Different environmental indicators lead to conflicting impact assessments: the example of South American beef production

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Background

- Beef is one of the most important food commodities.
- Global demand for beef has been rising consistently over the past five decades.
- About one third of all agricultural land is wholly or partially occupied by beef production systems.
- Beef production systems have a bad reputation in terms of environmental impacts from land area and total water requirements to GHG emissions.

Goal

To examine and to compare **three different evaluation tools** applied to extensive and semi intensive beef production systems in South America.

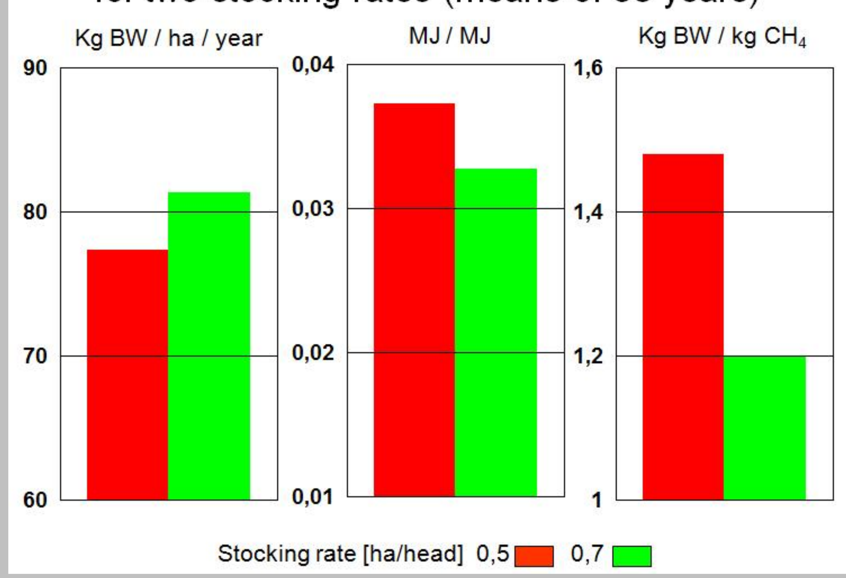
Materials and Methods

Production system behaviour in **cow-calf operations** was tested for the impact of interventions on energy efficiency and methane output by using simulation models.

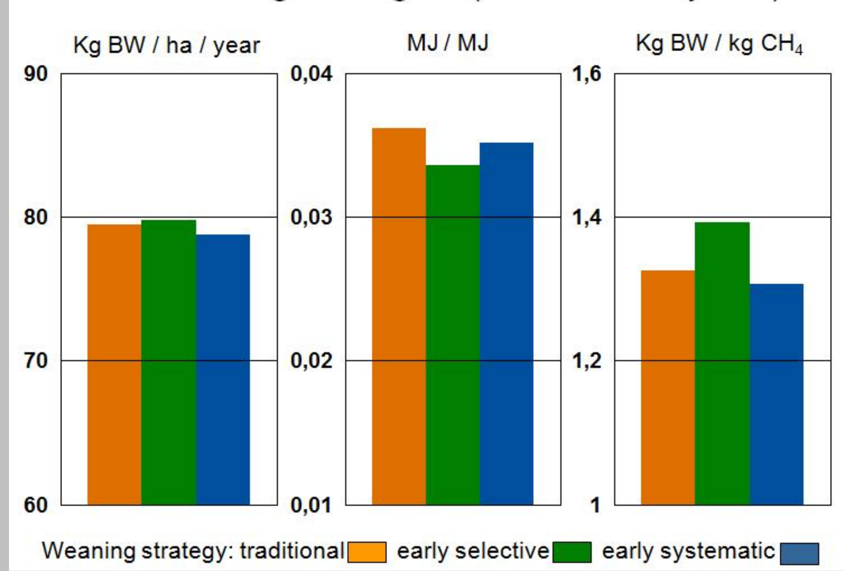
Compensatory carbon sequestration area was calculated for 31 beef production enterprises with three levels of production intensity using a “carbon footprint” type of accounting.

Evaluation of **water productivity** was carried out by calculating “virtual water contents” for three levels of production intensity typically found in South America.

