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**From the first AI
to technologies
of the future –
what role do
genetics play in
improving
sustainability?**

***British Cattle Breeders
Virtual Conference***

25th January 2022

Source: Dr. Jude L. Capper, 2022

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John Hammond – dinosaur geneticist?!

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Source: Created by Dr. Jude L. Capper, 2022

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Sir John Hammond CBE, FRS PhD Physiologist, veterinarian and pioneer of AI



Source: Created by Dr. Jude L. Capper, 2022

**Father of
modern animal
physiology.
Classic studies
in embryo
survival.**

**Author of first
authoritative
text on AI.**

Founded BCBC.



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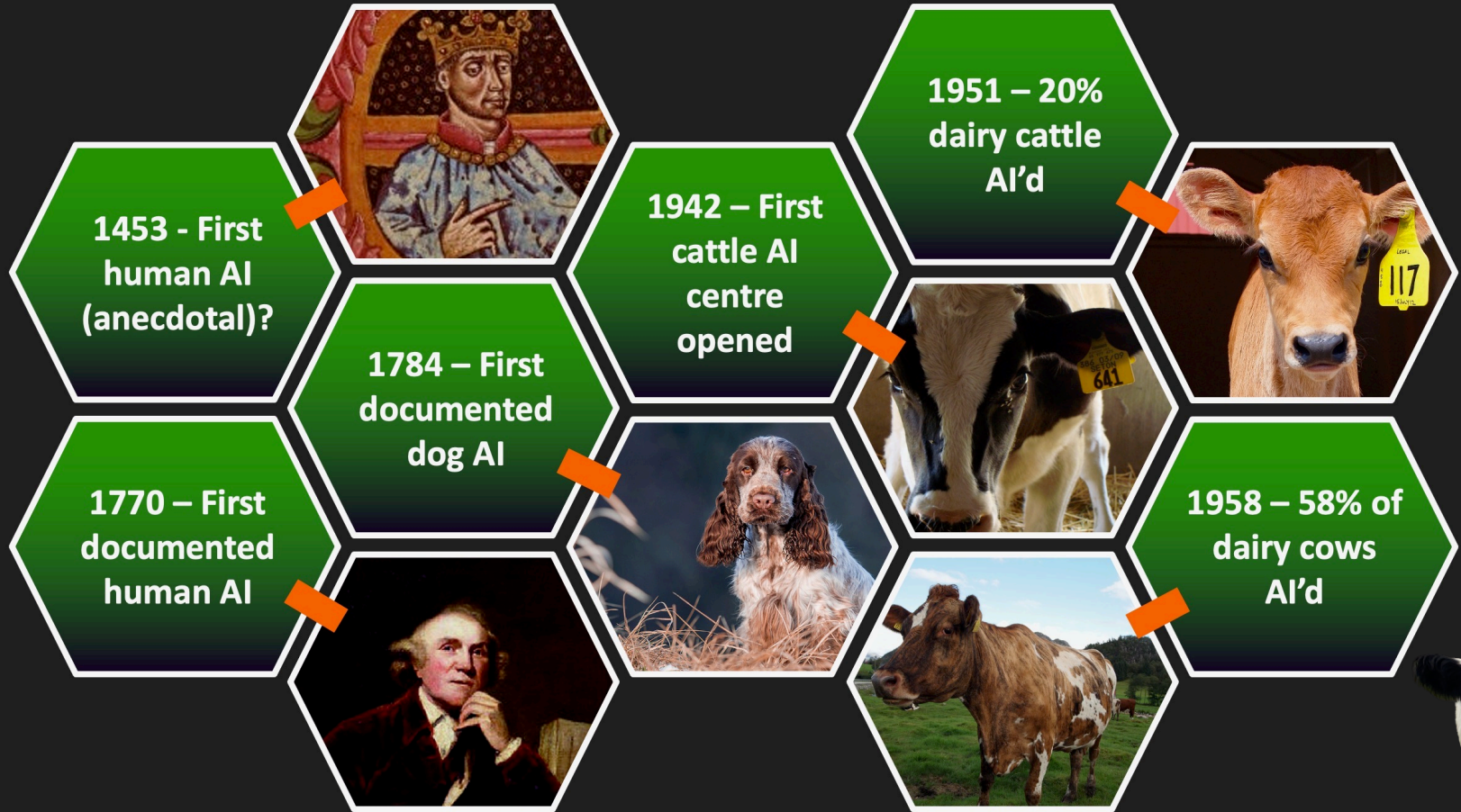


DS

Artificial insemination has a surprisingly long history

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Source: Created by Dr. Jude L. Capper, 2022. Data from: Ombelet and J. Van Robays (2015) *Facts Views Vis. Obgyn.*; and Wilmot (2007) *Stud. Hist. Philos. Biol. Biomed. Sci.* <https://doi.org/10.1016/j.shpsc.2007.03.007>

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Science and technology are often frightening concepts when applied to food

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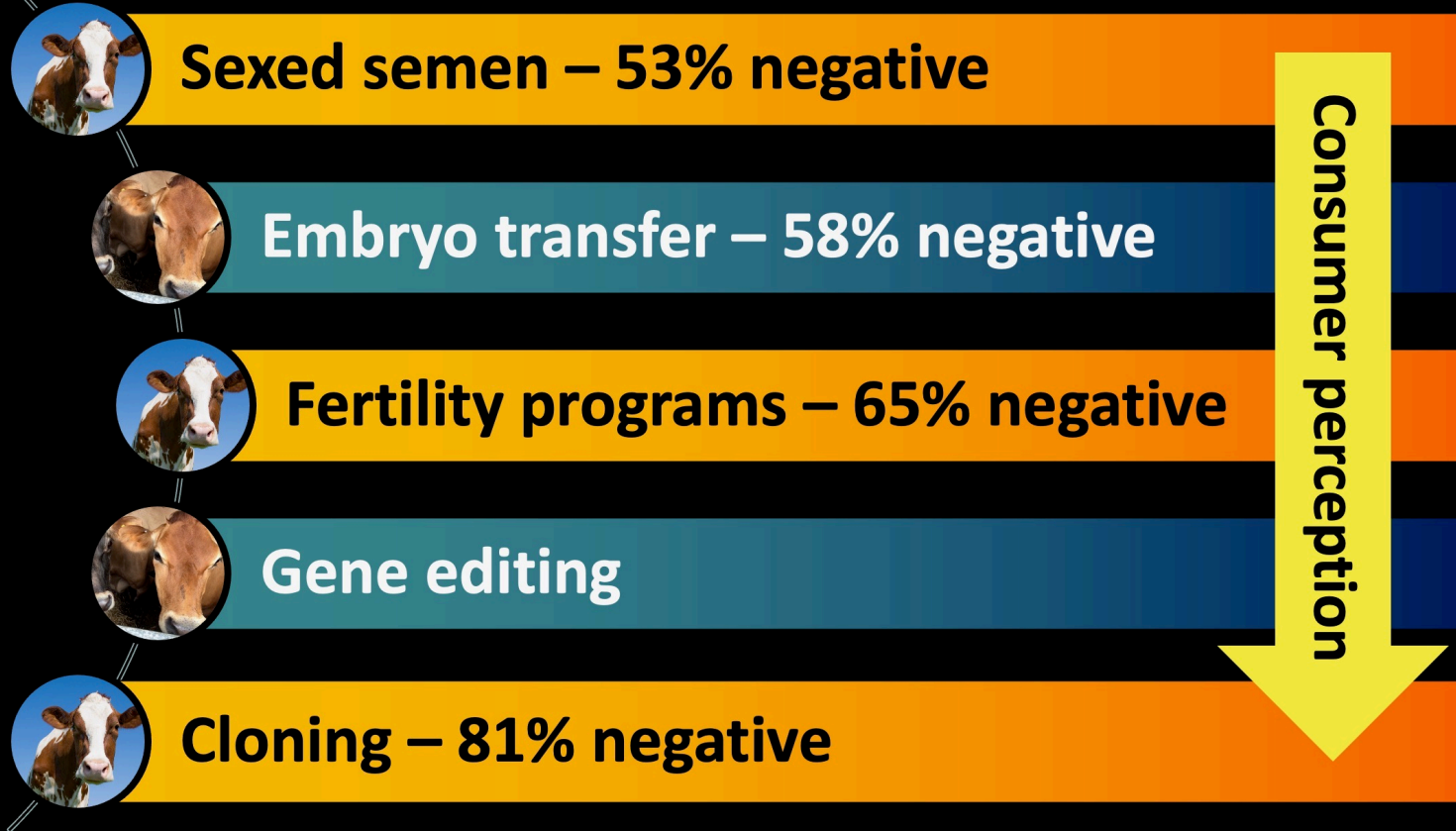
Source: Created by Dr. Jude L. Capper, 2022. Original art "The Farm" by Alexis Rockman.

