LCA of Sparse Historical Data from Pig Systems

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The development in pig performance in UK

- The UK pig production industry has seed drastic development in both management and animal performance
- Changes in animal performance:

Traits	2000	2017
Average Daily Gain (g)	657	833
Finishing weight (kg)	93.4	110.9
Feed Conversion Ratio (kg gain/kg feed)	2.62	2.86
Litter Size (n)	12.2	14.26

Source: AHDB

Have the Environmental impacts been reduced?

- Presumed lower environmental impacts today than previous:
  - ↑ Output per pig production space
  - ↓ Input per pig production space
- Not clear if environmental impacts are lower and if so, if this is due to management or genetics

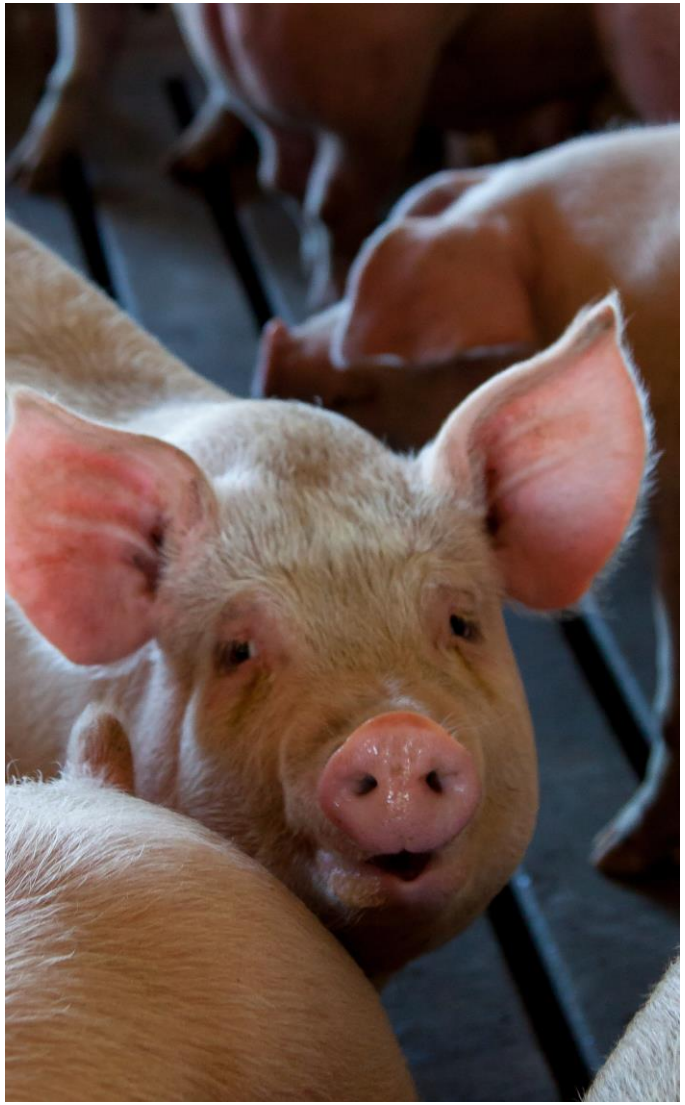
Aim: to investigate the environmental impacts due to the changes in pig performance under constant management system

