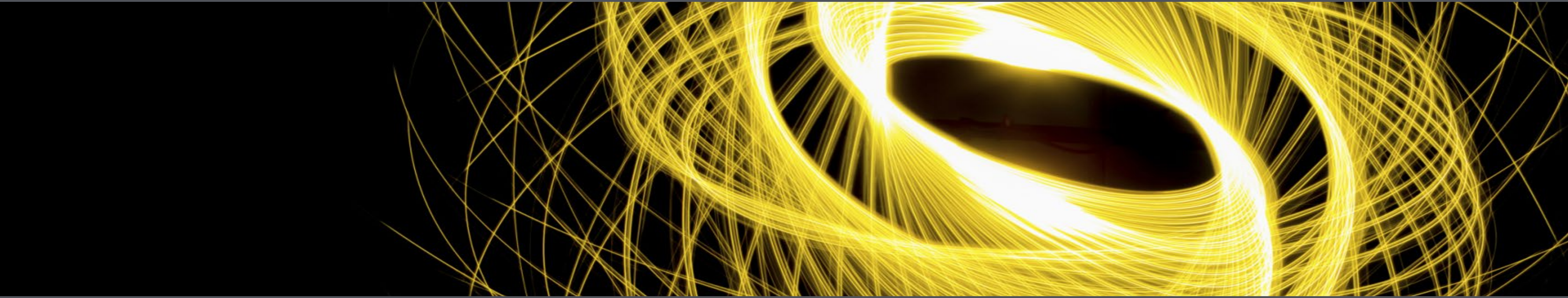
Department of Animal Sciences

Methane emissions from beef fed different protein sources and a forage-based diet

Session 34: Nutrition management to reduce methane emission and environmental impact, Part 1 02/09/2024



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Livestock and GHG emissions

Dark side?

- Livestock → **14.5 %** of total anthropogenic GHG (Gerber et al., 2013)

- Contribution to CH_4 emissions
  - Agriculture is the largest single source of CH_4 emissions
  - **≈39 %** from **enteric fermentation** in ruminants
    - **≈6 %** of total global anthropogenic GHG

(Beauchemin et al., 2020)

<u>Abbreviations</u>:
GHG= Greenhouse gas emissions

Beauchemin et al., 2020. animal, 14. S1. S2-16.
Gerber et al., 2013. FAO.

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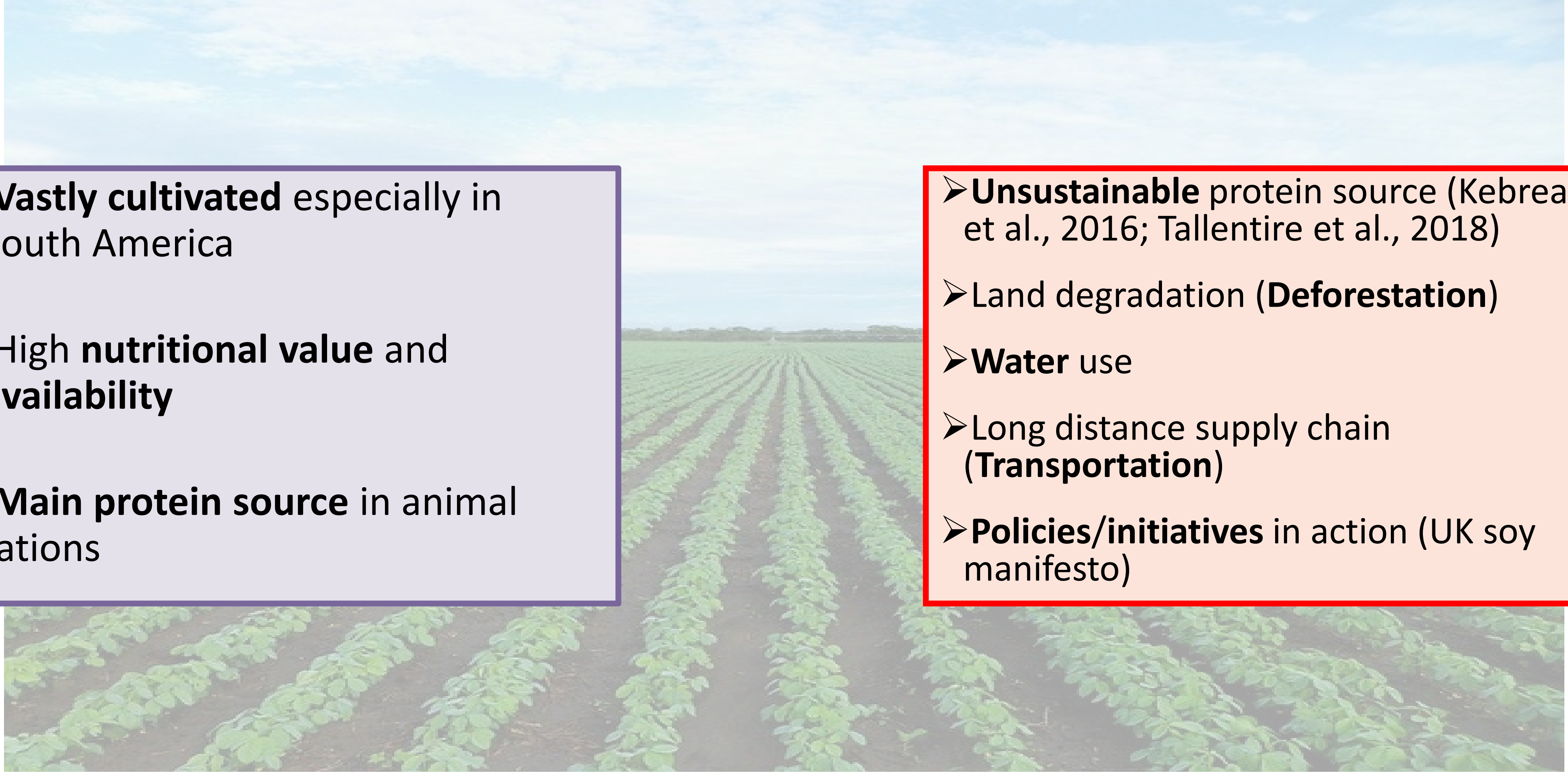
Soya



