Natural capital report for Taylors Run

December 2023

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Message from the Program Director

Thank you for your support for the *Farming for the Future* research program. We greatly appreciate the contribution you have made to understanding the value of natural capital to Australian agriculture.

Farming for the Future is a public good agricultural research and change activation program. It is designed to build the first national-scale evidence base of natural capital and its relationship to business performance on Australian farms. We aim to provide the national-scale evidence and practical support that farmers need to incorporate natural capital as part of the foundation of their farming businesses, and to activate the supply chain and financial services organisations to encourage and reward that shift.

The research question we're exploring in this phase of our program is whether natural capital is linked to the productivity, profitability, and resilience of a farm business. Also, whether investments in natural capital have the potential to reduce risk and unlock financial value for Australian farm businesses. As part of this research, we aim to provide you with the evidence base, tools, and resources you can use to build more profitable and climate-resilient businesses. We believe this will support a more financially prosperous, climate-resilient, and environmentally positive agriculture sector in Australia.

By participating in the project and contributing data and insights to the program, you have helped to advance research and understanding in several key areas. Firstly, in the development and testing of methods of quantifying farm natural capital in an objective, repeatable and robust way. Second, by helping us integrate natural capital in an analysis of differences in farm business performance, which is, as far as we know, a world first. The outputs of the research are regarded as being preliminary in nature – despite the size of this project, more datapoints will be needed before we can be confident that we fully understand relationships between natural capital and farm business performance.

We have aimed to produce this information in a way that helps you make decisions about the natural capital of your farm and how it might work in better supporting your goals for your family and business.

This report of the natural capital of your farm and the environmental performance of your farm business has been designed to give you useful information that you can use in making management decisions and to help you communicate your achievements to your stakeholders. Your report is confidential, and we won't publish it unless you ask us to or give us permission to publish.

As with the research, the designs of the individual farm reports should be considered to be preliminary and experimental– the first version of how on-farm natural capital should be described. We expect to gain significant insights with further feedback from you and other stakeholders.

We are very proud of the achievements of the *Farming for the Future* program so far and we thank you again for the significant contribution you have made to the work.

Yours sincerely

Sue Ogilvy

Program Director

Acknowledgements

Farming for the Future acknowledges the traditional owners of the lands on which we live and of the lands involved in the research. We pay our respect to their Elders past, present and emerging.

We appreciate the support of our philanthropic and industry partners especially the Natural Farmers' Federation, Meat & Livestock Association and Australian Wool Innovation. For our full list of partners see the About Us section of www.fftf.org.au.

We acknowledge the work of La Trobe University in development of the natural capital indices and the underlying protocols for the natural capital data collection. Their support has been invaluable.

We also acknowledge the work of many other scientists whose work we have been able to draw on in the development of these approaches as well as the significant contribution of farmers, farm advisors, farm accountants, our industry partners, and our natural resource management partners. These have been very important in the project, and we have greatly enjoyed working with them.

Cover photograph image credit: Dr Rachel Lawrence.

Disclaimer

Introduction

Farming for the Future's research program aims to help build a better understanding of the relationship between the natural capital of a farm and the efficiency, productivity, profitability and resilience of the farm business and the wellbeing of the farming family. As part of this research, the natural capital and environmental performance of participating farms has been quantified via a combination of satellite imagery analysis and field observations.

This report provides the natural capital results for Taylors Run from the assessments conducted on 16/12/2021. It also contains some background information about natural capital and the benefits it can generate for production and for society. A separate report will be provided that contains information about how the economic performance of the farm business and the natural capital of the farm compares to other farms in the study.

What is natural capital in agriculture?

Agricultural natural capital is the living parts of the farm - ecological assets like air, water, soil, plants, and animals. It represents significant ecological and commercial value and can be accounted for alongside agricultural assets like land size, infrastructure, and livestock to provide a full picture of a farm's assets.

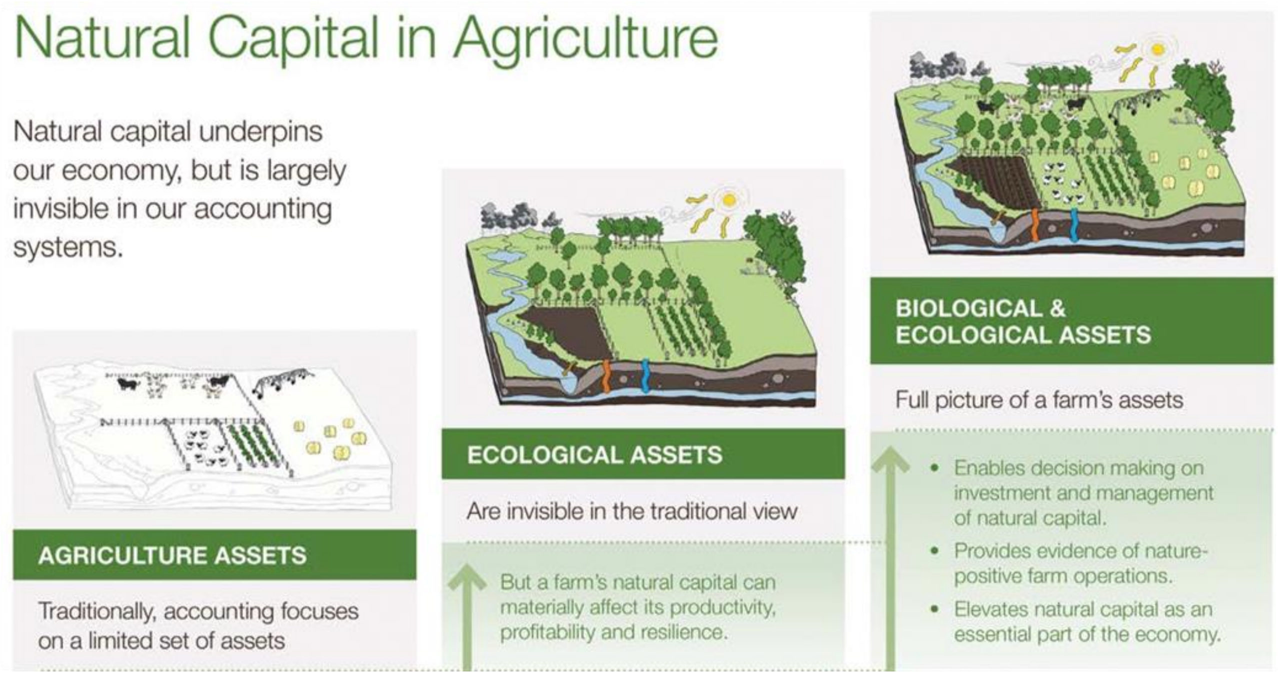


Figure 1: Natural Capital is not presently included in farm accounts. The inclusion of it would provide a more complete set of information about the assets of a farm and may assist with decision-making about farm business performance.

Illustrated in Figure 2, the natural capital[1] of a farm provides a range of different ecosystem services that can support production of crops and livestock. Depending on the types of natural capital it has, a farm business can benefit from shade, shelter and forage for livestock, habitat for beneficial insects and birds, regulation of soil and water quality and other services that support efficiency, profitability, and business resilience.

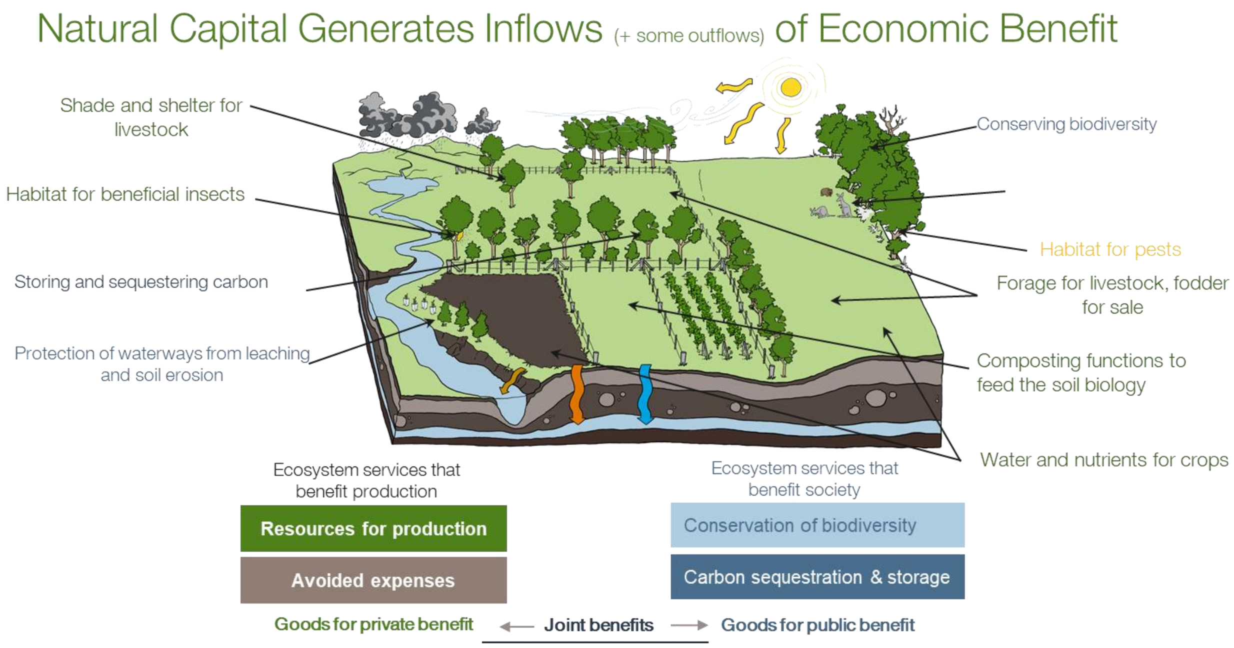


Figure 2: Overview of ecosystem services in agriculture. Different types of natural capital provide different types of resources that can benefit production (green) as well as providing benefits to society more broadly (blue). It is acknowledged that natural capital can also provide 'disservices' such as habitat for pests.

For our research, we have quantified seven experimental indices (indexes) representing different attributes of natural capital that contribute to the generation of ecosystem services that benefit production of livestock, pastures and crops and the capacity of the farm to support biodiversity. Each index is calculated as a number between 1 and 0 with one being the highest score for that attribute and 0 indicating that the farm is not showing significant amounts of this attribute. They will continue to be refined during the FFTF research program. The indices are reported along with information about the natural capital extent and condition prepared according to guidance by the United Nations System of Environmental Economic Accounting.

Where does data in this report come from?

A mix of sources including

- Farm records (provided by you).
- Assessments from ecologists who visited your farm. This helps gather data that satellites can't measure, as well as ground-truth satellite data.
- Remote sensed data (e.g., satellites).
- Other industry or academic modelling.

Farming for the Future focus

FFTF is focused on understanding how natural capital contributes to production of crops and livestock. This may be by providing:

- Resources for production (e.g., forage / feed, shade, and shelter)
- Ways to avoid expenses (e.g., fertility from soil biology, pest control, pollination)

[1] The term natural capital means the same thing as ecological capital and ecosystem assets.

Using the information

What does this information mean?

Information not advice	This report provides information on 'what type' and 'how much' natural capital is on the farm. No judgement is made on whether this is good or bad.
Your values and goals	'What good looks like' is up to you. The ideal natural capital for your farm depends on your unique context, values, goals, and changing circumstances. The Benchmarking report you will also receive will help you understand how the natural capital of your farm compares with the natural capital in your region and in the study.
Your sweet spot	Every farmer has their own preferred mix of natural resources to support their enterprise and personal goals. These may change over time. There may be a 'sweet spot' where natural capital and economic performance are both optimised.

Overview | Natural Capital Indices

The seven natural capital indices for Taylors Run are summarised here and described in further detail in following sections. Forage Condition and Soil Condition (light blue dials) are indices that relate to the provision of resources directly to livestock and crops. Proximity, Connectivity and Aggregation (the medium blue dials) are indices indicate the generation of indirect services such as shade and shelter and habitat for beneficial insects as well as aspects of biodiversity. Ecological Condition (dark blue dial) is the degree of modification of the farm from the original reference condition of the region.

Note: it is not necessarily desirable to aim for a result of 1 for each indicator. Additional information about what the indices mean, how they have been prepared and what 1 and 0 mean for each index is provided in following pages.

Forage Condition	0.62	A measure of the capacity of pastures to dependably produce high-quality forage for livestock.
Soil Condition	0.84	The degree to which the ground surface is covered by living vegetation and / or dead plant material (e.g., litter or stubble) as a proxy for soil condition.
Proximity	0.54	The degree to which production areas are close to wooded vegetation.
Connectivity	0.23	The degree to which wooded vegetation increases connectivity through connected corridors or 'stepping-stones' of wooded vegetation.
Aggregation	0.10	The degree to which wooded vegetation is arranged into continuous patches.
Aquatic Condition	0.25	The proportion of tree cover in riparian areas as a proxy for aquatic ecosystem condition.
Ecological Condition	0.28	The degree to which a farm has been modified from its 'reference' (pre-development) condition.

Overview | Greenhouse gas emissions and sequestration

This chart summarises the average of the annual greenhouse gas ('GHG') emissions estimated for your farm and the estimated carbon sequestration over the same period. Data is in tonnes of carbon equivalent[2] (tCO_2-e). The sum of emissions (above the 0 line) and sequestration (below the 0 line) produces net farm emissions.

Net values below the zero-value line indicate a farm business that is sequestering more greenhouse gases than it is emitting; net values above the zero-value line indicate a farm business that is emitting more greenhouse gases than it is sequestering. Further detail is provided in the body of the report.

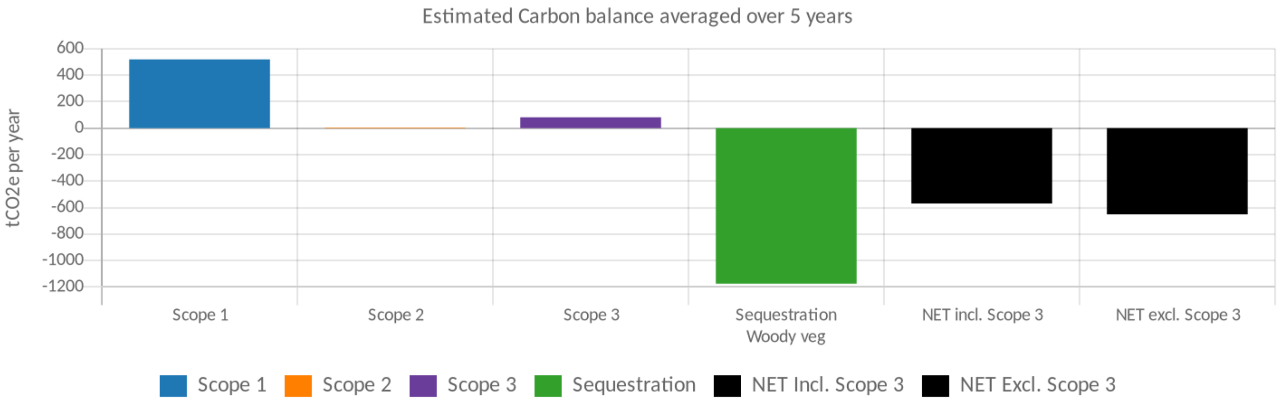


Figure 3: Summary of greenhouse gas emissions and sequestration (5-year average).

Table 1: Description of key terms used in emissions calculations.

