Department of Animal Sciences

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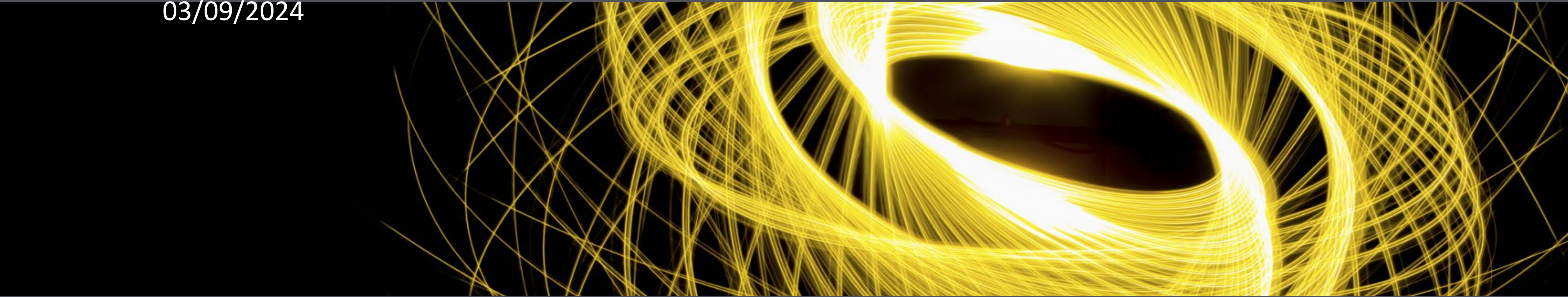
Nitrogen use efficiency from beef fed different protein sources and a forage-based diet

Session 47: Nutrition management to reduce methane emission and environmental impact, Part 2

03/09/2024



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Nitrogen

- Essential element for life and the conservation of biodiversity
- However,
  - Extensive use of N to increase crop and livestock productivity
  - N-cascade phenomenon - Agriculture main contributor (78 %) (Sutton et al., 2011)
  - Excreted N from faeces and urine ($\bar{x}$ = 72 % of N intake)
  - NO_3^- (soil and water eutrophication), NH_3, N_2O (urinary N is a main source from livestock systems)
- Therefore,

  Better nutritional management to improve N use efficiency and reduce N leaches (Calsamiglia et al., 2011; Djikstra et al., 2013)

Calsamiglia et al., 2010. animal 4, 1184-1196.
Dijkstra et al., 2013. animal 7, 292-302.
Sutton et al., 2011. The European Nitrogen Assessment, 1-6.

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Protein sources in ruminant rations

- **Unsustainable** protein sources (Pexas et al., 2023)
- Example is soya (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)

- **Local** alternatives (Wägeli et al., 2015; Pexas et al., 2023)
- **Resource** use efficiency
- Low **inputs**
- Reduce production **cost**
- Maintain or improve **production** and product quality

Kebreab et al., 2016. Journal of Animal Science 94, 2664-2681.
Pexas et al., 2023. Frontiers in Sustainable Food Systems 7.
Tallentire et al., 2018. Journal of Cleaner Production 187, 338-347.
Wägeli et al., 2015. International Journal of Consumer Studies 40, 357-367.

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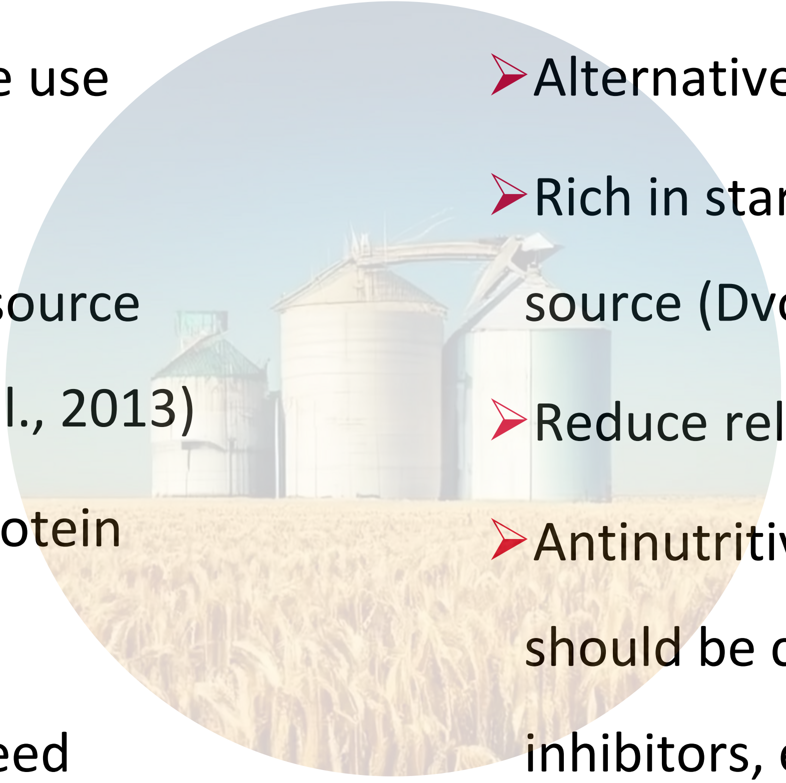