- **Vastly cultivated** especially in South America
- High **nutritional value** and **availability**
- **Main protein source** in animal rations

- **Unsustainable** protein source (Kebreab et al., 2016; Tallentire et al., 2018)
- Land degradation (**Deforestation**)
- **Water** use
- Long distance supply chain (**Transportation**)
- **Policies/initiatives** in action (UK soy manifesto)

Kebreab et al., 2016. Journal of Animal Science 94, 2664-2681.
Tallentire et al., 2018. Journal of Cleaner Production 187, 338-347.

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Alternative protein sources

Substantial value in the context of **resource use efficiency** and **waste reduction (agro-industry by-products, local alternative crops)** (Sun et al., 2004; Wagh et al., 2024)

Promote circular economy and **contribute** to a **resilient** and **eco-friendly** agro-industrial system (Sun et al., 2004; Wagh et al., 2024)

May have methane (**CH_4**) **mitigation** potential (rich in bioactive compounds, high fat content, etc.)

Typical examples could be **local brewery co-products** and **local field beans**

Sun et al., 2024. Resour. Conserv. Recycl., 201, 107325.
Wagh et al., 2024. Process Safety and Environmental Protection, 183, 708-725.

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Pasture-based low-input systems

- Grassland comprise ≈26 % of worlds total land area and 80% of the agricultural land (FAO, 2009)
- Can reduce production costs (Pinheiro Machado Filho et al., 2021)
- Support livelihoods and economies and preserve and enhance biodiversity (Boval and Dixon, 2012; Fraser et al., 2022)
- Often preferred by consumers for their benefits related to animal health and welfare, and their more favourable nutritional profile (Clinquart et al., 2022; Klopatek et al., 2022)

Boval and Dixon, 2012. Animal 6, 748-762.
Clinquart et al., 2022. Animal 16, 100426.
Fraser et al., 2022. Animal 16, 100671.
Klopatek et al., 2022. J Anim Sci 100.
Pinheiro Machado Filho et al., 2021. Animals 11, 3494.
The state of food and agriculture, FAO, 2009. p. 166.

