A PRECISION AGRICULTURE JOURNEY TO AMELIORATE SOIL CONSTRAINTS, INCREASE PRODUCTIVITY AND PROTECT SWAMPS IN HIGH RAINFALL ZONE (HRZ) FARMING SYSTEMS

Introduction

Glenelg Hopkins CMA's 'Our Catchment, Our Communities' focus region is a productive high rainfall region in a landscape of wetlands, many of which are not permanently wet.

Due to the seasonal variability of these wetlands, in dry years these wetlands are trafficable and have therefore historically been considered part of the arable area.

This project aims to encourage cropping farmers to use precision agriculture strategies to improve their productivity whilst managing their wetlands.

Focus Farm: Menenia

George is managing about 1500Ha between Mininera and Westmere and has a mix of sheep and cropping enterprises, that is split nearly 50:50. The cropping enterprise includes a canola, wheat, barley and faba bean rotation. There are 8-10 wetlands across the 1500ha totalling to about 270ha, the largest being approximately 120ha. While George is not currently using precision ag strategies, the recent purchase of a spreader that has variable rate capability means that he is ready to take the next step to incorporating precision ag.
"We are interested in resource use efficiency and wish to farm in an environmentally sustainable manner. We believe that VR technology has the potential to allow us to reduce our enterprise's CO2-e emissions, whilst also improving our financial performance." – George Coutts

The property has a long history of being continually cropped, however it has only been under the management of George Coutts since 2018. The paddocks were sown to beans and wheat in 2023, with identified wetland areas already removed from the current cropping system. Some of these wetland areas were cropped under previous management.

Figure 1: Identified project paddocks in Mininera

Due to this being a block under new management with a relatively unknown history, the recommendation to introduce precision agriculture strategies started with understanding surface soil variability and constraints through a grid sampling programme after the 2023 crop was harvested.

Wetlands

The Glenelg Hopkins Catchment Management Authority (GHCMA) and the Beyond Bolac Catchment Action Group (BBCAG) work with local landholders and groups who use land and water resources in the south-west of Victoria. Their aim is to support activities and programs to improve landscape health that deliver a range of social, economic and environmental outcomes for the region.

The south west region of Victoria contains more than 5,400 wetlands covering approximately 73,000ha, which is representative of nearly 44% of Victoria's total wetlands.

Figure 2: Wetlands GIS layer identifying numerous Temporary Freshwater marshes and meadows in the Mininera region, including the identified project paddocks outlined in red. Each identified wetland has a unique colour identification.

In both the East Grampians and West Wimmera regions, the likelihood that a wetland will be cropped is related to:

- surrounding land use - wetlands adjacent to crop land are highly likely to be cropped
- wetland size and depth - shallow wetlands up to approximately 8 ha are more vulnerable than are larger wetlands
- wetland water regime - permanent wetlands are less likely to be fully cropped than temporary ones
- water quality - saline wetlands are not much cropped, brackish and freshwater more so
- presence of trees and shrubs across the wetland - wetlands dominated by non-woody vegetation are more likely to be cropped than those dominated by woody vegetation

In the case of the wetlands present in Menenia, four of the wetlands have permanent or semi-permanent water as well as rocky areas, hence these areas are not being cropped. In Paddock 35, there is one previously cropped wetland region in the north eastern corner of the paddock. While is it not cropped under the current management system, there are significant weed burdens that may be of concern in coming years as the wetlands recover to its former state. There is also an area of a seasonal wetland in paddock 34 that is currently being cropped, which we aimed to better understand as a part of the grid sampling process.

Method

Precision Ag's research has shown that grid soil sampling is the best approach to the targeted amelioration of surface soil properties as the different surface soil characteristics rarely correlate with each other or yield and NDVI based management zones.

Compiled farm and paddock spatial data, including wetland layers were utilised to devise a soil sampling plan using a 2-hectare size grid sampling strategy. For each grid, 8 soil cores were collected along a 120m transect to a depth of 10cm, with the cores combined into a composite soil sample for each grid. Each soil sample was submitted to an independent NADA-accredited soil laboratory for soil analysis. Each soil sample was analysed for Phosphorus (Colwell), Exchangeable Cations (Ca, K, Mg, Na, CEC) & pH (1:5 CaCl2). Phosphorus Buffer Index (PBI) is also tested at strategic sites.

