Invited article

The impact of livestock on paddock health

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Take home messages

- **grain yields increase with higher crop inputs and, after grazing, further improve following a sown legume pasture and a more intensive grazing system**
- **there is no measured change in soil organic carbon as a result of either varying crop and pasture inputs or grazing compared with not grazing crop stubbles or pastures**

Background

A well run mixed farming enterprise of cropping and livestock can be as profitable as a continuous cropping business for most districts across Eyre Peninsula. In addition, it carries less risk, as shown by a profitability analysis in the Eyre Peninsula Grain & Graze and Farming Systems projects. However, as livestock graze, they remove plant biomass which would otherwise have been ground cover, then decomposed into the soil and thus contributed to the carbon pool.

In high rainfall areas, retaining stubble has been shown to improve soil carbon levels and microbial health. In low rainfall areas, stubble retention helps reduce erosion and can help plant establishment when moisture conditions are poor at sowing. However, in an environment in which biomass production, soil moisture and microbial activity levels are lower, a clear relationship between stubble retention and soil health is still to be established. Value adding to stubbles by grazing is usually regarded to be of greater economic value.

Aim

A trial was established on Minnipa Agricultural Centre in 2008 to test whether soil fertility and health could be improved under a higher input system compared with a lower input and more traditional system. The four year (2008-2011) wheat, wheat, pasture (annual medic), wheat rotation was also split for plus and minus grazing in both the high and low input systems to establish the impact of grazing between the two treatments.

Method

Location:	Minnipa Agricultural Centre, Eyre Peninsula SA
Replicates:	1 with 4 sub-plots (broad acre trial)
Sowing date:	varied dates (see Table 1)
Seeding density:	varied treatments (see Table 1)
Crop type/s:	Wyalkatchem wheat and Angel medic
Inputs/Fertiliser:	naried treatments (see Table 1)
Seeding equipment:	9m wide direct drill seeder with 30.5cm row spacing
Av. annual rainfall:	total 325mm, growing season 242mm

In 2008 a 14ha, red sandy loam (pH 7.7, $CaCl_2$) portion of a paddock at Minnipa Agricultural Centre was divided into 4 x 3.5ha sections. Each section represented a system treatment: Traditional (grazed), Traditional (ungrazed), High input (ungrazed) and High input (grazed). Four sampling points were selected and marked as ongoing in each section. Data presented for each treatment are a mean of the four selected points in each section. Table 1 presents the seed (Wyalkatchem wheat 2008, 2009 and 2011 and Angel medic, 2010) and fertiliser inputs over the four years. Weed control was imposed as required on all treatments in both summer and during the growing season: broad-leaf weed control in the wheat, selective grass control in the medic.

Table 1. Seeding rate (kg/ha), phosphorus and nitrogen (units N&P/ha) applied to the traditional and high input systems, sowing dates and annual and growing season rainfall totals (mm) over the 4 year rotation

Variable	System	2008	2009	2010	2011
Wyalkatchem wheat and Angel medic		Wheat	Wheat	Medic	Wheat
Rainfall (mm)	Annual	251	421	410	402
	Growing season	139	333	346	252
Sowing date	All treatments	19 May	7 May	22 April	9 May
Seeding rate (kg/ha)	Traditional	50	50	0	50
	High Input	70	70	5	70
Nitrogen (N) and phosphorous (P) (kg/ha)	Traditional	7N, 8P	7N, 8P	0	7N, 8P
	High Input	25N, 12P	25N, 12P	6N, 7P	13N, 15P

Results

Soil for chemical analysis by CSBP soil testing laboratory was collected prior to seeding at five sites surrounding the four selected points in each section. Table 2 presents the initial 2008 and subsequent 2010 and 2011 phosphorous, total nitrogen and soil organic carbon results.

