Section Editor:
Brian Dzoma
SARDI, Minnipa Agricultural Centre

The impact of livestock on paddock health: nine-year enterprise summary

Jessica Crettenden
SARDI, Minnipa Agricultural Centre

RESEARCH

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Location: Minnipa Agricultural Centre, paddock S7

Rainfall
Av Annual: 325 mm
Av GSR: 241 mm
2016 Total: 391 mm
2016 GSR: 268 mm

Paddock History
2015: Medic pasture
2014: Wheat
2013: Wheat

Soil Type
Red sandy loam

Soil Test
Organic C%: 1.05
Phosphorous: 23 - 28 mg/kg

Plot Size
3.5ha

Livestock
Enterprise type: Self-replacing merinos
Stocking rate: Rotational grazing and district practice

Key messages

- **Over nine seasons, incorporating livestock into the rotation improved overall system outcomes in this trial, including; increased nitrogen cycling and water use efficiency, reduction in weed and pest populations and no negative effects on cereal performance or soil health, while value adding to stubble and pastures by grazing.**
- **The high input grazed farming system had a gross margin of over $100/ha/year more than lower input and ungrazed treatments over the nine-year trial period.**

Why do the trial?

Mixed livestock and cropping systems have an important role to play in the diversification, risk management and sustainability of farming in low rainfall areas. The majority of farms in these areas use livestock to provide enterprise diversity and risk management, however grazing also offers a range of other system benefits that are generally not accounted for in mixed farming enterprises. As a result of increasing cropping intensity in these systems, there is a perception of declining productivity of the pasture phase, with pastures remaining largely unimproved and most farming systems continuing to rely on self-regenerating medic for livestock feed and nitrogen (N). Pastures in these lower input mixed farming systems are generally set stocked and grazed at low stocking rates throughout the season with minimal effort to manage grazing for optimal production. Farmers are hesitant to increase grazing in the break phase of the rotation partly due to the perception that livestock can damage soil health, remove organic matter and induce weed germination, but also because their efforts are often concentrated on the cropping enterprise due to the income it brings into the business. With prices for livestock (both meat and wool) increasing over the past decade, and the valuable nutrition and disease break effect that the pasture phase provides to subsequent cereal crops, interest in the productivity and profitability of medic and livestock systems has increased.

A long-term study was established at the Minnipa Agricultural Centre from 2008 to 2016 (EPFS Summaries 2008 to 2015) to assess the systems impact of grazing on crop and pasture production, and soil health. The nine-year broad acre demonstration with a wheat-medic rotation (Table 1) also tested whether productivity could be improved under a higher input system (e.g. higher fertiliser and seeding rates, establishment of improved pasture) compared to a lower input and more traditional system (district practice seed and fertiliser inputs, volunteer pasture), and what effect this had on soil fertility.

Table 1 Trial Treatments over the nine-year trial period (2008-2016) in paddock S7, Minnipa

Year	Low input (grazed)	Low input (ungrazed)	High input (grazed)	High input (ungrazed)
2008	Wheat sown @ 50 kg/ha + 45 kg/ha DAP Paddock not yet grazed		Wheat sown @ 70 kg/ha + 60 kg/ha DAP + 67.5 kg/ha ammonium sulphate	
2009	Wheat sown @ 50 kg/ha + 45 kg/ha DAP Paddock not yet grazed		Wheat sown @ 70 kg/ha + 60 kg/ha DAP + 67.5 kg/ha ammonium sulphate	
2010	**1070 DSE grazing days**	No treatment	Medic sown @ 5 kg/ha with 30 kg/ha DAP **2900 DSE grazing days**	Medic sown @ 5 kg/ha with 30 kg/ha DAP
2011	Wheat sown @ 50 kg/ha + 40 kg/ha DAP **30 DSE grazing days**	Wheat sown @ 50 kg/ha + 40 kg/ha DAP	Wheat sown @ 70 kg/ha + 60 kg/ha DAP **166 DSE grazing days**	Wheat sown @ 70 kg/ha + 60 kg/ha DAP
2012	**242 DSE grazing days**	No treatment	**521 DSE grazing days**	No treatment
2013	Wheat sown @ 50 kg/ha + 40 kg/ha DAP		Wheat sown @ 70 kg/ha + 60 kg/ha DAP	
2014	Wheat sown @ 50 kg/ha + 40 kg/ha DAP **324 DSE grazing days**	Wheat sown @ 50 kg/ha + 40 kg/ha DAP	Wheat sown @ 70 kg/ha + 60 kg/ha DAP **312 DSE grazing days**	Wheat sown @ 70 kg/ha + 60 kg/ha DAP
2015	**637 DSE grazing days**	No treatment	100 kg/ha DAP broadcast **1333 DSE grazing days**	100 kg/ha DAP broadcast
2016	Wheat sown @ 50 kg/ha + 40 kg/ha DAP		Wheat sown @ 70 kg/ha + 60 kg/ha DAP	

**DSE grazing days describes the number of grazing days per dry sheep equivalent per treatment area*

How was it done?

In 2008, a 14 ha red sandy loam portion of a paddock on Minnipa Agricultural Centre was divided into four 3.5 ha sections. Each section represented a system treatment: Low input - grazed, Low input – ungrazed, High input – grazed and High input – ungrazed. The pasture and grazing treatments were not imposed until 2010. Four sampling points were selected and marked as permanent sampling points in each section. Data presented for each treatment are a mean of the four selected permanent points in each section. Table 1 describes the treatments for each section over the period of the trial. More detailed treatment information can be found in EPFS Summaries 2008-2015.

A basic economic analysis was undertaken to assess gross margins of the four systems over the period of the trial, taking into account price and market differences from 2008 to 2016. The gross margin calculator tool is available on the Grain and Graze 3 website[1].

