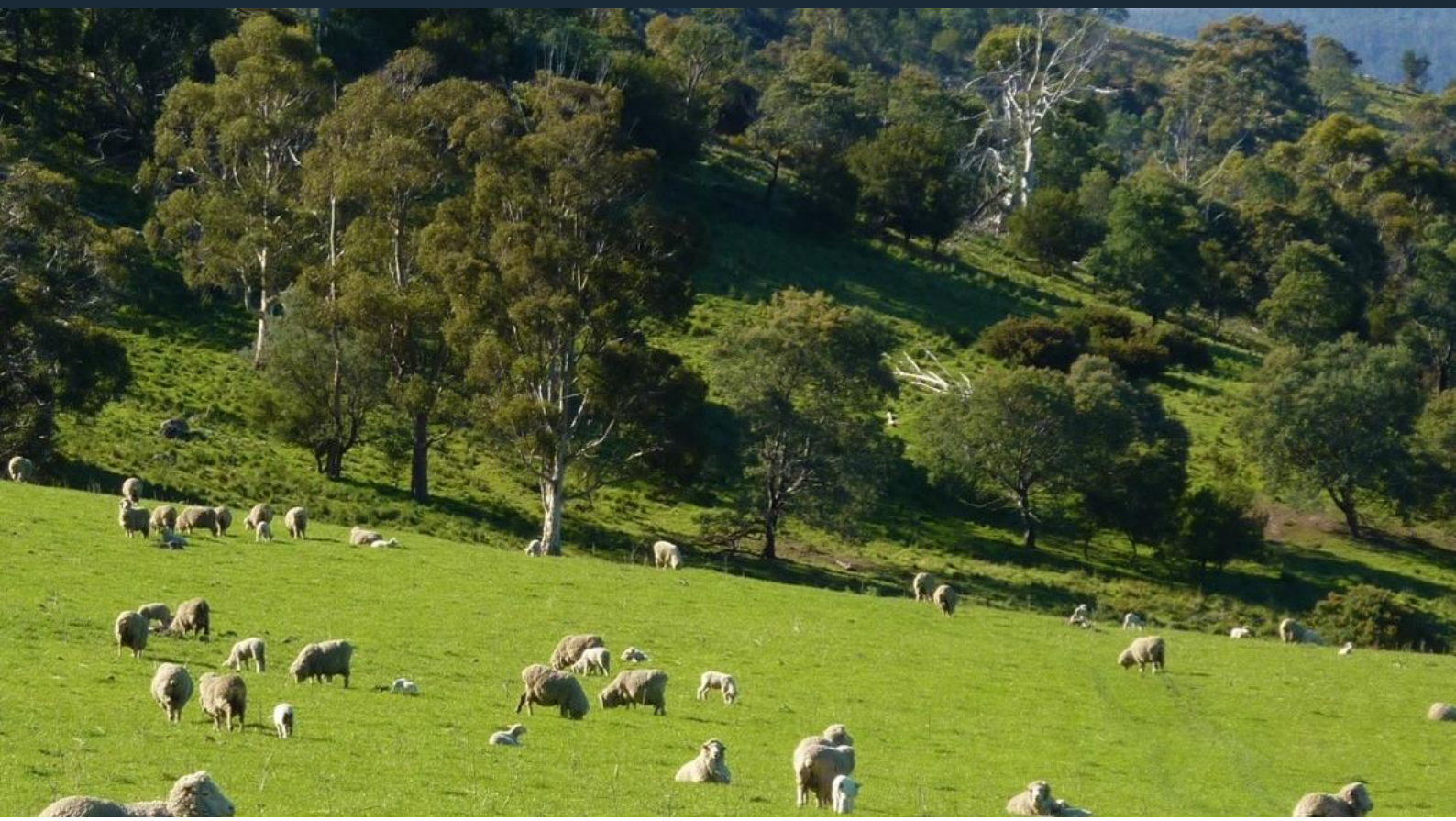
FARMING FOR THE FUTURE



Farming for the Future

Insetting for on-farm carbon and nature

Angie Haslem[1], Leanne Sherriff[2] and Jim Radford[1]

[1]Research Centre for Future Landscapes, La Trobe University
[2]Enviro-dynamics

October 2024

Contents

Acknowledgements

This work was supported with funding from philanthropy including the Macdoch Foundation and AWI. We are grateful for the feedback and suggestions from farmers, wool brokers, sustainability certification programs, industry representatives and staff at the National Farmers Federation. These have made an important contribution to ensuring that this work is comprehensive in its approach to supporting the emergence of useful and effective approaches to assessment of the environmental performance of Australian farmers.

Disclaimer

This report has been prepared by the Macdoch Foundation's ***Farming for the Future*** project for the purpose of developing collaborative strategies to accelerate the emergence of useful, cost-effective and broadly accessible ways of including on farm natural capital and farm business environmental performance in sustainability reporting.

The information contained in this publication are general statements based on research conducted by *Farming for the Future* and other published literature. *Farming for the Future* advises that such information may be incomplete or inapplicable to some situations. This report and case studies associated with it use modelled data and data provided to *Farming for the Future* by third parties, and whilst *Farming for the Future* has exercised due care, skill, and diligence in preparing this report *Farming for the Future* does not warrant the accuracy of data provided to it, or the accuracy of any conclusions drawn in reliance on the data.

This report does not constitute financial or investment advice and should not be relied upon for this purpose. To the extent permitted by law *Farming for the Future* excludes liability for any loss or damage suffered by any person arising from or in relation to this report. Any person receiving this report holds *Farming for the Future* harmless from any such liability.

1. Quantifying and reporting GHG and nature positive insetting

1.1. Background

Insetting is a relatively new concept in environmental accounting. It is related to offsetting, a common and well-recognised approach which involves businesses purchasing credits from a third party to neutralise or compensate ('offset') for the environmental impact of their business activities. Familiar examples include carbon or biodiversity offsetting, whereby the greenhouse gas emissions or environmental degradation resulting from a business are offset by carbon credits (e.g. activities that sequester carbon such as tree planting) or environmental gains, respectively (Hyams & Fawcett 2013, Ives & Bekessy 2015). A fundamental characteristic of most offsetting activities is that the environmental benefit (offset) occurs in a *different location* to the impact (Noor et al. 2017, Ebersold et al. 2023). This is the key point of difference between offsetting and insetting. In insetting, the beneficial actions – the 'insets' (cf. offsets) – are undertaken *within the realm of influence* of the business creating the impact, such that mutual benefits are derived (Tipper et al. 2009). For example, insetting interventions such as agroforestry or regenerative agriculture are undertaken on farms or in local communities *within the supply chain* occupied by the business producing the impact (Figure 1. Diagram illustrating the concept of insetting. Taken from the International Platform for Insetting; International Platform for Insetting).

