Carbon and financial performance of silvopastoral systems

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Annual global GHG emissions still rising!

- **New GHG emissions record in 2024**
- **1.5 deg C carbon budget likely to be surpassed by 2030**
- **Urgent need to decarbonise**

(Deng et al. 2025)

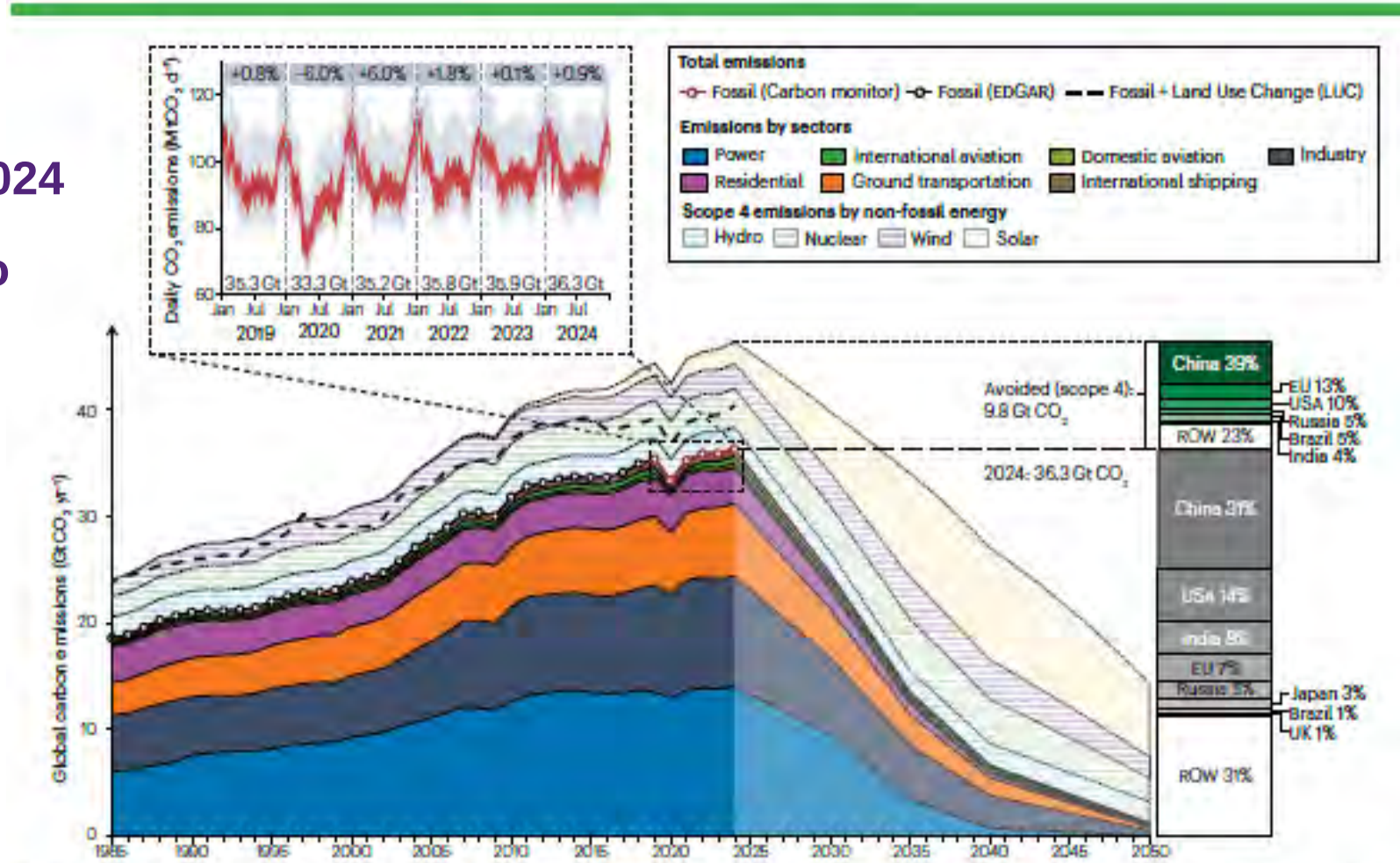


Fig. 1 | Global CO2 emissions and projections 1985–2050. Historical[8] and projected CO_2 emissions from fossil fuel combustion and cement production ('Fossil CO_2') by sector (solid colours), and historical and projected Scope 4 emission avoidance by renewable energy type (hatched colours). The inset displays daily near-real-time CO_2 emissions since 2019 from the Carbon Monitor project with accompanying absolute emissions and year-on-year changes; values are revised from earlier estimates[2,9] owing to updated activity data and methodologies[10]. The bar to the right displays 2024 emissions (greyscale) and Scope 4 avoided emissions (green shades) by country. Global CO_2 emissions fluctuate year to year but continue a positive trajectory, rapidly dwindling remaining carbon budgets.

