FARMLAB

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What is Soil Carbon and why does it matter?

Soil Organic Matter vs Soil Carbon

Soil organic carbon is a measureable component of soil organic matter. Organic matter makes up just 2–10% of most soil's mass and has an important role in the physical, chemical and biological function of agricultural soils.

Organic matter contributes to nutrient retention and turnover, soil structure, moisture retention and availability, degradation of pollutants, and carbon sequestration.

The amount of organic carbon stored in Australian soils could be increased by changing land management practices. This will help offset greenhouse gas emissions, increase farm productivity and potentially create offsets under the Carbon Farming Initiative.

Increasing the amount of carbon stored in soils could help reduce Australia's emissions of greenhouse gases by offsetting some of the carbon dioxide (CO_2) emitted into the atmosphere

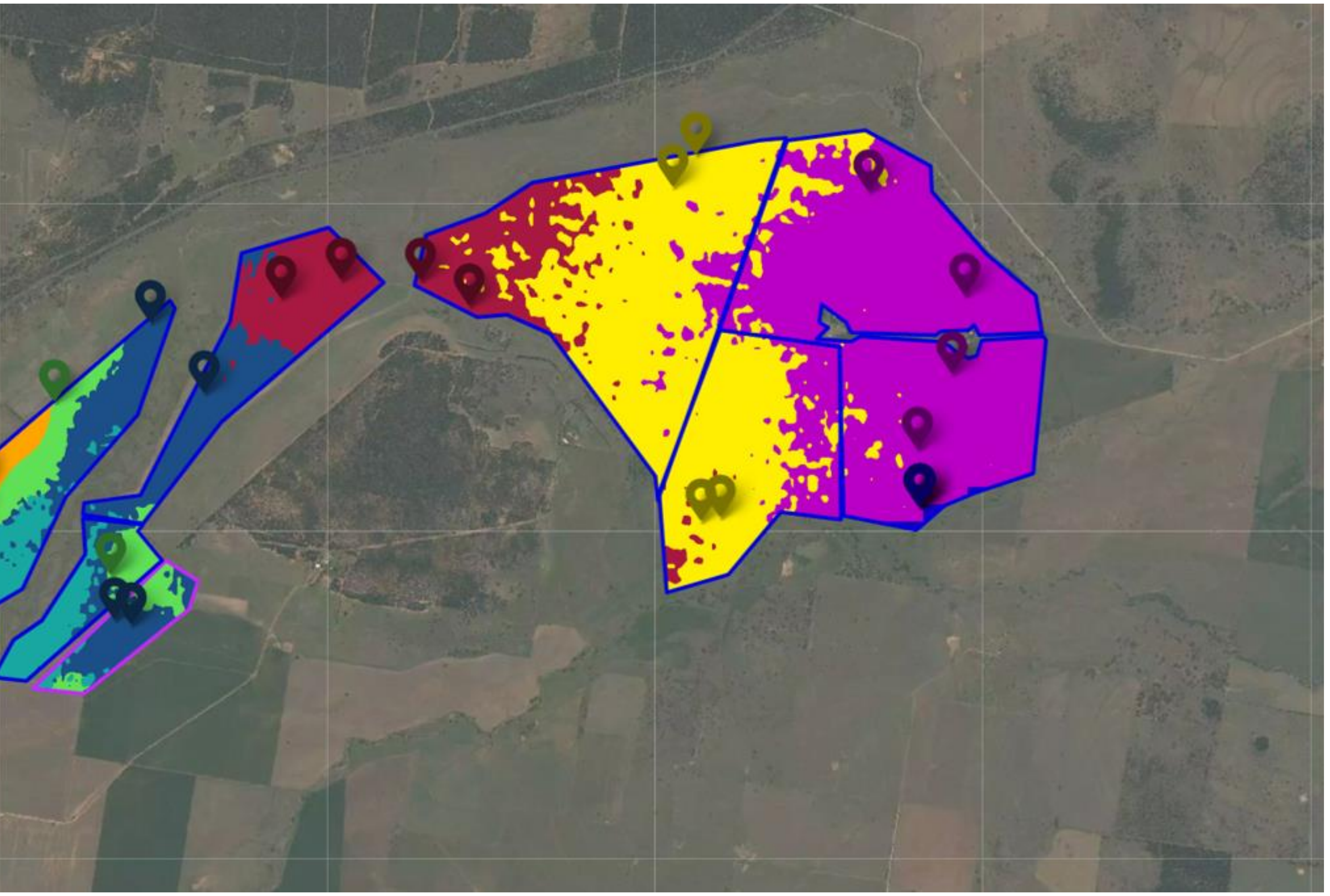
Every tonne of organic carbon is the equivalent of about 3.67 tonnes of atmospheric carbon dioxide.

Nutrient supply from organic matter

As a general rule-of-thumb, for every tonne of carbon (C) in soil organic matter, about 100 kilograms (kg) of nitrogen, 15kg of phosphorus and 15kg of sulfur becomes available to plants as the organic matter is broken down.

About 3% of the total soil organic matter pools turns over each year, so where we know how much carbon we have in soils, we can roughly estimate the potential supply of nutrients.

Measuring and reporting soil organic carbon



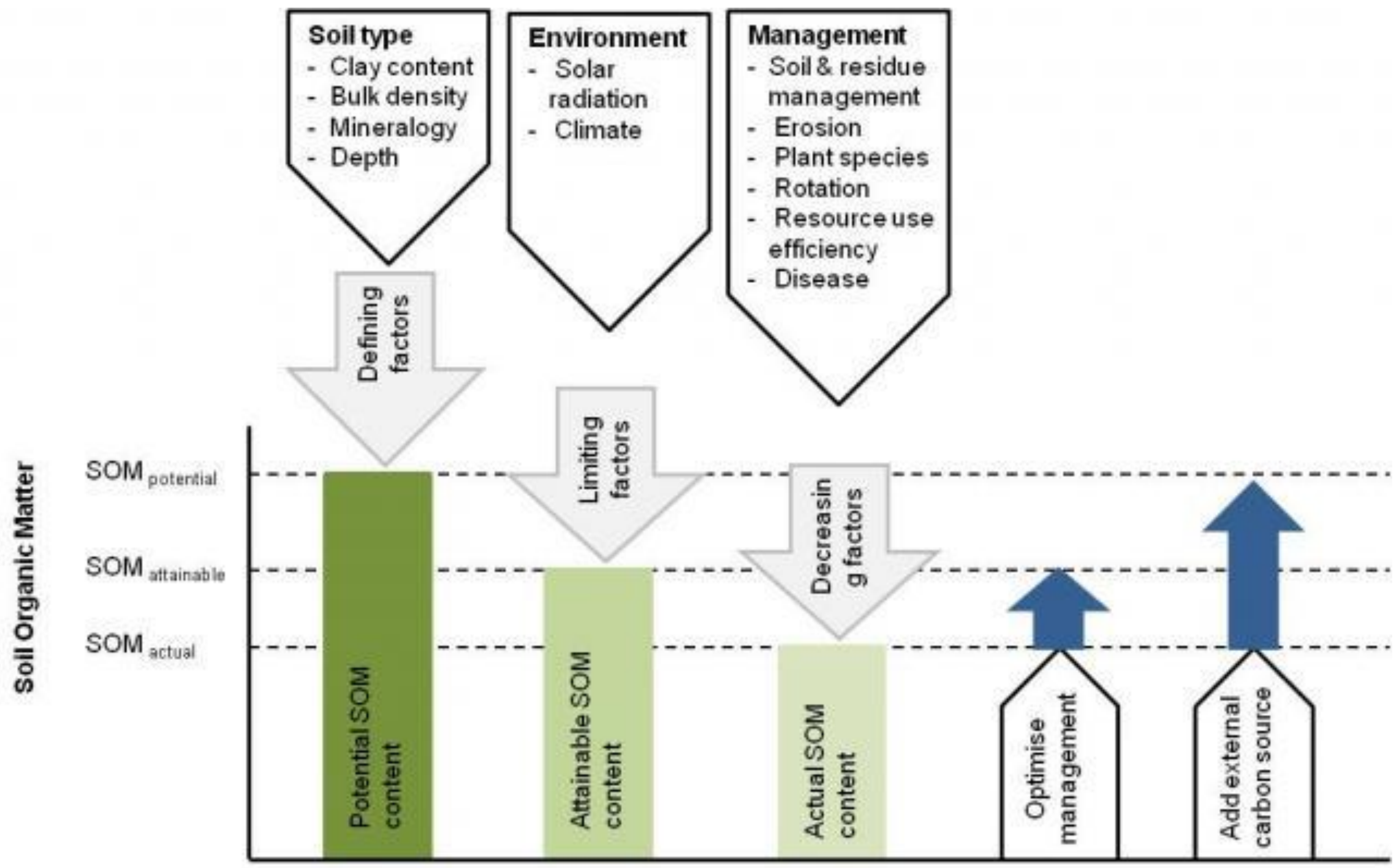
Changes in soil organic carbon (SOC) generally occur over many years, and it is often difficult to identify small changes.

A larger change in total organic carbon stock, which may take several years or longer to occur, is required before a significant change could be measured with any degree of confidence. With annual inputs of organic residues likely to be less than the 0.2t C/ha in typical grain cropping systems, more than 10 years would be needed to detect a significant change in soil organic carbon.

Accurate measurement of changes in organic carbon requires:

- a soil sampling strategy that captures the natural variation in soil carbon
- a measure of soil organic carbon concentration
- an estimate of bulk density of the soil to adjust for changes in soil mass at specified depth intervals.

Limiting Factors for Soil Organic Carbon



Soil type

Naturally occurring clay in soil binds to organic matter, which helps to protect it from being broken down or limits access to it by microbes and other organisms.
Organic matter in coarse-textured sandy soils is not protected from microbial attack and is rapidly decomposed.

Climate

In comparable farming systems with similar soil type and management, soil organic matter increases with rainfall. This is because increasing rainfall supports greater plant growth, which results in more organic matter accumulating in the soil.
Organic matter decomposes more slowly as temperatures decrease. In Western Australia under moist conditions, each 10°C increase in temperature doubles the rate of organic matter decomposition (Hoyle et al. 2006). This means moist, warm conditions will often result in the most rapid decomposition of organic inputs.