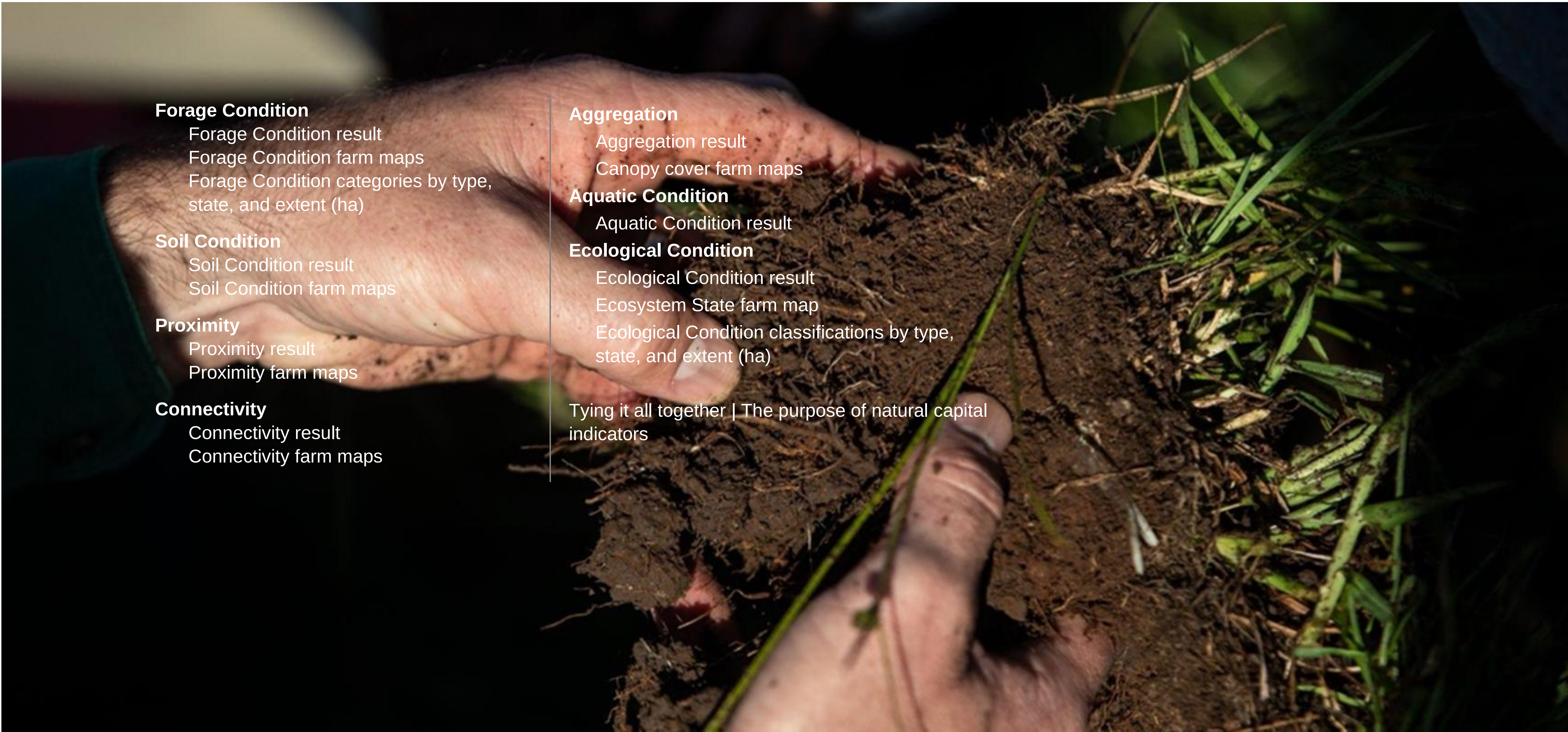
Emissions Scope	Description
Scope 1	Emissions generated directly from on-farm operations. For example, enteric emissions from livestock, and emissions associated with fuel use and oxidisation of nitrogenous fertilisers.
Scope 2	Electricity purchased from the grid and consumed on farm. Renewable energy generated and consumed on site is zero-carbon for the purposes of Scope 2.
Scope 3	Emissions generated by off-farm suppliers in producing and transporting select inputs used on your farm. Also, off-farm emissions from electricity use (namely, transmission losses) and upstream fuel consumption (e.g., extraction and processing of fossil fuels). The following inputs are included; sheep and cattle purchases, synthetic fertiliser, superphosphate, urea, feed (grain, hay/silage, lucerne).
Carbon sequestration[3]	Modelled tonnes of carbon (tCO_2-e per year) sequestered on farm. This is an estimate of carbon sequestered in woody vegetation only.

[2] Under GHG accounting, various greenhouse gases like methane and nitrous oxide are converted to carbon dioxide equivalents for comparative purposes.

[3] Sequestration has been modelled using FLINTPro™ and represents carbon stock changes in woody vegetation, including stocks in remnant vegetation. The methods used do not take into account the concept of additionality or any carbon sold by the land holder. As such, these figures should not be used for the purposes of trading carbon or to make formal claims of carbon neutrality. Each industry scheme will have particular requirements.

Natural Capital Indicators

The next section of the report provides information about how the natural capital indicators have been calculated and which parts of the farm are higher or lower on each indicator as well as information about 'what type' and 'how much' natural capital you have on your farm.



Forage Condition

Forage Condition is a measure of the capacity of the farm to dependably produce quality forage for livestock. It is estimated using the proportion and diversity of perennial, palatable, persistent, and productive forage plants (including native and exotic plants) on the land used for grazing.

Forage Condition (whole farm)

How Forage Condition is measured

The ecologist who visited your farm inspected a representative sample of your paddocks to assess pasture composition. They used this information to classify each paddock into one of four categories[4]:

- **A:** Paddocks with a high degree of cover of a diverse mix of pasture species that are regarded as perennial, palatable, productive (and persistent) (3P species). Annual grasses and forbs may be present as gap fillers.
- **B:** Paddocks that have a moderate to high cover of 3P species but generally with lower diversity. Annual grasses and forbs may be present along with perennial grasses of lower palatability or productivity.
- **C:** Paddocks with sparse perennial cover. 3P species are at very low abundance and perennials present are persistent but of lower productivity and/or palatability. May have a diverse mix of annual pasture species (may be sown pastures). Weedy or no value species likely to be present.
- **D:** Paddocks that are dominated by annual species, either sown or naturalised. Almost no perennial pasture species present. Pastures include swards with plants with no or very low forage value and may have significant amounts of bare ground.

Paddocks that weren't visited but had similar ground cover (evaluated using remote sensing) and management characteristics (from your farm records) to visited paddocks were assigned the same forage classification. The forage condition indicator is a weighted average of forage condition over the whole farm.

Pasture composition varies substantially with seasonal conditions and can be affected by timing of grazing. The pasture condition classifications, the timing of observations and the observation protocols used for assessing pasture composition in this research are designed to take these things into account.

Maps[5], summary tables, and charts are provided on the following pages to show how the paddocks have been classified. Areas that are not used for grazing are marked NA (grey).

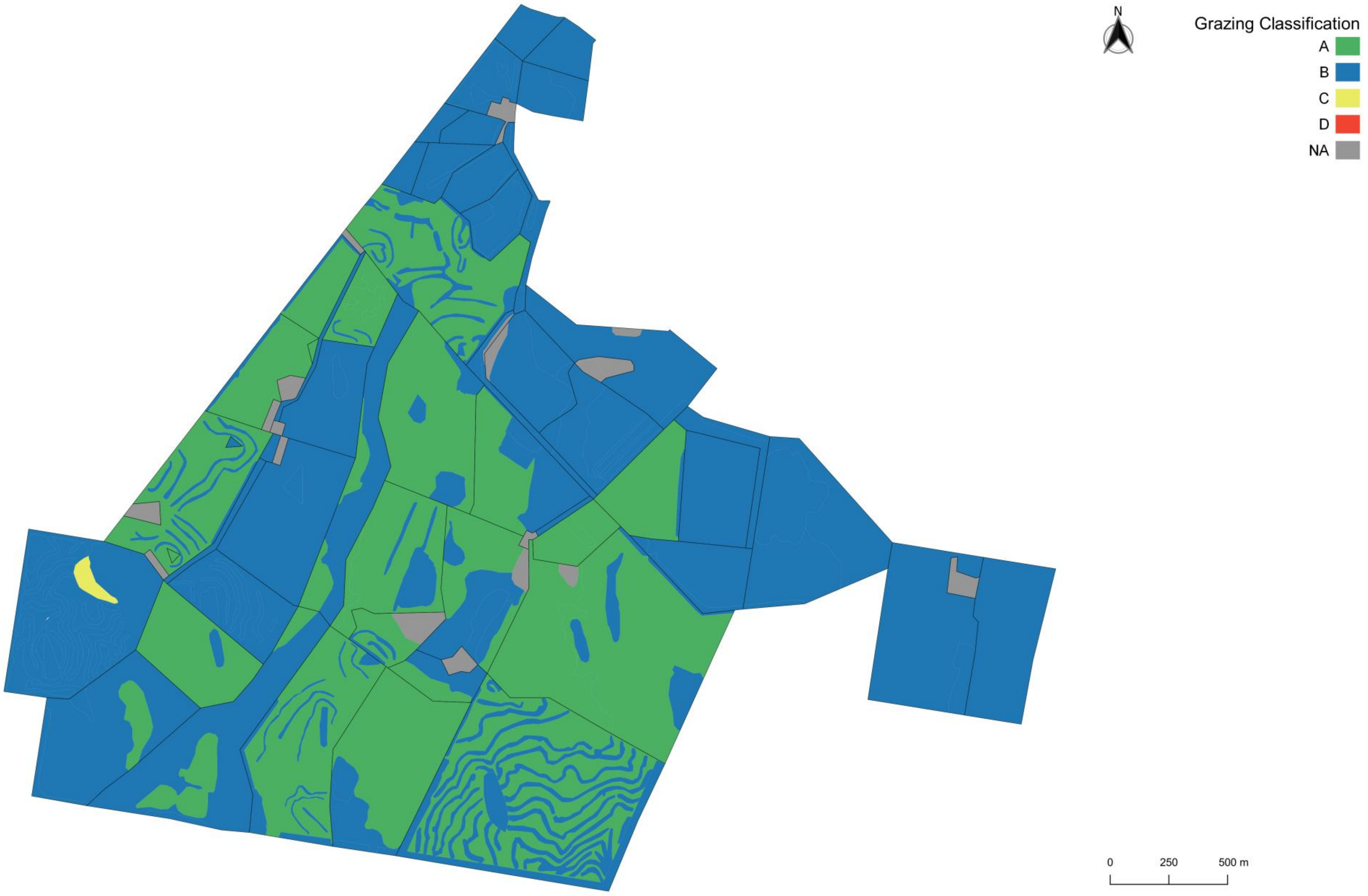
Forage Condition reference scenarios.

Result	Reference scenario
Closer to '1'	A farm where all pastures are dominated by palatable, perennial, productive and persistent forage species. Annual species may be present.
Closer to '0'	A farm where all pastures are dominated by annual forage species with low value for grazing.

[4] The labels A B C and D are not intended to imply a value judgement. FFTF recognises that different managers have different preferences for pasture type, species, and diversity.

[5] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in on particular details.

Forage Condition farm map(s)



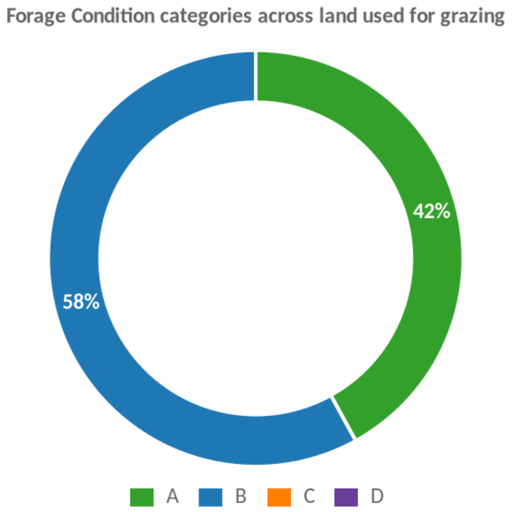
Forage Condition categories by ecosystem type and state

This table provides a break-down by area (ha) of the Forage Condition classes in each Ecosystem State. The use of alphabetic labels for these classifications is not intended to imply a value judgement. See the Ecological Condition section for information about Ecosystem Types and States.

		Area of each pasture classification (ha)			
Ecosystem Type	**Ecosystem State** (condition / quality)	**A**	**B**	**C**	**D**
Exotic woody vegetation	Exotic Trees - planted or self-seeded	0	145	1	0
Woodland	Transitioning Woodland 2 - some regeneration - some exotics in ground layer	36	0	0	0
Woodland	Transitioning Woodland 3 - little regeneration - mostly exotic ground layer	0	27	0	0
Woodland	Transitioning Woodland 4 - no regeneration - exotic ground layer	0	31	0	0
Grassland	Derived Grassland 2 - diverse native ground layer - some exotics	19	0	0	0
Grassland	Derived Grassland 3 - mixed ground layer with many exotics	169	140	0	0
Grassland	Derived Grassland 4 - mostly exotic ground layer with few natives	40	47	0	0
Grassland	Derived Grassland 5 - perennial exotic ground layer	34	8	0	0
Planted vegetation	Planted native trees - young (<10 years)	0	2	0	0
Planted vegetation	Planted native trees - maturing (10-40 years)	7	9	0	0
Infrastructure	Domestic Infrastructure	0	4	0	0
Infrastructure	Other infrastructure (roads, sheds, buildings)	0	0	0	0
Infrastructure	Roads & Laneways	0	8	0	0
Infrastructure	Sheds & Yards	0	0	0	0
Infrastructure	Water infrastructure (dams, channels)	0	0	0	0
Total land used for grazing (ha)		**306**	**422**	**1**	**0**
Proportion of total land used for grazing		**42 %**	**58 %**	**0 %**	**0 %**

Forage Condition | Other information

This chart shows the proportion of the farm within each forage condition category.



Our approach has been to consider native 3P species as equally valuable as introduced 3P pasture species. This differs a little from some industry approaches, although in industry guides such as Sustainable Grazing Systems, native species that are perennial, palatable, productive, and persistent are considered valuable.

Many of these native 3P species are particularly resilient in Australian conditions and are likely to persist very well in adverse climatic conditions. Thus, a diverse mainly native pasture with several 3P native grasses and forbs present will score as well as a pasture with a mix of exotic grasses and forbs. Ultimately, while this may differ from a more conventional, recent industry approach, it is the approach we have chosen to address the FFTF research question.

FFTF recognises that different pasture types will persist under different types of management depending on what species are desired, valued and managed for on each farm.

Soil Condition

In this phase of research, ground cover is used as a proxy for soil condition. Ground cover includes both living vegetation and/or dead plant material (e.g., litter or stubble).

Soil Condition (whole farm)

How Soil Condition is measured

Measuring soil condition directly is expensive and complex. For this phase of the research, we use ground cover as a proxy because it has been shown to be strongly related to many aspects of soil condition. Satellite data[6] is used to measure the ground cover across each 30m-by-30m area of your farm.

Annual metrics of minimum (10th percentile), average (50th percentile), and variability are calculated for each pixel, and a spatial mean then derived for each of the metrics.

The metrics are combined (equal weighting) for each year, and the final soil condition index is a mean across the 5-year period.

Observations of the variability, average, and minimum ground cover are combined across all locations for the 5-year period and aggregated for a whole of farm Soil Condition result.

A map[7] is provided on the next page to show areas of the farm with different ground cover. Maps of ground cover variations, minimum, and average for the 5-year period are provided in Appendix 4.