GHG Emissions from livestock production

Food value chains account for about 22% of global emissions

Livestock emissions account for:

- **14% to 18% of global emissions; and**
- **10% of Australia's emissions**

Kantaka Station property, Molangul, QLD

- **Sources: (Mrowczynska-Kaminska et al. 2021; Foong et al. 2022; IPCC 2023; Cusack et al. 2021; Twine 2021; Australian Government 2023)**

Silvopastoral systems (SPS)

Most promising strategy to make large reductions in net emissions from livestock production (Cusack et al 2021; Pelton et al. 2024)

Open pasture, Queensland

Native forest silvopastoral system, Queensland

Timber production SPS - planted

Alley silvopastoral system with flooded gum, Uruguay, South America

Alley silvopastoral system with spotted gum, Gayndah, Queensland

Native vegetation SPS

- **Limited scope to earn carbon credits while managing native vegetation**

Thin for ecological purposes only

1. Re-clear:

- **On-going livestock income**
- **High agricultural land value**

2. Carbon project:

- **Carbon income for 15 to 20 years**
- **Low future income stream**
- **Low ag. land value**

Trade-off between trees and pasture

Timber production SPS from native regrowth

- **Substantial opportunities in Australia, Africa, and North and South America**
- **e.g. ~ 1.5 M ha of post-1990 regrowth in southern Queensland and northern New South Wales**
- **But no Australian Carbon Credit Unit (ACCU) potential**

Income diversification

Roma, Queensland

CO_2 sequestration

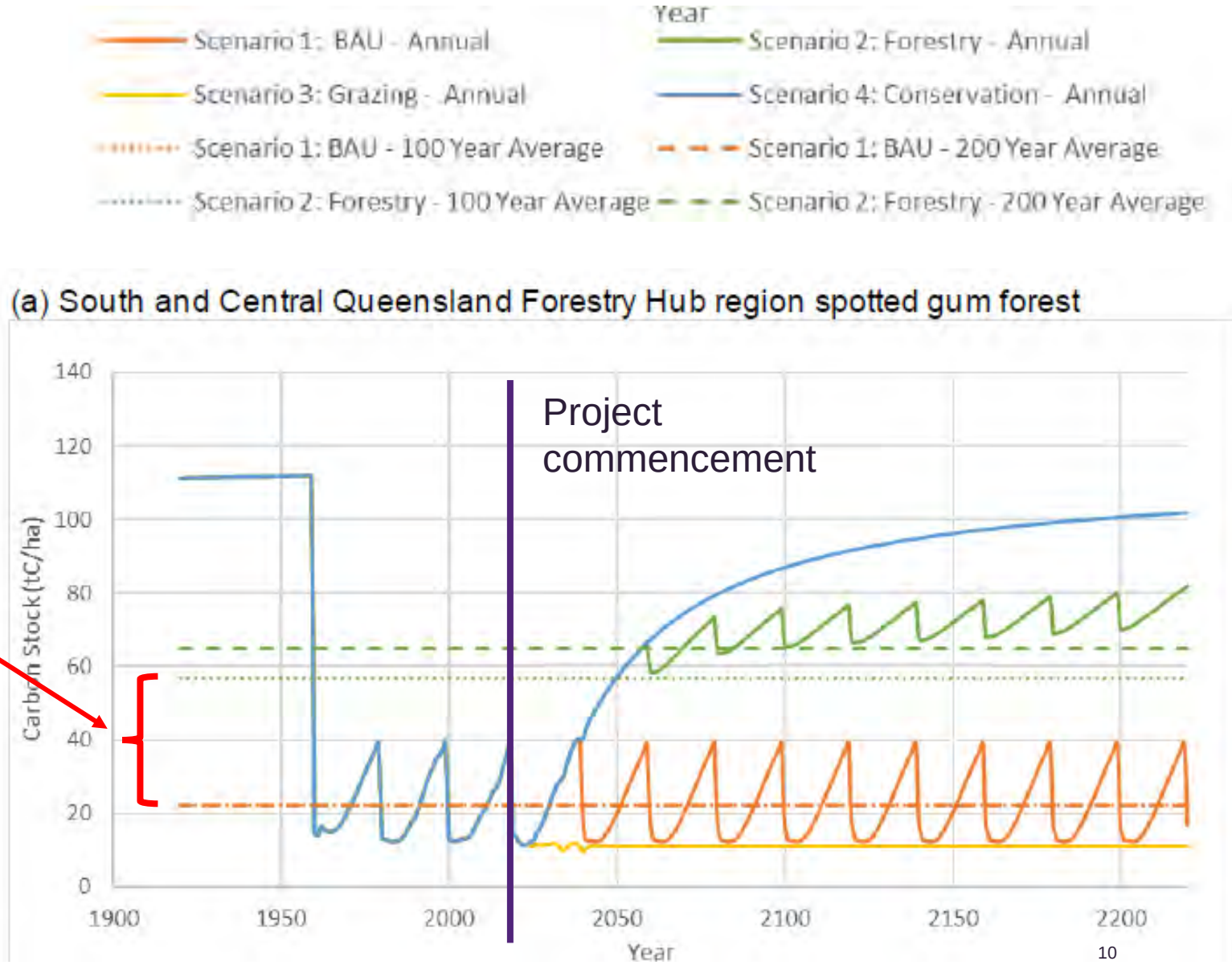
And many other benefits

1. **Domestic biodiversity conservation**
2. **International biodiversity conservation (reduce ‘high-risk’ timber imports)**
3. **Higher pasture quality (not quantity)**
4. **Reduce temperature and wind speed (increases calving rate and calf weight)**
5. **Increased nutrient cycling, soil condition and structure**
6. **Lowering water tables where salinity is a problem**
7. **Reduced runoff, erosion and transport of nutrients and agricultural chemicals**

