QUEEN'S UNIVERSITY BELFAST | IGFS THE INSTITUTE FOR GLOBAL FOOD SECURITY

The sources of variation in the environmental impacts of broiler systems

Ilias Kyriazakis

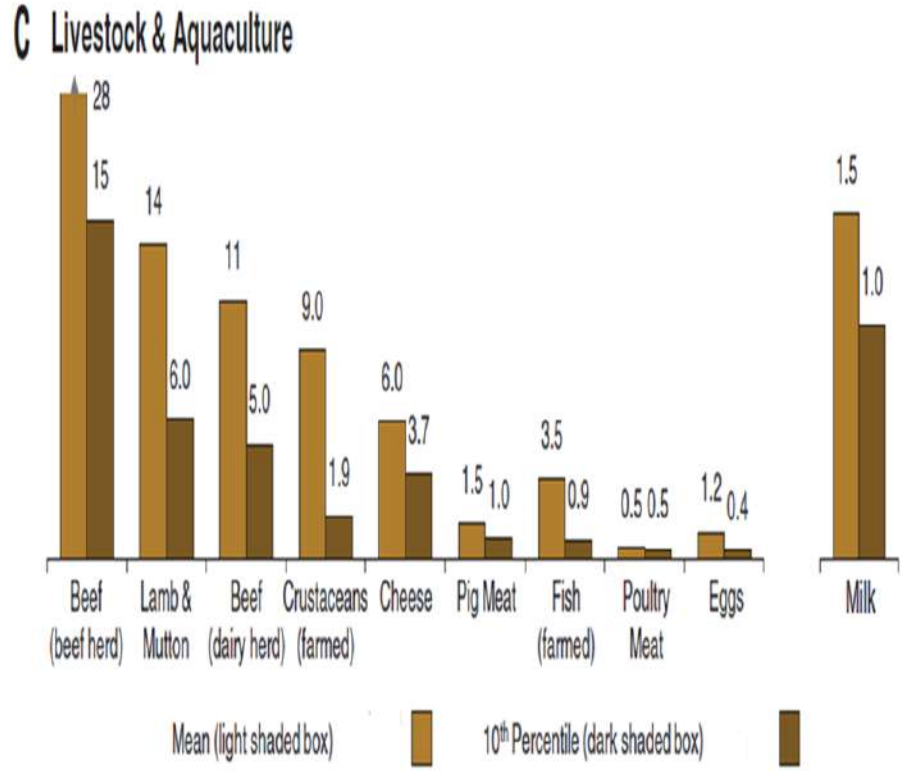
Friday 28 February 2025

Environmental impact of poultry systems

- Broiler and layer production systems have the **lowest Carbon footprint** (**Global Warming Potential**) amongst livestock systems

- However, they contribute **significantly** to other environmental impacts, through e.g., N (NH_3) and P emissions

- A special case arises from emissions associated with Land Use and Land Use Change (deforestation)



Context: Current trends in poultry production

- Poultry systems are considered as one of the least impacting livestock systems in terms of C footprint
  - This has been achieved through efficient use of resources, including using birds that convert feed very efficiently, and their management

Context: Current trends in poultry production

- Poultry systems are considered as one of the least impacting livestock systems in terms of C footprint
  - ➢ This has been achieved through efficient use of resources, including using birds that convert feed very efficiently, and their management
- Concerns have been raised about the sustainability of this trend in improvement in (especially animal) efficiency, and the effects this may have on bird health and welfare (EFSA, 2023)
  - ➢EFSA reviewed **the most relevant poultry husbandry systems in Europe** and identified the relevant welfare consequences for each system and hazards that can have welfare implications
  - ➢ Recommended measures to prevent or correct the hazards and/or mitigate the welfare consequences

SCIENTIFIC OPINION

efsa JOURNAL

ADOPTED: 14 December 2022

doi: 10.2903/j.efsa.2023.7788

Welfare of broilers on farm

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare),
Søren Saxmose Nielsen, Julio Alvarez, Dominique Joseph Bicout, Paolo Calistri,
Elisabetta Canali, Julian Ashley Drewe, Bruno Garin-Bastuji, Jose Luis Gonzales Rojas,
Christian Gortázar Schmidt, Mette S Herskin, Miguel Ángel Miranda Chueca, Barbara Padalino,
Paolo Pasquali, Helen Clare Roberts, Hans Spoolder, Karl Stahl, Antonio Velarde, Arvo Viltrop,
Christoph Winckler, Inga Tiemann, Ingrid de Jong, Sabine Gabriele Gebhardt-Henrich,
Linda Keeling, Anja Brinch Riber, Sean Ashe, Denis Candiani, Raquel García Matas,
Michaela Hempen, Olaf Mosbach-Schulz, Cristina Rojo Gimeno, Yves Van der Stede,
Marika Vitali, Eléa Bailly-Caumette and Virginie Michel

Some EFSA recommendations (out of 14 key) that might affect environmental impact of broilers

- Limit the growth rate of broilers to a maximum of 50 g/day.
- Substantially reduce the stocking density to meet the behavioural needs of broilers
- Avoid the use of cages, feed and water restrictions in broiler breeders.
- Keep ammonia concentration in the barn below 15 ppm.
- Provide a covered veranda for broilers and broiler breeders from 2 weeks of age.

Context: Current trends in poultry production

- Poultry systems are considered as one of the least impacting livestock systems in terms of C footprint
  - This has been achieved through efficient use of resources, including using birds that convert feed very efficiently, and their management
- Concerns have been raised about the sustainability of this trend in improvement in (animal) efficiency, and the effects this may have on bird health and welfare (EFSA, 2022)
  - EFSA reviewed **the most relevant poultry husbandry systems in Europe** and identified the relevant welfare consequences for each system and hazards that can have welfare implications
  - Recommended measures to prevent or correct the hazards and/or mitigate the welfare consequences
- **The question is are these recommendations consistent with the desire to reduce or maintain the environmental impact of poultry systems?**

