Project Catalyst

Case study

Steve Young trials low cost sensors to improve availability and accuracy of VR maps

Grower Name: Steve Young
Entity Name: Casey Zarb Pty Ltd
Mill Area: Mackay Sugar
Total Farm Area: 240ha
Area under Cane: 200ha
No. Years Farming: 20
Trial Subdistrict: Sandy Creek

Steve Young

BACKGROUND

Using known yield data would greatly improve the accuracy of remote sensing data and give growers the added confidence to apply variable rate nutrients. While the newer model harvesters have made great strides in improving the accuracy of factory fitted harvester yield monitors, the reality is most harvesters used in the industry are not fitted with yield monitors. After market harvester yield monitors have been plagued with false hopes and high expense with very little uptake from the general growing community.

Steve and Maguarite Young farm more than 240 hectares in the Homebush/Sandy Creek and Bakers Creek area in the Mackay region. Steve also operates a harvesting contract business harvesting his and several nearby farms.

Steve's harvester had one of the first GPS tracking devices fitted when introduced by Mackay Sugar in the early 2000's and he has taken a keen interest in understanding yield variations that exist within a farming operation.

This project seeks to explore opportunities to develop low cost and reliable yield data using a combination of GPS and satellite technologies utilising Steve's harvester. Data will be collated and analysed to produce effective yield maps that growers can utilise to develop variable rate nutrient application programs.

THE TRIALS

Sensors and Tracking Device

Air bags are often fitted as an alternative to conventional steel spring suspensions especially on trucks and trailers that travel over rough terrain. Air is pumped into reinforced rubber bellows which raises the trailer chasis from the axle. Tests had indicated that there is a direct correlation between air bag pressure and weight of product in the trailer to which the air bag is fitted.

The sensors fitted to the haulout vehicle were 0-10 bar Pressure transducers with a 4-20mA output (Figure 1) and were installed onto the airbags in September 2016. The output of the pressure transducers feed into a GPS tracking device which integrates GPS signals, GSM modem and data logger (Figure 2).

Figure 1 - 0-10 bar pressure transducer

What it's about

Project Catalyst is a grower-led innovation project in sugar cane that was formed to explore and validate farm management practice change leading to improved water quality for the Great Barrier Reef. For more information on Project Catalyst please visit our website https://www.projectcatalyst.net.au/ or phone Catchment Solutions on 07 4968 4216.

ReportTime	Latitude	Longitude	Direction	Input1	Input2
4:04:30 AM	21.26269	149.092093	333	171	304
4:04:32 AM	21.26268	149.09208	335	171	304
4:04:43 AM	21.26238	149.0919958	240	171	316
4:05:33 AM	21.26237	149.091958	240	175	317
4:05:44 AM	21.26251	149.0916928	61	175	317
4:06:34 AM	21.26251	149.0916928	61	175	318
4:06:45 AM	21.26251	149.0916928	61	174	318
4:07:34 AM	21.26251	149.0916928	61	173	318
4:07:45 AM	21.26251	149.0916928	61	173	318
4:08:35 AM	21.26251	149.0916928	61	232	310
4:08:44 AM	21.26251	149.0916928	61	249	295
4:09:34 AM	21.26251	149.0916928	61	279	310

