PLF technologies could reduce greenhouse gas emissions on beef farms

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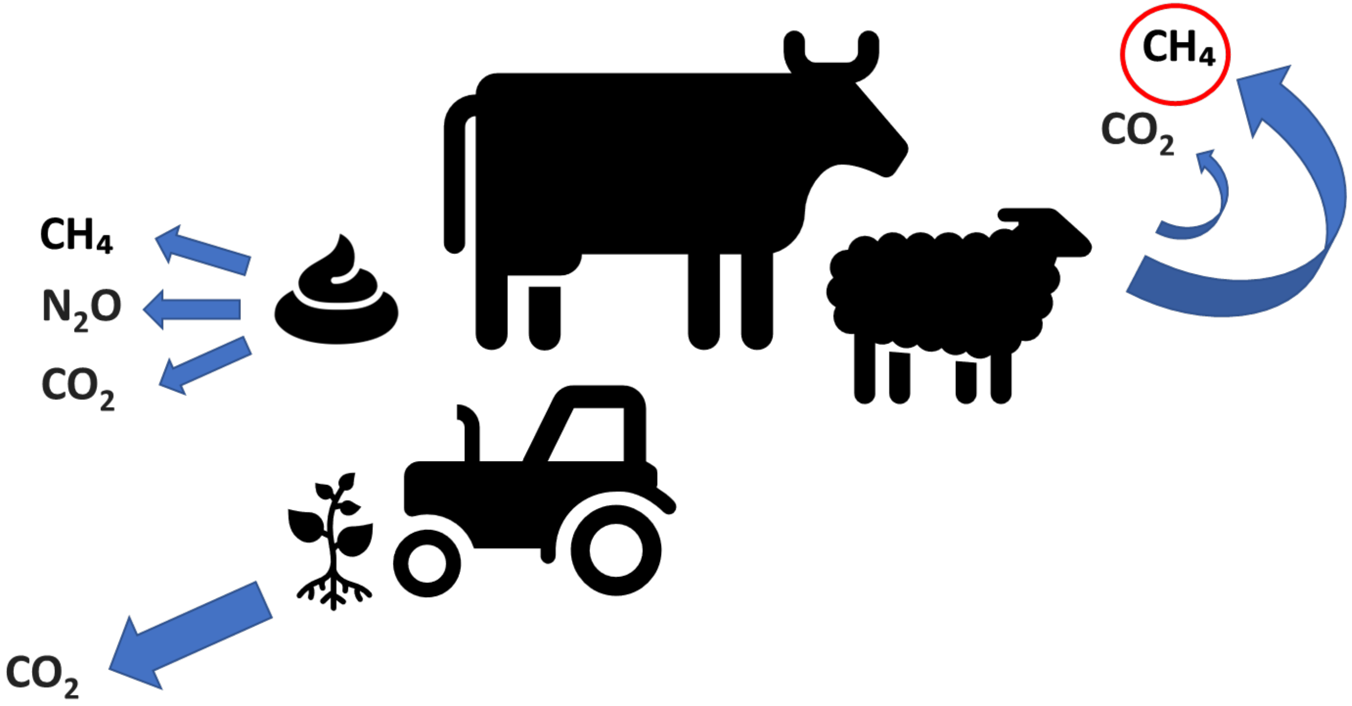
Background