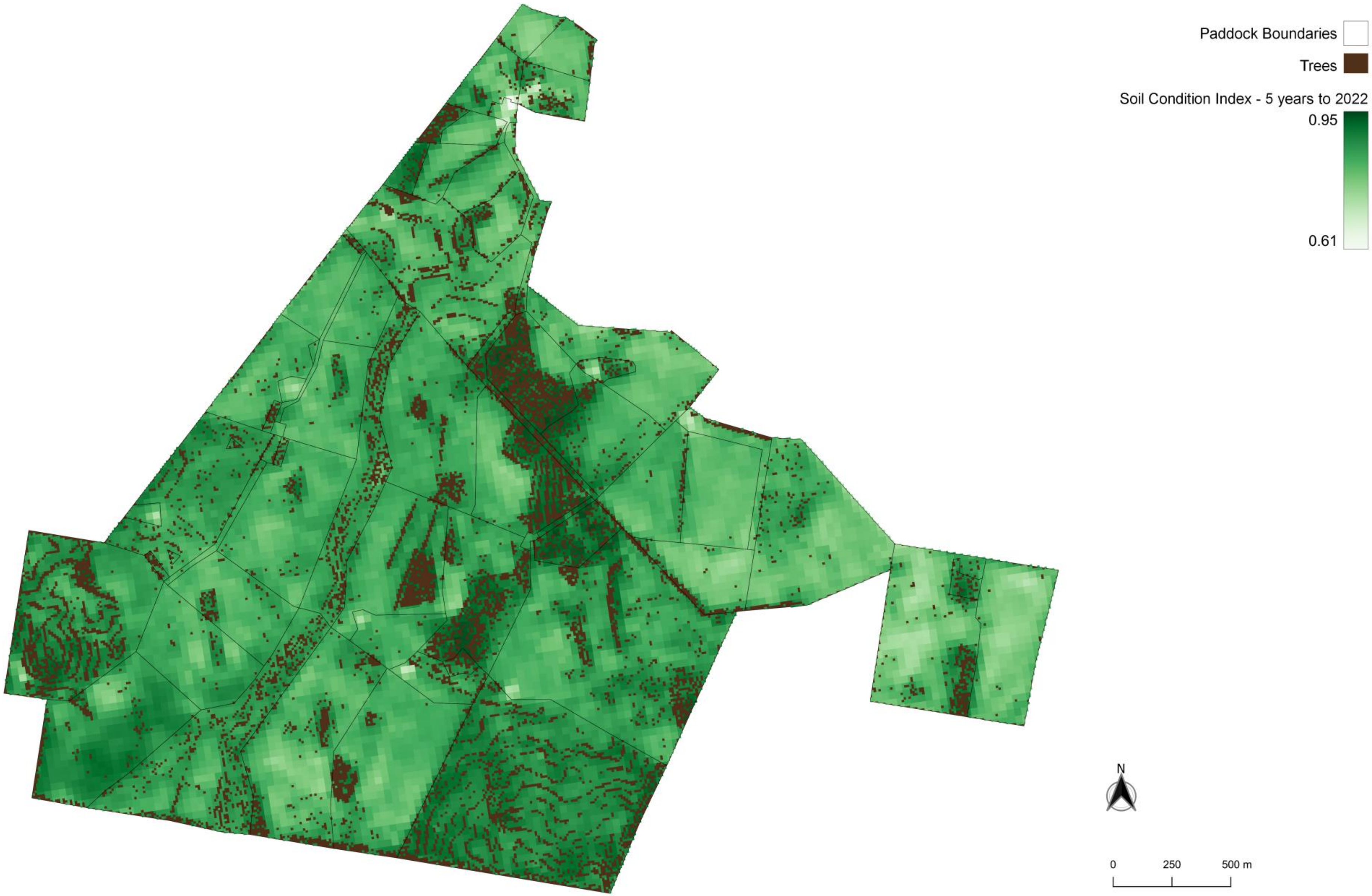
Soil Condition reference scenarios.
The below reference scenarios may help you interpret the result. Note: a result of '1' isn't necessarily always achievable everywhere in Australia. For instance, realistically achievable ground cover will differ depending on many factors, such as local climates, land and soil types, topography, and your goals.

Result	Reference scenario
Closer to '1'	Close to 100% ground cover on average across relevant areas for the 5-year period.
Closer to '0'	Close to 0% ground cover on average across relevant areas for the 5-year period.

[6] Ground cover is calculated using the Annual Fractional Cover product from Digital Earth Australia. This is produced using Landsat satellite data from NASA.

[7] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in.

Soil Condition farm map(s)



Proximity

Proximity is the degree to which production areas are close to wooded vegetation (including native and exotic trees, planted and remnant vegetation). The closer production areas are to wooded vegetation, the more likely they are to receive benefits from shade and shelter for crops and livestock, as well as beneficial animals such as pollinators and predators of pests.

Proximity (whole farm)

How Proximity is measured

Satellite data[8] is used to assign each 10m-by-10m area (grid cell) of your farm a value (from 0 to 1) depending on how close each grid cell is to wooded vegetation (canopy cover). Grid cells adjacent to wooded vegetation are assigned a value of 1 and the further away a grid cell is from wooded vegetation, the lower the assigned value. A 500 m buffer beyond your farm boundary is included to account for any wooded vegetation outside your farm boundary that contributes to production areas within your farm boundary. Data is for a point at time, rather than over-time.

The whole of farm Proximity value is an average of all grid cells in production areas on your farm. On your farm map, darker blue areas are closer to wooded vegetation (i.e., higher proximity values). Values approaching 1 (darkest blue) indicate production areas that are within 10 m of wooded vegetation. Non-production areas (grey) are excluded from proximity calculations. However, trees (brown dots) within these grey areas do contribute to proximity values in production areas. See separate methods report for more information.

The following page shows your farm map[9] that breaks down your total Proximity result into different locations.

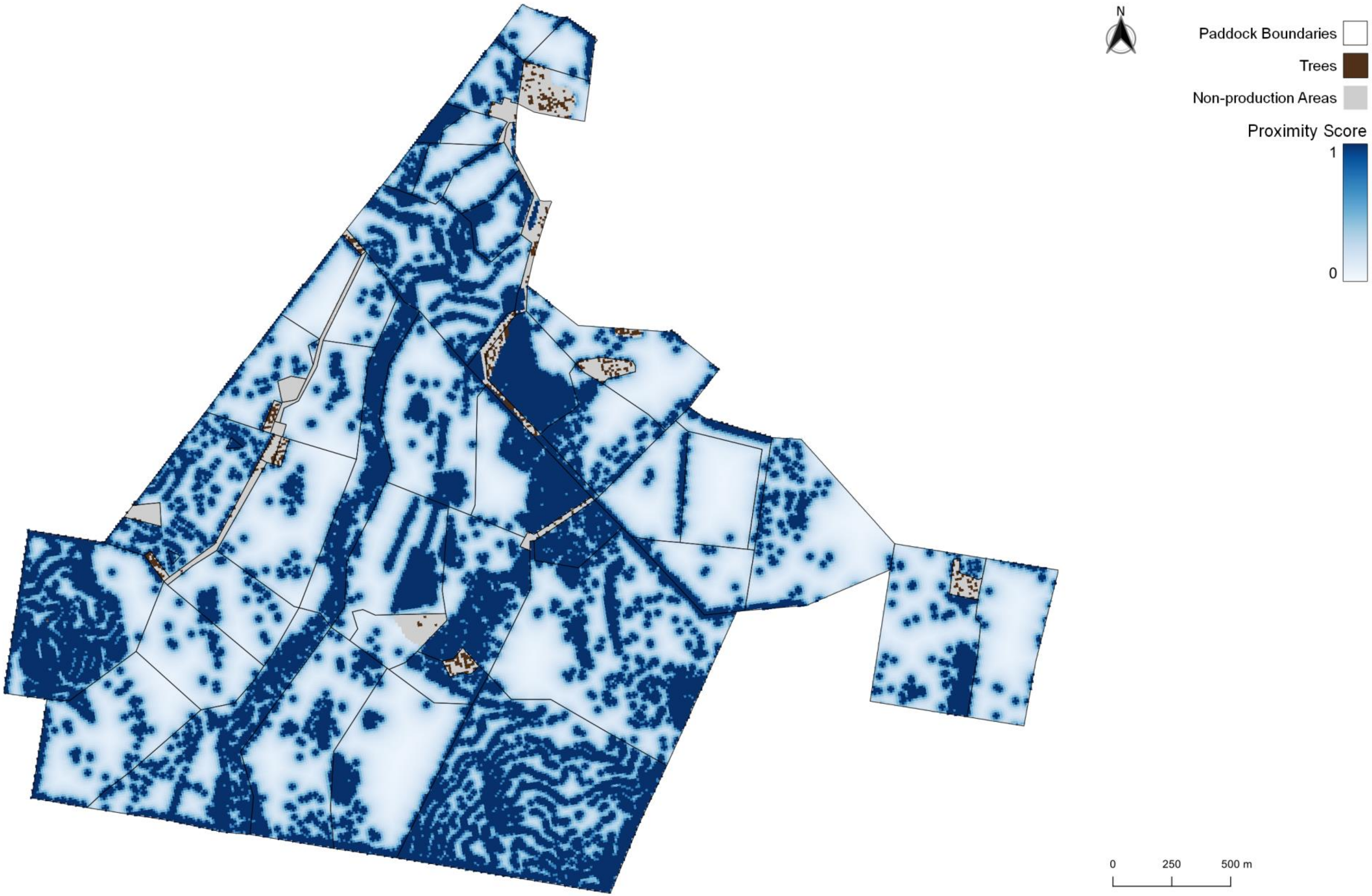
Proximity reference scenarios.
The below reference scenarios may help you interpret your result. It also shows why a result of ‘1’ isn’t necessarily always desirable.

Result	Reference scenario
Closer to ‘1’	Nearly all areas of production are within 10m of wooded vegetation.
A value of ‘0.5’	The average distance of all production areas to wooded vegetation is about 20m.
Closer to ‘0’	Most areas of production are roughly more than 200m from wooded vegetation.

[8] The canopy cover layers are generated through analysis of satellite and near-earth imagery. This is converted to a 10m grid cell layer for the purposes of calculating the proximity score.

[9] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in on particular details etc.

Proximity farm map(s)



Connectivity

Connectivity is the degree to which wooded vegetation forms connected corridors or 'stepping-stones' of wooded vegetation between patches of habitat (native and exotic, planted and remnant). It can benefit production by enabling habitat for and movement of beneficial species to provide pest control and pollination.

Connectivity (whole farm)

How Connectivity is measured

Satellite data is used to assign each 100m-by-100m area of your farm a connectivity value depending on how closely connected canopy cover is to other canopy cover. Data is for a point at time, rather than over-time. The average connectivity value for your whole farm is compared to the maximum regional connectivity value. Region here is defined by a 100 km buffer surrounding your farm.

Your whole of farm Connectivity result is an average of all locations on your farm. On your farm map, the darker the area the more connected it is. These areas are the 'raw' values for connectivity across your farm, which range from 0 to approximately 15. The final Connectivity result for your farm is calculated relative to the 100 km region around your farm boundary – this is, it is scaled from 0 to 1. See separate methods report for more information.

The following page shows your farm map[10] that shows differences in connectivity across locations on your farm.

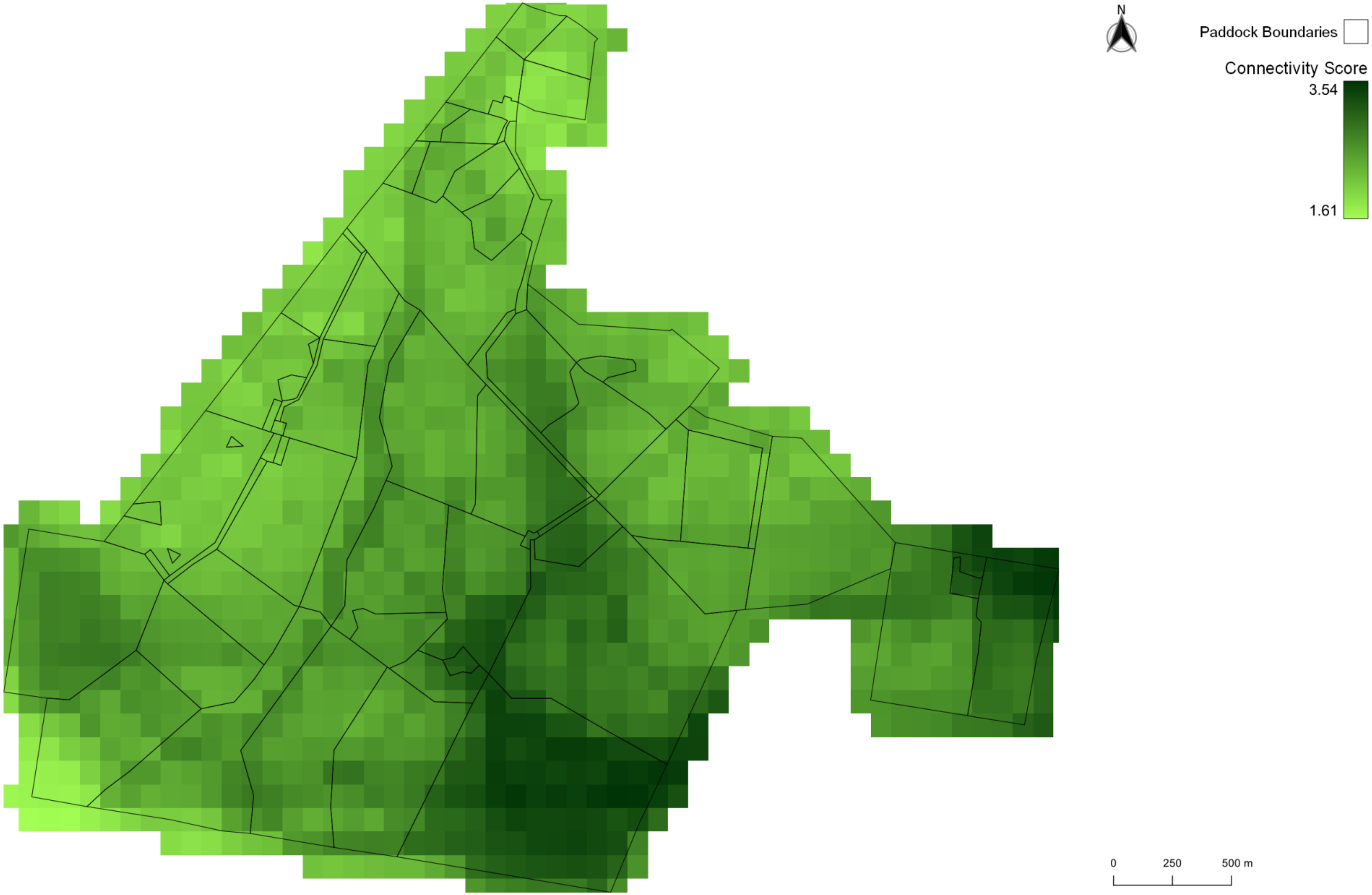
Connectivity reference scenarios.
The below reference scenarios may help you interpret your result. It also shows why a result of '1' isn't necessarily always desirable.

Result	Reference scenario
Closer to '1'	A farm with high Connectivity relative to the surrounding landscape. For example, a farm with lots of tree cover providing habitat corridors, laneways and stepping-stones is likely to have high connectivity.
Closer to '0'	A farm with low connectivity relative to the surrounding landscape. For example, a farm with low tree cover with limited habitat corridors is likely to have low connectivity.

Note: Aggregation, Connectivity, and Proximity all relate to arrangements of wooded vegetation on farm. They can be interpreted together for maximum insights

[10] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in on particular details etc.

Connectivity farm map(s)



Aggregation

Aggregation is the degree to which wooded vegetation (trees and shrubs including native and exotic, planted and remnant) is arranged into continuous patches.

Aggregation (whole farm).

How Aggregation is measured

Satellite data is used to identify canopy cover for each 25m-by-25m area of the farm.

Aggregation is the sum of the squared area of all wooded patches of the farm, divided by the total area of all wooded vegetation on the farm.

A result of 1 indicates total aggregation (the wooded vegetation is in a single large patch) and 0 represents complete disaggregation (no areas with clustered patches of trees).

