Does Controlled Traffic Have a Place in High Rainfall, Undulating and Difficult Environments?

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KEY MESSAGE

We have demonstrated the potential for controlled traffic farming (CTF) systems in undulating and dissected terrain, such as occurs in the Avon Valley of Western Australia. While compromising some of the objectives of CTF, a system based around ‘multi-width tramlines’ is relatively cheap and easy to implement and has benefits in terms of timeliness, efficiency and facilitating zone management. There has been no evidence of water erosion or run-off along tramlines running parallel to the slope to date. Work is continuing to quantify these impacts further and to determine the impact on long-term sustainability.

ABSTRACT

The sustainability of high production farming systems in the high rainfall Avon District of Western Australia is being investigated as a collaborative project between the Department of Agriculture and Food, Curtin University of Technology and the Western Australian No-Tillage Farmers Association. Paddock 30 at Curtin University’s Muresk Institute has been selected as the development site for this study with the approach of “putting the system back together”.

A CTF system based on ‘multiple width tramlines’ was adopted in 2005 following initial paddock benchmarking and analysis conducted the previous year. Detailed soil testing, radiometrics and analysis of previous years’ yield maps have been used to identify zones of production. A tramline approach is seen as innovative in the district by local growers due to perceived constraints of topography, diverse soils and a medium to high rainfall environment.

Investigations at the site currently focus on the practical elements of the cropping system in this environment. The limitations to yield, the consequences of high production farming on the system and the impacts of management options on production, profitability and sustainability are being examined. In this paper, the progress of the first two seasons at Paddock 30 is described. Practical issues with the implementation of CTF and future activities planned for the site are discussed.

INTRODUCTION

Crop yields in the shires of the central agricultural region’s high rainfall (400 to 550 mm) “Avon Valley” zone are historically low when compared to the water use efficiencies achieved by growers in the medium to low rainfall districts to the east (Russell, 2005). In many instances yields are about 60 to 70% of the water limited potential. Some growers in the district are able to achieve yields closer to 80 to 90%, but these are in the minority. In general, shire yields of cereal crops average about 2 t/ha when there is the potential to achieve 4 to 5 t/ha based on French and Schultz (1984) yield estimates.

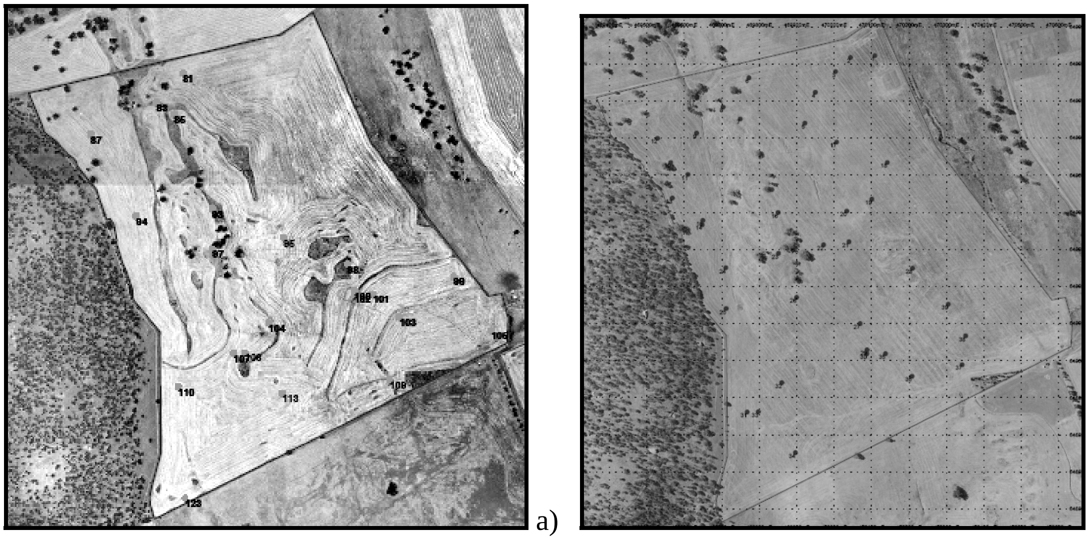
The Avon Valley zone has an area of just over 1.1 M ha of loamy valley and hillside soils. However, being a dissected landscape it suffers from issues such as extreme topography limitations of slope and rock and waterlogging of low lying areas. Farm sizes are also generally small compared to the state averages with the majority being less than 1,000 ha (Russell, 2006). On these farms cropping usually accounts for about 25 to 30% of the landuse, while pastures account for 40 to 45%, yet cropping delivers about 55% of the value of production for the typical farm. Constraints in the size of the farming operation are seen as limiting crop productivity in the district. In addition to this the Avon River itself is a major watercourse that flows into the Swan River. So the Avon Valley can be considered to be an environmentally sensitive region with downstream impacts possible for the urban community in the city of Perth.

