Juggling profit, climate, greenhouse gas emissions and biodiversity: the livestock farmer's conundrum

Introduction

Farmers have a lot on their plates maintaining profitability, while juggling other emerging challenges like climate change, greenhouse gas (GHG) emission reduction and biodiversity. The need for innovations that boost productivity, profitability and biodiversity while slashing GHG emissions has never been higher.

Companies in the value chain are setting targets to cut GHG emissions from farms. Under the Treasury Laws Amendment Act 2024, all agricultural value chain companies will need to report on their greenhouse gas emissions by 2027, including the farms that supply them with product. However, these GHG emissions are typically on the basis on which they purchase (e.g. mass or volume), that's being emissions intensity (t GHG/t product), this gives farmers far more options to respond, as it is just about improving farm production efficiency.

Reductions in emissions intensity can be achieved by:

- reducing GHG emissions while maintaining production;
- increasing production while maintaining GHG emissions or ideally;
- reducing emissions while increasing production.

The greatest reductions in emissions intensity often align with improving farm production and efficiency strategies such as improved weaning rates or greater liveweight gain of young animals.

The "Sustainable Pathways to CN30" Project, funded by Meat & Livestock Australia (MLA) and Australian Wool Innovation (AWI) conducted GHG audits on 13 beef and sheep farms across Australia (Figure 1). The project explored mitigation options across all farms, including tree planting, supplementation with feed additives, methane reducing legumes and improving LWG through better quality feed. The farmers also nominated options that were of interest and relevance, including pasture and soil fertility improvement, improved lambing times and weaning rates, changing herd/flock size, using organic compost versus nitrogen fertiliser. The range of interventions chosen reflected the diversity in enterprises, environments, interests and business goals of farmers involved.

Summary

Nineteen interventions were explored in a research project called 'Sustainable Pathways to CN30'. For some interventions, several options were explored, totalling 50 scenarios. This factsheet contains only 18 scenarios to illustrate the range of results found, further details can be found via the contact details at the end of this fact sheet.

Sustainable Pathways to CN30 summary

Core Challenges

- Maintaining profitability
- Reducing GHG emissions
- Enhancing biodiversity
- Adapting to climate change

Key Drivers of Emissions Intensity

- Earlier joining
- Improved growth/ finishing times
- Better lambing/ weaning rates
- Enhanced nutrition/ genetics
- Improved animal health

Policy & Industry Context

- Treasury Act requires agricultural companies to report GHG emissions by 2027
- Governments focus on total GHG emissions

Summary insights

- Supply chains report reduction targets based on emissions intensity (t GHG/ t product)
- Gives farmers flexibility to improve production efficiency
- Integrated approaches yield better results for profit, emissions and biodiversity (e.g., trees + legumes)

Explored 18 mitigation options across 13 beef and sheep farms

- Feed additives for reducing methane
- Tree planting/revegetation
- Improved conception/ weaning rates
- Methane-reducing legumes
- Replacing inorganic fertiliser with compost
- Adjusting herd/flock size

Trade-offs and Outcomes

- Some strategies decreased emissions but at the expense of profits and production
- Other strategies increased profits and production but at the expense of emissions
- Biodiversity benefits can be realised, but require 2-3 decades to achieve
- Carbon sequestration in tree vegetation mostly realised in the first decade

Greatest emissions intensity reductions came from:

- Co-benefit realised with tree planting
- Reducing breeder numbers for rangeland farms to adapt to the varying climate in the rangelands
- Improving liveweight gain