While it can be more expensive than offsetting (International Platform for Insetting), insetting provides a number of advantages beyond being a critical avenue to achieving global climate change commitments, and environmental benefits. Co-benefits of insetting include an increased resilience of the entire supply chain, improvements in the quality of raw materials, and supply chain efficiencies that can provide competitive advantages or customer loyalty (Tipper et al. 2019, International Platform for Insetting). These co-benefits mean there may be scope for implementing actions that produce superior environmental outcomes than would be possible under conventional offsetting arrangements (Tipper et al. 2009). Insetting is seen as a practical way to control impacts, especially Scope 3 emissions[1] – which are on average around 11 times higher than direct emissions (Plan A) –, and so may be a more effective way to achieve reduced impacts in the first instance (3degrees). For this reason, insetting is seen to be particularly advantageous for agricultural supply chains where Scope 3 emissions often make a large contribution to the carbon footprint of companies higher on the supply chain (3degrees). A further benefit is that because insets occur within the supply chain and allow for pro-active reduction of Scope 3 emissions (cf. offsetting, where Scope 1, 2 and 3 emissions are reported separately), insetting is considered a more defensible approach to 'carbon neural' claims (3degrees) and contributes to the decarbonisation of supply chains (International Panel on Insetting).

The International Platform for Insetting defines the scope of insetting as relating to interventions developed within the Scope 3 of supply chains, not within Scopes 1 and 2. Insetting also provides critically important opportunities to halt nature loss (International Panel on Insetting). Interventions commonly recognised as representing opportunities for insetting are diverse and include regenerative agriculture (including agroforestry and reforestation: International Platform for Insetting, World Economic Forum, 3degrees), the adoption of renewable energy (for carbon insetting: World Economic Forum) or energy efficient measures (for carbon insetting: Ebersold et al. 2023), and a range of other revegetation, rewilding or restoration programs and economic, community or societal values (International Platform for Insetting). A key point is that these interventions are undertaken at the farm-scale, or within the landscapes and communities where the associated supply chain operates. Companies are already starting to embrace and employ insetting approaches. Examples include Nespresso's AAA Sustainable Quality Program which provides 93% of Nespresso coffee from coffee farms that employ regenerative practices such as composting (to improve soil

[1] Scope 1 includes direct emissions from sources owned or controlled by the reporting company (e.g. from company vehicles); Scope 2 includes indirect emissions resulting from a company's use of purchased electricity; Scope 3 includes all indirect emissions (exc. those in Scope 2) resulting from a company's activities, both 'upstream' (e.g. from transport, travel, purchased goods) and 'downstream' (e.g. use and waste of sold products).

health) and maintain native vegetation cover on their farms (for biodiversity outcomes). PepsiCo includes 'carbon insetting at scale' and 'Regen and precision ag at scale' in its Climate Action Strategy, which aims to reduce emissions in its indirect value chain (Scope 3) by 40% by 2030.

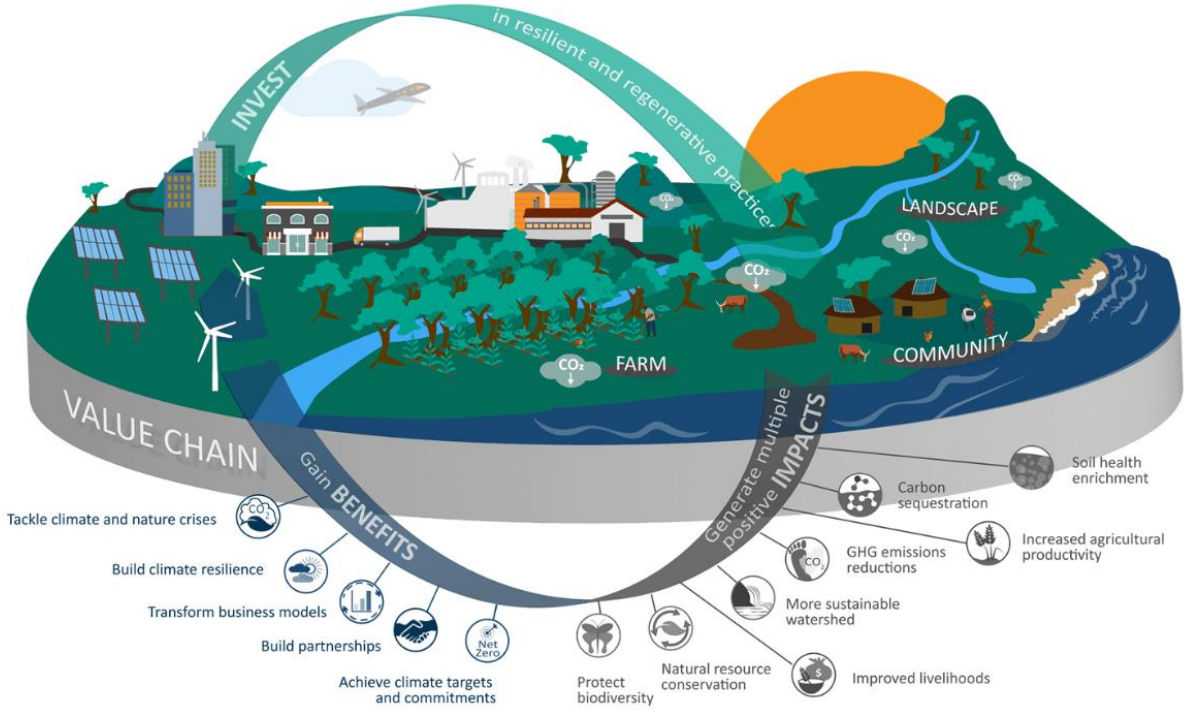


Figure 1. Diagram illustrating the concept of insetting. Taken from the International Platform for Insetting

The lack of agreed frameworks to govern many aspects of insetting is hindering its uptake (Abatable and the International Platform for Insetting 2023). Much work is contributing to filling these gaps, however most of this attention is focussed on considerations most pertinent to companies engaging with insetting. There is less focus on considerations that are relevant to those undertaking the insetting interventions, such as farmers. We address two objectives in this report:

1. Describe measures with the potential to contribute to quantifying greenhouse gas (GHG) and nature positive insetting in Australian agricultural supply chains.
2. Summarise key considerations associated with the governance, measurement and reporting of insetting.