Southern Queensland spotted gum regrowth SPS case study

- **Managed by periodic re-clearing**
- **Field experiments: MLA, CRC for Northern Australia and QDPI**
- **FullCAM 100-year additionality ~ 36 t C/ha or 133 t CO2/ha**
- **50% post-1990 regrowth could sequester 99 M t CO2**

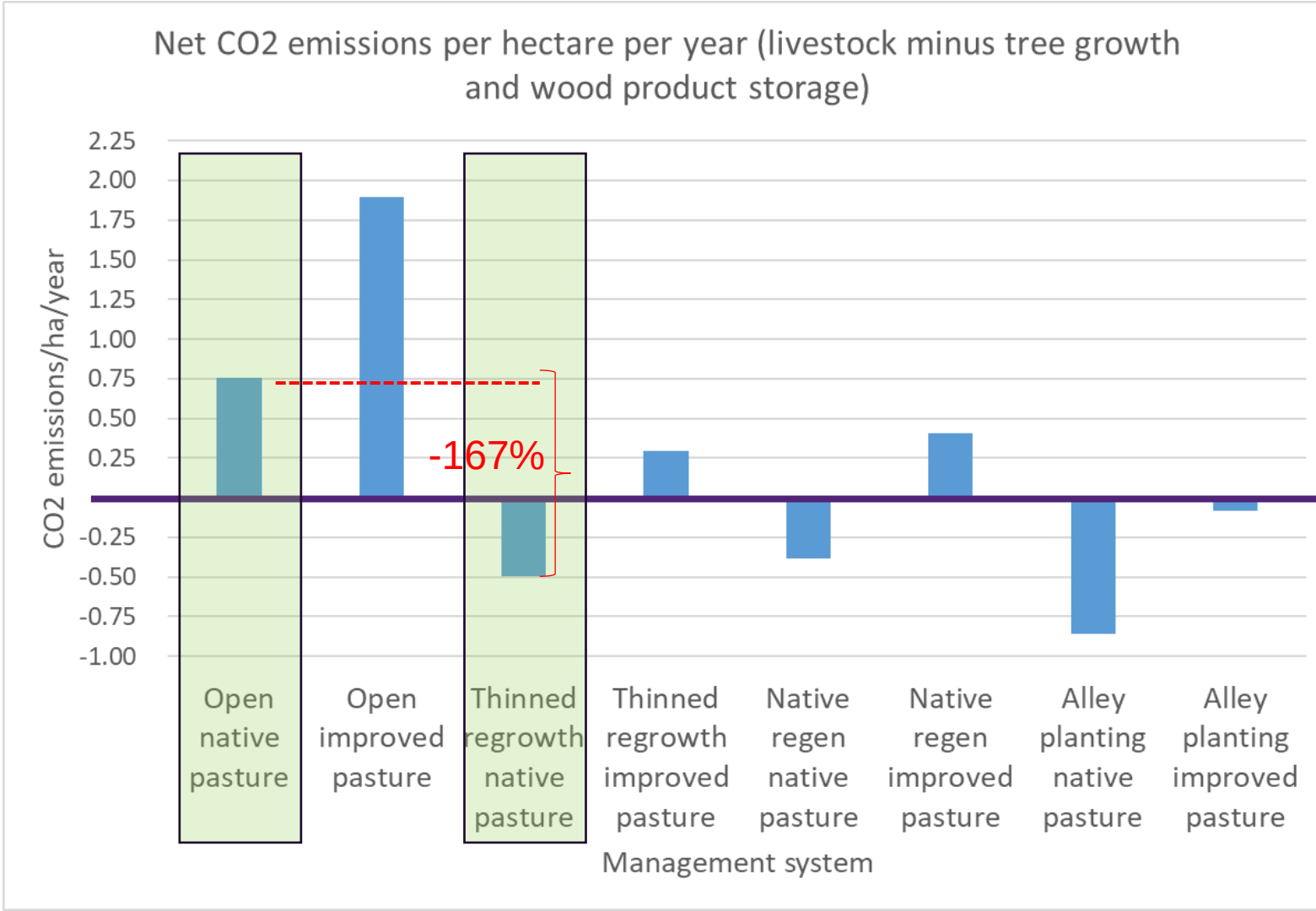
(Francis et al 2022; Lewis et al. 2022; Venn et al. 2022; Venn et al. 2025)



