Hillslope Erosion Trial – Jetsonville 2021

Demonstrating the cost-effectiveness of soil protection methods

Key Findings

- *Leaving soil bare through an intense rainfall period is an expensive option.*
- *Utilising any of the erosion control techniques was more beneficial than leaving the soil bare.*
- *Sowing a cover crop gave an 8:1 return on the investment.*

Overview

Tasmania's most productive vegetable growing areas have long suffered from significant hillslope erosion due to high rainfall, sloping paddocks, and crops that require bare seed beds.

Satellite images show red/brown flumes of soil being washed out to sea from intensive vegetable production areas following intense rainfall, resulting in the loss of some of Tasmania's most nutrient-rich soils.

The Hillslope Erosion Sub-Project established trial sites in areas of northern Tasmania with intensive cropping enterprises and high susceptibility to hillslope erosion, such as Deloraine and Scottsdale.

The trial sites were established to investigate the cost-benefit ratio of different erosion control methods and build awareness of hillslope erosion. Using these results, NRM North aims to demonstrate the cost-effectiveness of protecting soil from erosion.

Figure 1. Satellite image of Pipers, Brid, Forester estuaries and sediment plumes following heavy rainfall. Image taken 18 July 2021.

Trial Site

The 2021 trial site was located in Jetsonville, in a paddock sloping towards the Scottsdale-Bridport Road. Five treatment plots were established at 10m across X 25m up the slope, with a 4m buffer between them. Prior to the trial, the paddock had an onion crop harvested in May. Sheep grazed the paddock for a short period following harvest then the entire paddock was contour ripped in early June.

Australian Government | National Landcare Program

The Hillslope Erosion Sub-Project is supported by NRM North, through funding from the Australian Government's National Landcare Program.

Early winter rainfall meant that machinery could not be used on the site, therefore, trial plots were established by hand. This involved smoothing out the rip lines to create a flat seed bed on two of the five plots. Tama annual ryegrass seed was spread on three of the plots.

On 30 June, 190 notched bamboo pegs were inserted into the soil on each plot. The notch of each peg was flush with the soil level and placed in a standardised pattern across all plots.

Figure 2. The cover crop on the trial site was clearly visible to motorists on the Scottdale-Bridport Road.

The ripped, cover crop treatment intended for early termination (a practice designed to facilitate breakdown of the cover crop mass in time for Spring sowing of the next cash crop)

Figure 3. The fertile soil and high rainfall resulted in vigorous growth in the cover crops, making it challenging to find the erosion monitoring pegs for measuring.

was sprayed with glyphosate, using a knapsack sprayer on 1 September.

After the cover crop was sprayed, contractor availability, wet and windy conditions meant the bare plots were not able to be sprayed until the start of November. As a result, the plots designed to remain fallow had grown a mat of weeds during the last two months of the trial, reducing erosion.

Figure 4. Steel rulers were used to measure the difference between soil surface and peg notch.

The erosion-monitoring pegs were measured and removed by NRM North staff on 17 November. Staff measured the difference between the soil height and the peg notch.

The 950 data points were calculated for mean and median soil height difference.

Results

The findings from the trial reveal all plots experienced a decrease in soil height (erosion) and that the extent of erosion is generally reduced when soil protection methods are used.

Table 1. Average soil height change from the five treatment plots.

TREATMENT	SOIL HEIGHT (MEAN)	SOIL HEIGHT (MEDIAN)	MEAN SOIL LOSS/HA*
Bare fallow (smooth bed)	-8.6 mm	-8.7 mm	86 T
Cover crop (smooth bed)	-4.9 mm	-4.4 mm	49 T
Contour-ripped bare fallow	-7.6 mm	-5.5 mm	76 T
Contour-ripped cover crop	-4.7 mm	-5.1 mm	47 T
Contour-ripped cover crop early terminated **	-8.4 mm	-6.7 mm	84 T

*One millimetre of soil depth over a hectare means 10 m^3 of topsoil. A bulk density of 1 (ferrosol topsoil) equates to 10 T of topsoil. Soil loss results have been extrapolated to hectares for each plot.

**This high level of erosion is likely due to early cover crop termination, followed by bare soil for weeks through Sept/Oct/Nov rainfall, compared to the bare fallow plot which grew a cover of weeds over the same period.

Table 2. Cost per hectare for each treatment.

