

8.2 Surface Drainage Systems To Reduce Waterlogging Of Pastures - Derrinallum, Vic

Location:

14km south west of Derrinallum 38° 2'S, 143° 8'E.

Funding:

Grain & Graze Program, DPI

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Rainfall:

2006 total: 409 mm;
April – November 2006: 262 mm.

2007 total: 634 mm;
April – November 2007: 403 mm.

Summary of Findings:

During 2006 and 2007, a field trial designed to quantify the effect of two different surface drainage strategies of pasture (hump & hollow and raised beds) on farm productivity, profitability and sustainability was conducted on a commercial farm near Derrinallum.

Under the rainfall conditions experienced for the two years of the trial, it is concluded that the use of raised beds for the growing of pastures for grazing has little to offer the sheep industry. On the basis of the data obtained in this trial, it is recommended that the hump & hollow system is the preferred method of surface drainage for sheep grazing systems in this environment and should be promoted in the region. Major findings included:

- In both years, total annual pasture dry matter (DM) yields from the raised bed treatment were substantially less than for the undrained and the hump & hollow treatments.
- In the drought year of 2006 the raised bed treatment grew 37% (2.8 t DM/ha) less while the hump & hollow treatment grew only 7% (0.6 t DM/ha) less than the undrained (total of 7.6 t DM/ha).
- In the higher rainfall 2007 year the raised bed treatment produced 15% (1.6 t DM/ha) less pasture than the undrained. In contrast, the hump & hollow grew 10% (1.1 t DM/ha) more than the undrained (total of 10.7 t DM/ha) in 2007.
- The reasons for the lower than expected pasture yields on the raised beds are speculated to be a combination of low yields in the furrows, poorer plant establishment and density on the beds, and a reduction in the water holding capacity of the soil relative to the other treatments.
- Soil physical health was however considerably better on the raised beds than the other treatments. Aeration porosities at field capacity in November 2007 were a very healthy 16.3% in the raised beds, a moderate 11.8% for the hump & hollow and a poor 7.0% for the undrained.
- No significant differences in ewe or lamb weights at weaning were found between treatments in either year. This was most likely due to the set stocked sheep having pasture on offer in excess of requirements for most of the spring. In 2006 however, the raised beds were stocked at around 1 ewe/ha less due to the lower pasture growth rates.
- From a catchment and general environmental health perspective, the water run-off results raise some concerns about the environmental impact of growing and grazing pastures on raised beds.
- The raised beds proved to be very effective in removing excess water from the pasture. Over 2007, the raised bed treatment (47.1 mm) had 170% more runoff water than the undrained (17.4 mm) while the hump & hollow (26.7 mm) had 53% more runoff.
- Both drainage treatments had considerably higher concentrations of, and total loads of phosphorus (P) and nitrogen (N) in runoff water. Of particular concern were the losses of 0.5 and 0.4 kg P/ha for the raised bed and hump & hollow treatments respectively compared to 0.1 kg P/ha for the undrained in 2007. For N, corresponding losses were 6.3, 2.1 and 0.9 kg N/ha for the raised beds, hump & hollow and undrained respectively.
- It is recommended that if raised beds are to be used for grazed pastures, then the best practice recommendations developed for raised bed cropping also be applied to pasture.

Background:

Earlier research by SFS in south west Victoria has clearly demonstrated that a reduction in winter waterlogging by surface drainage can lead to substantial field crop yield increases in areas previously considered too wet for winter crops. Other preliminary research suggests that there may also be productivity gains to be captured by shortening the period of water logging of pastures during winter in these areas. This trial was conducted to investigate the effect of two different methods of surface drainage ("raised beds" and "hump & hollows") of pasture compared to an undrained control treatment on farm productivity and the potential impact on the environment.