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Negative consumer perceptions increase in tandem with technological artifice



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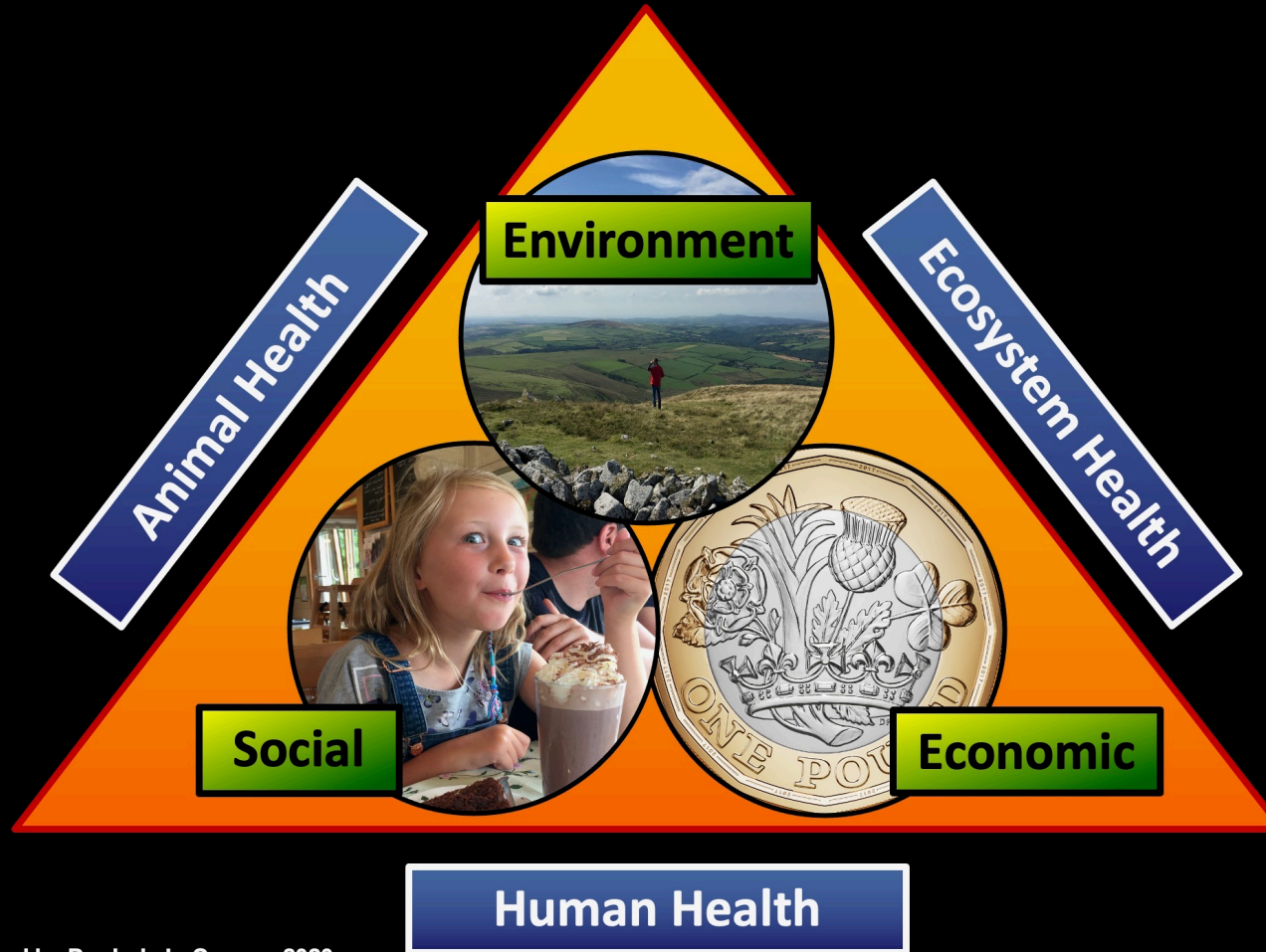
Source: Created by Dr. Jude L. Capper, 2022. Data from survey of 1,646 German consumers published in Pieper et al. (2016). *J. Dairy Sci.*
<https://doi.org/10.3168/jds.2015-10169>

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Sustainability comprises three pillars, all under the umbrella of One Health



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Source: Created by Dr. Jude L. Capper, 2020.

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Sustainability indices will be increasingly present on meat labels in future

Beef (animal-based) patty

Nutritional value*

Serving size: 227 g (8 oz) steak

78%

Pure beef protein
– contains no
lab-based
ingredients!

Sustainability index



Carbon footprint (under GWP*)



Water footprint



Antibiotic footprint



Community support rating



Farm webcam and sustainability assessment data



*compared to ideal protein



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Source: Created by Dr. Jude L. Capper, 2020.

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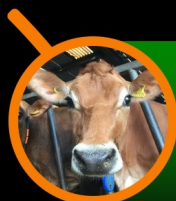
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Improved efficiency has reduced GHG emissions from U.S. livestock production



19% decrease in GHG emissions per litre of ECM between 2007 and 2017



18% decrease in GHG emissions per kg of HCW beef between 1977 and 2007



35% decrease in GHG emissions per kg of pork between 1959 and 2009



63% decrease in GHG emissions per ton of eggs between 1960 and 2010

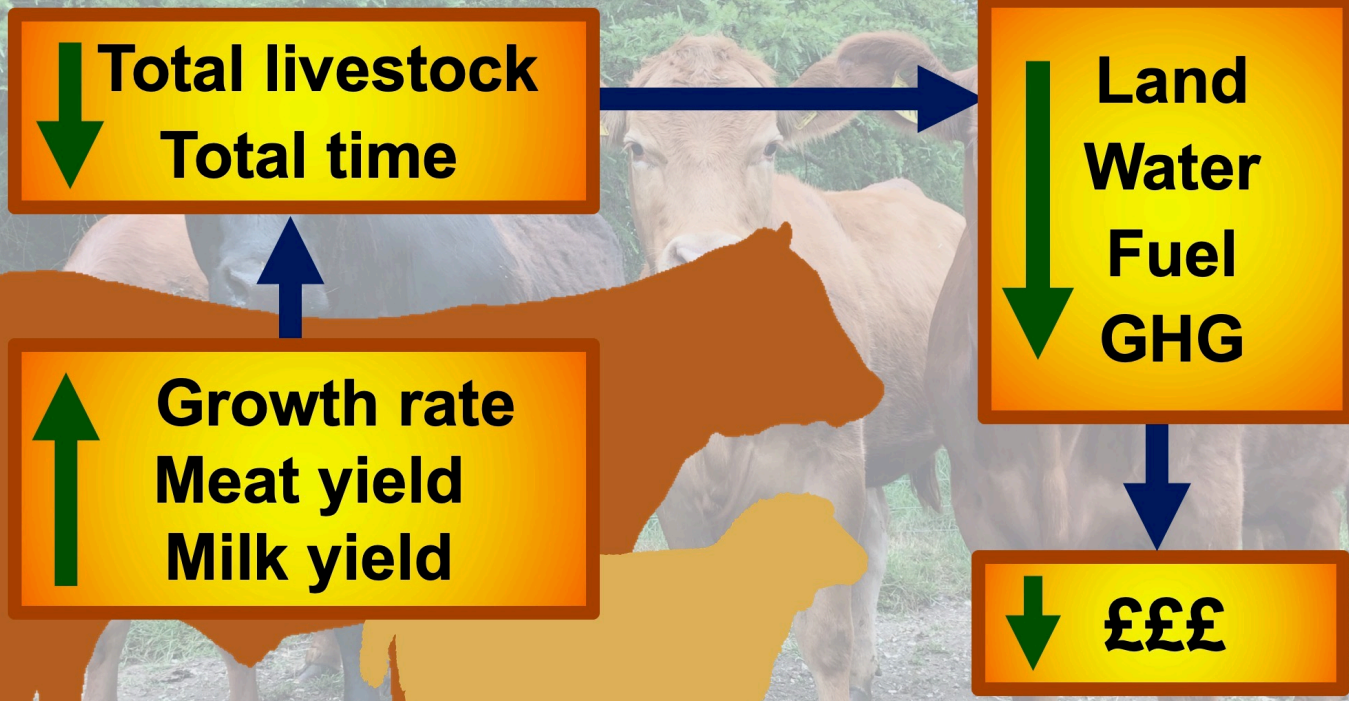
Source: Created by Dr. Jude L. Capper, 2020. Data from: Capper and Cady (2019) The effects of improved performance in the U.S. dairy cattle industry on environmental impacts between 2007 and 2017. *J. Anim. Sci.* and Capper (2011). The environmental impact of U.S. beef production: 1977 compared with 2007. *J. Anim. Sci.* and Cady et al. (2013) A 50-year comparison of the environmental impact and resource use of the US swine herd: 1959 vs. 2009. ADSA-ASAS Annual Meeting, 2013, Indianapolis, IN and Pelletier et al. (2014) Comparison of the environmental footprint of the egg industry in the United States in 1960 and 2010. *Poult. Sci.*



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Improving animal productivity reduces the environmental impact of milk and meat



Source: Created by Dr. Jude L. Capper, 2020. Data from: Capper, JL. 2015. Sustainability and One Health. In: Cockcroft, P. *Bovine Medicine*. Wiley-Blackwell, Oxford, UK.