ADAS

ADAS REPORT

A REVIEW OF THE EVIDENCE OF THE RELATIONSHIP BETWEEN ANIMAL WELFARE AND ENVIRONMENTAL IMPACTS

ANNEX 8.1 Poultry matrix

			Environmental Impacts						
			CLIMATE CHANGE				POLLUTION	LANDSCAPE/E	
ANIMAL WELFARE 5 FREEDOMS	Animal Welfare Objectives- Poultry	Industry Response- Poultry	Energy Use/ efficiency/ renewables	Reduce emissions of GHGs	Waste reduction/ Recycling opportunities	Water Conservation/ Flood prevention	Water Air Soil	BIODIVERSITY	PRESE LIVI LANDS
1. Freedom from hunger and thirst-- by ready access to fresh water and a diet to maintain full health and vigour.	Meet all nutritional requirements	Use approved feed materials only, on least cost basis	No effect	Least cost requirement may increase transport costs for feed materials	Unable to use processed animal proteins	No effect	No effect	Fewer home-grown crops needed (more imported)	More sc alterna landu
2. Freedom from discomfort- by providing an appropriate environment including shelter and a comfortable resting area.	Maintain a comfortable environment, no temperature extremes etc.	Broilers only - adjust stocking rate according to seasonality (fewer birds in summer)	No effect	No effect	Less waste (in the form of mortality)	More built-on land could increase flood risk	Less air pollution, due to carcass incineration	No effect	More ha need
3. Freedom from pain injury or disease--- by prevention or rapid diagnosis and treatment.	Prohibit 'un-natural' practices which may cause pain or distress	No beak-trimming of breeding or commercial egg laying birds	No energy used, if process not undertaken	No effect	Likely increase in mortality	No effect	More air pollution due to carcass incineration	No effect	No ef
3. Freedom from pain injury or disease-- by ensuring conditions and treatment which avoid mental suffering.	Maintain good health	Good biosecurity - best met by indoor production systems	No effect	More use of detergents, disinfectants and other chemicals	Less waste (in the form of mortality)	No effect	Indoors, so no risk of run-off on farm land	No effect	No poultr in lands
4. Freedom to express most normal behaviour-- by providing sufficient space, proper facilities and company of the animal's own kind.	Provide appropriate house space allowance for animals	Opt for less intensive systems, therefore more housing capacity needed	More heat may be needed during the brooding stage	No effect - if national flock size is unchanged	No effect	More built-on land could increase flood risk	No effect	No effect	More ha need
4. Freedom to express most normal behaviour-- by providing sufficient space, proper facilities and company of the animal's own kind.	Provide outdoor access	Replace indoor with free range systems	Maybe scope to save electricity whilst birds are outside	Carbon footprint higher because of inferior growth rates and FCR	No effect	Greater risk of flood damage	Risk of run-off on farm land	Scope to enhance, with planting schemes etc.	Scope to if house and des sympat
4. Freedom to express most normal behaviour-- by providing sufficient space, proper facilities and company of the animal's own kind.	Use systems that allow species-specific behaviours	Replace conventional laying hen cages with litter floored systems	No effect	No effect	More litter waste, unless recycled materials can be used as litter	No effect	More dust pollution in air	Opportunity to grow crops to provide litter materials	No ef

The Poultry Veterinary Study Group of the EU

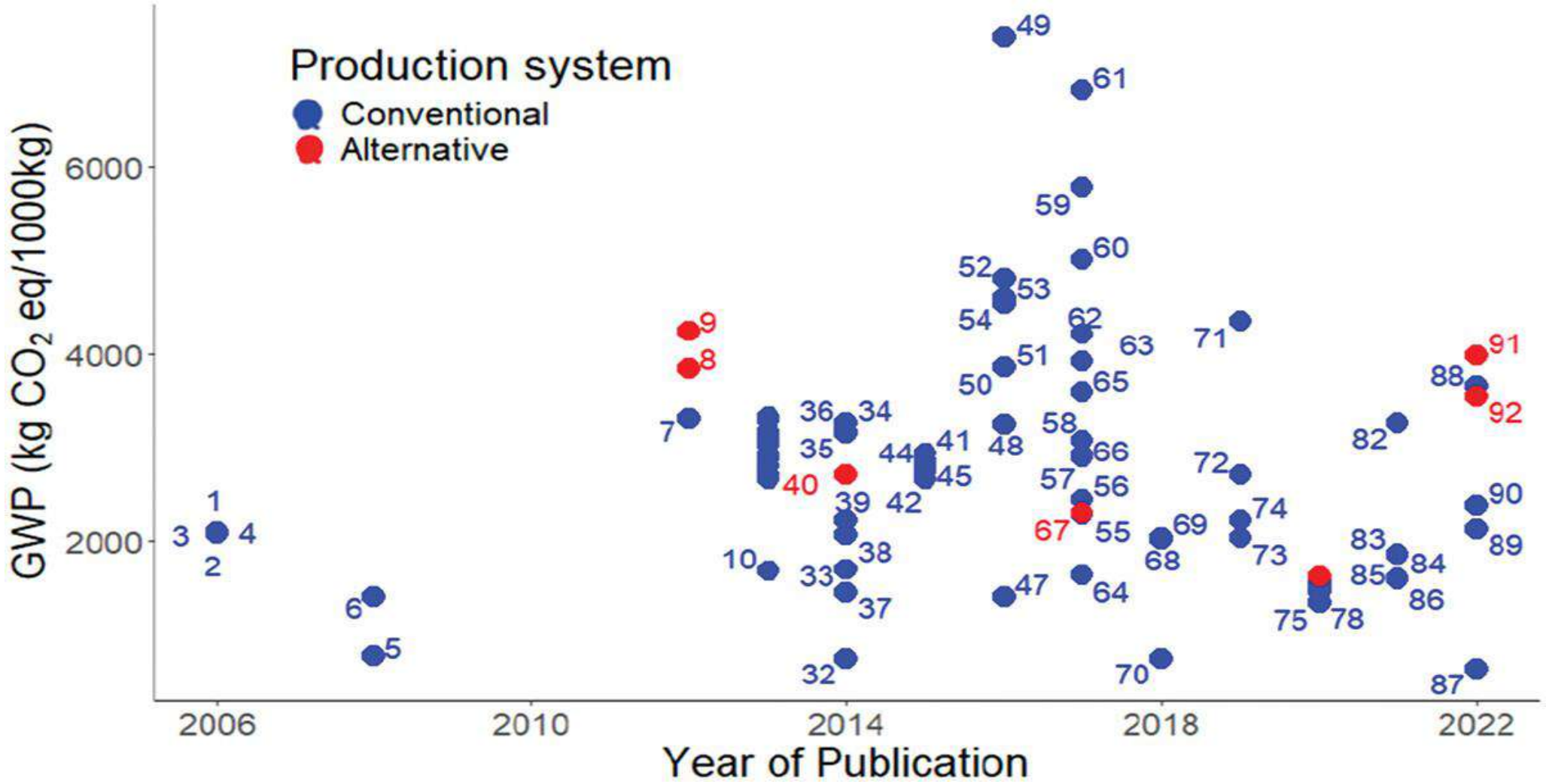
PVSGEU response to EFSA "Welfare of broilers on farm" report 2023.

The Poultry Veterinary Study Group of the EU (PVSGEU) welcomes the opportunity to respond to the EFSA Broilers on farm report 2023.

