Benchmarking sustainability performance in free range laying hen flocks

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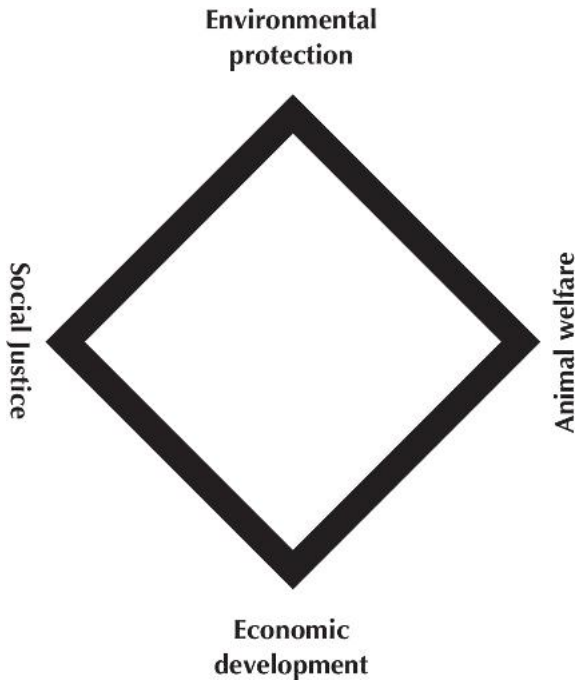
Overview

- ‘Animal treatment’ as a sustainability issue
  - *Animal welfare*
  - *Antimicrobial use*
- Multiple and often competing sustainability objectives in food systems > multi-criteria decision making
- Benchmarking using Data Envelope Analysis
- Results
- Conclusions

Animal welfare and AMU as sustainability issues



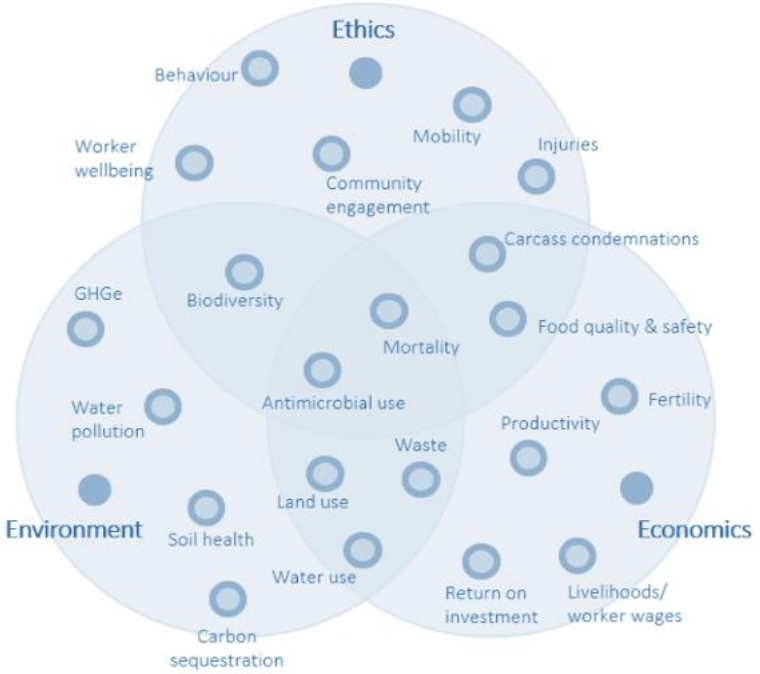
The “Sustainability Diamond” (Rawles, 2012)

- Animal welfare is often absent from sustainability definitions, frameworks and discourse, but holds *intrinsic* (sentience) and *instrumental* value.
- Antimicrobial use is amongst the most significant and pressing health challenges facing human civilisation, and use in animals is a key driver of resistance pressure and a precursor to diffuse environmental pollution with antibiotics and resistance genes.