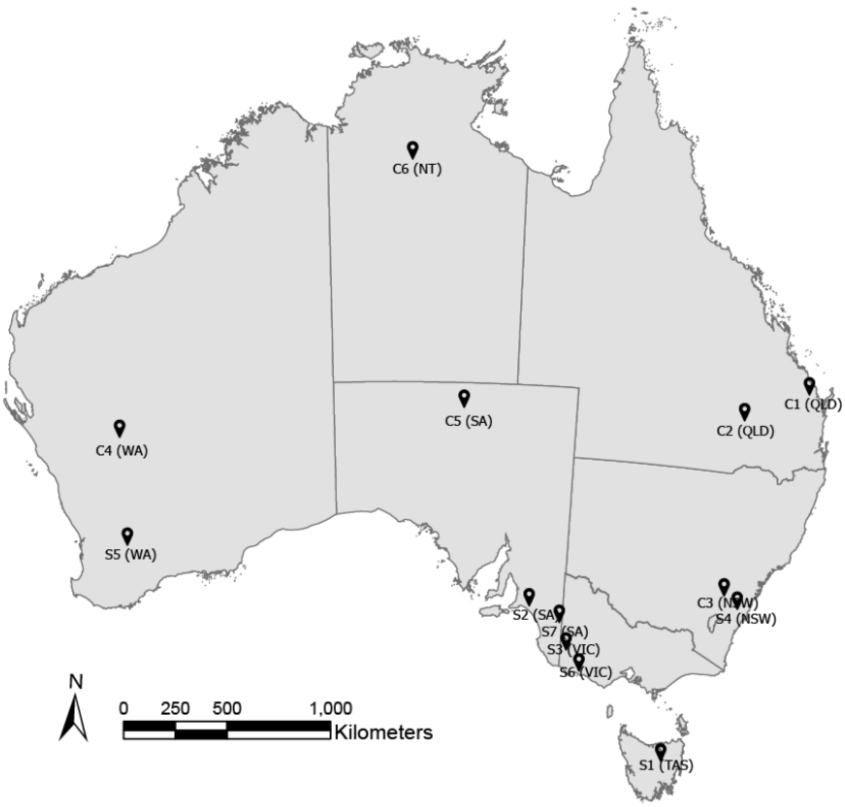

Fig. 1. Location of the 13 case study farms. C1-C6 are cattle farms, S1-S7 are sheep farms.

Trade-offs

Several interventions increased absolute GHG emissions and/or emissions intensity. However, these interventions also remained more profitable[i] than the baseline farm systems, even after placing a 'carbon tax' on the relative increase in GHG emissions. These included:

- Increasing the number of breeders by 33% (option 16),
- Supplementary feeding of ewes at joining to improve conception rates and increase weaning rates from 112% to 140% (option 15),
- Confinement feeding a month sooner to maintain ground cover and pasture recovery (option 12),
- Replacement of inorganic fertiliser (MAP) with organic compost fertiliser, increasing pasture production and stock numbers (option 7),
- Targeting a 50% liveweight gain in young stock (option 5) with additional supplementary feed. This resulted in increased costs, and thus declines in profits. In addition, in some instances, lambs reached target liveweight prior to shearing, further reducing profits.

Reducing emissions intensity

Figure 2 shows emission intensity (EI) as a change in the percentage in GHG per unit protein produced. Protein has been used as the product, rather than tonnes of meat or wool, to allow comparison of wool and meat on a similar basis. Greenhouse gas emissions per area (t CO_2eq/ ha) was also included as the message can alter depending on the metric examined.

Figure 2 shows that:

- 10% tree plantation (option 3) and running 33% less breeders (option 4) had a greater impact on the percentage reduction in emissions (middle two panels in Figure 2)
- Other strategies had a larger impact on emissions per hectare (bottom panel in Figure 2), predominantly driven by

reductions in enteric methane (e.g. feed additives (options 1 and 2), and anti-methanogenic pastures (option 13).

- Some scenarios increased emissions, although EI declined. Examples include feeding supplements to increase weaning rates (option 15) and extending confinement feeding by an extra month (option 12), as production increases were greater than emissions increases.
- Other options were more profitable compared with their baselines, but at the expense of increased emissions. Option 18 is an example of this, where young stock were held on farm longer to achieve a greater liveweight at sale (baseline retained for 18 months or 380 kg liveweight, whichever occurred first), now sold at 21 months or 490 kg (whichever occurred first). An advantage of this option was that even though net emissions increased, protein EI remained similar to the baseline.
- Another example is option 14 where the nitrogen content of new pasture growth was increased from 2.7% to 3.15% for the three rangeland farms, resulting in more beef sold, increased profits and reduced EI, but increased net farm GHG emissions.