Table 1 - Example of transmitted data from data logger

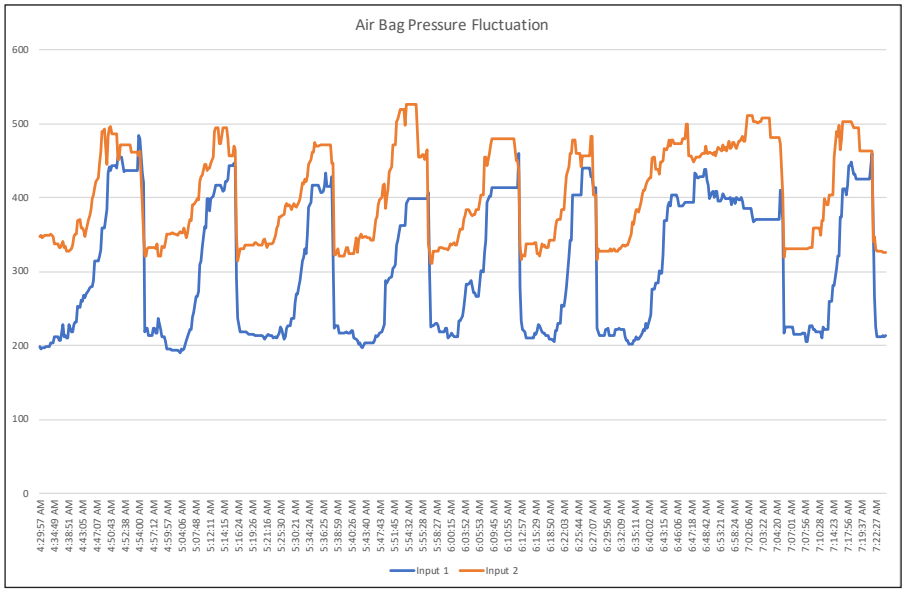

Figure 3 Fluctuation in airbag pressure over time

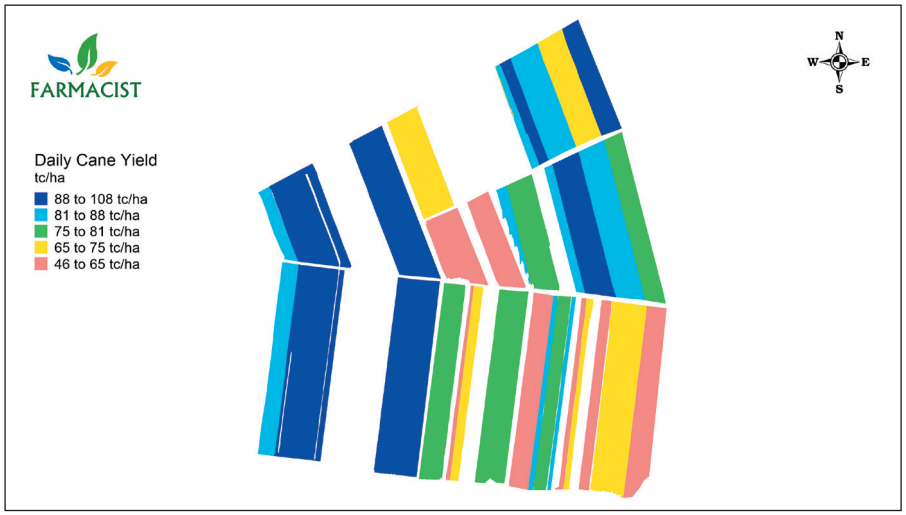

Figure 4 - Daily harvest yield map

Figure 2 - GPS tracker and Data Logger

Data from the loggers is sent via the mobile phone network to a purpose-built database. An example of the type of data sent is shown in Table 1.

A plot of air bag pressure versus time (Figure 3) clearly shows the pressure within the airbags increasing as the haulout bins are being filled during harvest operations and then rapidly declining when the haulout empties the load into cane bins on the mill rail system.

Upon closer inspection, there is considerable fluctuations in the sensor values as the bin is being filled. This can be attributed to a variety of reasons but predominately the rough terrain inside a cane paddock causes highly variable pressures in the air bags as the vehicle travels over the ground. These fluctuations are very difficult to assess as either weight increase in cane in the bin or air bags being pressurised from the travel over rough terrain.

A change in direction

In 2018, rather than monitoring the haulout vehicles and airbag sensors, the trial monitored harvest position on a daily basis. GPS tracking devices fitted to the harvester record the positional location of the harvester at regular intervals. This data is then transmitted from the GPS device into a dedicated database where the position reports are analysed and processed to produce maps of the locations where cane has been harvested.

The calculated harvest area for each harvest day is then matched to the weight of cane as measured by the mill weighbridge for each harvest dates to create a daily area yield map (Figure 4). Even without further processing these maps show the often extreme variability in cane yields across a farm.

The use of Satellite Imagery

Multi-spectral satellite imagery has been used for several years to assess the health, vigour and yield potential of many agricultural crops with Farmacist being one of the pioneers in developing techniques and algorithms to process satellite data into cane yield. Assessment of crop yields usually requires the conversion of the satellite data into vegetation indices such as Normalised Difference Vegetation Index (NDVI) or