- Livestock sector is a significant contributor to global emissions

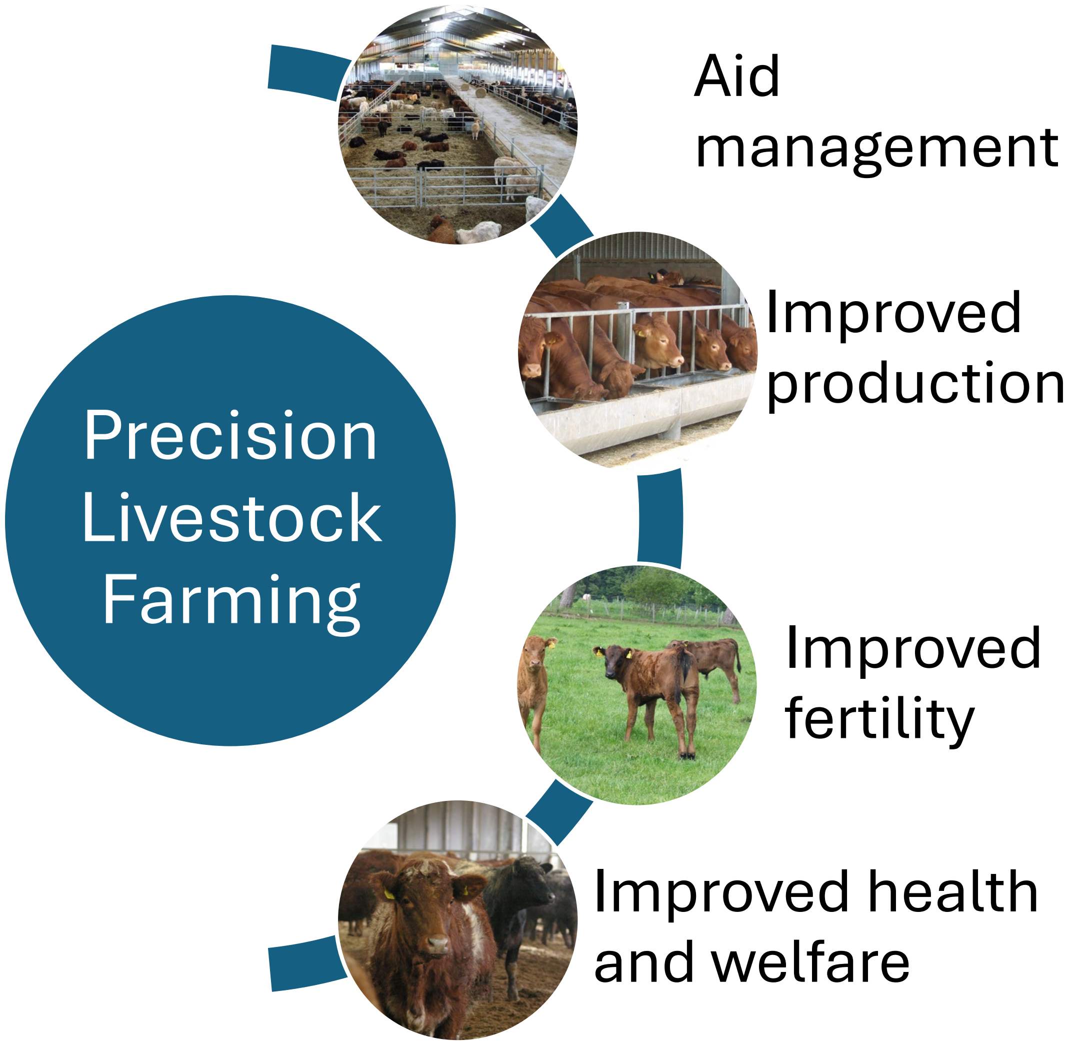
- Net zero targets
  - China – 2060
  - United States - 2050
  - Scotland - 2045

- Opportunity
  - Increase production efficiencies
  - Data-driven innovations



PLF technologies

- Continuous automated monitoring to gather data
- Potential to indirectly reduce emissions through increased production efficiencies
- BUT to what extent can PLF technologies reduce GHG emissions?