1.2. Quantifying GHG and nature positive insetting

Insetting is often proposed as an approach by which supply chains can reduce their carbon footprint (especially Scope 3 emissions) via interventions such as regenerative agriculture or the adoption of clean energy alternatives (World Economic Forum). However, the International Platform for Insetting recommends that organisations evaluate and mitigate their carbon impacts separately from their impacts on other environmental and social values (see the Insetting Program Standard v 2.0). These are accounted for by evaluating a company's 'GHG Footprint' and 'Global Footprint', respectively, where the latter comprises the "…forest, water, soil and air, resources, wastes, biodiversity, economic, social (revenues, livelihood) and societal footprint of the company". As such, regenerative agriculture and nature positive outcomes are most strongly, but not exclusively, aligned with Global Footprints. The Insetting Program Standard recommends a process by which companies can incorporate insetting into the evaluation and mitigation of their GHG

Footprint and Global Footprint. This process is illustrated in Figure 10 (see the Insetting Program Standard for more detail).

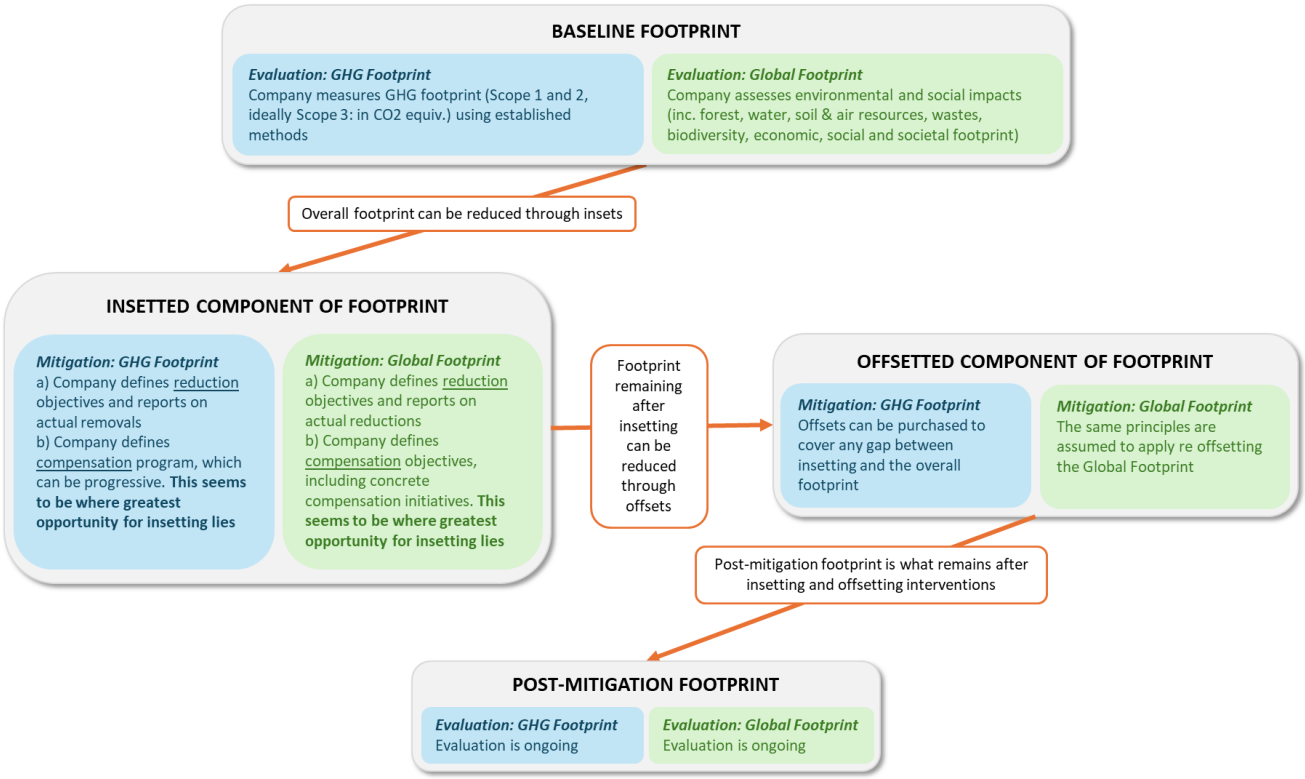


Figure 2. Illustration of the process recommended by the International Platform for Insetting by which companies can reduce their overall GHG (shown in blue) and Global (shown in green) Footprints through the use of insets and offsets.

Fundamental to companies being able to undertake the process shown in Figure 2 is a capacity to estimate their GHG and Global Footprints using measures that can be verified. The lack of agreed methods for this is currently hindering the capacity of insetting to contribute to the mitigation of Global Footprints (Insetting Program Standard v 2.0). This represents a critical area for future work. Importantly, because insetting focusses on farm or landscape-scale actions this means that associated metrics must provide quantitative information on GHG, nature positive and regenerative outcomes at these scales.

The 28 metrics developed by *Farming for the Future* may be suitable for quantifying insetting outcomes. These metrics provide a comprehensive and scientifically-based approach to measuring on-farm natural capital, environmental performance and biodiversity (see *Farming for the Future* report: Assessing the interoperability of metrics across key industry certifications and reporting schemes the interoperability of metrics across key industry certifications and reporting schemes). All are outcome-based metrics which are amenable to verification protocols. Many are based on remotely-sensed data, which is seen as an important opportunity for cost-reduction for monitoring insetting (International Panel on Insetting). These metrics are summarised in Table 1, and their potential for evaluating GHG and Global Footprints, and measuring associated mitigation interventions is shown in Figure 3.

