LAND MANAGEMENT SYSTEMS INCLUDING CONTROLLED TRAFFIC, EROSION CONTROL AND CROP ROTATIONS FOR DRYLAND COTTON

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BACKGROUND

A research project is currently being undertaken in Central Queensland in association with the dryland cotton industry. The work is focussing on sloping country (where soil erosion is a major concern), on cracking clay soils (to develop soil management principles based on an understanding of their specific properties and responses) and a range of crops. Dryland cotton cannot be a monoculture, but must be integrated into a broad cropping program.

Aims of the project are:

(i) to optimise cotton production by maximising infiltration (stubble retention and reduced tillage) and crop water use (opportunity planting);

(ii) to minimise soil structural degradation by controlled traffic and *permanent wheel tracks*; and

(iii) to minimise soil erosion by controlling runoff.

The *challenge* is to incorporate runoff control on sloping country into controlled traffic permanent wheel track layouts. This creates the problem that with controlled traffic, runoff will be directed by wheel tracks, crop rows and tillage furrows. Runoff could be concentrated in low undulations in the paddock where this water flows with high velocity and energy, producing rills and gullies.

One *solution* is to prevent this concentration by confining the runoff to closely spaced furrows, which may or may not be wheel tracks. Each furrow must carry all the runoff from its catchment or contributing area. If the furrows are 2m apart, the catchment area is small (for example, 0.1 ha for a 500m long furrow), the volume of runoff is small and a layout can be designed to prevent erosive flow velocities being developed. Furrows must not overtop, and they must drain through (no low spots). Consequently, furrows will in general go down the slope.

These concepts have many *secondary benefits* for dryland cropping, including:

(i) Controlled traffic provides tramlines for herbicide spraying so that markers are not needed. Once the layout is in place, markers are not needed for any operation. Many of the difficulties with reduced or zero tillage are reduced.

(ii) The ability to position the current operation relative to previous operations allows all forms of directed spraying, accurate inter-row cultivation, planting between rows of stubble etc.

(iii) The drained wheel tracks will increase trafficability. Typically, it is the wet, low spot in the paddock that dictates when any operation can begin.

(iv) The system may allow a degree of crack management. If large cracks form in the wheel tracks and furrows, and the system directs runoff to these cracks, high infiltration rates can be expected. With common broadacre farming, cracks rarely function as high infiltration zones. Increased infiltration increases production potential and decreases runoff and erosion.

MATERIALS AND METHODS

This experiment is based on an 8 m wide commercial system with 550 m long plots on a 1.5% slope. The plots go generally down the slope. Several rotations are used to provide a range of antecedent conditions (cover, soil water content, furrow condition) when runoff-producing rainfall occurs. Crop production, soil parameters, runoff and erosion are measured, and a comparison made of 1 m and 2 m beds, and wheeled and non-wheeled furrows.

Site

The experimental site is located on Elsden Farms, Tyson Road, Emerald (10 km west of the township of Emerald). The soil is a shallow open downs cracking clay, developed from weathered basalt. Long-term mean annual rainfall and evaporation for Emerald Research Station are 639 mm and 2265 mm, respectively.

Experimental Details

The experiment commenced in September 1993, with the installation of controlled traffic lanes. Planting opportunities and crop rotations (Table 1) have been restricted by rainfall. Wheat rotations were planned, but lack of winter rainfall has restricted this option. Total rainfall for 1994 was 523 mm (289 mm in March), and January-July 1995, 242 mm.