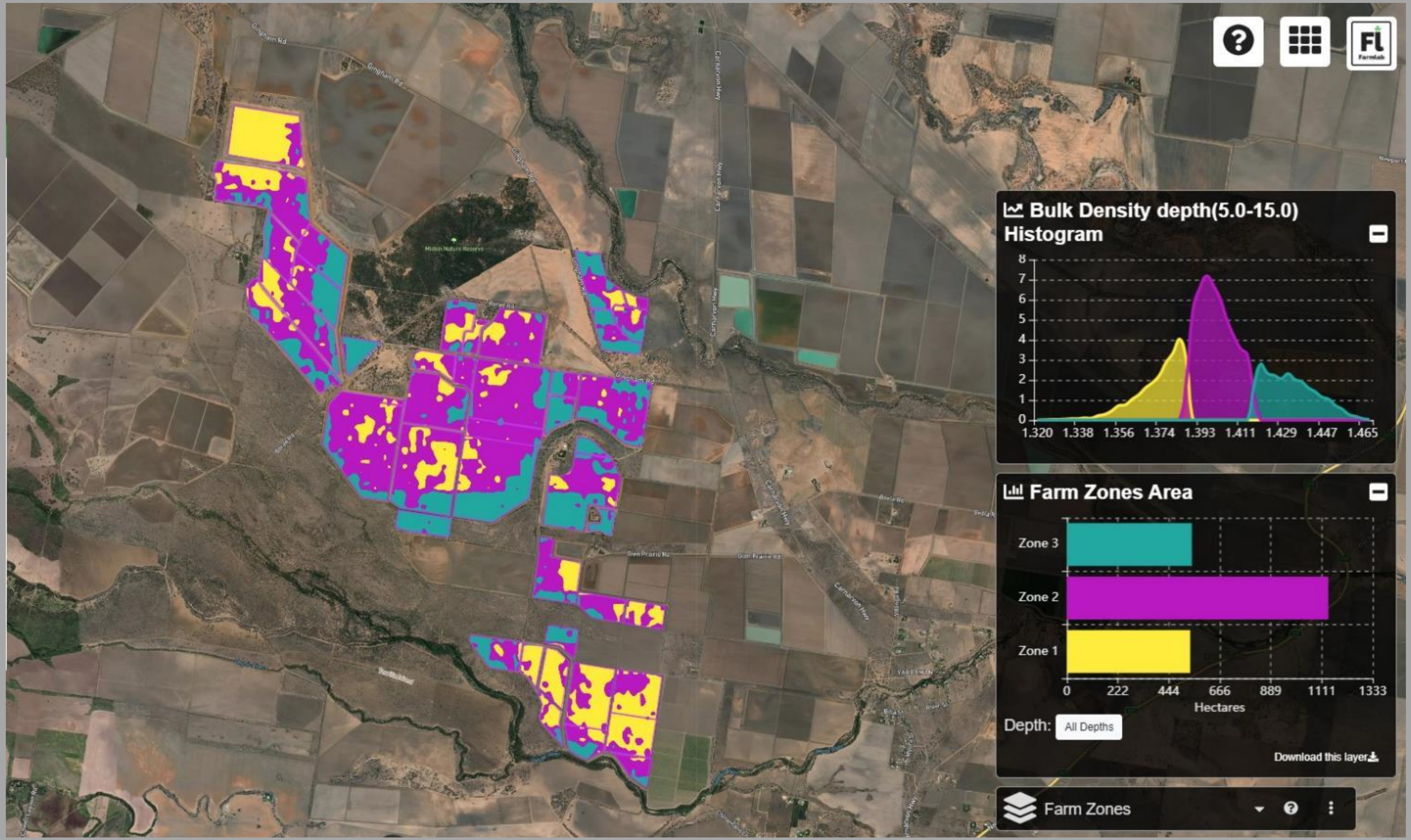
Use modern technology to help with the sampling strategy

Sampling in a paddock

- Sampling needs to capture the variability of SOC caused by:

- different soil types within a paddock variable crop or pasture history and yields across the paddock
- variable agronomy.
- Typically, a minimum of 20 cores (bulked) within a sampling area is needed to adequately capture variability.

Bulk Density Map



You can use FarmLab or other mapping solutions to map your properties

Soil Carbon Land Management

Land and soil management

- Maximising crop and pasture biomass via better water-use efficiency and agronomic management will increase organic matter inputs.
- As a large proportion of organic matter is present in the top 0–10cm of soils, protecting the soil surface from erosion is essential for retaining soil organic matter.
- Tillage of structured soils decreases soil organic matter stocks by exposing previously protected organic matter to microbial decomposition.
- Adding off-farm organic residues, such as manures, straw and char, can increase soil organic matter. The agronomic benefits should be measured to establish economic viability.
- Landscape can influence biomass production (inputs) associated with water availability.
- Transfer of soil and organic matter down slope via erosion can increase soil organic matter stocks in lower parts of the landscape.
- Soil constraints decrease plant growth and decomposition rates. This could slow the amount and transformation rate of organic matter moving into more stable fractions.
- Microorganisms and particularly bacteria, grow poorly in strongly acidic or alkaline soils and consequently organic matter breaks down slowly in these soils.

Carbon Sequestration and Carbon Credits

We already learned that sequestering Carbon is great for the soil. But we can also build Carbon Credits.
What is a Carbon Credit?

Australian Carbon Credit Units (ACCU) have been established under the Australian Energy Regulator. Each unit represents 1 ton of CO_2 stored or avoided by a Carbon project and can be traded under specific conditions. The ACCU is a financial product which can be earned, sold or kept.

Project lifecycle

You need to undertake the following actions at each stage of your soil carbon project:

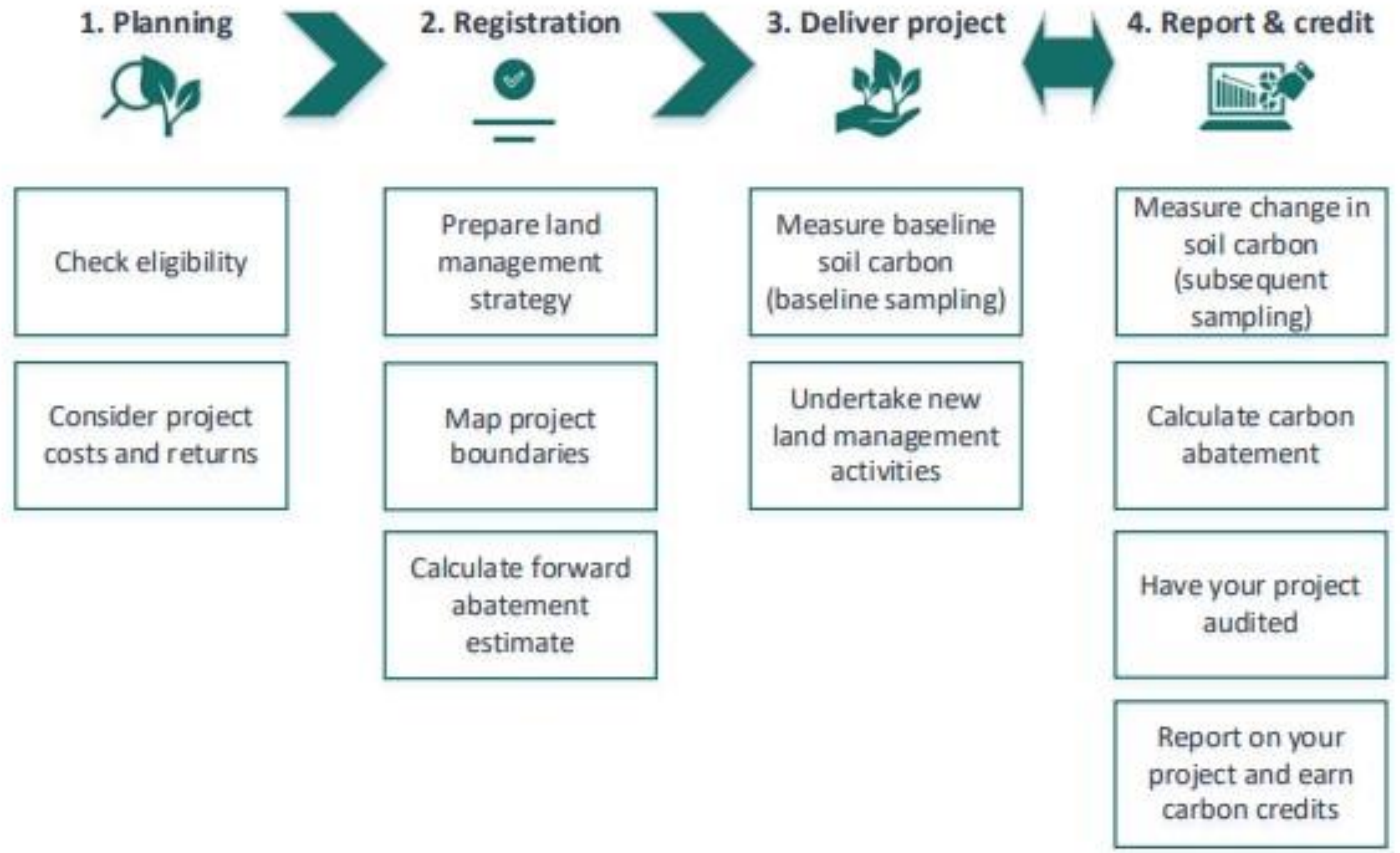


Figure 2: Soil carbon project lifecycle and actions

Carbon Sequestration Projects

Project timeline

You will need to continue land management activities, subsequent sampling rounds and reporting and earning credits for the duration of the 25 year crediting period.

You will need to continue land management activities and reporting until the end of the permanence period (25 or 100 years). You won't need to do sampling after the crediting period ends, but you also won't earn more carbon credits.

