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# Augmenta N-VRA Trial in Australia:

## An Outstanding Success

### Summary

- The Augmenta System is a valuable tool for farmers looking to optimize inputs to reduce waste and promote sustainability, while increasing yield and profitability.
- To evaluate possible benefits to farmers, a side-by-side comparison between Augmenta N-VRA and Fixed Rate operations on winter wheat and canola fields in Australia was undertaken during the 2020/21 growing season.
- The average fertilizer savings achieved were 6.2% and 7.8% for canola and winter wheat respectively.
- The average yield increase for both crops was exceptionally good at 11.2%.
- The Augmenta System performed well with its AUG-Index providing accurate field readings.
- The data collected during the trial was later used in a major N-VRA Augmenta System software update (Jan. 2021), as part of a continuous upgrading process.

### Introduction

Australia is a natural candidate for precision agriculture. It is an important global agricultural producer growing a wide diversity of crops under equally diverse conditions. To make sense of all these variables, the collection and analysis of data should allow for better agricultural strategies to improve efficiency and counter the financial burdens that Australian farmers face.

When it comes to the Variable Rate Applications (VRA) of inputs such as Nitrogen (N), the only practical choices available to date have been map or sensor-based systems. A prescription map based on drone or satellite imagery can be used to control VRA, but the expense, logistics and time delays involved have proven to be deterrents. Sensor-based systems are generally preferred as they are easier to use and they apply inputs in real-time to better meet crop needs. However, they are expensive, need to be calibrated and are typically dedicated to only one type of operation. Moreover, their accuracy to understand all field (i.e. paddock) variables can be called into question. When a sensor-based system measuring chlorophyll reflectance does not get a good return, the assumption is that the crop is not doing well. Consequently, more fertilizer is applied. But what if it is a rocky or waterlogged area? Then the fertilizer is entirely wasted, and the point of precision agriculture is entirely defeated.

However, farmers in Australia, and indeed the world over, can obviously benefit from optimizing their input operations. Lower input costs alone justify the effort. But what if it also worked well at the other end of the scale? What if less input could also achieve better yield? This seemingly counter-intuitive feat is precisely what the Augmenta System is designed to do - and it does it particularly well when field conditions are diverse or even extreme.

## Our Aim

We set out to prove that the Augmenta System can work just as well in Australia as it does in the 16 countries around the world where it already operates (at the time of writing).

It is understandable that farmers may express uncertainty about the effectiveness of new tech in their regions. After all, local conditions can vary greatly with different geographies. However, the Augmenta System has proven itself to be robust wherever it operates. Our expectations were, therefore, that it would perform equally well and results would allay any doubts Australian farmers might have.

**Note:** The impact of Augmenta N-VRA operations on plant growth, development and yielding was evaluated in fields of different profiles. The scope of the commercial evaluation was to prove the consistent performance of the Augmenta System under different regimes. The extent of the effect these factors might have on plant growth, development and yielding was outside Augmenta's control and beyond the evaluation scope.

## The Field Trial

The field trial took place just outside the city of Ballarat, in the rural heartland of Western Victoria, during the 2020/21 growing season. It was conducted with the kind assistance of Augmenta's partner in Victoria, OzValueAg and local farmers.

After mounting the Augmenta System on the cabin roof of a standard tractor, an Augmenta Retrofit Kit was used to convert a non-actuated spreader so it could do VRA. The Augmenta System was used on 7 winter wheat and 5 canola fields. All operations were in-season.

To put the Augmenta System through its paces, some fields had vastly different profiles (i.e differing soil type, previous crop etc.) and crops growing at different stages of development. Other fields had more similar profiles and crops growing at a more uniform stage of development.

At the same time, Nitrogen Fixed Rate Application (N-FRA) was undertaken on 5 winter wheat and 13 canola fields (of vastly different and similar profiles and crop stages) so that a side-by-side comparison of performance could ultimately be made. For each field, the recommended dose of Urea (as suggested by a local agronomist) was used in both Augmenta N-VRA and N-FRA operations.