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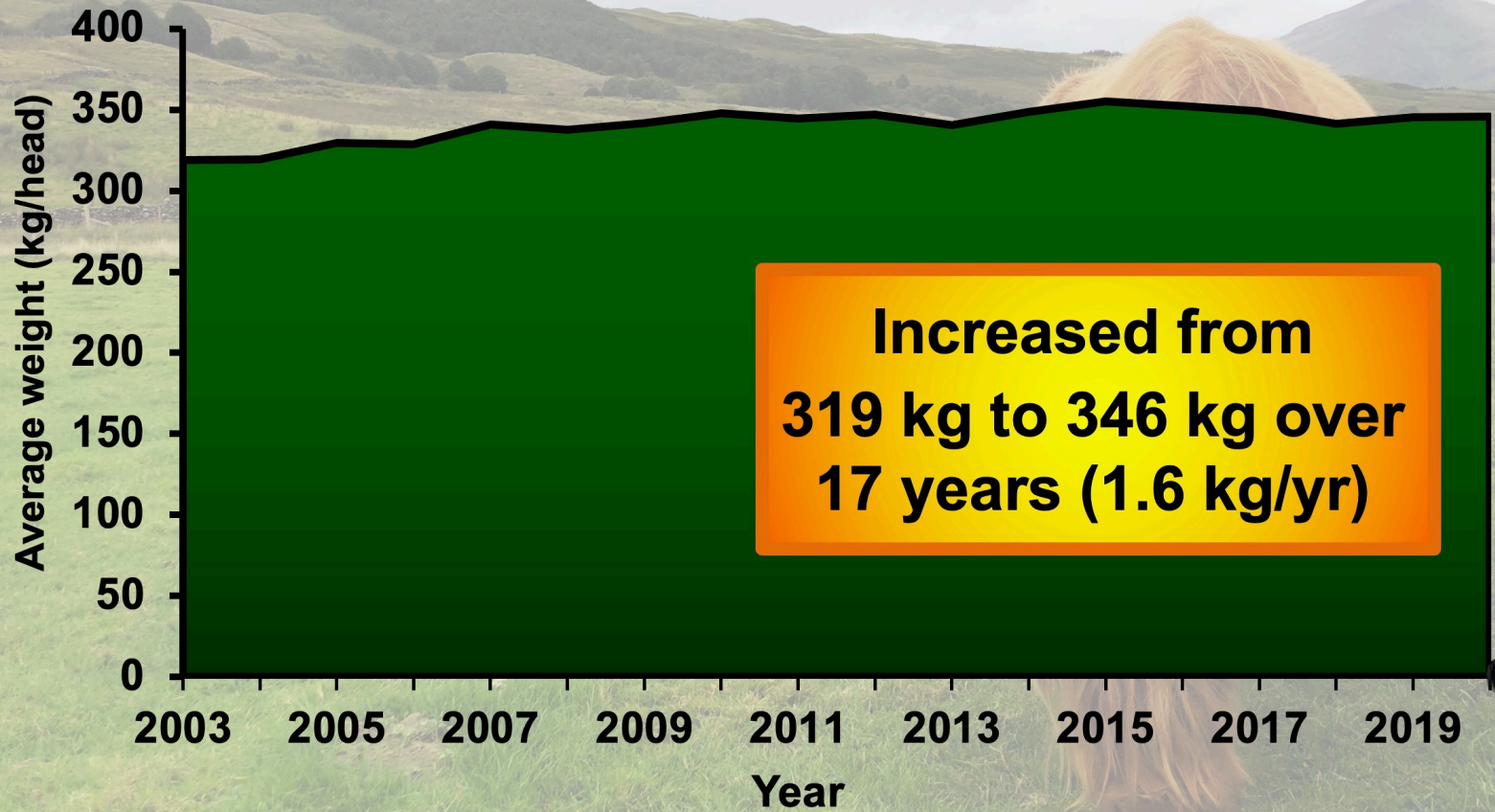


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UK prime cattle carcass weights haven't changed significantly over 20 years



Increased from 319 kg to 346 kg over 17 years (1.6 kg/yr)

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Source: Created by Dr. Jude L. Capper, 2022; Data from Statista.com (2022) <https://www.statista.com/statistics/298332/carcase-weight-of-slaughtered-prime-cattle-in-the-united-kingdom-uk/>

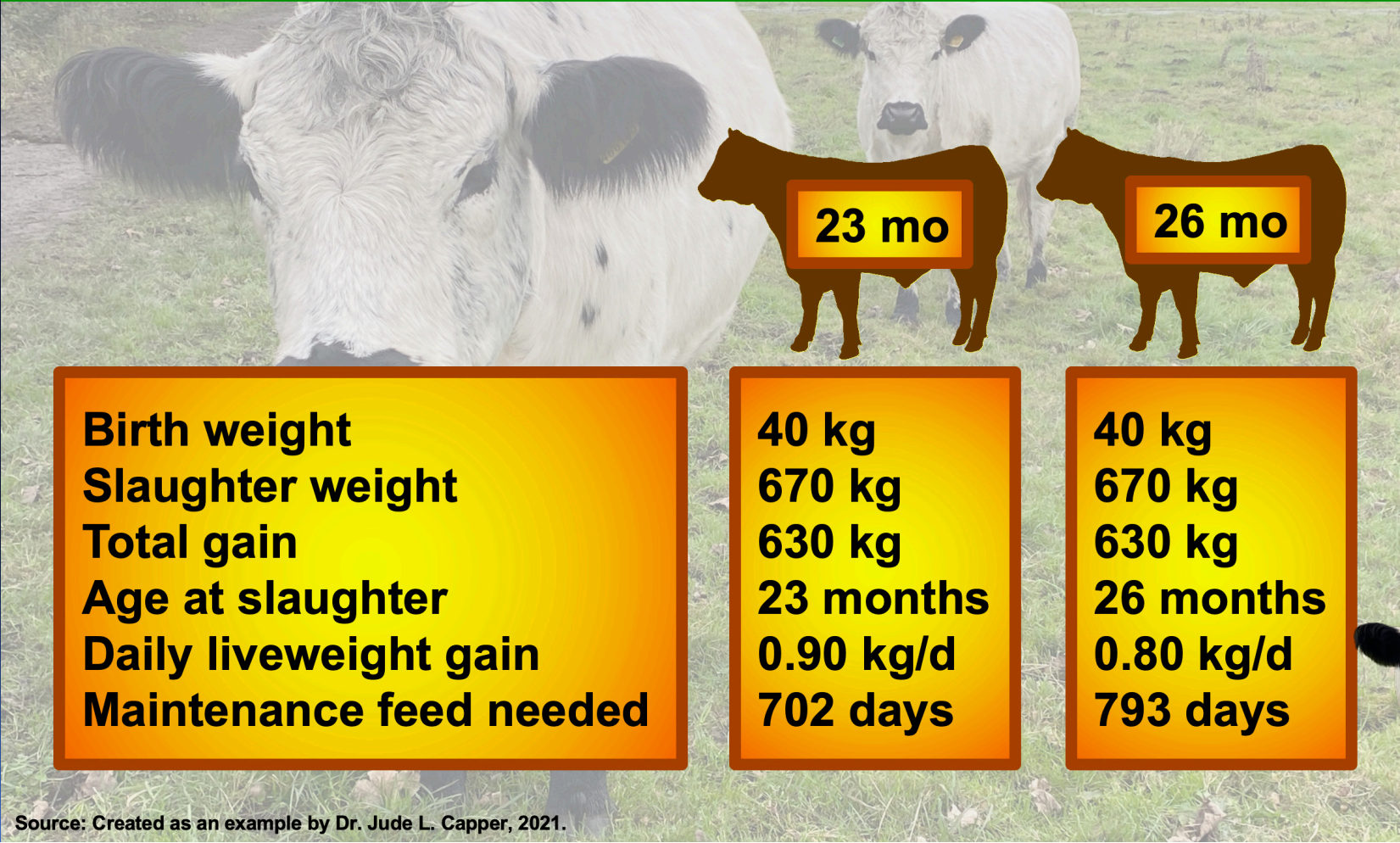
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Reducing age at slaughter has both economic and environmental benefits



Source: Created as an example by Dr. Jude L. Capper, 2021.