Summary:

The EFSA report is a comprehensive review of the published science on the welfare of broilers on farm and this should be welcomed as an aid to assist producers, legislators and consumers in decisions to continuously improve welfare of broilers. However the conclusions and recommendations of the EFSA committee are limited solely to welfare outcomes and do not consider the wider implications for sustainable poultry production, food security and environment which is surely a primary aim of the EU Green Deal Strategy and Farm to Fork initiative. The proposal to reduce broiler stocking density to 11kg/m^2 whilst theoretically improving broiler welfare will have serious implications for greenhouse gas emissions, cost of production and food security in the EU. If these recommendations are implemented Poultry producers in the EU will not be able to compete with producers from 3rd countries and the result will be to export our poultry meat production to 3rd countries which ultimately will not improve the welfare of the birds providing the meat we eat in Europe. Furthermore the availability of poultry meat as a nutritious, low carbon and affordable source of animal protein in EU will inevitably be compromised and potentially less available to a large proportion of the EU population. As veterinary surgeons we are committed to a One Health strategy

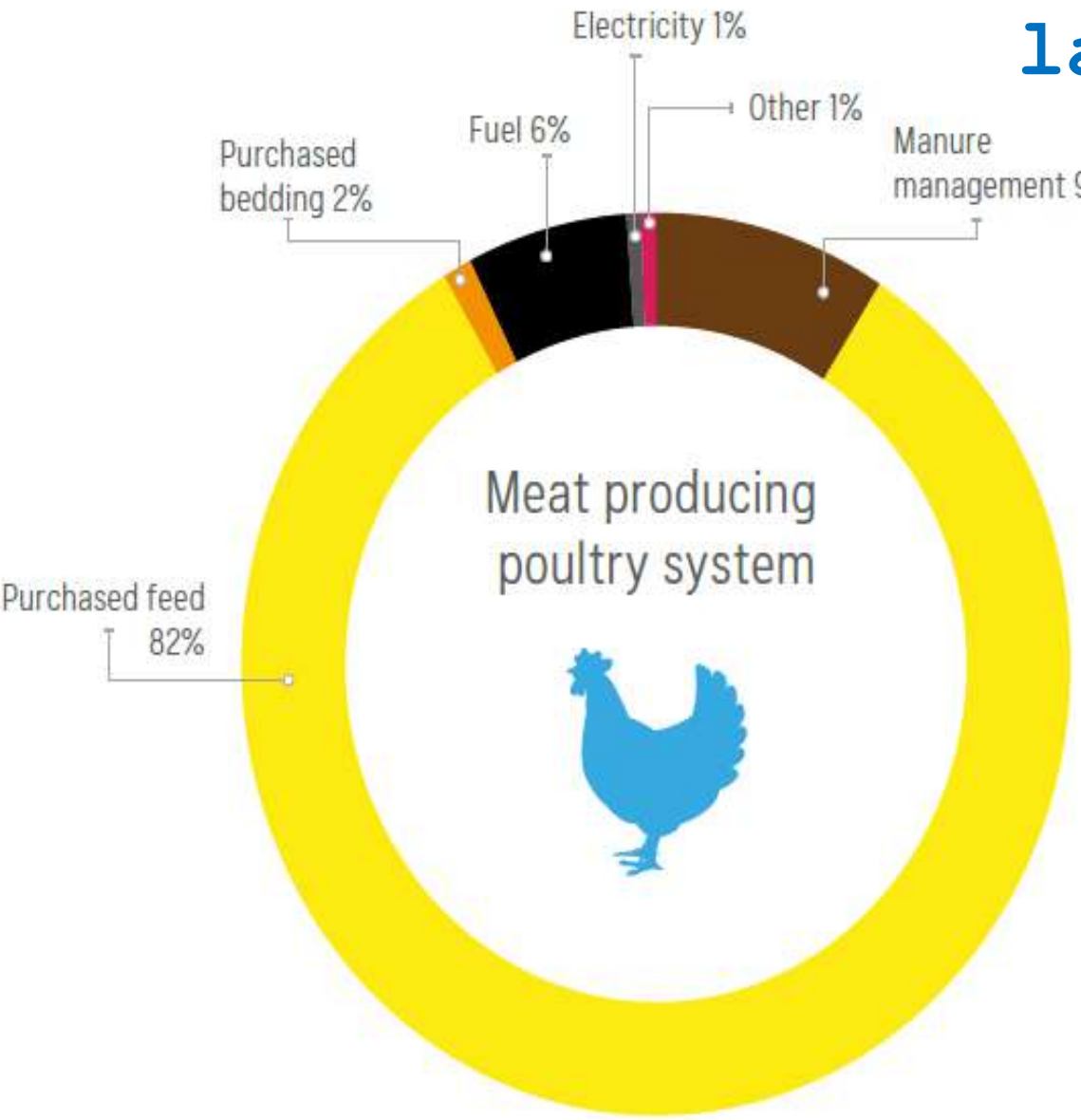
Variation in C footprint (GWP) between broiler studies

