

Antagonism in the carbon footprint between beef and dairy production systems

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Abstract

Primary beef cattle farming in South Africa is largely extensive, whereas dairy farming is based on both total mixed ration and pasture production systems. Under natural rangeland conditions, decomposition of manure is aerobic, which produces carbon dioxide (CO₂), part of which is absorbed by the regrowth of vegetation rather than released into the atmosphere, and water (H₂O) as end products. Thus the cow releases methane (CH₄) and the manure CO₂. This is in contrast to intensive cow-calf systems in large parts of Europe and North America, where large quantities of manure are stockpiled and undergo anaerobic decomposition and produce CH₄. Thus both the cow and the manure release CH₄, which result in a higher carbon footprint than the extensive cow-calf systems. In dairy farming, increasing cow efficiency through intensive feeding (same kg milk output by fewer animals) can reduce farm CH₄ production by up to 15%. In addition, when differences in productivity are accounted for, pasture systems require more resources (land, feed, water, etc.) per unit of milk produced and the carbon footprint is greater than that of intensive systems. This raises the question as to why the carbon footprint of intensive dairy cow production systems is less, but the carbon footprint of intensive beef cow-calf production systems is higher. The explanation lies in the differences in production levels. In the case of beef cows the weight of the intensive cows will be ± 30% higher than that of the extensive cows, and the weaning weight of their calves will also differ by ± 30%. In the case of dairy cows the weight of the intensive cows will be ± 20% higher, but their milk production will be ± 60% higher. The higher increase in production (milk) of intensive dairy cows, compared to the increase in production (calf weight) of intensive beef cows, explains the antagonism in the carbon footprint between different beef and dairy production systems. Unfortunately, carbon sequestration estimates have been neglected and thus the quantitative effects of these differences are not known.

Keywords: Cow-calf production, methane, pasture production, production levels, total mixed ration

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Introduction

In South Africa, the cow-calf production cycle is mostly extensive, since large parts of the country are not suitable for crop cultivation, with approximately only 13% that can be cultivated. The greater part of South Africa (71%) is thus only suitable for extensive livestock farming (RMRD SA, 2013). Under these natural rangeland conditions, decomposition of manure is aerobic, leading to the production of carbon dioxide (CO₂) and water (H₂O) as end products. Thus where the cow emits methane (CH₄), the manure releases CO₂. It is important to note that part of the CO₂ from the manure is most likely absorbed by the regrowth of the surrounding vegetation rather than released into the atmosphere. This is in sharp contrast to the intensive systems in large parts of Europe and North America, where large quantities of manure are stockpiled and undergo anaerobic decomposition. The anaerobic decomposition of manure in these intensive cow-calf systems, feedlots and intensive dairy systems then produce CH₄ as one of the major end products (Scholtz *et al.*, 2013).

Although the primary beef cattle cow-calf production cycle is largely extensive in South Africa, more than 75% of the cattle slaughtered in the formal sector are finished in feedlots (RMRD SA, 2013), over a fattening period of approximately 110 days, which means that they produce greenhouse gases (GHG) for only 110 days before being slaughtered. Cattle on rangeland/pastures in South Africa require more than 200 days of finishing before reaching the same carcass classification, because of the lower quality feed, than in a feedlot diet. The lower quality feed (mainly natural pastures consumed) also produce more GHG per

kilogram feed intake than the concentrates used in the feedlots (Capper, 2011; Meissner *et al.*, 2012). The bottom line is that feedlots maximize the efficiency of meat production, resulting in a lower carbon footprint.

With respect to dairy cows, both total mixed ration (TMR) and pasture production systems, or a combination thereof, are followed in South Africa, depending on the region. There is substantial evidence that cows on pastures produce more CH₄ than cows on high concentrate diets (Gibson, 2010). For example, Capper *et al.* (2009) indicated that in the USA the carbon footprint per kilogram milk produced in 2007 was only 37% of that produced in 1944. The carbon footprint of milk that is currently produced is 63% smaller than the mostly natural production systems of 1944. Other studies in the USA confirmed that milk production is 15% - 27% lower in organic than in conventional systems (Meissner *et al.*, 2012) and when differences in productivity were accounted for, the organic systems required more resources (land, feed, water, etc.) per unit of milk produced and the environmental impact was greater. This implies that milk from TMR systems has a lower carbon footprint than pasture based systems.

This raises the question as to why the carbon footprint of milk from intensive dairy cows is less than that of pasture dairy cows, but in the case of beef cows the carbon footprint of beef from extensive cow-calf production systems is lower than that of intensive cow-calf production systems. Due to this potential confusion, this paper attempts to explain this antagonism between beef and dairy production systems.

Materials and Methods

Information was collected to compare animal weights and production levels between intensive and extensive production systems of beef and dairy cows.

Cow and calf weights for extensive and intensive cow-calf beef production systems were taken from Scholtz (2010), where the information of commercial cows participating in performance recording was used; and from (www.angus.org) where the information of Angus cows in the USA were used. This information is summarized in Table 1.

Table 1 Summary of cow and calf weights of extensive and intensive cow-calf beef production systems

	Cow-calf production system		% Difference
	Intensive	Extensive	
Cow weight (kg)	650	520	31%
Calf weaning weight (kg)	295	220	33%

Cow weights and production levels were collected from 3 625 Holstein cows on TMR and 863 Holstein cows on pastures from farms in the southern and western Cape of South Africa that use the Afikim milking system. This information is summarized in Table 2.

Table 2 Summary of cow weights and milk production of TMR and pasture based milk production systems

	Dairy production system		% Difference
	TMR	Pasture based	
Cow weight (kg)	665	560	19%
Milk production (kg)	11 600	7 200	62%

Results and Discussion

From Table 1 it is clear that the cow and calf weights increase with almost the same percentage from the extensive to the intensive cow-calf production system. From Table 2 it is clear that although cow weight between the two production systems differs with only 19%, the difference in milk production was a very high 62%. The information from Tables 1 and 2 were then used to simulate the number of cows needed to produce (1) 30 000 kg of weaner calf and (2) 1 000 000 kg of milk and the results are presented in Table 3.

The conclusion from these results is that intensive cattle production systems will have a lower carbon footprint than extensive production systems, if the production period can be shortened (as is the case with feedlots) or the production per unit (as is the case with the TMR systems) can be significantly increased. Du Toit *et al.* (2013) estimated the methane emission factor for dairy cattle on a TMR to be 76.4 kg CH₄/head/year and for those on pasture based systems, as 71.8 4 kg CH₄/head/year. Although the methane emission factor for dairy cattle on pasture based systems is slightly lower, the production levels are much lower, resulting in a higher carbon footprint for milk produced from pastures.

Table 3 The number of cows needed for specific production targets from intensive and extensive production systems

(1) Number of cows needed to produce 30 000 kg of weaner calf		
Intensive	102	A difference of 34 cows or 33%
Extensive	136	
(2) Number of cows needed to produce 1 000 000 kg of milk per lactation		
TMR	86	A difference of 53 cows or 62%
Pasture	139	

Conclusion

The bottom line is that if production levels are not significantly increased or the production period not decreased through intensive production systems, the extensive production systems e. g. the extensive beef cow-calf production cycle in South Africa, will not have a lower carbon footprint, since part of the CO₂ from manure is absorbed by the regrowth of the surrounding vegetation rather than released into the atmosphere. Unfortunately, carbon sequestration estimates have been largely neglected and thus the quantitative effects of these differences are not known.

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