Reducing the Carbon Footprint of Australian Rubus Production: A Pathway to Sustainable Berry Farming

Strengthening the sustainability of berry production (RB22001)

Beatriz Reutter & Marguerite Renouf, Lifecycles

With climate change consequences being daily topics in the media, there is a need across Australian agricultural industries to publicly demonstrate environmental stewardship and reduce greenhouse gas (GHG) emissions. Here, the carbon footprint of raspberries and blackberries is presented, along with some opportunities to reduce the Rubus footprint.

Environmental sustainability policies are now part of doing business for many agricultural industries, and there is a growing need to measure environmental metrics and monitor improvements over time. This is particularly the case for climate change impacts from greenhouse gas (GHG) emissions, where there are emerging requirements and incentives for the agriculture sector to consider practices that can reduce GHG emissions. For the Rubus industry, a good place to start is by quantifying the GHG emissions intensities (carbon footprint) of Australian Rubus, as a baseline from which to consider future initiatives.

The Hort Innovation project ***'Strengthening the sustainability of Rubus production (RB22001)'*** conducted by Lifecycles, quantified the carbon footprint of Australian raspberries and blackberries using the life cycle assessment (LCA) method. This article provides a summary of the findings, including the industry-average carbon footprint results, the main sources of GHG emissions for Rubus production, and opportunities for reducing emissions. The findings from this study can be used to make informed decisions about the industry's response to climate change by targeting any emission reduction initiatives to those actions most likely to have a higher impact.

Life Cycle Assessment (LCA) method

This study employed environmental Life Cycle Assessment (LCA) methodology, adhering to international standard ISO 14044[1]. LCA provides a systematic approach to quantifying environmental impacts across the entire production cycle, ensuring comprehensive and comparable results.

The system boundary for the Rubus LCA was 'cradle to farm gate', up to the production of berries in punnets in cardboard trays. It included plant establishment, the productive phase of growing berries, on-farm packaging and cold storage, waste management, and upstream production and transport of all farming inputs (Figure 1). Transport of berries to market and refrigerated storage post-farm were not included.

The data required for the LCA were collected from a sample of 9 Rubus growers during 2024 and early 2025 (8 sites for raspberries and 5 for blackberries). The sample represented 36% of Rubus production in Australia. In order to observe regional differences, the sample differentiated northern production (9 sites in Southeast Queensland and Northern New South Wales) and southern production (4 sites in Victoria and Tasmania).