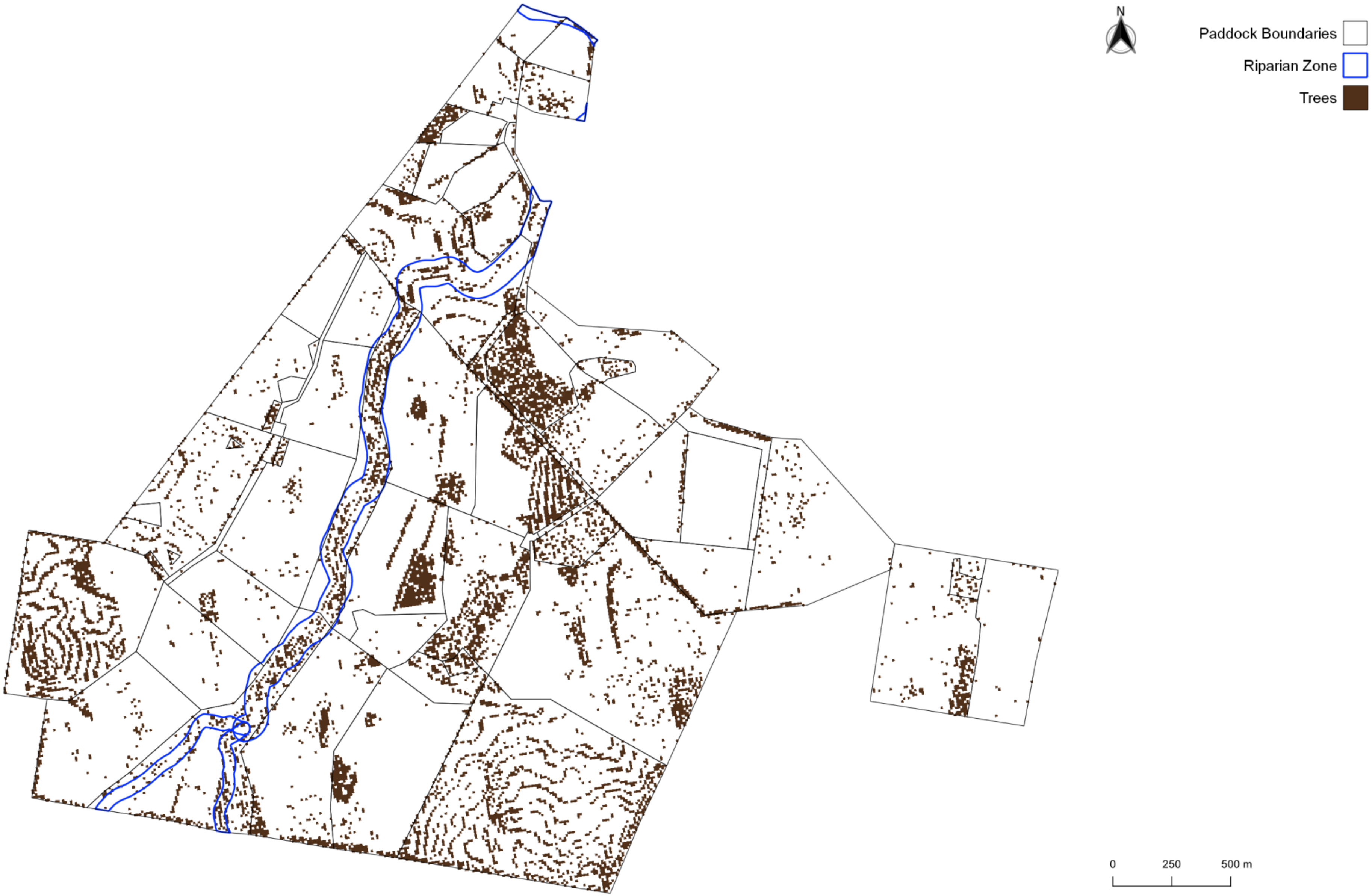
The image on the following page[11] shows the tree cover for the farm as brown dots. Clusters of brown are larger patches that indicate the degree of aggregation. Riparian areas are outlined in blue.

Aggregation reference scenarios.
The below reference scenarios may help you interpret your result.

Result	Reference scenario
Closer to '1'	All tree cover on a farm is arranged into a relatively small number of relatively small patches. There is often a large difference in the smallest and largest patches of the farm.
Closer to '0'	Tree cover on a farm is arranged in many discrete patches of similar size.

[11] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in.

Aggregation farm map(s)



Aquatic Condition

Aquatic Condition is the proportion of tree cover in the riparian zone (adjacent to streams, creeks, and riverbanks). We use it in this first phase of the research as a proxy of aquatic ecosystem condition[12].

Aquatic Condition (whole farm)

How Aquatic Condition is measured

The riparian zone is the area adjacent to the banks of rivers, streams, and creeks. We used a 30 m buffer either side of the bank to define the riparian zone for this indicator. Satellite data is used to identify canopy cover for each 10m-by-10m area within the riparian zone. Data is for a point at time, rather than over-time. Aquatic Condition is the proportion of the riparian zone on your farm that has canopy cover (native and exotic, remnant and replanted).

The canopy cover farm map (see Aggregation section above) shows trees (canopies) as brown dots. Blue lines show the riparian zone - the more trees in the riparian zone, the higher the Aquatic Condition score.

Aquatic Condition does not currently include any estimate of condition for wetlands (natural or artificial wetlands like dams) that are located away from creeks, streams, and rivers.

Other factors that influence water quality such as ground cover and fertiliser use are included in the Soil Condition indicator and the 'Resource Use Efficiency' indicators later in this report.

No attempt has been made to distinguish between off-farm (upstream) influences on Aquatic Condition.

The Aggregation maps in the previous section show canopy cover farm map[13] used in the calculation of Aquatic Condition

Aquatic condition reference scenarios.
The below reference scenarios may help you interpret the result.

Result	Reference scenario
Closer to '1'	The riparian areas are almost completed covered by wooded vegetation with good ground cover.
Closer to '0'	The riparian area has no or very little coverage of wooded vegetation.

[12] We acknowledge that the quality of the ground-layer in riparian areas is important in protection of streams and rivers.

[13] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in.

Ecological Condition

The degree to which a farm has been modified from its 'reference' (pre-development) condition. It shows both how much (the extent / hectares) of the farm has been modified, and to what degree (in terms of change from the native reference condition) areas have been modified. See Appendix 3 for more information.

Ecological Condition (whole farm)

How Ecological Condition is measured

Ecological Condition uses a series of "State and Transition Models" that describe the relative degree of modification (from the reference condition for the region) that has occurred on an area of land.

Analysis of satellite data alongside field observations (the ecologist who visited your farm) are used to classify each paddock (or sub-paddock) into ecosystem types (e.g., woodlands, grasslands, cropland). Each ecosystem type is further classified into ecosystem states which represent different conditions (ecological quality) within each ecosystem type. Each ecosystem state is assigned a "condition value" (from 1 = reference condition to 0 = completely modified).

A weighted average based on the area (extent) of each state is then calculated for the whole farm Ecological Condition result. See separate methods report for more information.

Ecological Condition is a way of estimating biodiversity or native vegetation condition.

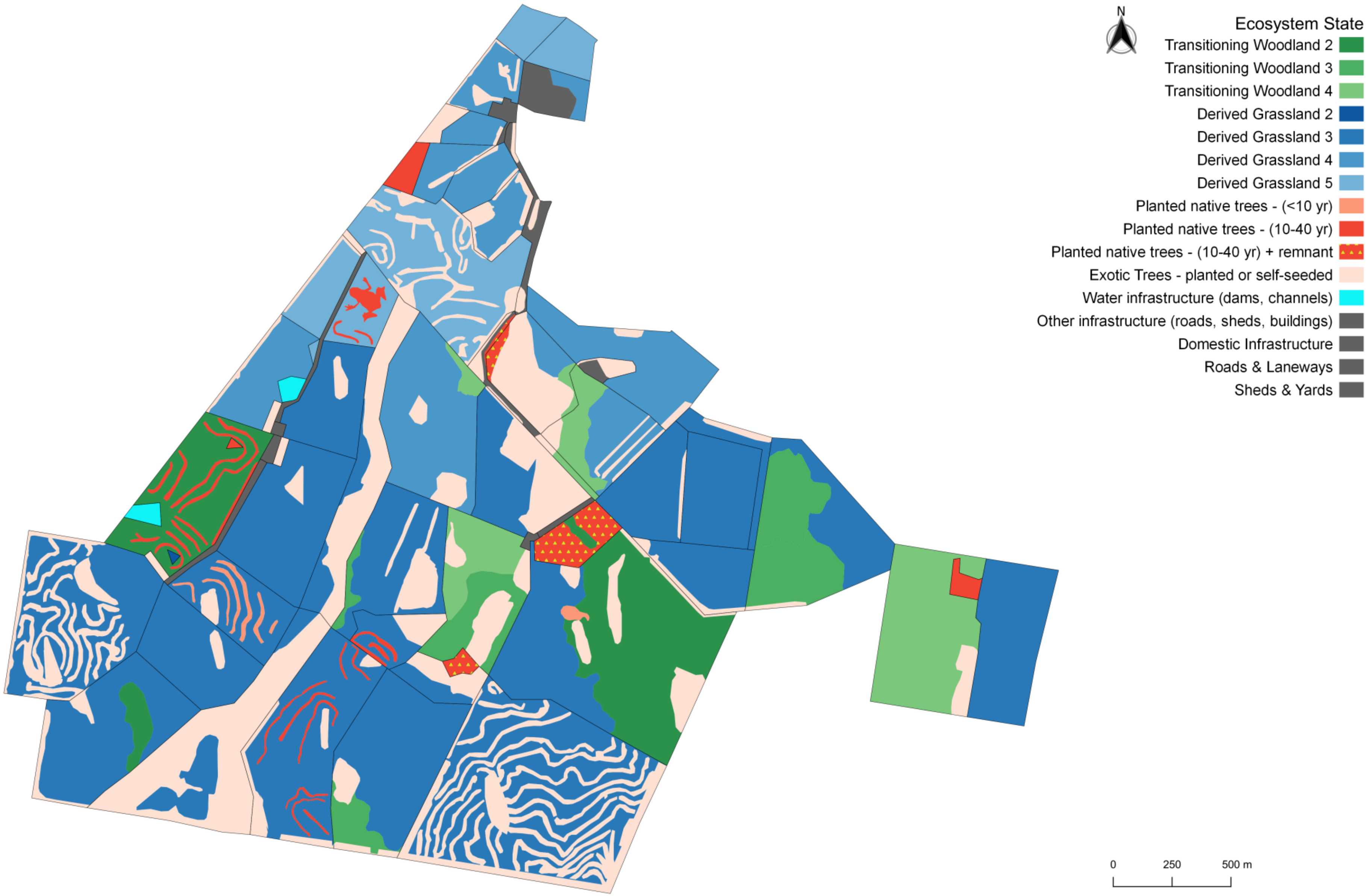
The following pages provide maps[14], summary tables, and charts to show additional information about your overall Ecological Condition result.

Ecological Condition scenarios.
The below reference scenarios may help you interpret the result.

Result	Reference scenario
Closer to '1'	A farm that has retained the vast majority of its remnant native vegetation in high to very high condition. For example, forest, woodland, shrubs, or grasslands with high proportion of diverse native species.
Closer to '0'	A farm that has completely cleared remnant native vegetation. For example, farms with completely modified exotic or sown pastures, cropland, and/or infrastructure.

[14] If you have multiple properties a single page map will be provided for each property. Higher resolution images are also provided separately to this report, allowing you to zoom in on particular details etc.

Ecological Condition farm map(s)



Ecosystem States and Asset types

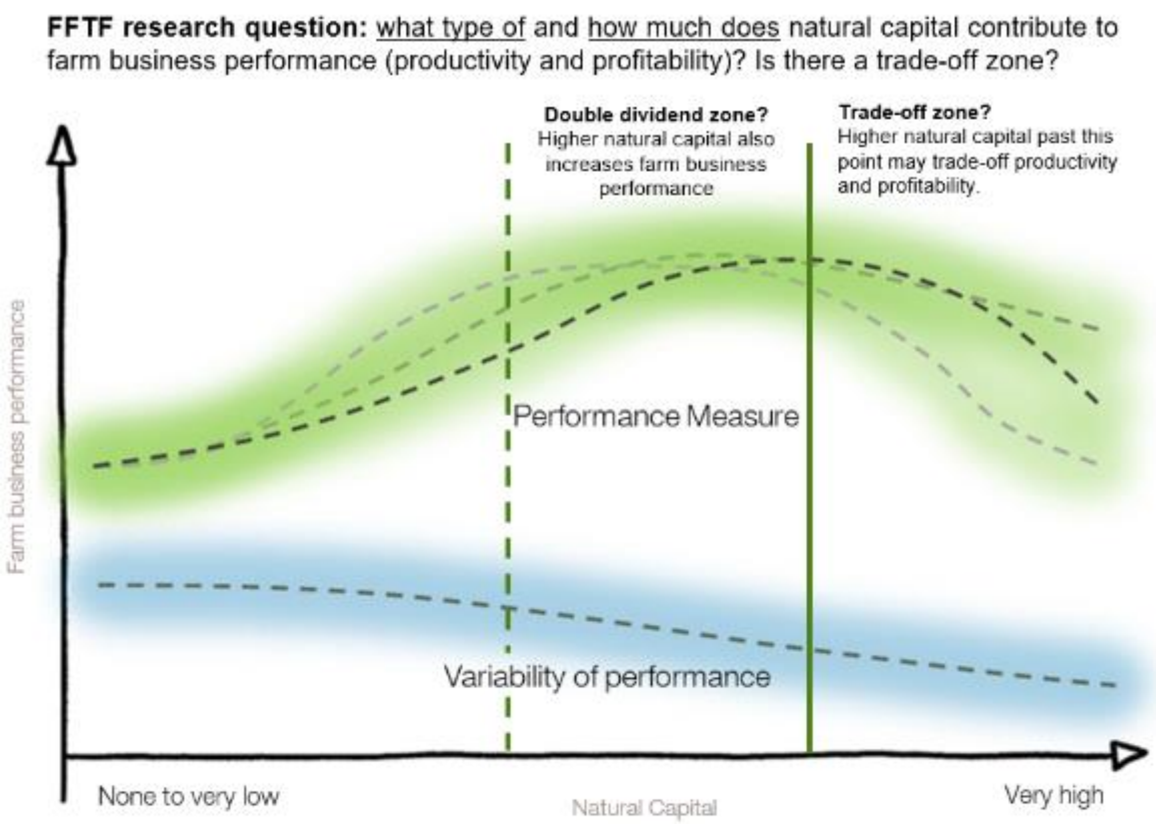
The first two columns in the table show Ecosystem Types and States that were observed on the farm. The third column provides the area (extent) of each ecosystem state. Note: each ‘Ecosystem Type’ has multiple States within it. For example, the Woodland ‘type’ has multiple States reflecting different woodland condition classes. The area of each Ecosystem State is shown in column 3 (Extent). The Ecological Condition weightings for each State are shown in column four. These are calculated by multiplying the area in hectares with the ecological condition factor for each State to provide an area-weighted total for the overall Ecological Condition indicator for the farm. The proportion of each ecosystem State on the farm is shown in column five.

Ecosystem Type	Ecosystem State (condition / quality)	Extent (ha)	Ecological Condition weighting	Proportion
Woodland	Transitioning Woodland 2 - some regeneration - some exotics in ground layer	36.37	0.80	5 %
Woodland	Transitioning Woodland 3 - little regeneration - mostly exotic ground layer	27.06	0.60	4 %
Woodland	Transitioning Woodland 4 - no regeneration - exotic ground layer	31.50	0.40	4 %
Grassland	Derived Grassland 2 - diverse native ground layer - some exotics	19.27	0.40	3 %
Grassland	Derived Grassland 3 - mixed ground layer with many exotics	309.78	0.30	42 %
Grassland	Derived Grassland 4 - mostly exotic ground layer with few natives	86.34	0.20	12 %
Grassland	Derived Grassland 5 - perennial exotic ground layer	42.19	0.10	6 %
Planted vegetation	Planted native trees - young (<10 years)	2.67	0.20	0 %
Planted vegetation	Planted native trees - maturing (10-40 years)	11.90	0.40	2 %
Planted vegetation	Planted native trees - maturing (10-40 years) with remnant trees	7.33	0.50	1 %
Exotic woody vegetation	Exotic Trees - planted or self-seeded	153.27	0.10	21 %
Infrastructure	Domestic Infrastructure	3.77	0.00	1 %
Infrastructure	Roads & Laneways	7.61	0.00	1 %
Infrastructure	Sheds & Yards	1.64	0.00	0 %
Infrastructure	Water infrastructure (dams, channels)	1.95	0.00	0 %
Total		**742.65**	**0.28**	**100%**

Tying it all together | Understanding the purpose of the Natural Capital Indicators

The diagram below illustrates the *Farming for the Future* research question, that the data you've contributed is helping us answer. That is, whether or not 'higher natural capital' is associated with better farm business performance (the double dividend zone) and / or whether adding more natural capital to a farm would 'come at a cost' (the trade-off zone). Note that this diagram is not a presentation of the actual findings. These are reported separately.