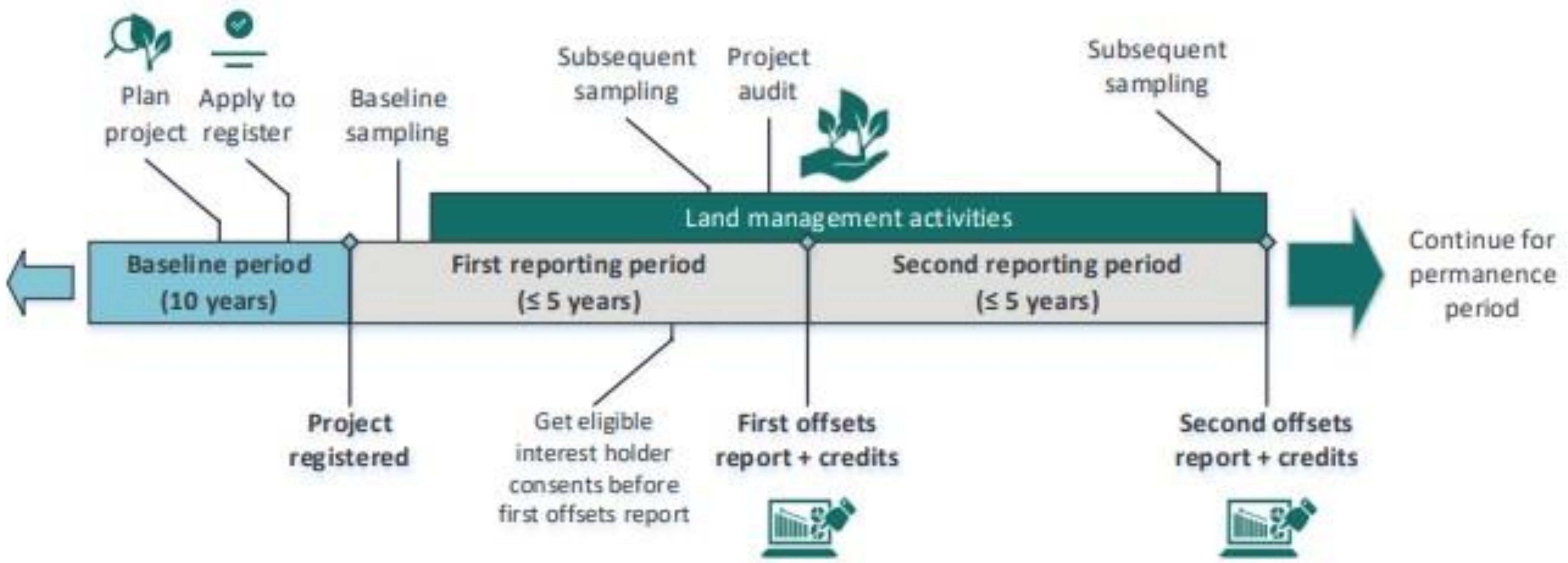
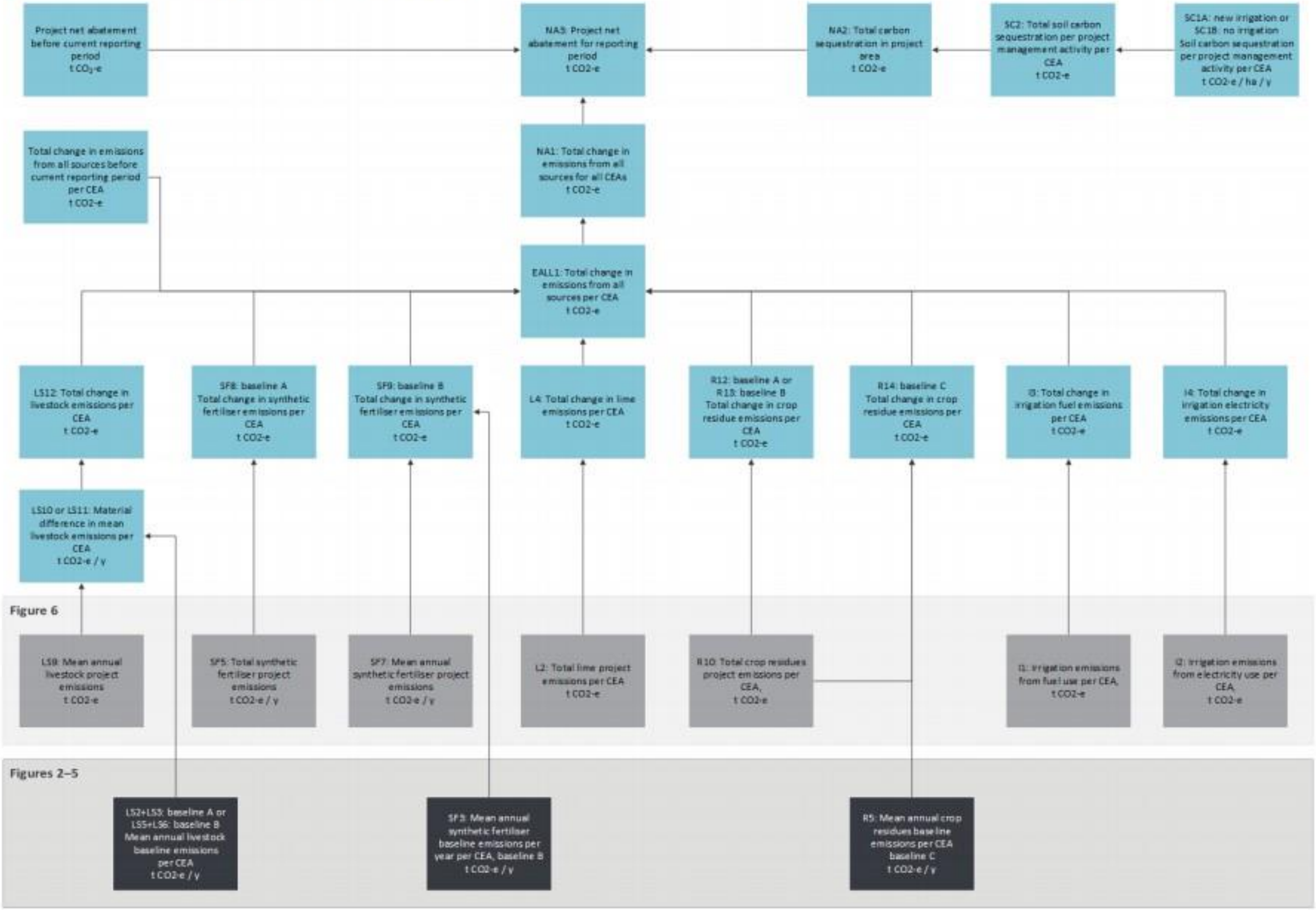
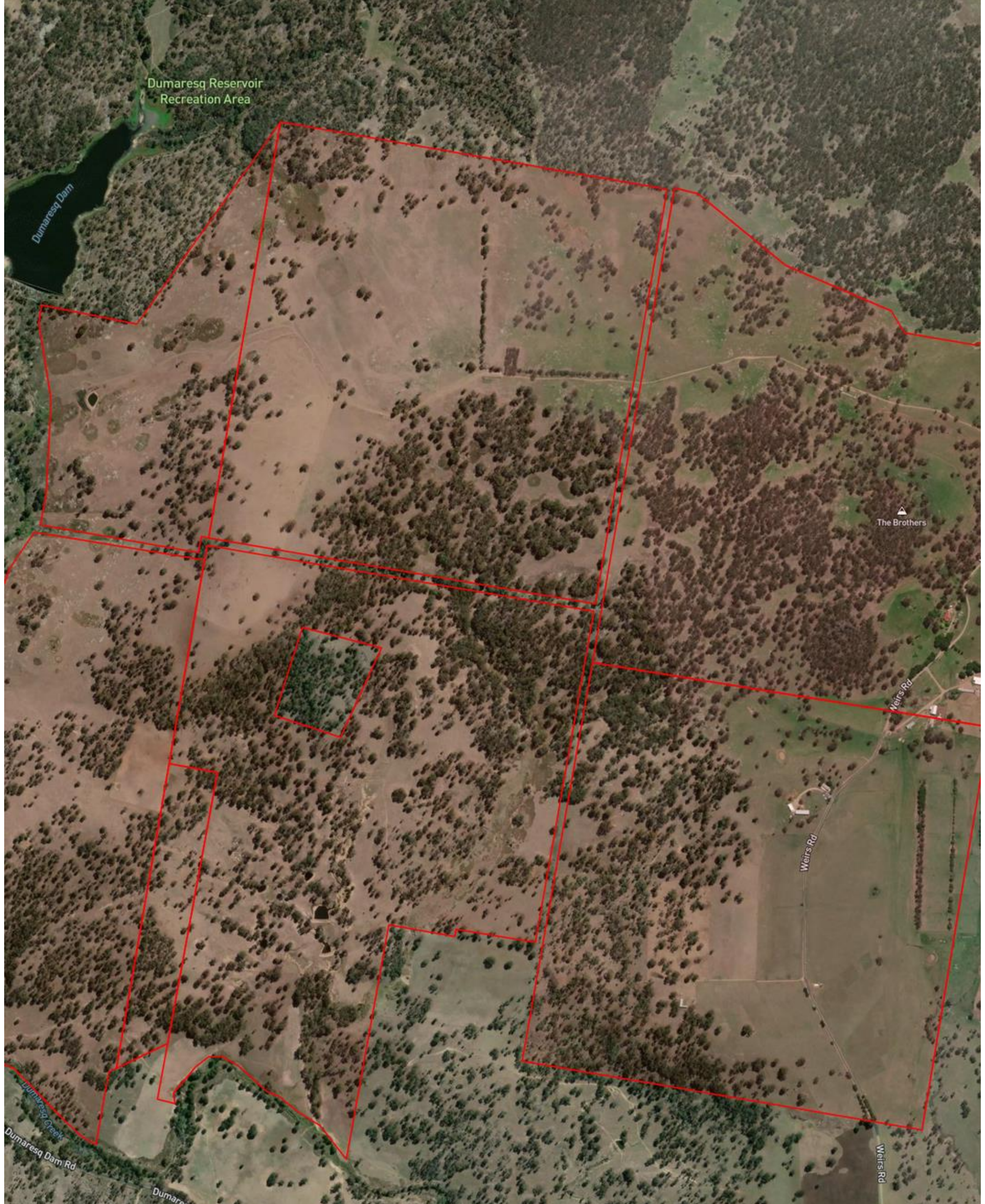