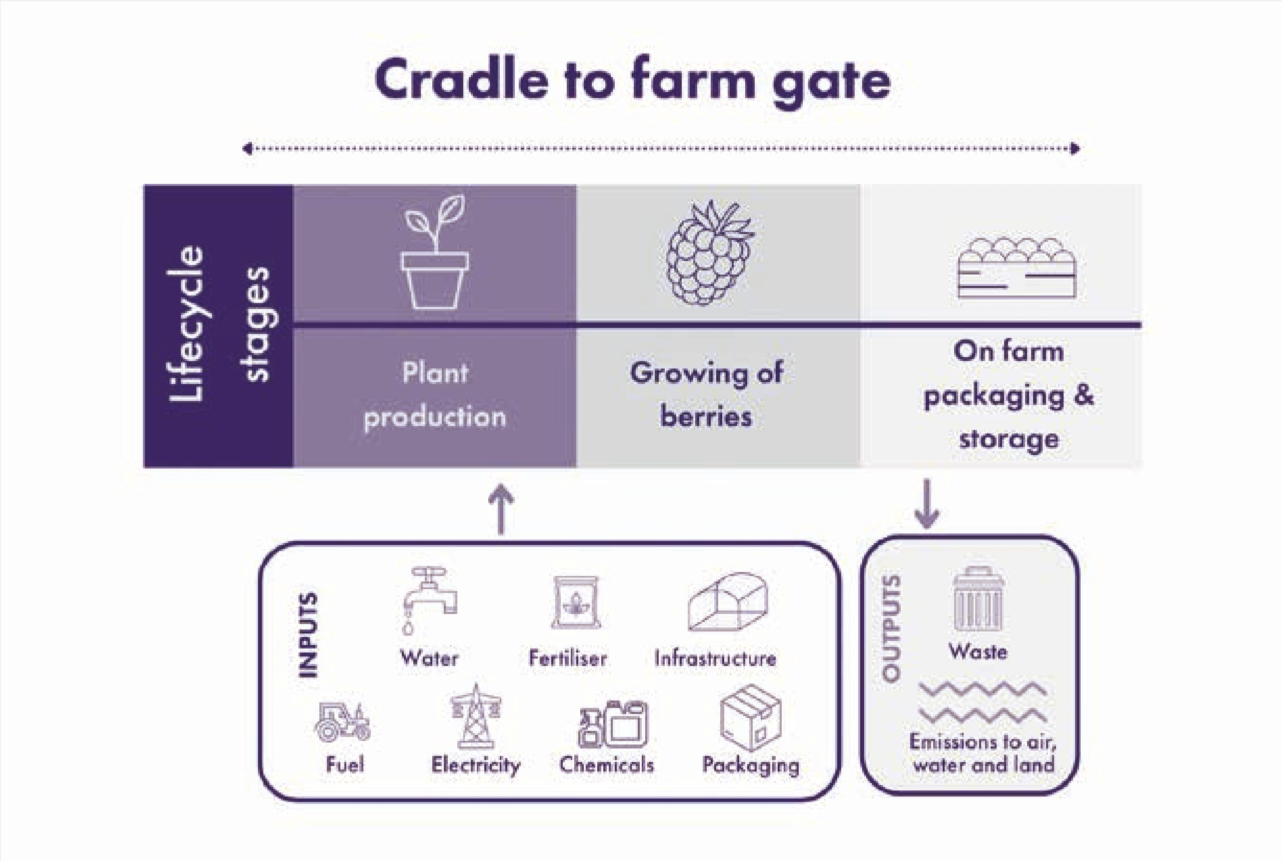

Figure 1. System boundary of the study, showing life cycle stages and processes for berry production

The data was populated into a life cycle model of raspberry and blackberry production in the Simapro LCA software, which combines the GHG emissions for all parts of the life cycle. The main GHG emissions accounted for were carbon dioxide (CO_2) from fossil fuels, methane (CH_4) and nitrous oxide (N_2O). All emissions aggregated, converted to carbon dioxide equivalents (CO2e), and divided by annual Rubus production to generate the carbon footprint per kilogram of harvested and packaged Rubus kg CO2e/kg.

When conducting a carbon footprint, all the life cycle emissions are assigned to the end product, describing the carbon credentials of the product (including scope 1, 2 and 3).

GHG emissions of Rubus production

The carbon footprint of Australian raspberries is estimated to be 2.2 kg CO2e/kg of raspberries at farm gate, and for blackberries 1.7 kg CO2e/kg of blackberries. Even though raspberry and blackberry production are very similar, the lower carbon footprint of blackberries can be attributed to higher yields.

These carbon footprint results are similar to values reported for Rubus grown in other countries[2-4], and consistent with horticultural products produced in protected cropping and greenhouse systems[5].

For both, raspberries and blackberries, the largest contributors to the carbon footprint are the production of materials for crop protection (tunnels and trellis) and fruit packaging (plastics and cardboard), on-farm energy use (electricity and diesel) and production and use of fertilisers (Figure 2). Other aspects, such as the production of pesticides, herbicides and insecticides, irrigation infrastructure, and fugitive emissions from refrigerants, are less significant to the total GHG emissions and included in the 'other' category in Figure 2.

