

The use of high resolution imagery in broad acre cropping

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KEY MESSAGES

The use of high resolution digital multispectral images (DMSI) allows for the detection and quantification of 'detailed' agronomy issues resulting in lower yielding patches/strips. Rhizoctonia damage was identified and quantified as was wheel track damage caused by urea spreading under wet conditions. Whilst no in-season management decisions were made based on these images, quantification of the damage using the DMSI allows for better decision making to rectify the issues.

AIMS

Over the last few years there has been a rapid adoption of precision agriculture (PA), particularly guidance systems and yield maps are now fairly common. The next step in PA is now to start making use of the yield maps and other layers of information. Yield maps will provide information of the actual yield, hence will assist in making management decisions in the following season. There are also other ways of gathering information about the crop that might be helpful to assist with possible management decisions. One such method is the high resolution digital multispectral imagery (DMSI) which consists of taking aerial photo's with a high quality digital camera and geo-referencing them (i.e. attach spatial information such as latitude and longitude to the image).

DMSI come both in true colour (i.e. a combination of red, blue and green light reflectance) and in false colour (i.e. near infra-red, red and green light reflectance) and in a processed format as the ratio of near-infra red and red light reflectance. All three images are geo-referenced. The images can come in different resolutions but the standard is 1 m resolution, so that one pixel (the grain of the image) reflects an area of 1 m² on the ground, which is a much higher resolution than a yield map. A yield map is made up of readings from the yield monitor and the GPS at a rate of, usually, 1 per second across the swath width of the header which is for example 10 m wide. At a harvesting speed of 7.2 km/hr (= 2.0 m/sec) and a comb width of 10 m the resolution of the yield map equals to 20 m² (2 x 10 m).

The yield map might give information on the effects of soil type, position in the landscape, and fertiliser applications on crop yield but because of the low resolution doesn't provide information about the 'smaller/detailed' issues in the crop such as nematode or Rhizoctonia damage, non-wetting problems, header rows (fertiliser effect or poor germination), or wheel track effects. Due to the higher resolution DMSI can highlight the effect of these issues. This paper reports on the capturing, interpretation and use of such images and includes an economic assessment.

METHODOLOGY

As part of a NHT funded Soil Health Program through South Coast NRM Inc. several farms along the South Coast were surveyed for soil health in terms of chemical, physical and biological 'well-being'. On three farms several paddocks were found to be affected by issues resulting in low yielding patches or strips which were clearly visible in the DMSI. In one paddock (Paddock 1) which was severely affected by low yielding patches, the cause of these patches was not conclusively identified. In another paddock (Paddock 2) Rhizoctonia was positively identified with the Predicta-B® test through detailed soil sampling of the affected and non-affected areas. In a third paddock (Paddock 3) wheel tracks were identified as the primary cause of low yielding strips by visually locating these wheel tracks in the field even though specific measurements to identify the impact of the traffic on the soil were not carried out. Two paddocks were photographed in early August and one in the middle of September. The images, which cost between \$3-\$5/ha depending on the area captured, were processed and the details highlighted by converting the red light reflectance to a contrasting image of only black and white. In that way the affected area could be easily calculated. The results are presented below.

RESULTS

Paddock 1

The image of Paddock 1 with many low yielding patches of which the cause is not clear is presented in Figure 1.

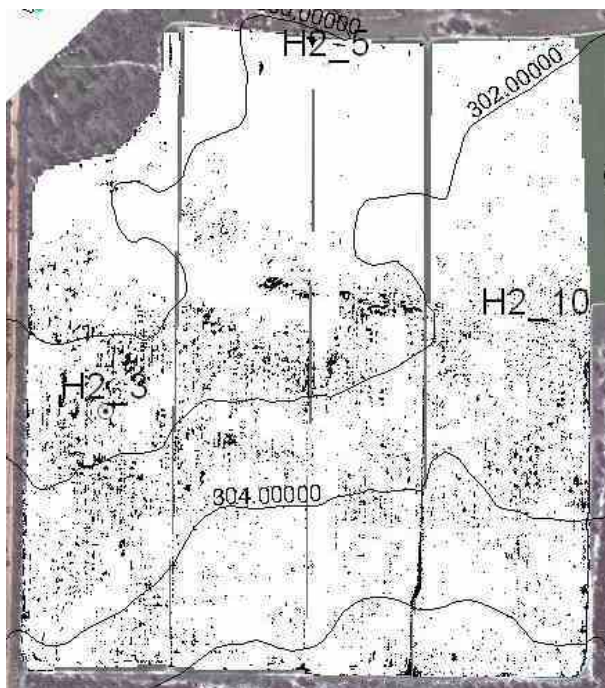


Figure 1 Patchiness of a barley crop in Paddock 1 in early August.