Figure 7: Equation tree for calculating net carbon abatement for a project



Kirby • March 2021



KIRBY

Location: Armidale

Size: 649 hectares (1603.71 acres)

Current Ground Cover: ~80%

Current Woody Coverage: ~60%

Primary Land use summary: Grazing

Lot and DP numbers provided as follows:

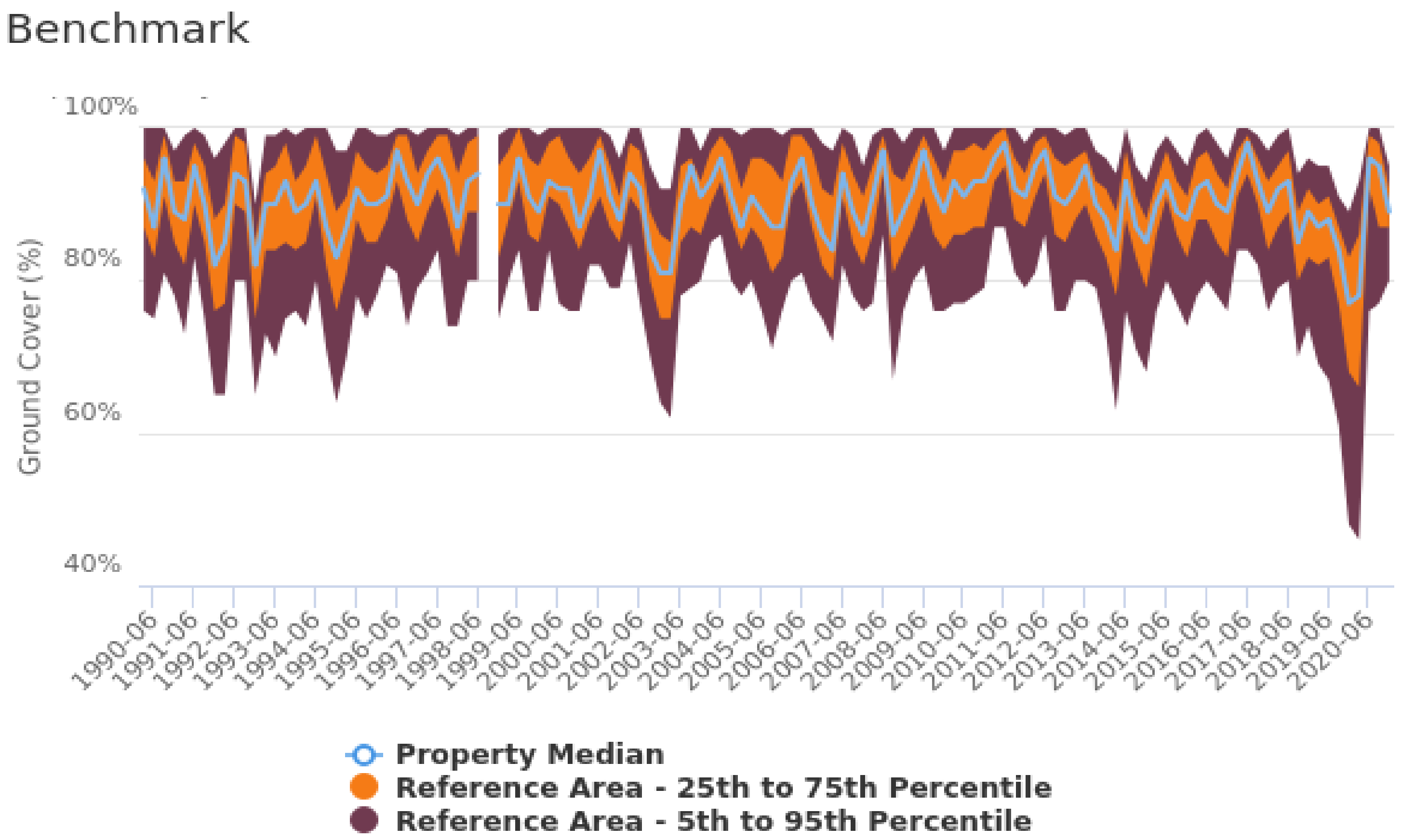
DP50001235 - LOT 1

DP5123459 - LOT 3

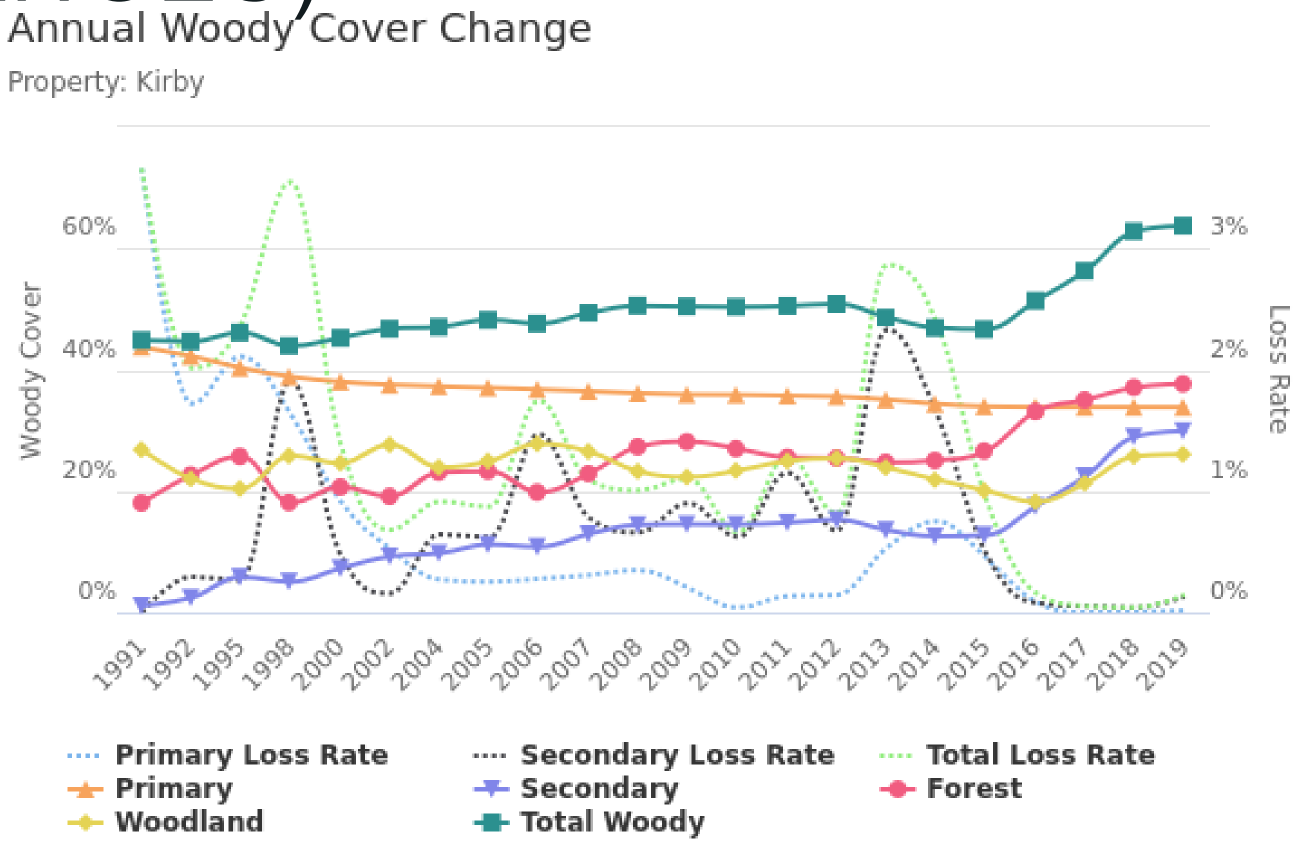
DP 50123456 - LOT 4 & 7

Kirby • March 2021

MEDIAN GROUND COVER



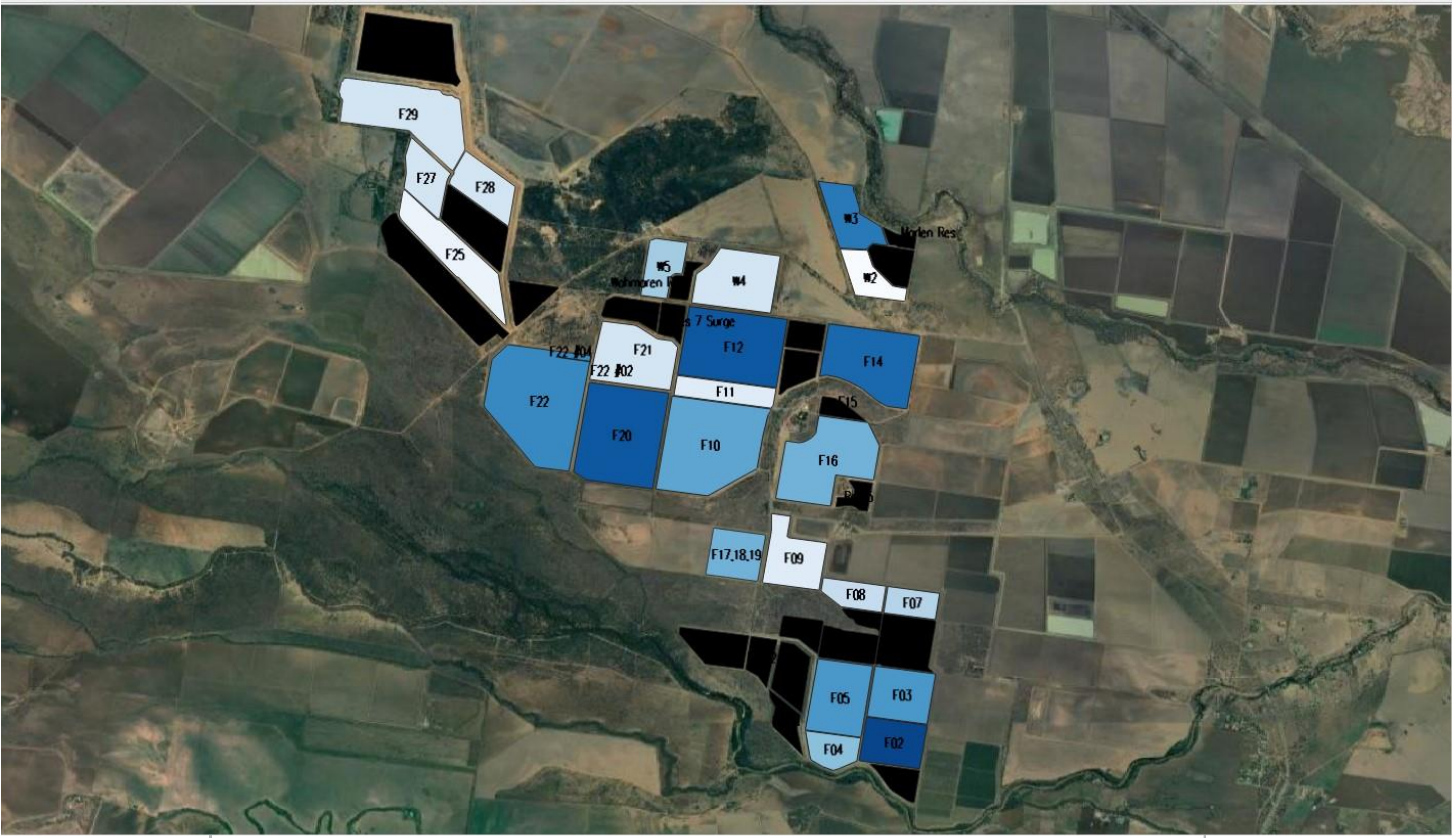
FORESTED AREAS (CHANGES)