Once laboratory analysis was completed, the soil data was processed and contoured using Precision Ag's Soli software. Following on from consultations with the George and their agronomists, key soil constraints were identified and amelioration strategies developed. On-farm prescription files were created which excluded wetland areas from cropping inputs.

Figure 3: Sampling plans for paddocks M7&8 (Left) and M34&35 (Right) with each point representative of a 2 hectare region. The sampling plan has been designed collect samples in the currently cropped regions.

Soil Test Results and Variable Rate Applications

Grid soil sampling was used to identify the variability in soil properties which can be a response to both fixed (e.g. soil type, geological features) as well as long term management and production. The soil results on Menenia showed significant variability across the various analytes tested, with soil pH identified as the first constraint for variable rate amelioration.

Soil acidity is a significant constraint to agricultural production across Australia and is a naturally occurring phenomena in productive agricultural systems. Soil pH directly affects the concentration of major nutrients and the forms of microelements available for plant uptake and can result in deficiencies or toxicities.

Amelioration of soil acidity, an increase soil pH, is achieved through the application of agricultural lime, with pH mapping allowing the quantity applied to be varied across the paddock based on the requirements.

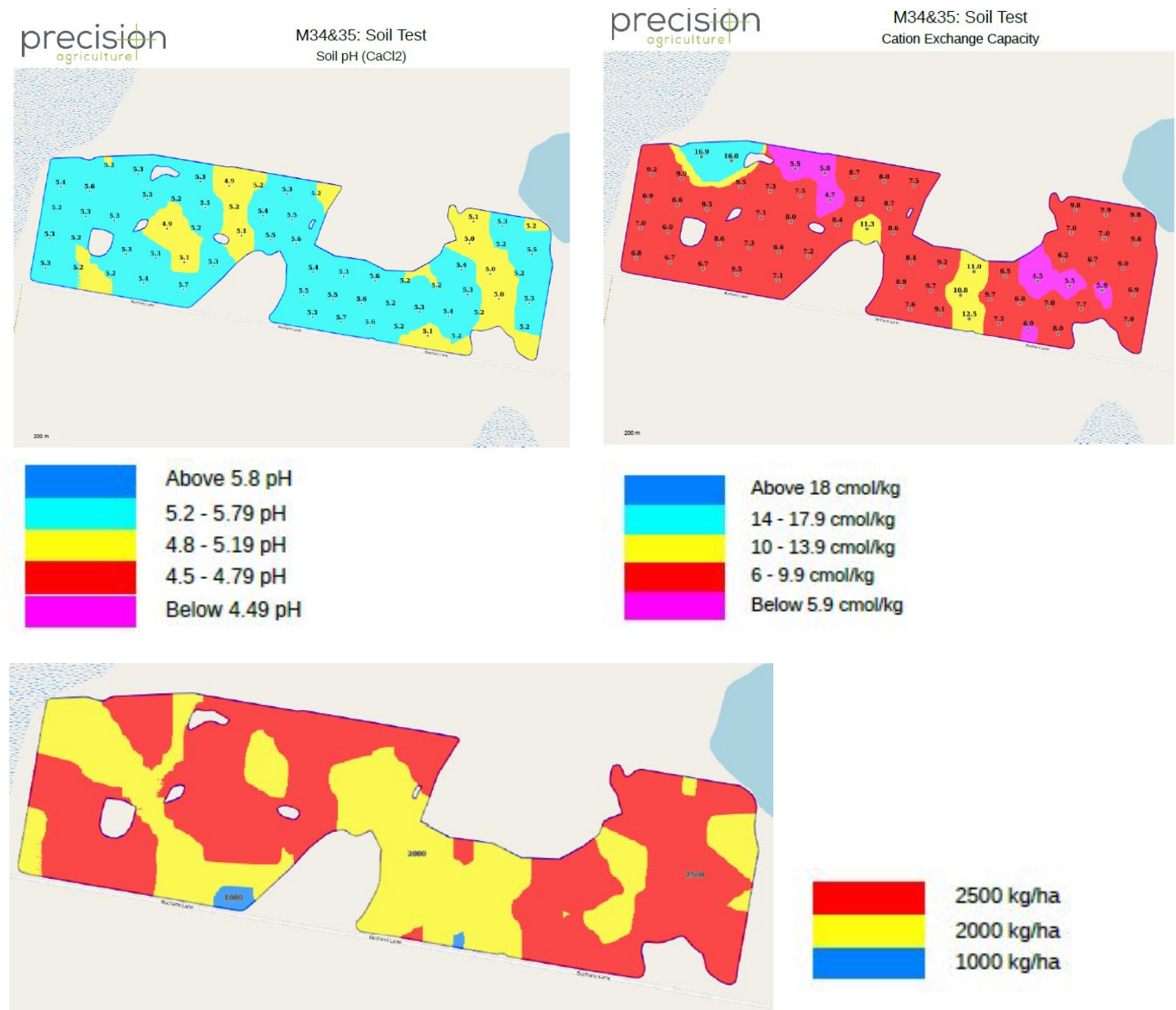


Figure 4: paddock M34 &35 Soil pH (CaCl2) grid results; Cation Exchange Capacity (CEC); resulting variable rate lime application map

