9.2 The Farming Systems Trial

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Researchers

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Research Objective

Development of profitable and sustainable farming systems for the high rainfall regions of Southern Australia

Background

The Farming Systems trial is currently the largest single field experiment conducted by the Southern Farming Systems (SFS). The experience gained by SFS over the years with raised beds as a means of alleviating waterlogging is further tested within this long-term 'Systems' trial as superimposed drainage treatments. Crops and pasture rotations are run on different sub-soil types into which the different drainage treatments viz. wide (20m) and narrow (1.7m) raised beds have been introduced. Grazing of sheep on these raised beds during the pasture phase makes this experiment unique; the first to study the long-term effects of crops and pasture rotations on soils generally prone to waterlogging in the high rainfall cool climate zone of southern Victoria.

The experimental area consists of 14ha, with 36 plots each measuring 0.4ha in extent. Four different sub-soil types have been identified (Adcock and MacEwan, 1999) in the trial area which are expected to behave differently in response to bedding and waterlogging.

Aims

Identify the most suitable crop/pasture grazing rotations on raised beds.
Compare the quantity and quality of soil water within and flowing from the different raised bed systems.
Identify modifications to soil structure by the adoption of raised beds.
Monitor changes in soil organic matter under different crops and pasture rotations and its impact on crop water balance and yield response.
Determine the quantity and quality of grain and pasture produced under the different raised bed systems.
For logistical reasons aim (b) is being researched at a different location at Mt. Pollock)

Hypothesis

"that drainage of waterlogged soils in southwest Victoria through the use of raised beds will increase crop and pasture production with no detrimental effects on the environments".

Rotation Treatments

The merits of three different rotations are being evaluated, on which the two different drainage treatments have been superimposed. The rotation treatments are:

- Continuous cropping (Wheat, Barley, Canola and Field Pea)
- 2 x 2 rotation (annual pasture)
- 4 x 4 rotation (perennial pasture)

The story so far.....

The drainage treatments were installed in March 1999. In the preparatory year (set up year for the rotation) crops and pastures were raised on the flat and their yield monitored. Wheat (6.9t/ha), Barley (5t/ha), Canola (4.3t/ha) and Field Pea (5.9t/ha) all yielded higher than district average, but due to below average rainfall during the growing season did not show any yield differences as a result of differences in sub-soil.

The long-term and growing season (May -Nov) rainfall in Gnarwarre are shown in Table 2. The marginal decline in the long-term average rainfall for the 1990-96 period was the result of poor rainfall in 1994 and 1996. This trend to decline has continued with below average rainfalls in 1997, 1998 and 1999. Because of this continuing trend, the 'anticipated' effects of waterlogging were not observed in 1999. However, differences in crop growth rates between wide and narrow raised beds and between the centre and edges of wide raised beds were observed to end October 1999.

The following Table gives the summary of crop yields (T/Ha) for 1999.

Crop	Narrow Raised Beds	Wide Raised Beds
Canola	1.9	1.8
Wheat	3.2	3.8
Barley	3.9	4.0
Field Pea	1.7	2.6

Differences in Total Dry matter production by the crops on different beds at end October 1999.

Plot Number	Soil Type	Crop	Drainage	TDM (t/ha) Centre	TDM (t/ha) Edge
A1	B	Wheat	WR	6.9	6.1
A5	B	Canola	NR	7.5	
A6	B	Wheat	NR	6.0	
B2	C	Barley	NR	6.7	
B3	C	Canola	WR	7.9	3.9
B4	B	Barley	NR	6.0	
B6	B	F.Pea	WR	3.9	2.7
C3	B	Wheat	NR	5.8	
C4	B	F.Pea	NR	2.6	
C5	B	Canola	WR	5.4	4.5
C6	B	F.Pea	WR	2.5	2.7
D1	C	Wheat	WR	6.1	6.1
D2	C	Canola	NR	6.4	
D4	B	Wheat	WR	5.9	5.1
D5	B	Barley	WR	8.0	5.8
E1	D	F.Pea	NR	4.0	
E2	D	Wheat	NR	7.1	
E4	D	Canola	WR	4.8	4.0
E6	B	Canola	WR	5.1	4.4
F1	A	Canola	NR	4.6	
F2	A	Barley	WR	9.6	7.2
F3	A	Wheat	WR	6.9	4.4
F4	A	Canola	NR	6.0	
F6	A	Wheat	NR	5.0	