The paddock had been divided into strips by the farmer to assess varietal productivity differences of barley. The size of affected areas is presented in Table 1.

Table 1 Total area of each strip, area affected by low yielding patches and percentage

Barley variety	Total area (m ²)	Affected area (m ²)	%
Baudin	258 230	7 993	3.1
Hindmarsh	180 690	6 608	3.7
Fleet	215 146	6 000	2.8
Vlamingh	197 013	10 738	5.5

From biomass cuts at the end of September the average dry matter weight in the paddock (excluding affected areas) was 9.5 t/ha. Biomass cuts taken in the affected areas yielded 5.8 t/ha. Assuming a harvest index of 35%, the affected areas would yield 2.03 t/ha while the unaffected areas would yield 3.3 t/ha. The affected areas were about 3–5% @ 2.03 t/ha which equates to about 65 kg/ha of grain due to the nematodes which in the context of the overall yield is a small effect. This is the equivalent of about \$19.5 per ha. Note that the crop was affected but not eliminated. A total elimination of the crop in the affected patches would constitute a loss of about 165 kg/ha @ \$300 per tonne which equates to \$49 per ha. These figures can be used to look into the cost effectiveness of possible treatments with reference to the cause of patches.

Paddock 2

The detail of a paddock photographed in the middle of September affected by *Rhizoctonia* is presented in Figure 2.

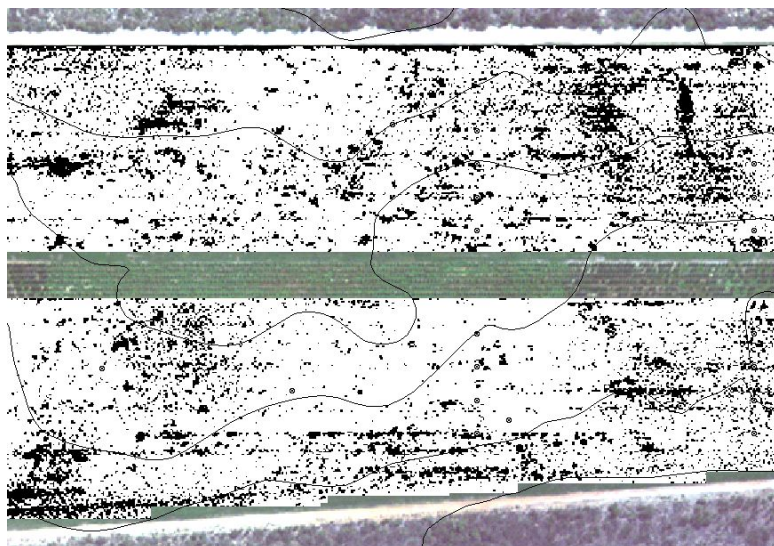


Figure 2 This image reflects the maximum area affected by Rhizoctonia and some other edge effects.

Depending how the black and white image is generated the black area can vary in size; hence a minimum and maximum area was calculated and presented in Table 2.

Table 2 Details of the size of the area in Figure 2, highlighting the areas affected by Rhizoctonia

Total area (m²)	649 781	
	Min	Max
Affected area (m ²)	94 386	165 908
% Affected	0.15	0.26
DM not affected area (t/ha)	8.9	8.9
DM affected area (t/ha)	4.5	4.5
Yield not affected area (t/ha)	3.56	3.56
Yield affected area (t/ha)	1.8	1.8
Average yield (t/ha)	3.3	3.11
Yield penalty (t/ha)	0.26	0.45
@ \$300/tonne	77	135

From the table it can be seen that the losses per ha can be considerable. The very dry start to the season, which hampered early root development, exacerbated the problem. The treatment for Rhizoctonia is cultivation, adequate nutrition and fungicide application at the time of crop establishment (DAFWA Bulletin 4732). A regular disc ploughing operation (once every 10 years) is included in the farming practices of this grower and was last carried out on this paddock in 2007. However, the impact of Rhizoctonia still appears to be significant.

Paddock 3

On one farm a very strong stripy pattern in the DMSI was noted. The stripes appeared at regular intervals 20 m apart. The stripy pattern in the image reflected indeed the biomass levels in the field. At the end of September biomass cuts were taken from the crop in the dark and the light grey strips. The results are presented in Table 3.