The average soil pH for M7&8 was 5.5, while the average pH for M34&35 was lower at 5.3. However, the data shows that over 10% of the paddock in M7&8 is underperforming with its pH between 4.8-5.2, while M34&35 has nearly a quarter of the paddock that fits in this more acidic range which is likely to affect production. While, the average pH was close to the targeted pH of 5.5, variable rate application of lime was used to ameliorate the more acidic areas.

In addition to areas of acidity, the results highlighted an area on the north-western side of Paddock 34 that stands out from the rest and is a part of the seasonal herbaceous wetland. First, the cation exchange capacity map (Figure 4b) shows a higher CEC in the region, suggesting a different soil type.

This same region was not harvested in 2023 (Figure 5) due to rain events during harvest and poor trafficability, and also had elevated phosphorus levels which suggest that it consistently underperforms with low production.

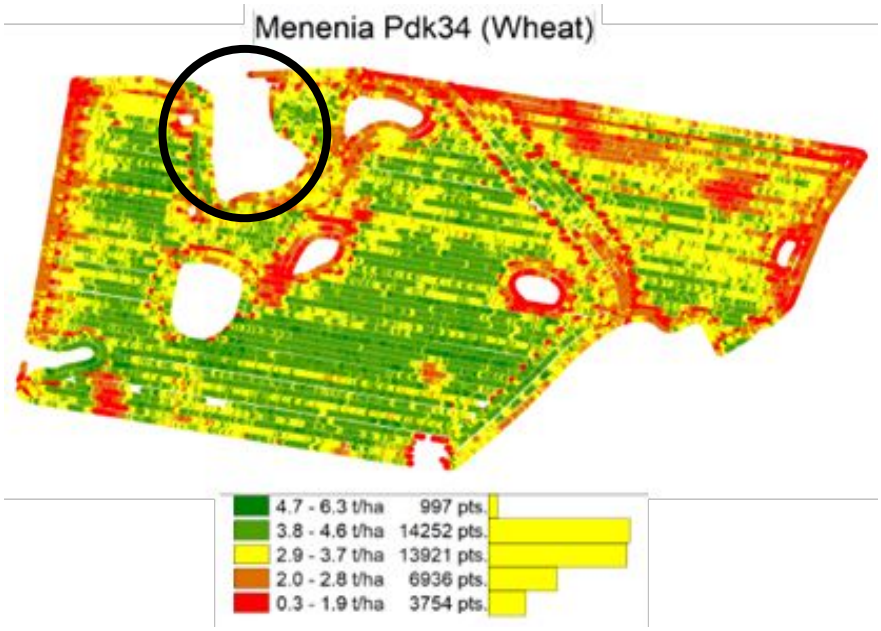


Figure 5: 2023 yield data for paddock 34 that shows that despite being sown, the region circled was unable to be harvested due to wet conditions.

Next Steps

Grid soil mapping and variable rate lime applications intend to increase the average pH and also reduce the variation in pH within the paddocks. However, the underlying drivers in variability including soil types, production, topography, water movement etc are still at play. Therefore, the utilisation of grid soil mapping and variable rate lime applications are not a 'one and done' venture, but should be considered an ongoing 3-5 year strategy to manage the variability in soil constraints such as soil acidity.