Wensley, 2020; de Pastille & Rushen, 2005; Hartung et al, 2009; Bright & Joret, 2012; Alonso et al, 2020; Chen & Weary, 2022; Bright et al, 2011; FAWC, 2009; Rawles, 2012; ECDC et al. 2017; Tang et al. 2017; Moran, 2019; Sarmah et al., 2006; Blanco et al, 2020.

Sustainability decision making

- Global livestock production is on the rise
- Remarkable productivity gains in global animal agriculture have been achieved to maximise production and improve efficiency
- But antimicrobial use, disease predispositions and environmental outcomes represent harmful externalities
- There is therefore a need to evaluate and compare farming units in terms of their performance against a broad suite of sustainability criteria



UNFAO, n.d., Bennett et al, 2018; BPC, 2020; Bessei, 2006.

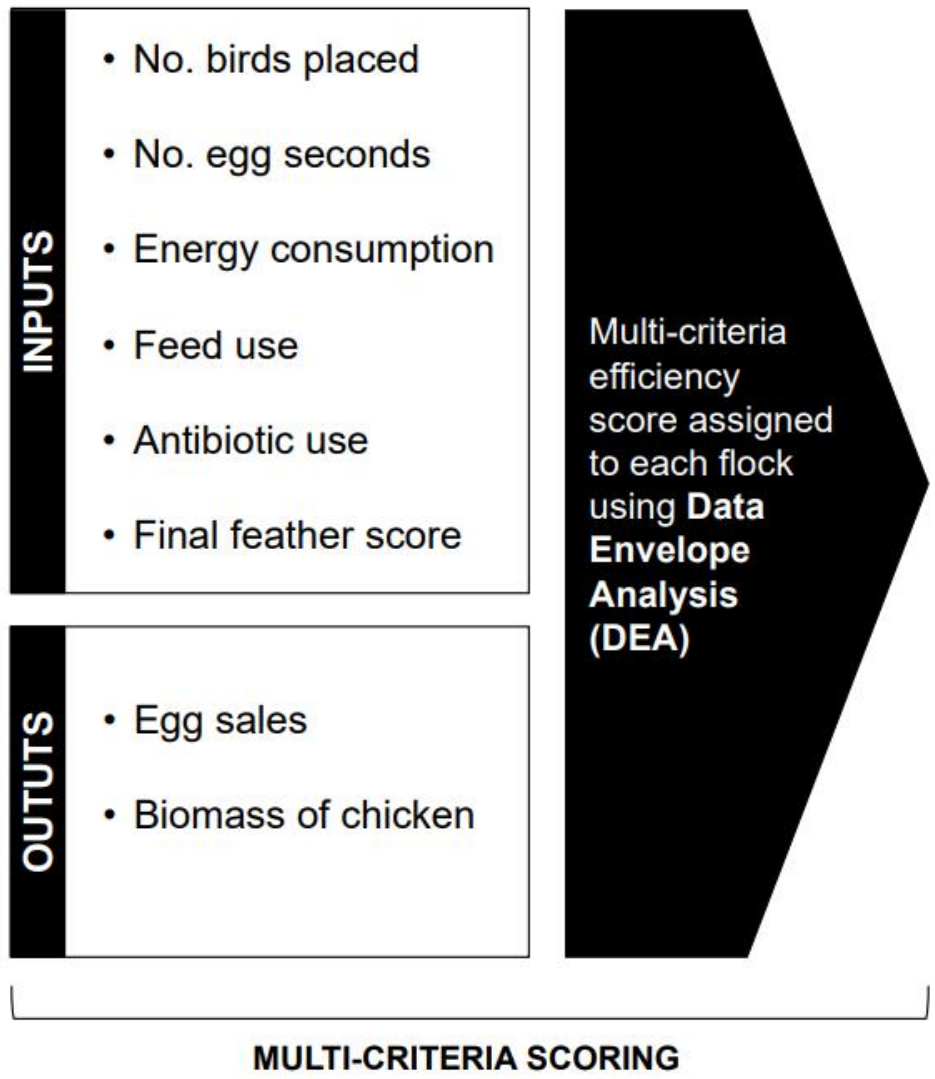
The study

- We benchmarked the sustainability performance of 80 free range laying hen flocks (17 farms) in production between 2016-2022 in England and Scotland.
- Data were extracted from a hardware system ‘BirdBox’ (FAI Farms) used across multiple farms supplying a single egg packer in England. Data were provided separately for feather score.
- Data represented 722k birds producing 225 million eggs, with c£18 million in packer-to-producer payments.