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Aim of the study

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Assess the effect of different dietary protein sources (soya, SB; local brewers’ spent grains, BSG; local field beans, BNS) and compared to a pasture-based low-input diet (GRA) on:

- Growth rates
- Nutrient intakes and digestibility
- Energy use efficiency
- CH_4 emissions

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Materials and Methods

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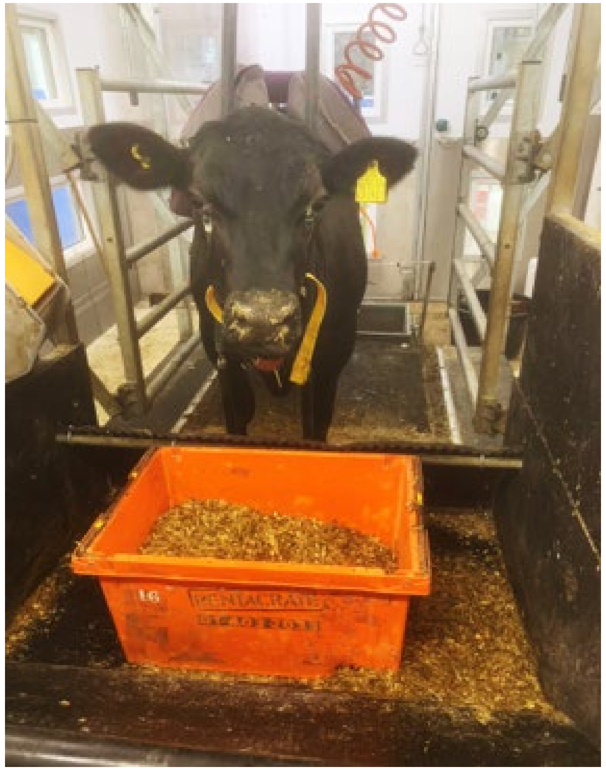
- 4 treatments n = 8 growing beef (4 heifers and 4 steers) per treatment:
  - ✓ TMR including soya as the main protein source (**SB**); 64:36 F:C
  - ✓ TMR including local brewers' spent grains as the main protein source (**BSG**); 64:36 F:C
  - ✓ TMR including local field beans as the main protein source (**BNS**); 64:36 F:C
  - ✓ Fresh-cut ryegrass-fed group 91:9 F:C (**GRA**)
- Every week, for 16 weeks, 4 steers (one per treatment) were in respiration chambers
- GHG measurements, individual records of DMI, BW, and total collection of faeces and urine



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Data and statistical analysis

- ✓IBM SPSS 29.0®
- ✓Linear Mixed Model
- ✓Fixed factors: Dietary Treatment (**D**), Period (**P**), Block, **D** × **P**
- ✓Random factor: ((Animal ID)Treatment)
- ✓Repeated measurement: Period
- ✓Pairwise comparisons: Fisher’s LSD test
- ✓*P*<0.05

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Results

Feed and nutrient intakes (kg/day) and digestibility (kg/kg) from steers fed the experimental diets during the chamber measurement periods of the animal trial

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	Dietary treatments[1]					
Item[2]	SB (n=16)	BSG (n=16)	BNS (n=15)	GRA (n=16)	SEM	*P*-value
Feed and nutrient intakes (kg/day)						
DM	5.71	5.84	5.67	5.14	0.36	0.544
OM	5.41	5.56	5.41	4.67	0.47	0.558
GE	96.3	105	96.5	92.7	8.65	0.771
N	113	120	105	115	14.9	0.908
NDF	2.38[b]	2.71[ab]	2.23[b]	3.06[a]	0.18	0.032
ADF	1.49[b]	1.59[b]	1.32[b]	1.94[a]	0.12	0.015
Oil	0.18[b]	0.29[a]	0.18[b]	0.15[b]	0.02	<0.001
EE	0.14[b]	0.23[a]	0.13[b]	0.11[b]	0.01	<0.001
Starch	1.18[b]	1.15[b]	1.46[a]	-	0.01	0.035
WSC	0.17[b]	0.11[b]	0.14[b]	0.35[a]	0.02	<0.001
Digestibility (kg/kg)						
DM	0.70[a]	0.66[b]	0.68[ab]	0.56[c]	0.01	<0.001
OM	0.73[a]	0.69[a]	0.71[a]	0.58[b]	0.03	0.005
DOMD	0.69[a]	0.65[a]	0.67[a]	0.53[b]	0.02	<0.001
GE (MJ/MJ)	0.67[a]	0.64[a]	0.65[a]	0.51[b]	0.02	<0.001
N	0.59	0.61	0.53	0.55	0.02	0.078
NDF	0.64[a]	0.59[bc]	0.57[c]	0.61[ab]	0.01	0.012
ADF	0.57	0.52	0.47	0.52	0.03	0.219

[1] SB = Total mixed ratio (TMR) including soya as the main protein source; BSG = TMR including local brewers' spent grains as the main protein source; BNS = TMR including local field beans as the main protein source; GRA = diet including solely fresh-cut grass.