All operational data was uploaded in real-time to the cloud via the local 4G mobile network where it was automatically compiled and presented on the Augmenta Web Portal. At each stage, data was compared to state-of-the-art satellite imagery from the US Geological Survey and Sentinel-2 satellite to ensure stability and validity. After several months of data collection throughout the growing season, our Agronomist team was ready to make a final analysis and publish the results.

## Augmenta System Stability

Uniquely, the Augmenta System uses an array of multispectral cameras to analyse crop need/health and field conditions. This requires light, but sunlight intensity varies considerably throughout a typical day due to the changing position of the sun, cloud patterns, atmospheric conditions and so on. To compensate

for these changes, the Augmenta System has an autonomous self-calibrating light sensor and camera combination which tracks the position of the sun and allows the System to operate normally throughout the day.

To double check that the Augmenta System was giving true readings while in operation, all the data gathered was compared with satellite imagery from the US Geological Survey and Sentinel-2 satellite. Results confirm that the light-sensing feature performed as designed and that the camera array was providing an accurate representation (both qualitative & quantitative) of the farm, irrespective of changing ambient conditions.

As part of its AI self-learning capability, the light-sensing data obtained by the Augmenta System during the trial was also used to **upgrade the adopted agronomic algorithm**. This ensures optimal performance whenever it operates under similar ambient conditions.

## Augmenta System Performance

In fields of high variability (standard deviation >0.7) caused by arid/damaged spots and crops at different growth stages, significant savings were achieved. This is well demonstrated in Field C11a, where 14.4% fertiliser savings were achieved compared with Fixed Rate (see Table 1 and Fig. 4a/Fig 4b).

**Table 1.** Vegetation Index (AUG-Index) monitored during a session performed on the 9th of September in field C11a in Australia, 2020.

Field Name	Operation	Crop	Min(AUG)	Avg(AUG)	Max(AUG)	std_AUG	savings
C11a	N-VRA	wheat	0.22	0.51	0.59	0.07	14.4%

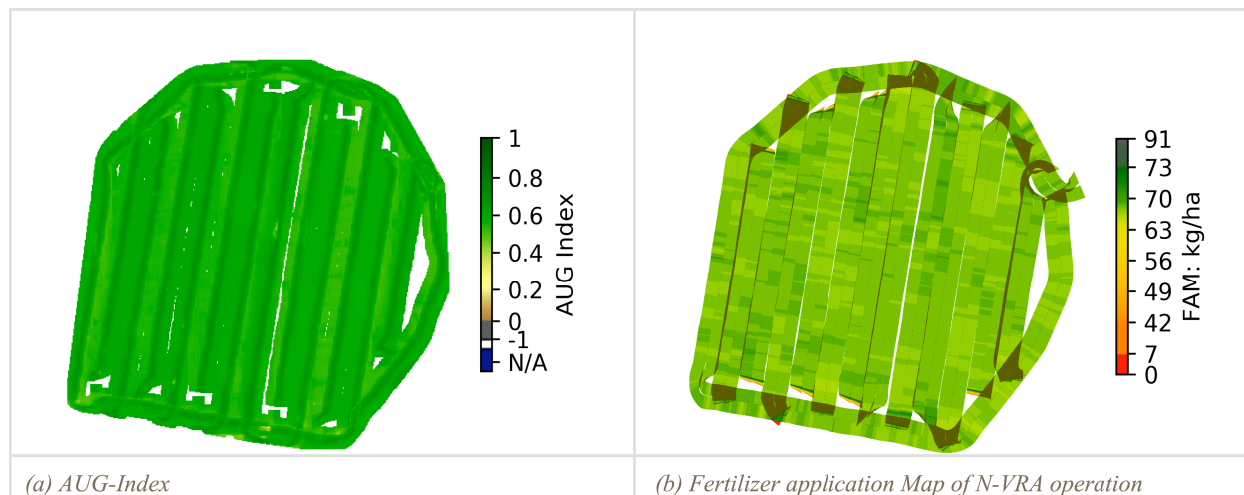
Even in fields where variability was negligible (standard deviation 0.1) and where the development of the plants was very uniform, the Augmenta System was still able to achieve fertilizer savings. For example, Field MFC15 demonstrates 2.1% fertiliser savings compared with Fixed Rate (see Table 2).