Benchmarks

Median ground cover is within the top 75% compared to the reference area of 5kms around the property. This is following a fall in 2019, likely resulting from the drought. This indicates the property exhibits good ground cover already, which may impact the potential to increase soil carbon resulting from changes to ground coverage.

Total Woody areas have increased to approximately 60%, due to an increase in forested areas. It should be noted that areas with significant canopy cover (>20%) may be excluded from soil carbon projects



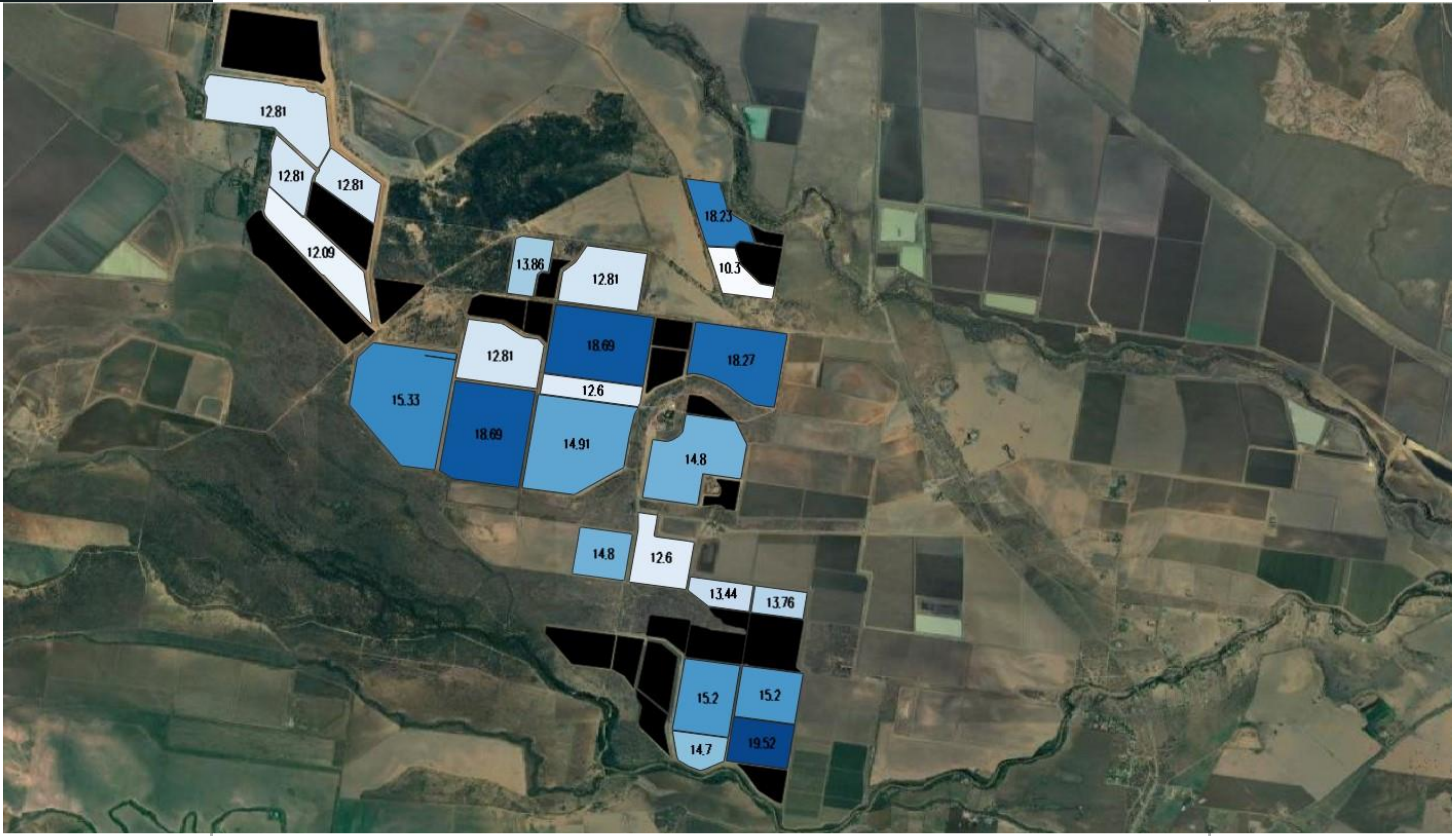
The coloured Paddocks are the ones we investigated or where we had data for. For the report we only used the newest available data.

Some of the Paddocks didn't have new soil test data available so we used older data.

Because we didn't have GPS data for the available soil test the Organic Carbon% is averaged out per Paddock which also applies for the Bulk density.

This is the current Organic Carbon Percentage per Paddock

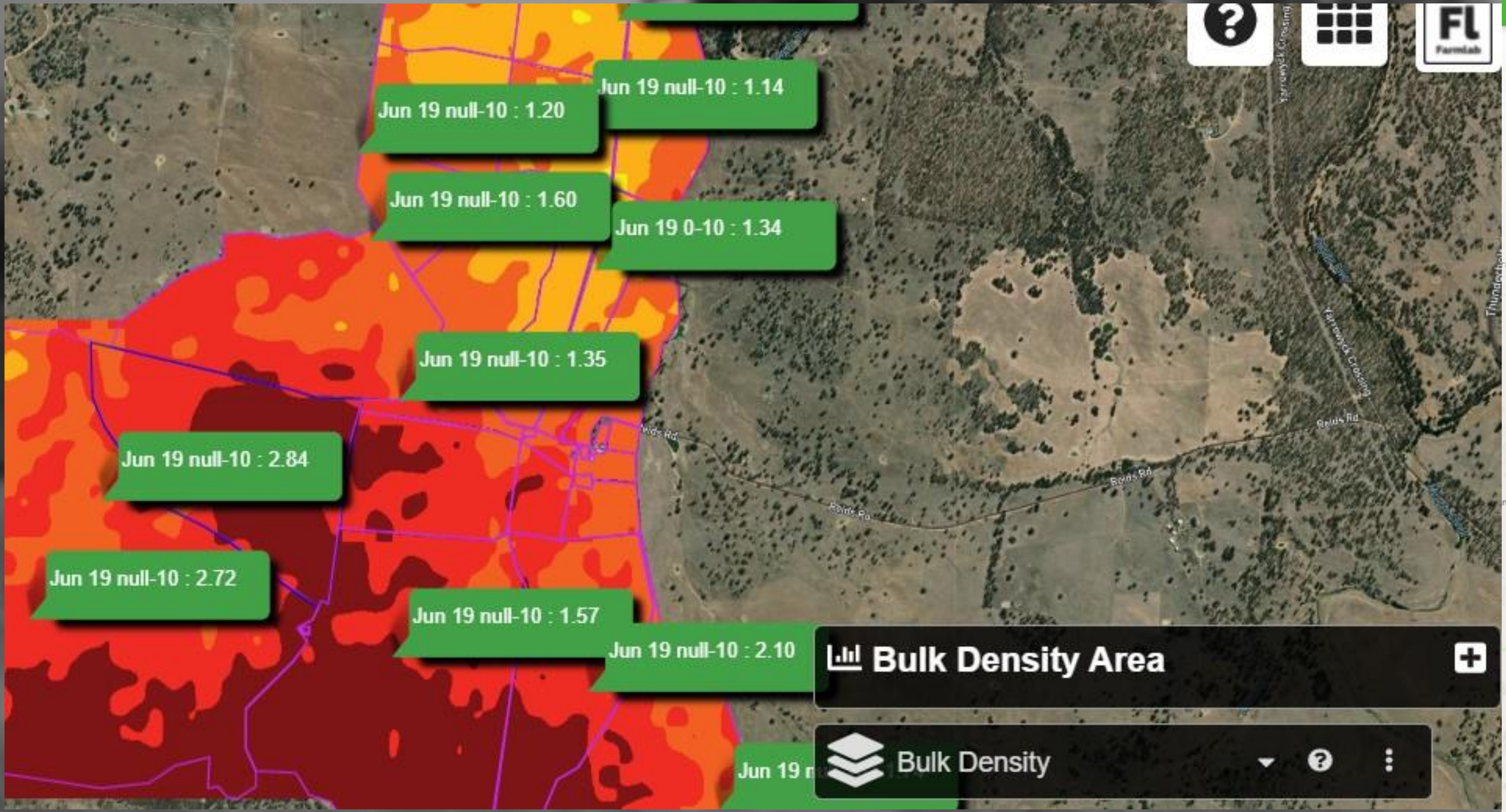
Theses results can be impacted through different management strategies and is the most important measure that can be changed in order to change the overall Carbon level.