[2] DM = dry matter; OM = organic matter; N = nitrogen; NDF = neutral detergent fibre; ADF = acid detergent fibre; EE = ether extract; WSC = water soluble carbohydrates; DOMD = digestible OM in DM; GE = gross energy.

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Body weight (BW) and Body weight change (BWc)

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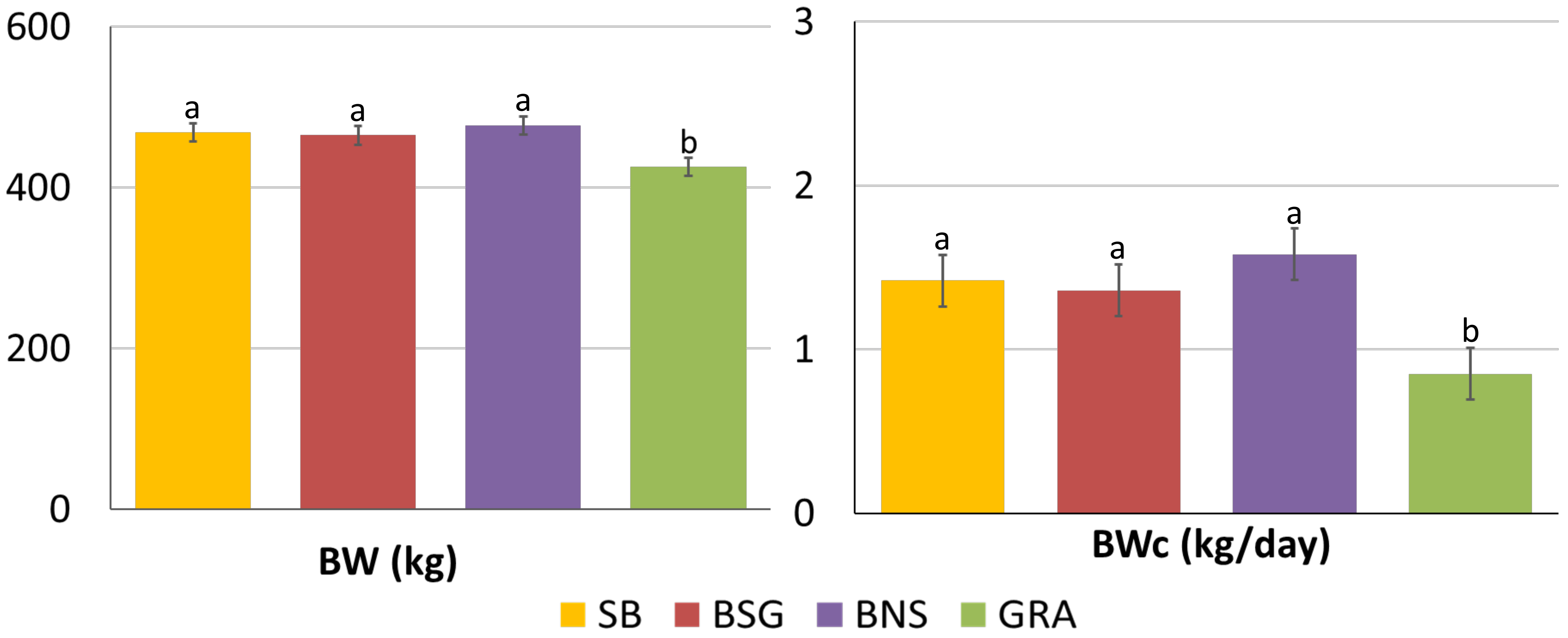

SB = Total mixed ratio (TMR) including soya as the main protein source; BSG = TMR including local brewers' spent grains as the main protein source; BNS = TMR including local field beans as the main protein source; GRA = diet including solely fresh-cut grass; BW = Body weight; BWc = Body weight change.

