# Management of Overland Flow in CT Systems in the Northern Agricultural Region, W.A.

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## INTRODUCTION

Surface water management may offer benefits in cropping systems that use relatively downhill and parallel cropping directions with controlled traffic. We still need to know more about the erosion risks of these systems, but experience to date for low slopes (<2%) has been relatively encouraging. Improved soil structure with better water infiltration rates from no-till and CT (controlled traffic) systems are generating less run-off, and in-furrow flow separation by relatively downhill and parallel working appears to reduce flow concentrations. Where adverse conditions have produced very low levels of ground cover and markedly reduced furrow depth, and this is combined with high intensity short duration summer storms, uncontrolled overland flow has occurred and caused visible soil erosion. Surface water control structures would still be recommended to minimize erosive overland flow in circumstances with poor traffic control, low levels of attached cover and set-stock grazing. Low crest broad-based grade banks which allow for continuous downhill operation, are being developed and trialled.

The increasingly widespread use of techniques such as tramline farming, controlled traffic, and autosteer, combined with very wide equipment means that working on the contour, and between grade or contour banks, is often not practical. Broad acre farmers have moved to achieving the longest straight and parallel working runs which are now measured in kilometres. Structures such as contour and grade banks that interrupt the long runs have been removed. It has been argued by many farmers that these structures are no longer necessary because of the observed reduction in run-off as a result of the adoption of minimum tillage and stubble retention practices.

A project was initiated with funding from NLP in collaboration with the Liebe Group to research the level of erosion risk that farmers face in the adoption of long run mainly downhill, parallel cropping CT systems. The aim is to provide information on ways to minimize the risk of erosion via a technical manual, field days and presentations; and in particular web-based information.

## FIELD OBSERVATIONS

These were undertaken at 4 sites: Riverside (Porter's) – 40 km N of Binnu; Mallee station (Groves) - 50 km north of Yuna; Pindar (Kerkmans) - 30 kms E of Mullewa; Buntine (Fitzsimmons) - 20 km East of Buntine; Sermon Road (Chappell's) – 30 km NE of Morawa.

The observations used the following methods:

a) Rainfall recording using a tipping bucket rain gauge to provide information on rainfall intensity and the duration of events.

b) Estimates of vegetative cover using quadrat counts.

c) Visual assessments of ridge stability - soil movement into furrows - surface wash and rilling or gullying - evidence of wind erosion - evidence of soil deposition.

d) Photographic records and physical measurements of rill and gully depth

e) Aerial photography analysis to establish water movement patterns after heavy rainfall events.

**Rainfall simulation:** (This was used as a technique for assessing maximum infiltration rates under storm conditions, rather than realistic simulation of natural rainfall). We used two methods:

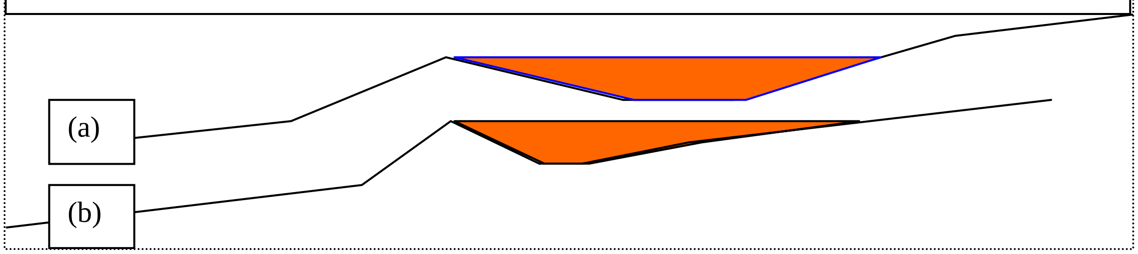
1. Collaboration with Landloch consultants from Toowoomba, Queensland in February 2006 measuring water runoff from simulated 100mm/hr rainfall events on paddock sites at Pindar and Buntine using a 2 m by 5 m area under an oscillating boom.
2. Use of a DAFWA mobile rainfall simulator with a 2 m x 2 m oscillating boom at Pindar, Buntine, Mallee Station, Riverside, and Sermon Road in May 2007, to help relate infiltration behaviour to soil structure and develop a simple visual indicator to predict maximum infiltration rates.

## INSTALLATION OF TRIAL BROAD-BASED ROLL-OVER BANKS

[A broad-based roll-over bank is a low profile earth structure, surveyed on a gradient, with a wide flat channel that enables farm operations (seeding, spraying and harvesting) to be carried out at right angles to the direction of the bank. The bank would discharge into a grassed waterway. The main features are minimal interference with long run, downhill CT farming and no loss of arable area.]