Farming for the Future research is looking at business performance indicators of a farm business as well as the variability of the performance over years. Variability reflects business resilience to things like seasonal differences, performance of markets, and changing input costs.



If others (off-farm) want natural capital beyond this trade off point, they may need to pay for it. This can include co-designing new investments with farmers (e.g., changing terms of trade, nature credits, different financing agreements)

Research* Program *Aims

- Better understand relationships between natural capital and farm business performance
- Equip farmers and their advice networks with information to prepare a 'business cases' for investment in natural capital.

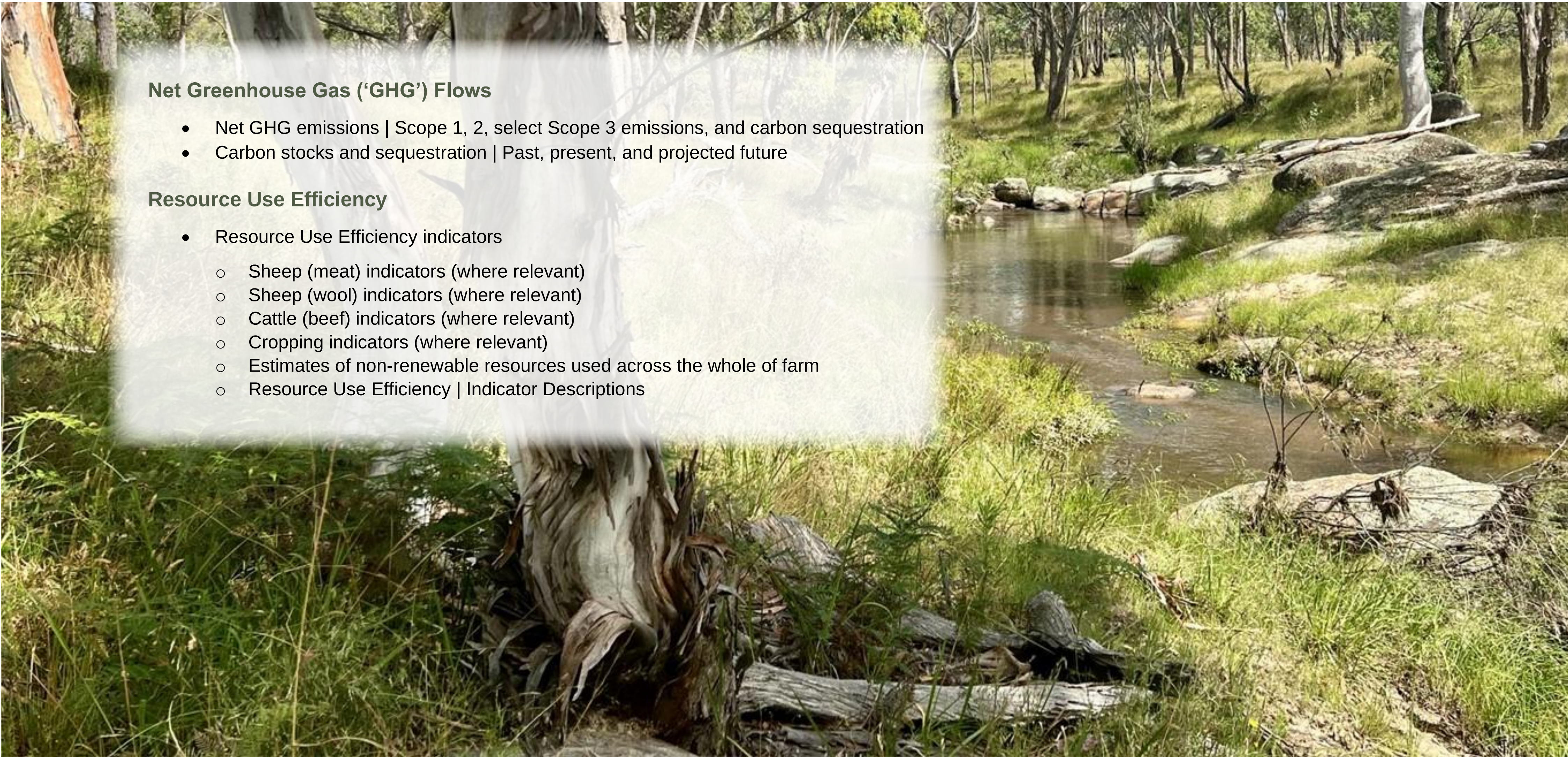
What's the shape of the curve?

- The Natural Capital Indicators on the previous pages are different experimental indicators of natural capital. So, it's not yet clear which indicators are most relevant for farm business performance.

See the separate *Farming for the Future* research findings report for results on the shape of this curve.

Environmental Performance Indicators

These indicators provide information about the environmental performance of the farm business. They provide insights into the sources of greenhouse gas (GHG) emissions, how efficiently resources are used in production, as well as estimates of land, air or water pollution generated.



Net Greenhouse Gas ('GHG') Flows

- Net GHG emissions | Scope 1, 2, select Scope 3 emissions, and carbon sequestration
- Carbon stocks and sequestration | Past, present, and projected future

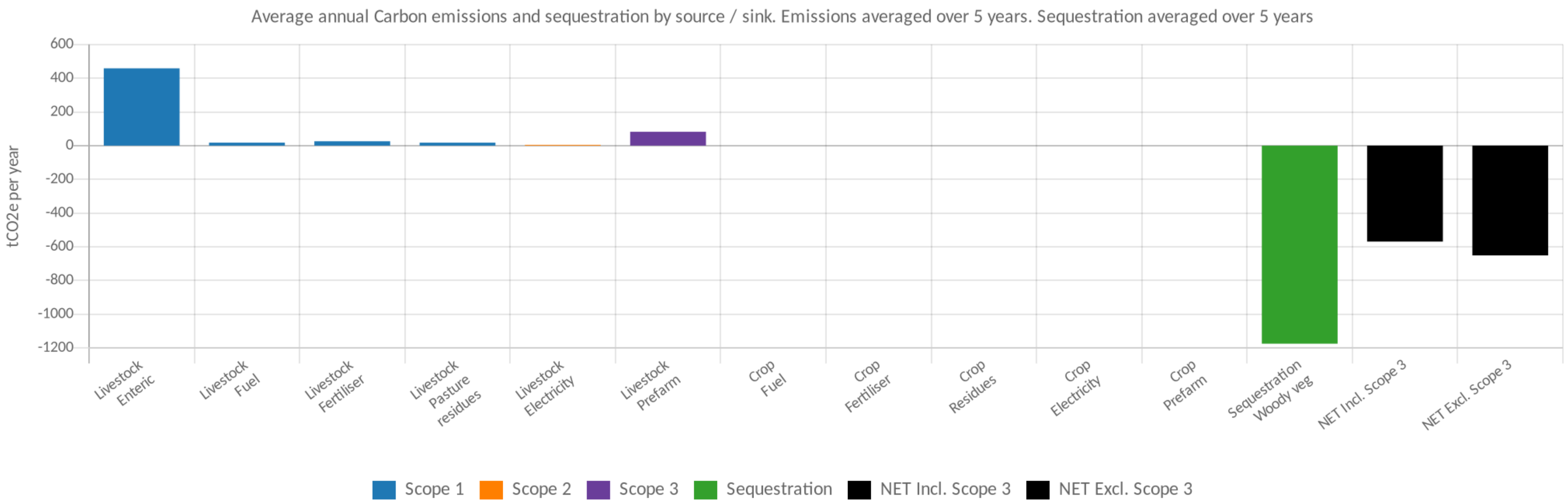
Resource Use Efficiency

- Resource Use Efficiency indicators
  - Sheep (meat) indicators (where relevant)
  - Sheep (wool) indicators (where relevant)
  - Cattle (beef) indicators (where relevant)
  - Cropping indicators (where relevant)
  - Estimates of non-renewable resources used across the whole of farm
  - Resource Use Efficiency | Indicator Descriptions

Net Greenhouse Gas ('GHG') Flows

Net GHG emissions | Scope 1, 2, select Scope 3, and carbon sequestration

This chart shows the average[15] annual emissions and sequestrations for the farm. Quantities above the zero line are emissions in tonnes of carbon equivalent (tCO_2-e). Quantities below the line are carbon sequestration (also in tCO_2-e). All these movements are combined into the 'net' bars on the right to show the net total emissions for your farm. See next page for more detail.



Emissions Scope	Description
Scope 1	Emissions generated directly from on-farm operations. For example, livestock emissions as well as fuel and input use.
Scope 2	Electricity purchased from the grid and consumed on farm. Renewable energy generated and consumed on site is zero-carbon.
Scope 3	Emissions generated by off-farm suppliers in producing and transporting select inputs used on your farm. The inputs included are; sheep and cattle purchases, 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).
Carbon sequestration[16]	Modelled tonnes of carbon sequestered on farm. This is an estimate of carbon sequestered in woody vegetation only. Modelled using FLINTpro™.

[15] The average is up to five years. If you haven't contributed five years of data, the average here is the number of years of data actually collected.

[16] Sequestration has been modelled using FLINTPro™ and represents carbon stock changes in woody vegetation, including stocks in remnant vegetation. The methods used do not take into account the concept of additionality or any carbon sold by the land holder. As such, these figures can not be used for the purposes of trading carbon or to make formal claims of carbon neutrality. Each industry scheme will have specific requirements for calculation and compliance, and they may vary from the methods used here.

Table 2: Average Annual emissions for the farm, split by commodity type.

The table below shows your average whole of farm Scope 1, 2, and selected Scope 3 emissions, and carbon sequestration (see previous page for definitions). This is also classified into geospheric and biospheric sources which have different influences on the global carbon cycle.

Geospheric emissions come from the use of fossil fuels. That is, fuel sourced from geological storages that have built up over millions of years. These emissions represent the longer-term carbon cycle.

Biospheric emissions come from the use of biological sources (i.e., livestock, as well as clearing and oxidation of vegetation). These emissions represent the shorter-term carbon cycle.

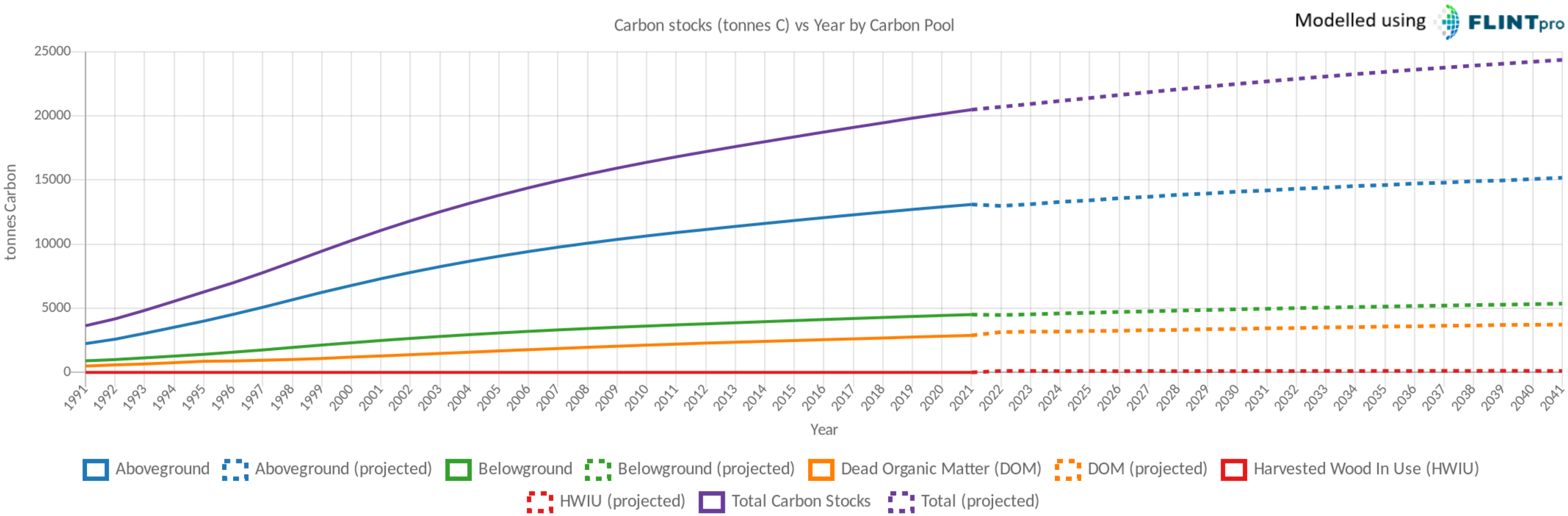
Location of emissions	Scope	GHG Emissions	5-year average[17] annual emissions (tCO2-e)		
			Geospheric Source	Biospheric Source	Total
Livestock production			**27.51**	**578.27**	**605.78**
On-farm	1	Enteric/manure/urine/leaching and atmospheric deposition	0.00	458.42	458.42
	1	Energy (fuel consumption),	17.54	0.00	17.54
	2	Energy (electricity consumption)	4.60	0.00	4.60
	1	Fertiliser application	1.09	24.74	25.83
	1	Pasture/fodder crop residues (oxidisation)	0.00	17.45	17.45
Off-farm	3	Pre-farm (production and transport of select inputs and upstream energy emissions)	4.28	77.67	81.95
Crop production			**0.00**	**0.00**	**0.00**
On-farm	1	Energy (fuel consumption)	0.00	0.00	0.00
	2	Energy (electricity consumption)	0.00	0.00	0.00
	1	Fertiliser application	0.00	0.00	0.00
	1	Crop residues (oxidisation)	0.00	0.00	0.00
Off-farm	3	Pre-farm (production and transport of select inputs and upstream energy emissions)	0.00	0.00	0.00
		Total Emissions	**27.51**	**578.27**	**605.78**
		On-farm | Scope 1 (Direct) total	18.63	500.60	519.23
		On-farm | Scope 2 (Indirect) total	4.60	0.00	4.60
		Off-farm | Scope 3 (Indirect) total	4.28	77.67	81.95
		Carbon sequestered[18]			**(1,175.1)**
		Net total emissions (excluding scope 3)			**(651.3)**
		Net total emissions (including scope 3)			**(569.4)**

[17] Farm emissions tend to vary significantly season to season due to production variations, so we use up to a five-year average (depending on data availability) to reflect usual business activity. For example, Scope 3 input emissions are calculated using purchases rather than when inputs are actually used.

[18] Sequestration has been modelled using FLINTPro™ and represents carbon stock changes in woody vegetation, including stocks in remnant vegetation. The methods used do not take into account the concept of additionality or any carbon already sold by the land holder. As such, these figures can not be used for the purposes of trading carbon or to make formal claims of carbon neutrality. Each industry scheme will have specific requirements for calculation and compliance, and they may vary from the methods used here.

Carbon stocks and sequestration | Past, present, and projected future

Modelled carbon in woody vegetation – past, present, and future projections.
This graph shows estimated carbon stocks and sequestration across your whole farm. Carbon stocks refer to the amount of carbon stored on your farm (estimated using woody vegetation – forests[19] and plantings only), whereas carbon sequestration is the ecosystem service that draws down and stores carbon (i.e., into carbon stocks). This data uses satellite imagery and regional modelling rather than actual on farm carbon tests. It covers the past, present, and future (dotted lines). The blue line estimates above ground carbon from living woody vegetation. The green line estimates below ground woody vegetation (the carbon stored in roots - this is different to soil carbon which is not calculated). The orange line shows dead woody vegetation (e.g. fallen logs and branches), and the red line shows wood harvested and used in wood products (construction, furniture, paper). These four lines are added together to represent the total carbon stored in woody vegetation (purple line). Carbon sequestration is represented by the movement in the purple line between periods.