Field MFC15 bears further consideration. Vegetation Indexes typically have a hard time quantifying vegetation biomass and plant vigor during the late developmental stages of a crop. However, as shown in this field, Augmenta's own Vegetation Index (i.e. the AUG-Index) had no problem detecting even minor differentiations in the field (see Table 2).

**Table 2.** Vegetation Index (AUG-Index) monitored during a session performed on the 8th of September in field MFC15 in Australia, 2020.

Field Name	Operation	Crop	Min(AUG)	Avg(AUG)	Max(AUG)	std_AUG	savings
MFC15	N-VRA	Canola	0.53	0.56	0.58	0.01	2.1%

This means that Augmenta N-VRA operations carried out in very uniform fields were unimpeded (see Fig. 3), though fertiliser savings were reduced, as expected.



**Fig. 3.** (a) AUG-Index and (b) Fertilizer application Map of N-VRA operation carried out in field MFC15 on the 8th of September 2020, Australia.

All Augmenta N-VRA sessions are compared with Fixed Rate fertilizer consumption of the same recommended dose. Of course, when a Fixed Rate operation is undertaken, there can be no savings as it represents the baseline for comparison. However, it is possible to run a simulation to calculate virtual savings.

A summary of the results is presented in Table 3, including the actual and virtual savings of fertilizer (% and kg) per crop, and the respective acreage (ha).

**Table 3.** Summary of results comparing the performance of Augmenta VRA vs FRA of N fertilizer in selected sessions in Australia, 2020.

Crop	Fertilizer Application	Area Fertilized (ha)	Savings (kg)	Savings (%)	Virtual Savings (kg)	Virtual Savings (%)
Wheat	Variable Rate	184.5	2067.3	7.8	-	-
	Fixed Rate	145.3	-	-	2285.8	11.2
Canola	Variable Rate	153.7	1546.2	6.2	-	-
	Fixed Rate	6.4	-	-	NA*	NA*

\* Simulation models could not provide results due to the presence of untrusted data in the session

Yield maps and weight of harvested yield were utilized to evaluate the effect of Augmenta N-VRA on yield (Table 4).



**Table 4.** Data regarding the yield of wheat and canola with different treatments of Nitrogen fertilization (VRA and FRA), Australia 2020.

Crop	Fertilizer application	Fields	Area Fertilized (ha)	Savings (%)	Yield Avg (t/ha)	Yield difference (%)
Wheat (Hard Red Winter)	Variable rate	7	184.5	7.8	7.2	11.2%
	Fixed rate	5	227.7		8	
Canola	Variable rate	5	153.7	6.2	4.1	11.2%
	Fixed rate	13	256.2		3.7	

In winter wheat fields where Nitrogen was applied at a Fixed Rate, the average yield was lower or equal to fields where Nitrogen was applied once during the growing period using Augmenta VRA. This enhanced yielding by 11.2% while reducing fertilizer consumption by an average of 7.8%.

