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Viridis Ag's pathway to net zero agricultural emissions

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Viridis Ag (Viridis) is a broadacre row cropping business with a large-scale portfolio of diversified assets across eastern and western Australia.

Established in 2018, Viridis is committed to the implementation of farming practices which promote sustainable outcomes across financial, social and environmental objectives. As a portfolio company within Macquarie Agriculture Fund – Crop Australia 1 (MAFCA1), Viridis operates alongside cotton producer Cubbie Ag (Cubbie) and a diversified portfolio of horticulture assets.

In 2018, Australia's Clean Energy Finance Corporation (CEFC) invested in MAFCA1 to support the adoption of low-emissions farming practices across the Australian agriculture sector and accelerate the industry's transition to net zero emissions. The CEFC's investment in MAFCA1 was the catalyst for the formation of the Energy, Emissions and Efficiency Advisory Committee (3EAC), a committee established by and for Macquarie Agricultural Funds Management (MAFML) in collaboration with the CSIRO, to reduce the emissions intensity of MAFCA1's farming operations.

Since its establishment, Viridis has worked closely with the 3EAC to accelerate the adoption of low-emissions farming practices across its cropping portfolio. In this case study, Viridis shares key learnings from the early adoption of FarmPrint (a web-based farm emissions calculation tool) to baseline on-farm emissions, establish a net zero target and begin the implementation of new farm management practices to lower the emissions intensity of its operations.

The CEFC's investment has been the catalyst in supporting and facilitating Viridis' pursuit of these goals, particularly as it relates to targeting a reduction in carbon emissions alongside enhanced on-farm productivity and sharing its learnings to drive improvements across the wider agricultural industry.

Viridis Ag

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Importance of decarbonisation for agricultural production systems

Decarbonising agricultural production systems goes beyond just reducing emissions, it aims to foster a more sustainable, resilient and profitable farming system that can navigate future uncertainties and challenges. By implementing decarbonisation practices, Viridis is seeking to enhance the long-term viability and sustainability of its operations whilst contributing to Australia's broader environmental and societal goals.

It is important to acknowledge that although the agriculture industry faces unique decarbonisation challenges associated with crop and animal production, it plays a key role in Australia's decarbonisation journey and is a core contributor to the country's GDP. Therefore, it is critical for industry stakeholders to come together to overcome various technological, financial and governance-related decarbonisation challenges and invest in solutions that help producers decrease emissions whilst maintaining or enhancing farming productivity and profitability.

In line with Macquarie Asset Management's (MAM) net zero commitment for its portfolio,[1] decarbonisation is a critical part of Viridis' strategy to mitigate the risks of climate change and enhance long-term business value. Lowering the emissions intensity of farming systems can provide a range of financial and productivity benefits for producers including Viridis, such as:

1. **Increased productivity and optimised input use efficiency**

Through adopting precision agriculture techniques, Viridis has optimised the use of essential production inputs such as fertiliser, chemicals and fuel. This ensures inputs are only applied where needed, enhancing productivity and lowering both the cost of production and emissions intensity of each unit of production.

2. **Climate resilience**

Implementing low-emissions practices, such as no-till farming and investing in on-site renewable energy sources has helped Viridis build a farming system that is more resilient to variations in climate, including extreme weather events and seasonal variability. This resilience helps support more consistent productivity and the long-term viability of Viridis' operations.

3. **Market opportunities**

As societal preferences increasingly shift towards sustainable products, there is growing demand from supply chain participants for agricultural goods produced with measured and/or low emissions. By regularly measuring emissions, benchmarking and implementing decarbonisation initiatives on-farm, Viridis aims to capture new market opportunities such as price premiums, data-sharing agreements and new market access.

4. **Regulatory compliance**

With evolving regulatory requirements and the introduction of mandatory climate reporting in Australia, embedding strategies to measure emissions and adopt low-emissions practices helps Viridis to readily manage regulatory changes.

1 MAM has made the following commitments: 1. where we have control or significant influence, we will invest and manage our portfolio in line with net zero Scope 1 and 2 financed emissions by 2040, subject to limited exclusions; 2. where we do not have control or significant influence, we will continue to support the goals of the Paris Agreement in a manner consistent with our client-guided fiduciary duties and regulatory responsibilities. Accordingly, where we do not have control or significant influence, we will invest and manage our portfolio in line with net zero financed emissions by 2050. For further information, please refer to **'Our approach to net zero'**.

Getting started: establishing a baseline

Establishing an emissions baseline is a critical first step for any agricultural producer embarking on its decarbonisation journey, as it provides an objective measure of a farm's 'average' emissions, acting as a credible reference point to track progress against emissions targets.