[19] For application within FLINTpro, a forest is considered to be land that contains woody vegetation which has, or has the potential to, obtain more than 20% canopy cover in vegetation more than 2m in height, consistent with the definition above. The forest potential extent was defined as land that has woody vegetation (>5%) and achieves 'forest' cover at least three times over the simulation period (1989-2021) according to the National Forest and Sparse Woody Vegetation Data (Version 6.0 - 2021 Release). The data product used also contains the other classes detailed in the forest definition, and therefore classifies the landscape into non-woody vegetation (<5% canopy cover), sparse woody vegetation (5-19% canopy cover) and forest (>20% canopy cover). Where land does not achieve forest cover at least three points in time (between 1989 and 2021), it is treated as non-forest for the whole simulation and excluded from the assessment. The approach of treating sparse vegetation as 'forest' when it achieves forest cover was taken to reduce loss and gain events when an area fluctuates between just over and just under the 20 percent canopy threshold. This approach results in a conservative outcome of emissions and removals.

Resource Use Efficiency

Your Resource Use Efficiency indicators

This section includes environmental performance indicators across input use, water consumption, water quality, and waste (plastic packaging). They show how efficiently resources are used to produce different commodities. Separate tables are provided on each page to differentiate resource use across the following commodities: sheep (meat), wool, cattle (beef), and cropping.

Averages annual use are calculated to represent the usual performance of the business. Apportionment of resources to a commodity is based on the physical production units, not the monetary value of production. For further information see 'Notes' within the 'Resource use efficiency | Indicator descriptions' sub-section.

Table 3: Resource use efficiency indicators for sheep meat.
This table shows average[20] annual resource use efficiency for sheep meat production only. Benchmarks are provided where available. Benchmarks allow you to compare your performance to industry averages but are not used to calculate your actual on-farm indicator result.

Sheep (meat) – based on kg liveweight sold				Benchmark
Indicator	**Units**	**5-year average**	**Notes (see Table 8)**	**NSW High Rainfall Zone - 600-950mm[21]**
Water Pollution Generated	kg N leached / kg liveweight	0.00	4	N/A
GHG emissions intensity (livestock emissions and pasture and fodder management)	kg CO2e / kg liveweight	7.85	11	8.9
Waste (non-biodegradable)	kg waste / kg liveweight	0.00	8	N/A
Water use (livestock drinking and embedded water in fodder)	litres H2O / kg liveweight	12.70	7	83.6
Normalised stress weighted water consumption (including evaporation)	litres H2O-eqiv/ kg liveweight	0.39	6	31.1
Nitrogen use efficiency	kg N applied / kg liveweight	0.09	1	N/A
Lime use efficiency	kg Lime applied / kg liveweight	0.00	2	N/A
Phosphorus use efficiency	kg P applied / kg liveweight	0.04	3	N/A

[20] The average is up to five years. If you haven't contributed five years of data, the average here is the number of years of data actually collected.

[21] S.G Wiedemann et al. (2016), Resource use and greenhouse gas emissions from three wool production regions in Australia. Journal of Cleaner Production 122: 121e132

Table 4: Resource use efficiency indicators for wool.
This table shows average[22] annual resource use efficiency for wool production only. Benchmarks are provided where available. Benchmarks allow you to compare your performance to industry averages but are not used to calculate your actual on-farm indicator result. Additional Kering benchmarks are available for wool production only.

Sheep – based on kg greasy wool				Benchmarks	
Indicator	**Units**	**5-year average**	**Notes (see Table 8)**	**Kering Conventional / Regenerated[23]**	**NSW High Rainfall Zone - 600-950mm[24]**
Water Pollution Generated	kg N leached / kg greasy wool	0.00	4	0.66 / 0.35	N/A
GHG emissions intensity (livestock emissions and pasture and fodder management)	kg CO2e / kg greasy wool	27.48	11	95.42 / 50.96	21.3 +/-3.4
Waste (non-biodegradable)	kg waste / kg greasy wool	0.00	8	0.03 / 0.01	N/A
Water use (livestock drinking and embedded water in fodder)	litres H2O / kg greasy wool	42.15	7	274.85 / 146.78	204.3 +/- 59.1
Normalised stress weighted water consumption (including evaporation)	litres H2O-eqiv/ kg greasy wool	1.31	6	N/A	74.6
Nitrogen use efficiency	kg N applied / kg greasy wool	0.29	1	N/A	N/A
Lime use efficiency	kg Lime applied / kg greasy wool	0.00	2	N/A	N/A
Phosphorus use efficiency	kg P applied / kg greasy wool	0.13	3	N/A	N/A

[22] The average is up to five years. If you don't have five years of data, the average here is the number of years of data actually collected.
[23] As per Kering 2020, https://kering-group.opendatasoft.com/explore/dataset/raw-material-intensities-2020/table/
[24] As per S.G Wiedemann et al. (2016), Resource use and greenhouse gas emissions from three wool production regions in Australia. Journal of Cleaner Production 122: 121e132

Table 5: Resource use efficiency indicators for beef.
This table shows average[25] annual resource use efficiency for cattle (beef) production only. Benchmarks are provided where available. Benchmarks allow you to compare your performance to industry averages but are not used to calculate your actual on-farm indicator result.

Cattle – based on kg liveweight sold				Benchmark
Indicator	**Units**	**5-year average**	**Notes (see Table 8)**	**NSW HRZ Domestic market[26]**
Water Pollution Generated	kg N leached / kg liveweight	0.00	4	N/A
GHG emissions intensity (livestock emissions and pasture and fodder management)	kg CO2e / kg liveweight	15.81	11	11.7
Waste (non-biodegradable)	kg waste / kg liveweight	0.00	8	N/A
Water use (livestock drinking and embedded water in fodder)	litres H2O / kg liveweight	82.05	7	196
Normalised stress weighted water consumption (including evaporation)	litres H2O-eqiv/ kg liveweight	2.55	6	15.6
Nitrogen use efficiency	kg N applied / kg liveweight	0.17	1	N/A
Lime use efficiency	kg Lime applied / kg liveweight	0.00	2	N/A
Phosphorus use efficiency	kg P applied / kg liveweight	0.07	3	N/A

[25] The average is up to five years. If you don't have five years of data, the average here is the number of years of data actually collected.
[26] S.G Wiedemann et al. (2015), Resource use and environmental impacts from beef investigated using life cycle assessment. Animal Production Science, 2016, 56, 882-894

Table 6: Selected resource use efficiency and pollution estimates for the whole farm business.

Enterprise / Metric	Description	Estimate	Notes (see Table 8)
Livestock Enterprise			
Rainfall use efficiency	The amount of production given the amount of rainfall.	0.52 DSE/ha/100mm rainfall	5
Water use	Livestock drinking and embedded water in fodder	21.80 Litres H_2O / kg liveweight	7
Water pollution generated	Includes estimates of Nitrogen leeched from fertiliser on pastures and crops fed to livestock	0.00 kg N leached / kg liveweight	4
Waste generated	Packaging waste associated with purchased inputs for the production systems	0.00 kg waste / kg liveweight	8

Table 7: Estimates of non-renewable resources used across the whole of farm.
This table shows the proportion of inputs that are finite and non-renewable (e.g., mined or fossil fuel based) for your whole of farm.

Finite resources used as inputs	5-year average	Unit	Proportion	Notes (see Table 4)
Phosphorous (from mined stocks)	0.00	Tonnes	0.0% of nutrient replenishment (tonnes)	9
Lime (from mined stocks)	0.00	Tonnes	0% of pH remediation (tonnes)	
Fossil aquifers	0	Litres	0% of total water use	10

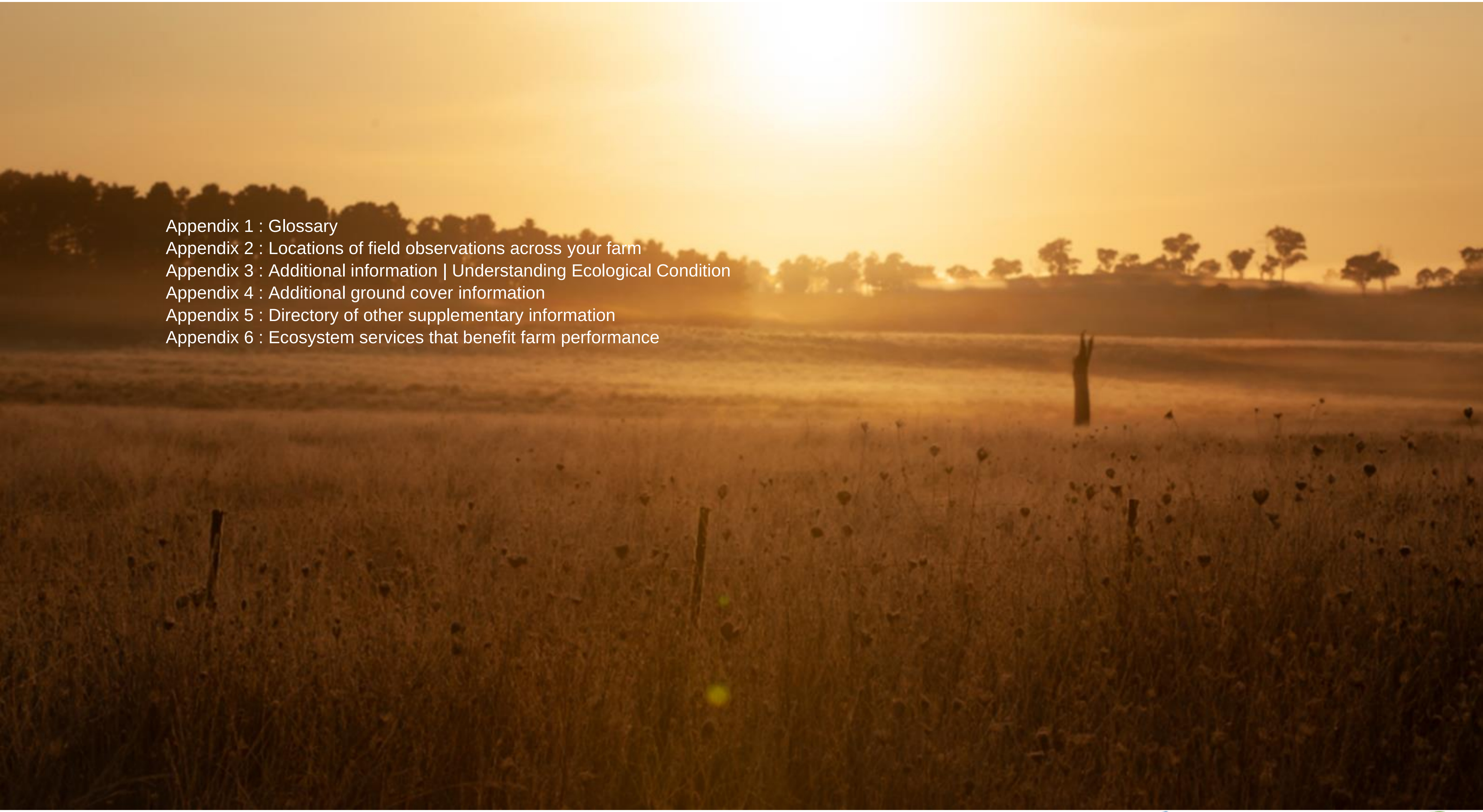
Resource use efficiency | Indicator descriptions

Table 8: Methods descriptions of each Environmental Performance indicator.
This table describes what is captured in each indicator. Each note number links to the 'notes' column in the previous Resource Use Efficiency commodity tables. For more see the separate FFTF methods report[27].

Note	Environmental performance indicator	Method Description
1	Nitrogen use efficiency	The amount of nitrogen used to produce a product.
2	Lime use efficiency	The amount of lime used to produce a product.
3	Phosphorus use efficiency	The amount of phosphorus used to produce a product.
4	Water Pollution Generated	Nitrogen from fertiliser and manure leeching into waterways and storages. This is only considered to occur when the ratio of mean annual evapotranspiration to annual precipitation (Et/P) is between 0.8 and 1. This is consistent with Australia's National Inventory methods.
5	Rainfall use efficiency (grazing only)	The amount of production given the amount of rainfall. This is Dry Sheep Equivalent ('DSE') per ha per 100mm of rainfall.
6	Normalised stress weighted water consumption	It is calculated by multiplying the freshwater used in production by a local Water Stress Index (WSI), and then divided by the global average WSI (0.602). It represents the equivalent volume of freshwater consumption at the global average WSI and allows results to be compared across geographies.
7	Water use efficiency	Water consumed in production. Livestock: e.g., livestock drinking water and water embedded in fodder. Cropping: e.g., irrigation water applied plus water used in preparation of applied fertilisers.
8	Plastic packaging waste generated	Non-biodegradable packaging waste from purchases. Livestock: e.g., wrapping on bales. Cropping: e.g., silage wrappers, non-recyclable chemical containers.
9	Finite resources used as inputs (phosphorous and lime)	Input use that comes from non-renewable (mined and / or fossil fuel based) sources. Phosphorus: non-renewable sources as a proportion of total nutrient replenishment (tonnes). Lime: non-renewable sources as a proportion of total pH remediation (tonnes).
10	Finite water resources used	The amount of water coming from non-refillable fossil aquifers. Other aquifers are excluded because they can be recharged by rainfall.
11	GHG emissions intensity	The quantity of emissions generated per unit of production. Livestock (sheep for meat, wool, and cattle): livestock emissions, as well as emissions from pasture and fodder management. Cropping: fuel use, fertilizer use and the breakdown of crop residues.

[27] The detailed calculations and scientific references for these are also available in an open access publication – made public through the support of Australian Wool Innovation. See the Sustainability Account, Management and Policy Journal for: "A natural capital accounting framework to communicate the environmental credentials of individual wool-producing businesses". Authors: Ogilvy, O'Brien, Lawrence, Gardner. https://www.emerald.com/insight/content/doi/10.1108/SAMPJ-06-2021-0191/full/html

Appendices



Appendix 1: Glossary

- **Additional environmental performance indicators**: These are supplementary indicators used to evaluate the environmental performance of an organization or project beyond natural capital indicators. They may include measures of energy efficiency, waste management, greenhouse gas emissions, pollution levels, and other environmental factors.
- **Condition**: In the context of natural capital, condition refers to the quality of an ecosystem state or natural resource. It assesses the health, and resilience of the ecosystem, considering factors such as biodiversity, habitat quality, and water quality.
- **Carbon sequestration:** Carbon sequestration is the process by which carbon dioxide (CO_2) is captured from the atmosphere and stored in natural or artificial reservoirs. It can occur through biological processes, such as photosynthesis in plants and trees, or through technological methods like carbon capture and storage (CCS). Carbon sequestration helps reduce the concentration of greenhouse gases in the atmosphere and mitigate climate change.
- **Carbon stock**: Carbon stock refers to the amount of carbon stored in a particular ecosystem or natural resource. It includes carbon stored in vegetation, soils, biomass, and other dead and living organic matter (excluding geological storages like fossil fuel reserves).
- **Extent:** Extent refers to the spatial coverage or size of an ecosystem or natural resource. It measures the physical area or volume occupied by a particular habitat, landscape, or natural feature. Evaluating the extent helps understand the distribution and availability of natural capital and assess its vulnerability to degradation or loss.
- **Native 'reference' state**: The native 'reference' state represents the original or unmodified pre-development condition of a particular ecosystem or natural resource. It serves as a baseline against which the current condition can be measured. The native reference state helps determine the impact of human activities and the extent to which natural capital has been altered.
- **Natural capital accounting**: a method of measuring and quantifying the value of natural resources and ecosystems. This can be done in physical units and / or monetary values. It involves assessing the stock, condition (i.e., quality), and flow of natural capital to inform decision-making.
- **Natural capital**: FFTF defines this as all natural resources that producers manage for the benefit of their businesses, their families and society. It includes soils, remnant native vegetation, pasture and croplands, riparian areas, water resources, agroforestry, environmental plantings, and animals.
- **Natural Capital Indicators:** FFTF has developed seven Natural Capital Indicators (see 'Summary | Natural Capital Indicators of your farm) being used to test our research question (see 'Tying it all together' page). The indicators represent different attributes of natural capital that help understand the condition, extent, and type of natural resources and production benefits to farmers.
- **Scope 1**: direct greenhouse gas emissions from sources that are owned or controlled by an organization. This includes emissions from activities like burning fossil fuels for heating, operating vehicles, or manufacturing processes.
- **Scope 2**: indirect greenhouse gas emissions associated with the consumption of purchased electricity, heat, or steam by an organization. These emissions occur during the production of the energy consumed by the organization.
- **Scope 3**: indirect greenhouse gas emissions that occur throughout an organization's value chain, including both upstream and downstream activities. This includes emissions from purchased goods and services, transportation, waste disposal, employee commuting, and other activities not directly owned or controlled by the organization.