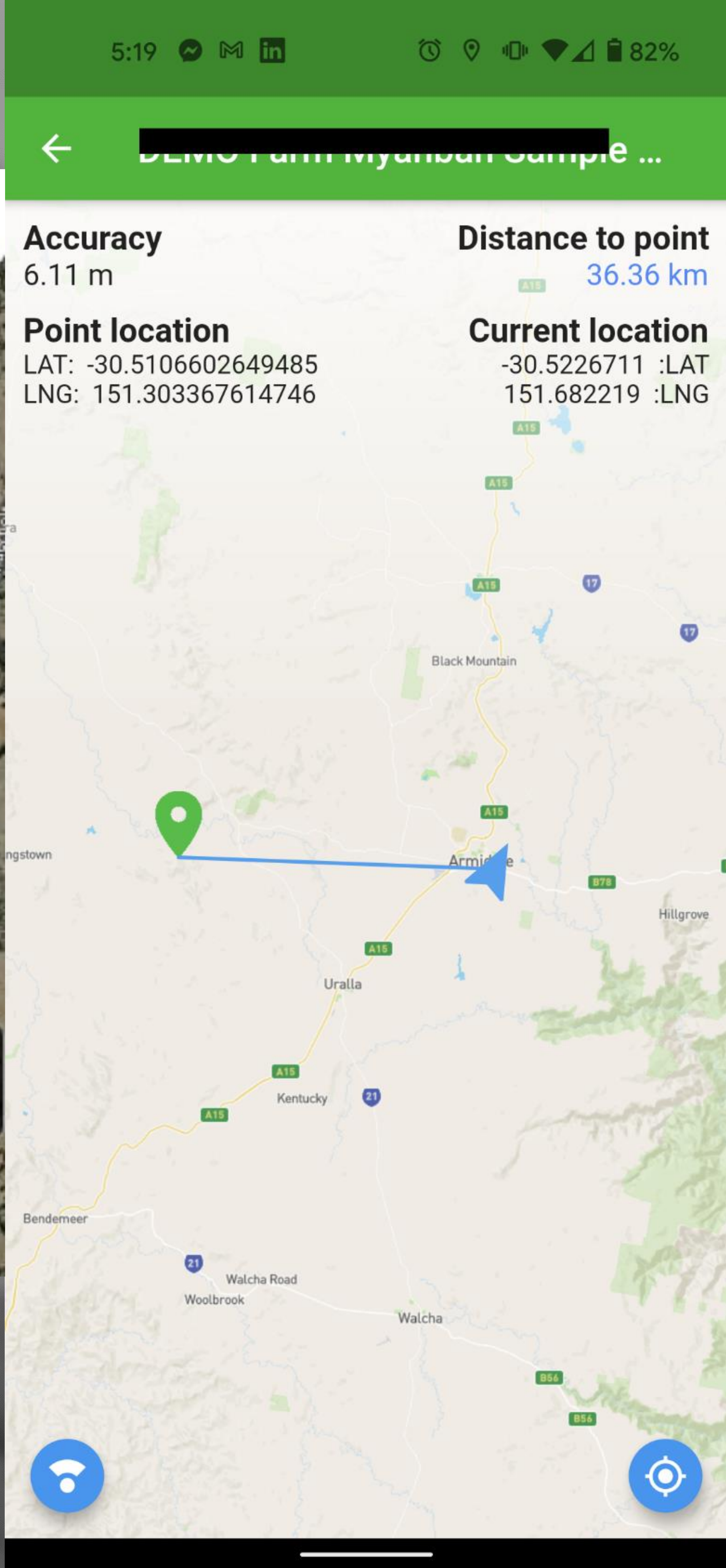


This is the t/ca/ha map. Based on the Bulk density (average per Paddock) and the Organic Carbon Percentage we calculated the tons Soil Organic Carbon per ha in each of the Paddocks with 0-15 cm soil test depth and mapped it.

The ton/ha calculated by the actual area for each Paddock gives us the tons of Soil Organic Carbon currently sequestered in the soil.

Every tons of organic carbon is the equivalent of about 3.67 tons of atmospheric carbon dioxide.


Jun 19 null-10 : 1.14
Jun 19 null-10 : 1.20
Jun 19 null-10 : 1.60
Jun 19 0-10 : 1.34
Jun 19 null-10 : 1.35
Jun 19 null-10 : 2.84
Jun 19 null-10 : 2.72
Jun 19 null-10 : 1.57
Jun 19 null-10 : 2.10
Bulk Density Area
Bulk Density


5:19
82%
[redacted]
Accuracy
6.11 m
Distance to point
36.36 km
Point location
LAT: -30.5106602649485
LNG: 151.303367614746
Current location
-30.5226711 :LAT
151.682219 :LNG
Black Mountain
Hillgrove
Uralla
Kentucky
Bendemeer
Walcha Road
Woolbrook
Walcha

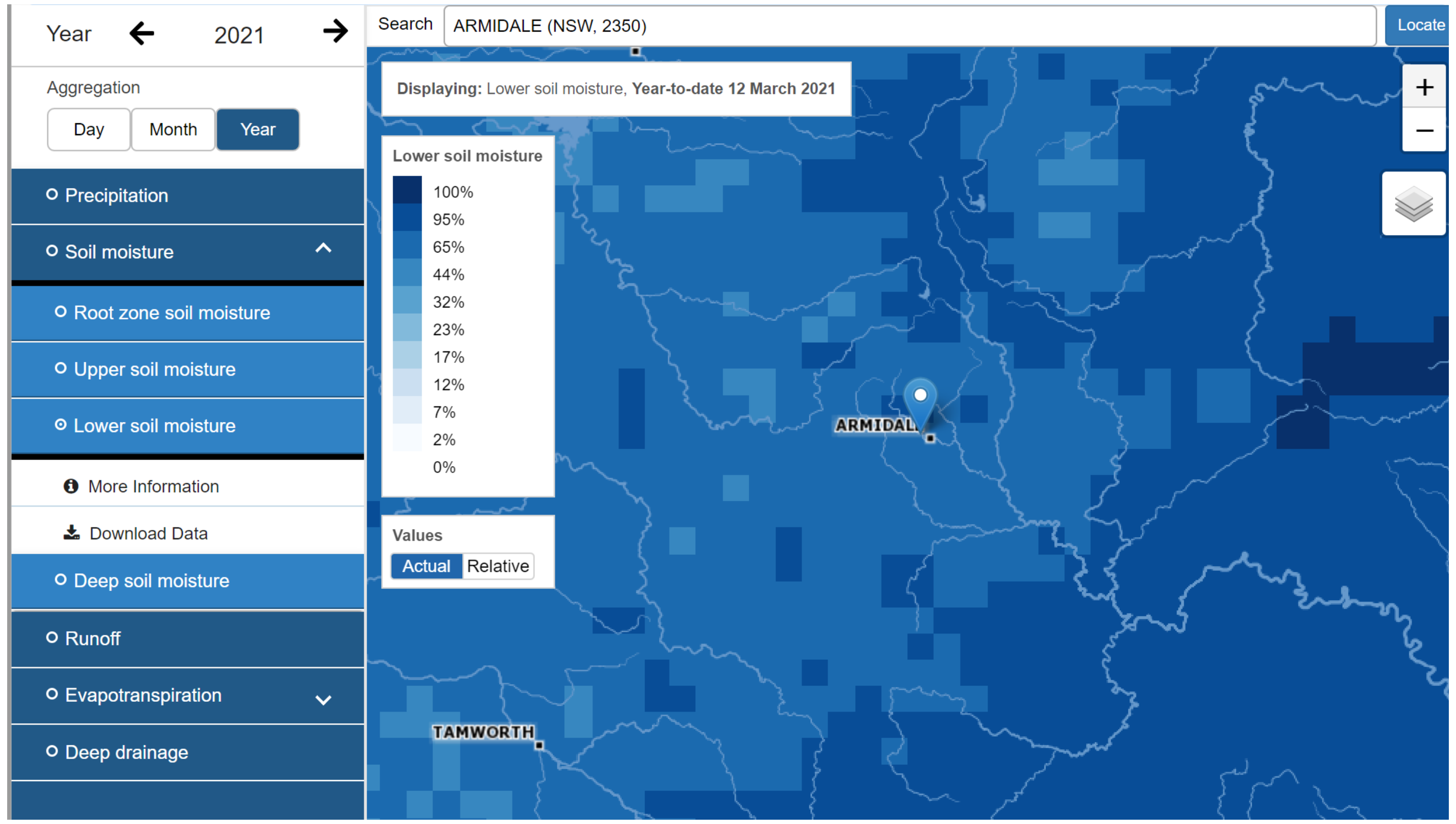
Climate Data

Source: http://www.bom.gov.au/climate/averages/tables/cw_056002.shtml

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	27.1	26.1	24.1	20.6	16.4	13.1	12.2	14.2	17.6	21.2	24.3	26.5	20.3	107	1857 1997
Mean minimum temperature (°C)	13.4	13.3	11.3	7.5	3.9	1.6	0.3	1.1	3.7	7.0	9.8	12.2	7.1	101	1857 1997
Rainfall															
Mean rainfall (mm)	104.5	87.1	65.0	45.9	44.4	56.9	49.2	48.4	51.6	67.8	80.4	89.2	791.8	132	1857 1997
Decile 5 (median) rainfall (mm)	91.6	72.3	53.9	39.4	35.2	48.2	43.3	42.0	47.0	62.2	75.0	80.2	767.6	134	1857 1997
Mean number of days of rain ≥ 1 mm	8.1	7.4	6.8	5.4	5.6	6.8	6.4	6.2	5.9	7.0	7.5	7.8	80.9	132	1857 1997
Other daily elements															
Mean daily sunshine (hours)															
Mean number of clear days	7.7	4.9	7.8	9.3	7.9	8.5	10.7	11.7	11.8	8.9	9.0	8.2	106.4	40	1957 1997
Mean number of cloudy days	12.3	12.1	11.8	10.0	13.9	12.6	10.6	9.6	8.1	10.6	10.2	10.9	132.7	40	1957 1997

Soil Moisture

Source: http://www.bom.gov.au/water/landscape/#/sm/Actual/year/-30.51/151.64/8/Point/Separate/-



Limitations

Rainfall is a major risk in sequestering soil carbon, driving the major ability to grow roots.