An important caveat is that uncertainty around the definition and/or measurement of regenerative and nature positive outcomes (see *Farming for the Future* report Towards a Nature Positive Farming definition and demonstration) hampers the quantification of insetting activities on the basis of these concepts (Insetting Program Standard v 2.0). Further work is required to:

1. Develop an agreed definitions of ‘nature positive’ and ‘regenerative’ that are applicable to Australian agricultural supply chains. The AWI Nature Positive Farming specification is a welcome step in this direction.
2. Develop and identify metrics that are suitable for quantifying farm-scale nature positive and regenerative outcomes (see *Farming for the Future* report Towards a Nature Positive Farming definition and demonstration). There are a number of considerations related to measuring nature positive and regenerative outcomes that are relevant to insetting. These are also discussed in *Farming for the Future* report Towards a Nature Positive Farming definition and demonstration.

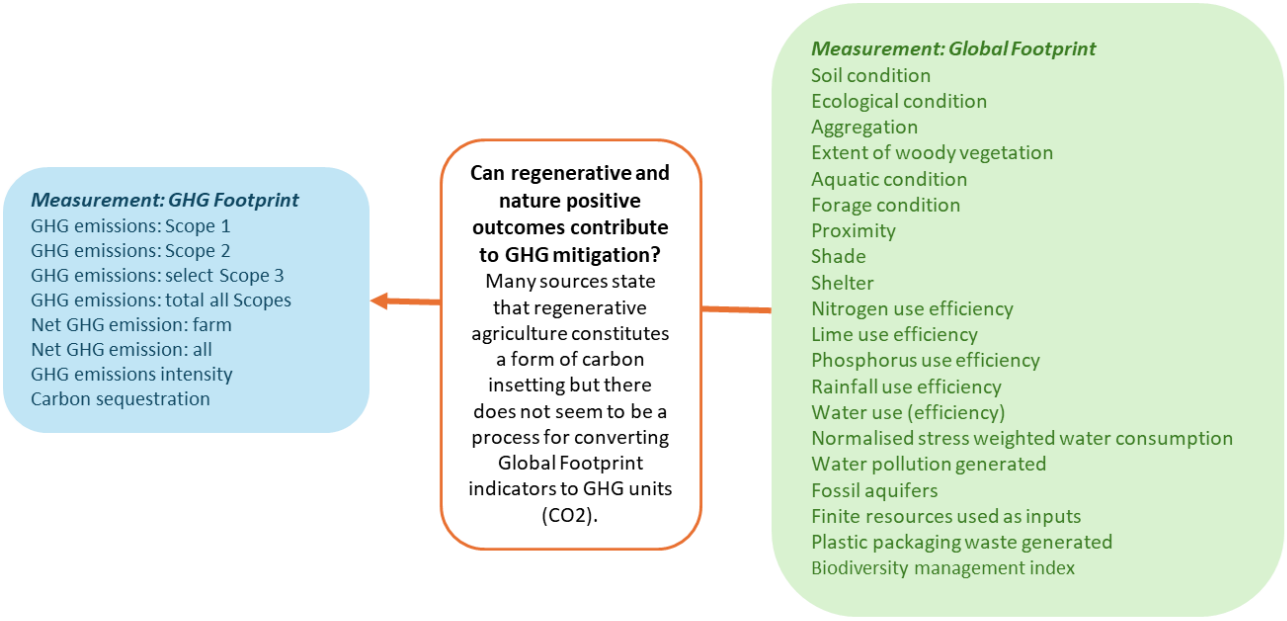


Figure 3. Diagram illustrating the alignment of Farming for the Future metrics with the measurement of GHG (shown in blue) and Global (shown in green) Footprints.

Table 1. Description of Farming for the Future metrics that have potential to contribute to quantifying GHG and nature positive insetting.

Metric	Description	Concept measured by metric *
Soil condition	Ground-cover (living vegetation, litter/stubble) is used as a proxy for soil condition	NP, RA
Ecological condition	The degree to which a farm has been modified from its original (pre-development) condition	NP, RA
Aggregation	The degree to which wooded vegetation on a farm is contained in contiguous patches	NP, RA
Extent of woody vegetation	The overall extent of tree cover on a farm	NP, RA
Aquatic condition	The proportion of tree cover in riparian areas (proxy for aquatic condition) on a farm	NP, RA
Forage condition	Pasture condition based on categories of palatability, productivity and perenniality	RA
Proximity	The distance of production areas to wooded vegetation	RA
Shade	Shade provided by trees to production areas (livestock, forage, crops)	RA
Shelter	Shelter from wind provided by trees to production areas	RA
GHG emissions: Scope 1	Emissions generated directly from on-farm operations (e.g. livestock emissions, fuel/input use)	GHG, RA
GHG emissions: Scope 2	Electricity from the grid consumed on farm	GHG, RA
GHG emissions: select Scope 3	Emissions generated by off-farm suppliers in producing and transporting select inputs[a] used on farm	GHG, RA
GHG emissions: total all Scopes	Total GHG emissions (all sources) emitted from a farm	GHG, RA
Carbon sequestration	Modelled tonnes of carbon sequestered in woody vegetation on farm[b]	GHG, RA
Net GHG emission: farm	GHG emissions generated within the farm boundary (exc. select Scope 3), minus carbon sequestration	GHG, RA
Net GHG emissions: all	Total GHG emissions (all sources) emitted from a farm, minus carbon sequestration	GHG, RA
GHG emissions intensity	Total GHG emissions (all sources) associated with a product (/kg product)	GHG, RA
Nitrogen use efficiency	The amount of nitrogen used to produce a product (/kg product)	RA
Lime use efficiency	The amount of lime used to produce a product (/kg product)	RA
Phosphorus use efficiency	The amount of phosphorus used to produce a product (/kg product)	RA
Rainfall use efficiency	The amount of production given the amount of rainfall (/kg product)	RA
Water use (efficiency)	The amount of water used in production (/kg product)	RA
Normalised stress weighted water consumption	The amount of water used in production, adjusted to reflect farm-specific rainfall: appropriate for comparison across regions/countries (/kg product)	RA
Water pollution generated	The amount of nitrogen from fertiliser and manure leeching into waterways and storages (/kg product)	RA
Fossil aquifers	Non-biodegradable packaging waste from farm inputs (/kg product)	RA
Finite resources used as inputs	Total farm inputs derived from non-renewable sources (mined and/or fossil-fuel based) (/kg product)	RA
Plastic packaging waste generated	Water use derived from non-refillable fossil aquifers (/kg product)	RA
Biodiversity management index	The degree to which a farm is managed in a biodiversity positive way	NP, RA

* NP = nature positive; RA = regenerative agriculture; GHG = greenhouse gases (carbon): see Section B

[a] Inputs included are: livestock, synthetic fertiliser, superphosphate, urea, feed (grain, hay/silage, lucerne). Also included are off-farm emissions from electricity use (e.g., transmission losses) and upstream fuel consumption (e.g., extraction of fossil fuels).