The data required to build pig LCA

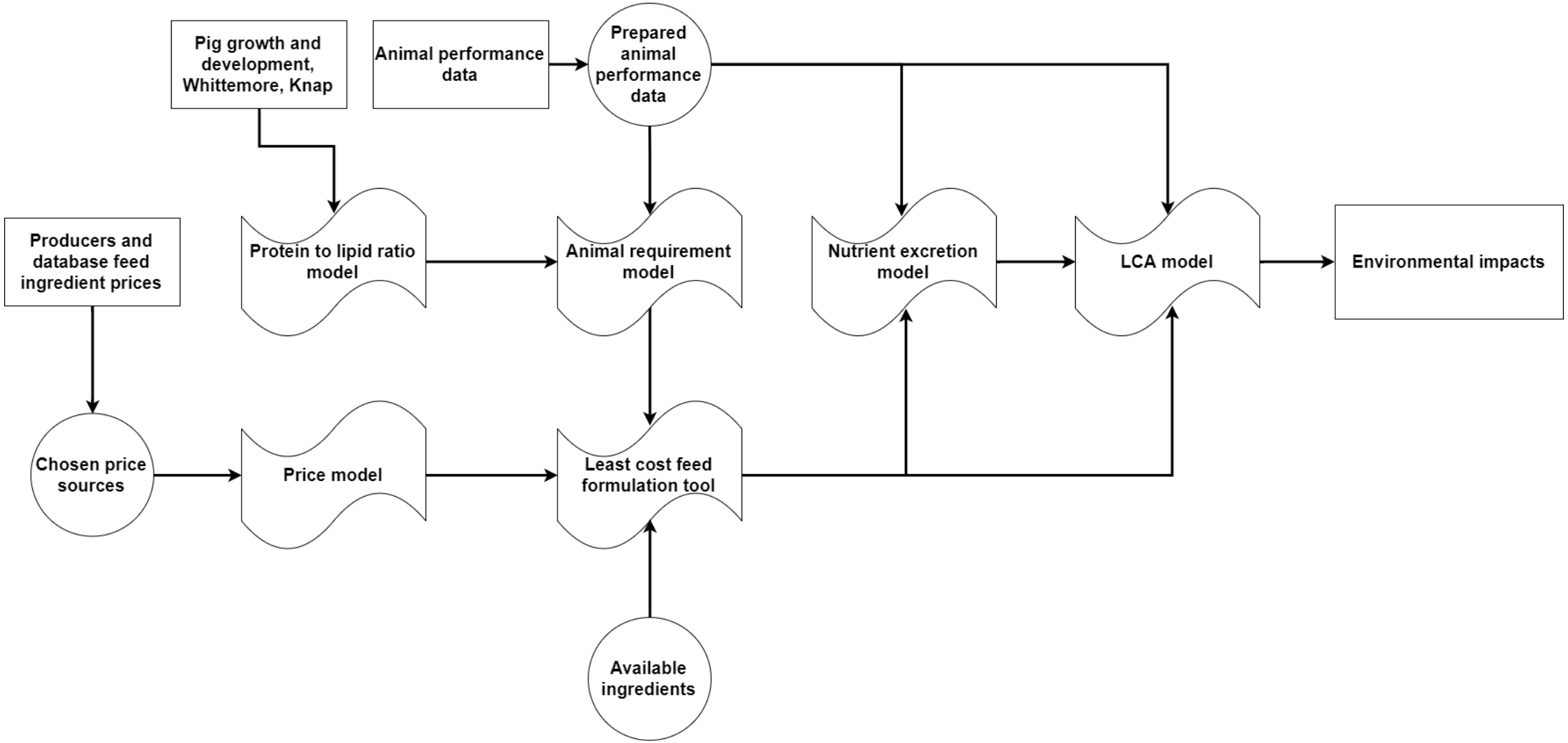
- To properly estimate environmental impacts from pigs, the following information is required:
  - Production rate of piglets and finisher pigs
  - All feed ingredients in all feeds in the full life cycle of both the sow and the slaughter pig
  - How much feed is eaten of which feeds to produce the finisher pig
  - All produced manure on the farm, nutritional composition and how it is managed

The data which is available for the LCA

- Only limited national pig performance data available for the last 2 decades:
  - Wean to slaughter pigs:
    - Mortality
    - Average daily gain
    - Feed conversion ratio
    - Start and end weights
  - Sows:
    - Litters per sow per year
    - Live born and total litter size
    - Prewean mortality
    - Weaning weight
    - Replacement rate
    - Annual feed intake
- Modelling is required to make up for the missing information



Estimating environmental impacts



Building LCA on what we know

1. Using performance data to predict nutrient requirements
2. Using nutrient requirements to predict feed compositions
3. Using feed compositions and performance data to predict nutrient excretion

Modified from: https://www.wikihow.com/Feed-Pigs

1) Animal requirement models

- Predict minimum energy and protein concentration in feed, and protein and lipid growth from:
- From wean to slaughter, including gilt stage:
  - Solving 4 equations:
    - Conservation of metabolizable energy
    - Conservation of digestible protein
    - Conservation of mass
    - Lipid to protein ratio as function of age and year
- Sows – gestation and lactation
  - Modified InraPorc (Dourmad et al., 2008) model complying with protein conservation

