**What's feeding our food: Right-sizing animal source food production**

**Commissioned by:** WWF UK, Living Planet Centre, Brewery Road, Woking, GU21 4LL

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**Output:** Research piece for internal use, format to be decided upon with successful bidder

**Research needs**

Globally, livestock production uses 70% of arable land, consumes large amounts of drinking water and is responsible for 14% of anthropogenic greenhouse gas emissions, coupled with the intense use of antibiotics that encourages the proliferation of resistant bacteria (van Zanten *et al*., 2019; [Herrero](https://www.sciencedirect.com/science/article/pii/S2211912417300056%22%20%5Cl%20%22bib39) *[et al](https://www.sciencedirect.com/science/article/pii/S2211912417300056%22%20%5Cl%20%22bib39)*[., 2016](https://www.sciencedirect.com/science/article/pii/S2211912417300056%22%20%5Cl%20%22bib39); [FAO, 2012](https://www.sciencedirect.com/science/article/pii/S2211912417300056#bib23),). Much of the environmental impact of food comes from the production of feed ingredients. However, livestock can play an important role in the bioconversion of inedible leftovers from agriculture and grass into valuable and nutritious food (van Zanten *et al*., 2018).

Our global feed system is dominated by a small number of agricultural commodities such as soybeans, maize, rapeseed oil and palm oil. Many of these are grown in expansive monocultures to the detriment of critical biomes like the Brazilian Cerrado and are likely to expand into other important places such as sub-Saharan Africa if the livestock industry continues to expand as projected (WWF, 2017). As well as ensuring these commodities are produced as sustainably as possible; free of deforestation, habitat conversion and human rights abuses, WWF-UK recognises the need to diversify the feed system with novel ingredients and more sustainable alternatives including viable waste streams. WWF-UK is keen to assess what it would mean for the UK if we were to take a more circular approach to the production of livestock feed ingredients by using only non human-edible by-products from other processes (ecological leftovers) and pastureland.

There has been some discussion (see key References below) on the amount of livestock that should be produced/consumed in the UK and what criteria should be used to make these decisions. One method that has been discussed recently, is to limit animal source food (ASF) to only the volume that can be produced from feed derived from ecological leftovers and pastureland (limited to specific boundaries defined by conservation of biodiversity). The amount of meat and dairy protein required in healthy human diets has also been quantified as well as the quantity of nitrogen that should be allowed to be released to the environment as a pollutant (a potential regulatory constraint). The proposed research is needed to quantify what a feed system would look like in the UK based on these 3 criteria and what impacts it would have on people and nature. This is essential to support a transition to a feed and livestock system providing for human and planetary health.

**Objectives**

1. To use existing literature and modelling to answer the question: How much feed could we produce from UK agricultural leftovers and pasture? What quality would it be depending on how it is used e.g. bio-converted into protein by insects or fermentation. How much would it cost? How much ASF could it supply? Would it entirely satisfy the nutritional needs of livestock in which case would we need additives from somewhere else? What is the right amount of land to be designated for pasture?
2. To review and summarise key points from the literature on carbon, nitrogen and phosphorus (CNP) use and pollution from livestock production in a UK context and regulatory levers to reduce pollution from livestock both UK and overseas.
3. Using modelling, to calculate the optimal projected size of UK livestock production and its environmental, health and social impacts both positive and negative in relation to the UK, based on the assumptions and conditions that have been stated above and suggest how a transition could be achieved.

**Background**

What is the right-size of the meat and dairy sector – if we are to produce the feed for it based on only ecological leftovers? About 40% of global arable land is used to produce feed (Mottet et al., [**2017**](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0025)). No matter how efficiently animal source food (ASF) is produced, using arable land to produce feed for ASF production is less efficient than using it directly for plant source food production (Foley et al., [**2011**](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0015); Godfray et al., [**2010**](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0022)). What factors should be considered in ‘right sizing’ meat production? Restricting livestock feed will lead to concentration into systems with the most efficient FCR’s and it has been suggested that it would favour poultry and dairy production (Van Hal et al., 2019). FFCC (**2021**) predict that beef cattle with feed supplements reducing enteric methane would become more important.

**Leftover material from agriculture as feed**. The role of animals in the food system should be centred on converting biomass that we cannot or do not want to eat (ecological leftovers) into valuable products, such as nutrient‐dense food (meat, fish, milk, and eggs) and manure. Biomass that we cannot or do not want to eat consists of biomass from grassland and leftovers. Leftovers include crop residues left over from harvesting of food crops, co‐products left over from industrial processing of plant source and ASF, and losses and waste in the food system. By converting these leftover streams, livestock recycle nutrients back into the food system that otherwise would have been lost in food production (van Zanten et al, **2018**; Garnett et al., [**2015**](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0020)).

**Pastureland**. How much grassland/pasture should be made available for grazing? (I.e. where is grazing beneficial for land in terms of carbon storage/sequestration **or** biodiversity e.g. marginal lands?). Ruminants can create nutritional value from grasslands by converting inedible grass products into milk, meat and manure for fertiliser and recycling. Therefore, by adopting this approach, arable land should be used primarily for production of food crops, rather than feed, so that livestock can contribute to nutrition supply without using arable land. However, not all grassland should be considered suitable for pasture and biodiversity conservation should also be considered. Rewilding or reforestation of some grassland that has been converted should also be considered. How much grassland and pastureland in the UK should be rewilded and how much retained as pastureland or turned to arable for food production?

**Nitrogen, carbon and phosphorus cycles**. Could limiting pollution by legislation also lead to limiting livestock production and if so, what levels should be set? There have been precedents for this, in Denmark in particular. What lessons have been learnt from these experiences? How much meat production would that allow in the UK or does that have to be determined by considering the whole agriculture system? Do we need to talk about imports?