Using design criteria originally developed in Queensland – the first trial at Buntine involved the modification of an existing grade bank to form a broad-based bank, and the second at Pindar was a new structure. The broad-based bank has a channel increased to between 4-5m compared to a conventional grade bank with a channel width of 1-2m. The bank construction straddles about 20 to 25m but now the whole bank area can be sown to crop. The bank was traversed by air-seeder in the planting operation with ease, but operation of a spray rig was more difficult and slower.

Comparison in shape and size between (a) new broad-based bank and (b) original grade bank at Buntine




Issues arising from cropping operations over the broad based bank in the 2006 winter growing season were:

1. Poor depth of seeding control on the crest of the bank, despite some capacity of the seeder to follow ground contours (DBS design).
2. Poor crop growth on the crest of the bank, probably due to poor crop nutrition in the ‘sour’ soil exposed from the centre of the original bank.
3. Difficulty traversing the bank with the spraying equipment (‘whip’ at the ends of the spray boom); it would be even more difficult at approach angles other than 90$^{o}$, depite slowing down.

4. Impracticality of harvesting the crop parallel to the direction of sowing; harvesting was done parallel to the bank alignment.

These issues have highlighted the need for more machinery design and development work.

Figure1. Air seeder unit traversing broad-based bank at Buntine 2006.

## QUEENSLAND EXPERIENCE AND RESEARCH

Controlled traffic in broadacre farming has been applied in the cropping areas of Central Queensland and the Western Downs since the early 1990's mainly on land with slopes of less than 2%. There were uncertainties relating to potential runoff and soil erosion levels that prompted researchers to investigate the implications of the widespread adoption of CT farming in relatively downhill and parallel cropping directions. The following are some outcomes.

Li et al. (2001) found that "the steady infiltration rate for non-trafficked soils was 4 to 5 times greater than for trafficked soil regardless of cover levels but the presence of cover led to increased infiltration rates for both states". Tullberg et al. (2001) conclude that "an important issue is the reliability of having high cover levels present. If cover cannot be retained due to drought, tillage or other reasons, then the soil erosion risk is increased". Titmarsh et al (2004) write that "there is a consensus that contour banks are still required (on sloping country) regardless of traffic lane orientation. Where the layout requires farming over contour banks, the banks require flatter batters and higher maintenance. CTF field layouts (farming practices) that combine maintenance of soil cover with reduced tillage are very effective in this endeavor" (i.e. give the best combination of runoff and soil erosion minimization). "Further, it has been shown that traffic lane orientation influences runoff and soil erosion with lower gradient orientations resulting in less runoff and soil erosion". (Titmarsh et al point out that the field studies have been undertaken during low rainfall years)

## OBSERVATIONS / RESULTS

Rainfall for the 2005-2006 seasons in the Northern Agricultural Region has been the lowest for years with areas in the north and east being declared drought affected. Field observations registered extremely low levels of cover, with the site at Riverside having significant wind erosion, and Mallee Station with heavy grazing pressure, which reduced furrow ridge heights to almost zero. This had dramatic effects at Riverside where a high intensity summer storm caused large scale overland flow and significant topsoil movement - the reduced capacity of the downhill furrows was not able to contain the rainfall volume (see Figure 2).

Runoff was measured with a simulated 100mm/hour rainfall event (collaborative effort between Landloch Consultancy and DAFWA) in paddocks at Pindar and Buntine with stubble cover levels of 5-10% in

February 2006. The greatest runoff rate was from the tramlines in a downhill working system (slopes 1.5 - 3%), and the least runoff from a deep cultivated soil between the tramlines, where the compaction had been removed. As the tramlines cover only 15 – 20% of the overall paddock area, there was less runoff from the downhill working than a cross slope system provided the soil was not compacted.

Further simulation work, using similar rainfall intensity, was undertaken at all of the five sites in May 2007 – similar results were observed with the effects of further reduced cover levels producing increased run-off rates across all sites.