Brewers’ spent grains

- Waste management / Resource use efficiency
- Rich in fibre and good protein source (Santos et al., 2003; del Rio et al., 2013)
- Could be used as alternative protein source
- Reduce reliance on imported feed

Field beans

- Alternative protein source
- Rich in starch content and good protein source (Dvořák et al., 2006)
- Reduce reliance on imported feed
- Antinutritive factors presented that should be considered (i.e., tannins, trypsin inhibitors, etc.) (Dvořák et al., 2006)

del Río et al., 2013. Journal of Cereal Science 58, 248-254.
Dvořák et al., 2006. 7th Middle European Buiatric Congress, Slovenian Veterinary Research, 174-179.
Santos et al., 2003. Food Chemistry 80, 17-21.

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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 this 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
- Nitrogen use efficiency

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Materials and Methods

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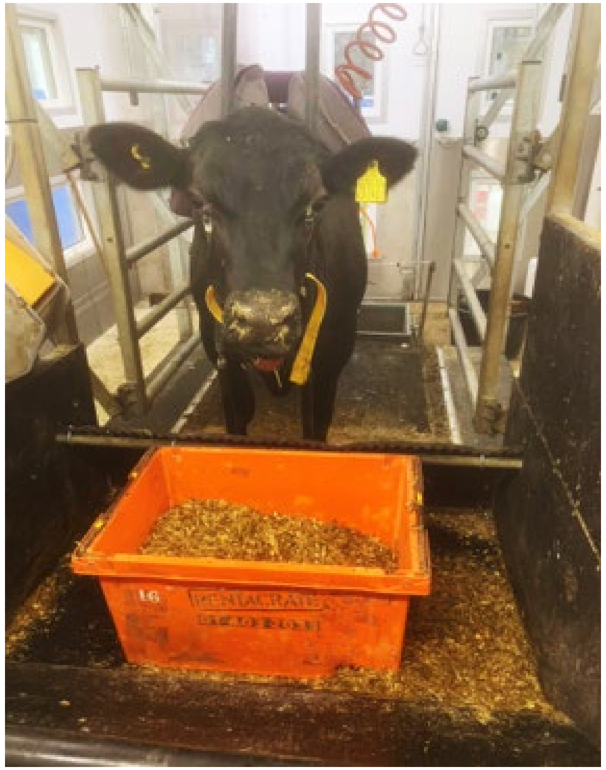
- 4 treatments n = 8 growing beef (4 heifers and 4 steers) per treatment:
  - ✓ TMR including soya as the main protein source (**SB**); 64:36 F:C
  - ✓ TMR including local brewers' spent grains as the main protein source (**BSG**); 64:36 F:C
  - ✓ TMR including local field beans as the main protein source (**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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Item[2]	Dietary treatments[1] 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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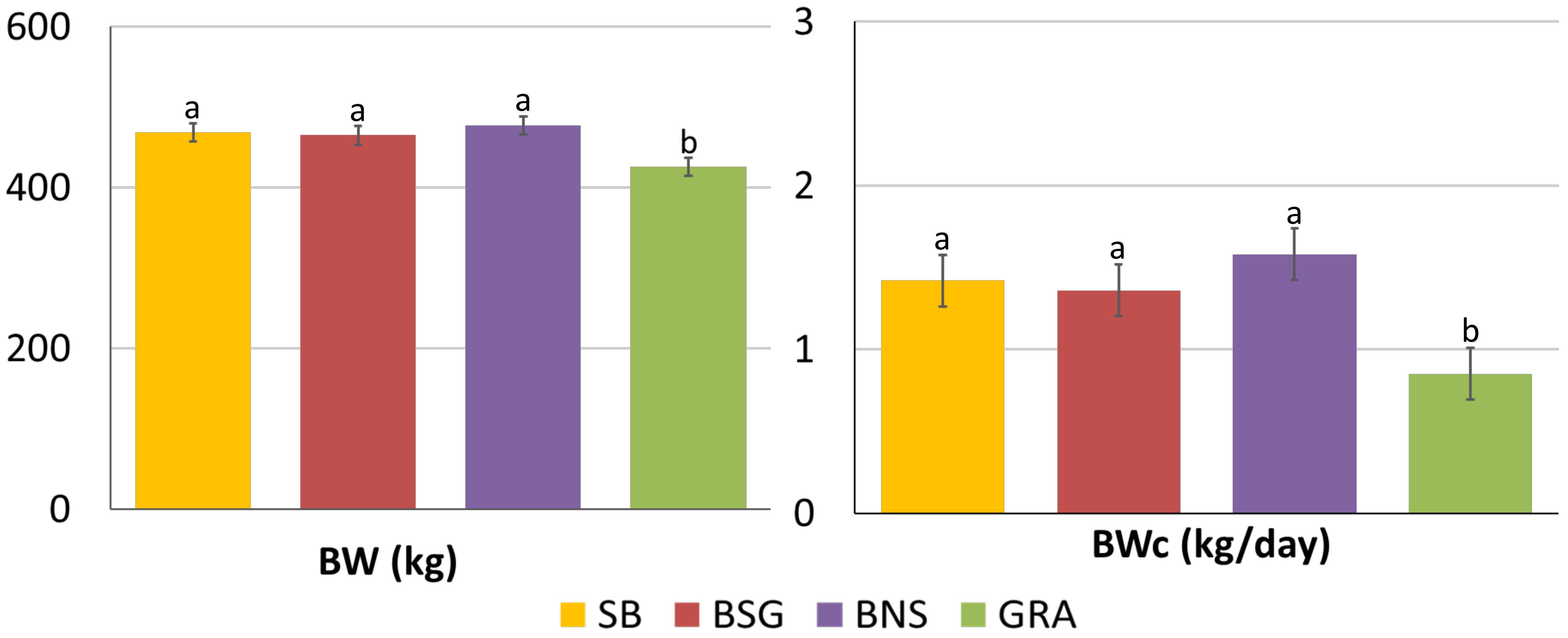