Table 1. Crop rotations

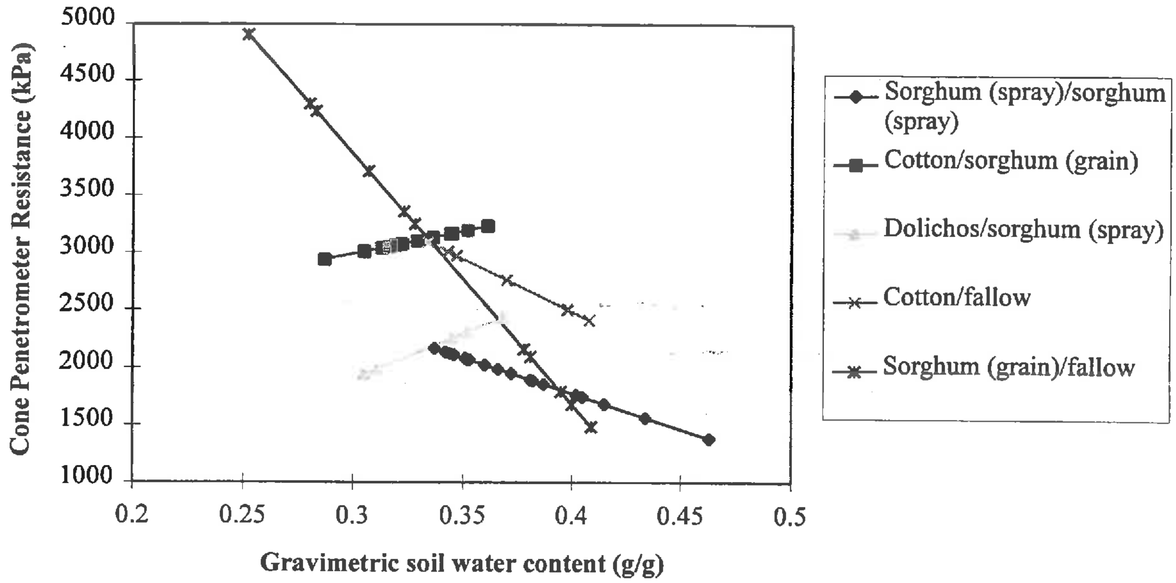
Treatment	1993		1994		1995	1996
(bed size)	Spring	Summer	Winter	Summer	Winter	Summer
T1 (1m)	S(sp)			S(sp)		C(lp)
T2 (1m)		C	D	S(gr)	D	C(lp)
T3 (2m)	S(sp)		R	S(sp)	R	C(lp)
T4 (2m)		C	O	S(gr)	O	C(lp)
T5 (2m)		S(gr)	U	fallow	U	C(ep)
T6 (2m)		S(gr)	G	fallow	G	C(ep)
T7 (2m)		C	H	fallow	H	fallow
T8 (2m)	S(sp)		T	S(sp)	T	C(ep)
T9 (2m)	D(sp)			S(sp)		C(ep)
Dates:						
Planting	S 7/9; D 13/9	C 19/11; S 10/2		S (21/2)		
Spray-out	S 18/11; D 15/3			S (5/4)		
Harvest		C 25/4; S 21/6		S (10/7)		

S = sorghum; D = dolichos; C = cotton.
sp = sprayed out; gr = grain; lp = late plant; ep = early plant.

Measurements

a) **Soil water content** - sampled gravimetrically using 37 mm diameter cores, with depth increments of 100 mm down the profile. Samples are taken at planting and harvest, and at anthesis for grain sorghum. In-crop measurements for cotton are taken using a neutron moisture meter (Campbell Pacific Nuclear Model 503) at identical depth increments.

Figure 1. Relationship between soil water content and penetration resistance (at 300-400 mm depth) for various crop rotations (sampled on 25/7/94 and 4/4/95)



Measurements were made of furrow cross sections during the 1993/94 cotton season on three occasions. The furrow cross-sectional areas are given in Table 5.

Table 5. Effect of rainfall runoff and refurrowing on furrow cross-sectional area (cm^2) for three treatments.