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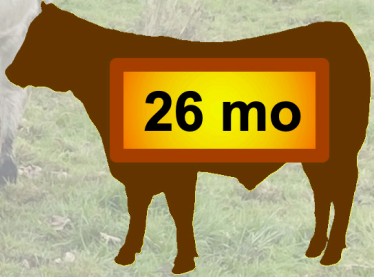
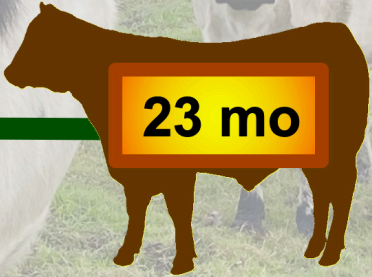
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Reducing age at slaughter has both economic and environmental benefits

91 fewer days of feed, land and greenhouse gases. Opportunity cost?



Birth weight
Slaughter weight
Total gain
Age at slaughter
Daily liveweight gain
Maintenance feed needed

40 kg
670 kg
630 kg
23 months
0.90 kg/d
702 days

40 kg
670 kg
630 kg
26 months
0.80 kg/d
793 days

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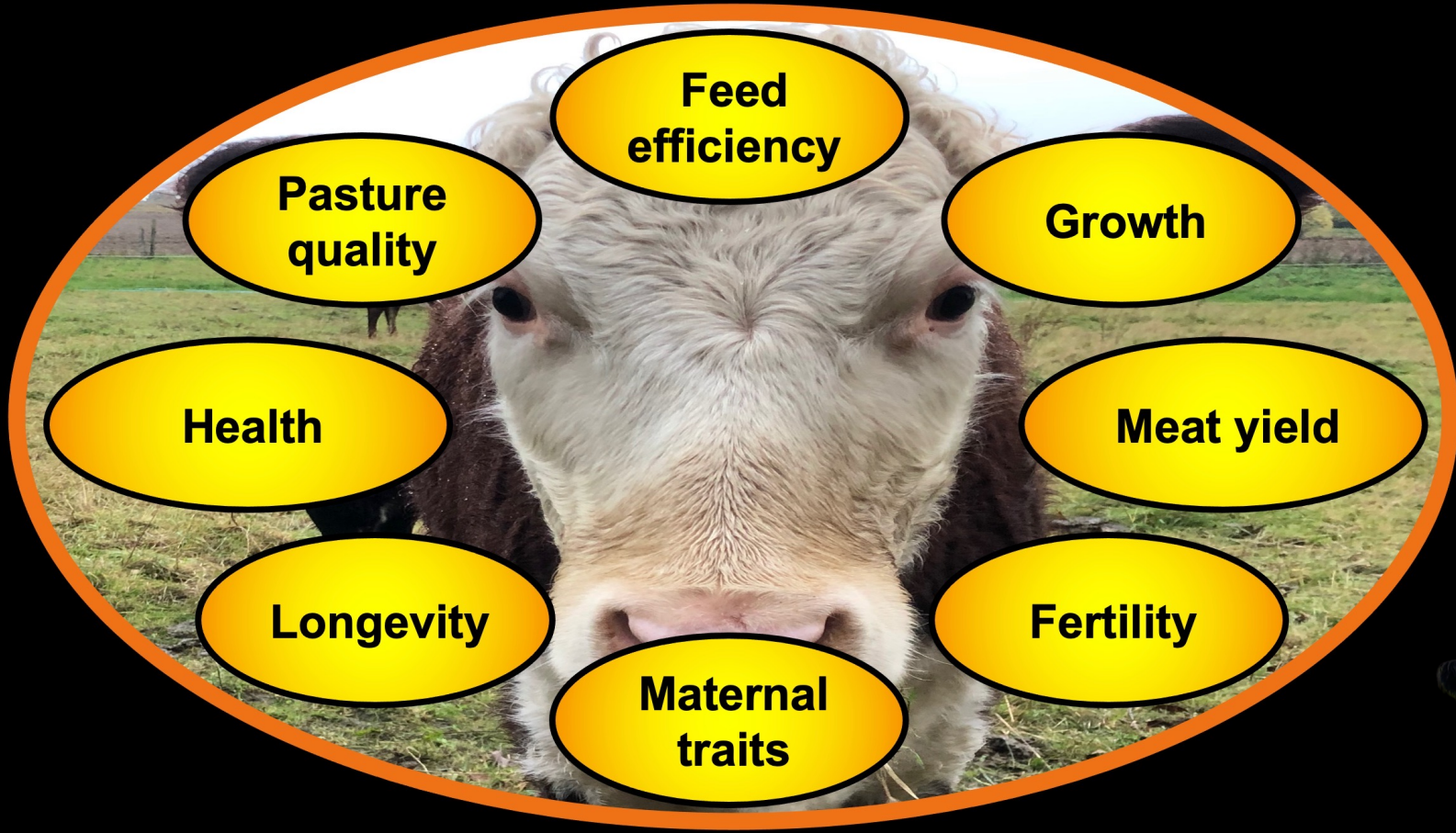
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Source: Created as an example by Dr. Jude L. Capper, 2021.

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Doing everything better on-farm improves economic and environmental sustainability



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Source: Created by Dr. Jude L. Capper, 2021

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Is there a definitively sustainable breed?



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Source: Created by Dr. Jude L. Capper, 2022.

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Has choosing dairy become a controversial issue?

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“The dairy industry is more cruel and horrible than the meat industry... dairy is truly a pleasure and I really feel guilty.”

Victoria Coren Mitchell

Source: Created by Dr. Jude L. Capper, 2019.
Screenshot from Apple Podcasts app, photo from:
<https://www.radiotimes.com/>

OFF MENU



0:02

- 1:16:25

Ep 17: Victoria Coren Mitchell
Off Menu with Ed Gamble and James A

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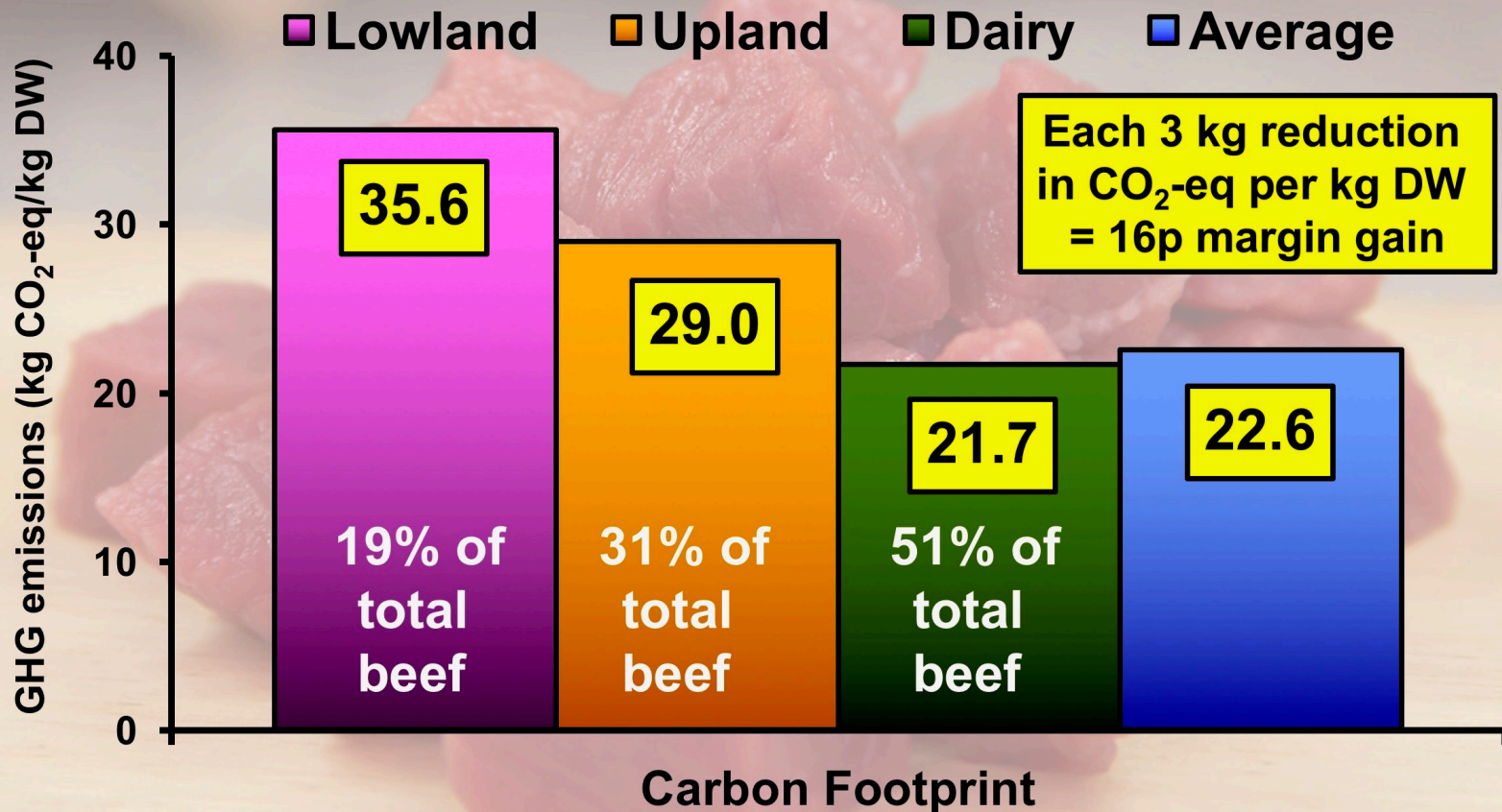