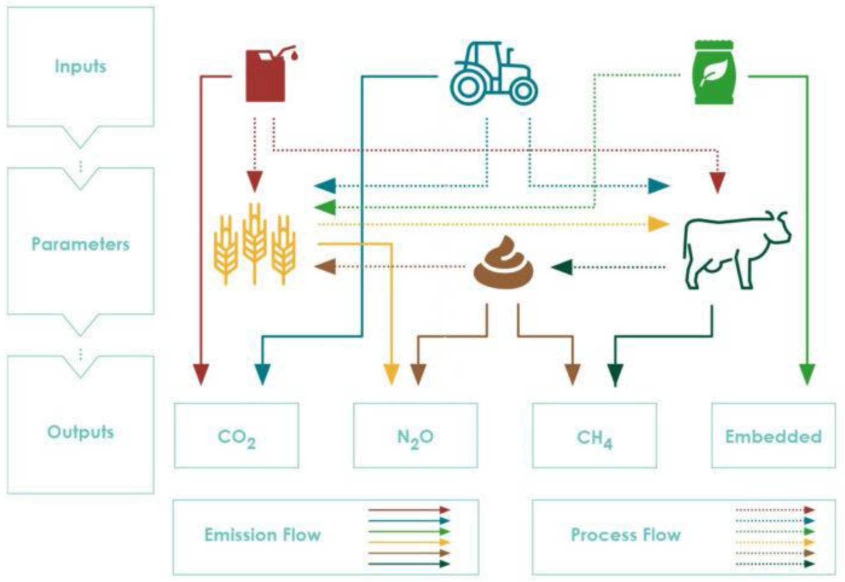


Methods

- Two scenarios (1 housed and 1 grazing) created using average data from the Scottish Cattle Tracing System
- Baseline emission estimates calculated using Agrecalc
- Modelled the impacts of 3 different PLF technologies
- Assumptions based on validated technologies, direct experience from farms and expert opinion

Emission estimates

- "Cradle-to-gate"
- Tier 2 country specific emission factors for all livestock emissions
- Conforms to PAS2050 and ISO 14044 LCA guidelines
- Expressed as total emission (kg CO_2e) and product emissions (kg CO_2e /kg dwt)



Scenarios

- Both spring calving lowland suckler herds

- Grazing
  - Age at slaughter 21 months
  - Grazing for 6.7 months and housed for 5.28 months

- Housed
  - Age at slaughter 19 months
  - Housed for 7.1 months and grazing for 4.9 months

- Grass and grass silage, supplemented with barley + minerals (13% CP and 65% digestibility)

PLF technologies

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- Automatic weigh platforms
- Accelerometer-based sensors for oestrus detection

  (fertility sensors)
- Accelerometer-based sensors for early disease detection

  (health sensors)

Assumptions – automatic weigh platform

- **Reduced age at slaughter by 1 month**
  - Reduced KO% by 0.5%
  - LWG increased by 0.05 kg/day

- **Reduced age at slaughter by 2 months**
  - Reduced KO% by 1%
  - LWG increased by 0.09 kg/day

- **Reduced age at slaughter by 3 months (grazing only)**
  - Reduced KO% by 1.5%
  - LWG increased by 0.15 kg/day
  - Final month of grazing replaced with 1 month of housing

Assumptions - sensors

- **Fertility sensors**
  - Increase in calves born (4%) and reared (3%)
  - Decrease in replacement rate of 1%
  - Age at first calving reduced to 24 months
  - Cow weight decreased by 20 kg

- **Health sensors**
  - Increase in calves born (4%) and reared (4%)
  - Decrease in replacement rate of 1%
  - Two fewer deaths (youngstock)
  - LWG increase by 0.16 kg/day