		T5 (2m bed)	T4 (2m bed)	T2 (1m bed)
Date	Condition	Fallow	Cotton	Cotton
7/12/93	after runoff	372	325	397
6/1/94	after furrowing	507	386	560
25/1/94	after runoff	406	429	505

Furrowing tended to increase furrow capacity, which was subsequently reduced by a small amount following a runoff event. There was a larger decrease in furrow capacity in fallow plots than those with a cotton crop. The furrow shape changed from deep and narrow (V shape) after furrowing, to broad and shallow (U shape) after runoff. Furrow capacity at the top of the slope varied little after runoff compared to the bottom of the slope. These results suggest that most of the observed silt deposition in furrows was due to furrow slumping, but some movement toward the bottom of the furrow was also observed. Observations during 1994/5 suggest that the furrows were more stable than the previous season. This could be attributed to increased stubble cover and natural consolidation. Soft edges of newly formed furrows and beds are very susceptible to erosion.

Runoff and soil loss measurements were recorded for events on the 4th and 7th February, 1995 (Table 6). Rainfall on the 7th February occurred in three events, which have been reported separately.

The runoff and soil loss data showed consistent patterns. The highest runoff and soil loss occurred from T4 and T7 (ex. cotton) during all events. Additional cover in T1, T3 and T8 reduced runoff by 42%, and soil loss by 38%. T5 and T6 provided the highest cover levels which reduced runoff by 72%, and soil loss by 89% (compared to bare plots). The highest runoff from each treatment (as a percentage of rainfall) was during the second event on 7/2/95 when the soil surface had been wet by the previous storm. The height recorder in T8 non-wheel track malfunctioned during these events.

The amounts of soil loss are small when compared to expected amounts from bare, cultivated soils. Total sediment concentrations were generally low (1.0-3.0g L^{-1}) with the lowest concentrations coming from plots with high stubble cover. These preliminary results indicate the possible benefits from controlled traffic layouts.

Table 6. Runoff and soil loss data from the experimental site, February 1995 (WT = wheel track)

a) 4th February - total rainfall 39 mm, I_5= 82.6 mm hr^{-1}.

Treatment		Runoff (mm)	Max. Runoff Rate (mm hr^{-1})	Soil Loss (t ha^{-1})
T1 WT	Sorghum sprayed 11/93	8.8	20.2	0.02
T1 non-WT	Sorghum sprayed 11/93	11.2	23.7	0.42
T3 WT	Sorghum sprayed 11/93	2.2	5.2	0.04
T4 WT	Cotton picked 4/94	15.6	26.6	0.34
T4 non-WT	Cotton picked 4/94	29.9	40.6	0.13
T5 WT	Sorghum harvested 6/94	10.9	19.7	0.01
T6 WT	Sorghum harvested 6/94	0.0	0.0	0.0
T7 WT	Cotton picked 4/94	26.4	59.9	0.15
T8 WT	Sorghum sprayed 11/93	2.8	7.0	0.02
T8 non-WT	Sorghum sprayed 11/93	?	?	0.07

b)7th February - total rainfall 54.4 mm

	Rain=22 mm I_5=45.6 mm hr^{-1}		Rain=25.6 mm I_5=79.2 mm hr^{-1}		Rain=6.8 mm I_5=19.2 mm hr^{-1}		Total	Soil
	Runoff	Rate	Runoff	Rate	Runoff	Rate	Runoff (mm)	Loss (t ha^{-1})
T1 WT	8.9	30.5	12.2	22.2	4.5	5.9	25.6	0.53
T1 non-WT	3.7	15.1	14.2	32.7	4.7	13.7	22.6	1.05
T3 WT	1.6	8.1	16.4	32.0	0.8	1.2	18.8	0.85
T4 WT	4.6	12.2	13.3	24.6	4.4	9.3	22.3	1.30
T4 non-WT	7.0	18.4	12.5	18.4	6.6	11.4	26.1	1.10
T5 WT	2.2	12.0	15.8	22.3	0.7	2.9	18.7	0.05
T6 WT	2.4	13.0	6.2	16.2	1.7	3.2	10.3	0.24
T7 WT	4.3	25.3	23.7	40.9	3.2	9.3	31.2	1.15
T8 WT	0.2	3.3	25.6	67.3	1.9	3.7	27.7	0.60
T8 non-WT	?		?		?		?	0.44

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