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English beef's carbon footprint shows significant system variation



Source: Created by Dr. Jude L. Capper, 2016; data from 131 beef units and 57 sheep units analyzed by E-CO₂ and reported in: EBLEX (2009) Testing the Water – The Beef and Sheep Roadmap – Phase Three. AHDB, Stoneleigh, UK and EBLEX (2009) Change in the Air – The Beef and Sheep Roadmap – Phase One. AHDB, Stoneleigh, UK.

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GHG benefits of dairy-beef now recognized – sucklers will need to demonstrate benefits

Annual requirements of one suckler cow:

- 3,954 kg feed DM
- 20,047 litres water
- 2,459 kg CO₂

Need to justify these impacts vs. beef from dairy.

Source: Created by Dr. Jude L. Capper, 2021. Calculation based on feed and water requirements of one Angus cow weighing 544 kg producing 7.8 kg of milk per day, with calf weaned at 207 days of age.



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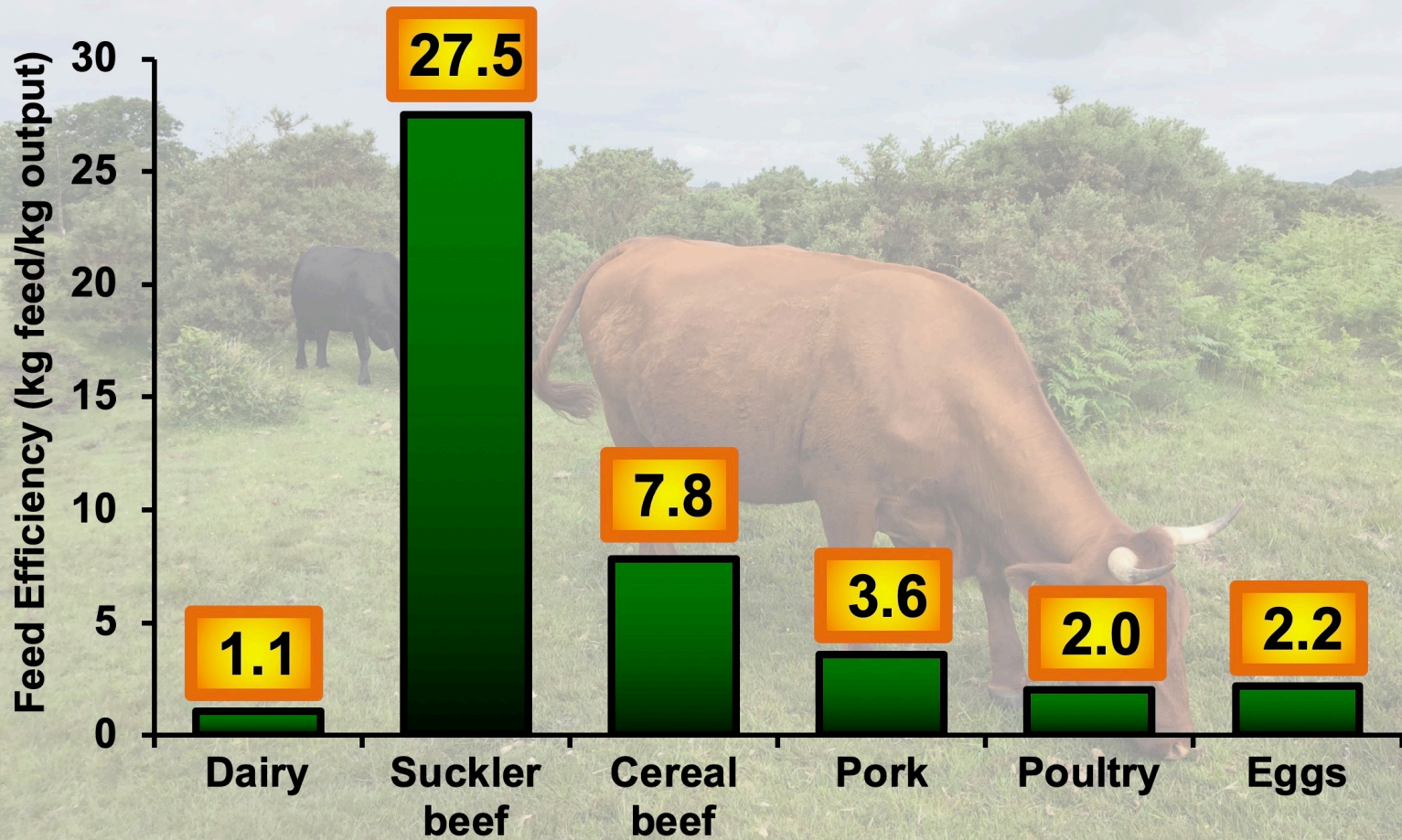
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Feed efficiency ratios vary between systems and species



Source: Created by Dr. Jude L. Capper, 2020; data from Wilkinson (2011) Re-defining efficiency of feed use by livestock. *Animal*.

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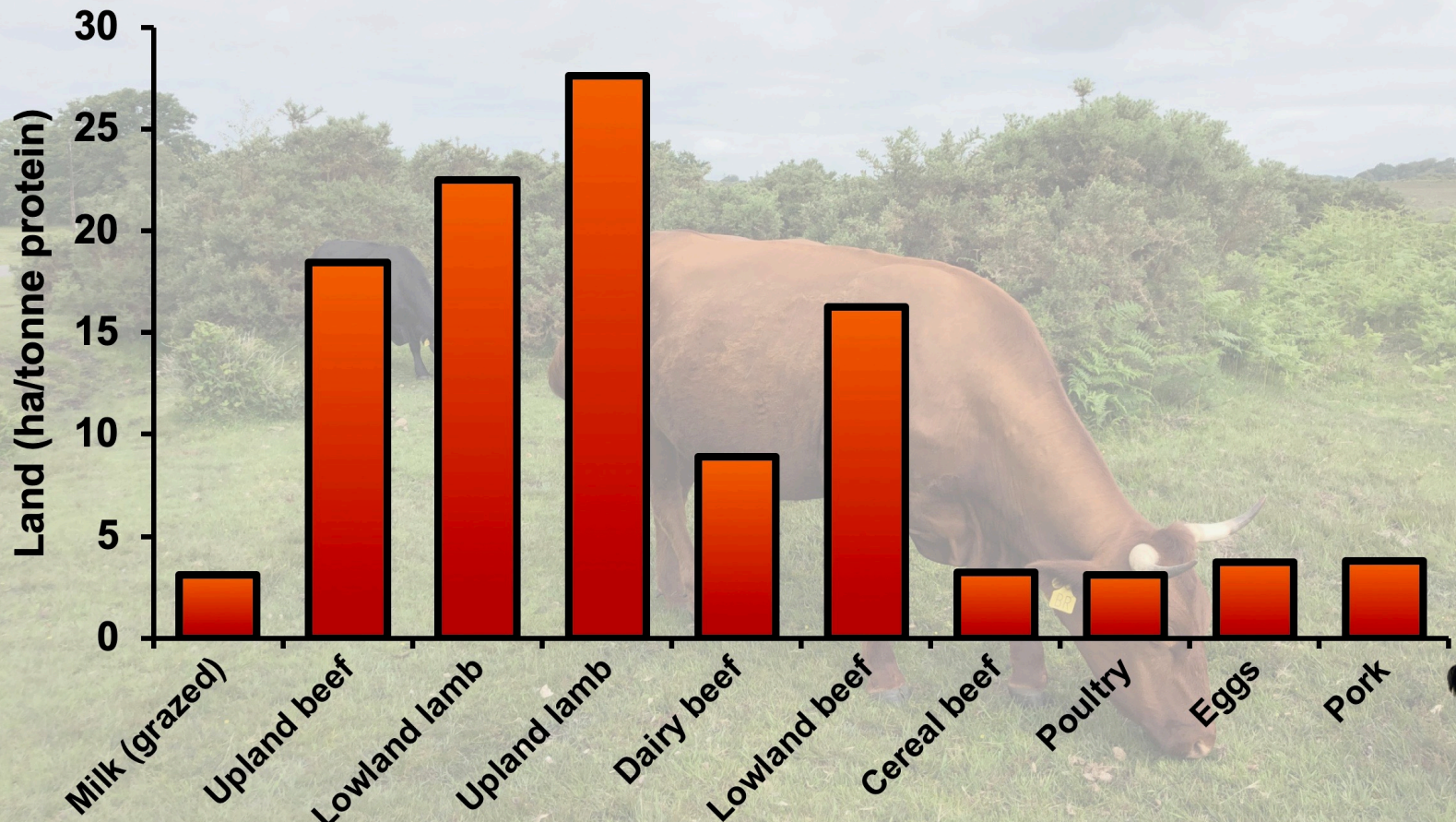
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Livestock systems vary widely in land use