Accurate baselining also identifies the key emissions sources for farmers, enabling them to prioritise the areas which will have the greatest decarbonisation impact.

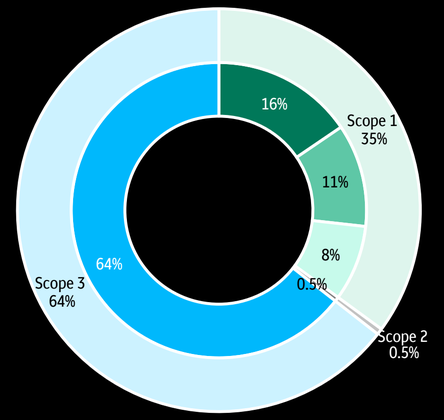
Having measured individual farm emissions since 2018, Viridis established its emissions baseline in 2021. This process was achieved with FarmPrint, an emissions calculation tool developed and piloted as part of a collaboration between the CEFC, CSIRO and MAM from 2018 onwards.[2]

Designed specifically for Australian broadacre row crop farming, FarmPrint uses a range of input and activity data, coupled with emissions factors, to generate an estimation of the carbon dioxide equivalent emissions of a farming enterprise. FarmPrint was designed to make baselining easy, reducing manual entry requirements through its Application Programming Interface (API) connections which has the ability to evaluate a portfolio of farms.[3] It has now been developed by CSIRO as a tool that can be used by farm managers, service providers and the broader agriculture sector to support the evaluation, benchmarking and reporting of greenhouse gas emissions.[4]

In establishing Viridis' baseline, historical production practices and activities were analysed to establish reasonable parameters of an 'average' production year, by balancing various factors including crop selection and seasonal variation. Based on this analysis, Viridis made the decision to use its 2021 actual emissions as its baseline, as the 2021 season was a good representation of Viridis' average crop rotation and seasonal conditions.

A screening of Viridis' total 2021 emissions data shows that the primary sources of emissions are attributable to emissions embedded in purchased goods and services, such as fertiliser and diesel (see Figure 1), also known as Scope 3 emissions that occur during the manufacture of these production inputs in the supply chain. Scope 1 and 2 emissions directly arising from Viridis' on-farm management practices include emissions linked to the application of fertiliser and lime as well as diesel usage and the decomposition of crop residuals post-harvest. Whilst there were variations in emissions between individual farms based on rainfall, soil type and crop selection, the relative contribution of each of these emissions sources to overall emissions was similar across all farms and align with broader row crop industry trends.

Figure 1: Viridis baseline emissions – Gross Scopes 1-3 (2021)



Gross emissions by source (inner circle)

- Scope 1: Fertiliser and lime application
- Scope 1: Fossil fuels (diesel)
- Scope 2: Electricity
- Scope 1: Crop residuals
- Scope 3: Purchased good and services

2 As part of the CEFC's investment in MAFCA1, the CEFC, MAFCA1 and CSIRO created the Energy, Emissions and Efficiency Advisory Committee (3EAC) to promote the early adoption of new technologies to identify potentially viable decarbonisation opportunities and to increase the uptake of climate solutions by Australian agriculture.

3 FarmPrint methodology and data is accessed via an Application Programming Interface (API) allowing for a theoretically unlimited number of tools to leverage the same central method and databases, thus increasing consistency and reducing administrative burden for users.

4 For further information, visit: https://www.csiro.au/en/research/environmental-impacts/sustainability/farmprint.

Developing an emissions reduction target

Using the insights gained from FarmPrint, Viridis established an emissions reduction target to reach net zero Scope 1 and 2 emissions by 2040 through continuous improvements and reductions in its emissions intensity.[5] The target was informed by the Science Based Targets Initiative (SBTi) Forest, Land and Agriculture (FLAG) framework with the aim of following a science-based approach.[6] Viridis will continue to screen its Scope 3 emissions annually, however has focused on prioritising Scope 1 and 2 emissions to concentrate its emissions reduction efforts on areas where it has the greatest direct control and influence.

In addition, to improve the comparability of results and reduce volatility driven by seasonal conditions, Viridis adopts an emissions intensity-based approach to measuring its emissions footprint – i.e. tonnes of carbon dioxide equivalent per tonne of grain produced. Due to the cyclical nature and inherent volatility of agricultural emissions, Viridis is focused on managing its portfolio in line with a long-term, 'through-the cycle' reduction in emissions intensity. This includes initiatives on both sides of the emissions intensity equation – that is, Viridis is executing on decarbonisation strategies to reduce total emissions, whilst maintaining a focus on its core business objective of uplifting farm productivity.