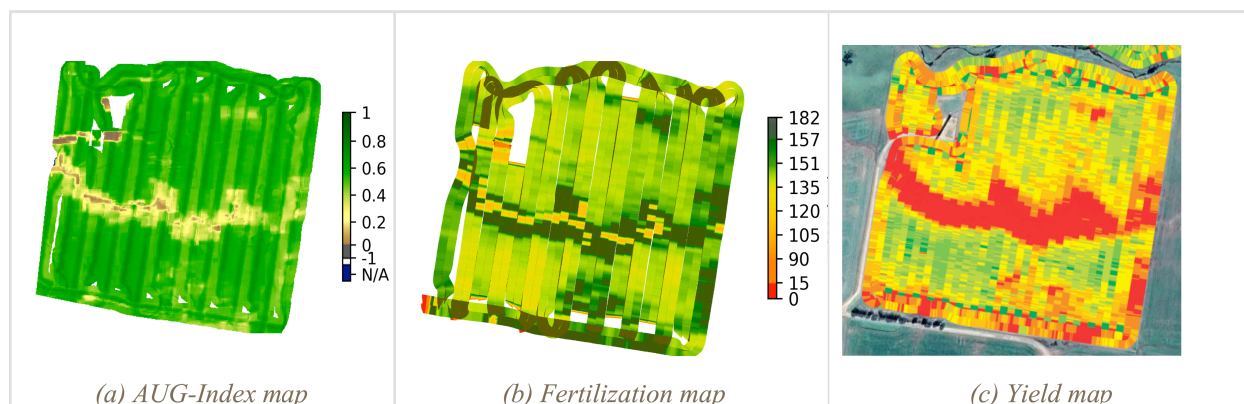
As regards canola, the average yield of fields where the Augmenta System was used for Nitrogen application, was also higher by 11.2% compared to fields where the fertilizer was applied at a Fixed Rate. This yield increase was achieved while fertilizer consumption was reduced by 6.2% on average.

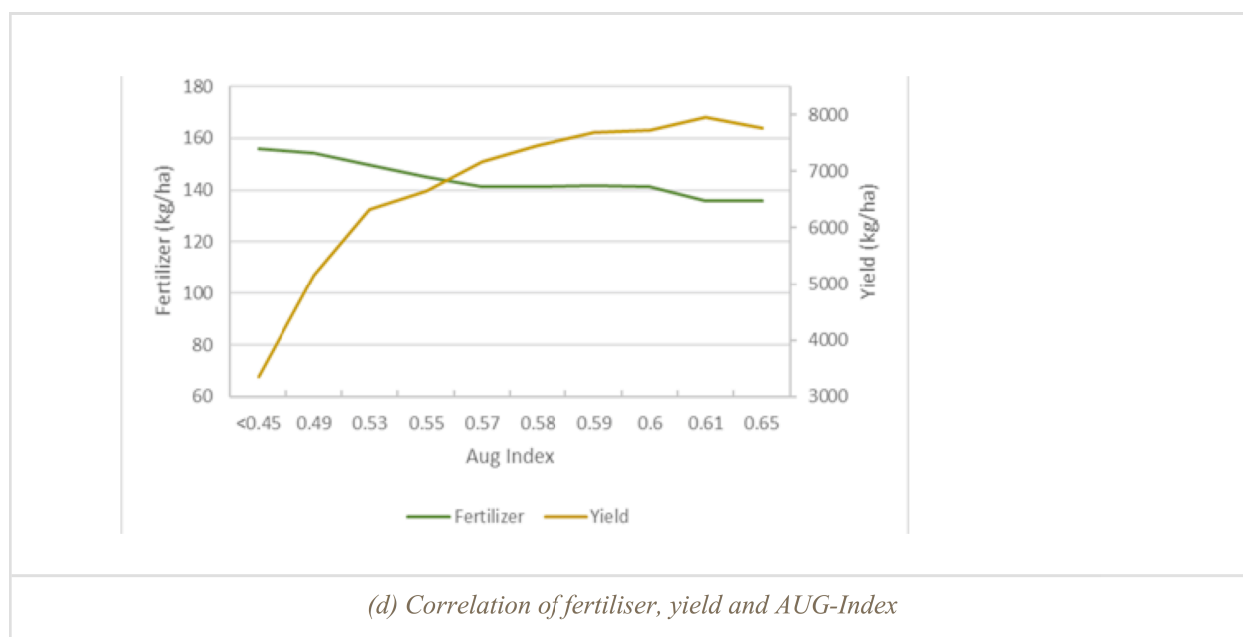
## Augmenta N-VRA Evaluation

To understand and evaluate how the Augmenta System carrying out N-VRA deals with different field regions, it is necessary to consider the correlations between Yield maps, AUG-Index maps and Fertilizer application maps. In turn, this allows a better understanding of why a consistent yield increase was observed, despite the reduction of fertilizer added.