TREATMENT	COST OF EROSION	COST OF TREAMENT	TOTAL COST/HA***
Bare fallow (smooth bed)	$4,451	$50	$4,501
Cover crop (smooth bed)	$2,558	$220	$2,778
Contour-ripped bare fallow	$3,942	$160	$4,102
Contour-ripped cover crop	$2,460	$330	$2,790
Contour-ripped cover crop early terminated	$4,368	$330	$4,698

***These costs were produced using v1.1 of the Tasmanian Erosion Economic Calculator and include the cost of seeding treatment, tillage, spraying and assumed loss of topsoil carbon, lime and nutrients, per hectare if using mean soil height change data. Nutrients and carbon costed at late 2021 prices. Cost of treatments taken from 2021 Agricultural Contractors of Tasmania Handbook.

Discussion

The Jetsonville trial results and economic analysis contribute further evidence to the 2019 trial at Weetah that spending money on cover crops or tillage to reduce erosion risk through winter and early spring is most often a cost-effective investment in Tasmania's higher-rainfall agricultural zones.

Figure 5. One month through the trial, soil level change was already visible.

In both trials, bare fallows led to the most erosion and were, except for the early-terminated ripped cover crop this year, the most expensive option to a farm business. Particularly if that soil is lost to a neighbour, road verge or waterway. Findings from both trials show that when the cost of high-fertility topsoil for vegetable cropping is considered; the total cost of erosion and erosion management (tillage, seed, spray) is usually lower when soil protection methods are adopted.

In perspective, 1 mm of soil lost over a hectare corresponds to 10 m^3 of topsoil. Using a bulk density of 1 (for ferrosol topsoil), this equates to 10 T of topsoil. Therefore, the average soil depth change for the bare fallow in this trial was 8.6 mm, or 86 T of topsoil lost per hectare.

As expected, the combination of contour-ripping and cover crop was the most effective treatment in reducing erosion. However, it was only marginally more effective than cover cropping alone, while carrying the additional cost of the soil ripping.

Figure 6. Weed coverage on the fallow plots could not be sprayed out through October due to wet and windy conditions.

For the bare fallows, contour ripping only resulted in a slightly lower level of erosion (1 mm) compared to the smooth seedbed, when it was expected that the benefit would be greater. However, the 1 mm figure is calculated using the average of the datapoints, but the median indicates a 3.2 mm reduction in erosion from contour-ripping. As averages are very sensitive to outlier values (extreme values in a dataset), this has affected these final values. Outlier datapoints were of higher prevalence in the fallow plots, likely due to the higher occurrence of soil 'clods' which dislodged during heavy rainfall, creating deeper depressions in the plots.

The contour-ripped early terminated cover crop results do not reflect usual farm operations. Generally, a crop would be sown a few weeks following cover crop termination, rather than the plot remaining fallow for another ten weeks - which was the case in this trial. High October rainfall and contractor unavailability meant the planned cash crop was unable to be sown through October. In this situation, in terms of the cost of erosion, spraying out the cover crop early was not a good option due to the circumstances.

It is assumed that the soil loss of 4.7 and 4.9 mm in the cover crop plots likely relate to the later sowing than usual (30 June). Significant July rainfall and erosion is likely to have occurred prior to the canopy closure and subsequent soil protection. Sowing the cover crop shortly after the onions were harvested in May would have likely seen better results.

While no data collection or assessment was carried out on soil biology in this trial, by observation it was clear that the cover crop maintained and/or stimulated soil biological activity whereas the fallow plots did not. Co-benefits from cover cropping that are not included in the analysis of this trial, could include maintenance or improvement in soil structure, soil carbon and beneficial soil biology such as mycorrhizal fungi.

When travelling to the site over the course of the winter-spring trial period, NRM North project staff observed many bare fallow paddocks and incidences of erosion in the larger Scottsdale area. While the heavy rainfall events through autumn would have made it difficult for farmers to establish suitable erosion controls in time, we hope that the results of this trial will lead to increased adoption of soil protection techniques in the local farming community.

Note that this trial assumes that soil is lost from the property, into places such as waterways, roads, or neighbouring farms. In situations where soil erosion results in topsoil deposition in dams or at the bottom of a paddock, there are financial costs associated with redepositing the soil onto the slope, and a subsequent loss of soil structure. These costs and consequences were not considered in this trial.

