Precision Agriculture (PA) project study sites

WHY ARE THESE IMPORTANT, WHAT ARE THEY BEING USED FOR, AND WHAT ARE WE LEARNING FROM THEM?

Bernard Schroeder[1,4], John Panitz[1,4], Craig Baillie[2,4], Troy Jensen[2,4], Rob Bramley[3,4], Cam Whiteing[1,4] and Tony Webster[3,4]

[1]BSES Limited   [2]National Centre for Engineering in Agriculture   [3]CSIRO Ecosystems Sciences   [4]SRDC Project CSE022

Precision Agriculture (PA) is a topical subject amongst growers and other stakeholders across the Australian sugarcane industry. A recent article in the BSES Bulletin *(Issue 31) explained what PA is and what it isn't. It also explained that PA is a 'cyclical process of* observation*, typically based on yield mapping and supplemented by remote and proximal sensing of crops and/or soils, followed by* evaluation and interpretation *of the observed data leading to the development of a* targeted management plan'*. This is well illustrated using the cyclical process of PA shown here as Figure 1.*
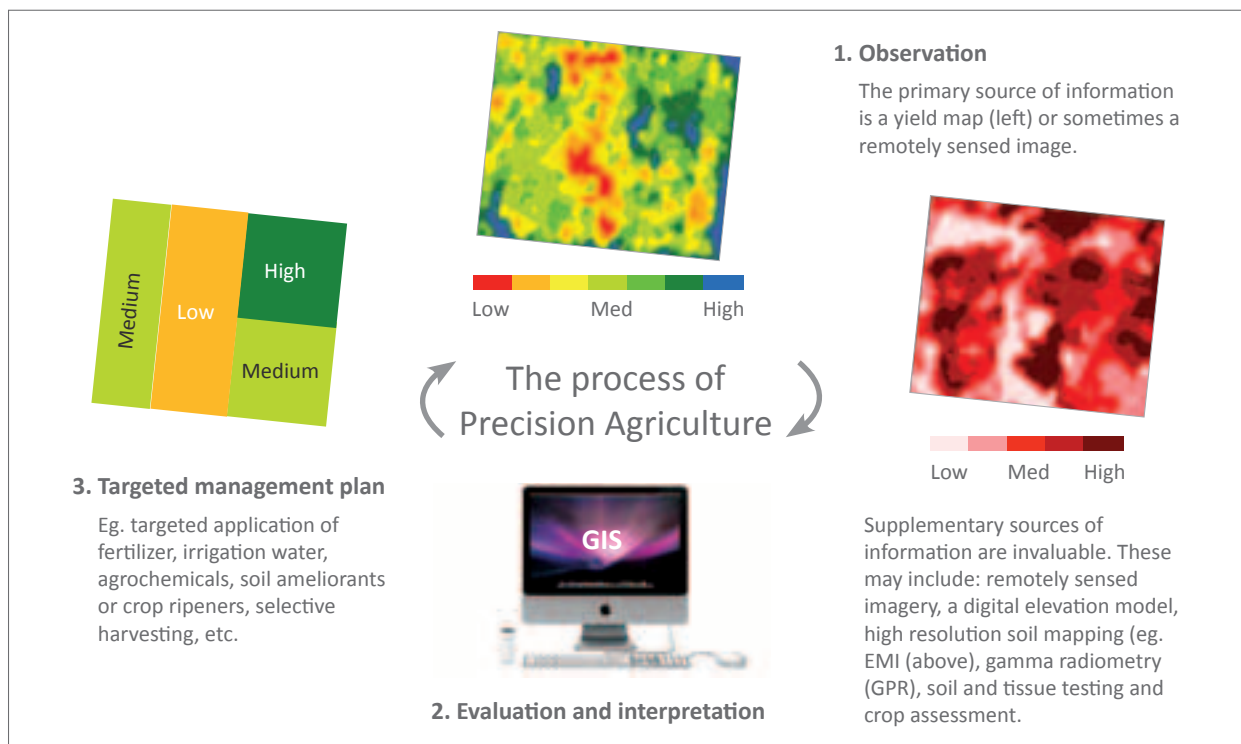

1. Observation

The primary source of information is a yield map (left) or sometimes a remotely sensed image.