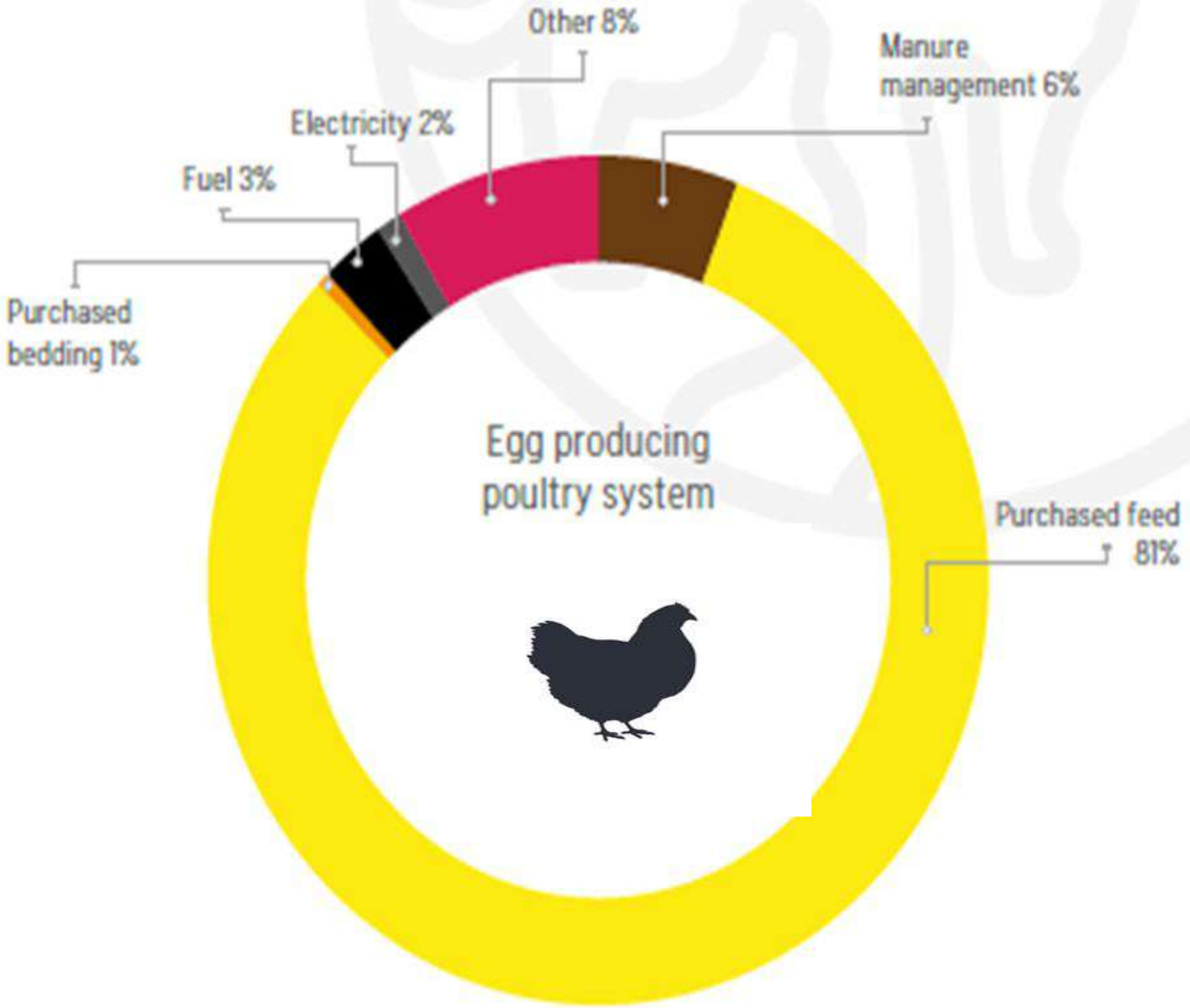


Some statements of the obvious

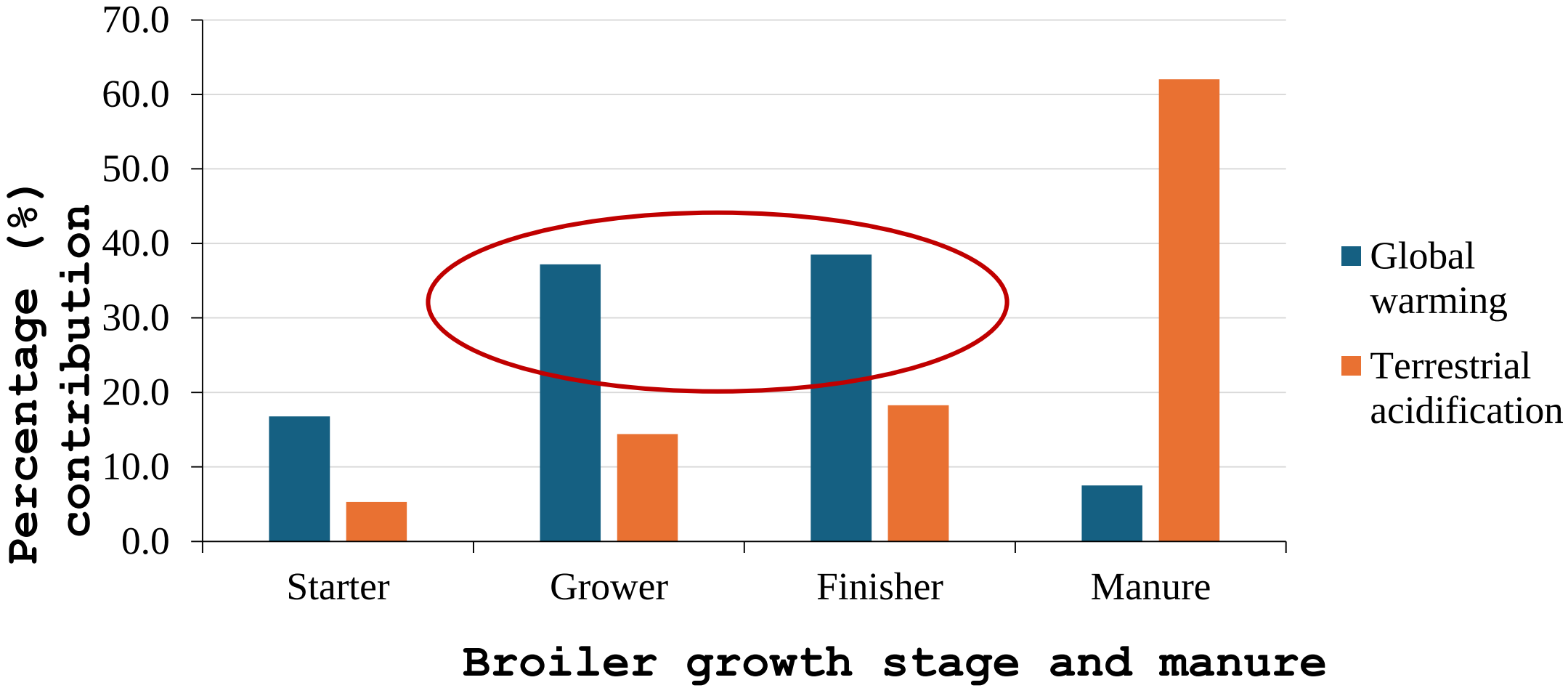
- Broadly speaking, emissions from livestock systems arise from system inefficiency
- Whatever is not retained by the animal and its products, is lost in the environment (emissions)
  - This includes inputs used for 'maintenance' functions
- System inefficiency also includes animals that die, are culled or whose products are condemned, as these 'outputs' can also be seen as 'waste'
- Anything that reduces system efficiency will, by definition, increase emissions and the environmental impact of a livestock system

Contribution of activities to the overall C footprint (kg CO_2eq/kg) of a broiler and a la





Contribution of growth stages to GWP and acidification (mainly due to NH3)



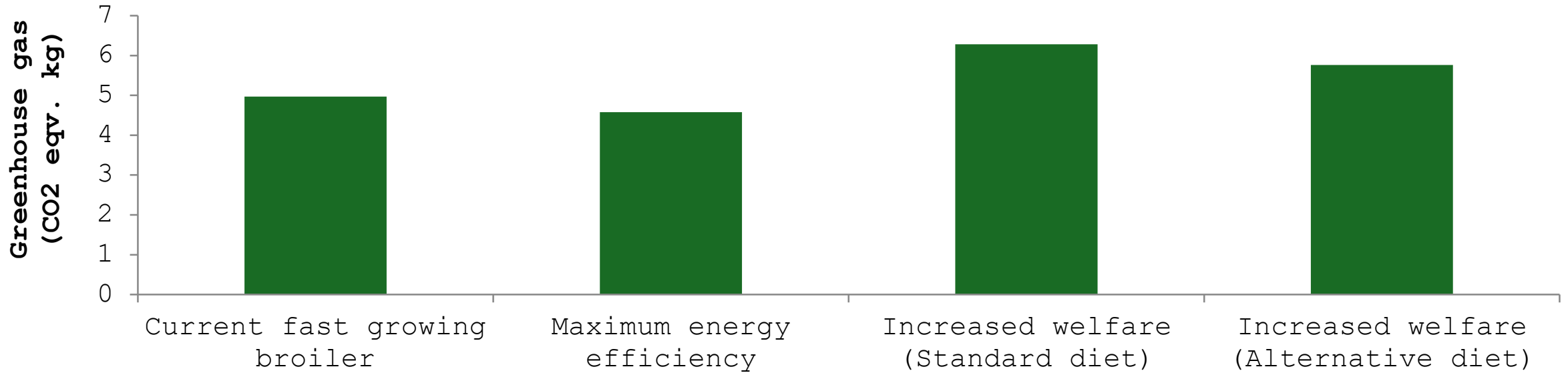
How would the broilers of the future look?

