Vegetable R&D
Your national vegetable levy at work

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Precision Agriculture

Technological advances are giving growers a valuable boost in their ongoing efforts to generate more value from existing resources. In recent years, attention is increasingly turning to the opportunities offered using new information technologies in agriculture, called Precision Agriculture.

Although Precision Agriculture offers new technologies and methodologies for growers to better use resources, it is not a reinvention of the wheel. Precision Agriculture is still based on long-standing horticultural principles which are used to varying degrees by Australian growers.

The bottom line

- Precision Agriculture (PA) uses a combination of new technology and existing agronomic knowledge to maximise farm efficiency
- There are many PA tools available to growers, but all require initial information to be gathered on the characteristics of the fields where the crops are grown
- A range of sensor options are available to growers such as Global Navigation Satellite Systems, Soil and Topography Monitoring, Yield Monitoring and Quality Monitoring

What is Precision Agriculture?

Put simply, the term Precision Agriculture (PA) describes a production system that aims to make better management decisions using a combination of new technology and existing agronomic knowledge. The outcome is an ability to better target inputs, such as fertiliser and irrigation, to the crop needs at each site in the field using spatial information systems and variable rate machinery.

Initially recognised as an opportunity to increase cost efficiencies, and in particular increase input use efficiencies, PA is increasingly gaining recognition as a viable option to also minimise environmental impact through reduced loss of input from the production system. The environmental, soil and crop data gathered in the initial stages of a PA strategy also has many applications and can often highlight troublesome areas before they become a problem.

There are many tools available to growers through PA, but all require initial information to be gathered on the characteristics of the fields where the crops are grown, possibly through soil moisture monitoring or aerial survey photos. The aim of the survey is to identify any areas of variation between different sections of the fields, such as composition of soil, native vegetation demands, even insect populations or requirements of specific crops. This enables growers to establish benchmarks for irrigation, nutrition and pest management.

Many growers maintain a fairly uniform approach to irrigation and nutrition of crops, enabling systems such as automated sprinklers to facilitate production over larger crop areas. The increased availability of agricultural machinery to provide automated labour and time saving functions over the past 50 years, has dramatically increased the scale of most production systems. This has lead to uniform management, based on average crop production, as being the best risk management approach for growers. However, crop production is rarely, if ever, uniform and PA technologies are now helping growers to manage variation in crop production.

Different irrigation systems are able to manage variations in crop production

To implement a PA strategy, growers need to establish if there is variability in the production system, either in plant production in different geographical locations on the property (spatial variation) or over different growing periods (temporal variation). Often, this can be determined by monitoring crop production over several harvests, giving a clear indication of where differences (such as varying yields or higher rates of weed and insect infestations) occur in a crop.

Often, however, familiarity alone will not provide detailed enough information on how extensive the differences may be and how best to tailor nutrition or irrigation of the plants. To provide more precise data, growers have a range of sensor options available.

With many growers further diversifying the types of crops they grow, an overall strategy to cater for the different characteristics and requirements of the plants is becoming increasingly important.

Global Navigation Satellite Systems

Although available in Australia for close to 20 years, Global Navigation Satellite Systems (GNSS), of which the Global Positioning System (GPS) is the best known, have not been widely adopted by growers until recently, due to the perceived cost of the technology.

GNSS enables crop fields to be surveyed and mapped and are a pivotal technology in the adoption of PA. GNSS have two main functions: 1) Geo-referencing management and sensor data, and 2) Assisting in machinery guidance to help minimise overlap and input wastage.

Automated steering and guidance systems have become very popular in agriculture as the benefits from reduced overlap are easy to calculate and quite significant. In addition, guidance also enables drivers to operate in conditions previously considered too dangerous (such as fog or darkness) and therefore increase the efficiency of farm operations. Guidance also reduces driver fatigue which results in fewer mistakes and more effective machinery productivity over longer periods of time.

Collecting yield or crop data is not useful if the data can not be referenced back to the location where the information was collected. When linked to crop and soil sensors, GPS allows data to be correctly geo-located for future analysis. GPS also provides information on the topography of the production system and can further be used to rectify imagery taken from aeroplanes or satellites.