5 See Footnote 1.
6 SBTi is a corporate climate action organisation that develops standards, tools and guidance which allows companies in different sectors to set GHG emissions reduction initiatives in line with what is needed to keep global heating below catastrophic levels and reach net-zero by 2050 at latest. For further information, visit: https://sciencebasedtargets.org/.

Implementing decarbonisation strategies

Viridis' emissions reduction strategy is designed to target the three primary emissions sources identified in its baselining project – namely, fertiliser and chemicals, fossil fuels (diesel) and crop residuals.

This strategy can be broken down into three major pillars:

1. Executing on commercially viable opportunities

For Viridis, this strategic pillar is focused on the implementation of precision farming techniques and other existing commercially viable practices to optimise productivity, soil health and input use efficiency across the entire business. Executing on commercially viable technologies is critical to Viridis' decarbonisation strategy as it allows for a near-term reduction in emissions. These technologies are generally scalable and cost-effective, allowing for a relatively fast and effective roll-out across the portfolio. Initiatives include the use of control traffic farming, variable rate technology, spray sensing camera technology, soil microbial inoculants, high-efficiency fertiliser application and the transition to green power purchasing agreements.

2. Trialling new and emerging technologies

Viridis regularly seeks opportunities to leverage its scale and farm support model to trial new and emerging technologies that address one or more of the key emissions sources of the business. Further detail on a number of Viridis' technology trials is provided on page 8.

3. Maximising carbon capture and storage across natural landscapes

The third pillar of Viridis' decarbonisation plan is leveraging its natural landscapes to maximise on-farm carbon capture and storage. This includes utilising unproductive and/or non-arable areas for environmental tree planting projects. Viridis aims to plant ~1.5-2.5 million trees over the five years to 2030, having already successfully planted hundreds of thousands of trees across its assets. The additional carbon captured and stored within these plantings can be used as insets in future years to net-out hard-to-abate residual emissions from agricultural operations.

Performance against benchmark

Having established a baseline and developed an emissions reduction strategy, Viridis' focus is now on implementing its decarbonisation initiatives and tracking progress against its targets.

Using FarmPrint, Viridis can compare its annual absolute emissions and emissions intensity against a comparable regional benchmark as well as its own baseline. This is an important process to capture long-term improvements in emissions intensity and verify the effectiveness of its decarbonisation initiatives across the portfolio.

Since 2020, Viridis has demonstrated a cumulative 12 per cent reduction in emissions intensity relative to the FarmPrint benchmark (Table 1). Importantly, Viridis has seen a decreasing trend in its emissions intensity since inception, driven by upfront soil improvement capital expenditure and the implementation of precision agriculture, which together have resulted in a more productive and efficient farming system. This emissions data indicates that Viridis' low-emissions farming system in combination with decarbonisation initiatives are yielding positive early results.

Table 1: Viridis cumulative gross Scope 1 and 2 emissions vs FarmPrint benchmark (2020-2024)[7,8]

Metric	*Units*	Eastern Properties (NSW)		Western Properties (WA, SA)		Viridis Total		
		Viridis	FarmPrint Benchmark	Viridis	FarmPrint Benchmark	Viridis	FarmPrint Benchmark	Variance
Total Gross Scope 1 and 2 Emissions (2020-2024)	*tCO_2e*	40,499	29,977	110,440	99,364	150,939	129,341	
Total Crop Produced (2020-24)	*t*	399,611	250,608	753,125	620,117	1,152,735	870,725	
Emissions Intensity	*$kgCO_2e/t$*	**101**	**120**	**147**	**160**	**131**	**149**	**(12%)**

Importantly, Viridis has also realised additional productivity improvements associated with its emissions reduction initiatives, including improvements in soil health and water use efficiency. This indicates that emissions reduction and increasing productivity can go hand-in-hand, with many decarbonisation initiatives also providing complimentary productivity benefits.

For example, since 2018, the business has experienced a year-on-year reduction in soil acidity (increase in pH) from applying higher-quality, lower-emissions lime products to treat acidity (Table 2). This unlocks essential soil nutrients for crop production, reduces toxic elements and boosts microbial activity, contributing to increased productivity.

Table 2: Viridis soil pH (2018-2024)

Metric	Units	2018	2019	2020	2021	2022	2023	2024
Soil pH	pH (weighted avg)	4.71	5.03	5.34	5.60	5.71	5.73	5.75

7 Viridis' historic emissions have undergone an independent limited assurance audit. FarmPrint benchmark emissions have not been independently audited.
8 2018-2019 excluded as Viridis' portfolio was in the early build-out phase.