SB = Total mixed ratio (TMR) including soya as the main protein source; BSG = TMR including local brewers' spent grains as the main protein source; BNS = TMR including local field beans as the main protein source; GRA = diet including solely fresh-cut grass; BW = Body weight; BWc = Body weight change.

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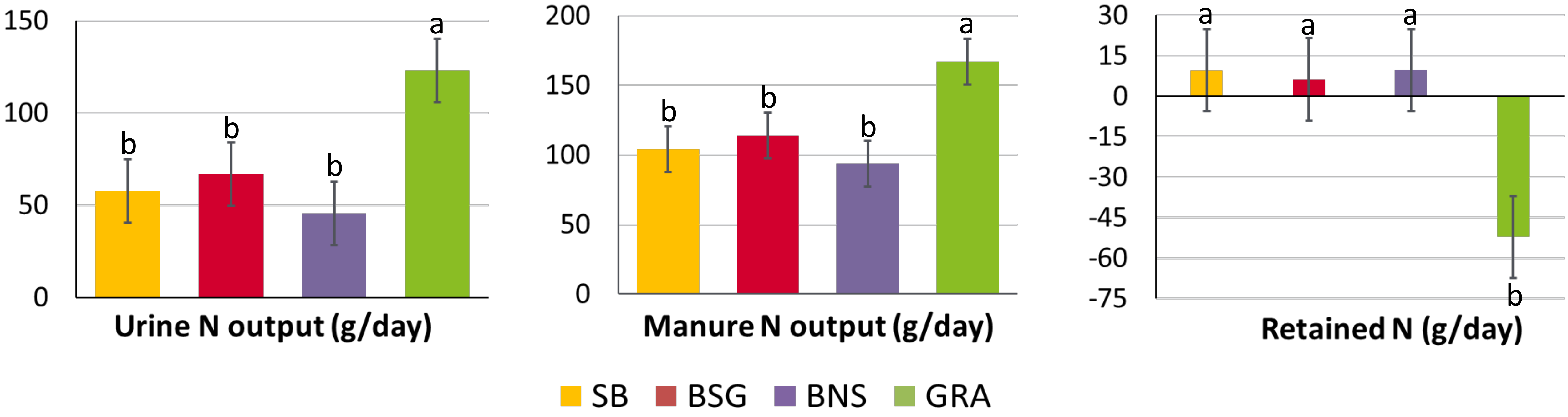
N intake and N outputs