2) Least cost feed formulations

- Prices obtained from industrial sources, national and international databases (DEFRA, EUROSTAT, FAOSTAT)
- Nutrients in each feed ingredient from PremierAtlas: ingredients matrix
- Lysine assumed to be 6.8 % of SID protein
- As a function of animal age:
  - Essential amino acid requirement relative to lysine from the InraPorc model
  - Minerals (Ca, K, Na, Cl and dig. P) from NRC (2012)
- Since the feed formulation problem is linear, the least cost solution can be found with the Simplex algorithm

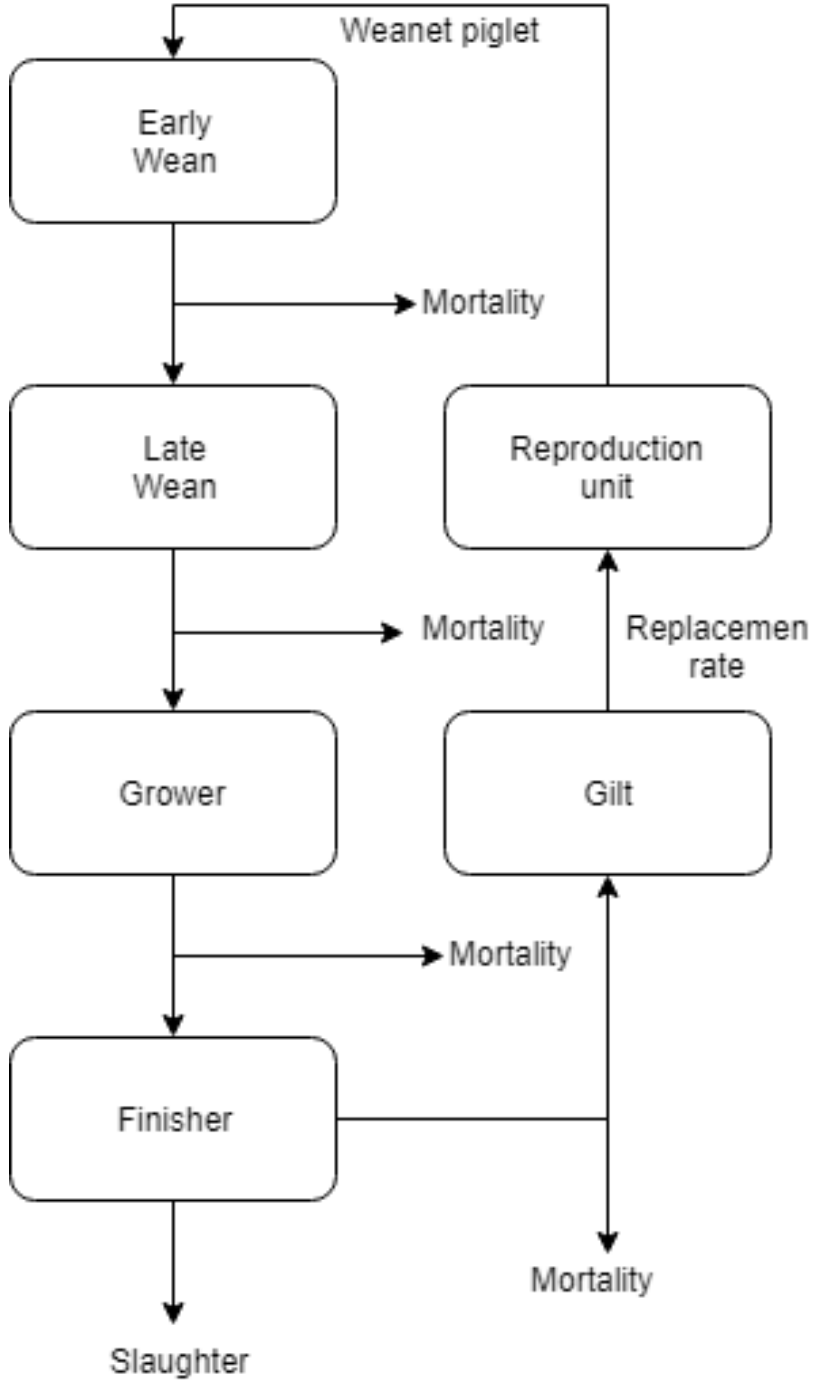
3) Nutrient excretion

- N, P and K retention estimated from predicted growth in protein and data on BW growth
- N, P and K intake from feed compositions and cumulative feed intake
- N, P, K, carbon and methane excretion from feed intake, retention and animal models