Method: Benchmarking farms

- Data envelope analysis is a linear programming technique for benchmarking flocks in terms of their efficiency in using a given quantity of inputs to optimise outputs. Flocks are given scores between 0-1.
- Inputs are ‘costs’ and can include multiple welfare outcome measures, antibiotic use and environmental indicators
- Outputs can include production and revenues
- Flocks on the ‘efficiency frontier’ (score = 1) are those that most effectively mimimise costs per unit of production, compared to their peers.

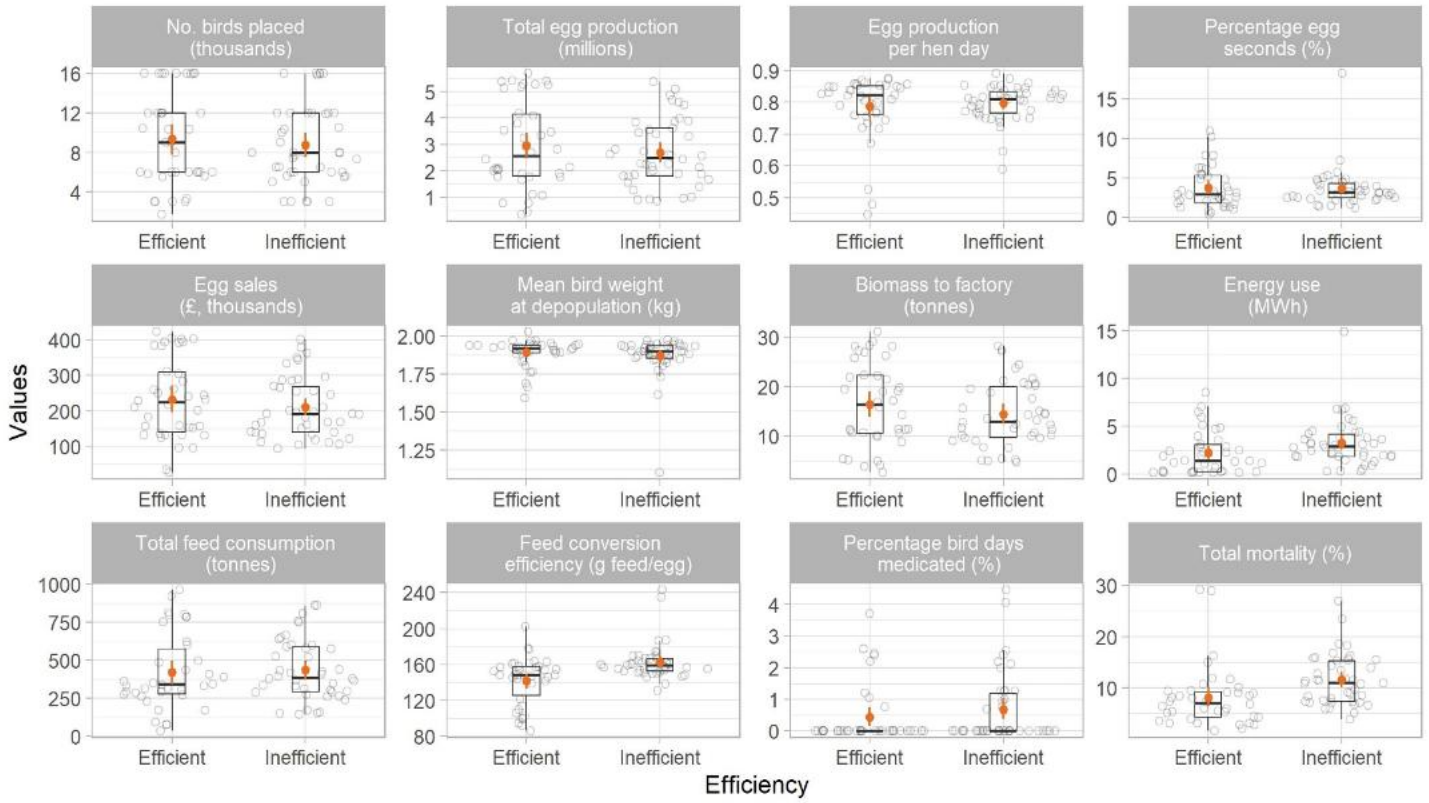
Charnes et al, 1978.