Soil carbon

Improving soil organic matter (SOM) has multiple productivity and sustainability benefits over the long term. Soil carbon is roughly 58% of soil organic matter, but soil organic carbon (SOC) itself does not confer the productivity benefits (i.e. nitrogen mineralization, soil buffering capacity and water holding capacity). SOM provides physical, chemical and biological benefits to plants.

It is also worth noting that SOM in soils tends to diminish over time (cannot accumulate indefinitely) and reversible (soil disturbance or drought). SOC change is strongly correlated with annual rainfall, meaning gains are made in wetter cycles and lost in drier seasons.

Trees: carbon and biodiversity

Planting trees is an interim step while we develop technologies to cut actual GHG. Although carbon sequestration in trees diminishes overtime as the trees mature, they offer many on-going co-benefits. Tree planting is viable in higher rainfall regions but only financially viable when focusing on co-benefits like animal welfare, shade, and shelter, with carbon as a bonus. Biodiversity payments are mainly philanthropic and unreliable.

If the primary focus is carbon sequestration, trees are typically planted in a single block on the least productive farm area. However, if the focus is on the co-benefits (biodiversity, reduced salinity, improved lamb survival, and heat stress reduction), trees are better integrated across the farm. Combining multiple interventions can lead to better outcomes.

Overall, planting native vegetation had significant biodiversity benefits, but this benefit was not realised for at least three decades after trees were planted. For example, threatened species habitat, as a percentage of the area planted to trees, increased by 43-353% in the 30 years after planting trees. The greatest change in high-quality habitat occurred because:

- revegetation occurred in riparian zones
- revegetation areas connected existing vegetation, facilitating wildlife corridors, and
- new vegetation resulted in complementary and additional benefits.

Impacts of tree planting on each biodiversity indicator varied depending on whether absolute or relative changes were considered. Habitat area and high quality habitat conditions were correlated to farm grazing area.

