Precision Agriculture in the Australian sugar industry – past, present (Nov' 2013) and future.

Sugar industry interest in Precision Agriculture (PA) arose in the mid-1990s when Graeme Cox and Harry Harris (USQ) developed a prototype sugarcane yield monitor. This was subsequently used in preliminary research by Rob Bramley (CSIRO) in partnership with the late Ray Quabba (Herbert River farmer), and commercially by Davco farming (Burdekin) who funded part of its development; alas, it was never commercialised in spite of evaluation by equipment manufacturers such as Case-IH and the then fertilizer company, Pivot, who were looking to develop PA services. The collapse of the sugar price at the end of the 1990s helped to ensure no further work with PA occurred in Australia beyond the on-going use of selected technologies by Davco.

Following a resurgence in industry fortunes during the mid 2000s, strong sugar industry interest in PA emerged. This occurred on the back of

- considerable progress with PA in other Australian agricultural sectors (grains and wine in particular);
- attempts in the Herbert (HCPSL and partners) to develop a regional harvest management and yield mapping capability supported by a community GPS network; and
- increased support for initiatives deemed of value in minimising possible impacts of sugarcane production on the Great Barrier Reef, including the provision of grants to growers for the purchase of GPS guidance systems and variable rate controllers.

Against this background, SRDC decided to have another look at PA and commissioned CSIRO and USQ to produce the reviews contained in SRDC Technical report 3/2007. A workshop held to mark the delivery of these reviews identified a number of PA-related R+D priorities which collectively could be characterised as being aimed at properly positioning the sugar industry for appropriate PA adoption, supported by access to the necessary technology, skills, methodological protocols and case studies. Thus, SRDC project CSE022 was funded to address these priorities, a 6-year multi-agency project (USQ, BSES and led by CSIRO), *A collaborative approach to Precision Agriculture RDE for the Australian Sugar Industry*, based around core field sites in the Bundaberg, Burdekin and Herbert districts.

As indicated, work being conducted by HCPSL in the Herbert at the time of CSE022 commencing, involved equipping a majority of the harvesters operating in the district with either an 'AgGuide' or 'TechAgro' sugarcane yield monitor. Other work supported by Mackay Sugar in both the Mackay and Burdekin regions involved the connection of 'off the shelf' hydraulic pressure sensors to the 'MT data' units being used in those districts for harvester fleet monitoring. This work, especially that in the Herbert, served to create the impression that a robust yield monitoring capability was available to the Australian sugar industry. However, none of these yield mapping efforts were supported by robust protocols for either yield data acquisition, mapping, or importantly, calibration of the yield sensors against Mill data. It was also apparent to the CSE022 team, who collectively had many years PA experience in other sectors, that the Herbert yield maps were characterised by many artefacts – either of the harvesting process and/or as a consequence of the lack of appropriate methodological protocols. An unforeseen but essential early CSE022 task therefore, was to evaluate the yield monitoring technologies and processes being used.

CSE022 trials conducted in the Herbert quickly identified significant shortcomings with all three of the yield monitoring options being used at the time. In particular, there were gross inconsistencies in the patterns of yield variation identified by the three sensors, all three were significantly compromised by the nature of the harvest (harvester speed, presentation of the crop, logging interval), and their calibration against mill tonnages was highly subject to the vagaries of the consignment process. The AgGuide sensor was subsequently taken off the market, whilst the project team recommended against use of the MT data-based system at all. The TechAgro sensor came close to reproducing the actual patterns of yield variation but was nevertheless affected by harvesting conditions and issues associated with calibration (Jensen et al. – ASSCT, 2010).