Implications for farm carbon budgets

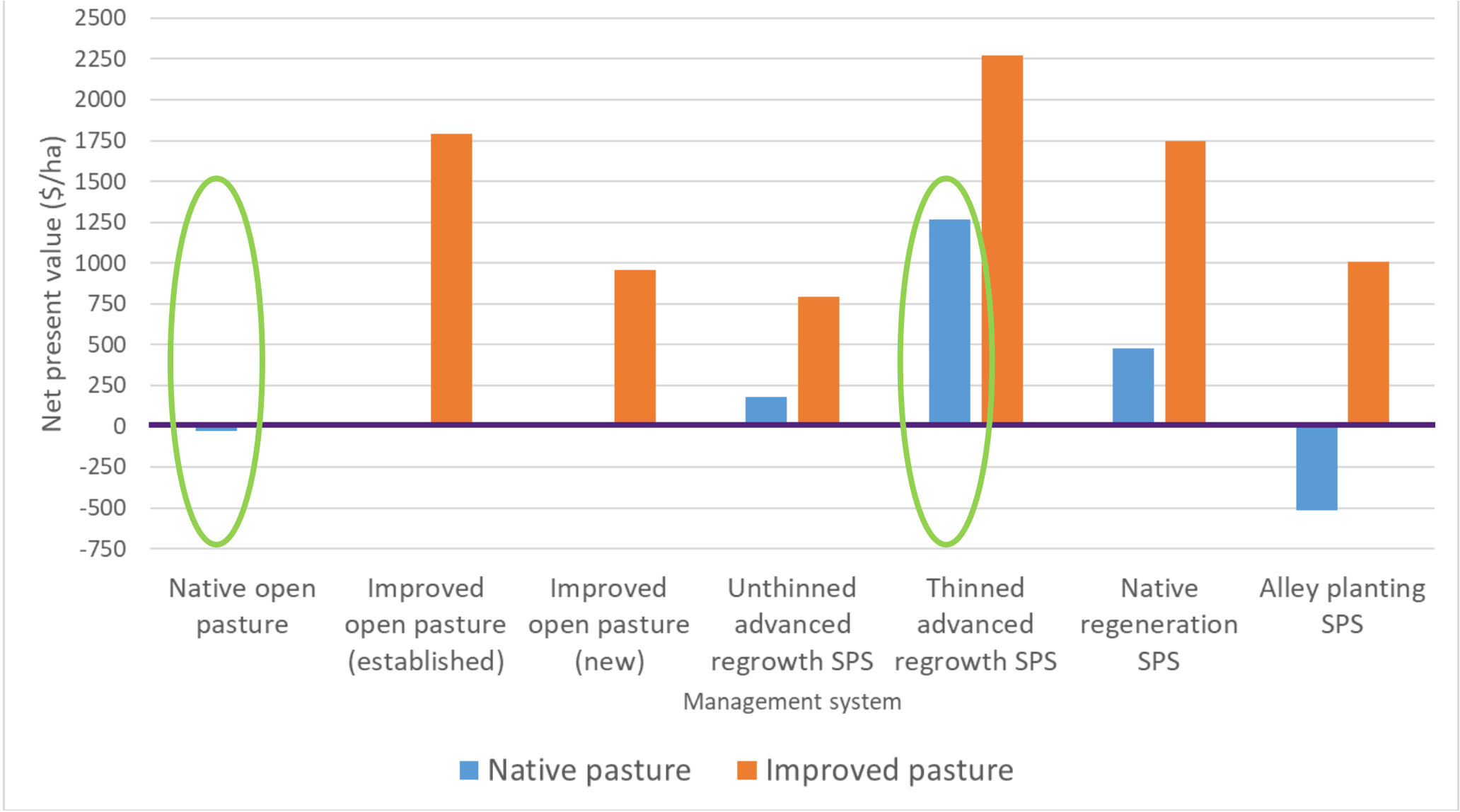
- **Taking into account livestock and farm management emissions….**

- **There are opportunities for livestock producers to become net carbon sinks for decades**