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Energy Intakes and Outputs

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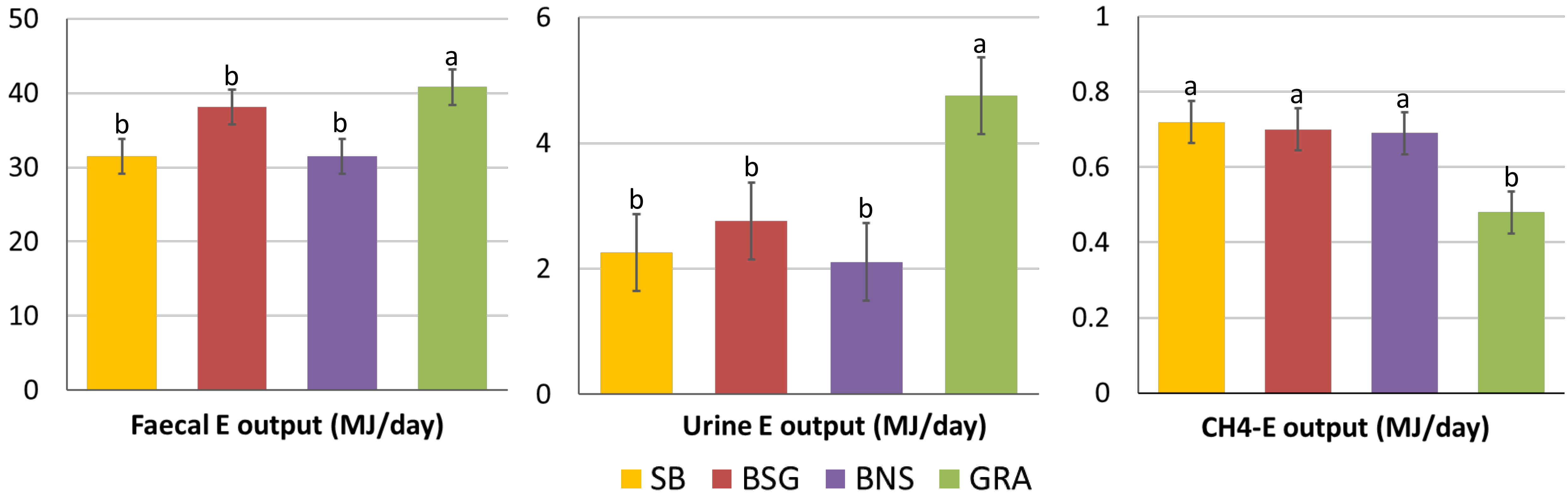
- Intakes of gross energy (**GE**), digestible energy (**DE**), and metabolisable energy (**ME**) **did not differ (*P*>0.05)**



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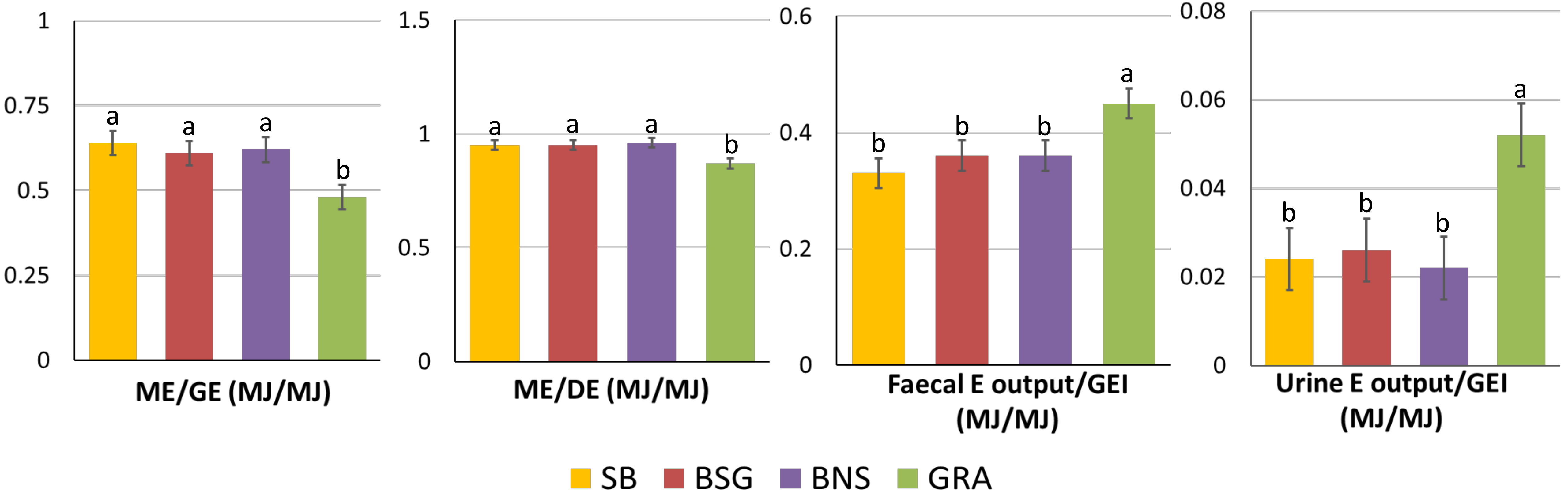
Energy utilisation



SB = Total mixed ratio (TMR) including soya as the main protein source; BSG = TMR including local brewers' spent grains as the main protein source; BNS = TMR including local field beans as the main protein source; GRA = diet including solely fresh-cut grass; DE = Digestible energy; GE = Gross energy; ME = Metabolisable energy; GEI = Gross energy intake.