Soil and Topography Monitoring

Sensors embedded in the soil can provide invaluable information on key soil properties such as moisture holding capacity, salinity, fertility and compaction, which in turn gives an understanding of crop responses.

Soil sensors, particularly soil electrical conductivity (ECa) sensors, are commonly used in agriculture and can provide real-time breakdowns of soil moisture levels, clay type and percentage and soil temperature on a daily basis. This information can be collated to identify areas requiring more or less irrigation. A variable-rate irrigation system will then deliver a more effective level of irrigation, minimising stress effects that may be caused by under or over watering in different parts of the field.

Soil sensors are also available to determine site-specific pH and lime requirements, with the results able to be gathered manually or electronically, depending on the monitoring systems employed.

Information can also be gathered and compiled in conjunction with other monitoring devices such as satellite imaging, highlighting attributes such as surface wetness, elevation, curvature and slope of the terrain.

Soil sensors can provide invaluable information on key soil properties

The spatial soil maps can be adapted to target soil fertility levels, providing growers with the opportunity to evaluate the long-term viability of production and implement strategies to conserve and extend the viability of cropping.

Yield Monitoring

Load-cell yield sensors can be mounted on harvesters using cross or discharge conveyor belts to enable information to be recorded about the mass of crop harvested over a given area. Geo-referencing the mass of the crop harvested with the location in the field allows growers to make yield maps to quantify how much yield variation is in the field.

Although commercially available in Australia and currently used by grape and potato growers, yield sensors have not been widely adopted. This is due to many crops still being hand-harvested and others only having semi-automated harvesters. In horticulture, growers are often more focused on the quality rather than the quantity of production.

Quality Monitoring

Much of the quality monitoring is currently conducted in store houses or packing houses but there is an advantage to using infield quality sensors to highlight particular characteristics of plants, while monitoring the ongoing quality and maturity of a crop.

An on-harvester sensor can also be used to complement a yield sensor, providing the ability to develop maps of crop quality properties, as well as information assessing the efficiency of the production system. Infield and on-harvester quality sensors provide growers with an opportunity to differentially harvest their production and take advantage of opportunities to segregate different quality lines into different markets. For high value crops, being able to target the right market, particularly premium markets, can be very lucrative.

With major retailers increasing their focus on supply chain technologies, monitoring and tracking technologies are likely to impact growers. Coupled with this is an increasing consumer demand to pinpoint the origin of produce and access associated information, such as the produce quality and duration since harvest. This information can be collated using barcodes and scanning tubs in the packing house, which collects information on the location the produce came from and an assessment of the quality of the produce. In some cases individual produce may be tagged with a barcode or radio transmitter that allows the vegetable to be tracked through the supply chain.

Used correctly, this information can add value to the final product resulting in a higher premium. Improved automation or work practices within packing houses can also free up labour, further improving efficiency.

Making use of the information

While technology can be a major component (and cost) of any PA strategy, the basic approach is based on gathering information to determine how to meet the site-specific requirements of a crop in a field. This process will minimise any wastage of resources such as fertiliser, pest solutions or water, while maximising the conditions for a crop to grow in. This can be particularly useful to growers developing several different crops, which often require different levels of nutrition.

With an increasing number of sensors and information options becoming available to growers, it is important to develop a PA strategy that makes use of different sources of information to pinpoint and eliminate waste while improving the quality of the final product.

An integrated farm management plan covers every aspect of production, from planting the initial seed to forwarding the packed containers to the customer. With the rapid increases in technology and an increased pressure to get better value for resources, PA offers growers a viable option to further develop their business.

