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W.J. Whiteley

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THE USE OF PRECISION FARMING TECHNOLOGIES IN CROP DECISION MAKING

W.J.Whiteley

Sustainable Farm Management Group, The University of Sydney, Faculty of Rural Management, Orange. NSW Australia

ABSTRACT

Precision Farming Technologies are being used by an increasing number of farmers in eastern Australia. The adoption of these technologies has resulted in a change in some agronomic practices. This project examines how the technologies are being used. Global Positioning Systems are being employed most readily with significant economic benefit particularly in setting up controlled traffic systems and the banding application of chemicals and fertilisers. Awareness of the benefits of controlled traffic has increased the use of GPS. A secondary reason for high accuracy GPS is to give the farmers greater labour options due to the shortage of experienced machine operators. Yield monitors and maps are mainly used for zoning fields with farmers being cautious about their value until better tools for analysing variance become available. Variable rate technology is not being used in a systematic manner at the present time.

INTRODUCTION

The rapid adoption of Precision Farming (PF) technologies in Australia in the mid-nineties by broadacre annual cropping farmers has not continued due to their cost and the lack of clearly demonstrated returns to those who purchased them. While there has been frustration among both the farming and the research communities at the lack of progress and the general feeling that the technologies are ahead of agronomic knowledge (Cook and Bramley, 2001), there is still an optimism that the technologies will have a role to play in crop management. Many of the farmers who have purchased the technologies have updated the equipment as they believe that there have been other advantages besides demonstrated financial gain.

Due to a steady decrease in their terms of trade, grain and fibre farmers are constantly seeking methods that will improve their efficiency by making more correct decisions and fewer mistakes. In the farming areas of northern New South Wales (NSW) and

south east Queensland (Qld), there is a willingness to adopt PF technologies, particularly among those farmers cropping more than two thousand hectares. Smaller farmers often use contractors who have the required technology depending on cost and availability. This region has a variable climate and the need to continually adjust practices has encouraged the adoption of new technology.

This paper will examine how farmers in these districts make use of Global Positioning Systems (GPS), yield maps and, to a lesser extent, Variable Rate Technologies (VRT) in crop management decision making.

THE PROJECT

The project involved interviews with users of the technologies including farmers, contractors and agronomists. All respondents selected are regarded as leaders in the area and have adopted at least one of the technologies. There were also interviews with farmers in the same area who are growing the same crops without access to PF technology. The objective was to select farmers in each group who were regarded as equally successful and were growing similar areas of crops

With one exception, each farmer crops in excess of 2000 hectares. All were growing dryland wheat plus at least one other dryland crop; cotton, sorghum, a winter grain legume, or barley. Most of the farmers were committed to minimum tillage although major flooding in the area in November 2000 and February 2001 has meant that there has been extensive cultivation to repair fields suffering from severe erosion. The use of controlled traffic was widespread in both groups as the soils in the region compact readily with significant yield reductions as a result.

Initially, six farmers were interviewed to establish what information could be obtained in an in-depth interview and, as a result, a broad set of questions were compiled. It was suggested that some consulting agronomists and contractors be interviewed as these also had a significant input into the decision making process. Consequently a further twelve farmers, three agronomists and two contractors were interviewed. The interviews took place between September 2000 and March 2001.

Farmers were asked:

- what PF technology they had purchased
- why they bought the PF equipment
- what were they using it for
- what ,if anything, was it replacing
- what were the benefits and/or limitations of using the equipment
- were there any unexpected changes (such as the need for additional machinery) after purchase.

The contractors were either spraying or harvesting specialists. They serviced some of the interviewed farmers as well as a large number of other clients both large and small. The agronomists were both private and government and were not actively promoting PF though they made limited use of any data made available to them. Discussion with both groups centred around their use and/or knowledge of the technology and how it helped in their interaction with farmers.

DISCUSSION

This paper won't describe the technologies but will look at the context in which the PF technology is used. The majority of the discussion will centre on GPS and yield monitoring as the adoption of VRT is not as widespread as originally anticipated.