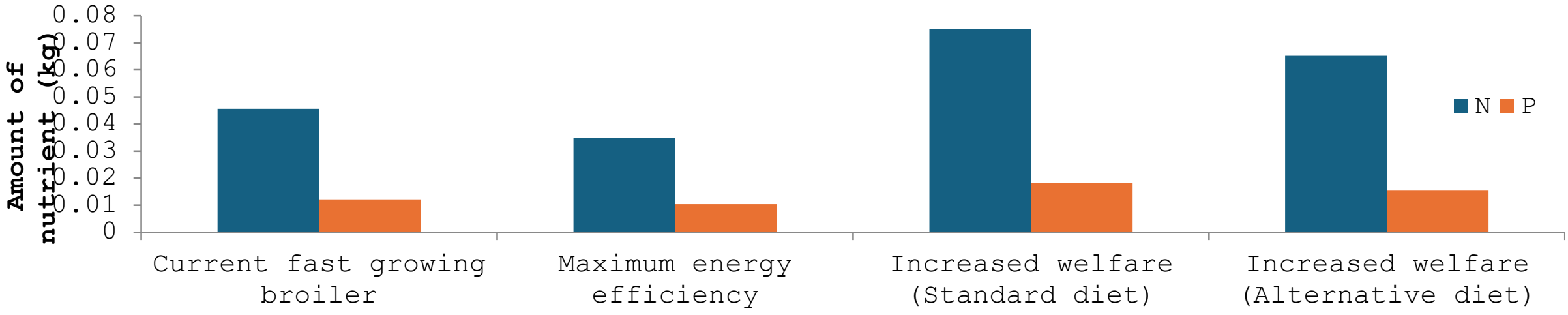
Scenario	Age at 2.2 kg	Growth rate (g/day)	Total ME intake (MJ)	ME intake per unit gain (kJ/g)
Current fast growing broiler	34.2	63.1	45.9	21.3
Increased feed intake and leanness (**maximum energy efficiency strategy**)	33.0	65.3	42.0	19.4

How would the broilers of the future look?

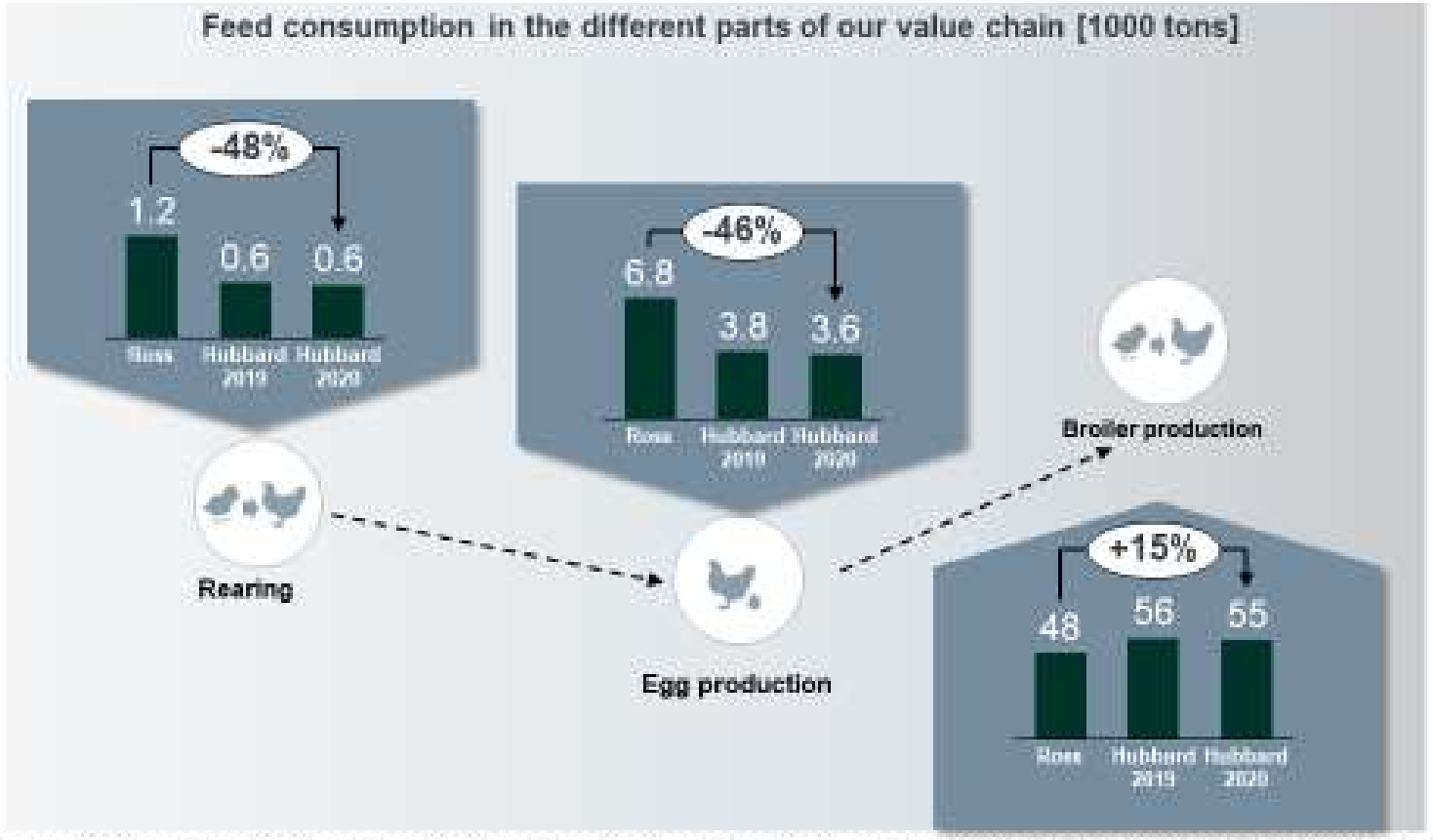
Scenario	Age at 2.2 kg	Growth rate (g/day)	Total ME intake (MJ)	ME intake per unit gain (kJ/g)
Current fast growing broiler	34.2	63.1	45.9	21.3
Increased feed intake and leanness (**maximum energy efficiency strategy**)	33.0	65.3	42.0	19.4
Reduced growth rate and increased leanness (increased	56.0	38.6	58.3	27.0

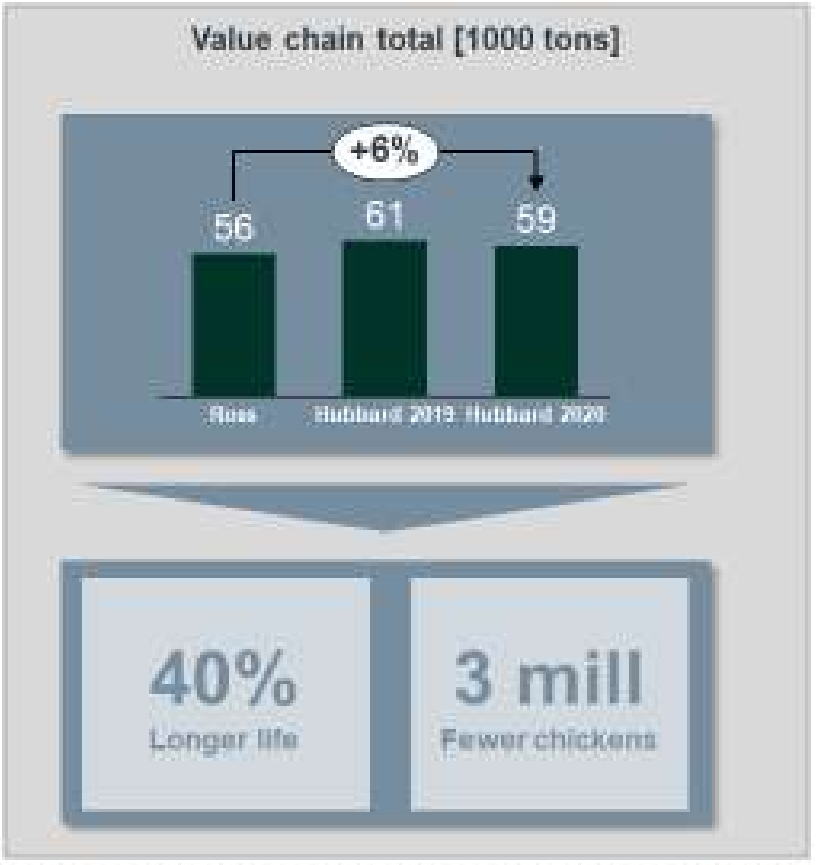
Environmental impact of different breeding strategies