### Case Study Field C11a, Session 2020-09-09 (5098)

In this session, AUG-Index values range from 0.22 to 0.59, with an average of 0.51 (Fig. 4a). Due to the condition of the field, Augmenta N-VRA implementation resulted in fertilizer savings of 14.4% (Fig. 4b).





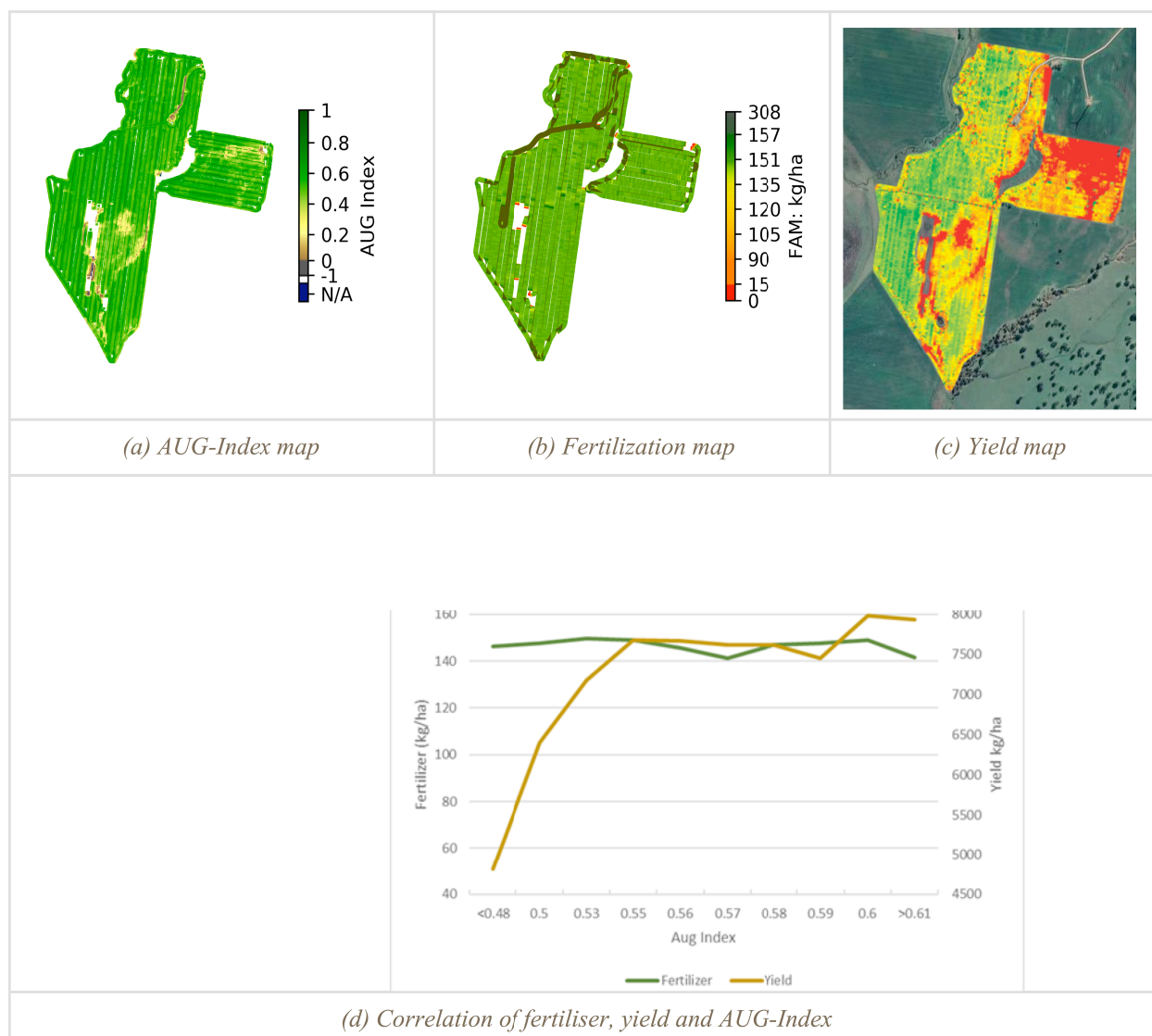
**Figure 4.** (a) AUG-Index map, (b) Fertilization map, (c) Yield map and (d) Correlation between fertiliser added, yield and AUG-Index of field C11a, Session 2020-09-09 (5098), Australia 2020