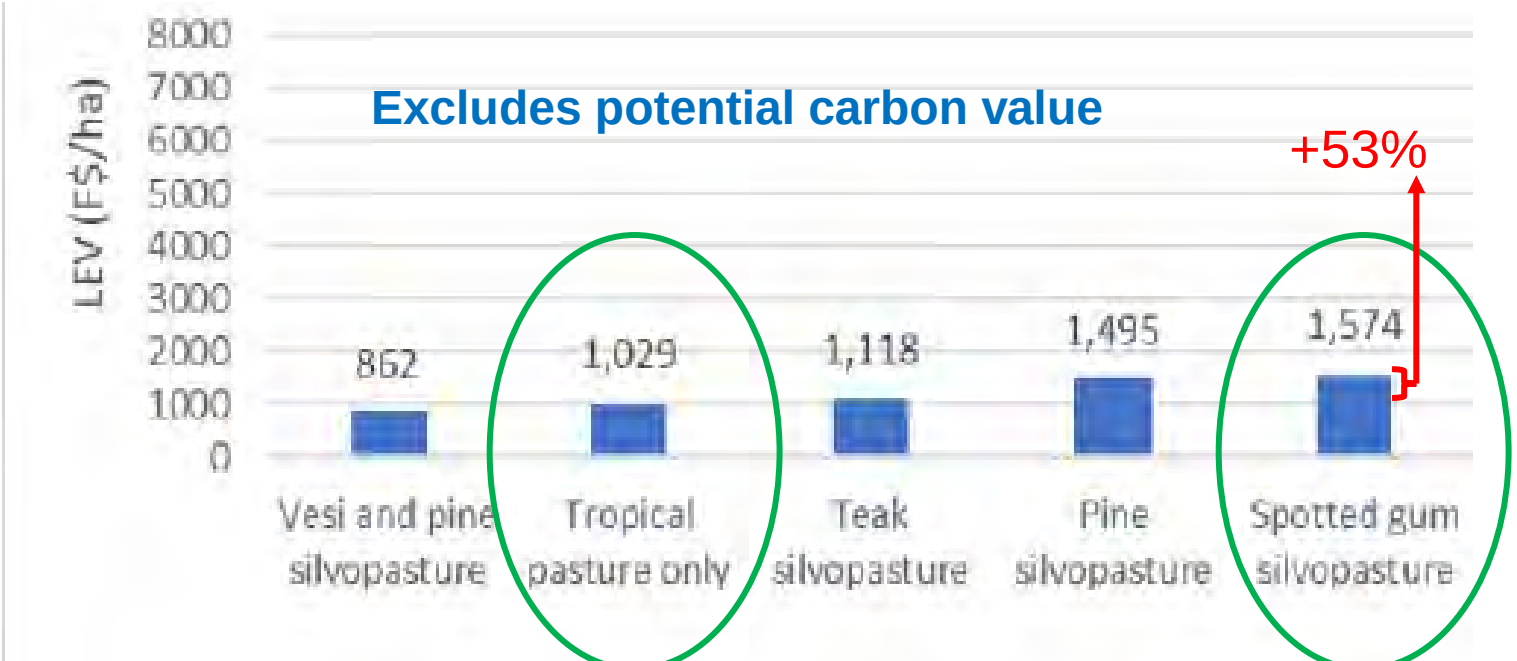
Strong long-term financial viability

Net present value at 5% discount rate. Does not include potential carbon revenues



SPS in Fiji

- **ACIAR project FST/2016/147 (Venn et al. 2023)**
- **Seasonally dry, degraded sloping lands on Viti Levu, Fiji – 26% (235,000 ha)**
- **SPS positive LEV at 8% discount rate**
- **Increase CO2 by 138 t CO2/ha**
- **Net CO2 sink for decades with livestock**



Complements growing international literature

Particularly from North and South America

- **Strong long-term financial performance; and**
- **Large increases in carbon storage**

(e.g. Bruck et al. 2019; Chizmar et al. 2020; Resende et al. 2020; Cusack et al 2021; Aryal et al. 2022; Monteiro et al. 2024; Pelton et al. 2024; Orefice et al. 2025).

Challenges for SPS adoption

- **Insecure land tenure and/or property rights**
- **Reduction in annual income from livestock and long wait for timber income**
- **Policy constraints (real and perceived) that do not support the integration of trees and livestock, e.g. Australia's carbon market**
- **High upfront cost of initial establishment**
- **Higher ongoing farm management costs**
- **Risk of damage from wildfire and cyclones**
- **Lack of knowledge and awareness**
- **Cultural attitudes**

Nanango, Queensland

Three Actionable Recommendations to encourage adoption of silvopastoral systems

1. Secure, long-term rights to manage trees

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Sovereign risk is a large disincentive for tree growing

- **40 amendments to vegetation management laws in Queensland between 2000 and 2020 (AgForce 2021)**

Exacerbated by negative media coverage, e.g.:

- **stricter natural vegetation management laws on farms**
- **harvest restrictions in timber plantations**

Encourages more land clearing and disinterest in tree planting!

If we want more trees on farms, landholders require secure, long-term rights to manage vegetation

Koala safety concerns over plans to clear-fell a Gordon blue gum plantation

https://www.abc.net.au/news/2021-12-24/gordon-koala-safety-fears/100705900

By Patrick Laverick | ABC Ballarat | Trees

Fri 24 Dec 2021

ACF says satellite evidence shows mass native habitat destruction by farmers

https://www.abc.net.au/news/rural/2025-06-21/acf-citizen-scientists-satellite-images-of-land-clearing/105436794

By Liana Boss, Lara Webster and Timothy Fernandez

ABC New England | Land Clearing

Sat 21 Jun

2. Carbon credit methods that permit native vegetation management

e.g. Forestry Australia's proposed: "Enhancing Native Forest Resilience" method

1. Re-clear:

- **On-going livestock income**
- **High agricultural land market value**

2. Carbon project:

- **Carbon income for 15 to 20 years**
- **On-going livestock income**
- **Future timber income**
- **High agricultural land market value**

3. Comprehensive lifecycle analysis methods in carbon markets

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Carbon markets must accommodate the science and economics of additionality and leakage, otherwise methods will:

- **Over-estimate the carbon benefits of projects;**
- **Threaten global action to achieve the Paris climate target; and**
- **Undermine the integrity of carbon markets.**

e.g. Improved Avoided Clearing of Native Regrowth (IACNR) ACCU method

Methods that account for leakage will encourage sustainable agrifood systems, including SPS, and maximise climate risk mitigation