[b] Relates to changes in carbon stocks (in woody vegetation) between 2018-2022; modelled using FLINTpro™ using the National Forest and Sparse Woody Vegetation dataset as the primary input.

1.3. Considerations associated with GHG and nature positive insetting

Table 2 summarises the considerations that apply to the governance, measurement and reporting of GHG and nature positive insetting in Australian agriculture supply chains.

Table 2. Summary of key considerations associated with the governance, measurement and reporting GHG and nature positive insetting.

Consideration	Rationale	Implication
1. Governance protocols to guide insetting at the supply chain level will be helpful	Insetting is a new approach and may require substantial shifts in the strategic and financial perspectives of companies	The International Platform for Insetting recommend that insetting governance takes a two-tier approach: the overall 'Insetting Program' provides the framework of insetting interventions and Projects, while 'Insetting Project/s' generate specific outcomes in the supply chain. The following considerations relate primarily to 'Insetting Program' at the supply chain level: a. what interventions are included? b. what are the geographic boundaries of insetting interventions (e.g. farm, landscape, national)? c. over what time-frame will insetting interventions be undertaken? d. what level of traceability is required (e.g. farm-level, supply shed (i.e. all farms contributing to the supply chain))? e. is certification required? f. how will insetting be financed? g. how will accounting frameworks capture insetting benefits (e.g. via supply chain decarbonisation, compensation towards climate neutrality)? (see International Panel on Insetting; Abatable and the International Platform for Insetting 2023)
2. Accounting frameworks are required to govern inset accounting	There are a number of complexities related to inset accounting that may result in inadequate environmental outcomes. Work in this area has commenced (see Gold Standard) and is ongoing.	Clear guidance on the allocation and reporting of insets is needed to avoid: a. Double counting. Double counting occurs when insetting activities are reported at both the farm and supply chain level (Tipper et al. 2009). This concept also applies to farms that contribute to multiple supply chains (e.g. wool, meat). Insets should only be tallied once per intervention. b. Additionality. Additionality occurs when interventions that were already planned to occur are reported as insets (World Economic Forum)

Consideration	Rationale	Implication
		c. Leakage. Leakage can occur when unforeseen impacts occur due to changes over time in inset projects (Smart Freight Centre and DPDHL Group 2020). d. Interventions contributing to inset *and* offset accounts. Any given intervention should only contribute to one of these accounting approaches. And adequately quantify: e. Co-benefits. Insetting provides many co-benefits that, if quantified and included in financial systems, may enhance support of insetting (Smart Freight Centre and DPDHL Group 2020)
3. Insetting must lead to credible outcomes that are verified	There is no requirement for insetting interventions to be certified or verified against a global standard (International Platform for Insetting). This contrasts with offsetting requirements which must be independently verified by a third party (see Climate Active).	Agreed frameworks should be established to verify that insetting interventions: a) are undertaken in a way that avoids accounting-related issues outlined above, and b) result in measurable improvements in GHG or nature position. This is essential to avoid greenwashing and promote trust in insetting.
4. Insetting outcomes for biodiversity may not benefit the taxa that is impacted by the company's activities	Due to the specific requirements of plant and animal species and communities, inset interventions may not actually mitigate the impact on the affected species/community.	Due to insetting being undertaken within the same supply chain/landscape as the impact, there is a greater chance that inset interventions more directly mitigate the actual impact on affected components of biodiversity, compared with offsetting where impacts and benefits are less geographically connected.
5. Insetting interventions must be quantified using outcome-based measures that are verifiable and robust	For greatest uptake and credibility, insetting must result in measurable outcomes for climate and nature loss mitigation.	For insetting to be credible and robust, and to avoid greenwashing, measures must be quantitative, outcome-based and verifiable. Payments should be linked to outcomes (cf. practices) (International Panel on Insetting)
6. Agreed methods for measuring regenerative and nature positive outcomes are required	Nature positive in particular is a concept that lacks clear guidance around the quantification of outcomes. This complicates the process of numerically balancing nature positive insets against environmental impacts.	The capacity to evaluate and mitigate a company's Global Footprint is currently hindered by a lack of methods to do so (Insetting Program Standard v 2.0). Some considerations include: a) more than one metric will be required to adequately represent a company's impact on biodiversity (or other values included under Global Footprints)

Consideration	Rationale	Implication
		b) measures must be suitable for representing a company's baseline Global Footprint as well as their reduction and compensation insetting activities
7. Guidance on identifying opportunities for insetting will likely be required	Insetting interventions take a range of forms, and are likely to exist across multiple stakeholders within the same supply chain. Guidance will help companies select the most appropriate alternative for them.	Selection of insetting interventions involves considerations such as: a. identifying the opportunities for insetting that exist across a company's supply chain b. prioritising interventions to ensure that selected alternatives provide greatest alignment with company goals c. a consideration for insetters (i.e. farmers) contributing to multiple supply chains is how to determine which supply chain to inset in relation to (or how to apportion fractional inset benefits across multiple supply chains) (see International Panel on Insetting)
8. Greater understanding of the cost of insetting is required	Historic data on insetting costs and outcomes is lacking	Further work is required to ensure insetting interventions and audits thereof are appropriately costed in financial structures (Abatable and the International Platform for Insetting 2023)
9. Time is required to realise the full range of outcomes associated with insetting interventions	Unlike offsetting projects which are often already-developed projects when purchased, insetting interventions will often take time to yield the full range of environmental benefits.	a. Businesses and their financial processes should recognise the longer-term benefits (or disbenefits/trade-offs) of insetting interventions (International Platform for Insetting) b. Long-term insetting agreements are likely to be required (Abatable and the International Platform for Insetting 2023)
10. Guidance on quantifying avoided or mitigated impact by insetting	Insetting interventions may reduce GHG or Global impact of business activities throughout the supply chain.	Further work is required on quantifying the avoided impact of insetting interventions (Abatable and the International Platform for Insetting 2023).