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Enteric CH_4 emissions

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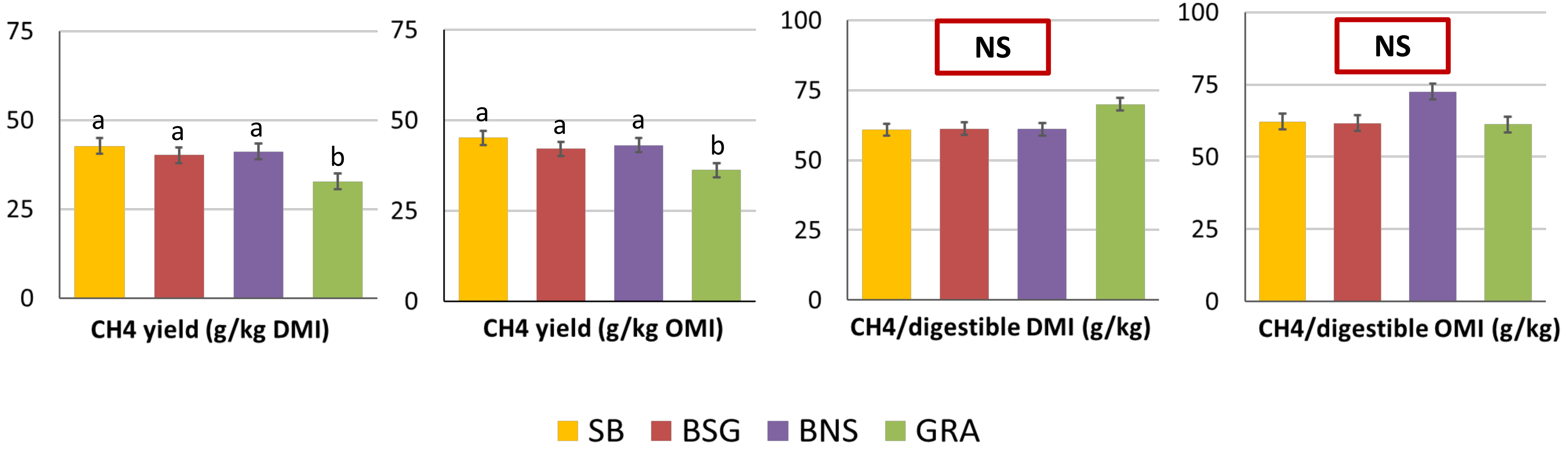

SB = Total mixed ratio (TMR) including soya as the main protein source; BSG = TMR including local brewers' spent grains as the main protein source; BNS = TMR including local field beans as the main protein source; GRA = diet including solely fresh-cut grass; DMI = Dry matter intake; OMI = Organic matter intake.

Enteric CH_4 emissions

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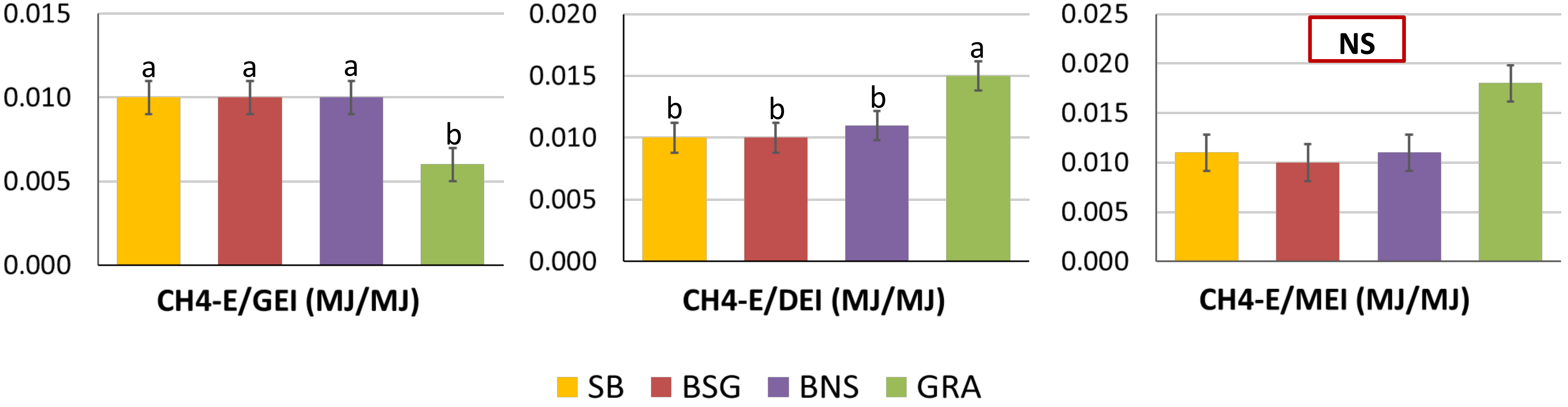

