CHAPTER 11

Precision Ag – Tools To Improve Efficiency

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Cotton growers in Australia are not only familiar with the term Precision Agriculture (PA), but are also very familiar with the concepts, solutions, and products that are available. Justifiably, PA is often described in terms of the primary enabling technologies, the Global Positioning System (GPS), and Geographic Information Systems (GIS). However, for the PA practitioner, mastery of the technology is only a small part of a successful on-farm implementation.

Broadly, PA refers to productivity enhancing concepts such as tractor and machine control, site-specific input placement, improved product efficacy, and increased irrigation efficiency (Precision Irrigation). More specifically, we can divide PA into two main areas:

1. Spatial Control – this includes guidance, as well as remote monitoring and control
2. Spatial Agronomy and Management (SAM) – analysis of spatial data which is decision based.

Spatial Control products have been widely adopted. In general, implementation is reasonably straightforward and benefits are easily quantifiable. SAM is more complex, requiring each value proposition to be understood at a local level. It is an agronomic and management strategy that brings together multiple data sources to allow the agronomist and manager to build knowledge and make better crop production decisions based on in-field variability. SAM comprises 3 main steps:

BEST PRACTICE

- Discuss precision ag ideas with your agronomist.
- Consider training to help interpret and utilise precision ag data.
- Where possible use multiple layers of information, such as several years of yield data with an EM survey to better inform management and agronomic decisions

1. Measurement and capture of data
2. Interpretation and analysis of data, and
3. Implementation of a management response.

PA has generally aided profitability in cotton farming systems by understanding and then improving the varying links between inputs (particularly water and varieties) and their interaction with soil production capabilities.

Crop variability

Variability in cotton farming systems can be categorised as stemming from these main factors:

- **Climate –** Overall crop yields on a national level are controlled mostly by what the climate delivers. (Major events such as flooding and hail are also climate related but the outcomes of overall yield will generally only affect individual farms.)
- **Farm –** Location or valley specific incidents as previously mentioned will affect overall farm performance. Individual farm management and ownership will also impact.
- **Field –** In-field variability will be determined by a number of factors including soil types, terrain, and the impact of historical practices.
- **Agronomic –** Variety choice, pest management, irrigation timing, location of checking, and individual interpretation of events, etc
- **Management –** Timing and type of farming practices, historical decisions, and general farm practice.

It is rare that you can attribute in-field variability to any single factor. It is far more likely that a complex relationship between several of the above factors is driving cotton production patterns. It is therefore important to consider all potential drivers in variability and comprehensively understand what site-specific combination of factors is present.

While there are many 'tools' available to measure variability in cotton production systems , there are several that have proved to be consistently reliable in the majority of circumstances. These include:

- EM surveys
- Remotely sensed images
- Elevation maps (including derivatives such as slope and wetness maps).
- Yield maps

Measuring variability

EM soil survey

Electromagnetic induction (EM) surveys are methods of measuring apparent soil electrical conductivity (ECa) by inducing an electrical current into the soil. These surveys have become very popular for a variety of reasons, including speed of data gathering, interpretability, and excellent correlation with real world observations.

Soil ECa is highly correlated to a combination of soil properties including water content, clay content, and salt

FOR THE BEST RESULT YOU'VE GOT TO START EARLY

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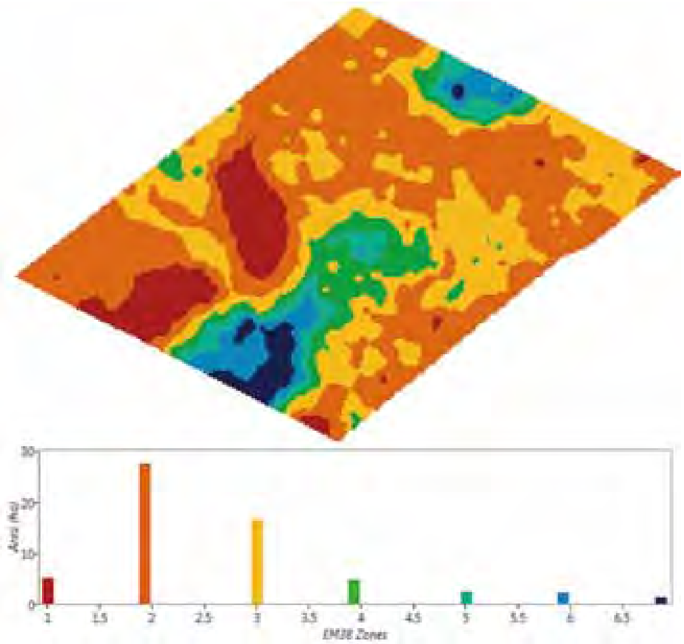
Best Practice