Trials site and design:

The trial was conducted on the "Grain & Graze" program surface drainage demonstration paddock established on the property of Darren and Michelle Evans, Kurweeton Road Derrinallum. The 23 ha paddock had raised beds (2m wide) and hump and hollow (25 m wide beds) drainage installed on approximately one third each of the paddock during the autumn of 2005, with the remaining one third of the paddock being left as an undrained control area in an unreplicated design. The paddock was fenced along the boundaries between treatment areas to form six small paddocks; two in each drainage treatment. During January-February 2006 a road grader was used to form hydraulically isolated treatment catchments in each of the western side of the raised bed, control and hump & hollow treatment paddocks. Each of these catchments were 2.5ha in size and had flumes and automated water measurement and sampling equipment installed to collect surface runoff water.

In the autumn of 2006 and 2007, the trial areas were direct drilled with 25 kg/ha of "Crusader" Italian ryegrass and a mixture of 10 kg/ha of "Crusader" Italian ryegrass and 15 kg/ha of "Abundant" annual ryegrass respectively. A Glyphosate knockdown herbicide was applied prior and the seed was drilled with 80 kg/ha of diammonium phosphate fertiliser in both years. An aerial application of 100 and 120 kg/ha of urea was applied to the trial in July 2006 and 2007 respectively to boost early pasture growth. All treatments were stocked with Coopworth ewes and lambed down on the trial. Ewe liveweights and condition score were recorded when placed on the trial and at weaning time. Lamb liveweights and lambing percentage were also recorded at weaning.

► **Photo 8.3: Extensive soil testing demonstrated that the soils on the raised bed treatment had much better physical health than the other treatments.**

A range of other productivity and environmental parameters were monitored and recorded throughout both years including:

- Pasture growth - measured using a system of moving pasture cages in the grazed pasture with falling plate pasture meter measurements and calibration cuts being taken every 21 days during the growing season.
- Pasture botanical composition and feed value - additional pasture cuts were collected at each harvest.
- Animal production – change in ewe liveweight, lamb growth.
- Soil physical condition or health - monitored by collecting and analysing intact soil cores in early winter and again in late spring.
- Runoff from each treatment – was recorded using automated flumes and water sampling equipment throughout the year. Chemical analysis of the water samples then allowed calculation of nutrient losses to surface waterways from each treatment.
- Other wet soil results including soil strength (susceptibility to pugging), pugging damage and the height of the perched watertable were recorded.



Results:**Pasture Yields:**

Due to the drought conditions experienced during 2006, total pasture yields for the year were low with the undrained treatment producing 7.61 tonnes Dry Matter/hectare (t DM/ha) (Table 8.5). Both surface drainage treatments had lower yields with the hump & hollow treatment producing around 0.5 t DM/ha and the raised beds producing 2.8 t DM/ha less. It is likely that these surface drainage systems reduced the amount of water in the soil profile available for pasture growth. In the higher rainfall 2007, the hump & hollow treatment yielded the highest with 11.71 t DM/ha, some 1.1 t DM/ha more than the undrained. However even in this wetter year, the raised bed treatment still yielded some 1.6 t DM/ha less than the undrained. The lower yields of the raised beds are thought to be a combination of lower sown plant numbers on the beds, the lower yields of the furrows and a reduced water holding capacity of the soil in these treatments.

Soil Health:

Despite having lower pasture production, the raised bed treatment had soil in much better physical health or condition (Table 8.6). In particular, the aeration porosity (that is how well aerated the soil is) at field capacity was at a very healthy 16.3% for the raised beds in November 2007. This was even after being compacted during wet soil periods in winter-early spring as evidenced by the increase in bulk density of the soils of all treatments from July 06 to November. In comparison the undrained treatment had an aeration porosity at field capacity of 7.0% at this time - a value well below the well accepted critical level of 10%, below which plant growth is believed to be reduced. The hump & hollow treatment in comparison had a moderate aeration porosity at field capacity of 11.8%. Despite having soils in physically better condition, the raised bed soils still could not grow as much pasture as the undrained or hump & hollow. This may have been in part due to the lower water holding capacity of the raised bed soils – likely to be a result of this soil having more large air pores, and fewer, smaller water storing pores.

