

# Greenhouse gas mitigation potential of current precision livestock technologies on Scottish beef farms

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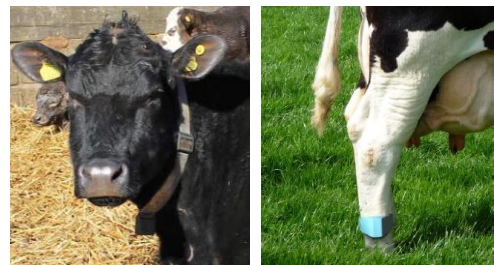
## Overview

Current commercially available precision livestock farming (PLF) technologies have the potential to indirectly reduce greenhouse gas (GHG) emissions from beef farms by improving production efficiency. Modelling based on real Scottish beef farm data showed that three PLF technologies - automatic weighing platforms, health sensors, and fertility sensors - reduced emission intensities on average, although impacts varied across production systems and technologies.

## Main Findings

Modelling was conducted on **12 Scottish beef farms** across two enterprise types: lowland suckler systems and beef finishing systems. Baseline GHG emissions were estimated using **Agrecalc**, and PLF technologies were modelled using assumptions informed by validated data, farmer experience, and expert input.

- **PLF technologies reduced emission intensities** across both **suckler and finishing systems** on average, with impacts varying by technology type and production system.
- **Automatic weighing platforms** reduced total emissions (**1-22%**) and emission intensity (**0.3-7%**) by reducing age at slaughter by 1-3 months (RAS1-3), with the greatest reduction observed in finishing systems. However, benefits were not always linear, suggesting an optimal reduction in age at slaughter may exist.
- **Fertility sensors** reduced total (**4%**) and product emissions (**9%**) in suckler systems by improving reproductive efficiency, increasing output, though adoption is limited to breeding herds.
- **Health sensors** increased total farm emissions (**8%**) due to higher productivity (more calves, improved growth rates, and lower mortality) but delivered the largest reductions in emission intensity (**10-12%**), reflecting improved output efficiency.
- Overall, PLF technologies show **strong potential for reducing GHG emissions** in beef systems, but their effectiveness depends on farm context, baseline performance, and production system characteristics.
- PLF technologies not only reduce GHG emissions but also improve production efficiencies, making them a **“win-win” solution** that delivers both **environmental and economic benefits**.
- Clearly demonstrating these benefits could help inform **policy** and support **wider adoption**.



## Introduction

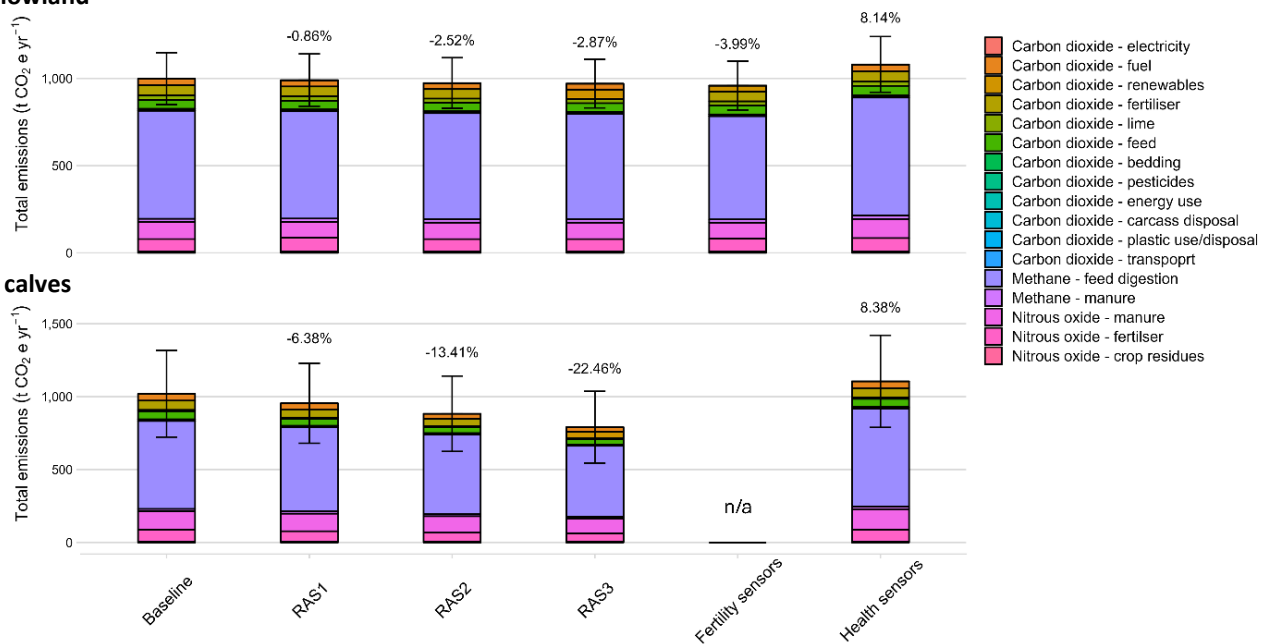
The UK aims to reach net zero by 2050, while Scotland has set a 2045 target. Agriculture, particularly beef production, accounts for a significant share of emissions, requiring substantial mitigation. PLF technologies have been identified as a means of increasing production efficiency (and therefore reducing GHG emissions) through continuous, automated, real-time data collection and data-driven management. These systems can enhance disease and reproductive management by detecting deviations in animal behaviour, enabling earlier intervention. The aim of this study was therefore to model the effects of health sensors, fertility sensors, and automatic weigh platforms on GHG emissions of Scottish beef farms.