IMAGE 1:
EM38V survey captured with full moisture profile where red = low conductivity and blue = high conductivity. Low EM zones represent lower clay, water holding capacity and salts. High EM zones represent higher clay, water holding capacity and salts.



content. In non-saline soils ECa variations are most often a function of soil texture and moisture content. In general EM is most successfully used in areas where a single dominant factor is the cause of soil variability as recorded maps will then directly reflect that property. The main uses for EM surveys are:

- Forming soil type maps for the farm.
- Creating crop-specific yield-potential zones (all crops extract varying levels of nutrients and water from the soil).
- To optimize location of moisture probes relative to the majority of the field.
- To direct soil sample placement to best understand subsoil limitations.
- To understand yield potential in dryland systems by relating EM and soil sample data to plant available water capacity (PAWC).
- To locate deep drainage or leakage areas in storages and channels.

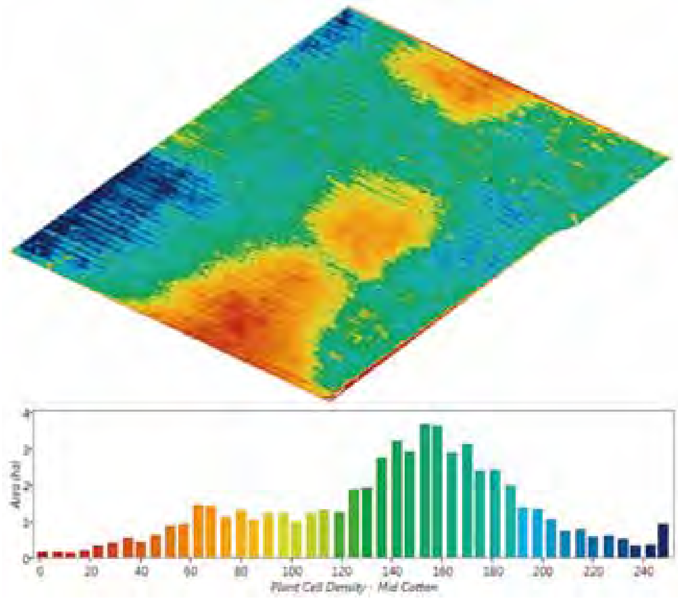
Biomass imagery

Airborne or satellite multispectral imaging systems measure the sunlight reflected off crops. Simply put, chlorophyll containing crops have strong reflectance in the green wavelength range and low reflectance in the red and blue wavelengths.

Plant Cell Density (PCD) and Normalised Difference Vegetation Index (NDVI) are indices which use the red and near infra-red (NIR) bands and have been used extensively in cotton farming systems for:

- Plant stand evaluation;
- Variable rate growth control;
- Variable rate fertiliser;

IMAGE 2:
Airborne imagery captured on 15th December 2002 where the relative PCD values on the X axis indicate the amount of biomass: Red = low biomass and blue = high biomass. NB. At this time in the season this map is mainly used for in crop growth management.



- Late season watering decisions; and,
- Variable rate defoliations.

Elevation and landscape change

The relationship between topography, soil water infiltration, and subsequent yield is quite complex because often where terrain changes so does soil type. Topography is however a primary determinant of the movement of water and subsequent infiltration, and its measurement and management can yield strong benefits. Fortunately, elevation maps can be created as a by-product by most RTK tractor guidance systems.

IMAGE 3:
Slope% Map created from an RTK tractor steering system where the X axis shows soil level above or below a "plane of best fit (0)" as a percentage (i.e.15ha of this field is 0.05% above the plane .