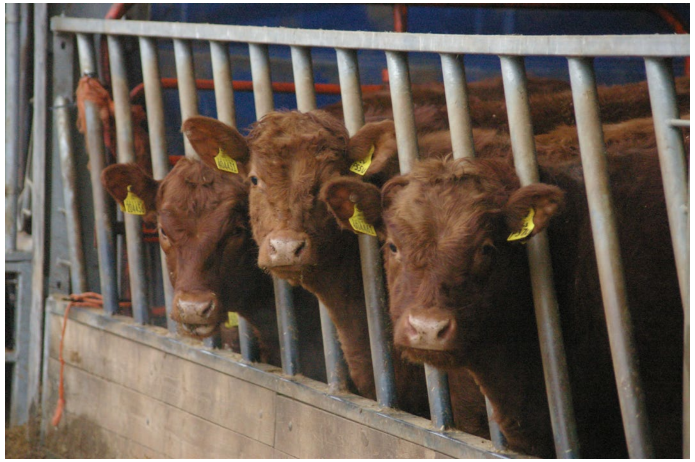
Grazing input data

Farm Info	Baseline	RAS1	RAS2	RAS3	Fertility sensors	Health sensors
Suckler cows (hd)	91.83	91.83	91.83	91.83	92.58	92.33
Calves born (%)	86	86	86	86	90	90
Calves reared (%)	80	78	78	78	83	84
Replacement rate (%)	15	15	15	15	14	14
Age at calving (months)	36	36	36	36	24	36
Cow weight (kg)	700	700	700	700	680	700
Age at weaning (months)	220	220	220	220	220	220
Age at slaughter (months)	21	20	19	18	21	18
Steer sale weight (kg)	652	654	653	648	652	681
Steer sales (hd)	40	40	40	40	42	43
Steer KO%	56	55.5	55	54.5	56	55
Steer LWG (kg/day)	0.94	0.99	1.04	1.09	0.94	1.1
Heifer sale weight (kg)	589	594	590	594	589	615
Heifer sales (hd)	25	25	25	25	28	29
Heifer KO%	56	55.5	55	54.5	56	55
Heifer LWG (kg/day)	0.85	0.9	0.94	1	0.85	1.01
Cow sale weight (kg)	700	700	700	700	680	700
Cow sales (hd)	13	13	13	13	13	12
Cow KO%	56	56	56	56	56	56
Deaths (hd)	8	8	8	8	7	6
Total deadweight (kg)	27961	27857	27575	27316	29521	29859
Total concentrates (t)	7.61	7.61	7.61	7.61	7.98	8.09