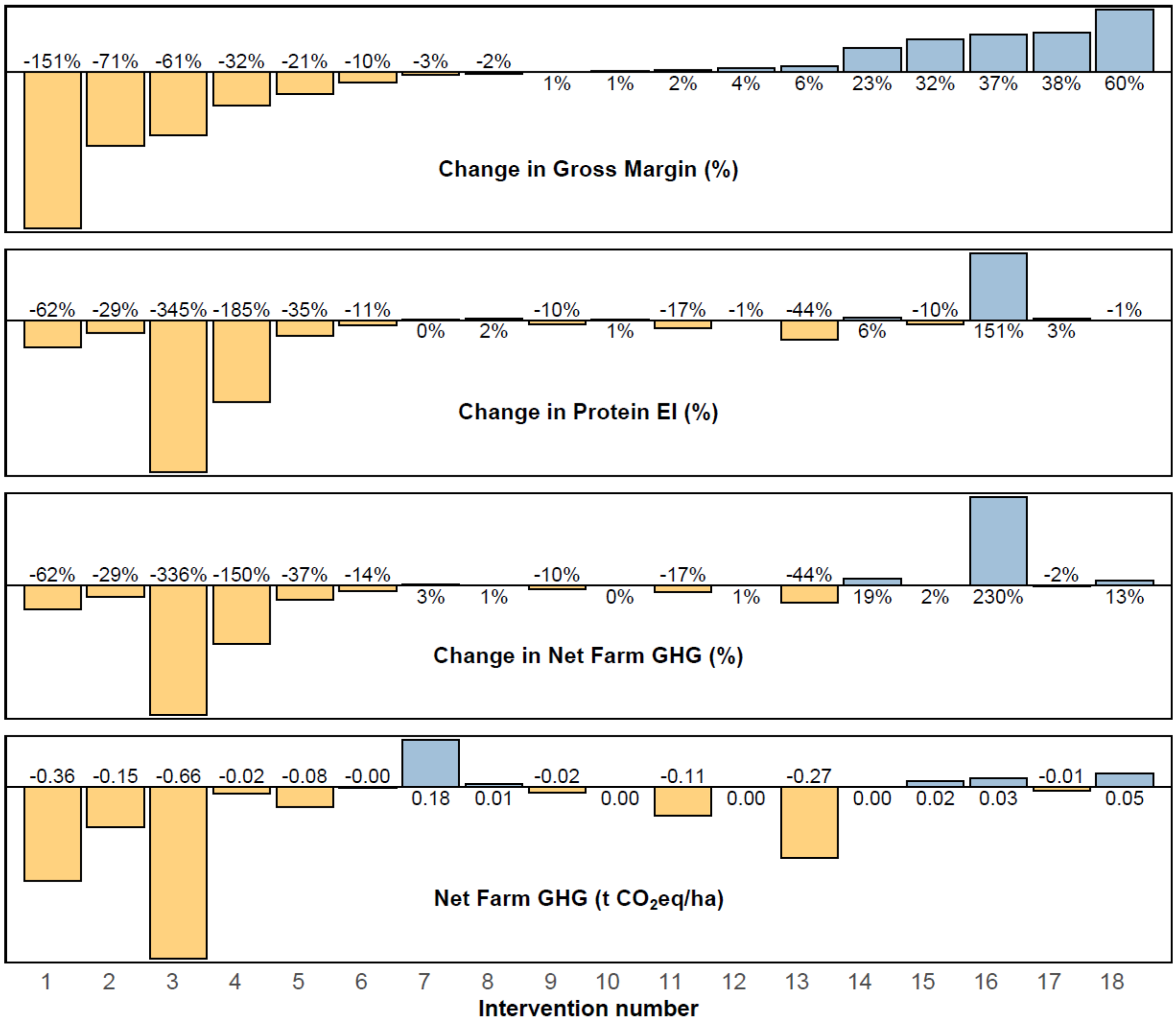

Figure 2. Change in gross margin (%), protein emissions intensity (%), net farm GHG emissions (% and t CO_2eq/ha), relative to baseline farms for 18 mitigation options, presented as 30-year averages. See text for details of interventions and end of factsheet for gross margin details.

1. *Asparagopsis* feed additive
2. 3-NOP feed additive
3. 10% grazing area planted with trees
4. 33% less breeders#
5. 50% improved liveweight gain
6. 10% less animal numbers#
7. Substitute inorganic fertiliser with compost*
8. Shift lambing from March to June*
9. 10% improvement in liveweight gain
10. 10% less land#
11. 10% enteric methane reduction via grazing management
12. Extending confinement feeding duration by one month*
13. Incorporate anti-methanogenic legumes in pastures
14. Improve pasture nutritional quality#
15. Weaning rates increase from 118% to 140% + supplementary feeding*
16. 33% more breeders#
17. More single lambs, fewer twin lambs per ewe, and reduced wool micron*
18. Finish steers and heifers at 21 months compared with 18 months*

*Options with * were modelled on a single farm only. Options with # were modelled on the three rangeland farms only*

Conclusions

- Results from this study show that metrics matter:
    - Governments are focused on total GHG
    - Supply chains are focused on emissions per unit of meat and/or wool production (EI).
    - Farmers should be focussed on reducing GHG relative to farm GHG in previous years (relative reductions)
- The greatest EI reductions, improvements in profit and biodiversity gains come from targeting underlying site-specific inefficiencies and combining options (e.g. trees and legumes).
- The key drivers of emissions intensity (t GHG/ t liveweight), include earlier joining, improved growth rates, finishing / turn off times, lambing/ calving/ weaning rates driven by nutrition and genetics.
    - This means that producers could select for improved fertility, reproduction, improved growth rates in early age (maintaining adult weights) and feed conversion efficiency.
    - Improving nutritive intake could be affected by grazing management, soil fertility, a higher proportion of legumes and improvement in forage quality in each season grazing is conducted.
    - Improving animal health can also improve growth rates and lead to more productive and fecund ewes.
- Planting trees had significant benefits for biodiversity, but this benefit took two-three decades after trees are planted to occur
- Carbon benefits from trees are greatest 10-20 years after trees are planted, then diminish thereafter.

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[i] Gross margins based on 10-year CPI-indexed 25th percentile meat price, 50th percentile wool price and income, equivalent to \$38/t CO_2eq, when net GHG emissions decline. Alternatively, when net farm GHG emissions increase, a carbon tax of \$38/t CO_2eq in incurred. Biodiversity improvements with the 10% trees intervention were valued at \$29/t CO_2eq.