Conclusions

The concept of insetting is new and evolving quickly. It has the potential to bring much needed resources to address climate and biodiversity crises. However, at this early stage more questions remain than answers.

There is likely to be increased demand from supply chains for insetting opportunities, but further work is required to develop frameworks for the implementation, payment and verification of the impact of insetting activities. There is broad acceptance that verification requires scientifically credible, cost effective, outcome-based metrics to measure the impact of insetting activities. This is essential to avoid greenwashing. The *Farming for the Future* metrics may provide these metrics, but further work on definitions and frameworks are needed to address the issues raised in this paper.

References

References

Abatable and the International Platform for Insetting. 2023. Addressing Scope 3 – how insetting can be scaled to tackle supply chain emissions. Opportunities and challenges in the insetting value chain. Abatable and the International Platform for Insetting.

Alexanderson MS, Luke H, Lloyd DJ. 2023. Regenerative farming as climate action. Journal of Environmental Management **347**:119063.

Arlidge WNS, et al. 2018. A Global Mitigation Hierarchy for Nature Conservation. BioScience **68**:336-347.

Baker T, Moroni M, Mendham Ds, Smith R, Hunt M. 2018. Impacts of windbreak shelter on crop and livestock production. Crop and Pasture Science 69:785-796.

Balch O, Zabey E, Ofosuhene-Wise M. 2022. How business and finance can contribute to a nature positive future now. Business for Nature.

Barbé H, Frascaria-Lacoste N. 2021. Integrating ecology into land planning and development: between disillusionment and hope, questioning the relevance and implementation of the mitigation hierarchy. Sustainability **13**:12726.

Bateman IJ. and Mace GM. 2020. The natural capital framework for sustainably efficient and equitable decision making. Nature Sustainability, 3:776-83.

Bull JW, et al. 2020. Net positive outcomes for nature. Nature Ecology & Evolution **4**:4-7.

Campbell BM, Beare DJ, Bennett EM, Hall-Spencer JM, Ingram JSI, Jaramillo F, Ortiz R, Ramankutty N, Sayer JA, Shindell D. 2017. Agriculture production as a major driver of the Earth system exceeding planetary boundaries. Ecology and Society **22**.

Ebersold F, Hechelmann R-H, Holzapfel P, Meschede H. 2023. Carbon insetting as a measure to raise supply chain energy efficiency potentials: Opportunities and challenges. Energy Conversion and Management: X **20**:100504.

Edens B, Maes J, Hein L, Obst C, Siikamaki J, Schenau S, Javorsek M, Chow J, Chan JY, Steurer A and Alfieri A. 2022. Establishing the SEEA Ecosystem Accounting as a global standard. Ecosystem Services, 54:101413.

Eldridge DJ, Wong VNL. 2005. Clumped and isolated trees influence soil nutrient levels in an Australian temperate box woodland. Plant and Soil 270:331-342.

Fraser H, Simmonds JS, Kutt AS, Maron M. 2019. Systematic definition of threatened fauna communities is critical to their conservation. Diversity and Distributions **25**:462-477.

Gagic V, Paull C, Schellhorn NA. 2018. Ecosystem service of biological pest control in Australia: the role of non-crop habitats within landscapes. Austral Entomology 57:194-206.

George RJ, Nulsen RA, Ferdowsian R, Raper GP. 1999. Interactions between trees and groundwaters in recharge and discharge areas – A survey of Western Australian sites. Agricultural Water Management 39:91-113.

Giller KE, Hijbeek R, Andersson JA, Sumberg J. 2021. Regenerative Agriculture: An agronomic perspective. Outlook on Agriculture **50**:13-25.

Gosnell H, Gill N, Voyer M. 2019. Transformational adaptation on the farm: Processes of change and persistence in transitions to 'climate-smart' regenerative agriculture. Global Environmental Change **59**:101965.

Green RE, Cornell SJ, Scharlemann JPW, Balmford A. 2005. Farming and the fate of wild nature. Science **307**:550-555.

Haslem A, Bennett AF and Radford JQ. 2022. *Development of a Biodiversity Index for estimating the farm-scale biodiversity of natural fibre producing properties in Australia.* Report to Farming for the Future. Research Centre for Future Landscapes, La Trobe University, Bundoora.

Hyams K, Fawcett T. 2013. The ethics of carbon offsetting. WIREs Climate Change **4**:91-98.

Ives CD, Bekessy SA. 2015. The ethics of offsetting nature. Frontiers in Ecology and the Environment **13**:568-573.

Jacobs AA, Evans RS, Allison JK, Garner ER, Kingery WL, McCulley RL. 2022. Cover crops and no-tillage reduce crop production costs and soil loss, compensating for lack of short-term soil quality improvement in a maize and soybean production system. Soil and Tillage Research **218**:105310.

Kaye JP, Quemada M. 2017. Using cover crops to mitigate and adapt to climate change. A review. Agronomy for Sustainable Development **37**:4.

Khangura R, Ferris D, Wagg C, Bowyer J. 2023. Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health. Sustainability **15**:2338.

LaCanne CE, Lundgren JG. 2018. Regenerative agriculture: merging farming and natural resource conservation profitably. PeerJ **6**:e4428.

Leach K, Grigg, A, O'Connor B, Brown C, Vause J, Gheyssens J, Weatherdon L, Halle M, Burgess ND, Fletcher R, Bekker S, King S and Jones M. 2019. A common framework of natural capital assets for use in public and private sector decision making. Ecosystem Services, 36:100899.

Lentini PE, Martin TG, Gibbons P, Fischer J, Cunningham SA. 2012. Supporting wild pollinators in a temperate agricultural landscape: maintaining mosaics of natural features and production. Biological Conservation 149:84-92.

Locke H, et al. 2020. A nature-positive world: The global goal for nature. Wildlife Conservation Society.

Loo I-L. 2020. Regenerative agriculture: A global opportunity for the Australian agriculture industry. Trust WCM.

Mace GM, Barrett M, Burgess ND, Cornell SE, Freeman R, Grooten M, Purvis A. 2018. Aiming higher to bend the curve of biodiversity loss. Nature Sustainability **1**:448-451.

Maron M, et al. 2024. 'Nature positive' must incorporate, not undermine, the mitigation hierarchy. Nature Ecology & Evolution **8**:14-17.