**Human nutrition.** According to the WHO, the average adult requires 50–60 g of (plant and/or animal) protein each day (Alimentarius, [2013](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0003)). The current average global supply of terrestrial animal protein (excluding fish) per capita is 27 g per day (FAOSTAT, [2017](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0013)), while large differences exist between countries. There is considerable global variation (e.g. 51g of terrestrial animal protein per day in Europe and 8g in West Africa). High consumption levels of ASF, especially red processed meat, in the western world are associated with the rise in noncommunicable diet‐related diseases, such as obesity, heart diseases, and cancer (Tilman & Clark, [**2014**](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321#gcb14321-bib-0041)). How much terrestrial animal protein is required in the UK for a healthy population?

**How much food could we produce from non-edible waste?** Several studies have calculated the amount of ASF that could be produced in feed systems that limit livestock production based on the principle of low‐cost livestock (i.e., avoiding feed‐food competition) and arrived at a figure of 9–23g/d (van Zanten et al, 2018). Presumably this will also affect the mix of species if the quantity of feed is limited there will be a move towards the most valuable or the most efficient. Ecological leftovers would probably require conversion by processes such as fermentation (single celled organisms-algae, bacteria, fungi) or insects.

**How much ruminant meat could we produce from the available grassland in the UK?** What are the alternative uses of grassland? How much should be maintained as pasture and how much should be rewilded planted with trees or other alternative uses such as arable land to produce food? How would this decision be made-based on biodiversity conservation/restoration or other criteria?

**What are the alternative uses of ecological leftovers?** Are there better uses for ecological leftovers such as biofuels? Would this be a more efficient use?

**Environmental benefits.** What would be the benefits/impacts on the environment of reducing the amount of livestock based on the discussed parameters? Under what conditions – if any – must a minimum threshold of livestock be met to ensure positive environmental outcomes?

**How could this change be achieved? What are the levers for change?**

Legislation: Legislate to restrict the use of arable land for feed ingredient production or to restrict the feeding of livestock with feed ingredients produced from arable land.

Demand: Retailers/feed manufacturers/consumers: advocacy and case study?

**Budget**

The budget for this piece of work is a maximum of £20,000 including VAT.

**Project deliverables**

Report in MS Word fully referenced of not more than 50 pages including results of modelling scenarios

A shorter executive summary with takeaways and recommendations for WWF-UK to be developed into a peer reviewed paper published in a recognised journal.

Full list of references

Modelling methods in appendices

**Project timeline and application requirements**

Date for project to start: asap inMarch 2021

Date for project to end: 30th June 2021

Bid for the work should include:

* Detailed approach for completion of the project
* Relevant experience (and case studies of similar previous work if applicable)
* CVs of consultants who will participate in the project
* A precise budget broken down by key tasks, including consultant daily rates
* The estimated number of person-days required
* A detailed timeline for delivery

The application should be no longer than 4 sides, plus relevant experience and CVs of participating consultants attached in an appendix.

Proposals will be assessed according to the following criteria:

* Fit to brief
* Existing expertise of food, agriculture, livestock feed and farming standards
* Existing expertise of nutrition, health and food policy
* Robustness of proposed approach

**Please email proposals to Piers Hart (****phart@wwf.org.uk****), with Mollie Gupta (****mgupta@wwf.org.uk****), by 26/02/2021.**

WWF will then contact the successful bidder on 1-7/03/2021.

Some key References:

van Hal O., de Boer I.J.M., Muller A., de Vries S., Erb K.-H., Schader C., Gerrits W.J.J., van Zanten H.H.E., (2019). Upcycling food leftovers and grass resources through livestock: Impact of livestock system and productivity. Journal of Cleaner Production 219.

van Zanten H.H.E., Van Ittersumb M.K., De Boer I.J.M., (2019). The role of farm animals in a circular food system. Global Food Security. 21:18–22

[van Zanten H.H.E,.](https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14321) Mario Herrero M., van Hal O., Roos E., Muller A., Garnett T., Gerber P.J. Schader C., De Boer I.J.M., (2018). Defining a land boundary for sustainable livestock consumption. Glob Change Biol. 24:4185–4194.

[FAO, 2012](https://www.sciencedirect.com/science/article/pii/S2211912417300056#bbib23), **Livestock and Landscapes**, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FFCC (2021). FARMING FOR CHANGE: MAPPING A ROUTE TO 2030, The Food, Farming and Countryside Commission

Herrero M., Conant R., Havlik P., Hristov A.N., Smith P., Gerber P., Gill M., Butterbach-Bahl K., Henderson B., Valin, H. Thornton P.K. (2016). Greenhouse gas mitigation potentials in the livestock sector. Nat. Clim. Change, 6, pp. 452-461

Mansholt lecture (2018) “Circularity in agricultural production” by Imke J.M. de Boer and Martin K. van Ittersum.

Soil Association papers: ([Fixing Nitrogen: The challenge for climate, nature and health,](https://www.soilassociation.org/media/21286/fixing_nitrogen_soil_association_report.pdf?_cldee=dHN0dWFydEB3d2Yub3JnLnVr&recipientid=contact-40a786a152deea11818f005056ad0bd4-9bf5d0bf63bf4b508b777c15335410d7&esid=b8182b95-56de-ea11-818f-005056ad0bd4) etc)

WWF (2017). papers: [Appetite for Destruction](https://www.wwf.org.uk/sites/default/files/2017-10/WWF_AppetiteForDestruction_Summary_Report_SignOff.pdf) : Environmental Impacts of Livestock, 3Keel, 2017