Low   Med   High

The process of Precision Agriculture

GIS

3. Targeted management plan

Eg. targeted application of fertilizer, irrigation water, agrochemicals, soil ameliorants or crop ripeners, selective harvesting, etc.

2. Evaluation and interpretation

Supplementary sources of information are invaluable. These may include: remotely sensed imagery, a digital elevation model, high resolution soil mapping (eg. EMI (above), gamma radiometry (GPR), soil and tissue testing and crop assessment.

Low   Med   High

FIGURE 1 | The cyclical process of PA (Rob Bramley, BSES *Bulletin* Issue 31)

FIGURE 2

Example of different soil types shown on the farm map of one of the PA study sites. These are represented by various colours (pink, green yellow and orange) to separate soil with different parent materials. However, red curved lines within a particular colour (eg. green zones) are used to further separate soils based on other attributes including position in the landscape, parent material and soil texture.

With a growing interest in the subject, a number of growers are exploring options for implementing PA on their farms and determining how to access/utilise some of the enabling technologies/equipment that can assist in this process.

CSIRO Ecosystems Sciences, the National Centre for Engineering in Agriculture (NCEA) and BSES Limited are partners in an SRDC funded project (CSE022) entitled '*A collaborative approach to Precision Agriculture RD&E for the Australian sugar industry*'. This project has several objectives that include:

- Evaluation of PA technologies (ie. yield monitoring and mapping) in collaboration with leading growers by means of case studies and on-going communication. There will also be an emphasis on economics.

- Investigations aimed at assessing and understanding apparent variability within specific blocks of sugarcane and how this knowledge can assist in making management decisions on-farm.

- Empowerment of extension staff with upgraded skills and information to support growers that are interested in pursuing PA.

The existence of in-field variability is often acknowledged by growers and other industry stakeholders. However, very few growers have the capacity to make use of their inherent understanding of differences in soil type, crop growth and yields within

blocks of cane to quantify, and then manage, this variability. Several study sites have been included in project CSE022 to investigate such in-field variability, determine the spatial representation of various soil/crop attributes, and illustrate how the various aspects of PA come together to enable targeted management within blocks.

Growers with a passion for PA were identified as potential collaborators within the project. The existence of portions of their farms suitable for the required detailed investigations was then used to refine this identification process. The potential on-farm sites were assessed by reviewing the farming system, management/cultural practices usually used by the particular grower. On-going achievement of typical or above average yields was also considered. Study sites were then selected in the Bundaberg, Burdekin and Herbert districts. This spread of localities ensured that different environments, climatic conditions and sources of in-field variability could be included and assessed within the project. A number of technologies and activities have been used to quantify variability at the study sites. These include:

- Identification of broad soil types using existing farm maps (Figures 2 and 3).

- Use of EM38 mapping (Figure 4) to identify appropriate soil sampling sites (30 sites samples

in 20 cm increments to a depth of 1 m) for detailed analyses of chemical and physical properties.

- Remotely sensed imagery to assess crop growth/identify areas of poor growth. This imagery is being accessed via a separate SRDC funded project (FP818).

- Determination of block yields and yield variability along rows and within blocks using commercially available and experimental cane yield monitors (CYM).

The evaluation of different CYM technologies will be the topic of a subsequent Bulletin article involving the NCEA project participants. However, it is important to reiterate that a robust and reliable cane yield monitor is essential for identifying in-field areas of varying productivity and profitability. Irrespective of how this is achieved, it is important to be able to investigate and understand the cause(s) of sub-optimum yields within blocks. Conventional wisdom would suggest that several different data layers are needed per block to appropriately identify 'zones' for developing, implementing and assessing targeted in-field management.

Substantial progress has been made with the above mentioned activities at the three study sites (Table 1), with the most comprehensive assessment being undertaken at the Bundaberg site over the two past seasons.