In this area, Average Rainfall is **798.1mm** per annum, below **300mm** it is considered unlikely that soil carbon can be increased significantly.

Other Limitations include toxicity at depth, preventing root growth and impacting **plant available water**. It is recommended advice be sourced from an experienced agronomist/professional to appropriately determine this.

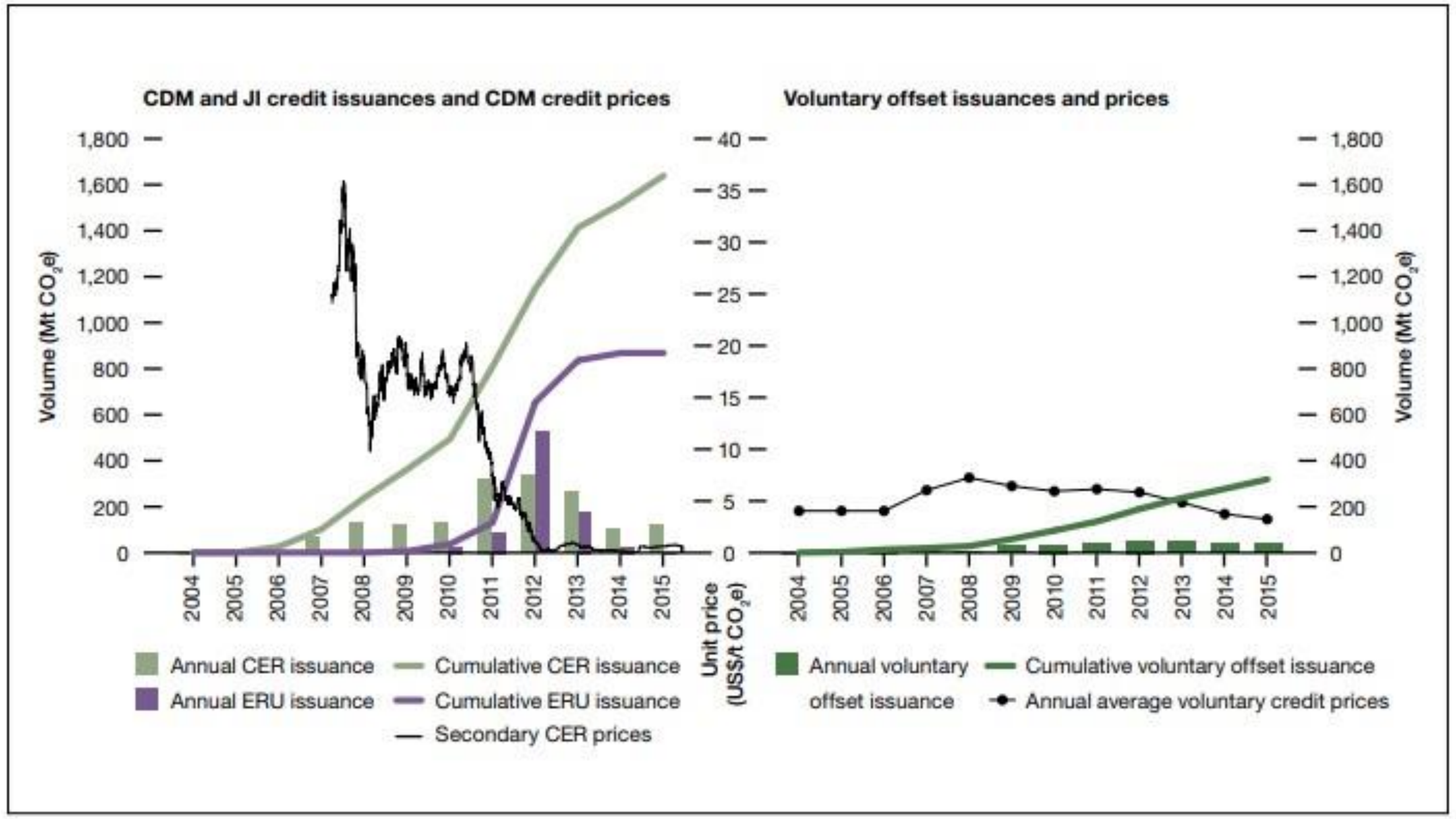
Management options for sequestering carbon

0 = nil; + = low; ++ = moderate; +++ = high; H = high; L = low; M = medium; SOC = soil organic carbon

Management	Option	SOC benefit[a]	Confidence[b]	Justification
Shifts within an existing cropping or mixed system	Maximising efficiencies •Water use •Nutrient use	0/+	L	Yield and efficiency increases do not necessarily translate to increased SOC return to soil
	Increased productivity •Irrigation •Fertilisation	0/+	L	Potential trade-off between increased SOC return to soil and increased organic matter decomposition rates Irrigation can increase the rate of soil carbonate precipitation, but, depending on the source of calcium and bicarbonate, the net reaction can be an atmospheric carbon sink, a carbon source or carbon neutrality
	Stubble management •Elimination of burning and grazing	+	M	Greater carbon return to soil should increase SOC stocks
	Tillage •Reduce tillage •Direct drilling	0 0/+	M M	Greater organic matter return to soil should increase SOC stocks Reduced till has shown little SOC benefit Direct drilling reduces erosion and destruction of soil structure, thus slowing decomposition rates; however, surface residues decompose with only minor contribution to SOC pool
	Rotation •Elimination of fallow with cover crop •Increased ratio of fallow to crops •Pasture cropping	+ +/++ ++	M H M	Losses continue during fallow without any new SOC inputs; cover crops mitigate this Pastures generally return more SOC to soil than crops Pasture cropping increases SOC return with the benefits of perennial grasses, such as water use throughout the year and increased below-ground allocation, but studies are lacking
	Organic matter and other offsite additions	++/+++	H	Direct input of SOC (often in a more stable form) into soil; additional stimulation of plant productivity
Shifts within an existing pastoral system	Increased productivity •Irrigation •Fertilisation	0/+	L	Potential trade-off between increased SOC return to soil and increased organic matter decomposition rates Irrigation can increase the risk of soil carbonate precipitation, but, depending on the source of calcium and bicarbonate, the net reaction can be an atmospheric carbon sink, a carbon source or carbon neutrality
	Rotational Grazing	+	L	Increased productivity, including root turnover and incorporation of residues by trampling, but field experience is lacking
	Shift to perennial species	++	M	Plants can use water throughout the year; increased below-ground allocation, but few studies to date
Shift to a different system	Conventional to organic farming system	0/+/++	L	Likely highly variable, depending on the specifics of the organic system (e.g. manuring, cover crops)
	Cropping to pasture system	+/++	H	Annual production minus natural loss is now returned to soil; active management to replant native species often results in large carbon gains

Source: https://soe.environment.gov.au/theme/land/topic/soil-carbon-dynamics

CARBON PRICES

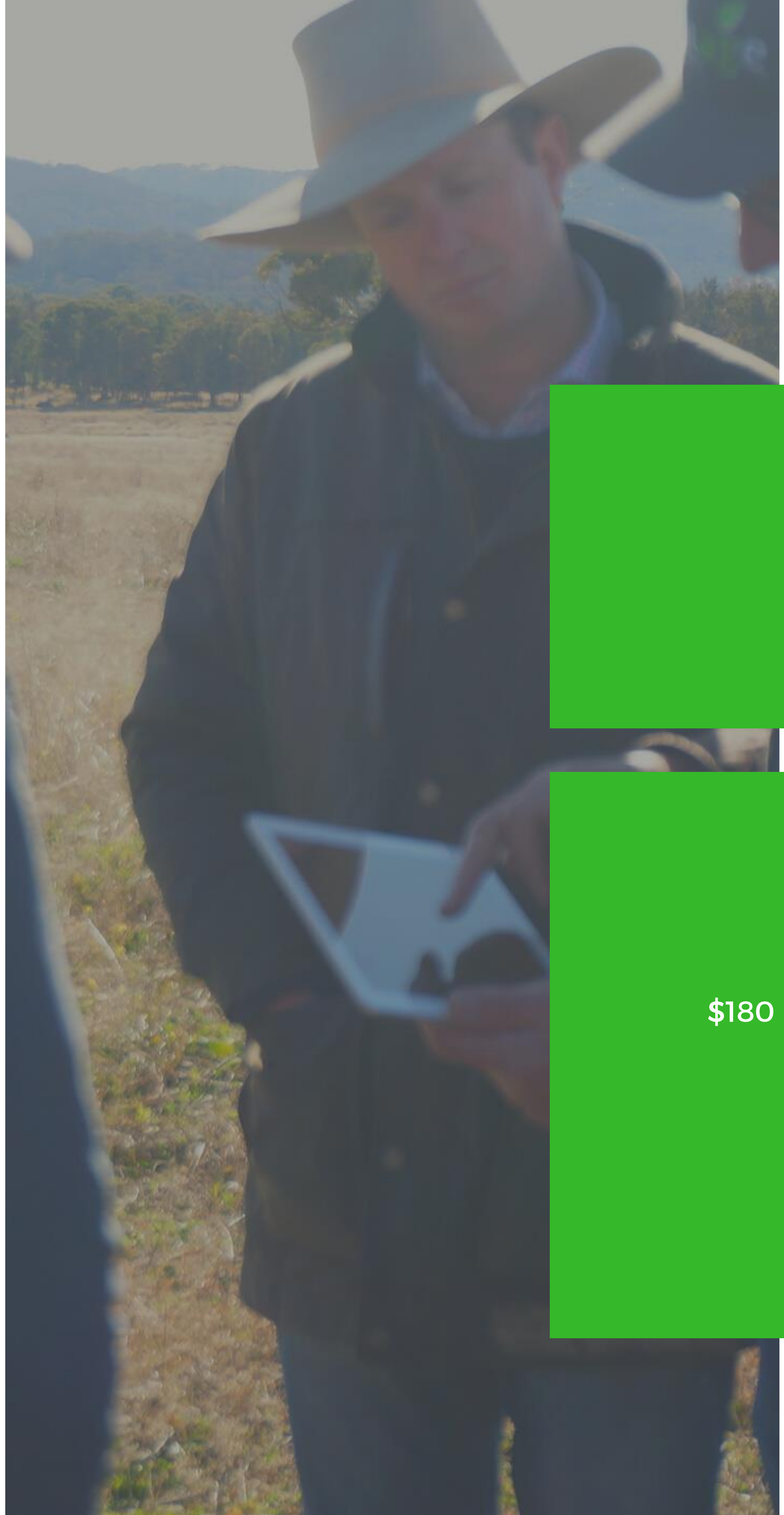


Global Carbon Market

Carbon credit prices are at an all time high, valued at $28USD each.