GPS

Navigation

Differential GPS was the most common purchase of all technologies. The accuracy of the system depended on the intended use with accuracy to two centimetres being selected where the farmer was incorporating automatic steering while sub-metre accuracy was sufficient in all other cases.

The decision to purchase the 2 cm accuracy was made for three main reasons:

- i. The need for straight rows for spray application and inter-row cultivation

- ii. The lack of experienced casual tractor drivers
- iii. Laying out and locating the exact position of controlled traffic tracks.

Spray Application

The major inputs in crop production in this region are herbicides, fungicides and insecticides. Glyphosate is the most common comprehensive herbicide for broadacre weed control and there are a range of specialist herbicides used according to the crop. Summer crops are grown on one metre row spacing (with single and double skip being used in cotton and sorghum). Band spraying (both pre- and post- emergence) reduces herbicide costs considerably, often by as much as 80%. Straight rows ensure that the bands are sprayed accurately and where inter-row cultivation is done, removal of crop plants is minimised. Winter crops are being grown on 40 centimetre row spacing and savings are less but still significant. By spraying a pre-emergent herbicide in a 20 centimetre band and sowing in the middle, savings of approximately 50% can be made.

The control of *Ascochyta* blight in Chickpeas and Faba beans by the application of fungicides is the most significant cost in growing these crops. Both farmers and agronomists agreed that the management decision to go to 40 centimetres row spacing and band spraying six to eight weeks after sowing in a disease control program has reduced costs by up to \$52 a hectare for chick peas and \$35 for faba beans. The accuracy of the application is paramount in obtaining this saving. Missed sections permit a build-up of the disease, hastening reinfection and resulting in additional spray applications.

Heliothis(*Helicoverpa armigera*) is the main problem insect in the region and control is increasingly being carried out in dryland cotton using hooded sprayers. While spray rates can be slightly reduced, both farmers and spraying contractors pointed to the advantage of very straight rows in the reduction of damage to the plant. This is most evident in the latter stages when the plant is at its widest. Farmers without automatic steering are loathe to attempt a ground spray at this stage and claim significant losses of plants due to wayward tractors.

Machine Operators

All farmers interviewed who have purchased GPS of 2cm accuracy claimed that part of the reason was the lack of experienced tractor operators. Much of the work is seasonal and casual labour is employed. The level of misses and overlaps without GPS can be as high as ten per cent but is commonly four to five percent (Mailer, 1997). This level of inefficiency can be costly in wasted chemical, seed contamination, reduced yield and accidental plant loss. By installing automatic steering the farmer is not restricted to employing experienced operators who can command higher wage rates.

For contractors, the use of GPS for measuring the size of fields is important to ensure correct payment. Harvesting contractors claimed that farmers were regularly understating the size of fields and spraying contractors stated that in order to ensure a “clean” job, overlapping of the order of five percent was common. This resulted in disputes which are now avoided. All the farmers that had the highly accurate navigation equipment were doing some contract work, particularly laying out controlled traffic lines or band spraying to recoup part of the purchase cost.

Controlled Traffic Systems

Commonly known in this area as “tramlines”, these are a recent innovation to reduce soil compaction. The soils in this area are typically heavy black or grey clays which are susceptible to compaction on any wheel tracks. Tramlining can ultimately result in fuel costs being reduced by half (Tulberg, 2001). By adapting machinery so that the wheels of all machines (with the exception of harvesting equipment) travel on the same track, the area of compaction is reduced to a minimum. Most farmers attempt to make these tracks permanent in a minimum till system with cultivation only used in exceptional circumstances such as the recent floods. The decision to adopt tramlining has been made easier with the availability of GPS. The use of GPS ensures that the same tracks are used every time and navigation aids keep the tracks straight. Using GPS to mark the tramlines has resulted in a reduction in the use of marking devices such as physical marker arms and foam or paint markers. There is widespread use of contractors to mark out the tramlines with farmers relying on their driving ability to stay on the tramlines.