Method: Characterising efficient flocks

- Univariate and multivariate regression were then used to characterise flocks attaining maximum efficiency.
- The flock characteristics were selected based on their availability within the dataset and their relevance to farm and supply chain policy:
  - *Season of placement*
  - *Season of depopulation*
  - *Age of flock at depopulation*
  - *Production system (free range or organic)*
  - *Avian influenza housing order imposed during production: Y/n; duration (days)*
  - *Laying hen breed*
  - *Housing system (flat deck or multi-tier)*
- Fisher's Exact tests were used in univariate regression
- AICc measure of model fit was used for multivariate regression.

Results



- 48.8% of flocks attained the maximum efficiency score of 1.
- The average efficiency was high at 0.955.
- Optimal flocks size 9,203 birds (11,000 too big; 7,000 too small)
- Analysis of composite measures showed that the majority of welfare, AMU, environmental and production criteria were on average superior in the most efficient flocks.

Results

- Multivariable regression found that none of the farm and production factors analysed were statistically significant predictors of maximum efficiency at the level $p<0.05$;
- However univariate analysis indicated that laying hen breed was associated with efficiency at the level of $p<0.1$.

Variable	No. flocks	No. efficient flocks	Prop. (lci-uci)
Breed (Reference level – Breed A; p = 0.0822*)			
A	19	11	0.58 (0.33 - 0.8)
B	58	24	0.41 (0.29 - 0.55)
Other	3	3	1 (0.29 - 1)
Housing system (Reference level – Flat Deck; p = 0.4633)			
Flat Deck	58	26	0.45 (0.32 - 0.58)
Multi-tier	22	12	0.55 (0.32 - 0.76)
Production system (Reference level – Free Range; p = 1.0000)			
Free range	66	31	0.47 (0.35 - 0.6)
Organic	14	7	0.5 (0.23 - 0.77)
Subject to housing order (Reference level – No; p = 0.1162)			
No	42	16	0.38 (0.24 - 0.54)
Yes	38	22	0.58 (0.41 - 0.74)
Season of depopulation (Reference level – Summer; p = 0.5115)			
Summer	41	21	0.51 (0.35 - 0.67)
Winter	39	17	0.44 (0.28 - 0.6)
Season of placement (Reference level – Summer; p = 0.8214)			
Summer	46	21	0.46 (0.31 - 0.61)
Winter	34	17	0.5 (0.32 - 0.68)

Prop. = Proportion of flocks scored as efficient | lci = lower 95% confidence interval | uci = upper 95% confidence interval | * = statistically significant at the level of p<0.1

Conclusions

- Some farms are successfully reconciling superior environmental, animal welfare, antibiotic use and production goals.
- No flocks were at an advantage or disadvantage in attaining maximum efficiency based on the input and output criteria set selected.
- However, weaker association supports the notion that breeds with balanced genetic merit will play an important role in food systems seeking to mitigate externalities of production (Oltenacu et al, 2010)
- Gains can still be made amongst farmers working with similar production systems and standards, presumably owing to unmeasured influences such as farm condition and human factors.
- Possible over-simplification of complex sustainability challenges using single scores - therefore individual criteria must also be scrutinised for regressive trends (Grandin, 2022)
- Need for hard-to-reach datasets, requiring equitable data sharing programmes
- Option to select criteria using stakeholder elicitation, including positive welfare, environmental and social outcomes
- DEA can be used to foster continuous improvement and incentivise best practice within supply chains or government schemes.