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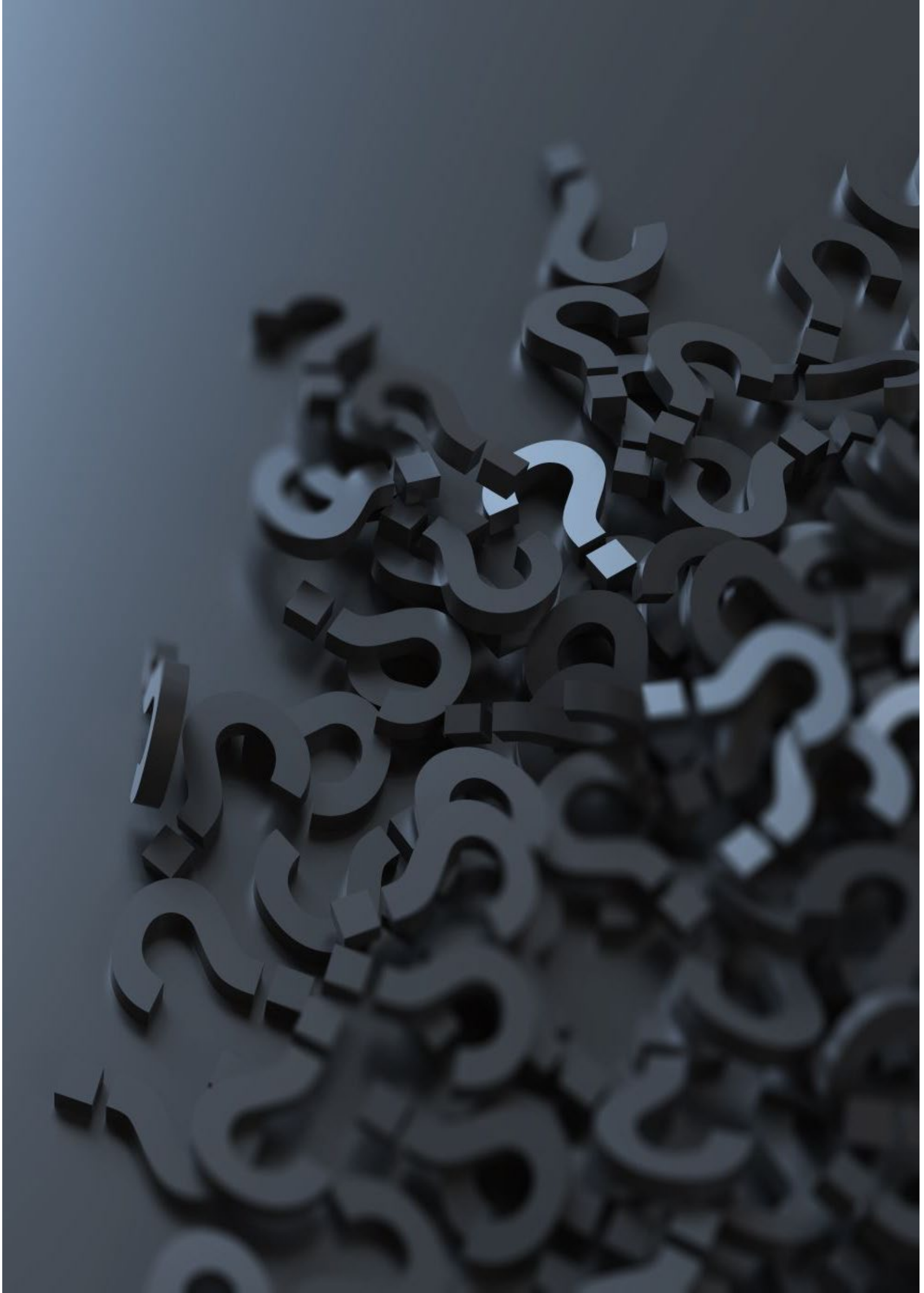

Conclusions

- The higher energy output in faeces and urine in the fresh-cut ryegrass-fed steers indicates inefficient digestion and energy utilization.
- Low-input pasture-based diets reduced methane yield expressed as g per kg of dry matter intake and organic matter intake.
- However, methane yield expressed as g per kg of digestible dry matter intake and digestible organic matter intake was not affected.
- This could indicate that the lower digestibility of pasture-based low-input diet was likely the reason for the lower methane yield.