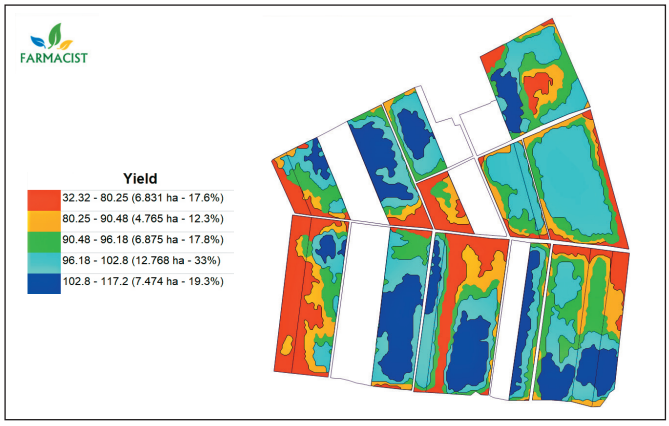

Figure 5 - Yield variation map

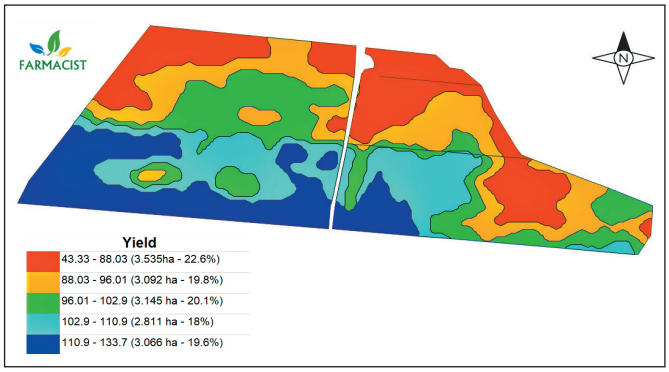

Figure 7 - 2019 yield variation map generated from combination of harvester position and satellite image analysis

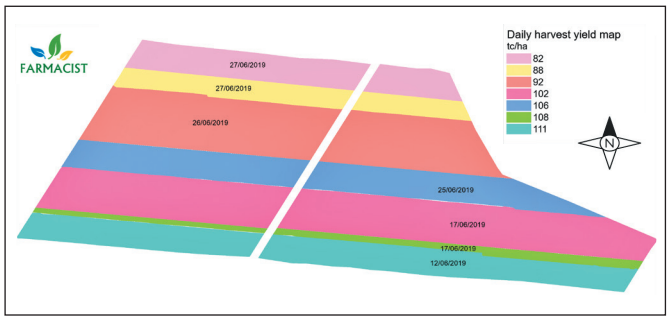

Figure 6 - 2019 harvested area daily yield map

Figure 8 - Upgraded GPS monitor fitted to the harvester for the 2019 harvest season.

Figure 9 - Validation plots

Green Normalised Difference Vegetation Index (GNDVI). Once converted, calibration algorithms are used to convert the indices into cane yields. However, one of the lingering doubts as to the level of accuracy of calculated cane yields is the lack of detailed calibration data to assess the validity of the algorithms when converting from the vegetation index.

This project has produced a method whereby the daily yields as calculated from the harvester and weighbridge date can be used to accurately calibrate satellite data to show actual and detailed cane yield variability.

Prior to the commencement of the 2018 harvest season, a 10 metre Spot multispectral satellite image was acquired and analysed to indicate the variability in vigour using NDVI. The satellite data was overlayed onto the daily harvest map (Figure 4) where daily harvest yields were used to convert the variations in NDVI values from the satellite image into a yield variation map (Figure 5).

2019 DATA

Harvester position reports from early in the 2019 harvest season combined with daily delivery data from the farm were used to create a daily harvest yield map (Figure 6). This shows a wide variation in average cane yields for each harvested area within the 16 hectare block ranging from less than 82 to more than 111 tonnes per hectare.

A satellite image captured in April 2019 was converted to GNDVI and overlayed onto the daily yield map. The variability within the GNDVI values from the satellite imagery were calibrated using the daily yield data producing a detailed yield variation map (Figure 7). The map shows large variation exist in yields within this block ranging from a low of 47 tonnes per hectare to a high of 131 tonnes per hectare. Overall , the block averaged 100 tonnes per hectare (tc/ha).

In July 2019, an upgraded GPS tracking device was fitted to the harvester (Figure 8) that provided similar positional accuracy to the previous device, however the upgraded devices improved installation efficiency by more than 50% as they do not require external antennas to be mounted to the harvester.

Included in the upgrades were changes to processing software that allowed for the automated processing of daily harvesting reports, matching cane harvested for the day to the area harvested for the same day.

VALIDATION OF IMAGE CALIBRATIONS

In November 2019, a cane block within the Young's farm was used to validate the accuracy of the calibrated satellite image. Using the Farmacist weigh truck, plots of 3 rows wide (row width 1.83m) by 30 metres long were harvested and weighed to calculate actual cane yields within each plot (Figure 9).

A comparison of the actual cane yield as derived from the weigh truck to the calibrated yield from the satellite image showed a high degree of correlation achieving an R2 of more the 0.85 (Figure 10).

A yield variability map generated from the calibrated satellite image for this block also showed extreme variability of cane yield (Figure 11) ranging from a low of 26 tc/ha to more than 100 tc/ha.

VARIABILITY WITHIN WHOLE OF FARM

The Young's Baker's creek farm was harvested in mid-October 2019 with average daily harvest yields ranging from 65 to 85 tc/ha (Figure 12).

Once again the creation of the calibrated satellite yield variation map highlighted significant variability of more than 54 tc/ha across the farm and also within paddocks (Figure 13).

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