Total feed consumption has only increased b 6% *
Hubbard needs less protein resulting in an unchanged climate footprint





Lower feed consumption in rearing and egg production because we get more chickens from each female, and therefore need fewer females. The females are dwarf hens, and therefore eat less feed.

Lower mortality and less disease** in the broiler production reduced losses result in increased feed exploitation.

Because Hubbard is slower growing it needs 7,9% less soy in the feed compared to Ross***

* Produksjonstall fra NKs Rossproduksjon i 2018

**Produksjonsdata jan-okt 2020: Sykdomskassasjoner = 0,82%, Totaldødelighet = 2,04%

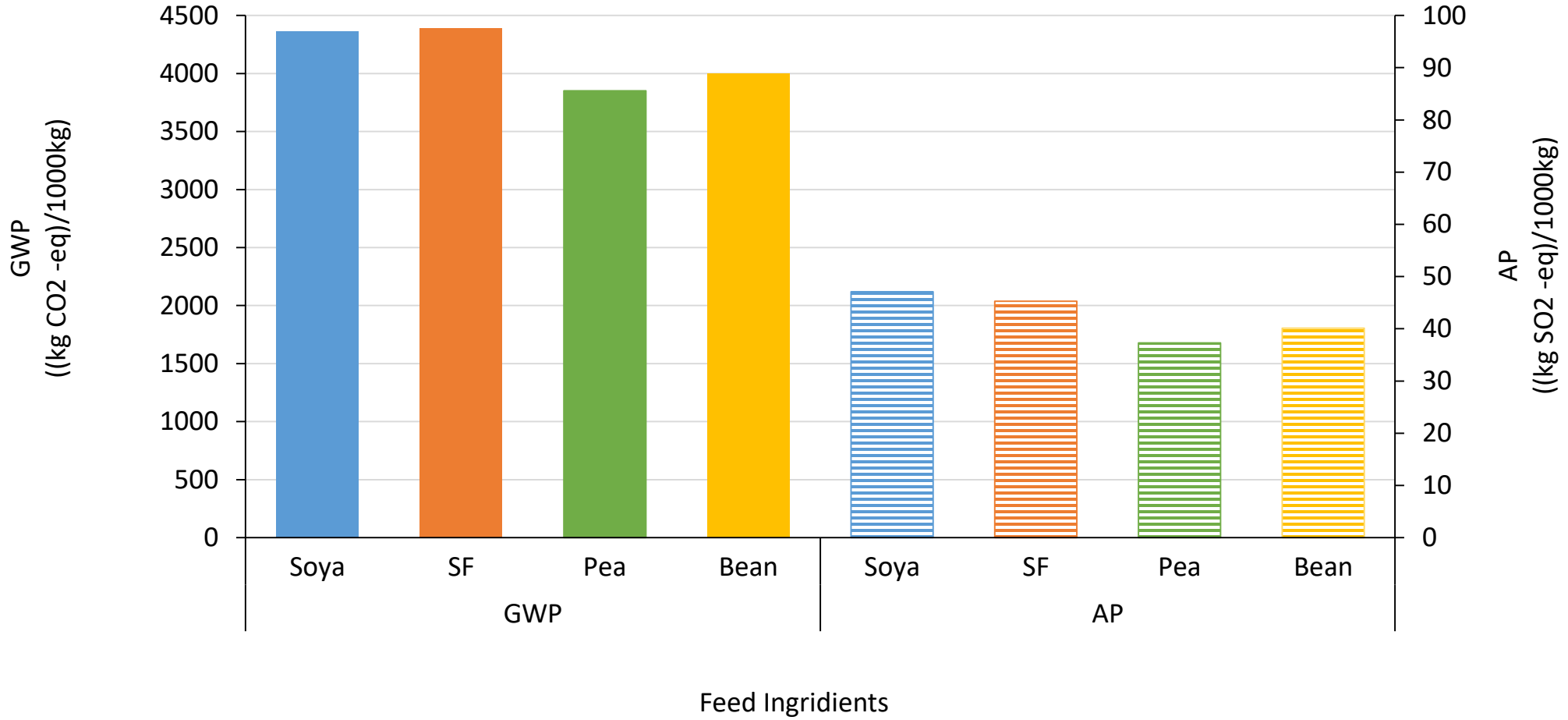
***Sammenligning fôresepter Hubbard og Ross mai 2020

Norsk Kylling

GWP (1000 kg CO_2 eqv) per 1000 kg meat or eggs

Material or Activity	Conventional broilers	Free Range layers
Feed + Water	3.05	2.36
Electricity	0.16	0.20
Gas + Oil	0.43	0.18
Housing + Land	0.53	0.50
Manure + Bedding	0.14	0.14
Total	4.41	3.38
Broiler or Layer stage	4.06	2.78
Pullet	-	0.57 (17%)