CTF systems have not been widely adopted in the Avon Valley. Issues arise with the need for this to be compatible in the physical environment. Constraints are imposed on the adaptability of machinery with the standardising of wheel widths, along with operating stresses and machinery size and the costs of implementation. A possibility to overcome this is to develop landuse priorities for paddocks – those specifically suitable for cropping and those for grazing livestock based on the physical topography and operational size. In the case of cropping, gains in efficiencies of between 5-10% are considered to be made through controlled traffic in seeding and spraying (Webb et al. 2004).

Staff from the Department of Agriculture and Food, Curtin University of Technology and the Western Australian No-Tillage Farmers Association are involved in a collaborative project to assess the sustainability of high production farming systems in the Avon District. The use of CTF is viewed as one component of the system's methodology being used to achieve the aim of lifting crop productivity in this environment. The adoption of contemporary agronomic practices and the diagnostic amelioration of soil constraints to improve soil health are others. As such this is viewed as a test case for this practice of 'putting the system together'.

METHOD

Paddock 30 at the Muresk Institute, Northam was selected to investigate the practical elements of a high production cropping system (Fig 1). It met criteria covering accessibility, had a recent continuous cropping history and detailed records of paddock operations and yield mapping were available. The total paddock area is 89 ha with an estimated 81 ha considered arable. It has a slope mainly down to the north with a slight area sloping down on the south western edge. A water way also runs down to the northwest end of the paddock. Soils are mixed, light loam on the western edge with the balance being loam to clay. Rock heaps are also more prominent on the upslope areas of the southern half of the paddock. Since its cropping history made it likely to have built up a grass weed seed bank, TT canola (*Brassica napus*) cv Stubby was grown in 2004 as a cleaning crop to set the paddock up for the following year. In 2005 and 2006 the paddock was cropped to wheat (*Triticum aestivum*) cv Calingiri. In 2007 the paddock was sown to barley (*Hordeum vulgare*) cv Baudin.



a) b)

Figure 1. Aerial photographs of Paddock 30. a) Pre 2005, showing soil test sites marked for use in an earlier project. The location of now removed contour banks and non arable areas can be seen. b) Early 2006, with additional sampling sites and tramlines now established.

Detailed soil testing had been conducted at a number of sites (Fig. 1a) in the paddock during 2002 by Georgina Warren. as part of the CPSTOF project to develop 'Collaborative planning support tools for optimising farming systems', which was financed by the Australian Research Council (ARC-Linkage programme, LP0219752). These sites plus others were sampled in detail in March 2005 to make up 39 data sites (Fig. 1b) within the crop as sampling locations within the paddock.

In January 2005 a geophysical survey of the paddock was conducted by Geoforce. Terrain, EM31, EM38 and radiometric images were produced. The contour banks that were located up the slope at the southern and south eastern parts of the paddock (Fig. 1a) were removed in April 2005 as were the larger piles of rocks.

