it is hard for them to stay in this environment, they will drop out, they drop themselves out on the fertility.'*

Other seedstock breeders spoke about the benefit and requirement for continued genetic improvement in production traits and that fertility could be cost effectively managed through improved animal management practices, in particular meeting the energy requirements of the cow over the production cycle. They believed animal management systems based on substantial weight and energy fluctuations to be inefficient and perceived well managed high yielding high growth cows as more profitable to the beef supply chain compared with lower performance contemporaries. The following quotes support the above observations.
'I don't believe in storing fat on cows back, I believe in storing feed in the shed. You harvest the feed, at about 95% efficiency where as a cow harvests at about 70% efficiency. Then there are energy requirements to store metabolisable energy and also to re metabolise it. It seems to me that the obvious thing to do is to feed them when they require it!'
'The reality is that you can get the fertility and still have yield. When animals are under stress the first thing that shuts down is reproduction so that is what we are trying to manage.

The interview results provided the basis for the approach taken in the data analysis, namely quantifying the effects of increased genetic performance potential for leanness, growth, milk and muscularity on body fatness with the use of scan P8 fat depth as an indicator of energy reserves. Analysis results are reported in Table 1 with size of effect reported as percentage change in P8 fat depth per standard deviation change in EBV with approximate standard error listed. For Angus and Hereford respectively, the effect of a single standard deviation reduction in P8 EBV (1.14mm, 1.19mm) combined with a single standard deviation increase in 600d weight (13.2kg, 12.7kg) and milk (3.9kg, 3.9kg) EBV is considerable. Under this scenario, P8 fat depth was reduced by 21% for Angus at both pre-calving and weaning, and 27% and 35% for Hereford at pre-calving and weaning across parity. Results from Table 1demonstrate that P8 fat EBV is highly related to increased P8 fat depth in cows. Moreover, 600d weight potential and 200d Milk EBV have a significant effect on P8 fat depth such that increased genetic potential is associated with lower P8 fat depth at weaning and pre-calving.

Table 1. Variates affecting P8 fat depth pre-calving and weaning first and second parity

		Angus				*Hereford*				
EBV	NWS	PC1	W1	PC2	W2	PC1	W1	PC2	W2	App. SE
P8	34.7%	+16.9	+13.5	+13.4	+14.0	+19.8	+21.7	+15.8	+21.8	1.7
600d	3.7%	-4.5	-5.5	-7.2	-3.9	-6.6	-8.6	-11.9	-14.7	1.4
Milk	1.1%	+0.7	-2.8	-1.4	-3.6	+1.0	-2.2	+0.4	-0.8	1.1

Model accounted for 85% of the variance in P8 fat depth. All values significant (P<0.001)
NWS = Normalised Wald Statistic, percentage of total variation accounted for by fitted term
PC1: pre-calving first parity, W1: weaning first parity, PC2: pre calving second parity, W2: weaning second parity

Conclusion

Amongst seedstock breeders targeting similar end markets, substantial variation in animal selection and management exists. Cattle breeders must be aware that increased production potential is associated with decreased energy reserves and thus carefully assess the economic benefit of increasing genetic production potential. Where nutrition is limiting and the cost of controlled input animal management high, the benefit of high genetic production potential cows may be outweighed by additional feed costs needed to attain optimal body energy reserves at calving. These results demonstrate that selection for leaness has a significant effect on fatness of cows. Moreover, for breeders using an adaptation model for animal management, the high repeatability of fat depth across ages means that selection for increased fat depth in heifers could be used to negate the correlated effects of selection for increased production on cow energy reserves.

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