- **NI** (g/day) (SB = 113, BSG = 120, BNS = 105, GRA = 115; g/day; ***P*=0.908**)
- **Faecal N output** (SB = 45.8, BSG = 46.9, BNS = 48.2, GRA = 44.4; g/day; ***P*=0.794**)



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N utilisation

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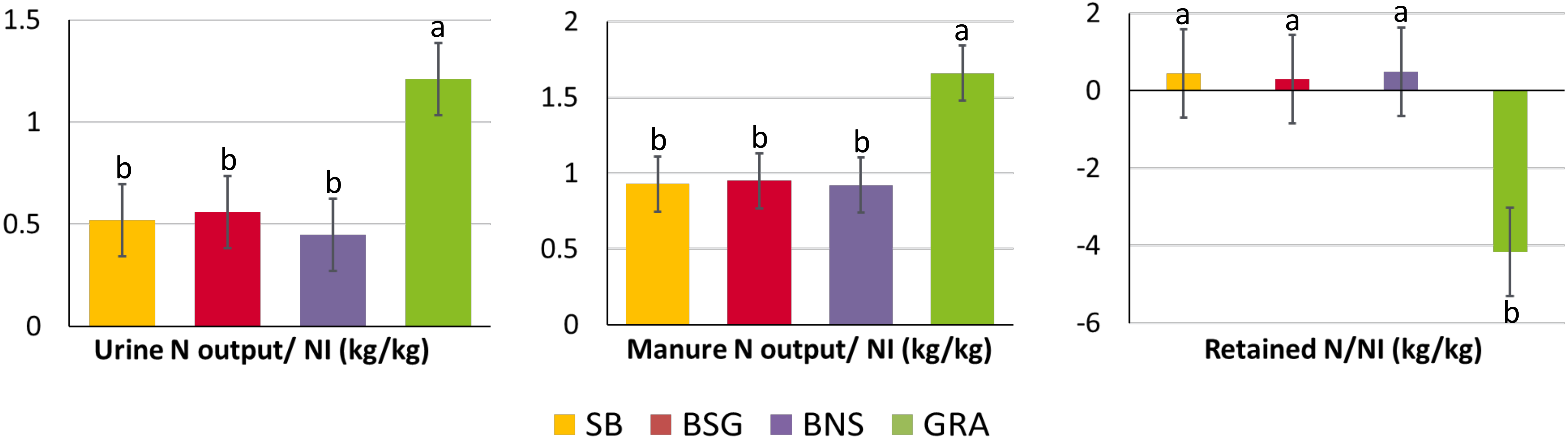

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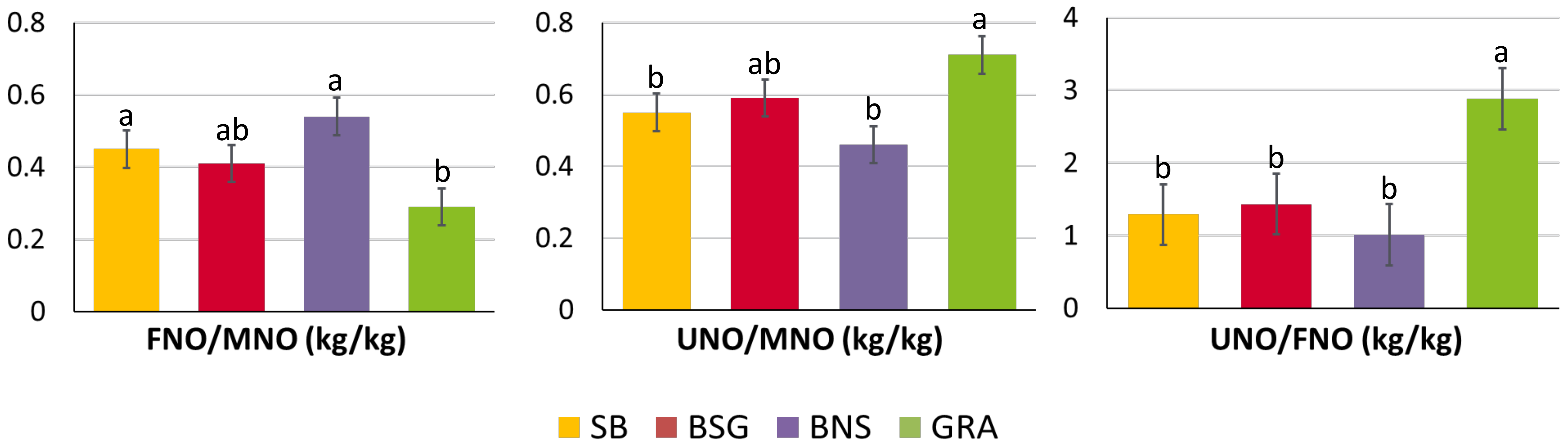
N utilisation



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; FNO = Faecal N output; UNO = Urinary N output; MNO = Manure N output.