Tramlines running northwest–southeast down the longest slope were installed in May 2005. Two guidance systems were used—one in the seeder and the other in the boom spray—a borrowed steering assist programme and a ZYNK GPS, respectively. An ‘A B line’ was set-up to commence operations on the paddock. A variation of ‘multi-width tramlines’ (Webb et al 2004) was created by the best matching of the wheel tracks around the centres of the machines. The widths of the tractor tyres were 1.84 m, the seeder bar 3 m and the boom sprayer 2.4 m. The width of the boom (18 m) being twice that of the seeding bar (8.8 m) allowed for trafficking of every second seeder run. The harvester, while having tyre centres of 2.9 m, was offset as it had a comb width of 6.6 m and so was left out of the system (Fig. 2).

Machinery upgrades have occurred during the normal course of farm operations and a new tractor was purchased having dual wheels in 2007, so the effective width of the tramlines is now 1.4 m each (Fig. 2). This would be in keeping with many of the existing farming operations used in the Avon district and serves as a demonstration to neighbouring farmers as to how to adopt similar transitions.

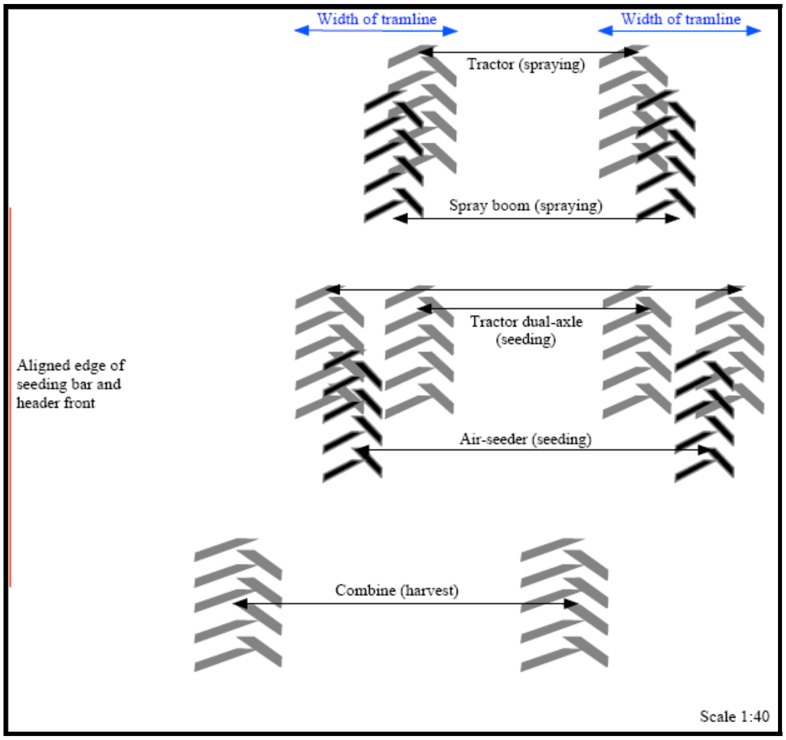


Figure 2. Schematic diagram of the multi-width tramline controlled traffic system being used on the paddock in 2007. Seeding and spraying operations are aligned centrally to allow for a reduction in the width of the tramlines with proposed adaptations to machinery. The combine harvester is not included in the system due to incompatibility of widths of the comb and seeding bar.

During 2005 and 2006, Paddock 30 was used as a teaching resource for Muresk's agribusiness students. Practical field work activities were conducted several times through the year and contributed to the collection of baseline information required in helping to ascertain soil properties, weed dynamics on the paddock and agronomic measures from the 39 sampling locations within the paddock.

Yield maps for the paddock have been made at harvest since 1996. In 2006 these data and the radiometrics information were dispatched for analysis to "SilverFox Solutions" from which management zones for the paddock were determined.

RESULTS

A detailed soil map developed from the 2005 radiometric survey showed a complex mosaic of seven soil types (Fig. 3). There is no one dominant soil type, though some are more prominent in certain areas of the paddock.