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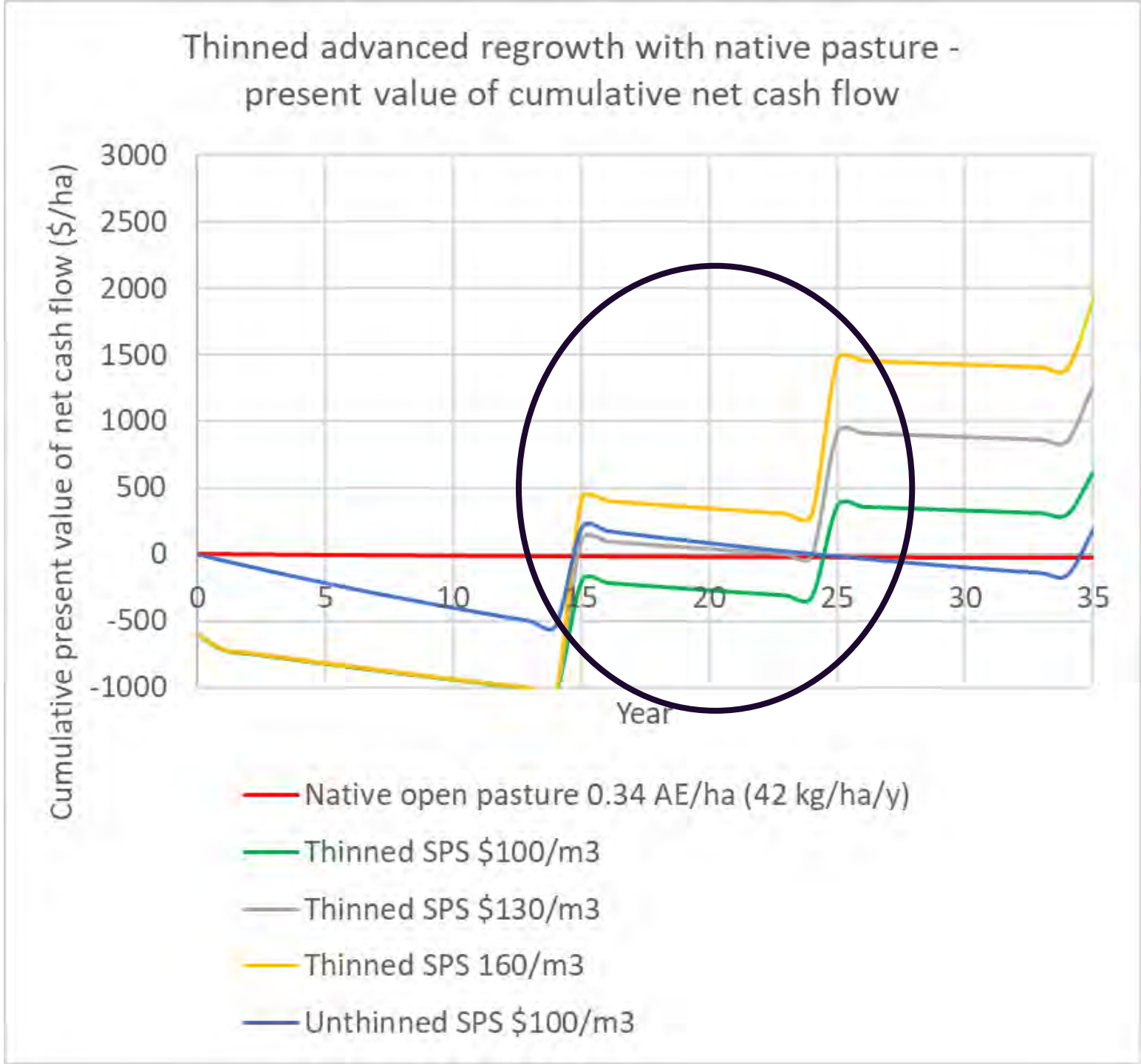
Long-term opportunity costs relative to native open pasture



Silvopastoral systems (SPS)

Fruit and nut trees

Leucaena systems

Eucalyptus grandis silvopastoral system in Uruguay

52% of graziers in Sweden were willing to consider establishing SPS if compensated – mean level was Euro308/ha/y (Opdenbosch and Hansson 2023)

Insecure land tenure and/or property rights (Harrison et al. 2021; Venn 2023; Adegbeye et al. 2024; Poudel et al. 2024)

Silvopastoral systems largest opportunity to reduce GHG emissions in USA beef supply chain (Pelton et al. 2024)