Further reading

Taylor, J.A, Short, M, Rogers, D, Ancev, T & McBratney, A.B June 2006, *Scoping study to assess the application of precision agriculture for vegetable production*, Project VG05060, The Australian Centre for Precision Agriculture, Faculty of Agriculture Food and Natural Resources, The University of Sydney

The Australian Centre for Precision Agriculture: http://www.usyd.edu.au/agric/acpa/

Precision Agriculture: Profiting from variation: http://www.csiro.au/science/PrecisionAgriculture.html

Cover image, Precision Agriculture in action

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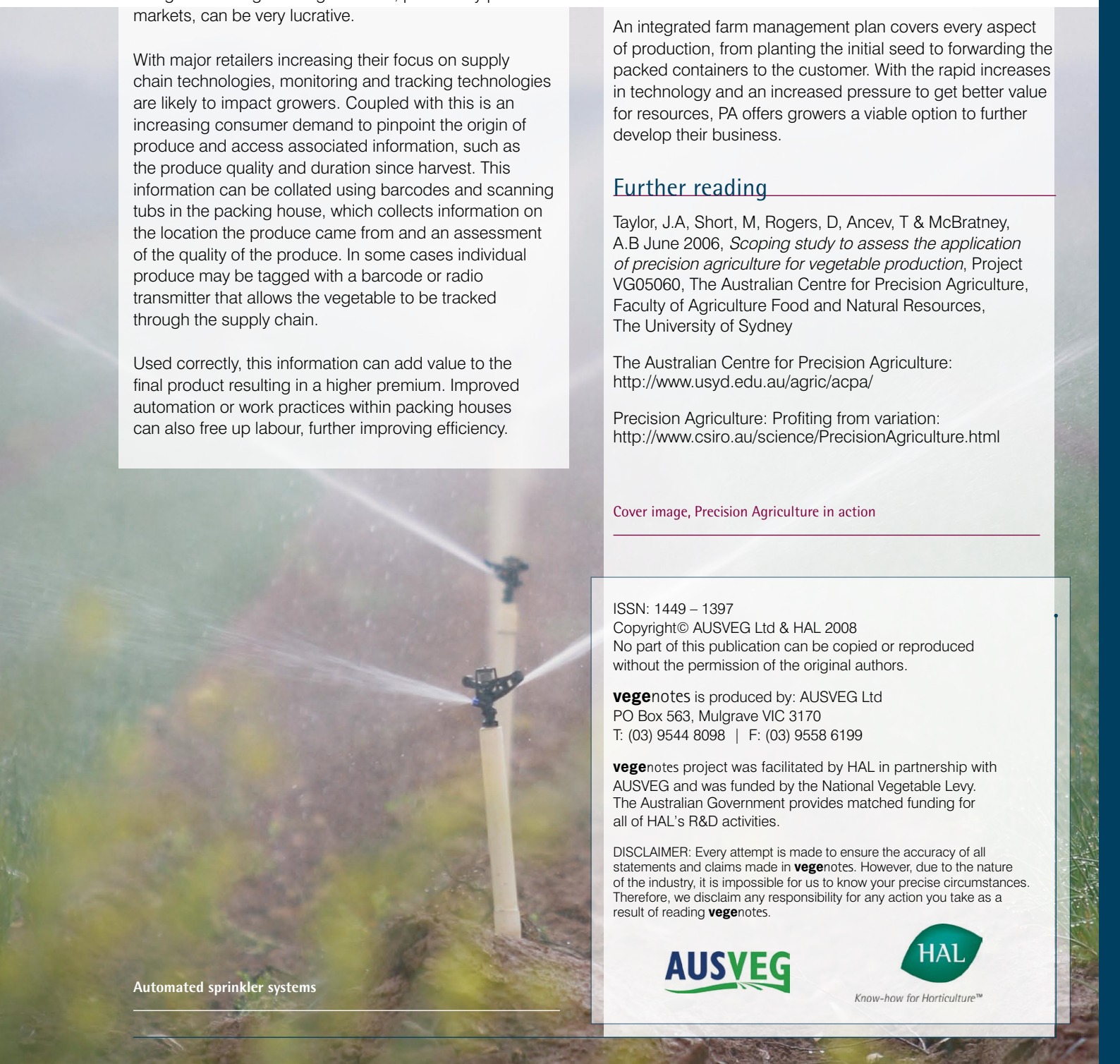

Automated sprinkler systems