▼ **Table 8.5: The total annual yield (tonnes Dry Matter/hectare) of pasture growing on the undrained, hump & hollow and raised bed treatments during 2006 and 2007**

Year	Undrain- ed	Hump & Hollow	Raised Beds weighted ¹	Raised Beds Tops	Raised Beds Furrows
2006	7.61	7.05	4.81	4.77	5.06
2007	10.65	11.71	9.07	9.68	4.61

¹ Based on 1.7m width top of beds and 0.3m furrow width

▼ **Table 8.6: Effect of drainage treatment on the bulk density (kg/L), aeration porosity at field capacity (% V/V) and plant available water (mm) in the top 100 mm of surface soils in July 2006 and November 2007**

Soil Physical Parameter	Date of Test	Undrain- ed	Hump & Hollow	Raised Beds
Bulk Density (kg/L)	Jul 06	1.19	1.29	1.17
	Nov 07	1.36	1.33	1.27
Aeration Porosity At Field Capacity (% V/V)	Jul 06	6.5	11.4	15.7
	Nov 07	7.0	11.8	16.3
Plant Available Water in the top 100mm of soil (mm)	Jul 06	28.5	19.8	17.8
	Nov 07	24.7	21.2	20.2

Runoff and nutrient loss:

No runoff was recorded from any of the treatments during the drought 2006 year. During the much wetter 2007, there were eight recorded runoff events from the trial. The raised beds were very efficient at removing any surplus rainfall having a total of 47.1 mm of runoff for the year compared to 26.7 mm for the hump and hollow and only 17.4 mm for the undrained treatment (Table 8.7). This runoff carried with it varying amounts of phosphorus (P) and nitrogen (N). Average concentrations of P in the runoff water for the two drained treatments were over double that of the undrained. This together with the greater runoff from these treatments resulted in the hump and hollow and the raised bed treatments having four and five times the total amount of P running off the paddock compared to the undrained treatment. (Table 8.7). Similarly, the average concentrations of N in the runoff water from the drained plots were in the order of two and three times that of the undrained. This resulted in the hump & hollow treatment losing over double and the raised beds six times the amount of N per hectare compared to the undrained. Given such results, it is recommended that if raised beds are to be used for grazed pastures, then the best practice recommendations developed for raised bed cropping also be applied to pasture.

▼ **Table 8.7: The total runoff (mm) of water, average concentration of phosphorus (P) and nitrogen (N) (mg/L) in that water and the total load (kg/ha) of P and N lost in run-off from the three drainage treatments during 2007**

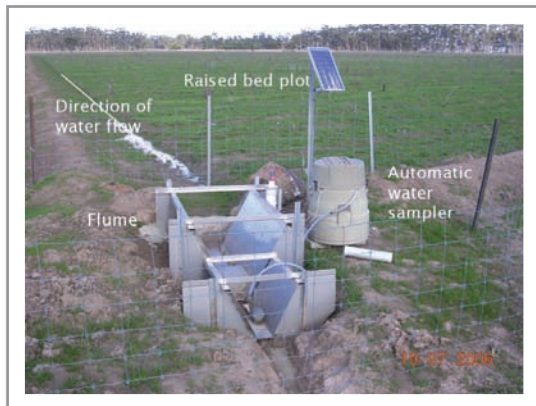
Drainage Treatment	Runoff (mm)	Phosphorus		Nitrogen	
		Av. Conc (mg P/L)	Total Load (kg P/ha)	Av. Conc (mg N/L)	Total Load (kg N/ha)
Undrained	17.4	0.6	0.1	4.7	0.9
Hump & Hollow	26.7	1.6	0.4	8.0	2.1
Raised Beds	47.1	1.3	0.5	16.8	6.3



▲ **Photo 8.4: Poor groundcover on the top of the raised beds would have contributed to elevated runoff generation and nutrient loss in runoff.**



▲ **Photo 8.6: Earth banks and perimeter drains prevent outside water running onto the undrained treatment plots.**



▲ **Photo 8.5: Flume and automatic water sampling equipment used to measure the volume of runoff water and collect water samples for nutrient analysis from the raised bed trial area.**



▲ **Photo 8.7: Pasture on the raised bed treatment showing the reduced plant density that contributed to the lower pasture production of this drainage treatment.**