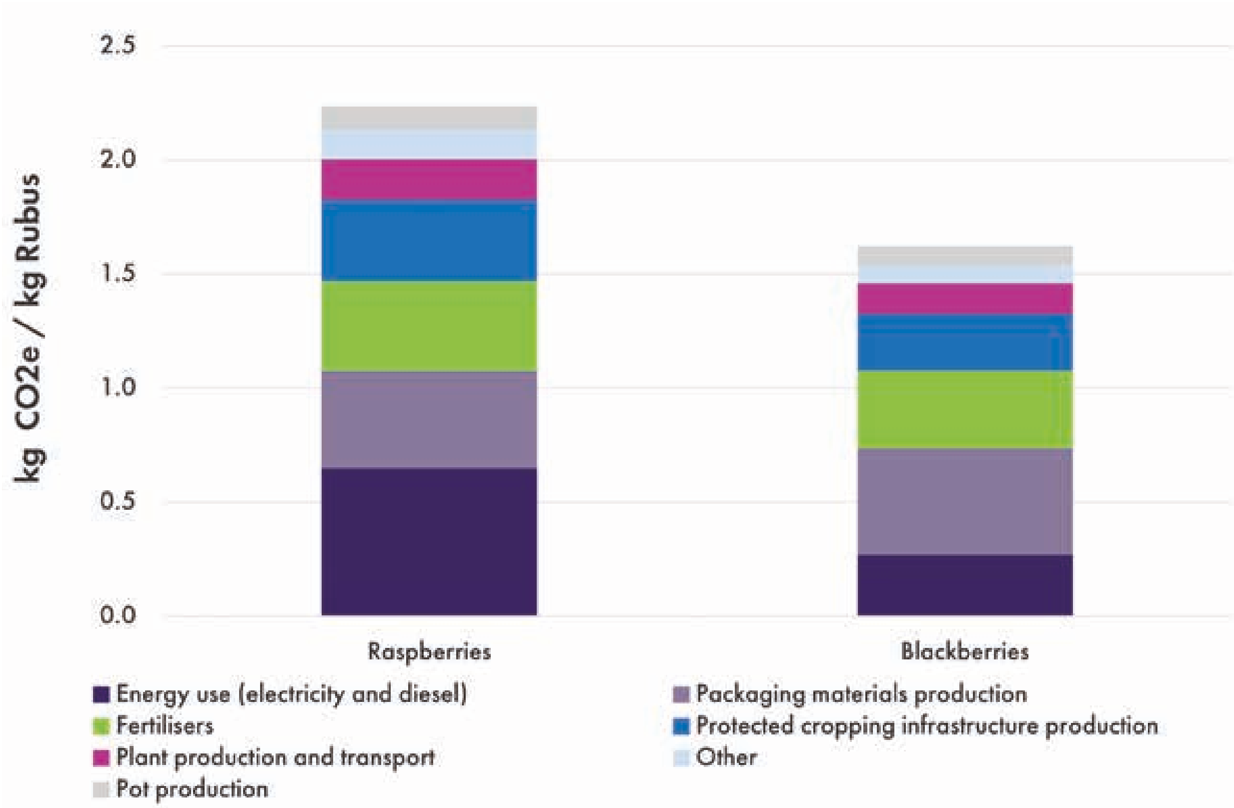

Figure 2. GHG emissions of raspberry and blackberry per kilogram fruit at farm gate

Regional variation

Northern production sites (Southeast Queensland and Northern New South Wales) have an average carbon footprint of 2.5 kg CO_2e/kg of raspberries, while the southern production sites (Victoria and Tasmania), have an average footprint of 2.0 kg CO_2e/kg of raspberries. The difference can be explained mostly by yields and energy consumption for irrigation. The sample did not allow for regional values for blackberry production.

How to reduce the carbon footprint of Rubus

The carbon footprint profile of Rubus production can be used to inform opportunities to reduce GHG emissions. Based on the main emissions sources identified in Figure 2, a sensitivity analysis was conducted to test and compare the scale of emission reduction that may be possible for a selection of system change scenarios, relative to the average (Figure 3). The assessment was performed for raspberries but applies equally to blackberries. This helps to identify the initiatives that offer the best potential.

Energy use: As is typical for most horticultural systems, on-farm energy use in the form of fuel for machinery operations and electricity for irrigation is a significant contributor. Many Rubus farms have already installed photovoltaic (PV) solar panels for self-generation of renewable electricity, which has reduced the carbon footprints of these farms significantly. If a switch to 100% solar electricity were made, a 12% reduction in the average carbon footprint could be expected.

Another opportunity to reduce the energy-related emissions is to consider the electrification of farm vehicles. If 50% of farm vehicles were replaced with electric vehicles, the emissions reduction could be around 3%.

Any reduction of on-farm energy use will reduce the Rubus carbon footprint. This could be achieved by implementing energy efficiency measures, including pump optimisation, irrigation system upgrades, and preventive equipment maintenance.