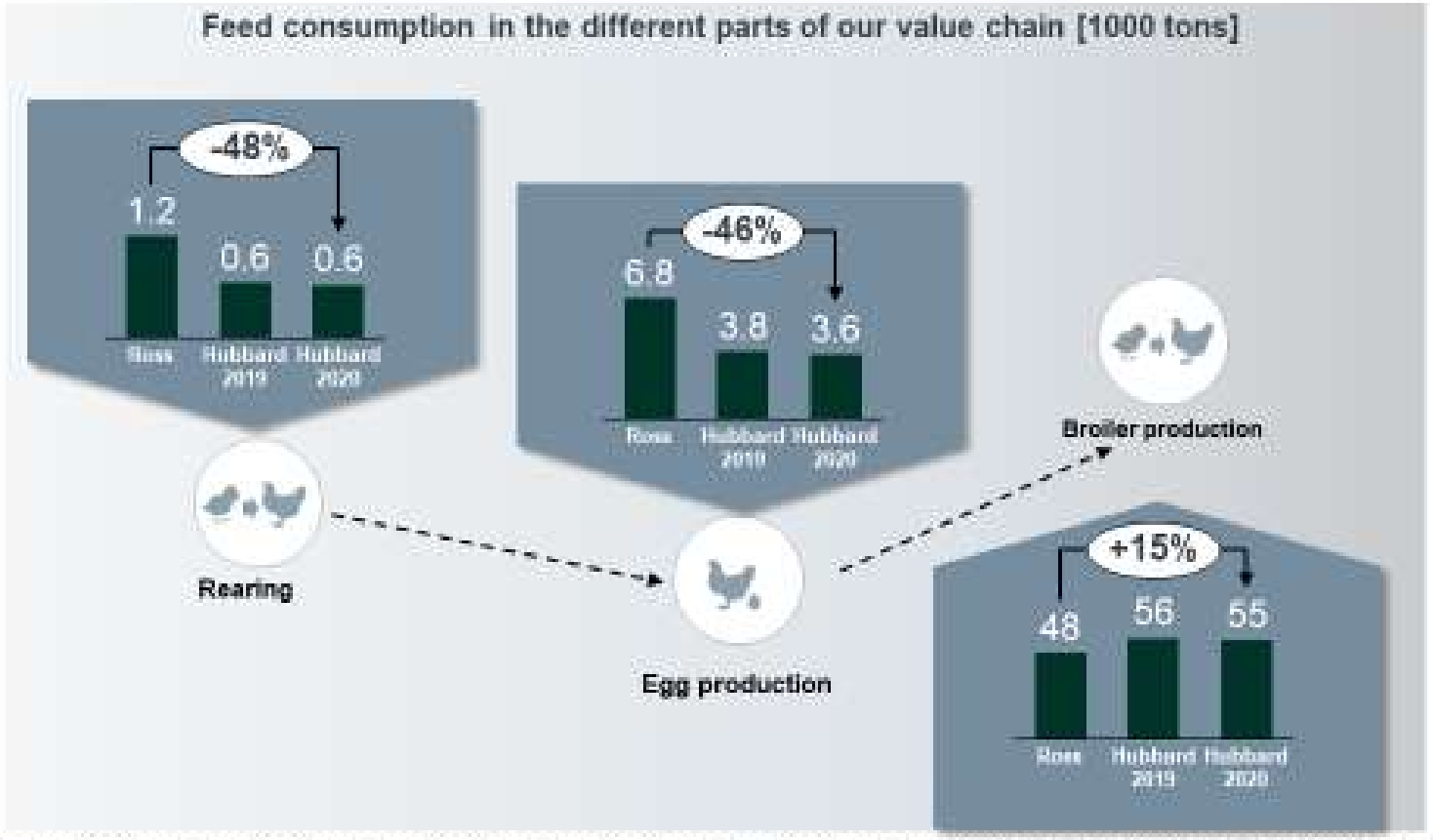
Substitution of soya bean with home-grown protein sources in conventional systems

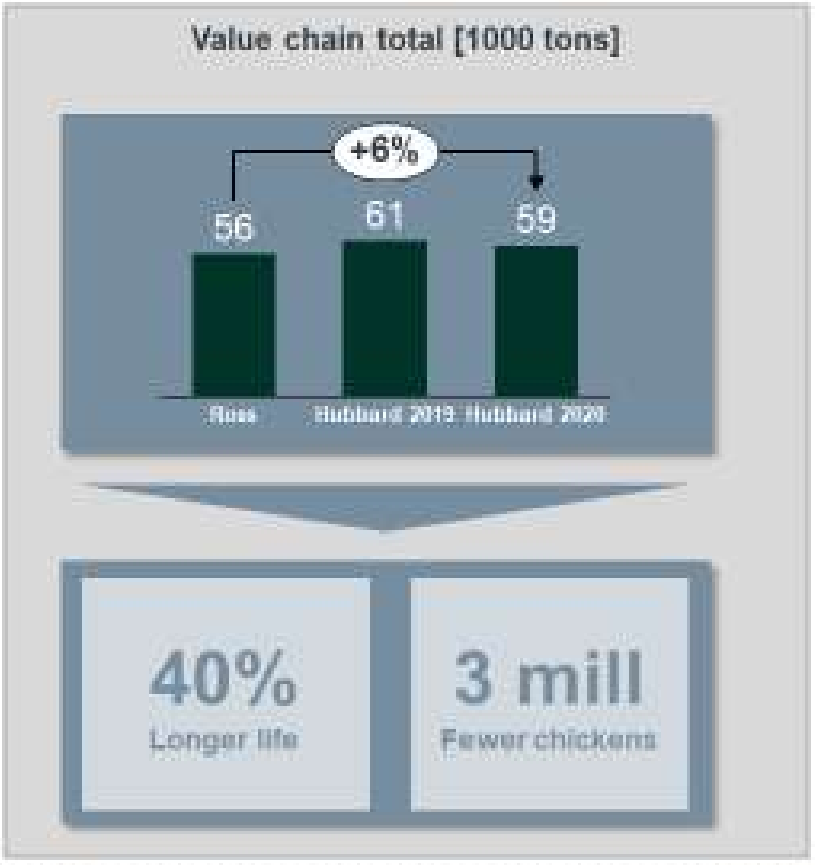


The effect of faba bean inclusion on fast and slow growing broilers

Faba Bean (%)	d35 BW (g)		FCR d0-d35	
	Ross 308	Hubbard JA787	Ross 308	Hubbard JA787
0	2757	1799	1.342	1.501
10	2723	1810	1.350	1.524
15	2790	1816	1.353	1.527
20	**2713**	1845	**1.371**	1.515
25	**2771**	**1783**	**1.371**	**1.561**
30	**2695**	**1757**	**1.376**	**1.550**
s.e.d	37		0.012	

Total feed consumption has only increased b 6% *
Hubbard needs less protein resulting in an unchanged climate footprint





Lower feed consumption in rearing and egg production because we get more chickens from each female, and therefore need fewer females. The females are dwarf hens, and therefore eat less feed.

Lower mortality and less disease** in the broiler production reduced losses result in increased feed exploitation.

Because Hubbard is slower growing it needs 7,9% less soy in the feed compared to Ross***

* Produksjonstall fra NKs Rossproduksjon i 2018

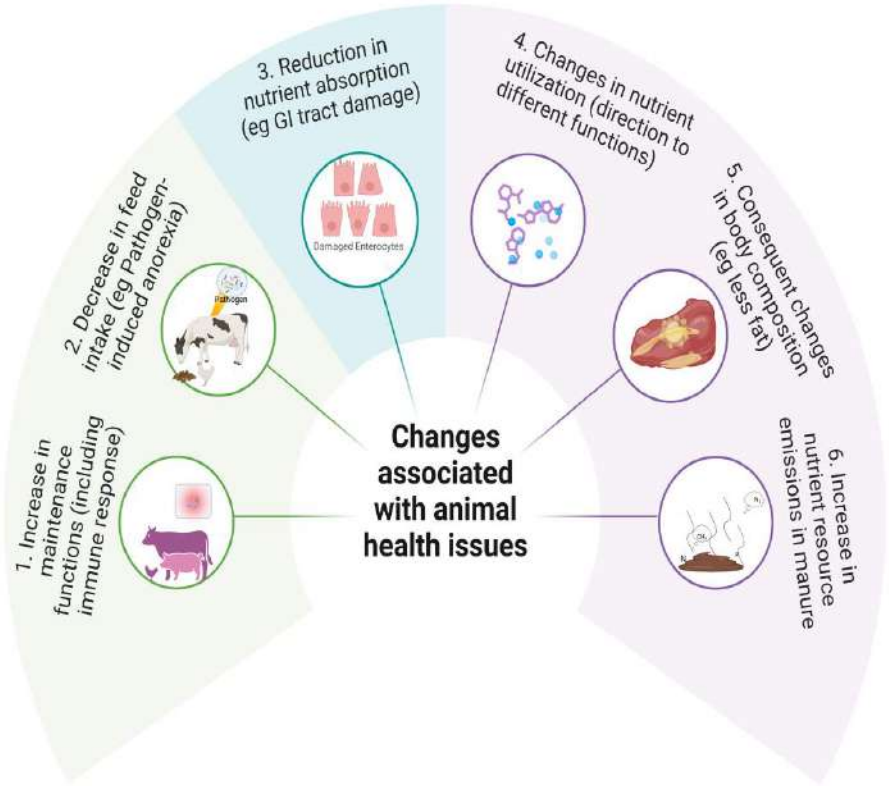
**Produksjonsdata jan-okt 2020: Sykdomskassasjoner = 0,82%, Totaldødelighet = 2,04%