Table 2. Collwell P (mg/kg 0-10cm), total nitrogen (kg/ha 0-60cm) and soil organic carbon (% 0-10cm) in from sampling points

System	2008			2010			2011		
	P	N	SOC	P	N	SOC	P	N	SOC
Traditional (grazed)	32	83	1.2	25	93	1.1	41	134	1.2
Traditional (ungrazed)	32	109	1.2	25	51	1	29	99	1.1
High input (ungrazed)	29	107	1.2	25	50	1	34	84	1.1
High Input (grazed)	22	92	1.1	17	54	1.2	23	119	1.1

2010 soil analysis figures indicate that there has been no increase in residual P or N contents in response to higher inputs in 2008 and 2009. However, the 2011 results suggest increased total N content in response to the 2010 medic pasture, with increased additions in response to the 2010 grazed sown medic treatments. Soil organic carbon levels have remained constant in the study to date.

Grain yields were collected by a 9m commercial harvester with yield monitor from the four selected points in each section in 2008 and 2009. In 2011 an experimental plot harvester harvested two 1.8 x 9m plots at the four marked points in each section. Table 3 presents the grain yield data for the three wheat crops and the estimated water use efficiency figures for 2011.

Table 3. Grain yield (t/ha) and water use efficiency (kg/ha/mm of plant available water) in cereal rotation years

System	Grain Yield* t/ha (kg/ha/mm of H^2O)		
	2008	2009	2011
Traditional (grazed)	0.2	4.0 b	2.0 c (14)
Traditional (ungrazed)	0.2	4.1 b	1.7 d (12)
High input (ungrazed)	0.3	4.4 a	2.1 b (14)
High Input (grazed)	0.3	4.5 a	2.4 a (16)

**Different letters indicate significant differences at the 5% level*

Grain yields were higher in response to increased seeding rates and/or fertiliser inputs in 2009 and 2011; grazing in 2010 also increased 2011 yields. Estimated water use efficiency in 2011 was directly correlated with higher yields, with each treatment having similar available water. Wheat grain protein content did not differ significantly between treatments; the averages were 14.3, 9.7 and 10.2% respectively in 2008, 2009 and 2011.

Pasture biomass was collected in 2010 from 5 x 0.1m^2 quadrats sited at each of the four identified points in each section. Table 4 presents the annual pasture biomass, grazing pressure and stocking rate on the 2010 medic pasture.

Table 4. Annual pasture biomass (t DM/ha) in September following August grazing, grazing days (DSE) imposed in March, August and November and total annual stocking rate (DSE/ha) in 2010

System	Biomass	March	August	November	Annual DSE/ha
Traditional (grazed)	1.8	200[a]	120[c]	750[e]	3
Traditional (ungrazed)	3.9				
High input (ungrazed)	4.9				
High Input (grazed)	3.8	200[b]	1200[d]	1500[f]	8

[a]40 days grazing with 5 sheep @ 1 DSE, [b]7 days grazing with 28 sheep @ 1DSE, [c]14 days grazing with 7 sheep @ 1.2 DSE, [d]14 days grazing with 70 sheep @ 1.2 DSE, [e]21 days grazing with 24 sheep @ 1.5 DSE and [f] 21 days grazing with 48 sheep @ 1.5 DSE

The food on offer in September represents the utilisation through grazing and the comparative recovery capability of the volunteer self-regenerating and sown medic pastures. The sown medic pasture carried more than double the stocking rate of the volunteer self-regenerating medic pasture.

Interpretation

Higher grain yields were measured in all three cropping seasons in response to a higher seeding rate and phosphorus and nitrogen applications. A further wheat yield benefit was measured in 2011 as a result of the grazing of both the sown and self regenerated medic based pastures in 2010. This benefit was considered to be due to the increased total soil N levels measured pre-seeding in 2011. It could not be attributed to increased water access as soil water content measurements taken before seeding were similar in each section.

There has been no measured change across sections in soil organic carbon levels after three seasons of below (1 year) and above (2 years) average growing season and annual rainfall.

Commercial practice: what this means for the farmer

- higher seed and fertiliser input result in higher grain yields (although any economic benefit is still to be determined)
- soil N and water use efficiency increases with grazing, and further improves with a sown legume pasture and an associated more intensive grazing system
- there is no measured effect on soil organic carbon as a result of varying crop and pasture inputs, grazing or not grazing crop stubbles or pastures.

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