Figure 2. Riverside site after 46 mm in 30 min. rainfall event in December 2006

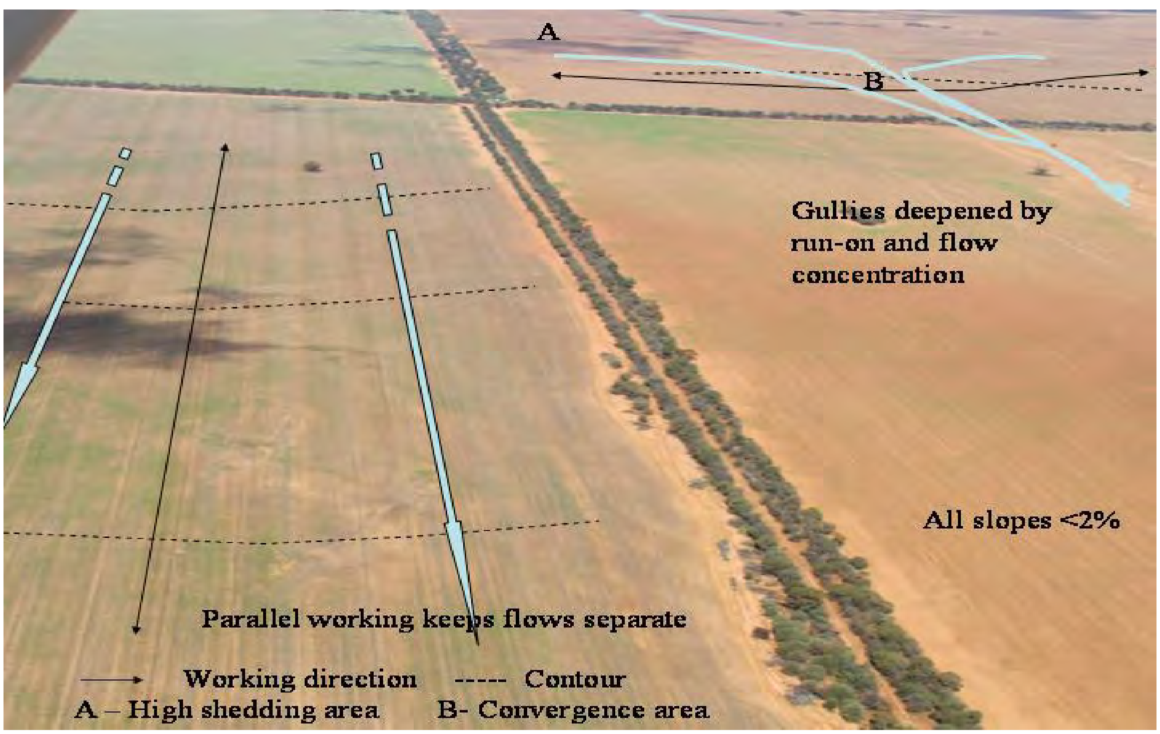



Figure 3- Aerial photograph (May 2005) of Sermon Road sites - contrasting effects of working up and down, and across the slope. Bottom left stable site in full cover and ungrazed; top right unstable site with low cover, run-on from high shedding area and flow concentrations by cross slope working.

Table 1: Summary of observations made over 3 years linked to potential risk and the main drivers/features that modify the risk level.

| Case Study | Observation from Rainfall simulation | Support for general concept | Erosion/ Runoff risk | Observation over 3 years | Key features |
|---|---|---|---|---|---|
| Sermon Rd Downhill | Less runoff between tramlines with good cover | NT+CT + no stock -low need for banks on slopes <2% | Safe | Some runoff esp. on tramlines | Good traffic control No grazing /stubble retention promotes infiltration – furrows stay intact for flow separation |
| Sermon Rd Ariel paddock Across slope | Flow concentration at low points | Cover in inter row | High risk in intense storms | Cascade down slope to form rills – gullying at main convergence | Furrows overflow at convergence points – upland run-on areas with high shedding capability. |
| Riverside | Stubble loss from wind - drought. Levelling of ridges - still more infilt. in inter-row | NT+CT + no stock. Root mass in furrow – still good infilt. Upland area slope >4% | Low on slope <2% Moderate to high- on upland | Cover loss from dry season and wind – ridges flattened – storm caused overland flow and top-soil removal | Good traffic control No grazing /stubble retention – bank needed to reduce flow velocity from upland area |
| Pindar | More runoff in areas with wide row spacing | NT+CT + no stock. | Low on slope <2% Moderate to high on upland | Stable | Good traffic control No grazing /stubble retention – bank needed to reduce flow velocity from upland area |
| Mallee Station | No cover No defined furrow/ridges - low infilt. rate | Heavy grazing (set stocked), and soil loosening | High risk in current condition | Unstable – Surface loose | Grazing regime needs serious review Consistent traffic control areas needed |
| Buntine | Ripped sandy soil - good infilt. | NT+CT Managed grazing | Low | Stable | Consistent traffic control areas needed |

## CONCLUSIONS

Soil erosion by water can be viewed as a direct product of runoff and soil condition – the better the soil condition the greater the infiltration which in turn generates less run-off. The gentler the slope the less erosive power for the runoff produced.

More downhill operations at low slope may not be as risky as first imagined; however the risks are greatly increased by poor surface cover and low permeability soil structure. Where long working runs are used, broad-based banks (or other flow control measures such as filter strips across the slope) should be installed to manage flow length, cumulative flow volume and velocity.

To reduce soil erosion risk, it is vital that CT Farming layout and practices:

a) maximize rainfall infiltration by maintaining good soil structure, maximum traffic control and cover levels

b) have crop furrows draining to a safe disposal point with no reverse gradients or low spots

c) retain runoff generated within each traffic lane or furrow

d) maintain soil surface roughness in the crop area to increase erosion resistance

e) ensure that furrow gradients are considered when orientating the runs, to minimize any soil movement.

## REFERENCES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