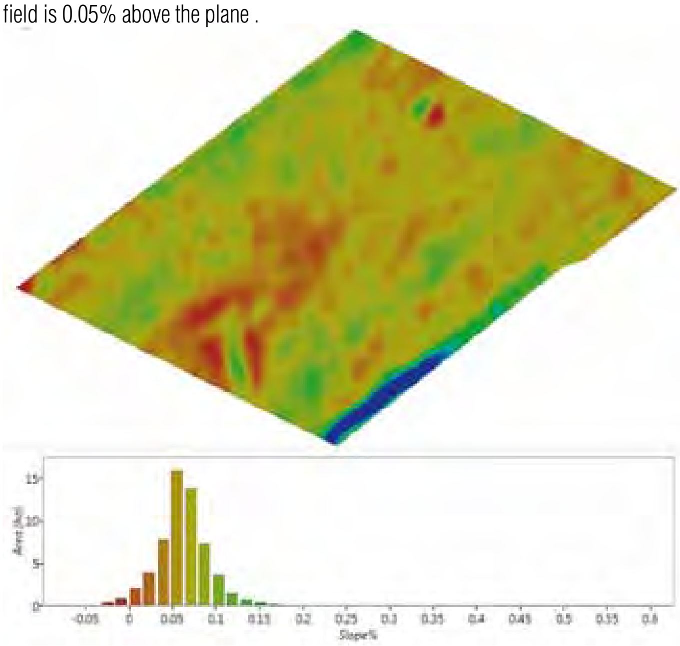
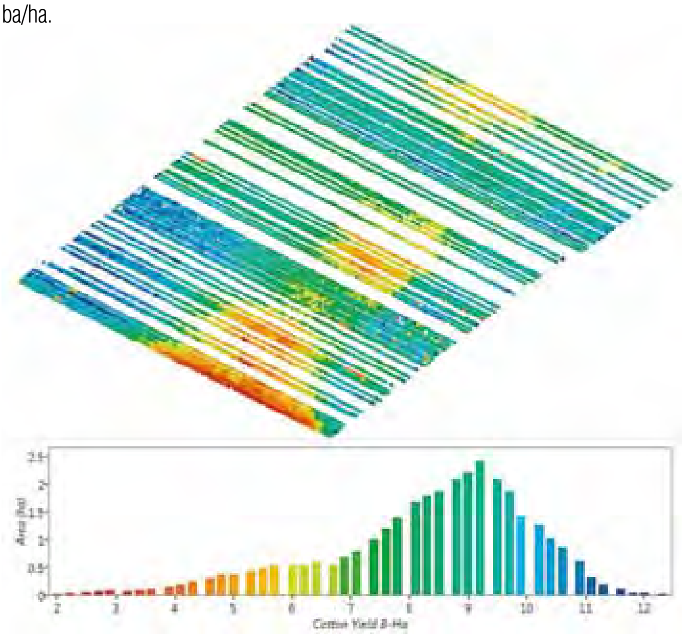


IMAGE 4:
Cotton yield from an actual cotton yield monitor, where the x axis shows yield in ba/ha.



Variations of soil type and topography combine to create differing growing environments and in the presence of subsoil constraints the relationship becomes even more complex. Elevation data coupled with EM surveys provide valuable information about the likelihood of waterlogging within irrigated fields. High EM and low elevation areas of the field will often be subject to prolonged waterlogging which has severe detrimental effects on cotton production.

The main uses for elevation data are:

- Locating moisture probes to avoid to areas in the field where water may lay or shed excessively (in combination with EM maps).
- Prioritising areas for remedial earthworks.
- Designing surface drainage to improve trafficability.
- Designing farm layouts to manage water flow and erosion.

Yield

Recording actual yield response is critical as a starting point for developing information about inherent field variability. Even if the information is merely anecdotal, it still remains as one of the simplest and most economical ways to monitor variability (and the integrated effect of environmental factors that influence yield). Recent technology improvements have enabled the accurate and effective monitoring of cotton yield. Subsequently yield monitors are becoming more commonly used in cotton pickers.

Outside of simple visual inspection, the main uses of yield maps rely on having other layers of information for combined analysis. These analysis outcomes include:

- Determining which soil types yield highest and lowest.
- Prioritizing management efforts with respect to soil types.
- Calculating which fields or parts of field are viable for earthworks.
- Calculating yield loss from areas in dryland fields that are water logging, and therefore the viability of surface drainage.
- Overlaying in-season imagery to build knowledge of yield outcomes at certain stages of crop growth for future crops.
- Building yield-potential zones with actual yield data for more accurate pre-crop fertiliser application.
- Calculating the viability of using gypsum in dryland or irrigated fields.

Using a simple correlation analysis method we can investigate cotton yield on a zone level based on EM value. Figure 1a shows Cotton Yield in 2002 (y-axis – right) is compared within EM zones (x-axis). In this situation the highest yielding zones (i) are also our higher area zones (y-axis- left) (b) and low EM zones. This indicates water was managed well in this irrigated field.

Further analysis showing profit/ha (b) identifies areas that have made money vs. areas that have lost money – the higher EM zones (in this case investigation in the field revealed high salt levels) are negative profit but only encompass a total area of approximately 3ha.

Using zones rather than ha basis, profit, revenue and costs are tightly aligned, but show a cumulative value for each zone based on the calculated ha's in each zone.

Summary

Growers all across the cotton producing regions of Australia are starting to realise the benefits of PA. For some the benefits flow quickly, while for many a lead time of data collection, analysis, and knowledge enhancement is required before realistic management plans can be implemented to manage spatial variability. Over the past decade personnel at Precision Cropping Technologies have observed and aided a wide variety of successful PA outcomes. Most agronomic solutions are, by definition, site specific, and require local knowledge and expertise. All growers are advised to discuss their ideas about PA with their agronomist.

FIGURE 1:
Correlation between cotton yield (ba/ha) and EM zones (a), showing financial results per ha (b) and per zone (c) where revenue , costs and profits were based on receiving $450/bale and the cost/ha was $2500.

A

B

C