## Assumptions

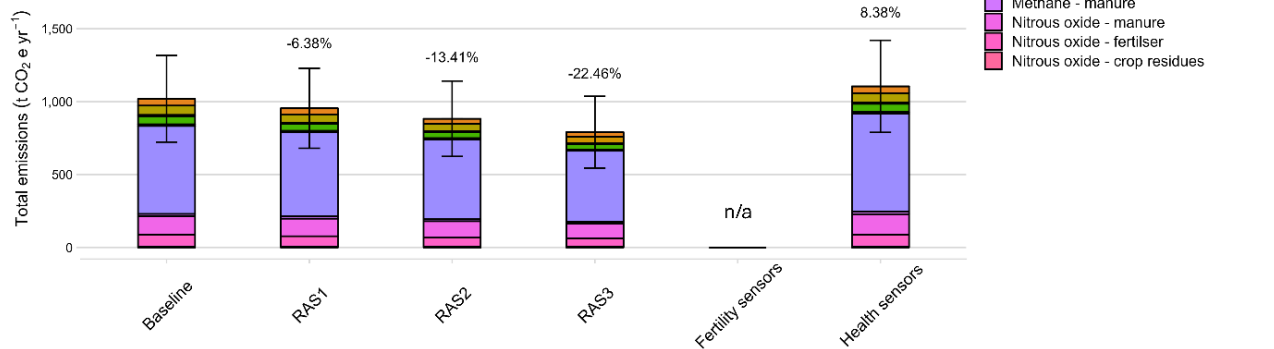
RAS1	RAS2	RAS3	Health sensors	Fertility sensors
↓ KO% by 0.5% ↑ DLWG to maintain slaughter weight + corresponding change in feed intake	↓ KO% by 1% ↑ DLWG to maintain slaughter weight + corresponding change in feed intake	↓ KO% by 1.5% ↑ DLWG to maintain slaughter weight + corresponding change in feed intake	↑ calves born (4%) and reared (4%) ↓ KO% by 1% ↓ replacement rate of 1% ↓ 2 youngstock deaths ↑ DLWG increase by 0.16 kg/day + corresponding change in feed intake	↑ calves born (4%) and reared (3%) ↓ replacement rate of 1% ↓ age at first calving to 24 months ↓ cow weight by 20 kg + corresponding change in feed intake

## Results

### Spring calving lowland



### Finishing beef calves



	Emission intensity (kg CO <sub>2</sub> e kg dwt <sup>-1</sup> yr <sup>-1</sup> )					
	Baseline	RAS1	RAS2	RAS3	Fertility sensors	Health sensors
Spring calving lowland	31.04	30.96 (-0.27%)	30.69 (-1.13%)	31.16 (-0.38%)	28.37 (-8.61%)	27.15 (-12.54%)
Finishing beef calves	24.85	23.89 (-3.86%)	23.17 (-6.78%)	23.76 (-4.39%)	-	22.28 (-10.36%)

## Policy Implications

- PLF technologies show strong potential for reducing GHG emissions in beef systems while improving production efficiency and supporting climate targets.
- Evidence of their mitigation potential can inform policy design, particularly in targeting financial incentives towards the most effective technologies across production systems.
- Supporting investment, knowledge exchange, and adoption of PLF technologies could accelerate emissions reductions across the sector.

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