There was divided opinion as to the need for 2 cm or sub-metre accuracy (20 to 30 cms) as tractor and machinery tyre widths vary by as much as 40 centimetres. Those in favour of the higher accuracy argued that this was what PF was all about and that the extra expense could be recouped by using the strategies outlined earlier. Those favouring less accuracy based their decision on the difference in cost, claiming the higher accuracy equipment was too expensive and that their other machinery would have to be upgraded to take advantage of it. These farmers could not see sufficient improvement in efficiency to cover the cost of upgrading. This is an area that requires more research.

YIELD MAPS

While the farmers were satisfied with the use of GPS for navigation, they were less than satisfied with yield maps. They were not inclined to pay a higher rate to contractors whose machinery had the capability to produce yield maps as most have been told by their consultants that they were of no use. Research, both in Australia and the USA, has indicated this (Cook and Bramley, 2001, Doerge, 1999). Farmers who do have access to yield maps said that they confirmed what they already suspected or knew and noted the high correlation between the yield map and the soil map. Where the map differed greatly from what was expected and there was no obvious reason, the aberration was put down to disease, frost or lack of moisture. One farmer, who had cut and filled gilgais, said the map corresponded to the laser map precisely and another commented that there was some correlation between the yield map and the soil depth.

The one positive that came to light was the usefulness of yield maps in zoning, particularly where there was no detailed soil map. This was first mentioned by a contract agronomist and confirmed by a number of farmers in discussion. All these farmers used consultant agronomists and generally followed their recommendations. The lack of support data such as grid soil tests and soil maps showing depth and type (because of their cost) and, in some cases, accurate paddock histories (because the area was recently acquired) meant that the yield maps were the only indicators the agronomist had of the field's potential.

Yield monitors were used mainly to get an accurate assessment of the production of a field and also large area trials comparing the performance of varieties. Generally these trials were not scientifically designed but as one farmer said, “ This gives me a much better indication than small area trials because it is on my place”.

One of the difficulties in the project was that only a minority of farmers had complete yield map data. Most farmers use a number of machines, some of which are not fitted with monitors, in order to complete harvest in the shortest possible time. This means that some areas are not mapped and the farmer has not visually observed differences. The majority of farmers interviewed have either not used the yield maps produced or have discontinued using them except for the occasional trial. No farmer claimed an economic advantage from having access to yield maps and most were reluctant to incur further expense of grid soil tests until profits were clearly demonstrated. The importance of yield maps to the agronomists varied according to the length of association with the farmer.

VARIABLE RATE TECHNOLOGY

The farmers often acquired VRT because it came with a machine that they had purchased. It was not used in conjunction with yield maps but rather where the farmer had an excellent field history. Areas of “good soil” received higher rates of fertiliser and seed than was applied to the rest of the field while rates of herbicides were varied according to the visual assessment of the operator. This suggests that farmers did like the option of varying rates but preferred to use their knowledge from experience rather than aids such as yield maps. As spatial analysis develops, this should be one technology that will become more readily adopted.

CONCLUSION

Farmers in northern NSW and south east Queensland have used PF technologies to varying degrees in their crop decision making. GPS use is becoming widespread as

farmers recognise the benefits of tramlining and the cost savings associated with band application of chemicals. The expense was a concern to most farmers even though they could see an economic benefit. All farmers who had purchased high accuracy GPS undertook contract work to help offset the purchase cost. Yield maps were not used extensively in the decision making process because farmers were reluctant to spend money on collecting associated data such as grid soil test information until a clear economic benefit is demonstrated. Varying rates of chemicals and fertilisers is an option the farmers might use but they are waiting for a reliable method for determining the variations. At this stage the technology is ahead of the agronomy in PF and so farmers can only use it to a very limited extent.

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Author's Biography

Wal Whiteley is a lecturer in Farm Management at the Faculty of Rural Management, The University of Sydney, Orange. Wal's principal interest is in the farmer's decision making processes particularly with regard to Cropping Systems. Wal's initial training was as an oilseed agronomist. He then managed his family's 783 hectare property before joining the university in 1992. Wal still has his own mixed enterprise farm. His other interests include international comparisons of farm systems and the use of situated learning in the education of young farmers.