Source: Created by Dr. Jude L. Capper, 2020; data from Wilkinson and Lee (2018) Review: Use of human-edible animal feeds by ruminant livestock. *Animal*.

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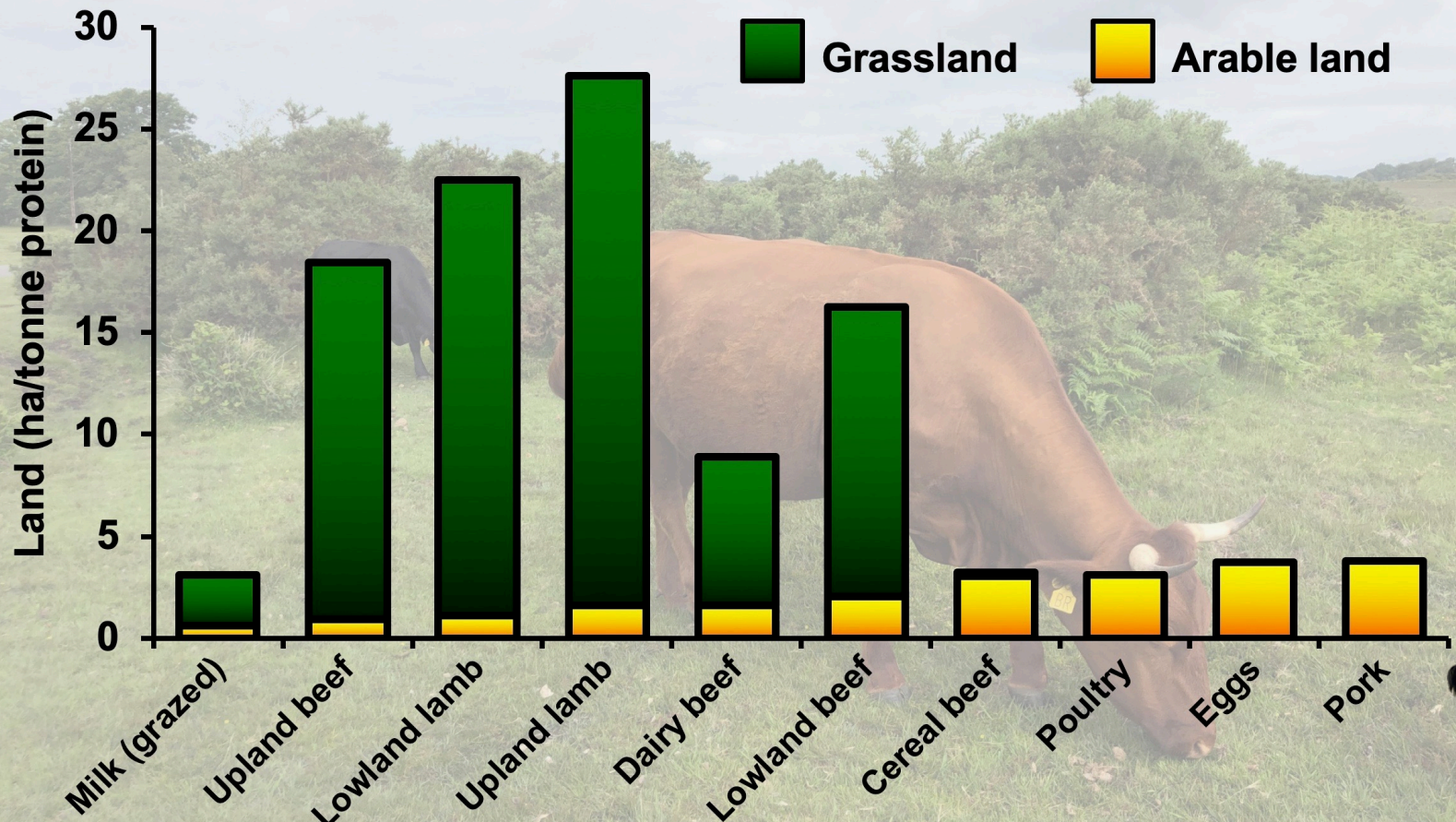
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Livestock systems vary widely in arable and grassland use



Source: Created by Dr. Jude L. Capper, 2020; data from Wilkinson and Lee (2018) Review: Use of human-edible animal feeds by ruminant livestock. *Animal*.

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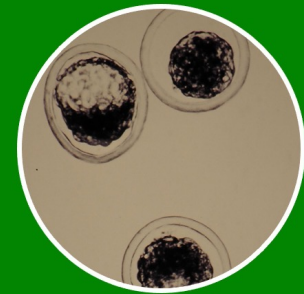


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Moving sustainable genetics forwards



**Appropriate
breeding
goals**



**Technology
adoption**



**Supply
chain
feedback**



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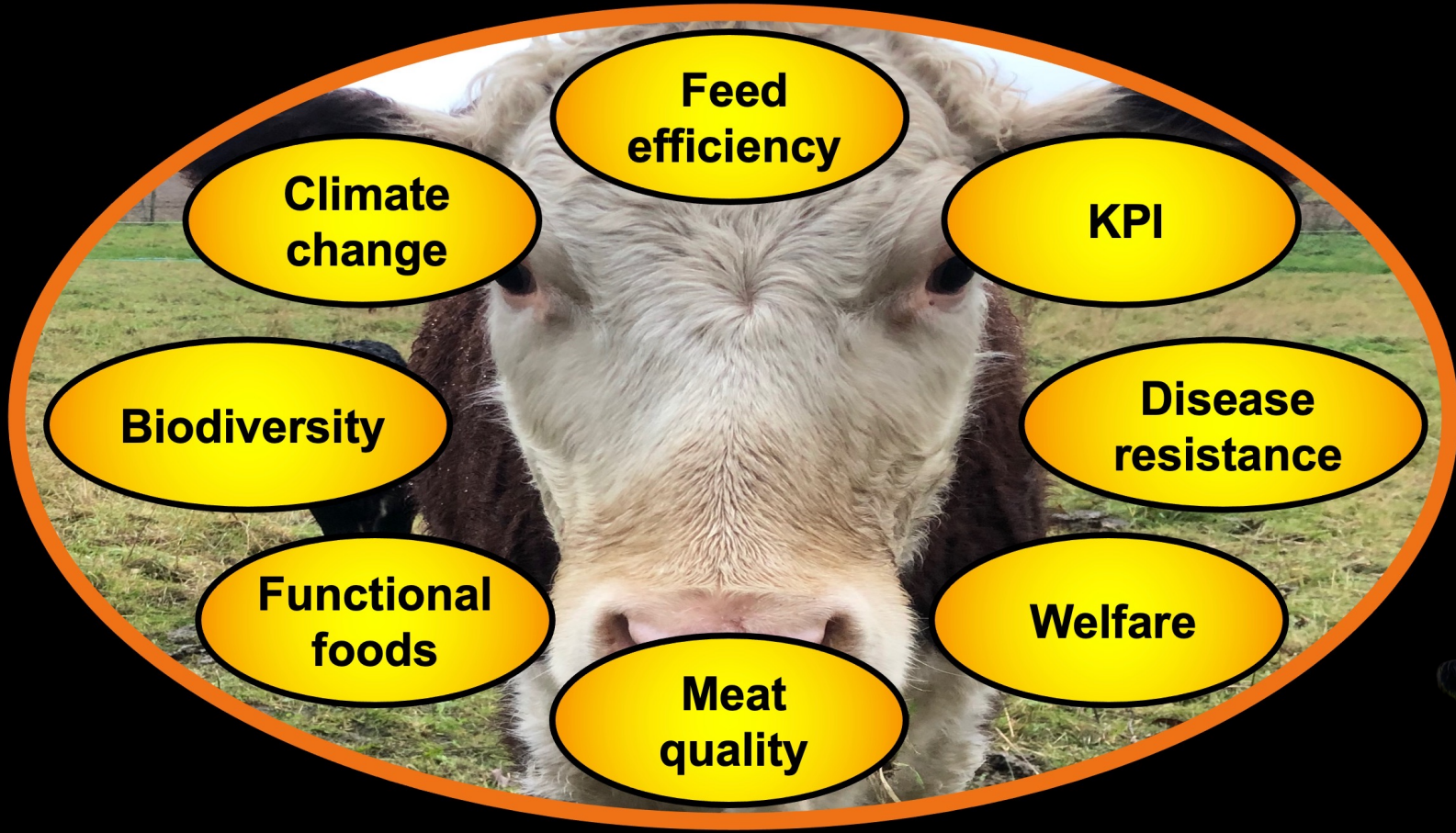
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Sustainable breeding must consider current and future needs