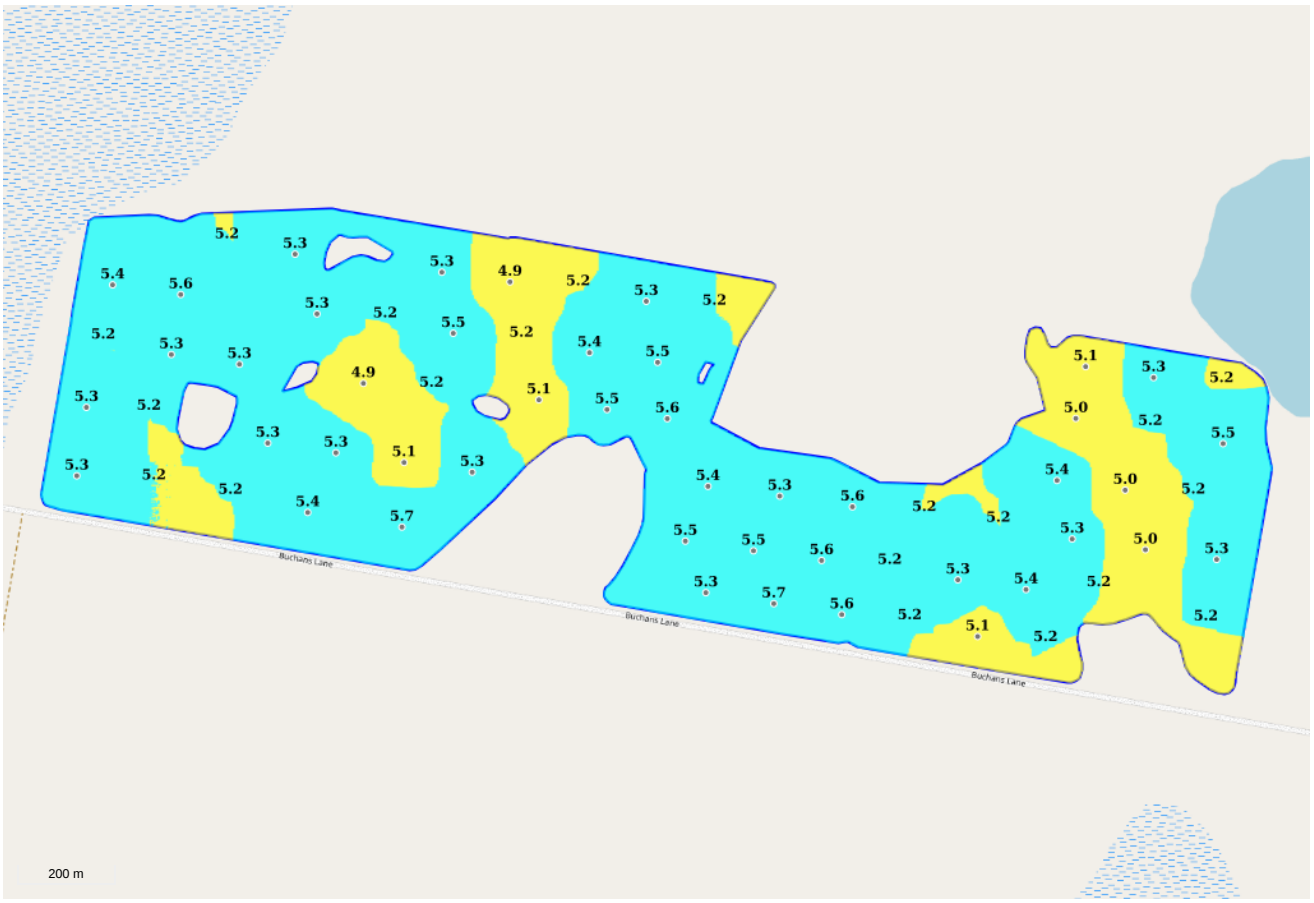
Beyond the use of soil pH maps, there are opportunities for George to use other data layers already obtained such as the Colwell P grid soil data, to create a variable rate P strategy at seeding.

The focus for Menenia in the coming season is to work towards strategic nutrient placement, which will work two-fold in addressing nutrient shortfalls across the paddocks, but also work to preserve the existing identified wetlands.

precision agriculture

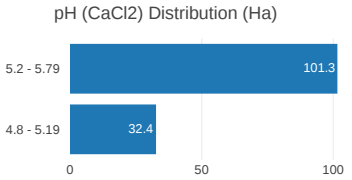
M34&35: Soil Test

Soil pH (CaCl2)