As shown in Figure 4a and 4b, fertilizer savings occur mostly due to the slight reduction of added fertilizer in the areas of the field which have already reached their potential. However, as evident in Figure 4c and 4d, there are yield increases in the respective areas, despite the reduction of added fertiliser, or even because of it.

This is a general trend observed between fields, not only in Australia but in multiple global geographies, supporting Augmenta's decision to differentiate from the competition by following a much more complex, non-linear approach to realize a truly effective N-VRA agronomic algorithm.

#### Case Study Field C8, 2020-10-09 (4761)

In contrast, in a field where Fixed Rate was carried out, the increased input of fertilizer in regions with higher AUG-Index values is not accompanied by a respective yield increase (Fig. 5c).



**Figure 5.** (a) AUG-Index map, (b) Fertilization map, (c) Yield map and (d) Correlation between fertiliser added, yield and AUG-Index of the field C8, Session 2020-10-09 (4761), Australia 2020.

In other words, this is a suboptimal application, wasting resources and compromising yield, while having an increased environmental impact.

## Summary

In comparison with Fixed Rate operations, Augmenta N-VRA achieved average **fertilizer savings** of **7.8%** for winter wheat, while the **yield increase** was **11.2%**. In canola fields, average **fertiliser savings** came to **6.2%**, while **yield increase** was also **11.2%**.

Augmenta N-VRA was used on a combined acreage of 338,2 ha (184.5 ha and 153.7 ha of canola and winter wheat respectively). This means a total fertilizer saving of 3.6 tonnes. With the average price of Urea at \$386 USD per metric ton, that equates to a \$900 USD saving for the farmer.

The yield increase of the respective acreage based on calculated averages would imply an extra 61.5 tonnes of canola and 147.6 tonnes of wheat. Based on current market prices (wheat \$201 USD/ton , canola \$448 USD/ton in 2021), this amounts to **\$58,000 USD (i.e. \$65,000 AUD) additional income** for the farmer (see Table 5).

These results confirm that when used in N-VRA operations, the Augmenta System is able to seemingly achieve the impossible - that is to reduce input while increasing yield. Moreover, they demonstrate that greater field variability actually increases performance, rather than hinder it. As shown, these unique capabilities can translate into significant cost benefits for the farmer.

Not only do these findings prove that the Augmenta System works well in Australia, but there is another implication. Optimizing inputs and reducing waste is in line with good farming practices and the promotion of sustainability. In other words, it is kinder to the environment we all share and depend on.

**Table 5.** Summary of Financial analysis of acreage where Augmenta N-VRA was implemented (wheat VRA) and (canola VRA), *Australia 2020*.

Crop	Area Fertilized (ha)	Savings (kg)	Savings (USD/ha)	Yield Increase 11.2% (ton/ha)	Yield Increase 11.2% (USD/ha)	Total Income Increase (USD)
Wheat	184.5	2067.3	4.3	0.8	160.8	<b>30,466</b>
Canola	153.7	1546.2	3.9	0.4	179.2	<b>28,138</b>
Total	<b>338</b>	<b>3,614</b>		<b>209</b>	<b>340</b>	<b>58,603</b>

**Note:** Since, annual yield can significantly vary as indicated by the available historic data, the results obtained are to be treated with caution. Different data sets obtained in consecutive years would assist to more accurately determine the percentages reported above.