N fertiliser (t)	57.27	55.16	52.86	51.37	54.17	52.9

Housed input data

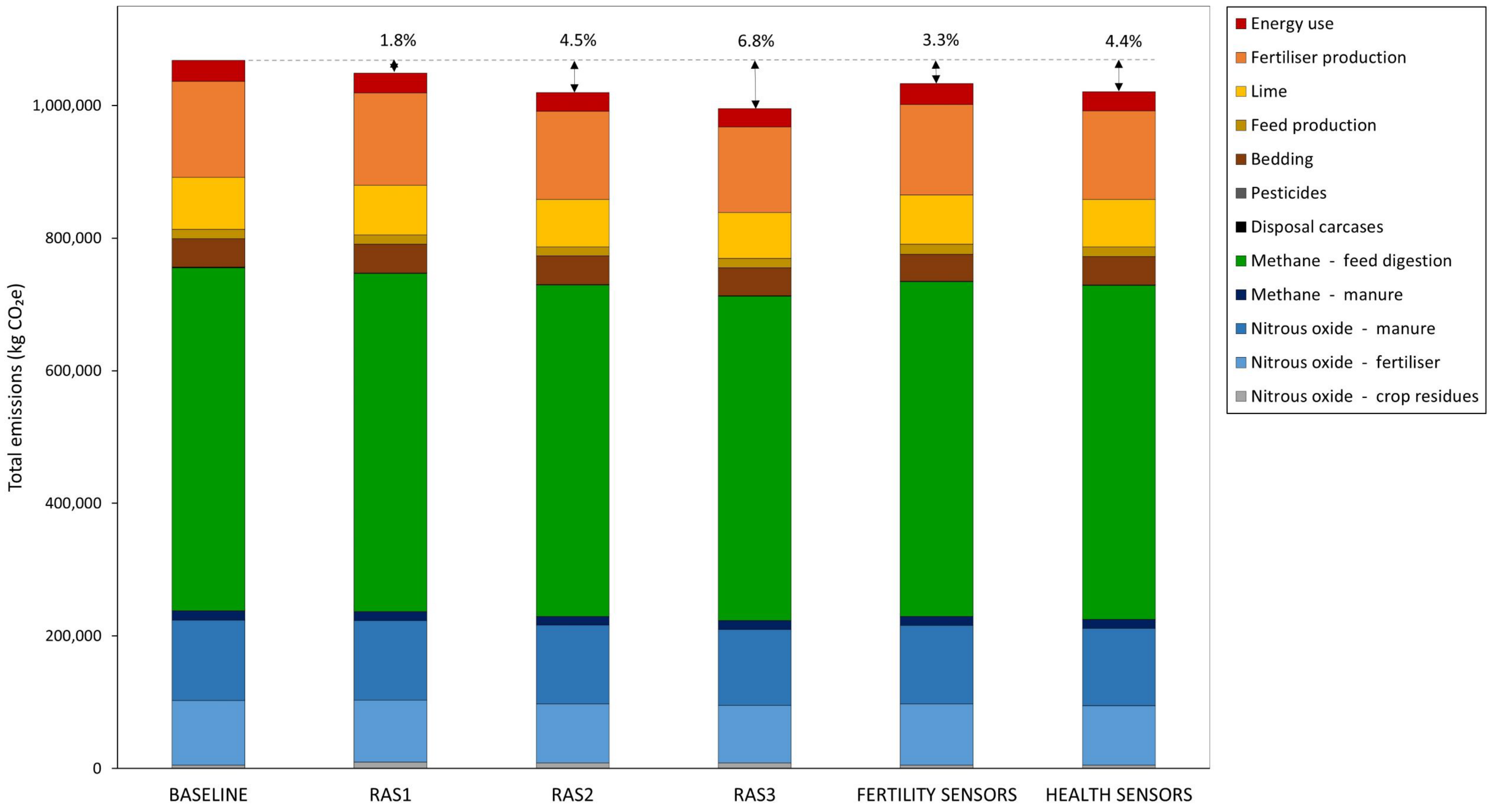
Farm Info	Baseline	RAS1	RAS2	Fertility sensors	Health sensors
Suckler cows (hd)	91.83	91.83	91.83	92.33	92.33
Calves born (%)	86	86	86	90	90
Calves reared (%)	80	80	80	80	80
Replacement rate (%)	15	15	15	15	15
Age at calving (months)	36	36	36	24	36
Cow weight (kg)	700	700	700	700	700
Age at weaning (months)	220	220	220	220	220
Age at slaughter (months)	19	18	17	19	17
Steer sale weight (kg)	641	637	654	641	654
Steer sales (hd)	40	40	40	42	43
Steer KO%	56	55	55	56	55
Steer LWG (kg/day)	1.02	1.07	1.10	1.02	1.10
Heifer sale weight (kg)	578	583	579	578	579
Heifer sales (hd)	25	25	25	28	29
Heifer KO%	56	55	55	56	55
Heifer LWG (kg/day)	0.92	0.98	1.03	0.92	1.03
Cow sale weight (kg)	700	700	700	680	700
Cow sales (hd)	13	13	13	12	12
Cow KO%	56	56	56	56	56
Deaths (hd)	8	8	8	8	8
Total deadweight (kg)	27550	27537	27550	28713	29854
Total concentrates (t)	7.61	7.61	7.61	7.98	8.09
N fertiliser (t)	60.27	57.58	55.43	57.72	56.78