Technology trials

Continued evolution, improvement and integration of precision technology provides opportunities for Viridis to further optimise its use and drive enhanced productivity outcomes. Likewise, the emergence of alternative or modified inputs presents novel ways of reducing emissions whilst maintaining productivity. By leveraging its extensive and diverse portfolio, Viridis is able to trial new practices and partner with innovative companies to test and commercialise select emerging technologies, with the aim of making them accessible to farmers of all scales. Some recent examples of this across Viridis' portfolio include:

Auto-turn functionality for farm machinery during seeding and harvest:
This capability removes the requirement for the operator to manually take control of the machine at end-of-run turns and optimises the engine and speed settings, delivering fuel savings. Following a trial period on select operations which indicated a material reduction in fuel usage and improvement in safety, Viridis plans to roll out this functionality across its portfolio.

Autonomous machinery:
Viridis is currently trialling smaller, more efficient autonomous equipment across its properties. These self-driving, sensor-guided machines can be operated remotely via a smartphone or computer. Equipped with next-generation spot-spray technology, they can identify and spray individual weeds, significantly reducing chemical usage compared to traditional farming methods that blanket-spray entire paddocks. Viridis will continue to trial this equipment as part of its commitment to exploring innovative farming solutions.

Alternative soil ameliorants:
Application of lime is common practice across much of Viridis' portfolio and is a key source of emissions. Recent trials of an ultra-fine particle lime product, which aims to reduce the quantity of product required to achieve a targeted soil pH response, showed promising results. Soil pH targets were achieved, and trial results indicate that the product has the potential to reduce the quantum of lime used across the portfolio by up to 50 per cent due to the efficiency of the product.

Enhancing emissions calculators:
To recognise the emissions impacts of these alternative fertiliser and lime products, Viridis is working with CSIRO to integrate the emissions factors for these new products into FarmPrint. The ability to recognise these technologies and other interventions in emissions calculators is important as it helps incentivise producers by allowing their decarbonisation efforts to be recognised in their emissions monitoring.

Alternative fertilisers:
In 2024, Viridis undertook trials across its Australia portfolio to test a range of biological and higher efficiency fertilisers, which allows crops to access atmospheric nitrogen to support crop growth, potentially reducing the amount of synthetic nitrogen-based fertiliser applied to crops. Initial trial results indicate an increase in yields across most trial paddocks, complimenting traditional fertiliser programs. Trials are still underway to assess the impact across different seasons, crop types and soil types.

Coated fertilisers:
Several coated fertiliser products are now available on the market; these products are designed to coat conventional fertiliser to slow its breakdown in the soil and minimise nitrogen losses to the atmosphere. Following a successful trial in 2023, Viridis implemented a coated fertiliser product across the entire wheat and barley urea program at one of its aggregations (~5,000 hectares) in 2024, representing the property's full transition from conventional uncoated urea. Results from 2024 indicate a ~10 per cent reduction in urea usage (kg/ha) for the coated urea compared to conventional urea, with the farm team observing equivalent yields while using less product.

Variable input seeding:
In response to identified high-risk areas within paddocks, Viridis has trialed the use of variable seeding technology which allows variety and input changes (within a paddock/seeding run), with the objective of reducing any frost impact and improving yield and emissions intensity from these higher risk zones. Viridis will continue to test and analyse the results from these trials.

Emissions accounting and verification

To track progress against its emissions reduction target on an ongoing basis, Viridis has developed a set of integrated carbon emissions accounts alongside its financial accounts. Using FarmPrint, Viridis measures emissions for each of its farms monthly, allowing for regular monitoring and management of its emissions footprint.

Viridis is also working with its audit partners to develop a framework for certified emissions accounting specific to broadacre cropping enterprises. A key benefit of having a robust emissions accounting framework is the potential to generate a financial return by demonstrating the effectiveness of the business's decarbonisation initiatives to downstream customers. Viridis is in the process of investigating such opportunities in consultation with its supply chain partners.

The path to net zero

Through Viridis, MAFCA1 has demonstrated the nexus between agricultural productivity and emissions reduction.

The adoption of precision technology has been effective for Viridis in reducing the emissions intensity of its row cropping operations to date. As the effects of changing weather patterns become more intense, new farming techniques can make a material difference to on-farm productivity and sustainability, as well as emissions reduction. Importantly, by accurately measuring and reporting on the impact of these changes, agriculture can provide transparent stakeholder reporting, which is fundamental to attracting industry investment.

Looking forward, the continued optimisation of technology and adoption of new and alternative practices present opportunities to unlock barriers and further reduce the emissions intensity of Viridis' farming operations.

The road to net zero is a long-term, iterative process. Like many Australian broadacre crop producers, Viridis is committed to continuous improvement and supports the sharing of successful decarbonisation strategies to facilitate awareness and accelerate the adoption of proven solutions across the broader agriculture industry.

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