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Comparison of the performance and carbon footprint of dairy-origin beef systems

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Introduction One of the key aims of a profitable beef rearing and finishing enterprise is to make best possible use of available resources and to adopt rearing/finishing enterprises which are efficient in terms of carcass gain per unit input costs over the lifetime of the animal. However, with increased emphasis on carbon footprint, it is important that these beef production systems are also efficient in terms of carbon emissions per kg output. On this basis a study was undertaken to evaluate the lifetime performance of a range of dairy-origin beef systems and to determine the carbon footprint of each of the systems.

Materials and methods Two hundred and twelve spring-born calves (Holstein, Angus, Limousin and Belgian Blue) were sourced from dairy farms from Northern Ireland at 4 weeks of age and allocated to one of four lifetime rearing/finishing regimes at weaning as follows: (1) Intensive bulls - bulls offered *ad libitum* concentrates (total concentrate input 2.2 tonnes (t) DM) (2) Forage/concentrate-based bulls - bulls offered grazed grass in their first summer followed by grass silage plus concentrates (50:50 ratio on a dry matter (DM) basis) (total concentrate input 1.5 t DM) (3) Medium concentrate input steers – steers offered grazed grass during the summer and grass silage-based diets during the winter with total concentrate input of 1.3 t DM (4) Low concentrate input steers – as for (3) but total concentrate input 0.6 t DM. Bulls were slaughtered at 550 kg live weight and steers at 650 kg live weight. Animal performance (live weight gain and dry matter intake) was monitored throughout the life of the animal. At slaughter cold carcass weight, carcass conformation and fat classification and fat depth measurements were taken. Data were analysed using REML Variance Component Analysis with year, farm of origin, breed, start age and start weight used as covariates. Carbon footprint of each of the systems was calculated using mean data for each of the systems. Methane emissions from enteric fermentation were estimated using the methane prediction equation developed by Yan *et al* (2009); methane emissions associated with manure storage and nitrous oxide emissions were estimated using IPCC (2006) Tier 1 emission factors; emissions associated with concentrate and inorganic fertiliser manufacture were taken from Lovett *et al* (2006) and Edwards-Jones *et al* (2009) respectively; a carbon sequestration rate of 1.16 tonnes CO_2e/ha/year was used (Natural England 2008).

Results Increasing the proportion of forage in the ration of finishing bulls reduced lifetime liveweight gain by 12%, increased slaughter age by 42 days and reduced carcass weight by 11 kg ($P<0.001$). Reducing total concentrate input in steers reduced lifetime liveweight gain 7% ($P<0.01$), increased slaughter age by 33 days and reduced carcass weight by 12 kg ($P<0.001$). The carbon footprint of forage/concentrate-based bulls was similar to intensive bulls. However, the carbon footprint of bulls was 52% of that of steers. Reducing concentrate inputs in steer-based systems reduced carbon footprint by 7%.

Table 1 Performance and carbon footprint of four dairy-origin beef rearing and finishing systems.

	Intensive bull system	Forage/ concentrate-based bull system	Medium concentrate input steer system	Low concentrate input steer system	s.e.d.	Sig
Lifetime live weight gain (kg/day)	1.22^{d}	1.07^{c}	0.82^{b}	0.76^{a}	0.021	***
Age at slaughter (months)	15.0^{a}	16.4^{b}	25.1^{c}	26.2^{d}	0.30	***
Carcass weight	309^{b}	298^{a}	340^{d}	328^{c}	3.1	***
Conformation†	2.7^{b}	2.7^{b}	2.2^{a}	2.1^{a}	0.09	***
CO_2e (kg/head)	2061.4	1986.1	4023.0	3733.9		
CO_2e (kg/carcass weight)	6.7	6.7	11.8	11.4		

† Conformation based on EUROP classification where E=5 and P=1

Conclusions Increasing the proportion of forage in the diet of dairy-origin bulls has only a marginal effect on carbon footprint. Bull-based systems of beef production have superior performance relative to steer-based systems and have a lower carbon footprint.

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