Results

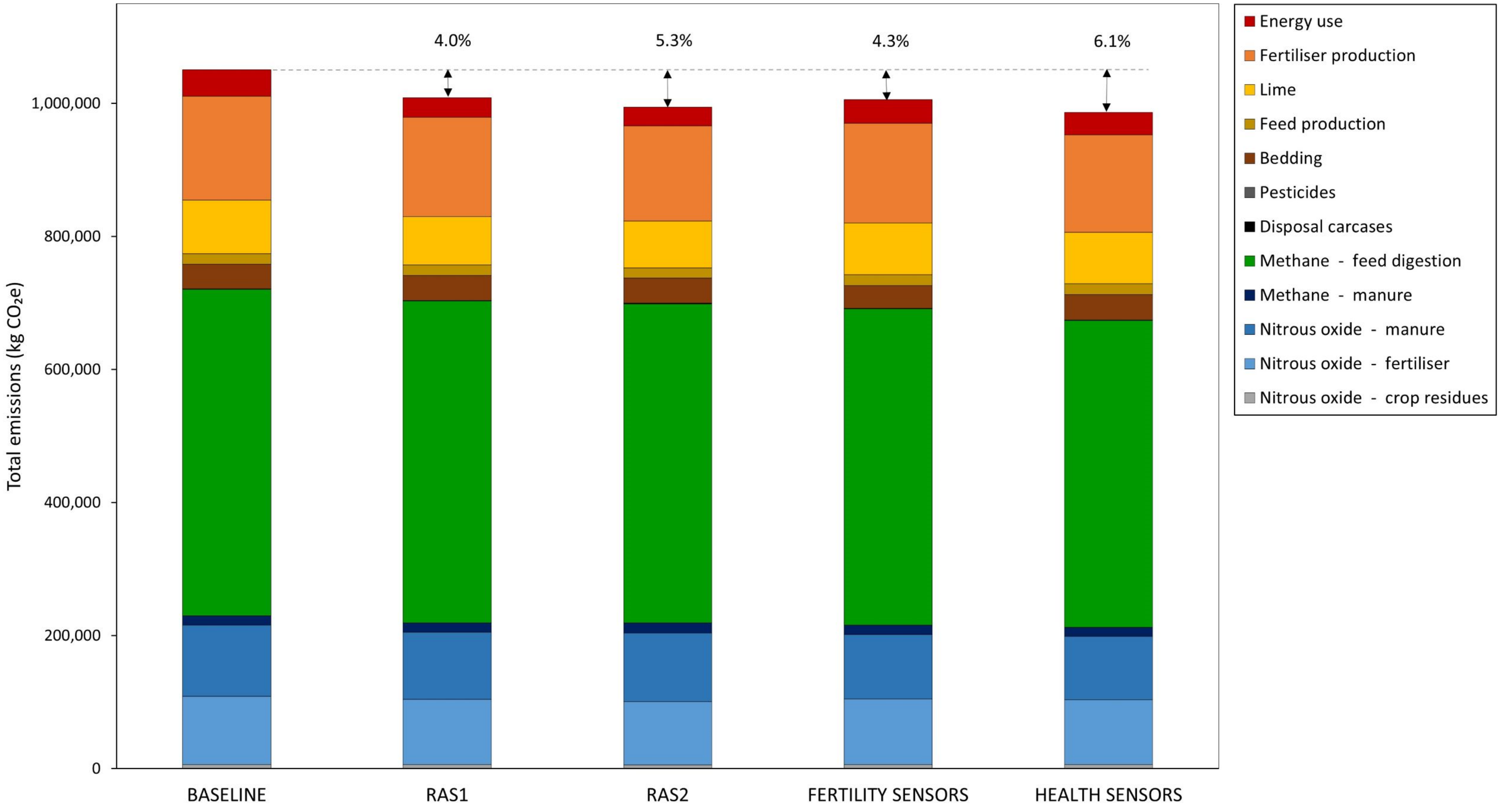


- Baseline total emissions and product emissions were similar in grazing and housed scenarios
- All PLF technologies reduced total and product emissions in the both scenarios
- In general, PLF technologies had larger impact in housed system

Results – grazing scenario



Results – housed scenario

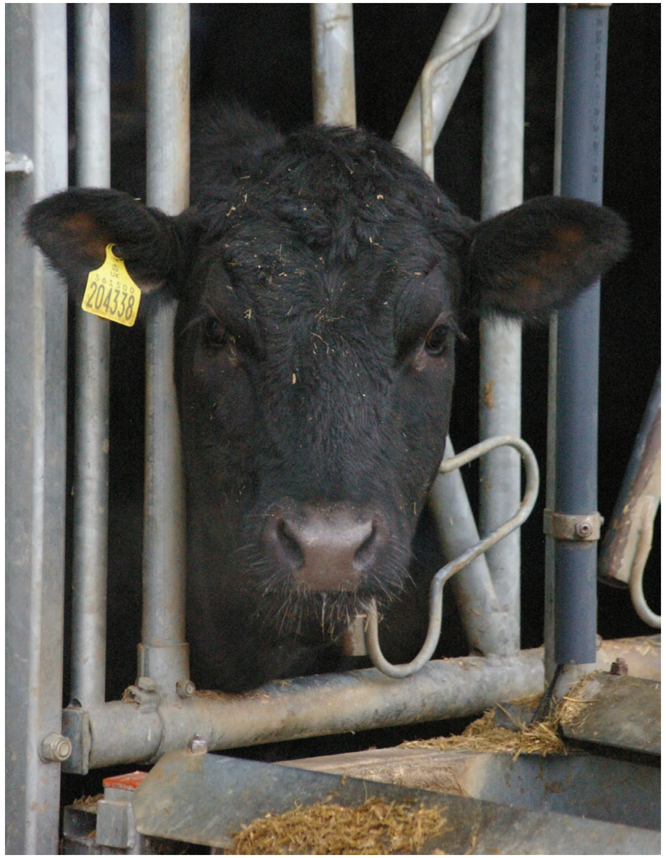


Results – product emissions

	Product emissions (kg CO_2e/kg dwt)					
	Baseline	**RAS1**	**RAS2**	**RAS3**	**Fertility sensors**	**Health sensors**
Grazing	38.20	37.65 (-1.4%)	36.99 (-3.2%)	36.45 (-4.6%)	35.00 (-8.4%)	34.19 (-10.5%)
Housed	38.14	36.89 (-3.3%)	36.24 (-5.0%)	- -	35.02 (-8.2%)	33.58 (-12%)