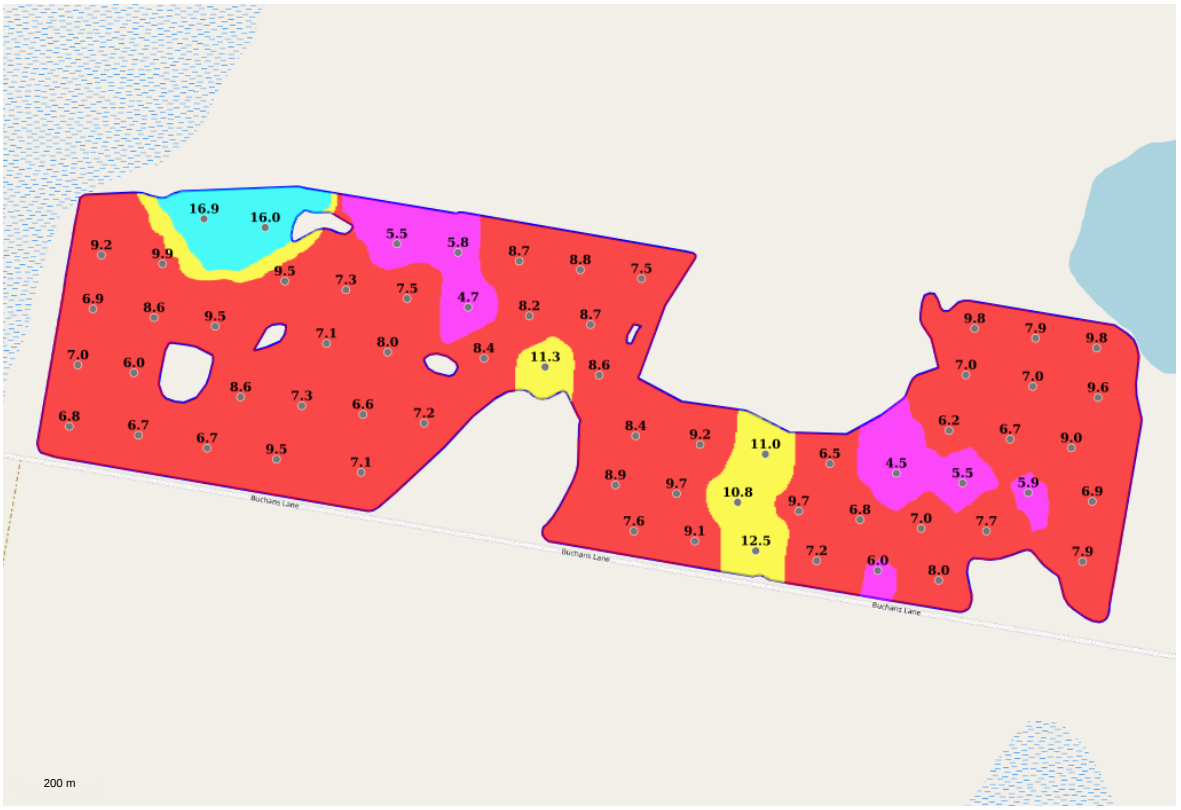
Client:	Menenia Pty Ltd
Farm:	Family Farm
Paddock:	M34&35
Name:	M34&35
Type:	Soil Test
Date:	18/01/2024
Min:	4.9 pH
Max:	5.7 pH
Avg:	5.3 pH