Milner-Gulland EJ. 2022. Don't dilute the term Nature Positive. Nature Ecology & Evolution **6**:1243-1244.

Natural Capital Coalition. 2016. Natural Capital Protocol.

Newton P, Civita N, Frankel-Goldwater L, Bartel K, Johns C. 2020. What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. Frontiers in Sustainable Food Systems **4**.

Noor FMM, Gassner A, Terheggen A, Dobie P. 2017. Beyond sustainability criteria and principles in palm oil production addressing consumer concerns through insetting. Ecology and Society **22**.

O'Brien D, Hawdon A, Lawrence R, Maisey A, Ogilvy S, Rainsford F, Semmler I, Sutton G and Radford J. 2023a. *Farm-scale Natural Capital Accounting Methods.* La Trobe University, Bush Heritage Australia and Integrated Futures.

O'Brien D, Hawdon A, Lawrence R, Maisey A, Ogilvy S, Rainsford F, Semmler I, Sutton G and Radford J. 2023b. *Orana Farm-scale Natural Capital Account 2022.* La Trobe University and Integrated Futures.

O'Donoghue T, Minasny B, McBratney A. 2022. Regenerative Agriculture and Its Potential to Improve Farmscape Function. Sustainability **14**:5815.

Obura DO, et al. 2023. Achieving a nature- and people-positive future. One Earth **6**:105-117.

Ogilvy S, O'Brien D, Lawrence R and Gardner M. 2022. A natural capital accounting framework to communicate the environmental credentials of individual wool-producing businesses. Sustainability Accounting, Management and Policy Journal, 13:765-802.

Ogle SM, Breidt FJ, Paustian K. 2005. Agricultural management impacts on soil organic carbon storage under moist and dry climatic conditions of temperate and tropical regions. Biogeochemistry **72**:87-121.

Radford JQ, Haslem A, Rainsford FW, Maisey A and Bennett AF. 2022. *Management of biodiversity on livestock farms with a focus on Wool Growers: a review of relevant literature for Australian Wool Innovation*. Report to Farming for the Future. Research Centre for Future Landscapes, La Trobe University, Bundoora.

Rehberger E, West PC, Spillane C, McKeown PC. 2023. What climate and environmental benefits of regenerative agriculture practices? an evidence review. Environmental Research Communications **5**:052001.

Roberts K, Gregg T, Fox T and Heath R. 2022. *Development of the Australian Agricultural Sustainability Framework 2021-22.* Australian Farm Institute.

Robertson M, Macdonald B, Farrell M, Norman H, Macdonald L, Vadakattu G, Taylor J. 2022. What can science offer the proponents of regenerative agriculture practices?

Schreefel L, Schulte RPO, de Boer IJM, Schrijver AP, van Zanten HHE. 2020. Regenerative agriculture – the soil is the base. Global Food Security **26**:100404.

Sherren K, Fischer J, Pink J, Stott J, Stein J, Yoon H-J. 2011. Australian Graziers Value Sparse Trees in Their Pastures: A Viewshed Analysis of Photo-Elicitation. Society & Natural Resources 24:412-422.

Smart Freight Centre and DPDHL Group. 2020. Carbon insets for the logistics sector: Innovating carbon offset practices to accelerate freight decarbonization. Smart Freight Centre.

Sutton G, Bennett A, Ogilvy S, Radford J. 2023a. *Methods and protocols for measures of the emergent properties of on-farm natural capital leading to development of natural capital indices*. Report to Farming for the Future. Research Centre for Future Landscapes, La Trobe University, Bundoora.

Sutton G, Haslem A, Radford J. 2023b. *A preliminary analysis of biodiversity management by wool-grower participants in Farming for the Future*. Report to Farming for the Future. Research Centre for Future Landscapes, La Trobe University, Bundoora.

Textile Exchange. 2022. Regenerative Agriculture Landscape Analysis. https://textileexchange.org/knowledge-center/reports/regenerative-agriculture-landscape-analysis/.

Tipper R, Coad N, Burnett J. 2009. Is 'Insetting' the New 'Offsetting'? Ecometrica, ecometrica.com.

United Nations. 2017. System of Environmental-Economic Accounting 2012 – Applications and Extensions. New York.

Vermeulen SJ, Campbell BM, Ingram JS. 2012. Climate change and food systems. Annual review of environment and resources **37**:195-222.

Wilson KR, Myers RL, Hendrickson MK, Heaton EA. 2022. Different Stakeholders' Conceptualizations and Perspectives of Regenerative Agriculture Reveals More Consensus Than Discord. Sustainability.

zu Ermgassen SOSE, Howard M, Bennun L, Addison PFE, Bull JW, Loveridge R, Pollard E, Starkey M. 2022. Are corporate biodiversity commitments consistent with delivering 'nature-positive' outcomes? A review of 'nature-positive' definitions, company progress and challenges. Journal of Cleaner Production **379**:134798.

Websites related to insetting

3Degrees (accessed April 2024). Renewable Energy Partner - Sustainability Consulting | 3Degrees (3degreesinc.com)

Climate Active (accessed April 2024). Homepage | Climate Active

Gold Standard (accessed April 2024). Scope 3 Value Chain Interventions Guidance (goldstandard.org)

Plan A (accessed April 2024). What are Scope 3 emissions? (plana.earth)

The International Platform for Insetting (accessed April 2024). Home - IPI (insettingplatform.com)

World Economic Forum (accessed April 2024). Carbon insetting vs offsetting – an explainer | World Economic Forum (weforum.org)

Specific resources of relevance to insetting

Forest, Land and Agriculture Guidance, developed by the Science Based Targets Initiative. Link: Forests, Land and Agriculture - Science Based Targets

Insetting Program Standard, developed by the International Platform for Insetting. Link: INSETTING_PROGRAM_STANDARD_IPS_V2.0_Final.pdf

Land Sector and Removals Initiative, developed by the Greenhouse Gas Protocol. Link: Project Overview_18 Dec 2023.pdf (ghgprotocol.org)

Value Chain (Scope 3) Interventions – Greenhouse Gas Accounting and Reporting Guidance, developed by Gold Standard. Link: VALUE CHAIN (SCOPE 3) INTERVENTIONS – GREENHOUSE GAS ACCOUNTING & REPORTING GUIDANCE (prismic.io)

Appendices

Appendix 1

Classification of the *Farming for the Future* metrics (n=28) on the basis of the Australian Agricultural Sustainability Framework (see Roberts et al. 2022). Principles represent the desired outcome or ideal state; criteria outline the conditions to be met to comply with a Principle.