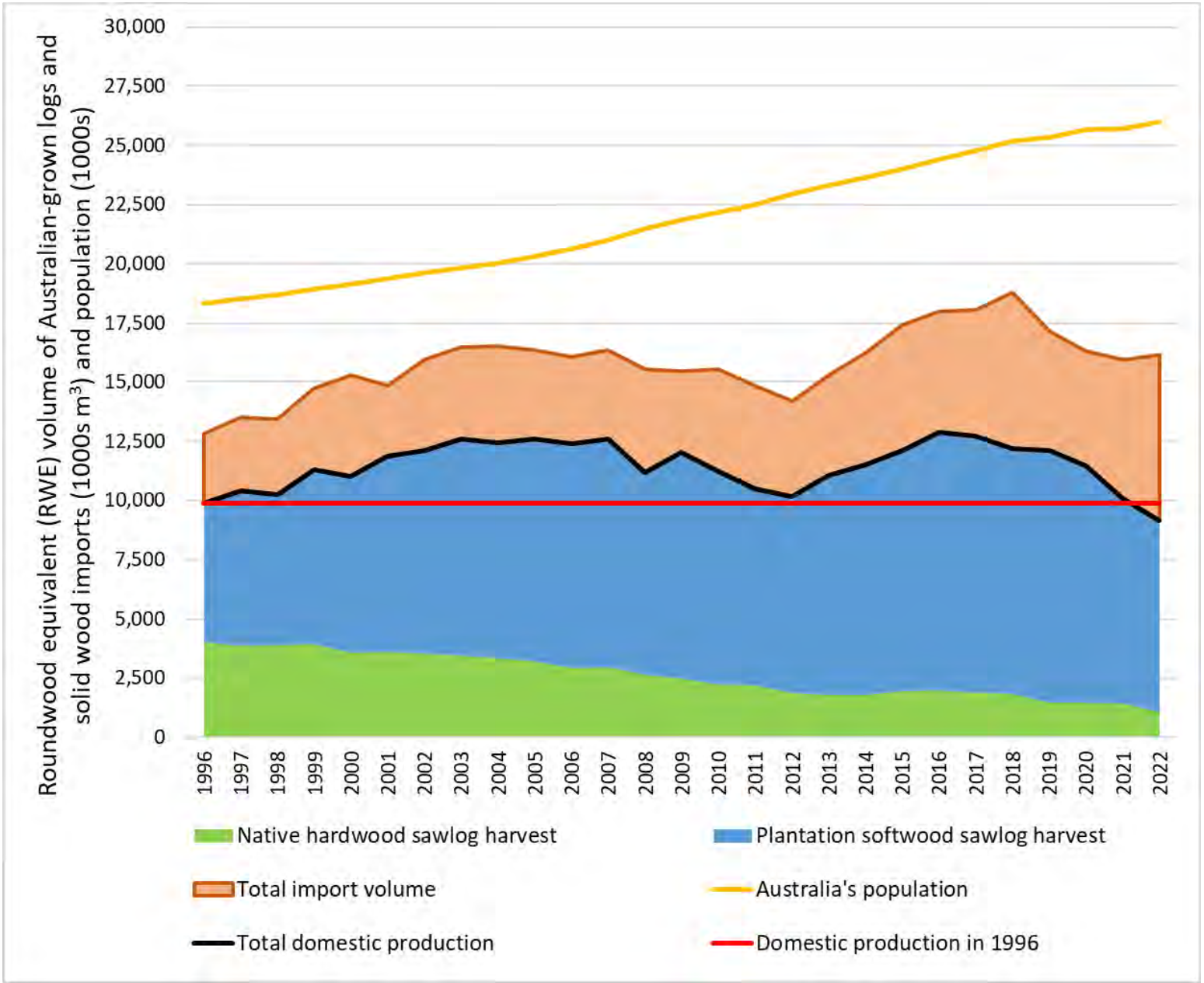
Brazilian silvopastoral systems with planted eucalypts can be net carbon sinks (Resende et al. 2020; Monteiro et al. 2024)

SPS in Mexico can increase carbon stored in livestock dominated landscapes by 27% to 163% relative to open pasture lands (Aryal et al. 2022)

SPS in northeaster USA 43% more carbon sequestered in silvopasture relative to treeless pastures (Orefice et al. 2025)

Global meta-analysis of 292 studies of “improved” vs “conventional” beef production – Land-based C sequestration, incl. silvopastoral systems, was the only strategy showing promise to reach net zero showed th reduced net beef GHG emissions by 46% on average over decades (Cusack et al 2021).