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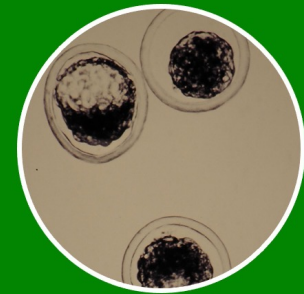


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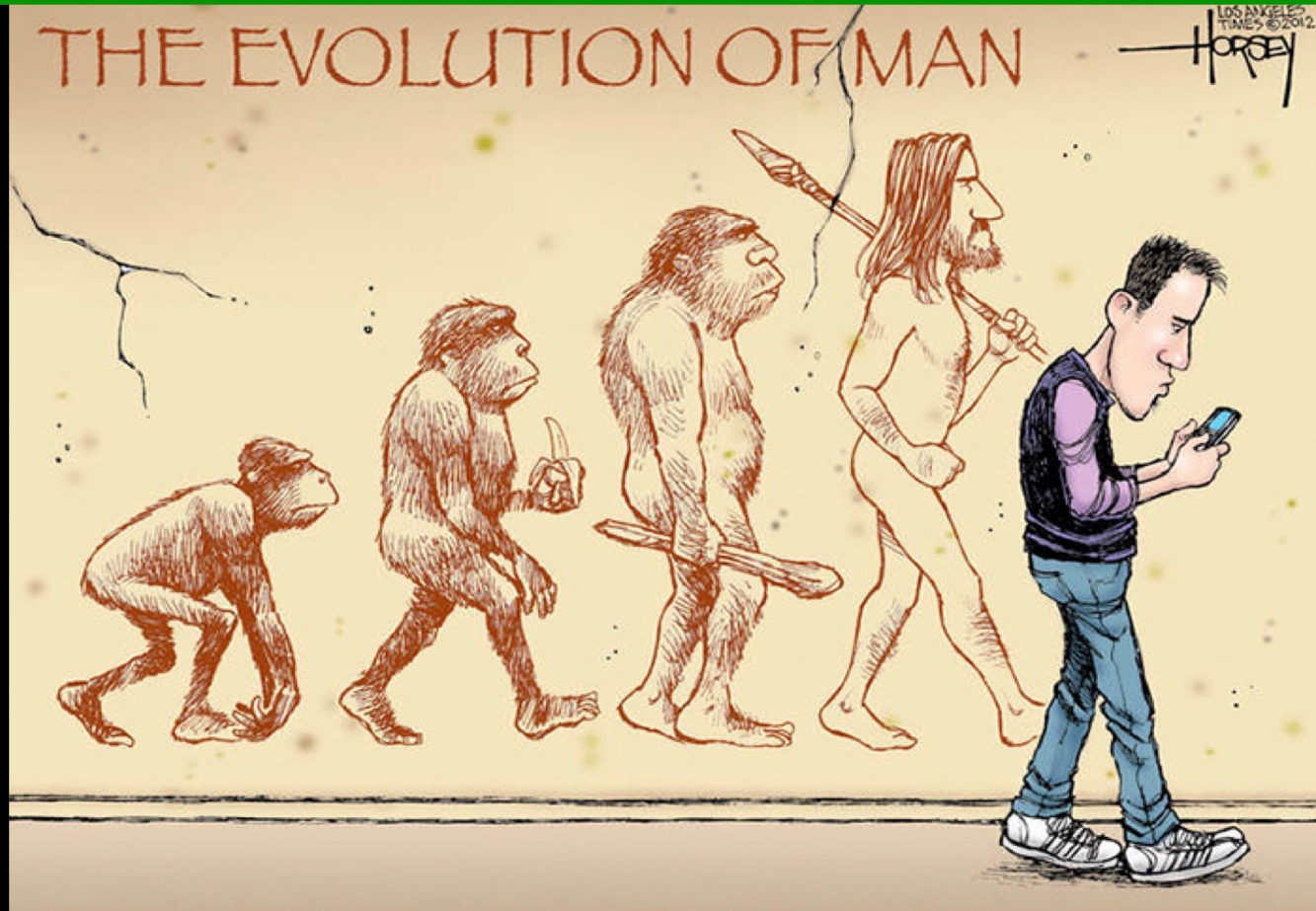
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Source: Created by Dr. Jude L. Capper, 2022.

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How have we changed over time?



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Source: Created by Dr. Jude L. Capper, 2019. Cartoon from: https://static.boredpanda.com/blog/wp-content/uploads/2016/02/funny-satirical-evolution-charles-darwin-day-251_700.jpg

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Reproductive interventions must be economically and environmentally sustainable

Improving maternal trait genetics via AI over 20 yrs

95 - 2,009 kg CO₂ reduction in GHG emissions per cow

Decreased mature weight and calving interval

£47-344 improved economics per cow calving

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Source: Created by Dr. Jude L. Capper, 2022. Data from Quinton et al. (2018) Predicted economic and greenhouse gas benefits from using improved maternal genetics in UK beef cattle. Proceedings of the World Congress on Genetics Applied to Livestock Production, 11.364

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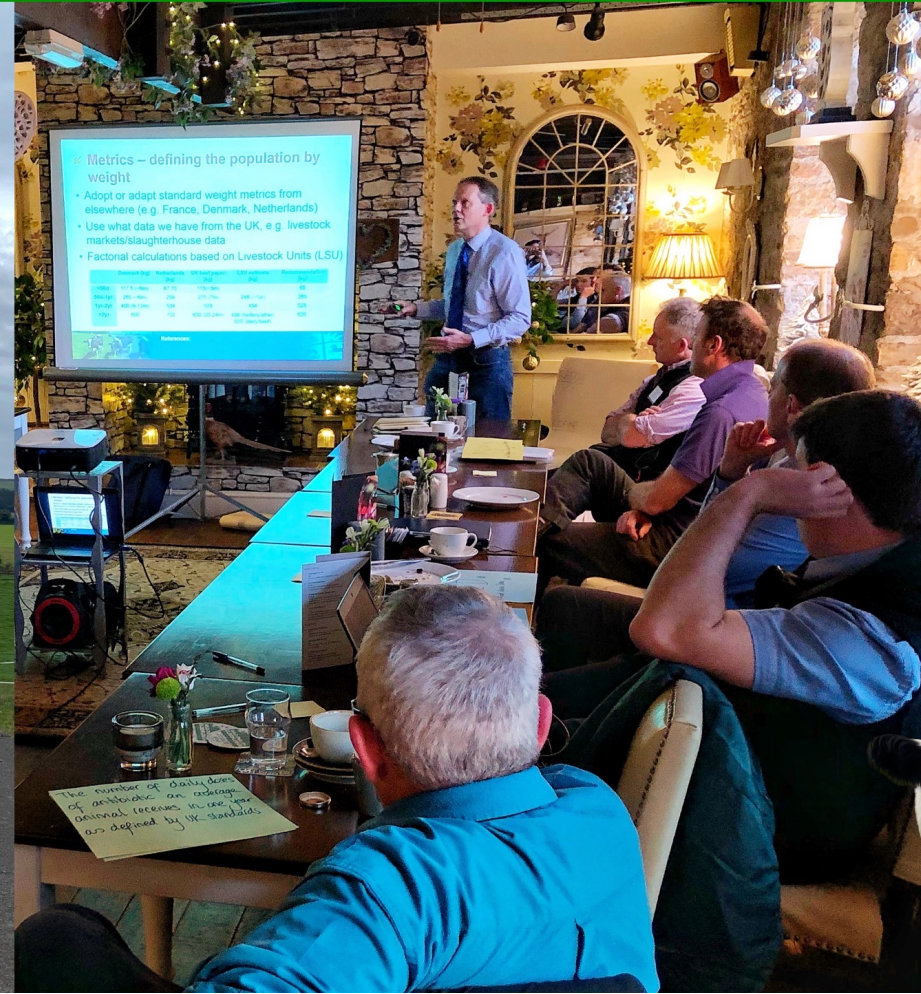
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Peer-to-peer learning, discussion groups and farmer incentives aid behavioural change

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Source: Created by Dr. Jude L. Capper, 2021.