Table 3 Biomass cuts in dark and light grey strips of the image at Figure 3a

Replicate	Dark grey (t/ha)	Light grey (t/ha)
1	8.4	5.3
2	6.8	4.4
3	7.1	6.8
4	8.8	5.8
5	8.9	7.0

A sample of the area taken up by the low yielding strips can be seen in the Figure 3b.

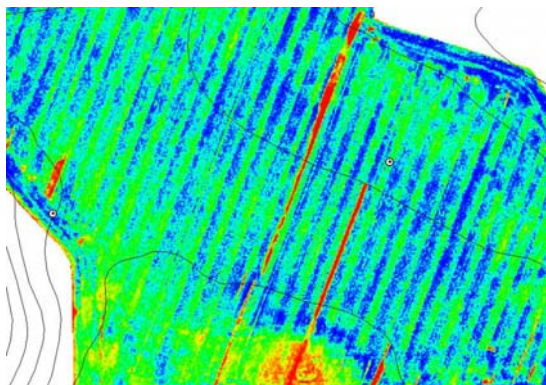
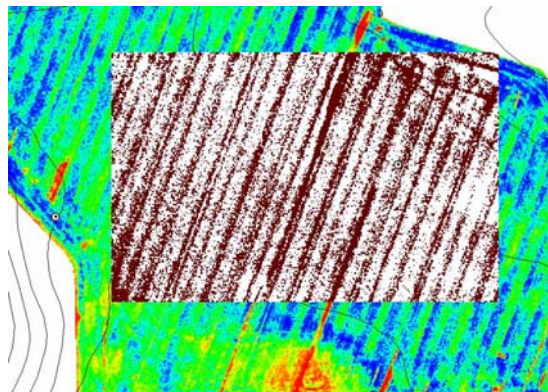


Figure 3a DMSI from area in the paddock.



3b Black and white contrast square highlights the size of the affected areas.

The square represents 10.4 ha of which 39% is affected. Those affected strips yielded 5.9 t/ha compared to 8 t/ha in the better areas. At a harvest index of 35% at the time of the year (10 October) the low yielding areas would cause a yield reduction of 0.29 t/ha which @ \$300 would equate to \$87/ha.

From observations in the paddock the strips of affected crop were clearly associated with wheel tracks (2 m apart), every 20 m and were from the urea spreader mixed with wheel tracks from sprayer. The urea was applied at the end of July after a very wet period and caused damage to the crop and the soil. Applying a liquid fertiliser through the spray rig, instead of the urea spreader, could have been an option to reduce the damage but the farmer was not set-up for that option. An aerial application of the urea (@ \$15–20/ha) would have been another option. Given the soil conditions at the time with the associated crop loss from the damage caused by the urea spreader, this could have been a more profitable option.

CONCLUSION

Quantifying the 'smaller' and more 'detailed' issues in the agronomy of broad-acre crops allows the farmer to make better informed decisions on the whether to address the issues or not. The use of DMSI is a very useful tool to help in that decision making process.

Some comments

DMSI's were captured with a conventional aircraft utilising specialised equipment sourced from Perth via a local supplier. The timing of image capturing can be critical. However, the service is dependent on the weather which at times limits the usefulness of the service. Other services are available that provide high resolution images from satellites, coverage of specific areas and the timing would need to be checked. Another development in the area of image capturing is the use of remote control aircraft, particularly helicopters such as the DraganFly®, equipped with high resolution cameras. The employment of such craft is very flexible but perhaps less economical and practical when large areas and distances between properties are involved. Regardless of the capturing technique, image processing and timely delivery to the client is of utmost importance if and when these images are to be used for management decisions.

KEY WORDS

precision agriculture, digital images

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Spraywise decisions—Online spray applicators planning tool

Steve Lacy, Nufarm Australia Ltd

KEY MESSAGES

- Off target deposition from pesticides can be minimised with correct application techniques and applying product in the right climatic conditions.
- Spraywise Decisions has been designed for the pesticide applicator to plan for the best possible conditions for the spraying process.
- Spraywise Decisions uses unique geo-spatial interpolation techniques to generate weather parameter estimates for the nearest 1 km² grid cell anywhere across Australia.

Off target deposition (drift) is a major concern in most agricultural areas today.