Note: TDM-Total Dry Matter; WR-Wide raised bed; NR-Narrow raised bed; A, B, C and D refer to different soil types

It appears that many factors contribute to these apparent differences. Crop phenology certainly appears to be affected in the different bed systems contributed by the differences in organic matter, depth and quality of topsoil and their hydraulic properties. Table 3 shows the organic matter (organic carbon) content and the gravimetric water content at field capacity and wilting point in the different soil types before and after bed formation. It is difficult to provide an immediate explanation of some inconsistencies in organic carbon content and the soil water properties, which are most likely to be the result of topsoil movement and mixing in the initial year of bed formation. These characteristics will be monitored into the future years to provide an explanation of the beneficial improvements to soil that favour higher potential crop yields on beds.

A grazing plan has been developed to graze wethers on both annual and perennial pastures grown on wide and narrow raised beds. Pasture and animal production data will be collected and will help farmers to advance their understanding on the cost effectiveness and sustainability of the different rotations used.

Soil water content and its lateral movement in the soil will be monitored (with the occurrence of heavy rainfall events that will cause waterlogging) to gain an understanding of the temporal release of air-filled pore space after such an event and this is expected to improve our knowledge on the optimum bed width for different sub-soils

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Rainfall for Southern Farming Systems: Gnarwarre

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Long-term (100 year) mean rainfall (mm)	32	36	40	42	48	45	48	49	51	53	47	44
Mean rainfall (1990 - 1996)	44	48	26	36	25	48	45	43	63	54	44	57
1990	6	107	24	43	20	37	71	48	34	90	34	28
1991	80	2	26	17	19	97	27	56	70	22	35	103
1992	15	22	52	63	65	38	26	58	91	70	84	96
1993	90	36	17	15	8	41	42	31	102	61	43	108
1994	25	110	12	25	22	17	18	24	31	38	42	22
1995	54	16	44	76	43	69	45	36	39	73	63	35
1996	38	45	7	10	1	36	84	45	75	21	7	5
1997	43	7	10	8	98	34	20	28	75	41	22	4
1998	45	31	3	49	18	73	40	26	33	52	60	34
1999	31	80	37	10	51	35	25	50*	19	44	25	42

Rainfall from May to November

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Long Term (100 yrs)
334	326	432	328	192	368	269	317	302.5	248.2	341

Note: Rainfall records up to 1996 are from Geelong. The rest are from Gnarwarre/Mt. Pollock.

Changes in organic matter and soil water holding capacity before and after bedding in the different soil groups in the Farming Systems Trial

		Flat versus Centre of raised beds				Edge of wide (20m) beds				
Soil Group	**Depth (cm)**	**O.C 1998**	**O.C 1999**	**GWC at FC 1998**	**GWC at WP 1998**	**GWC at FC 1999**	**GWC at WP 1999**	**O.C 1999**	**GWC at FC 1999**	**GWC at WP 1999**
	0-10	2.7	2.8	39.1	22.1	37.5	22.3	2.5	41.1	23.4
Gnarwarre	10-20		2.0	41.2	22.8	40.8	23.6	1.8	41.3	23.3
A	20-30			43.1	23.6	41.9	23.8		40.0	22.5
	0-10	2.3	1.7	29.7	13.9	27.9	14.1	2.0	30.5	15.3
Gnarwarre	10-20		1.4	33.7	16.6	30.7	15.8	1.3	32.5	16.7
B	20-30			37.5	19.5	33.7	18.7		35.3	18.5
	0-10	2.1	2.1	31.6	15.3	30.2	15.9	1.6	31.8	16.2
Gnarwarre	10-20		1.5	24.0	12.4	32.1	17.1	1.1	36.5	18.7
C	20-30			39.7	19.7	34.7	18.5		37.1	18.9
	0-10	2.6	2.5	36.1	21.0	35.1	20.1	2.9	39.4	20.8
Gnarwarre	10-20		1.9	39.2	22.4	37.5	22.3	2.1	40.9	22.9
D	20-30			42.4	23.5	39.4	21.4		41.7	22.8

Note: O.C - Organic Carbon; GWC - Gravimetric water content; FC - Field Capacity; WP Wilting Point