Appendix 2: Locations of field observations across your farm

A mix of measurement approaches have been used to assess the natural capital of the farm. These include:

- Farm records relating to planting and management of individual paddocks, as well as other production information (provided by you)
- Assessments from ecologists who visited your farm. These were done at several locations pre-selected to provide a representative perspective of the Ecosystem Type and State. On-farm assessments help ground truth satellite data and gather detailed data that satellites can't measure.
- The ecological data from these ground assessments is used to generate the Forage Condition and Ecological Condition indicators.

Locations of field observations.
The yellow dots on the map show which sites were visited by field ecologists. Information from remote sensing (and the management information provided) is used to link unvisited sites to visited sites. FFTF is investing in techniques to improve the accuracy of these calculations and will provide the methods so that they can be used by the industry in future.

Table 9: Natural Capital data sources across your paddocks.
This table shows the links between the paddocks that were visited and the ones that have been judged, as a result of satellite imagery analysis and management information, to be in a similar condition as the observed paddocks.

Taylors Run - Ecosystem condition measurement process as @ 16/12/2021		
Condition Data Source	**Ecosystem State**	**Paddocks where the source information was used to impute the Ecosystem State**
Visited - BFDP	DG3	C, FL, TFDB
Visited - Junction - 29.7ha	DG3	Long Frog - 16.8ha, Lower Spring - 19.2ha
Visited - Lower Spring Reserve - 6.5ha	DG3	Lower Spring - 19.2ha
Visited - Lower Sugarloaf - 29.3hs	DG3	Junction - 29.7ha, Top Spring Reserve - 4.9ha
Visited - Pentagon North - 12.9ha	DG3	Junction Yards - 12.4ha, Reserve - 33.5ha, Tussock - 22.5ha, Wollun - 26.4ha
Visited - Rosedale Orchard	DG3	
Visited - Shugg - 29.7ha	DG3	Pentagon South - 14.7ha
Visited - Wattles - 58.2ha	DG3	Ram - 17.5ha, Top Spring - 20.0ha, Top Sugarloaf - 63.6ha, White Clover - 12.1ha
Visited - Junction Dam - 10.3ha	DG4	Lower Ram - 25.7ha, Top Spring - 20.0ha
Visited - Pasture - 5.2ha	DG4	House - 5.6ha, Pit - 5.8ha, Shaft Hill - 4.1ha, Weathershed - 2.9ha, Woolshed - 5.7ha
Visited - Stringies - 17.6ha	DG4	
Visited - Ural - 13.7ha	DG4	Ural - 13.7ha, Wallaby - 12.6ha
Visited - Creek - 29.3ha	DG5	
Visited - Frog Forest - 7.0ha	DG5	NR1, Tub - 6.2ha
Visited - Windmill - 3.4ha	DG5	Little Dip - 4.6ha
Visited - Junction - 29.7ha	EWV1	Shugg - 29.7ha, Top Spring Reserve - 4.9ha
Visited - Long Frog - 16.8ha	EWV1	
Visited - Reserve - 33.5ha	EWV1	
Visited - Wallaby - 12.6ha	EWV1	
Visited - Wattles - 58.2ha	EWV1	
Visited - Shugg - Planting 41	PNT2	
Visited - Treefest - Planting 69	PNT2+	Wallaby - 12.6ha
Visited - Tank - 22.0ha	TW2	NR10, Treefest - 6.1ha
Visited - Wattles - 58.2ha	TW2	
Visited - Wollun - 26.4ha	TW2	
Visited - C	TW3	C, Lower Sugarloaf - 29.3hs
Visited - Top Spring - 20.0ha	TW3	
Visited - Rosedale	TW4	
Visited - Ural - 13.7ha	TW4	Lower Ram - 25.7ha, Wallaby - 12.6ha
Farmer Supplied Data	EWV1	C, FL, Junction - 29.7ha, Junction Dam - 10.3ha, Junction Yards - 12.4ha, Lower Ram - 25.7ha, Lower Spring - 19.2ha, Lower Sugarloaf - 29.3hs, NR2, NR3, NR6, NR7, NR9, Pasture - 5.2ha, Pentagon North - 12.9ha, Pentagon South - 14.7ha, Pit - 5.8ha, Planting 10, Planting 11, Planting 12, Planting 13, Planting 14, Planting 15, Planting 16, Planting 18 - 66, Planting 3, Planting 32, Planting 46, Planting 48, Planting 5, Planting 55, Planting 6, Planting 65, Planting 66, Ram - 17.5ha, Reserve - 33.5ha, Rosedale, Sawmill - 1.7ha, Shaft Hill - 4.1ha, Shugg - 29.7ha, Stringies - 17.6ha, TFDB, Top Spring - 20.0ha, Top Sugarloaf - 63.6ha, Tub - 6.2ha, Tussock - 22.5ha, Ural -

		13.7ha, Wattles - 58.2ha, White Clover - 12.1ha, Wollun - 26.4ha, Woolshed - 5.7ha
Farmer Supplied Data	PNT1	Pentagon North - 12.9ha, Wattles - 58.2ha
Farmer Supplied Data	PNT2	Frog Forest - Planting 19, NR5, Planting 19, Planting 23, Planting 45, RR, Shugg - Planting 41
Farmer Supplied Data	PNT2+	NR8
Remote Imagery	Domestic Infrastructure	House - 5.6ha
Remote Imagery	Infrastructure	Sawmill - 1.7ha
Remote Imagery	PNT2	NR4
Remote Imagery	Roads & Laneways	FJ, JL, Top, TS, WS
Remote Imagery	Sheds & Yards	JY, SLY, Woolshed Yards
Remote Imagery	Water Infrastructure	JD, TD

Appendix 3: Additional information | Understanding Ecological Condition

The Ecological Condition indicator is a measure of how modified a farm is compared to its pre-development 'reference' condition i.e., what the farm landscape was considered to be like prior to European influence over the landscape. The index is a combined measure of how the extent that the farm has been modified from that pre-development condition, and to what degree (in terms of change from that reference condition) modified areas have been altered.

As an example, 10% of a farm may be reasonably diverse woodlands that are largely protected from agricultural influence (grazing or cropping), 20% of a farm may have been partially altered through moderate levels of grazing in native pastures and woodlands. Much of the remainder of the farm may have been completely transformed by practices such as introduced sown pastures and croplands with few or no remaining trees where they were present originally. There may also be some areas that are heavily modified but for practices such as agroforestry.

Modifications to the farm landscape are a complex interaction of ecological, social/cultural, geographical, and economic influences and are likely to have occurred over a long period of time. They are also unlikely to have been under the influence of the current managers.

It is also important to acknowledge that most, if not all, farms are necessarily modified from their pre-development 'reference' state, otherwise they wouldn't function well as farms. For a farm that is less modified and that maintains more areas in, or close to, the reference condition there may be significant trade-offs with productivity and profitability. On the other hand, farms that retain significant areas of partially modified ecosystems could be highly productive and profitable as these traits are likely to confer drought resilience and an abundance of free services from nature. The FFTF research aims to better understand where these trade-off zones are and where the 'sweet spot' or perhaps more accurately 'sweet zone' of optimal natural capital to support farm business performance is. See the 'Tying it all together' section of this report for more and await the findings of this large-scale research project.

What is the relationship between Ecological Condition and farm performance?

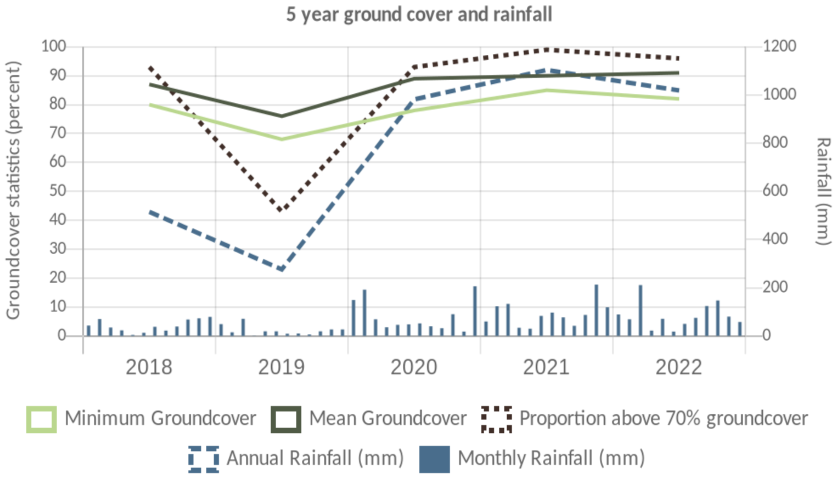
A primary goal of FFTF is to test the relationship between Ecological Condition and farm performance (profitability, productivity, and business resilience). Research results are published separately and at this stage are preliminary. Future phases of the project will provide far greater confidence in the findings.

What this indicator is saying	This indicator is NOT SAYING
The closer a farm is to the native reference condition, the more likely it is to have higher-quality native vegetation and associated habitat, more native biodiversity, and corresponding ecosystem services (such as pest control, pollination, extreme weather resilience and nutrient cycling.)	**Not saying that** farms with less modification are better or worse than other farms.
According to research, native habitat condition and extent is a very good indicator of native biodiversity.	**Not saying that** we've concluded our research. The data you've contributed is part of ongoing testing of our hypotheses.
	Not saying that farms should transition back to the pre-development condition states. Or that this is even possible, especially with a changing climate.
	Not using the term 'condition' as a judgment of a farmers' business. It is instead in the context of the pre-development native 'reference' condition.

What this indicator is saying	This indicator is NOT SAYING
	Not saying that ecosystems can't be functional and provide valuable ecosystem services if they include exotic species. For example, as reflected in the Forage Condition indicator, exotic grasses are recognized for their value in productive pastures. In the Proximity, and Aggregation indicators, exotics are recognised for their contribution to shade and shelter which benefits production. Exotics have also been observed to provide good habitat for some native species.

Appendix 4: Additional ground cover information | more maps of your farm

The maps on the following pages are additional ground cover information showing minimum, average, and variability over the past 5-year period. These three data points are a part of calculating your overall Soil Condition result.

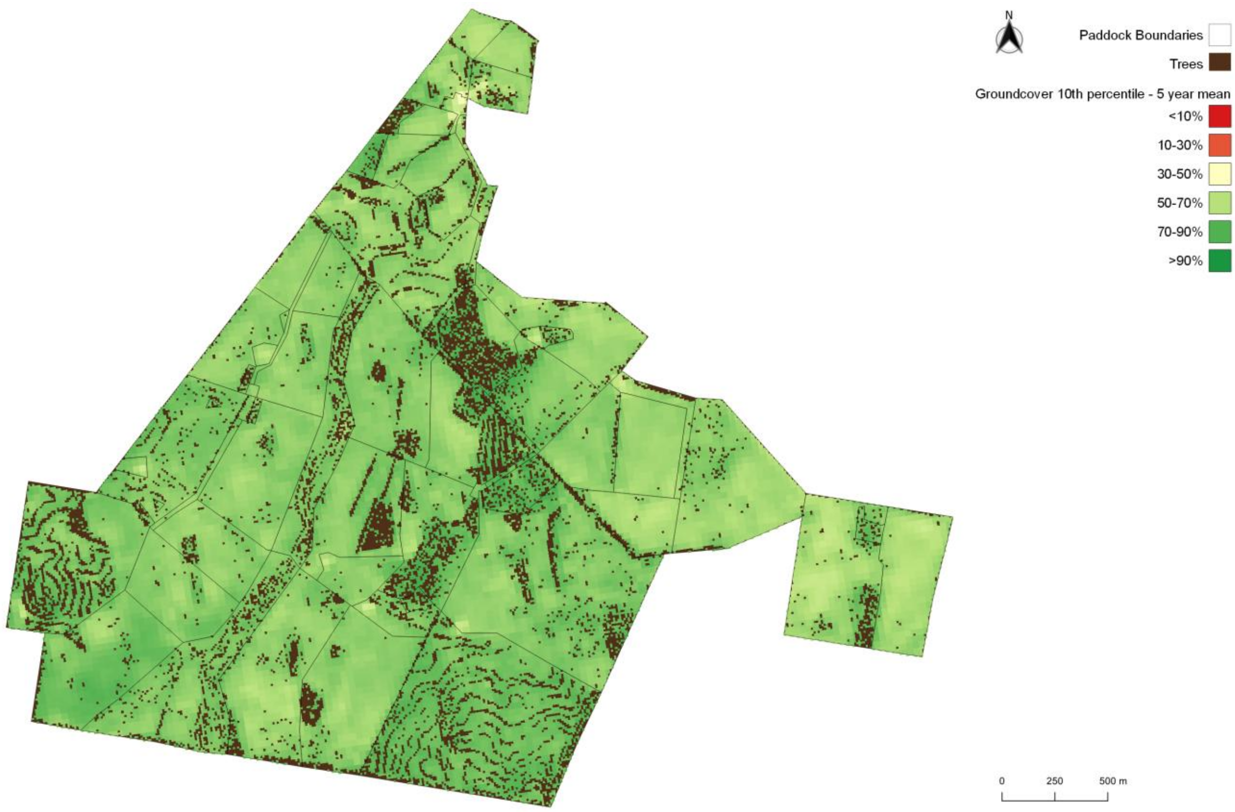


The estimates of minimum ground cover are a good proxy for soil regulation services such as the protection from erosion (wind and rain). The proportion of the property maintained at or above a threshold of 70%[28] has been analysed for the last 5 years.

Rainfall is obviously a key factor in the ability to retain ground cover. The various ground cover metrics have been plotted against monthly and annual rainfall.

<u>Minimum</u> ground cover

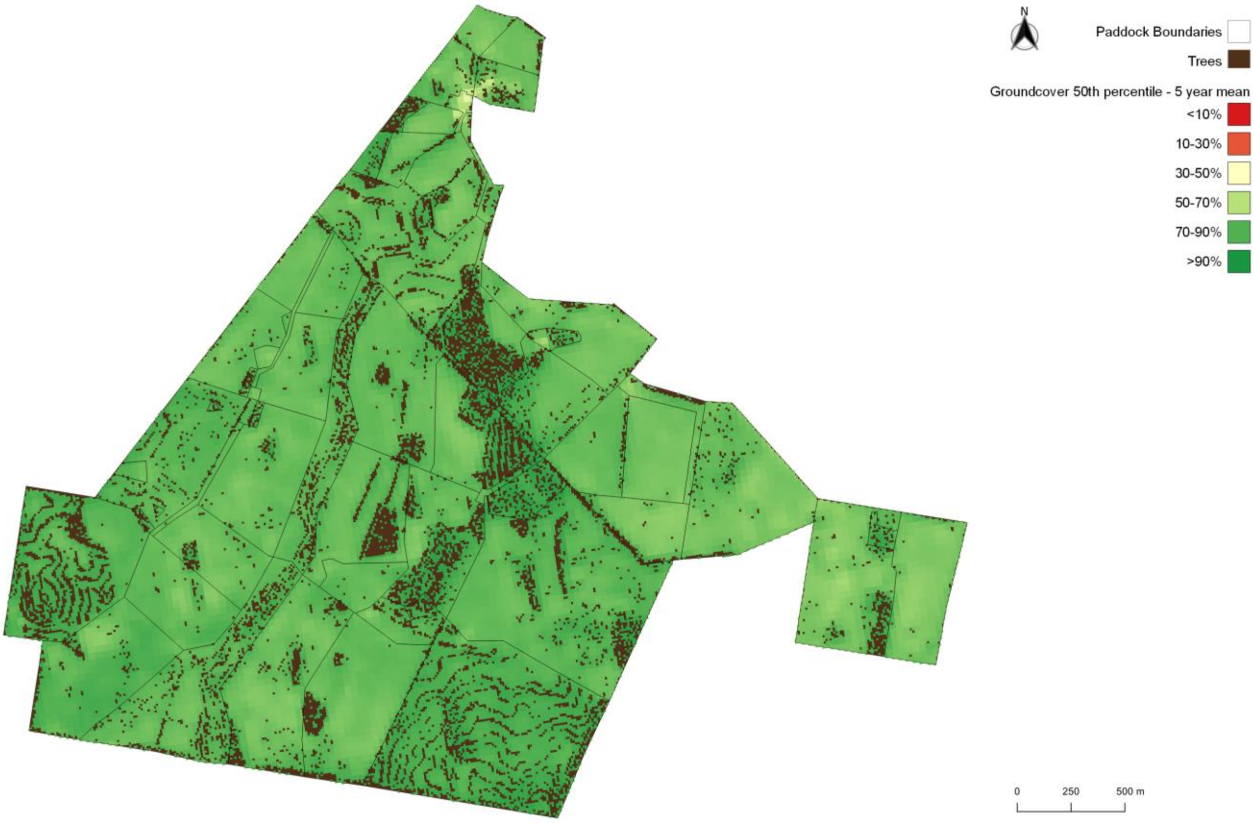
This shows the 5-year average of the '10th percentile' ground cover measurement for each location (pixel). That is, the 10th percentile figure generally represents the lowest ground cover value over the 12-month period. The annual values are then averaged over 5 years. This map can be used to identify areas of the farm that are vulnerable to soil loss (erosion) and reduced fertility (productive capacity).