Metrics - defining the population by weight

- Adopt or adapt standard weight metrics from elsewhere (e.g. France, Denmark, Netherlands)
- Use what data we have from the UK, e.g. livestock markets/slaughterhouse data
- Factorial calculations based on Livestock Units (LSU)

Species	Weight (kg)	LSU
Sheep	45	1.0
Cattle	450	10.0
Pigs	250	5.0
Hens	4.5	0.1

The number of animals of a certain breed or variety of animal reared in the year as defined by the standards.

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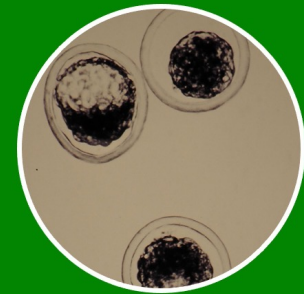


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Retailers face challenge of meeting net zero commitments

50% reduction in food-related GHG emissions by 2030 is possible, but only if we take

URGENT ACTION

wrap.org.uk/GHGPathway



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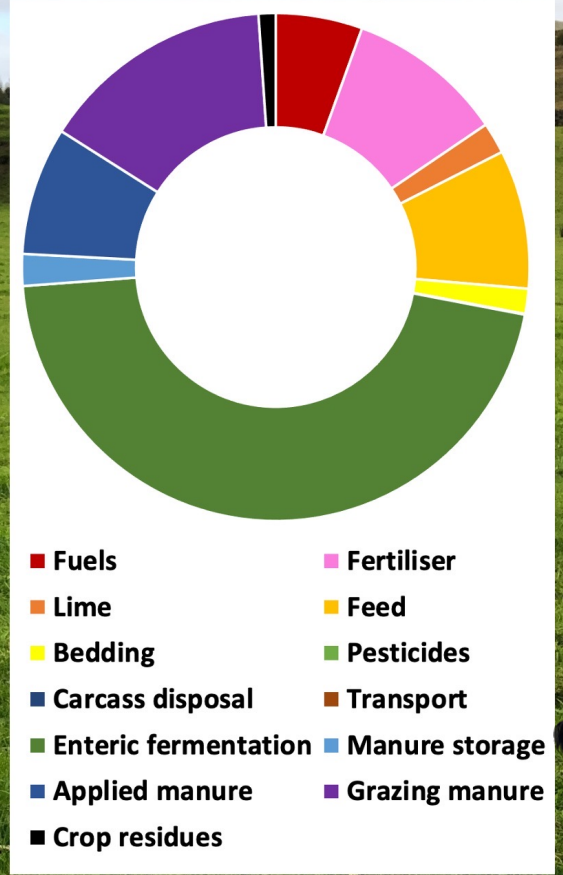
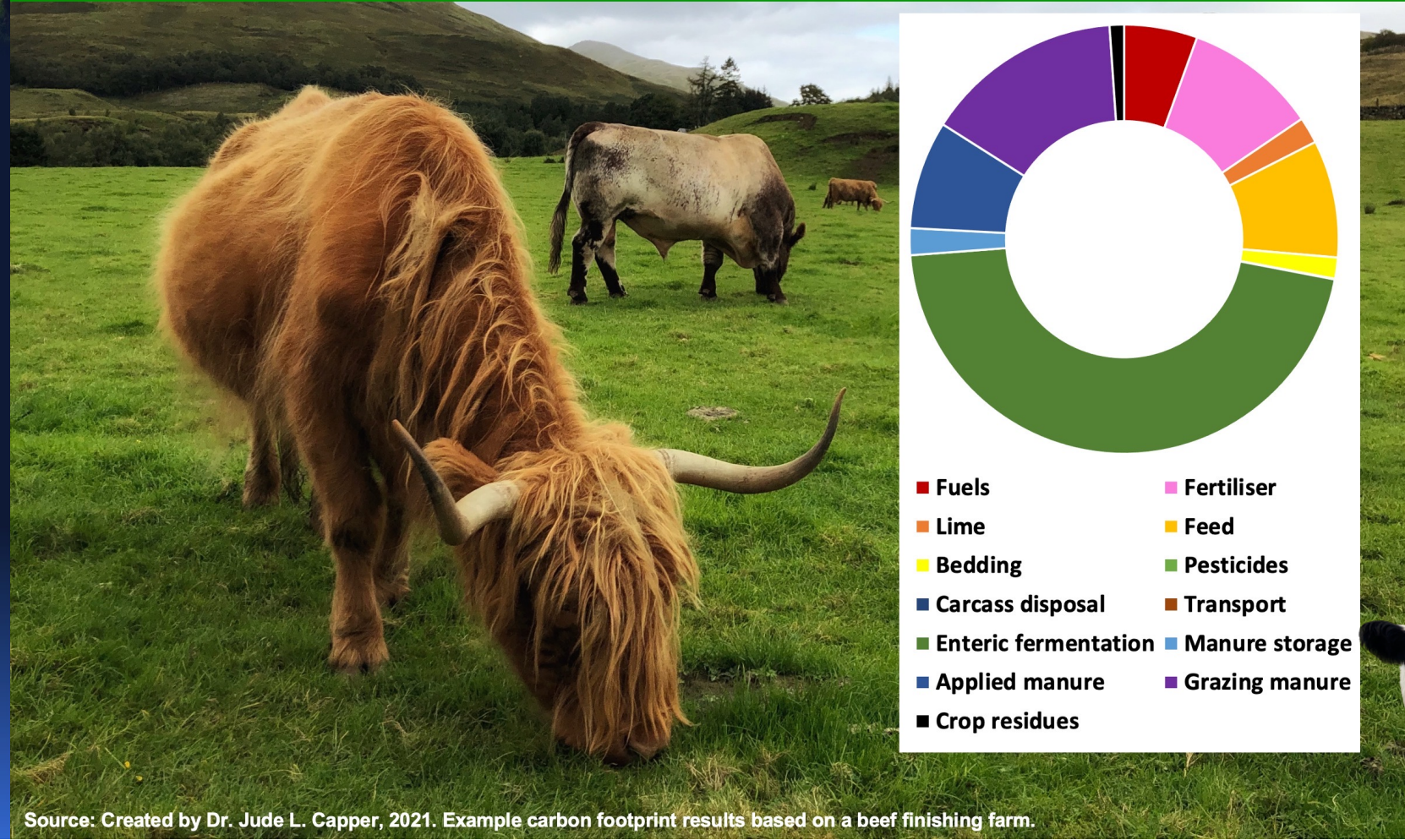
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Source: Created by Dr. Jude L. Capper, 2021. Infographic from: https://wrap.org.uk/sites/default/files/2021-10/WRAP_UK_food%20systems_GHG_Report_TWITTER_Urgent%20action.jpg?itok=8txblEnz

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Standard footprinting tool urgently needed across the industry

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Source: Created by Dr. Jude L. Capper, 2021. Example carbon footprint results based on a beef finishing farm.

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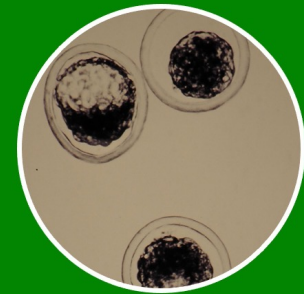


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Thank you!

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<http://bovidiva.com/presentationlinks>

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Questions?



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Source: Created by Dr. Jude L. Capper, 2020. Cartoon from: <http://snipurl.com/methanecartoon>