Solid wood consumption in Australia



Australian population growth +42%

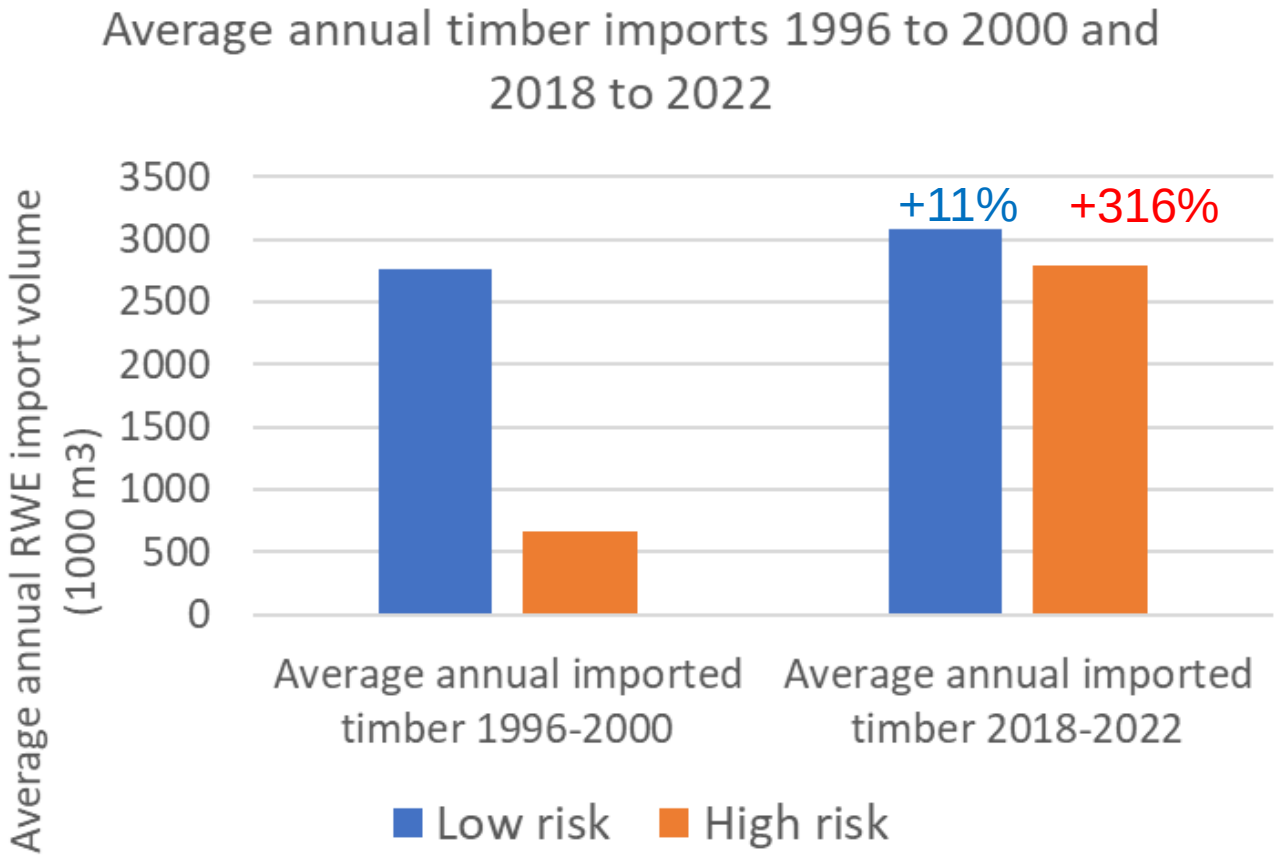
Imported solid wood products

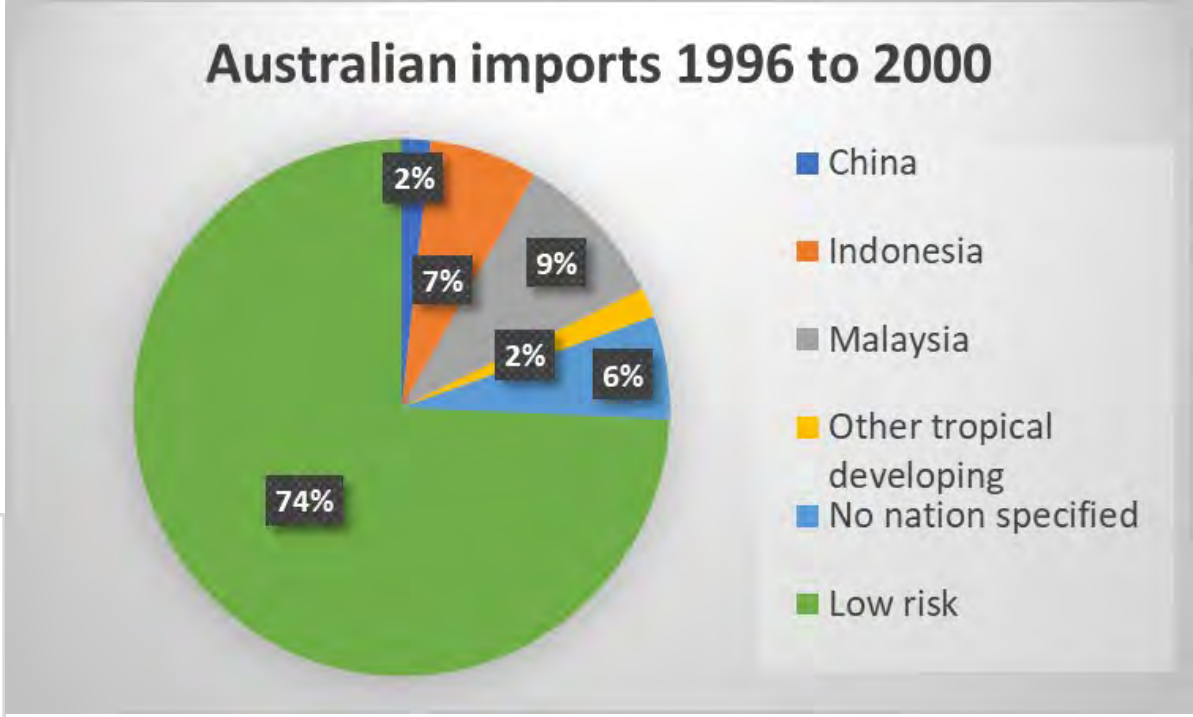
- **1996 24% of traded wood**
- **2022 46% of traded wood**

Plantation pine + native forest timber steady

Native forest timber -75%

Hypothesis 3: Leakage has been primarily to high-risk countries





8. SPS with timber will reduce leakage of consumer demand to high-risk timber imports

**Imports account for 46% of traded wood in Australia

"High risk" timber imports from countries associated with:

- **illegal logging;**
- **deforestation; and**
- **forest degradation.**

accounts for 22% of all traded solid wood in Australia

(ABARES 2024; ABS 2024; Forest Trends 2025)