Key points

- Importance of total vs product emissions
- PLF technologies offer “win-win” solutions, but uptake remains low
- While this modelling was based on Scottish farms, similar reductions are likely attainable in other European countries with similar farming systems



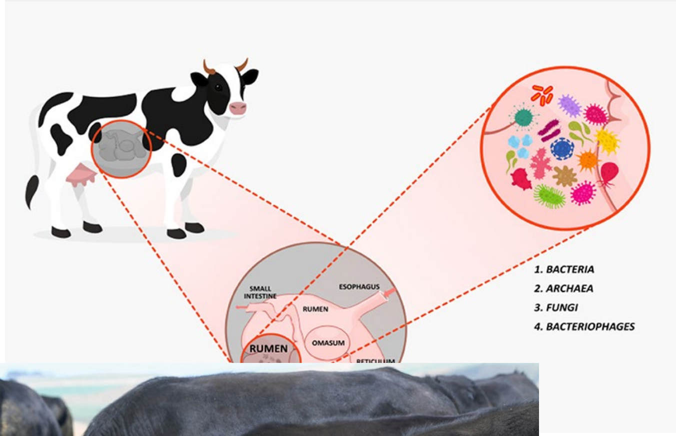
Limitations

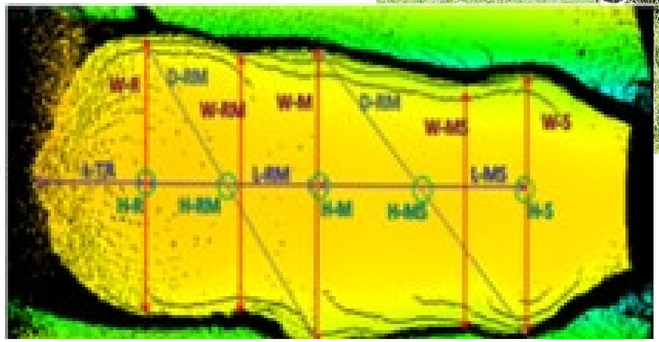
- Emission reductions in practice may not reach maximum technical potential
- Potential for over- or under-estimation of abatement potentials
- This modelling did not consider other environmental or socio-economic impacts

Future work

- Modelling the same technologies on real farms
  - Data from 850+ farms in Scotland
  - “good”, “bad” and “average” farms for 2 enterprise types
  - Spring calving lowland and finishing beef calves

- Modelling the effects of future tech
  - 3D cameras
  - Virtual fencing/mob grazing
  - Microbiome driven breeding





Conclusions

- Individual PLF tech could reduce emissions by up to 6.8%

- PLF offers a “win-win” solution and demonstrating these benefits could increase uptake

- More studies are needed to assess the effects of PLF on production and GHG emissions, as well as social and economic impacts

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Adoption of precision livestock farming technologies has the potential to mitigate greenhouse gas emissions from beef production

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To meet the objectives of the Paris Agreement, which aims to limit the increase in global temperature to 1.5°C, significant greenhouse gas (GHG) emission reductions will be needed across all sectors. This includes agriculture which accounts for a significant proportion of global GHG emissions. There is therefore a pressing need for the uptake of new technologies on farms to reduce GHG emissions and move towards current policy targets. Recently, precision livestock farming (PLF) technologies have been highlighted as a promising GHG mitigation strategy to indirectly reduce GHG emissions through increasing production efficiencies. Using Scotland as a case study, average data from the Scottish Cattle Tracing System (CTS) was used to create two baseline beef production scenarios (one grazing and one housed system) and emission estimates were calculated using the Agrecalc carbon footprinting tool. The effects of adopting various PLF technologies on whole farm and product emissions were then modelled. Scenarios included adoption of automatic weigh platforms, accelerometer-

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