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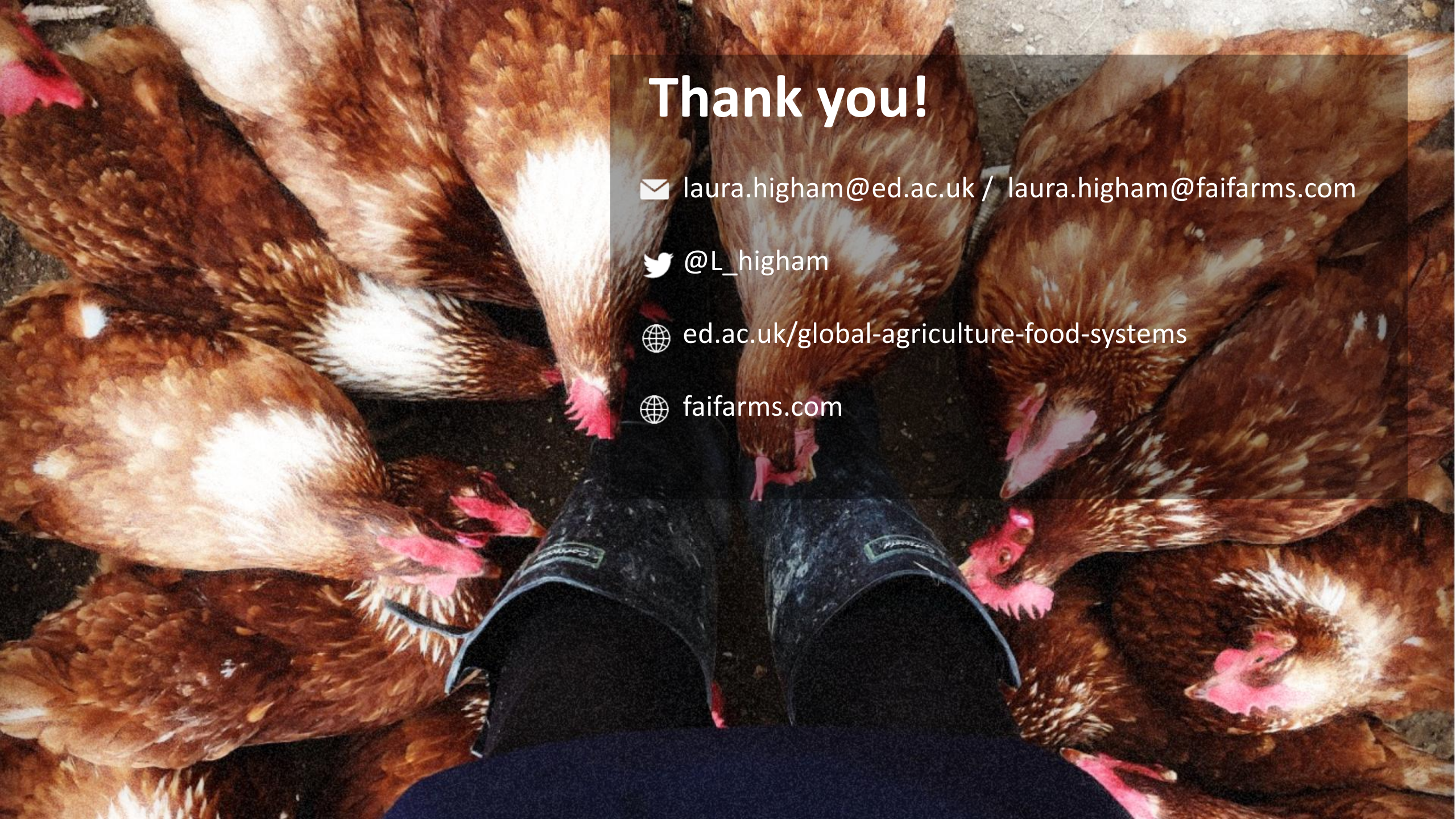

Thank you!

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