***Sammenligning fôresepter Hubbard og Ross mai 2020

Norsk Kylling

Changes associated with animal health issues

- **Increase** in maintenance functions (including immune response)
- **Decrease** in feed intake (eg pathogen induced anorexia)
- **Reduction** in nutrient absorption (eg GI tract damage)
- **Changes** in nutrient utilization (direction to different functions)
- **Consequent hanges** in body composition (eg less fat)
- **Increase** in nutrient resource emissions in manure



PROCEEDINGS B

royalsocietypublishing.org/journal/rspb

Perspective

Cite this article: Kyriazakis I *et al*. 2024 Improve animal health to reduce livestock emissions: quantifying an open goal. *Proc. R. Soc. B* **291**: 20240675.
https://doi.org/10.1098/rspb.2024.0675

Received: 20 March 2024
Accepted: 4 June 2024

Subject Category:
Biological applications

Improve animal health to reduce livestock emissions: quantifying an open goal

Ilias Kyriazakis[1], Claudia Arndt[2], Aurelie Aubry[3], Johannes Charlier[4], Vanessa O. Ezenwa[5], Olivia F. Godber[6], Mogens Krogh[7], Pim F. Mostert[8], Karin Orsel[9], Mark W. Robinson[1], Frances S Ryan[10], Philip J. Skuce[11], Taro Takahashi[3,12], Corina E. van Middelaar[13], Stafford Vigors[14] and Eric R. Morgan[1]

[1]Institute for Global Food Security, Queen's University, Belfast, UK
[2]Mazingira Centre for Environmental Research and Education, International Livestock Research Institute (ILRI), Nairobi, Kenya
[3]Agri-Food and Biosciences Institute, Hillsborough, UK
[4]Kreavet, Kruibeke, Belgium
[5]Department of Ecology and Evolutionary Biology, Yale University, New Haven, CT, USA
[6]Department of Animal Science, Cornell University, Ithaca, NY, USA
[7]Department of Animal and Veterinary Sciences, Aarhus University, Tjele, Denmark
[8]Wageningen Livestock Research, Wageningen University & Research, Wageningen, The Netherlands
[9]Faculty of Veterinary Medicine, University of Calgary, Calgary, Alberta, Canada
[10]Supporting Evidence-Based Interventions in Livestock, The Royal (Dick) School of Veterinary Studies, University of Edinburgh, Midlothian, UK
[11]Moredun Research Institute, Edinburgh, UK
[12]Bristol Veterinary School, University of Bristol, Langford, UK
[13]Animal Production Systems Group, Wageningen University & Research, Wageningen, The Netherlands
[14]School of Agriculture & Food Science, University College Dublin, Belfield, Dublin, Ireland

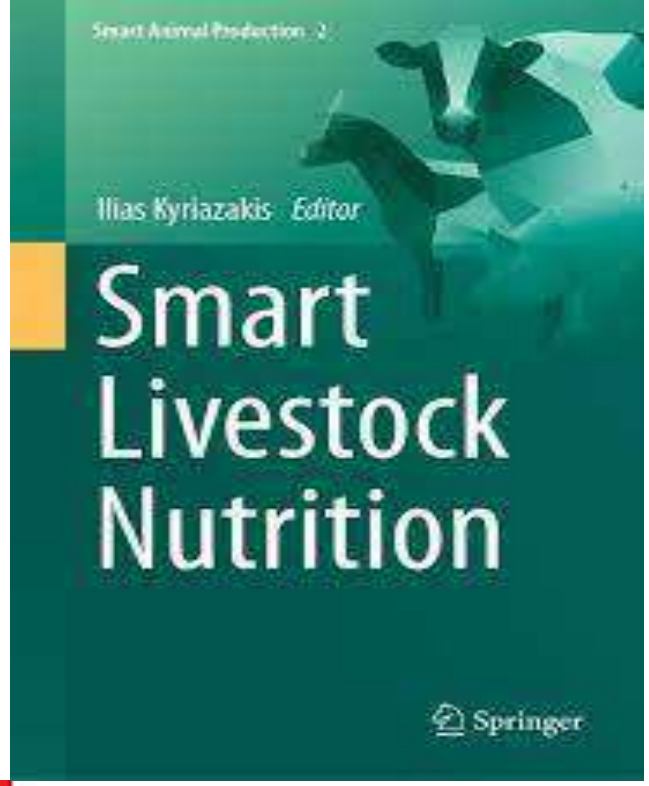
IK, 0000-0001-7703-3626; CA, 0009-0007-5699-0102; JC, 0000-0002-1332-1458;

Consequences of increasing stocking density in conventional systems on GWP (kg CO_2 eq/ kg BW)

Environmental Category	High Density (38 kg/m2)	Low Density (30 kg/m2)	Low Density + Heat exchanger
Feed + water	3.08	**2.95**	**2.94**
Farm electricity	0.16	0.18	0.18
Farm gas + oil	0.43	**0.68**	**0.48**
Housing	0.54	0.49	0.49
Manure + bedding	0.14	0.13	0.13

Some comments about stocking density effects

- A decrease in stocking density is **consistently** associated with a decrease in GWP
- The effect of 'thinning' counterbalances the higher energy inputs and using more birds to achieve the same functional unit
- **The change is a good example of**
  complexity of considering wit
  changes on environmental impa
- Reliance on novel technologies m
  some of the 'disadvantages' of
  broiler systems



Thank You!

QUEEN'S UNIVERSITY BELFAST

SCHOOL OF BIOLOGICAL SCIENCES

INSTITUTE FOR GLOBAL FOOD SECURITY

1ST IN THE UK AGRICULTURE, FOOD AND VETERINARY SCIENCES *(REF2021)

1ST IN THE UK AGRICULTURE *(Complete University Guide 2023)

4TH IN THE UK FOOD SCIENCE *(Complete University Guide 2023)

9TH IN THE UK BIOLOGICAL SCIENCES *(Complete University Guide 2023)

Royal Society of Biology Advanced Accredited Degree

Royal Society of Biology Accredited Degree

Institute of Food Science + Technology ifst

RICS Accredited Course

Athena Swan Gold Award

Gender Charter