The presence of sensitive crops growing adjacent to the spray target area invariably increases the possibility of off-target damage. The APVMA has already introduced restrictions for the application and use of 2,4-D products with the level of label constraints for the use of agricultural pesticides only set to increase. It is more important than ever that the agricultural industry demonstrates responsible chemical use practices to reduce the need for more severe restrictions.

The incidence of spray drift can be minimised through correct nozzle selection and proper application technique under the right environmental conditions.

Spraywise Decisions has been developed for Nufarm from the 'ground up' with the pesticide applicator in mind. It is a subscription based internet service that helps rural landholders and contractors to better plan and match the timing of pesticide application to prevailing local weather conditions.

Spraywise Decisions uniquely:

- Uses advanced geo-spatial technology to generate weather parameter estimates for the nearest 1 km² grid cell anywhere across Australia.
- Incorporates definitive accuracy estimates by comparing predicted versus recorded values on an ongoing basis for the nearest of 270 Bureau of Meteorology automated weather stations.
- Generates forecast meteograms (Figure 1) from two to fourteen days ahead with predicted wind speeds, wind direction, Delta T, rainfall, temperature and humidity.
- Provides a Spray Planner (Figure 2) incorporating frost, wind and inversion risk predictions to plan the best application windows.
- Updates every three hours to provide the latest weather data.

Currently subscriber numbers for the Spraywise Decisions web-site exceeds 750. Applicators are finding that Spraywise Decisions is providing valuable localised planning information which allows greater efficiency and reduced off-target deposition.

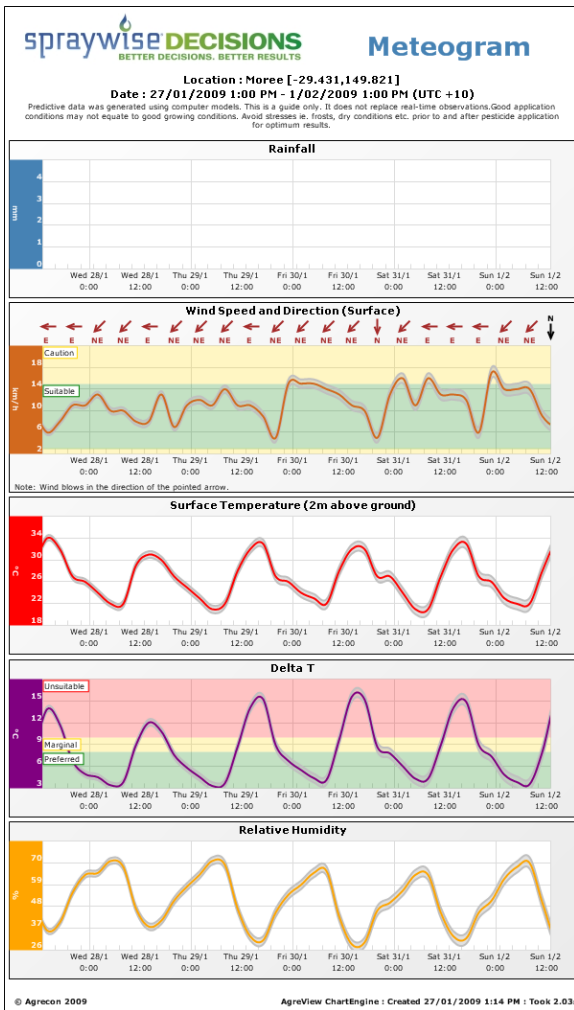


Figure 1

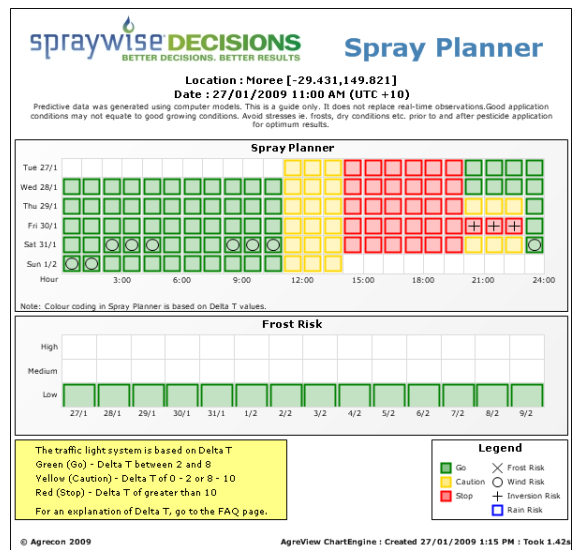


Figure 2

KEY WORDS

weather, application, drift, Delta T, inversion