Metric	Theme	Categories	Principles	Criteria
Soil Condition	Environmental Stewardship	Soil & landscapes	P3. Soil health and functionality are protected and enhanced	C6. Soils are managed to provide ecosystem services, including sustainable agricultural production
			P4. Landscape degradation is avoided or minimised	C7. Land under productive agricultural management delivers beneficial environmental services
Ecological Condition	Environmental Stewardship	Biodiversity	P5. Biodiverse ecological communities are protected and enhanced	C9. Farms support a diverse range of beneficial flora and fauna species C10. Farm-related ecosystems are functioning and thriving
Aggregation	Environmental Stewardship	Biodiversity	P5. Biodiverse ecological communities are protected and enhanced	C9. Farms support a diverse range of beneficial flora and fauna species
Extent of Woody Vegetation	Environmental Stewardship	Soil & landscapes	P4. Landscape degradation is avoided or minimised	C7. Land under productive agricultural management delivers beneficial environmental services
		Biodiversity	P5. Biodiverse ecological communities are protected and enhanced	C9. Farms support a diverse range of beneficial flora and fauna species
		Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C2. Carbon emissions are sequestered throughout lifecycle
Aquatic Condition	Environmental Stewardship	Soil & landscapes	P4. Landscape degradation is avoided or minimised	C8. Natural waterways are preserved and improved
		Water	P6. Water resources are used responsibly and equitably	C12. Adverse impacts to surface water and groundwater quality are prevented
		Biodiversity	P5. Biodiverse ecological communities are protected and enhanced	C9. Farms support a diverse range of beneficial flora and fauna species
Forage Condition	People, Animals & Community	Animal wellbeing	P12. Farmed animals are given the best care for whole of life	C26. Best practice on-farm husbandry is demonstrated
	Environmental Stewardship	Soil & landscapes	P4. Landscape degradation is avoided or minimised	C7. Land under productive agricultural management delivers beneficial environmental services
Proximity	People, Animals & Community	Animal wellbeing	P12. Farmed animals are given the best care for whole of life	C26. Best practice on-farm husbandry is demonstrated
	Environmental Stewardship	Soil & landscapes	P4. Landscape degradation is avoided or minimised	C7. Land under productive agricultural management delivers beneficial environmental services
Shade	People, Animals & Community	Animal wellbeing	P12. Farmed animals are given the best care for whole of life	C26. Best practice on-farm husbandry is demonstrated
	Environmental Stewardship	Soil & landscapes	P4. Landscape degradation is avoided or minimised	C7. Land under productive agricultural management delivers beneficial environmental services
Shelter	People, Animals & Community	Animal wellbeing	P12. Farmed animals are given the best care for whole of life	C26. Best practice on-farm husbandry is demonstrated
	Environmental Stewardship	Soil & landscapes	P4. Landscape degradation is avoided or minimised	C7. Land under productive agricultural management delivers beneficial environmental services

Metric	Theme	Categories	Principles	Criteria
GHG emissions: Scope 1	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle
GHG emissions: Scope 2	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle
GHG emissions: select Scope 3	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle
GHG emissions: total all Scopes	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle
Carbon sequestration	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C2. Carbon emissions are sequestered throughout lifecycle
Net GHG emission: farm	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle C2. Carbon emissions are sequestered throughout lifecycle
Net GHG emissions: all	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle C2. Carbon emissions are sequestered throughout lifecycle
GHG emissions intensity	Environmental Stewardship	Greenhouse gases & air	P1. Net anthropogenic GHG emissions are limited to minimise climate change	C1. GHG emissions are reduced throughout lifecycle
Nitrogen use efficiency	Environmental Stewardship	Water Materials & resources	P6. Water resources are used responsibly and equitably P7. Finite resources are safeguarded in circular economic systems	C12. Adverse impacts to surface water and groundwater quality are prevented C13. The use of inputs and resources that cannot be reused or recycled is minimised
Lime use efficiency	Environmental Stewardship	Materials & resources	P7. Finite resources are safeguarded in circular economic systems	C13. The use of inputs and resources that cannot be reused or recycled is minimised
Phosphorus use efficiency	Environmental Stewardship	Water Materials & resources	P6. Water resources are used responsibly and equitably P7. Finite resources are safeguarded in circular economic systems	C12. Adverse impacts to surface water and groundwater quality are prevented C13. The use of inputs and resources that cannot be reused or recycled is minimised
Rainfall use efficiency	Environmental Stewardship	Water	P6. Water resources are used responsibly and equitably	C11. Water is used efficiently in agricultural systems
Water use (efficiency)	Environmental Stewardship	Water	P6. Water resources are used responsibly and equitably	C11. Water is used efficiently in agricultural systems
Normalised stress weighted water consumption	Environmental Stewardship	Water	P6. Water resources are used responsibly and equitably	C11. Water is used efficiently in agricultural systems
Water Pollution Generated	Environmental Stewardship	Water	P6. Water resources are used responsibly and equitably	C12. Adverse impacts to surface water and groundwater quality are prevented
Fossil aquifers	Environmental Stewardship	Water Materials & resources	P6. Water resources are used responsibly and equitably P7. Finite resources are safeguarded in circular economic systems	C11. Water is used efficiently in agricultural systems C14. Renewable sources of inputs are prioritised
Finite resources used as inputs	Environmental Stewardship	Materials & resources	P7. Finite resources are safeguarded in circular economic systems	C14. Renewable sources of inputs are prioritised
Plastic packaging waste generated	Environmental Stewardship	Materials & resources	P7. Finite resources are safeguarded in circular economic systems	C13. The use of inputs and resources that cannot be reused or recycled is minimised C15. Residues and waste are reused or recycled

Metric	Theme	Categories	Principles	Criteria
Biodiversity management index	Environmental Stewardship	Biodiversity	P5. Biodiverse ecological communities are protected and enhanced	C9. Farms support a diverse range of beneficial flora and fauna species C10. Farm-related ecosystems are functioning and thriving

FARMING FOR THE FUTURE

Farming for the Future
E hello@fftf.org.au | **W** farmingforthefuture.org.au