These developments and the on-going lack of a reliable yield monitor had significant consequences for the direction of CSE022. Our original objectives in regard to investigating the temporal stability in patterns of within block variation, the development of PA case studies, use of experimental methods to aid development of site-specific management norms and evaluation of the benefits to be derived from the

use of PA technologies were compromised by the fact that we did not have a basis for quantifying yield response to different management strategies. In discussion with SRDC, this led to a refocussing of the project and a cash injection to enable significant further and previously unforeshadowed work on yield sensor evaluation to be conducted. Subsequently, we demonstrated that various options for on-the-go yield sensing during harvest were feasible (Jensen et al. – ASSCT, 2012), albeit subject to appropriate calibration. We also developed a protocol for sugarcane yield map production, but highlighted the fact that the efficacy of this was heavily dependent on the use of robust calibration against the measured tonnage harvested per harvest event (the TechAgro instrument assumes that for any given block, the calibration is stable irrespective of the number of harvest events used to the complete the harvest of that block). We also highlighted that in the absence of a calibration procedure independent of the Mill (e.g. possible use of a weigh bed at the siding), calibration is heavily dependent on the accuracy of consignment (Bramley and Jensen – ASSCT 2013). We therefore believe that CSE022 made a critical contribution by way of placing an important 'reality check' on yield monitoring developments that were underway in the industry at the time of project commencement. However, at present, the Australian sugar industry still does not have access to a commercially available yield monitor besides the TechAgro (now Solinftec) instrument, although a different sensor is commercially available in Brazil and is believed to perform well (Paulo Graziano Maghaeles, Feagri, UNICAMP – pers. comm.).

Meanwhile, aside from our work on yield monitoring and mapping, CSE022 has also made strong progress in:

- Demonstrating the value of high resolution soil survey and elevation modelling in understanding some of the drivers of within block yield variation;
- Demonstrating the equivalence of conductivity-based (EM38) and resistivity-based (VERIS) soil sensing, thereby expanding the soil sensing options (and their time of use) available to the industry (Bramley et al. – ASSCT 2012). Gamma radiometry has also been explored;
- Highlighting the utility of remotely sensed imagery, in concert with DPI021(Andrew Robson, Qld DAFF), for understanding the extent of within paddock variation in crop growth;
- Highlighting the potential importance of within-block CCS variation in terms of its impact on paddock gross margins and the consequent need for an on-the-go (i.e. high resolution) CCS sensing capability to complement yield monitoring (Bramley et al. – ASSCT 2012; Bramley and Trengove – Engenharia Agricola 33 – 2013);
- Demonstrating the inaccuracy of existing fertilizer application systems used in the sugar industry, such that with the exception of liquid fertilizer use, the benefit:cost of retro-fitting fertilizer boxes with variable rate controllers has to be regarded as questionable, especially with respect to their ability to provide an environmental benefit through more precise fertilization;
- Explaining the pathway to PA adoption through our Burdekin case study (e.g. PEC video) and numerous technical workshops (e.g. ISSCT, 2012; ASSCT 2010), presentations at ASSCT conferences and regional grower meetings.

What is now needed is a further period of R+D to build on CSE022 and maximise the opportunity for SRA / the industry to gain a return on its investment in PA R+D and to build on the limited adoption to date. In particular, we need to:

- Explore improved consignment / yield monitor calibration options so that the yield monitoring and mapping process can be made foolproof;
- Thereby gain clarity as to the temporal stability in patterns of yield variation and the robustness of management zone delineation;
- Evaluate the commercially available Brazilian yield sensor with a view to it being a rapid adoption option for intending yield mappers in Australia;
- Understand the degree to which yield and CCS variation follows similar patterns (i.e. with the same or similar drivers) or require separate consideration;
- Begin exploring options for on-the-go CCS sensing;
- Develop case studies aimed at enumerating the benefit:cost of PA adoption through both input cost savings and enhanced yield/CCS productivity;
- Derive a basis for the site-specific application of 6 EASY STEPS based on sub paddock-scale estimates of potential yield (from yield mapping) and N mineralisation rate, including considering a role for crop modelling to inform this;

- Evaluate methods of spatially distributed experimentation to better inform issues such as norms for the use of fertilizers, soil amendments, variety selection, weed control options, etc...; and
- In partnership with PEC (Summer Olsen), SRA project NCA013 *Implementing a framework for farmers to engage in the use of Precision Technologies* (Jensen – HACP) and emerging consultant capability (e.g. Farmacist), ensure effective extension of PA procedures and practices to industry.

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