Despite this, Australian Carbon Credit Units are only being bought for $17AUD.

Opportunities exist to sell overseas in the EU and South Korea, where carbon prices are fetching in excess of $50USD each.



FarmLab

Mobile

$3 admin fee per soil sample processed

Web

$180 per year per farm, discounted to $120 per year for consultants and agronomists who on-sell a FarmLab subscription to a client.

$0.10 per hectare for remotely sensed data

(Optional) $2,000 per month software and GIS support

What is a Carbon Credit?

Australian Carbon Credit Units (ACCU) have been established under the Australian Energy Regulator. Each unit represents 1 ton of CO2 stored or avoided by a Carbon project and can be traded under specific conditions. The ACCU is a financial product which can be earned, sold or kept.

What is a Soil Carbon Project?

A soil carbon project stores carbon in agricultural soil to reduce the level of greenhouse gases in the atmosphere. You improve your soil carbon levels by undertaking new, eligible land management activities. Examples of such activities include improving fertiliser application or modifying grazing practices.

You'll need to measure your soil carbon levels before and after your new land management activities to calculate the changes. The results have to be reported to the Clean Energy Regulator at every five years. The Farmer can earn ACCU's for measured increases in soil carbon above previous levels.

What are the timelines of a project?

There are four steps in running a project:

- Plan your project, make sure the project is eligible, and ensure you hold legal right.
- Register your project with the Climate Solutions Fund.
- Run your project and deliver on project activities.
- Report on your project and claim carbon credits.

A project also is divided in different project periods:

The **Baseline period** covers 10 years before you apply to register your project and gives out the baseline of the carbon content of your soil before you undertake the project. You earn credits by increasing your carbon above that level.

The **Crediting period** is the period during which you can earn the credits by reporting on your project over 25 years.

Finally, the **Permanence period** which can be either 25 or 100 years during which carbon stored by the project must be maintained. This will decide about a percentage reduction in credits (see Carbon Credit discounts). A land management activity needs to be conducted over the Permanence period.

FAQ's

For further information on data used to outline this method, see Enclosure 1..
Source: https://looc-c.farm/methodDiscovery

What is a Land Management Strategy?

The LMS helps to align the land management activities to long-term farm objectives and needs to be included into the project application. For the LMS to be accepted it needs provide information about:

- The planned New land management activity or activities and outline that at least one of those will performed until the end of the permanence period.
- Inform about possible limitations to increase carbon and risks to maintain it such as drought prone land.
- Describe the monitoring and record keeping procedures
- Be signed by all landholders involved in the project
- Be reviewed by an independent person or body that declares that the activities are eligible, that they are different to previous practices and likely to improve carbon levels over time.

How is my project income being calculated and what do I have to know?

Carbon Credits earned over 25 years will vary based on the land conditions and types. ACCUS can be sold on government auctions, on the secondary market or to other parties. You can sell your credits once you have earned them or hold them to sell later. Before you start a project, Carbon storage estimates can be taken from model-based soil carbon methods. Those are illustrated examples only, but they help to scope your project. You will need to deduct increases in emissions above levels in pervious activities from fuel use, fertilizer or livestock numbers. Also, the calculation needs to imply the three Carbon credit discounts that apply to ensure that issued credits do not overestimate stored carbon.

- The permanence discount is based on the length of the permanence period and is either 5% (100 years period) or 25% (25-year period) and applies to all credits issued.
- The calculated change in soil carbon between your baseline and your first sample 50%. This is a temporary discount that accounts for the uncertainty of only having 2 sample rounds. It doesn’t apply when you use 3 sampling rounds before your first report, and you will earn back that discount when you prove the increase in soil carbon over your baseline.
- There is also a discount for reporting a high variable soil carbon amounts. The more consistent the increase the less discount will apply.

FAQ’s

For further information on data used to outline this method, see Enclosure 1..
Source: https://looc-c.farm/methodDiscovery

What costs are involved in a project?

Before you start a project, it is important to understand the running costs involved for operations, samplings, reporting and auditing the project.

- Operational costs will depend on the management activities, the size of the project area and can include fertilizer costs, fencing and extra time that is necessary for the reporting and record keeping.
- Sampling costs for the engagement of a soil technician and the laboratories for the soil analysis.
- Preparing the project reports
- Getting help through Project developers or Agronomists
- Engaging an auditor to prepare an audit report for at least three audit reports over a 25-year time period and the first audit report is due with the first project report.

What activities do I have to plan?

Planning your project:

- Hold legal rights
- Eligible interest-holder consent
- Regulatory approvals
- Activities need to be new (LMS)
- Fit and proper person assessment
- Eligible project areas
- Project return and costs (business model and estimation)

Registering your project

- Land Management Strategy
- Map the project boundaries
- Calculate a forward abatement estimate

Running the project

- Baseline sampling round
- Map your area and create sample plan
- Eligible Soil Carbon Land management activities

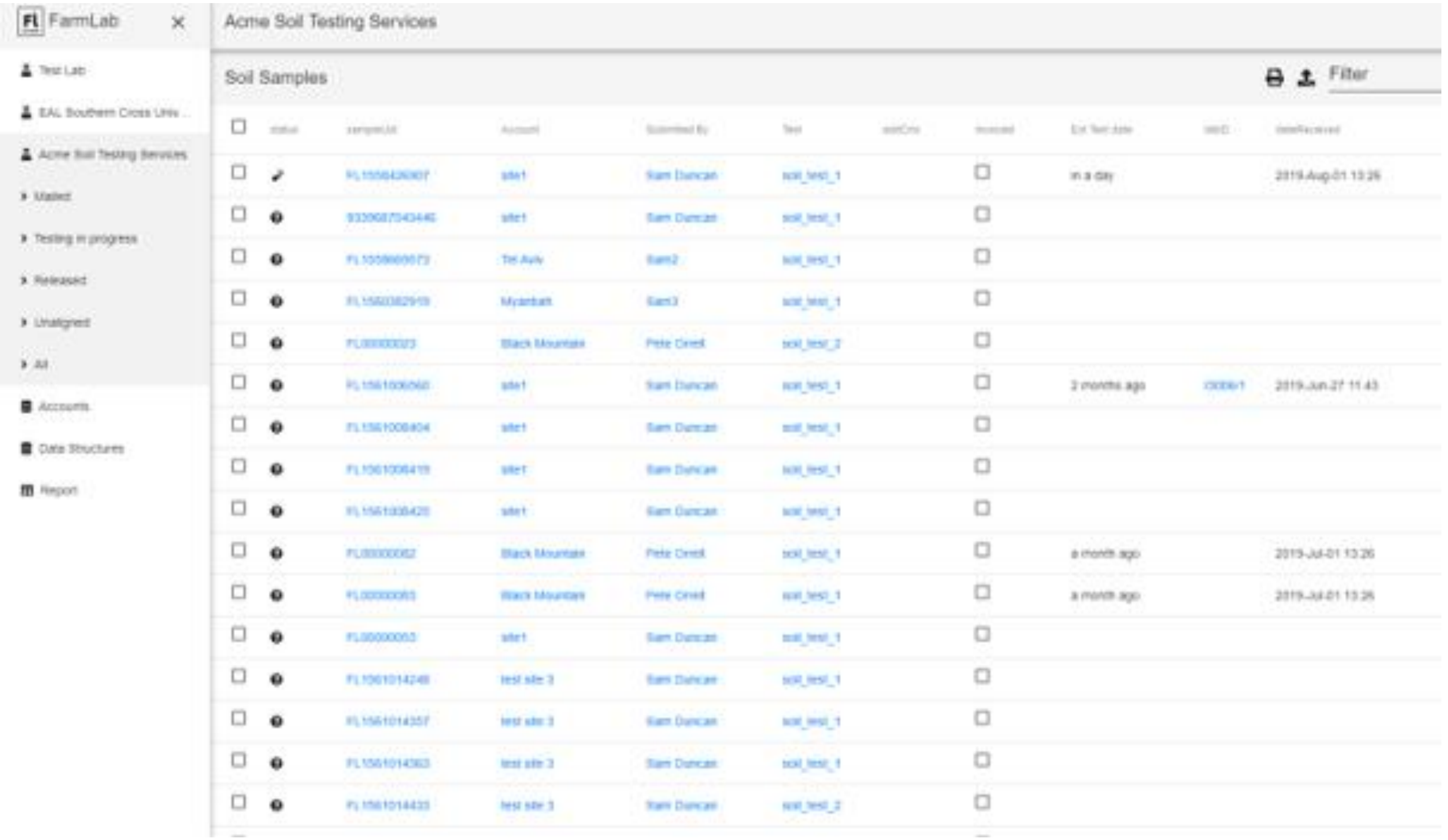
Reporting and crediting

- Earn credits measuring the soil
- Subsequent sampling rounds
- Calculate carbon abatement
- Audit your project
- Offset report and claim credits

FAQ's

For further information on data used to outline this method, see Enclosure 1..
Source: https://looc-c.farm/methodDiscovery

Streamlined sample processing



The majority of soil tests in Australia are undertaken using wet-lab testing, so to completely integrate the testing process for our users we developed a proprietary lab portal that soil testing labs can interact with.

Labs can view all their incoming samples, notify users when they've been received, and send results straight back to FarmLab.

We've currently partnered with Environmental Analysis Laboratory at Southern Cross University, as well as Australia's largest independent soil testing lab Apal, and Agvita (for our horticultural users) to process our samples, We are continuing to work on further integrations.

With these labs, we cover approximately **20% of all soil tests across Australia.**

Get in touch.

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