[28] The thresholds considered to prevent erosion are range from 50-100% and are region and slope dependent. We have chosen a figure of 70% as a representative threshold. See the following reference for further information: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/162306/groundcover-for-pastures.pdf, https://www.soilquality.org.au/factsheets/benefits-of-retaining-stubble.

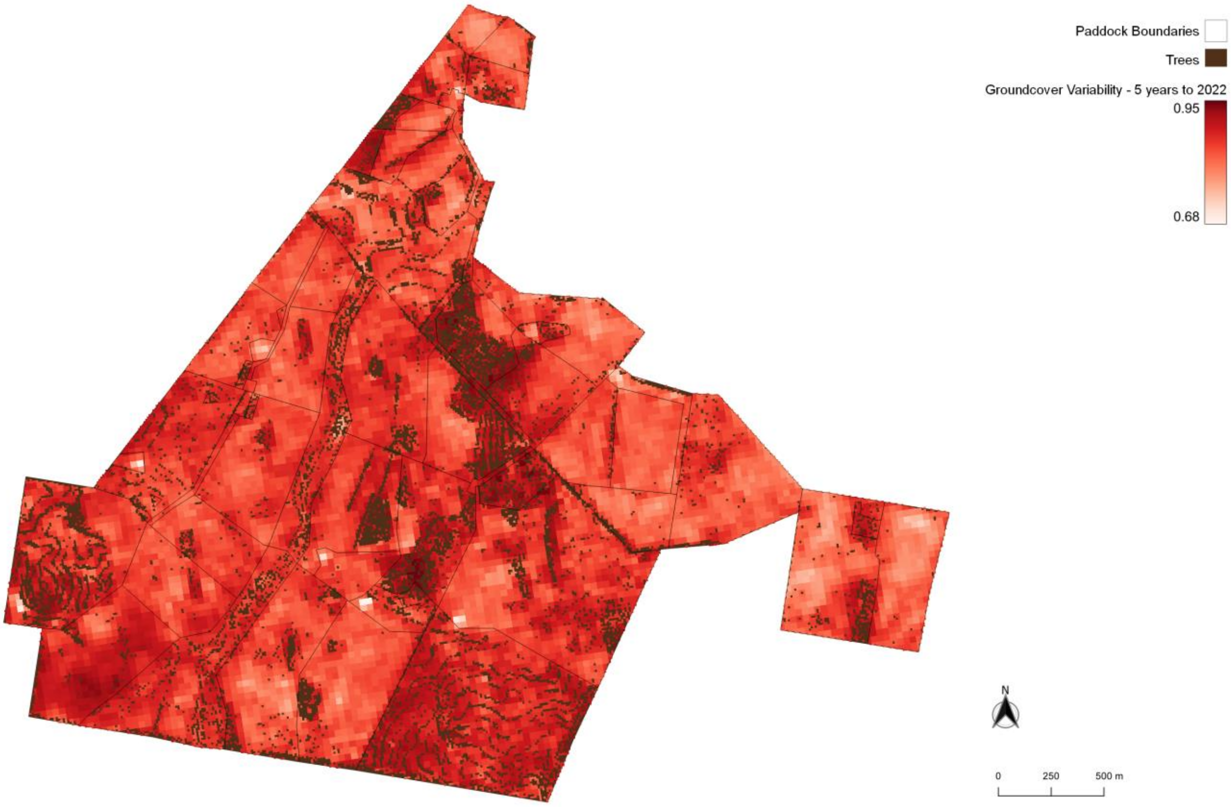
Average ground cover

This shows the 5-year average of the '50th percentile' ground cover measurement for each location (pixel). That is, the 50th percentile figure generally represents the average ground cover value over the 12-month period. The annual values are then averaged over 5 years. This map can be used to identify areas that consistently perform well and are generally more resistant to soil loss (erosion) and maintain relatively high fertility (productive capacity).



Ground cover variability

This map shows the variability in the ground cover of the farm. This is calculated using the formula of 1 – ((maximum – minimum) / maximum). A higher value indicates more stable ground cover, whereas a lower value indicates more variable ground cover. This map can be used to identify areas that have high variability in ground cover and thus are susceptible to soil loss and reduced fertility under some conditions or seasons.



Appendix 5: General limitations of satellite data

Satellite data is a powerful tool, particularly for use across large and diverse landscapes, and to track data over time. FFTF combines satellite data and data from farm visits to generate a comprehensive natural capital dataset. Farm visits help 'fill in the gaps' where satellites can't provide the full picture.
While significant and ongoing investments are being made to improve satellite data accuracy, the following description of its general limitations may help contextualise the relevant natural capital data in this report.

Limitation	Description
Small trees may be excluded.	Woody vegetation with a canopy size smaller than 1m[29] (roughly) is often too small to be identified by the satellites used.
Satellites measure presence and size of canopies.	The types of trees are not measured by the satellites used. Species mix is instead assessed during ecologist farm visits.
Canopies can block a view of ground cover	Ground cover under trees is not easily viewed by satellites
Cloud cover affects satellite imagery.	Cloud cover can affect the quality of the information able to be generated by satellites.

[29] Noting that 1m pixels are aggregated into 10m-by-10m pixels to align with other data sets. Therefore, a 10m pixel will only be counted as having canopy cover if the majority of the ten 1m pixels around it have trees in them.

Appendix 6: Ecosystem services that benefit farm performance

Table 10: Natural capital attributes.
Just like a meal can be hot or cold, spicy or sweet, each different type of natural capital (each ecosystem asset) has different attributes and generates different services – examples are provided in the below table.

Natural capital assets	Example benefits to farmers	Example co-benefits to society
A grassy woodland	Shade, shelter, and forage for food and fibre production	Moderate amounts of carbon sequestration and storage and habitat for native flora and fauna
Intensive cropping paddocks	High food and fibre production per hectare	Availability of food and fibre
Planted native vegetation	Ecosystem services like shade and shelter, pest control and pollination	Potentially large amounts of carbon sequestration and storage and increased connectivity for native flora and fauna
Remnant native vegetation.		Large amounts of carbon sequestration and storage and habitat for native flora and fauna

Using this information

- The Natural Capital Indicators measure the capacity of your farm to produce different ecosystem services for your business.
- There are links between the different types of natural capital on a farm and the type and range of ecosystem services being generated.
- Different benefits and trade-offs exist across the different types of natural capital. There is no one size fits all.
- FFTF is focused on ecosystem services that directly benefit farm performance (productivity, profitability, and business resilience).

Table 11: Linking Natural Capital Indicators to natural capital assets and ecosystem services.
The below table shows selected relationships between the Natural Capital Indicators, and the ecosystem services being generated. This table is not exhaustive.

Natural Capital Indicators	Soil Condition	Ecological Condition	Aggregation	Connectivity	Proximity	Aquatic Condition	Forage Condition
Natural capital assets							
Native Ecosystems	✓	✓	✓	✓			✓
Planted vegetation	✓	✓	✓	✓			
Croplands - perennial	✓	✓			✓		✓
Croplands - annual	✓	✓			✓		
Pastures	✓	✓			✓		✓
Water resources	✓					✓	
Ecosystem services							
Microclimate regulation				✓	✓		
Carbon sequestration	✓	✓					✓
Moderation of extreme events		✓	✓		✓		✓
Wastewater treatment						✓	
Soil fertility and erosion control	✓	✓				✓	
Pollination		✓	✓	✓	✓		
Biological pest control		✓	✓	✓	✓		
Regulation of water flow	✓					✓	
Food	✓						✓
Raw materials (fibres, timber, biofuel)		✓					✓
Freshwater	✓					✓	
Habitat for species		✓	✓	✓			
Genetic diversity	✓	✓	✓	✓			

Appendix 7: Detailed method for calculation carbon stocks and sequestration in woody vegetation

Modelling the carbon stocks

The carbon stocks stored in the woody vegetation have been modelled using FLINTpro (www.flintpro.com). The modelling is based on a spatial and temporal assessment of the woody vegetation on the farm as defined in the National Forest and Sparse Woody Vegetation Data (Version 6.0 - 2021 Release), combined with updated overlays for plantings undertaken by the property manager that may not appear in the National Forest and Sparse Woody Vegetation Data. The detailed planting information has been included to ensure that we are able to provide a more realistic picture of the carbon stocks as these plantings will often not appear in the NFSWV data for many years or may never appear if the planting is narrow (the National Forest and Sparse Woody Vegetation Data has a resolution of 30m, and currently spans from 1989 through to 2021). Other inputs to the model include ANUClimate 2.0 rainfall and temperature data, as well as Australian Annual Fire Data

For application within FLINTpro, a forest is considered to be land that contains woody vegetation which has, or has the potential to, reach more than 20% canopy cover in vegetation more than 2m in height, consistent with the definition above. The forest potential extent was defined as land that has woody vegetation (>5% canopy cover) and achieves 'forest' cover in at least three years over the simulation period (1989-2021) according to the National Forest and Sparse Woody Vegetation Data (Version 6.0 - 2021 Release). The data product used also contains the other classes detailed in the forest definition, and therefore classifies the landscape into non-woody vegetation (<5% canopy cover), sparse woody vegetation (5-19% canopy cover) and forest (>20% canopy cover). Where land does not achieve forest cover at least three points in time (between 1989 and 2021), it is treated as non-forest for the whole simulation and excluded from the assessment. The approach of treating sparse vegetation as 'forest' when it achieves forest cover was taken to reduce loss and gain events when an area fluctuates between just over and just under the 20 percent canopy threshold. This approach results in a conservative outcome of emissions and removals.

It is also important to understand that the model may underestimate the carbon stored in scattered paddock trees. Scattered paddock trees will typically not appear in the National Forest and Sparse Woody Vegetation Data and are not dense enough or large enough to be included as plantings in the overrides applied. This can be seen in Figure 4 where the green shading shows areas included in the estimation, and non-shaded areas will not be included in the carbon calculations (even where there are trees).

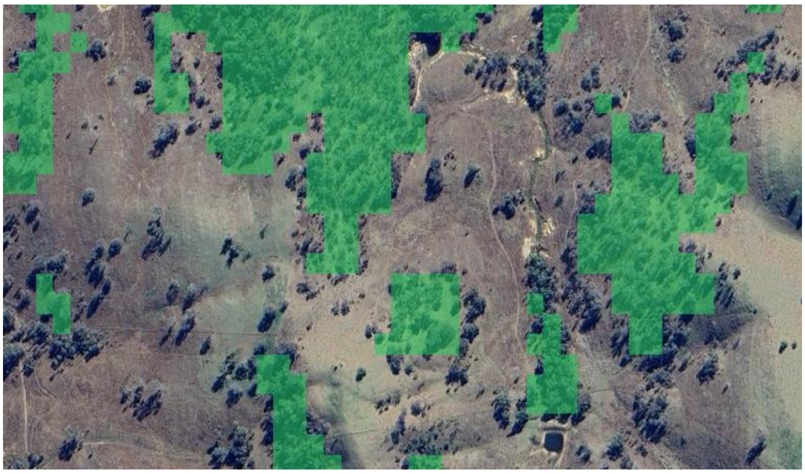


Figure 4. Example of forest and sparse woody cover (green shading)

The simulation was run from 1920 through to 2050, and any pixels defined as forest in 1989 of the National Forest and Sparse Woody Vegetation Data were modelled to be planted in 1920. This provides sufficient time for the model to 'spin up' and stabilise. Forest cover changes detected in the National Forest and Sparse Woody Vegetation Data are then applied from 1989 to 2021. Data from 2022 onwards show a growth model without any clearing/loss or planned planting events. The exception to this is where a farm enterprise has plans to clear woody vegetation (thin/harvest in plantations), in which case the planned harvest events have been included in the modelled data.

The modelling may show a loss event (removal of carbon from the sink and emission to the atmosphere) for a number of reasons, including:

- Deliberate clearing events – thinning and clearing of remnant vegetation and plantations

- Fire events
- Thinning events – where the forest has thinned due to die-back, pest infestation or drought

A farm manager may not have control over all these events, although management decisions can have some influence over the severity of some of them.

It is important to understand that a loss event is not instantaneous, and that not all the carbon from a tree is considered to be emitted in the year of clearing. The model allows for some of the biomass to move into the woody debris pool, which is then emitted to the atmosphere (and also stored in soil) over a number of years following the event. This is demonstrated in Figure 5. The rate of emission from the dead organic matter pool to the atmosphere in the years following the clearing event is dependent upon local climatic factors.

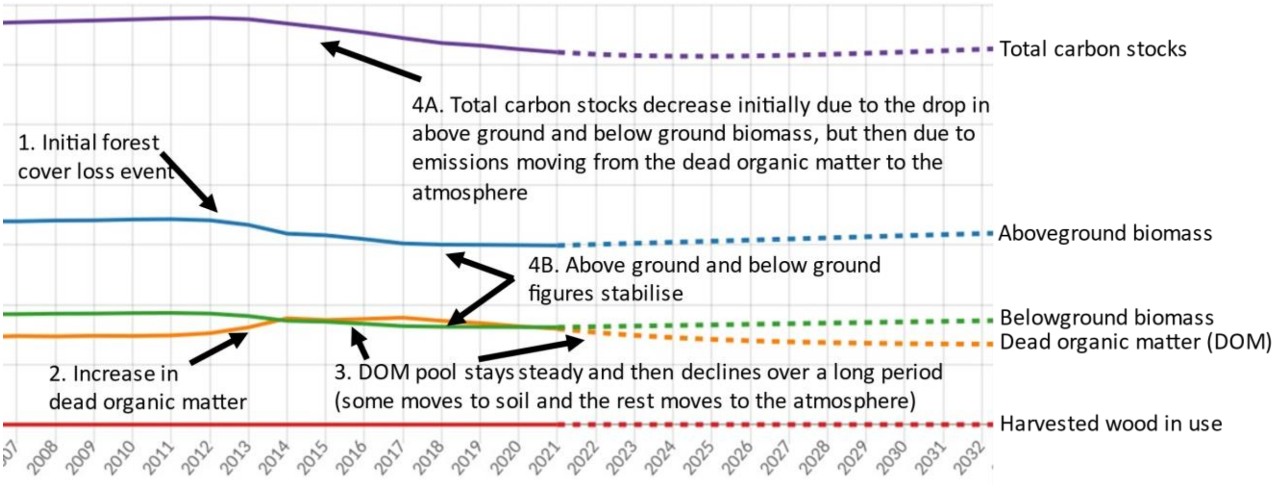


Figure 5. Carbon stock changes following a clearing event

Calculating the sequestration rate

The sequestration rate figure (used in the carbon summary in the overview and in the GHG flows section) is calculated using the change in total carbon stocks over the 5 years leading up to and including the latest year of production data. The time-period has been chosen to align with the timeframe of the production data used to calculate the emissions figures.

The consequence of this is that the sequestration rate figure is sensitive to the events occurring leading up to and during the 5-year window used. This can have an impact on determining whether a farm has a negative or positive carbon balance for the reporting window.

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