Key Take Home Messages

- Cost-effectiveness of erosion control techniques were tested. This included the cost of sowing, spraying, and ripping. As well as the cost of losing topsoil carbon and nutrients.
- Leaving a seedbed bare through the high rainfall period led to the most erosion
- Only the early-terminated, ripped cover crop plot was more expensive than the bare, smooth fallow
- Even a late-sown basic cover crop gave an 8:1 return on the investment

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Tasmanian Erosion Economic Calculator

The calculator used to estimate financial costs of erosion, as reported here, can be accessed from: https://nrmnorth.org.au/land/hillslope-erosion-project/

The calculator is a free tool that was developed to enable members of the agricultural community to understand their own financial risks of erosion, and the potential costs of inaction.

Acknowledgements

Special thank you to Cameron Moore (Moore's Farm Fresh Vegetables, Jetsonville) for allowing NRM North to use one of your paddocks for the demonstration site and allowing us to hold subsequent trial related events on the farm.

Thank you to Elders Scottsdale for sponsoring the Hillslope Erosion Trial Christmas Wrap-Up dinner and to Frank Mulcahy (PotatoLink), Ian Parr (Plant Diagnostic Services) and Ossie Lang (RMCG) for donating their time to speak at the event.

Figure 7. The erosion-monitoring pegs were measured and removed by NRM North staff on 17 November. Staff measured the difference between the soil height and the peg notch. The 950 data points were calculated for mean and median soil height difference found in Table 1.

APPENDIX

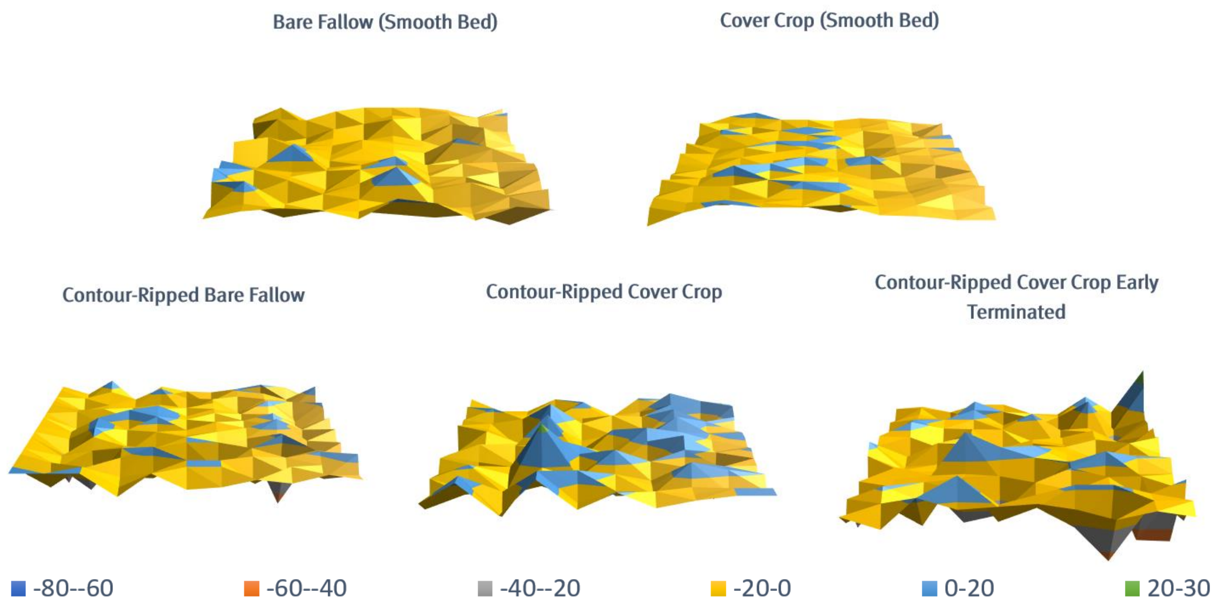
Local Rainfall During Trial Period

Bureau of Metrology rainfall data from the Scottsdale weather station (091219):

MONTH	AVG. RAINFALL	ACTUAL RAINFALL (MM)	NOTES
May	95.8 mm	54.6 mm	
June	100.8 mm	112.6 mm	Trial site established; cover crop sown.
July	119.5 mm	167.4 mm	
August	116.1 mm	37.6 mm	
September	93.9 mm	73 mm	
October	81.3 mm	155.8 mm	38.8mm of rainfall received 15 October
November	67.1 mm	51.2 mm	Before pegs measured on 17 November
TOTAL	**674.5 MM**	**652.2 MM**	

Soil Depth Change Maps

These charts represent soil depth change data mapped according to the placement of the individual monitoring pegs. In each case the left side is the upper part of the slope, running downhill to the right. Colours represent data categories of depth changes in 20mm increments.



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