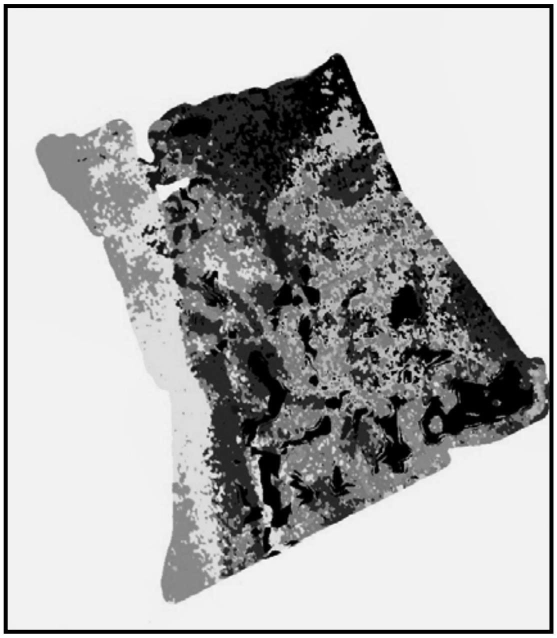


Figure 3. Soil map of Paddock 30 derived from radiometrics showing a complex soil type distribution.

Near average conditions prevailed for the 2005 season. May to October growing season rainfall was 327 mm. The crop was sown on multiple width tramlines (Fig. 4.) on 6 June and yielded about 2.76 t/ha as a paddock average. This is a production equivalent of about 8.4 kg/mm. In 2006 the paddock yields were much lower, despite a similar sowing date (12 June), due to an extremely dry growing season totalling 179 mm. The paddock average yield was recorded as 1.06 t/ha. Giving a production equivalent of 5.9 kg/mm. These yields were calculated from the tonnage of grain collected by conventional machine harvesting of the paddock.

Harvest estimates calculated from hand harvested samples taken from the 39 data sites gave a wide range of yields in both years (Table 1). The paddock averages derived from these data were much greater than the machine harvested values (probably due to errors associated with the estimated grain size used when calculating yield from the hand harvest samples). Three potential management zones were identified based on the radiometric and yield map data and related biomass imagery (Fig 5).

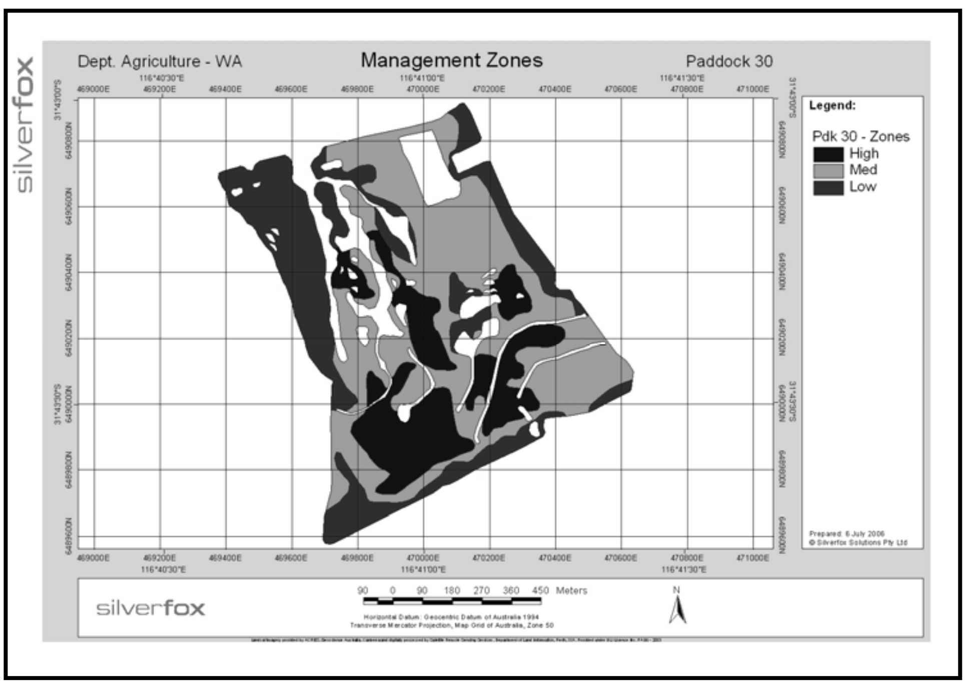
A number of qualitative and quantitative benefits have been identified to date. A small increase in area of about 4 ha has been measured due to the removal of the contour banks, rock piles and establishment of tramlines. The farm manager estimated that the time for seeding was about 40% faster than usual. As there was less overlap, use of fuel, time, seed and fertiliser, an overall estimated 10% increase in efficiency has been achieved.