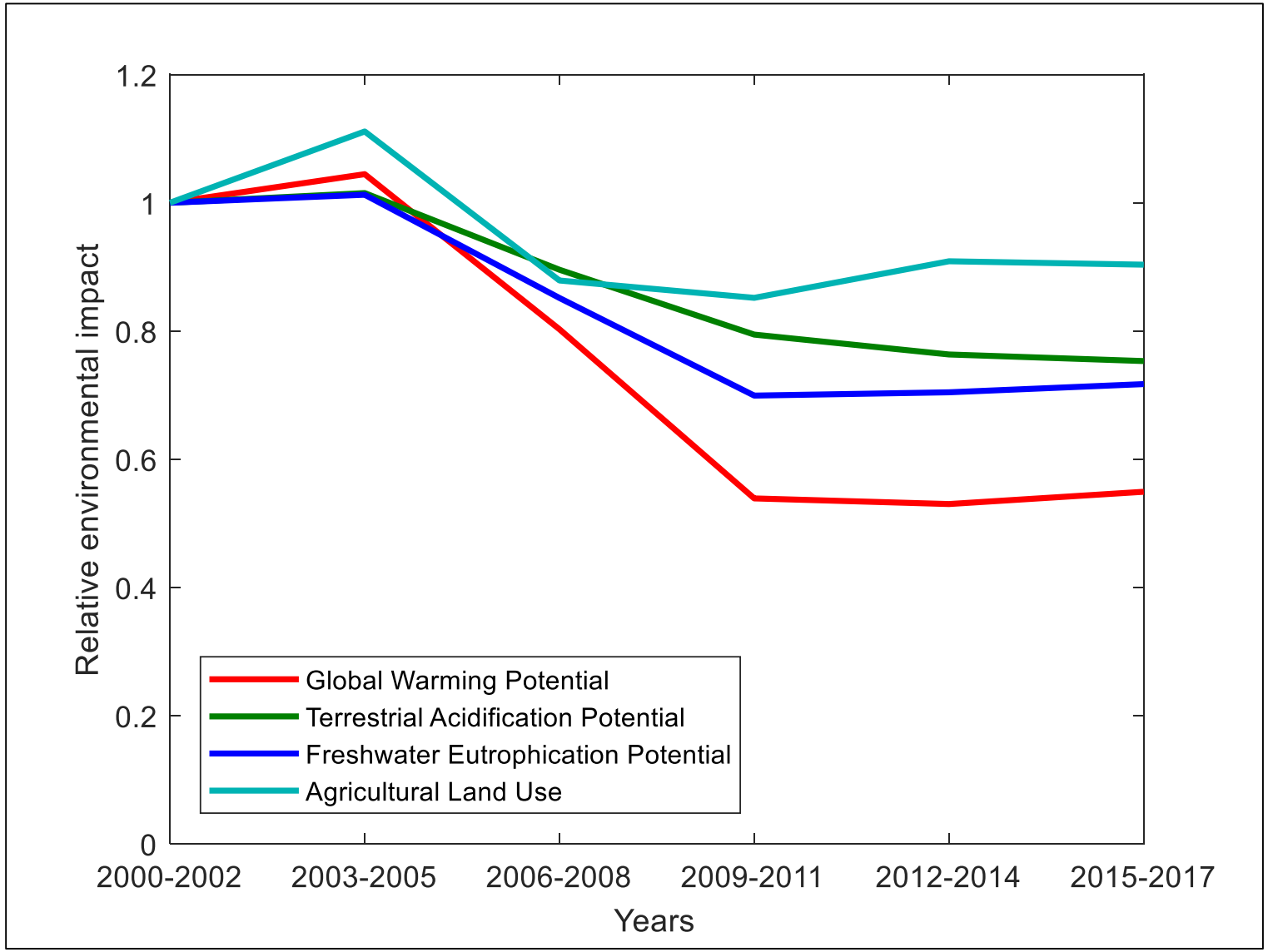
$$Excretion = Intake - Retention$$

LCA framework

- Present day impacts for UK feed ingredients were exported from SimaPro database
- Model was built in MATLAB applying matrix LCA methodology
- Implemented present day manure management for UK with a best practise artificial fertiliser replacement rate
- Functional unit was 1 kg of live finisher pig at farm gate