- Above 5.8 pH
- 5.2 - 5.79 pH
- 4.8 - 5.19 pH
- 4.5 - 4.79 pH
- Below 4.49 pH



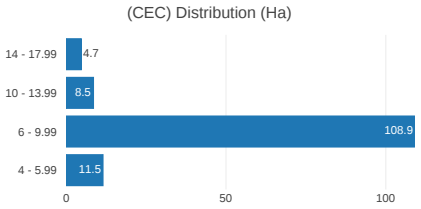
M34&35: Soil Test

Cation Exchange Capacity

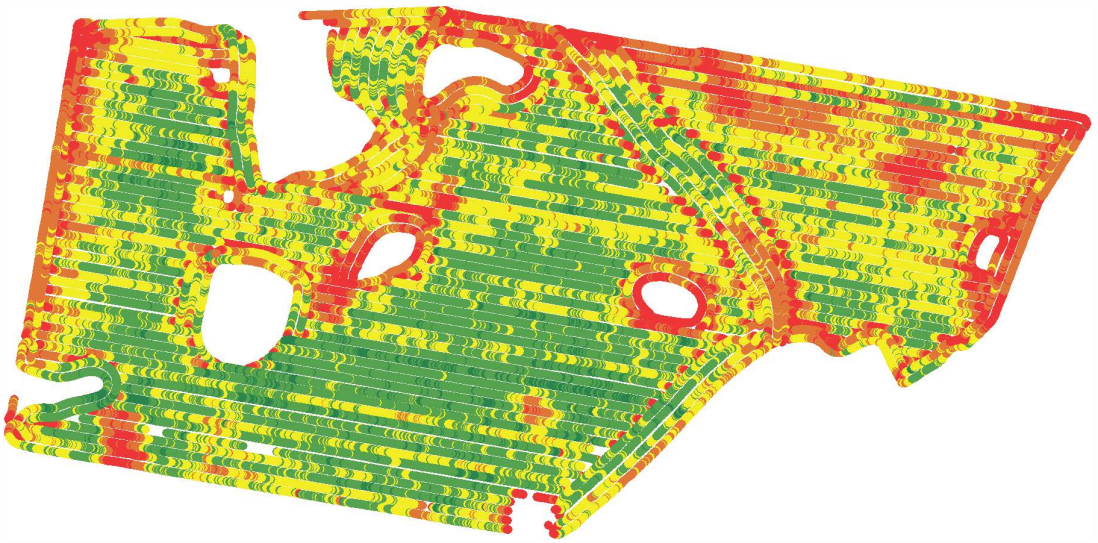


Client: Menenia Pty Ltd
Farm: Family Farm
Paddock: M34&35
Name: M34&35
Type: Soil Test
Date: 18/01/2024
Min: 4.5 cmol/kg
Max: 16.9 cmol/kg
Avg: 8.2 cmol/kg

- Above 18 cmol/kg
- 14 - 17.9 cmol/kg
- 10 - 13.9 cmol/kg
- 6 - 9.9 cmol/kg
- Below 5.9 cmol/kg



2023 Yield Data Menenia Paddock 34 (Wheat)

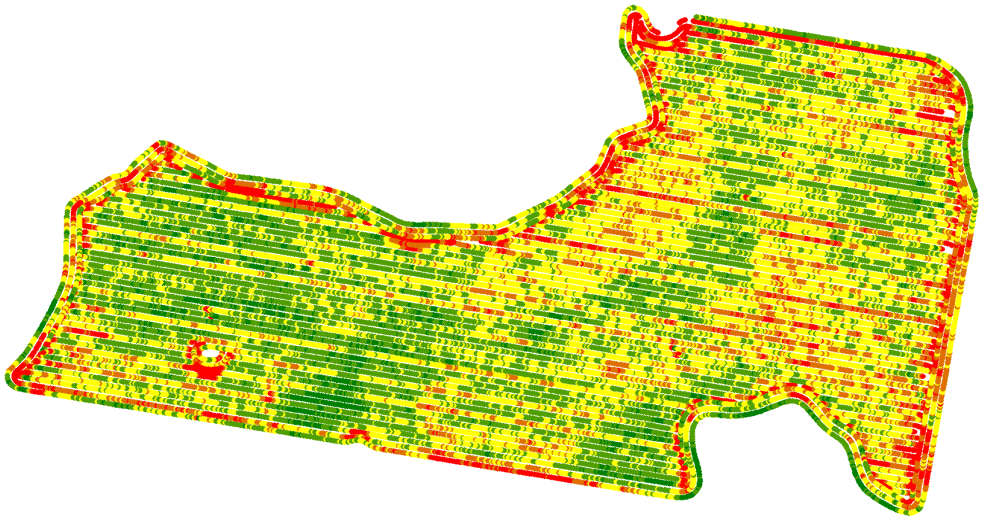


0 350 700
meters

4.7 - 6.3 t/ha	997 pts.	
3.8 - 4.6 t/ha	14252 pts.	
2.9 - 3.7 t/ha	13921 pts.	
2.0 - 2.8 t/ha	6936 pts.	
0.3 - 1.9 t/ha	3754 pts.	

Trimble

2023 Yield Data Menenia Paddock 35 (Beans)



0 350 700

meters

3.8 - 7.2 t/ha	1234 pts.	
3.2 - 3.7 t/ha	9958 pts.	
2.6 - 3.1 t/ha	11736 pts.	
2.1 - 2.5 t/ha	3628 pts.	
0.3 - 2.0 t/ha	2081 pts.	

Trimble