a) b)

Figure 4. Crop establishment on multiple width tramlines in a) July 2005 and b) June 2007 with the new dual wheel tractor

Table 1. Wheat yields estimated from hand harvested samples

Year	**Lowest**	**Highest**	**Median**	**Average**
2005	1.818	6.591	3.864	3.989
2006	1.580	4.451	2.669	2.745



Fgure 5. Management zones determined for Paddock 30.

DISCUSSION

Despite still being under development and having only been used in two completely different seasons, the site has demonstrated some important practical issues and potential benefits of a CTF system in undulating, dissected terrain. The stepwise transition and upgrading of machinery is a realistic and pragmatic approach when considering the development of a system that can be used across a farm in such an area. With the current configurations of the machinery 0.32 ha is trafficked for each hectare cultivated (about 27 ha over the 85 ha now arable). This could be reduced to about 20% trafficked by reducing the wheel widths of the airseeder and boom spray and removing the outer duals. However, such changes need to be compatible with all paddocks on the farm, some of which require greater traction. While identification of cropping and pasture areas is possible, there needs to be flexibility in machinery to enable switching between these enterprises according to seasonal and economic considerations. In addition, there will always be mixed farming paddocks in such areas. The small increase in cropping area at this site was mainly due to the removal of obstacles. Similar small gains are likely to be replicated across paddocks in such terrain due to the removal of previously uncropped areas as a result of the change in the direction of tillage. Estimated increases in efficiency at the site are encouraging, but are not sufficient evidence of the benefits of a CTF system. These figures will be quantified in 2007 using a similar sized cropping paddock that is being cultivated according to current farm practice as a comparison.

The extremely variable environment is highlighted by the soil map derived from the radiometric survey and the range of yields from hand sampled locations across the paddock. This range of yields indicates the potential for additional benefits to be derived from zone management. Three management zones were identified but, due to the dry season, zone management was not implemented as planned in 2006. In 2007, it is planned that post-seeding fertiliser applications will be based on these zones.

The multi-width tramlines were created around the centres of the machines to enable reduction in the width of the tramlines over time as adaptations in machinery enable better matching of widths between machines. One issue that will require thoughtful consideration in the coming years will be how a CTF system is implemented with hay production. Hay production in the Avon Valley has become an increasingly important industry in recent years. Crop sequences are now often focused around hay as the main crop in a 1 in 3 to 1 in 5 rotation. Hay production requires more paddock traffic than cropping, representing a challenging situation to developing a CTF plan in a multi-pass system.

Background information on the paddock has been collected from Muresk records and these are currently being documented in greater detail to give a general overview of the history of the paddock. These, together with the detailed soils data collected by Warren, will serve as a useful benchmark upon which to match changes to soil properties in future years. After heavy rain in 2005 there was no evidence of run-off down the tramlines. Additional information on surface and sub-surface water and soil biology to be collected from 2007 will help to monitor environmental impacts of agronomic practices aimed at high productivity in this environment.

ACKNOWLEDGMENTS

1st Year students at Muresk for assisting in sampling in 2005 and 2006; Boekeman machinery for help in establishing tramlines. Mike Collins, previous WANTFA scientific officer.

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