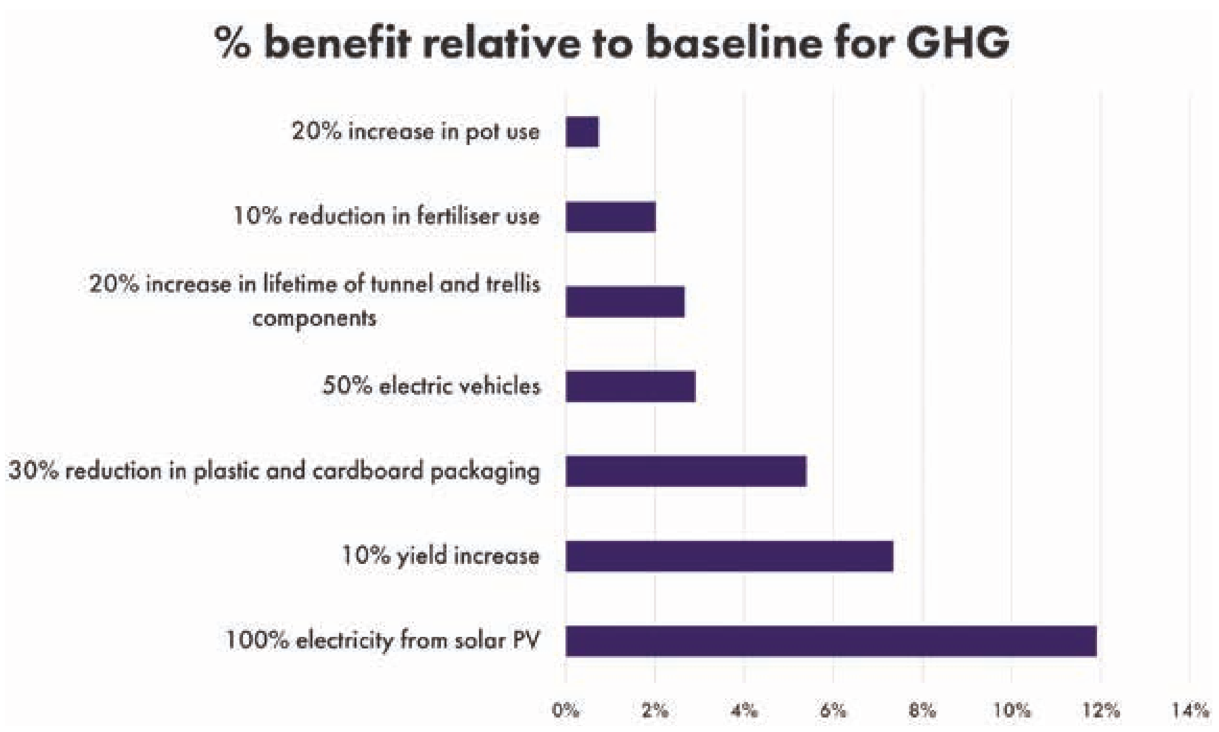

Figure 3. Estimated percentage reduction in GHG emissions, relative to the average, from adoption of practice change scenarios

Yield increase: Since the carbon footprint is considered per unit of product produced (kg of Rubus), if a higher yield could be achieved from the same inputs, then the carbon footprint will be reduced. A 10% yield increase is expected to reduce the footprint by 7%. There is no linear relationship because the packaging isn't yield-dependent.

Packaging: The type and amount of plastic punnets and cardboard boxes for packaging significantly influence the carbon footprint. Results show that punnets are responsible for about 60% of the packaging-associated GHG emissions, with cardboard boxes making up the remainder. This highlights the importance of cardboard secondary packaging.

If the amount of both packaging types is reduced by 30% per unit of fruit, the carbon footprint can be expected to reduce by 5%. This can be achieved by getting more fruit per package, by light-weighting punnets and cardboard boxes, or by sourcing packaging materials with lower emission intensities. For cardboard secondary packaging, the use of reusable plastic crates could also be explored.

Higher recycled content of punnets reduces the carbon footprint; most of the farms included in the study already include a high percentage of recycling content. For those farms that don't, this is a little action that can help reduce the carbon footprint.

Fertilisers: Emissions are mostly associated with the nitrogen (N) component of fertilisers, in relation to both their energy intensity for production, and also the potential loss of nitrous oxide (a strong GHG) released when used. In a scenario where the fertilisers applied are reduced by 10%, the carbon footprint could be reduced by about 2%. This could be achieved through precision application for greater efficiency or by reducing the amount lost through drainage.

Crop protection infrastructure (tunnels and trellis): Impacts could be reduced by extending their life, as far as practicable. In a scenario where their duration of use is increased by 20% (for example, 5 years instead of 4 years of use), the total GHG emissions are reduced by 3%.

Next steps

This project has provided an understanding of the scale and hotspots of GHG emissions for Rubus production, and a path to reduce the carbon footprint of Rubus starts to form.

The results suggest that priority GHG emissions reduction opportunities for the industry would be:

1. increasing the use of solar energy and electrified vehicles,
2. increasing yields,
3. investigating alternative packaging systems and materials,
4. fertiliser use efficiency, and
5. extending the life of crop protection infrastructure.

The information generated by this project can be used to advance the industry's sustainability efforts by guiding strategic investments of the industry and farmers alike, and responding to customer and supply chain partners' data requests.

Lifecycles Hort Innovation RASPBERRY AND BLACKBERRY FUND

Acknowledgements

Project RB22001 has been funded by Hort Innovation, using the raspberry and blackberry research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

The research team thanks the participating growers who provided essential production data, the Project Reference Group members for their industry insights, and Berries Australia for their communication support throughout the project.

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