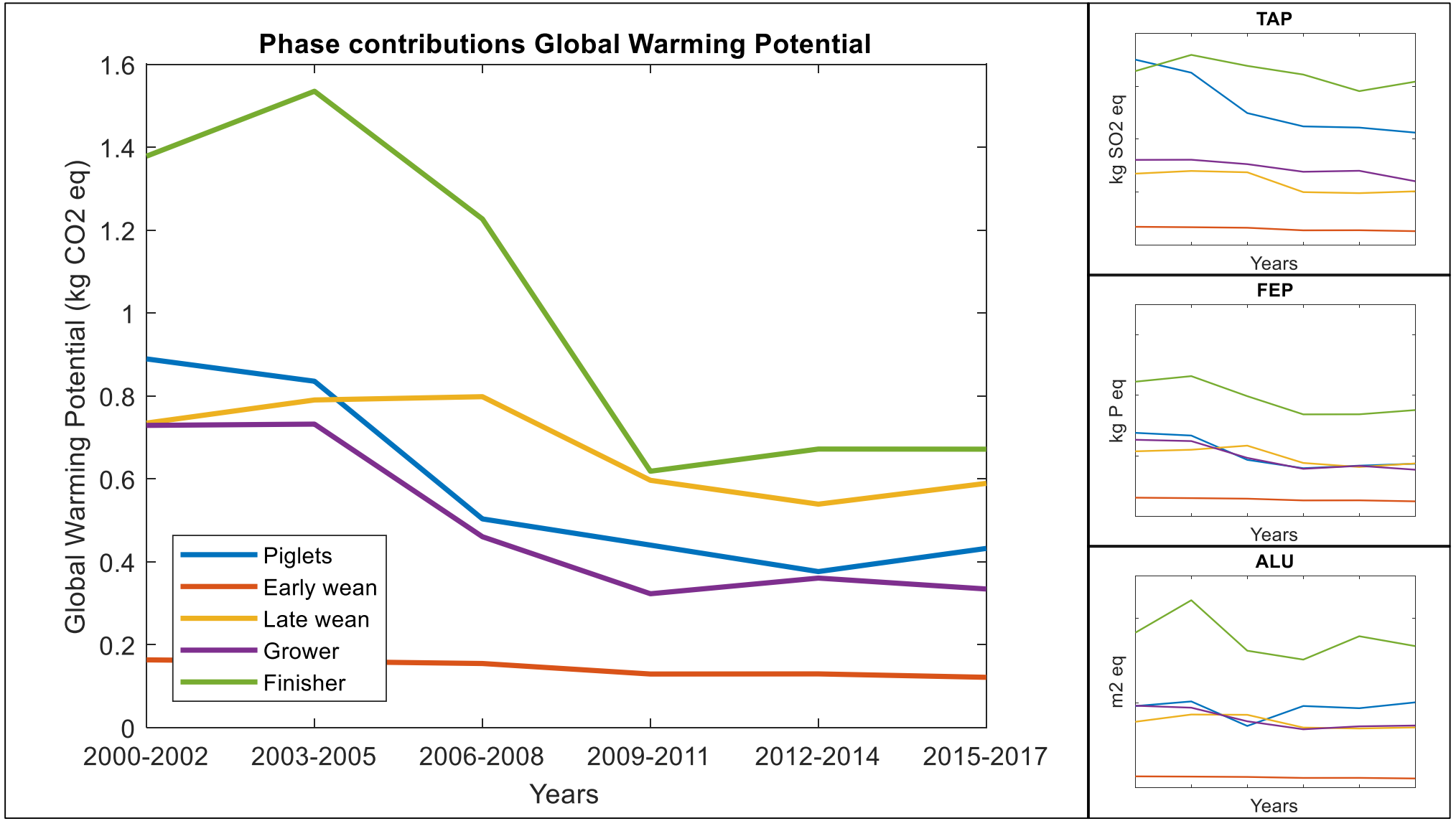


Results - Relative environmental impacts



- Large reductions in GWP
- Intermediate reductions in TAP and FEP
- Oscillations in ALU