FIGURE 3 | Two broad soil types, red clay loam and yellow clay loam, were identified within the 22 ha Bundaberg study site.
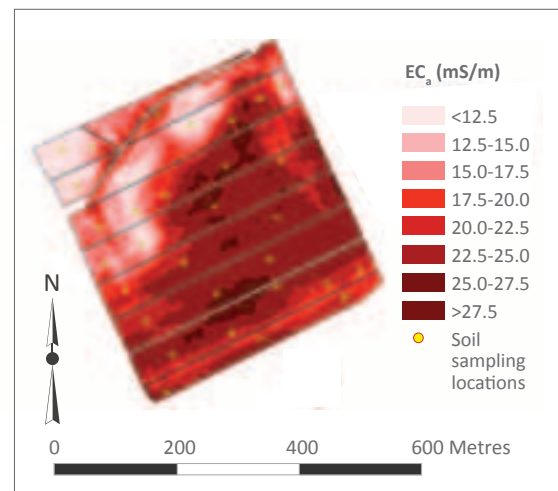

FIGURE 4 | The EM38 map of the Bundaberg PA study site was used to identify appropriate soil sampling sites (30 sites sampled in 20 cm increments to a depth of 1m) for detailed analyses of chemical and physical properties.

TABLE 1 | Activities undertaken at the three sites that are included in project CE022.

PA activity	Study site		
	Bundaberg	Burdekin	Herbert
Site identification	✓	✓	✓
EM38 survey	✓	✓	✓
Gamma radiation survey*	✓	✓	✓
Extensive soil sampling (to depth)	✓	✓	✓
Comprehensive soil analysis	✓	✓	Initiated
Remotely sensed imagery	✓	✓	Initiated
CCS variation survey	✓	Possible**	
Crop details / inputs (2009/2010)	✓	✓	✓
Harvest / yield data (2010)	✓	Standover***	✓
Crop details / inputs (2010/2011)	✓	-	
Harvest / yield data (2011)	✓	✓	✓

*   The gamma radiation survey was undertaken because of the availability of the appropriate equipment from CSIRO - results need further assessment and interpretation.

**   Following the successful CCS survey at the Bundaberg site and the production of a map that indicated that CCS is spatially variable and structured, another survey will possibly be undertaken at the Burdekin site due to its marked soil variation.

*** Due to the exceptionally wet conditions during the spring of 2010, the cane at the Burdekin site was not harvested but left as 'standover'.

The lessons learnt so far from Bundaberg illustrate that a number of in-field characteristics (Table 2) need to be understood prior to implementing targeted management at a particular site. The data and information gleaned from these 'characterisation' activities are best viewed by superimposing separate 'layers' on a farm block map. The grower's ability to identify and interpret the drivers behind in-field variability will increase as more layers of information become available. This, in turn, will contribute to greater confidence in making decisions about varying inputs / management practices in-field with the aim of optimising productivity (and therefore profitability) across the block.

TABLE 2 | Summary of characteristics that need to be determined to understand in-field variability to successfully implement PA at a particular site.

Variable site characteristics	Source or process of assessment
Soil types	• Soils map (best scale available) • EM38 / VERIS survey
Elevation and topography	• Topographic map • Map based on real-time kinematic GPS
Soil chemical and physical properties	• Soil sampling based on EM38 / VERIS map • Laboratory analysis
Sugarcane variety	• Farm map or grower information
Crop growth	• At least one remotely-sensed image per site (possibly during March/April) • Observation
Yield data	• Cane yield monitor
Areas of poor growth / incidents of pests / diseases and/or weeds (identified by various means)	• Assessment and understanding of different in-field zones

Based on the PA learning cycle (as illustrated in Figure 1), a grower embarking on PA will be able to test alternative strategies within and between block zones. This will allow targeted applications / practices without having to implement these across entire blocks. PA is all about recognising in-field variability and targeting inputs and strategies to manage that variability in the most effective manner. Future articles will expand on the elements of the project outlined in Tables 1 and 2.