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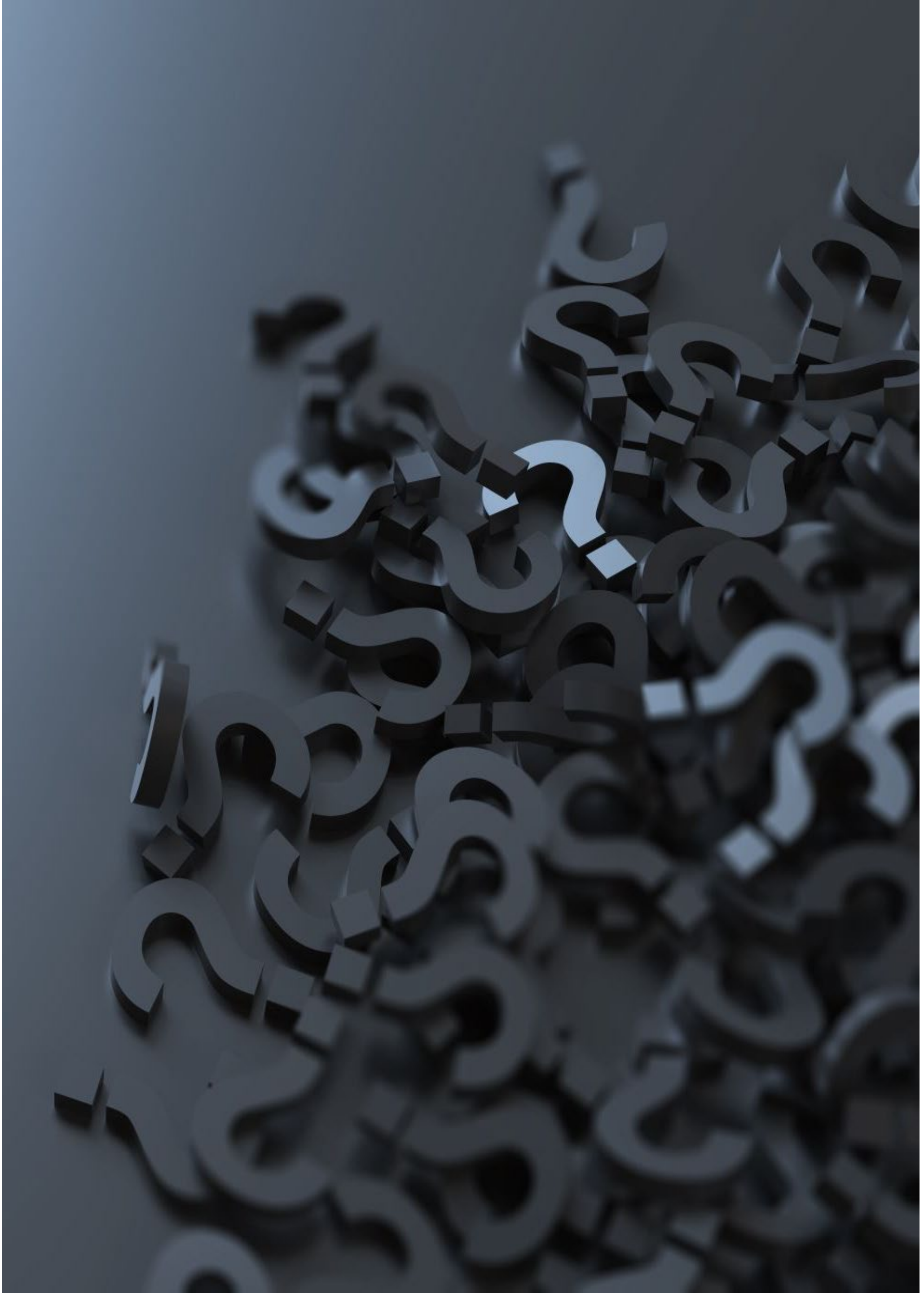

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Conclusions

➢ Replacing soya with local brewers' spent grains and local field beans in growing beef diets did not affect nitrogen intake.