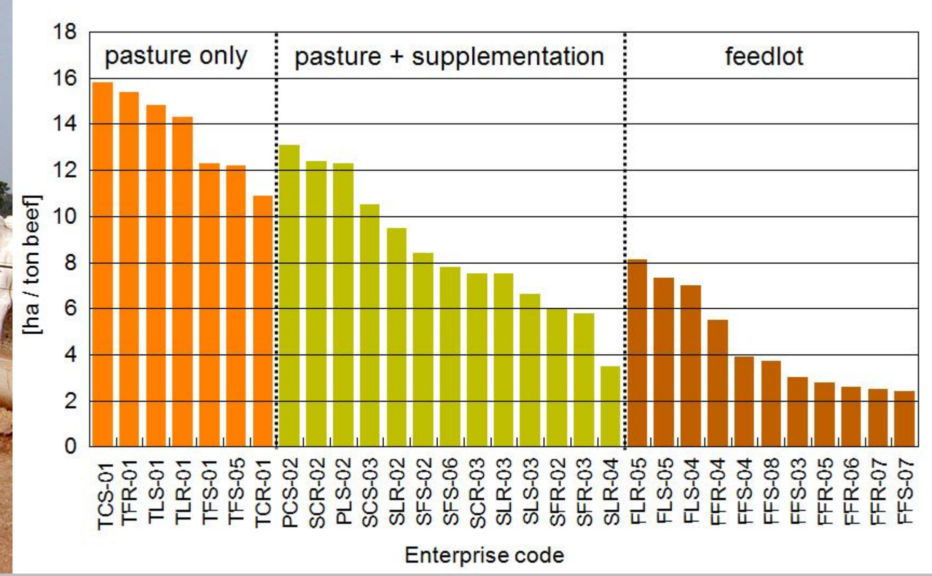
Results



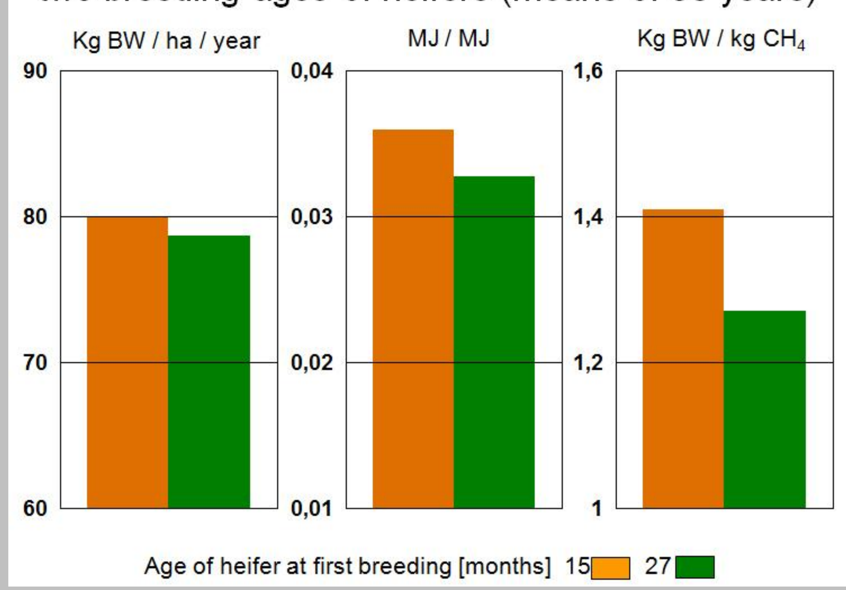
Simulated efficiency of cow-calf operations for two stocking rates (means of 30 years)



Simulated efficiency of cow-calf operations for three weaning strategies (means of 30 years)



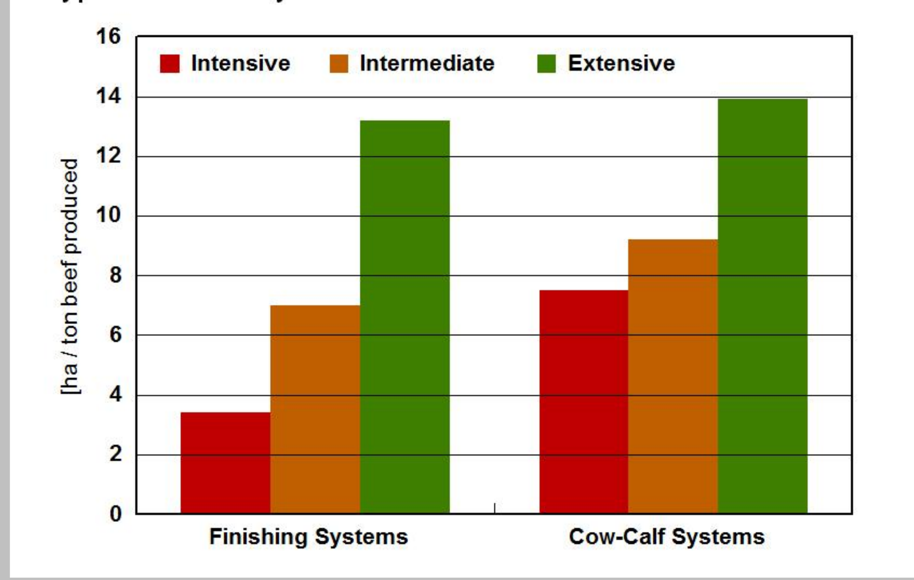
Total area appropriated per ton of beef in Central Brazil at three levels of intensification