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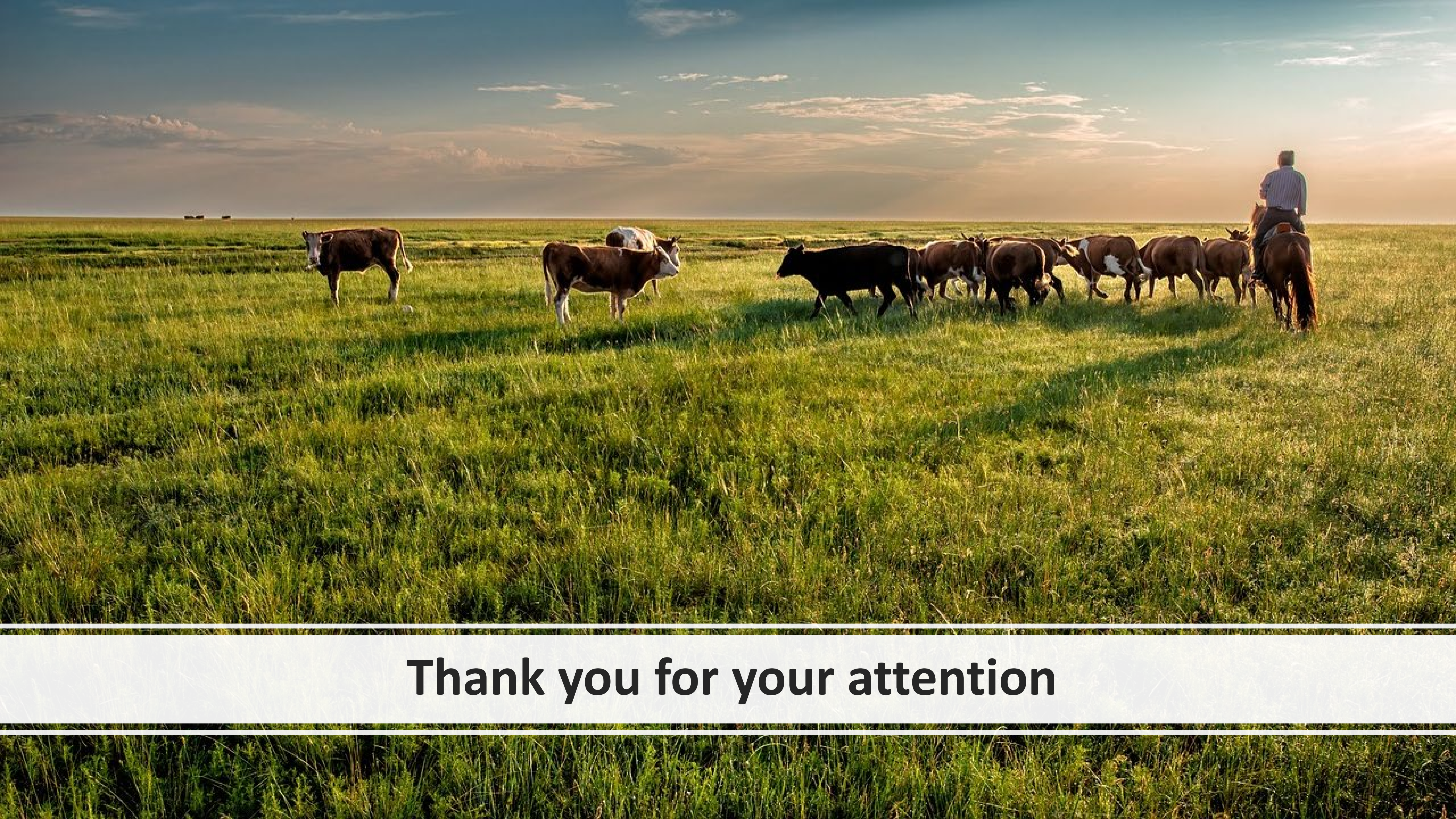

Thank you for your attention