➢ Urinary N output was higher for the low-input pasture-based diet which may be considered environmentally undesirable, given that urinary N is a main source of N_2O emissions from livestock systems.

➢ Consequently, the results of the present study indicate that pasture-based low-input diets could lead to higher N losses and reduced N utilisation than concentrate-based diets.

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Acknowledgments

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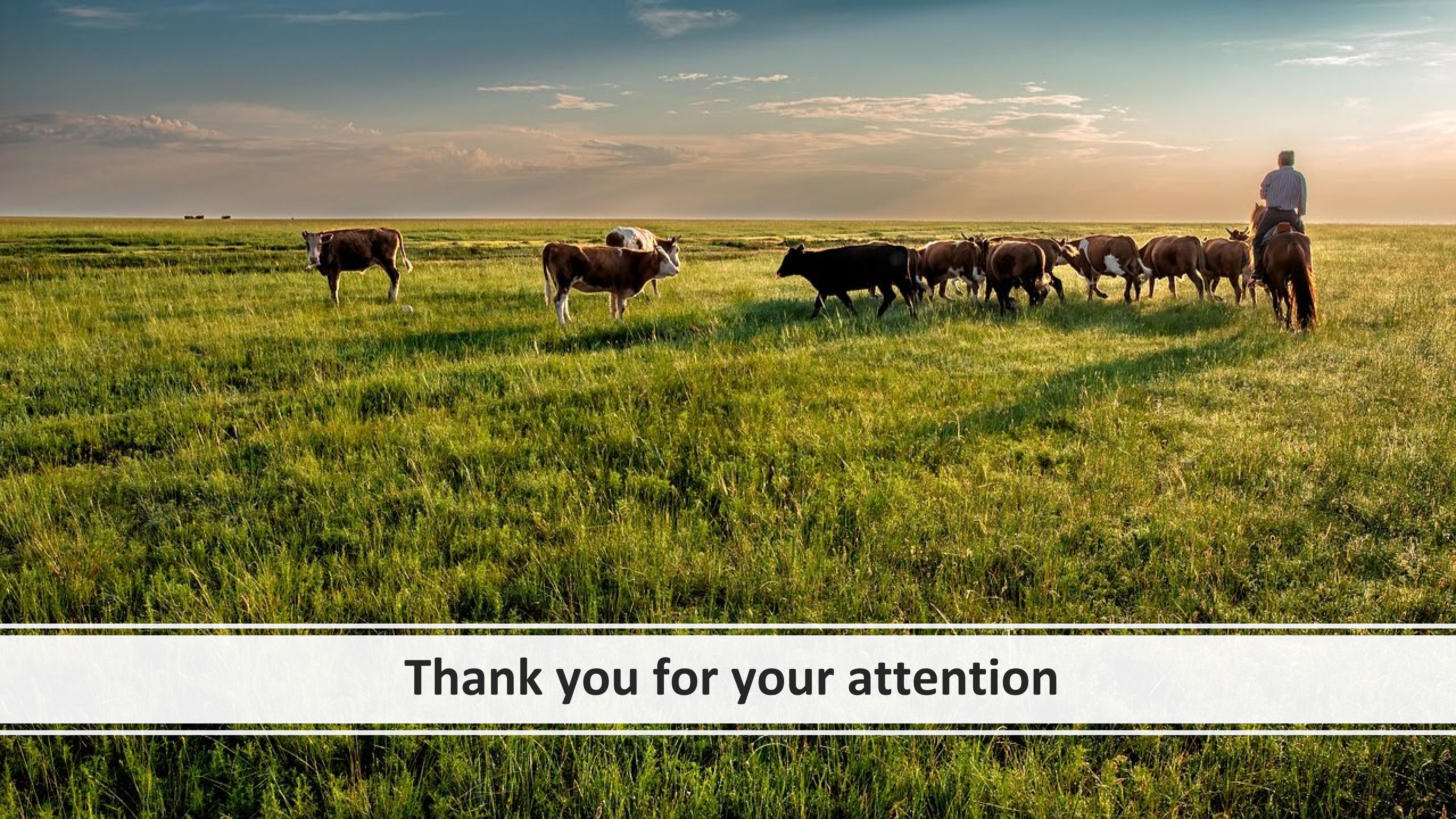
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