Contributions from individual phases



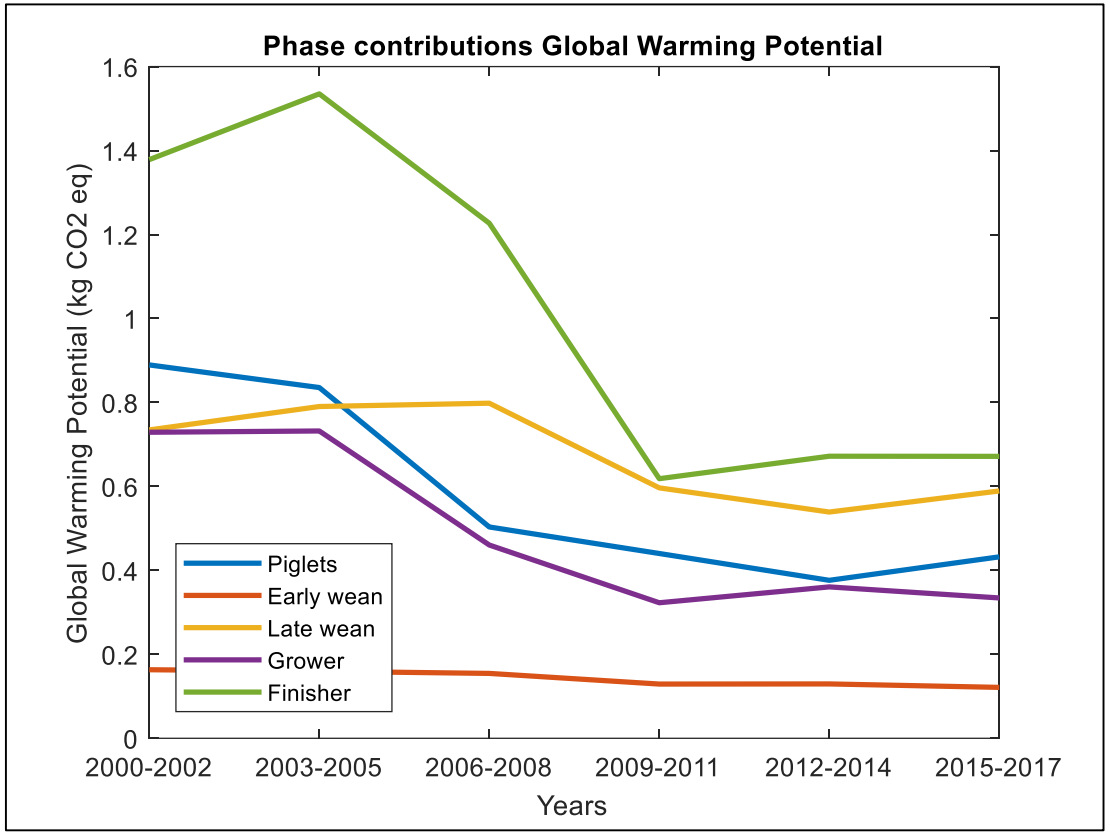
Discussion

Reductions before 2012-2014

- Soya product inclusion has been considerable reduced for all feeds
- Lower feed intake
- Sows produce more piglets per year

Increases after 2012-2014

- Higher slaughter weights
- Higher FCR
- Higher sow replacement rate



Conclusions

- LCA framework could be utilised on sparse performance data but validation is desirable if data were available
- The results suggest that British pig production has reduced environmental impacts over the last two decades, especially in Global Warming Potential and Freshwater Eutrophication Potential
- The largest reductions were achieved in the finisher phase
- Feed prices may have large effects on the environmental impacts from the pig industry

Acknowledgement

This research is part of the European SusPig and Feed a Gene projects. SusPig receives funding from the ERA-NET Sustainable Animals and the Department for Environment, Food and Rural Affairs of England. Feed a Gene receives funding from the European Union Horizon 2020 Programme for Research, Technological Development, and Demonstration under grant agreement no. 633531.

We are grateful for the data we have received from Agriculture and Horticulture Development Board (AHDB)

Thank you for your time

Any questions?

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