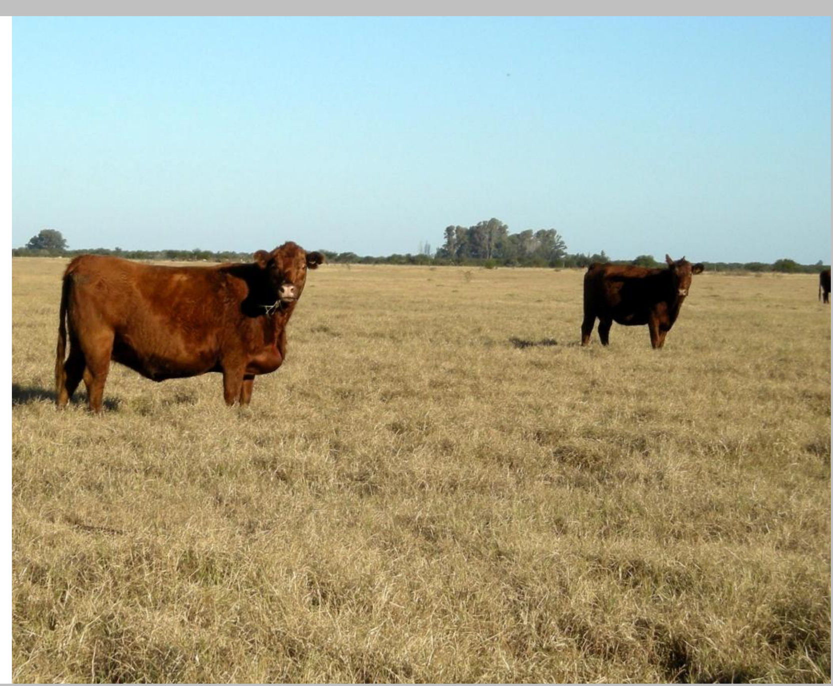
Simulated efficiency of cow-calf operations for two breeding ages of heifers (means of 30 years)

Simulated efficiency of cow-calf operations under different strategies. Production efficiency (kg of body weight sold per year per hectare), energy efficiency (MJ in product sold per MJ uptake) and methane emissions (kg of body weight sold per kg of enteric methane produced). Results are the mean (standard deviation) of 30 years.

Stocking rate [heads·ha^{-1}]	Age of heifer* [month]	Weaning**	Efficiency: kg BW · ha^{-1} · year^{-1}	Efficiency: MJ · MJ^{-1}	Efficiency: kg BW · kg CH_4^{-1}
0.5	15	T	79 (26)	0.0377 (0.018)	1.51 (0.51)
0.5	15	Sel	79 (23)	0.0398 (0.017)	1.55 (0.47)
0.5	15	Sys	74 (37)	0.0380 (0.023)	1.58 (0.78)
0.5	27	T	75 (25)	0.0377 (0.018)	1.37 (0.51)
0.5	27	Sel	78 (34)	0.0398 (0.020)	1.40 (0.62)
0.5	27	Sys	79 (38)	0.0308 (0.018)	1.47 (0.63)
0.7	15	T	81 (29)	0.0325 (0.013)	1.21 (0.41)
0.7	15	Sel	80 (29)	0.0331 (0.015)	1.23 (0.45)
0.7	15	Sys	87 (36)	0.0347 (0.017)	1.39 (0.57)
0.7	27	T	80 (26)	0.0331 (0.015)	1.14 (0.38)
0.7	27	Sel	81 (40)	0.0320 (0.018)	1.12 (0.55)
0.7	27	Sys	79 (38)	0.0308 (0.018)	1.13 (0.56)



Mean area appropriated per ton of beef produced in two types of beef systems at three levels of intensification



Conclusions

- Energy efficiency and enteric methane output were not favourably influenced by the studied intensification interventions.
- Area appropriation for sequestration of CO_2 produced was considerably reduced with increasing intensification and scale of operation.
- Water footprint was decreasing with increasing production intensity, but only if green water use for feed production was included in the balance.
- The results were not mutually supportive.

- In summary there is **no clear environmental advantage in intensification**. Using different indicators leads to incompatible conclusions.
- Consolidating the results into recommendations will require a **trade-off analysis** of the different environmental objectives which were targeted.

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