What happened?

Production results

Table 2 presents the averages of production and soil measurements over the nine-year duration of the trial. The higher input system produced 1.25 t DM/ha more medic biomass overall in the pasture phase of the rotation (2010, 2012 and 2015) and grazing reduced total biomass by 0.25 t DM/ha on average. The grazed systems carried a total of 2303 and 5232 DSE grazing days in the low input and high input systems respectively during the three years of medic pasture and grazing wheat stubbles over the summer/autumn period. The higher input systems had 0.5 t/ha greater wheat grain yield than the lower input system and the grazed systems had 0.1 t/ha more grain yield on average. Total mineral N was similar for high and low input systems, however the grazed systems had considerably more soil N on average (17 and 13 kg N/ha greater in the low and high input treatments respectively). There was an average of 11 mg/kg more extractable phosphorous in the low input system, compared to the high input treatments. Soil organic carbon remained steady throughout the lifetime of the trial, with similar results across all treatments.

Table 2 Averages of production and soil measurements over the period of the trial (2008-2016)

Paddock treatment	Pasture biomass (t DM/ha)	Grain yield (t/ha)	WUE (kg/ha/ mm)	Total mineral N 0-60 cm (kg/ha)	Colwell P (mg/kg)	Soil organic carbon (%)	DSE grazing days Total (average)
Low input (grazed)	3.4	2.3	19.0	83	31	1.2	2303 (2.1 DSE/ha av.)
Low input (ungrazed)	3.8	2.2	16.2	66	27	1.1	
High input (grazed)	4.8	2.8	22.3	81	21	1.1	5232 (4.9 DSE/ha av.)
High input (ungrazed)	4.9	2.7	20.2	68	26	1.1	

There were several production influences in grazed treatments that may have had an effect on the overall farming system within each treatment, which were observed but not adequately measured over the period of the trial. Grazed treatments appeared to have lower snail and mice populations, increased ground cover outside of the growing season and reduced summer weed height and density.

Economic analysis

A basic economic analysis of the study (Table 3) showed that over nine years, grazing contributed $328/ha to the low input treatment and $725/ha to the high input treatment. $274 and $651 of this was attributed to grazing medic in the pasture phases, with the remainder attributed to grazing the wheat stubbles over summer/ autumn in the low and high input grazed systems respectively. The cost of improving pastures in the high input systems (seed and fertiliser application in 2010, and fertiliser application in 2015) was $99/ha in total. However the grazed high input system was able to offset these costs through the extra livestock production value, and achieved a total profit of $524/ ha compared with the ungrazed high input system with a $127/ha loss for the pasture phase years. The low input system had minimal costs in the pasture phase years (only herbicide application) - the ungrazed low input system made a $66/ha loss in total, while the low input grazed system off-set these costs by grazing livestock, making a total profit of $208/ha.

Table 3 Gross margin ($/ha) for the different input treatments in the nine-year trial[1]

		Gross Margin ($/ha) – crop and sheep enterprises			
Year	**Crop/pasture**	**Low input (grazed)**	**Low input (ungrazed)**	**High input (grazed)**	**High input (ungrazed)**
2008	Wheat	-49	-49	-42	-42
2009	Wheat	803	829	905	879
2010	Medic	96	-23	284	-39
2011	Wheat	362	284	465	366
2012	Medic	26	-27	89	-27
2013	Wheat	356	332	464	390
2014	Wheat	598	525	749	677
2015	Medic	86	-15	151	-60
2016	Wheat	372	339	490	490
Total	**$/ha**	**2651**	**2194**	**3556**	**2635**
Average	**$/ha**	**295**	**244**	**395**	**293**

Lower sowing rates and fertiliser inputs in the low input system meant that total costs for the cropping operations for the six wheat production years (2008, 2009, 2011, 2013, 2014 and 2016) were only $2451/ha, compared with the high input systems total costs of $2845/ha. The high input systems managed to compensate these costs through increased yield with a total $5719/ha profit compared to the low input system with $4647/ha profit in total over the six years.

Over the nine years, taking into account both the cropping and livestock systems, the average gross margin of each treatment was $295, $244, $395 and $293 in the low input (grazed), low input (ungrazed), high input (grazed) and high input (ungrazed) systems respectively. This means that running sheep added a $51/ha profit per annum to the conventional (low) input, ungrazed system, while adding higher inputs earnt an extra $49/ha. Including both sheep and higher inputs to the conventional system earnt an extra $155/ha.

What does this mean?

The nine-year period of this study began with a severe drought in 2008, followed by 6 years of average to above average rainfall seasons (2009-2011 and 2014-2016) and the two seasons in 2012 and 2013 slightly below average growing season rainfall. The trial showed that over a range of seasons, integrating livestock grazing into a cropping system improved productivity and profitability, particularly in higher input farming systems, with no apparent negative effect on soil or system health.

Diversification into sheep can assist growers to better manage their risk, by reducing the effects caused by seasonal and grain market variability, and help reduce the levels of diseases and pests. Livestock are also a reliable source of income in years when yields or grain prices are low, and are recently proving they are as profitable as cropping gross margins even in average years.

The high input system carried over twice the stocking rate as the low input system over the trial period and was more productive in both the cropping and pasture rotations. This indicates that increased inputs into low rainfall mixed farming systems could be more productive and lucrative than they are currently on Eyre Peninsula. The decision to increase input rate and subsequent costs will however depend on the farmers attitude to risk and whether their business can cope with extra input costs if the season is unfavourable, and for how many seasons, versus having a system set up to capitalise better on a good year. Maintaining a degree of flexibility to respond to seasons (e.g. top-dress nitrogen, graze a crop) and markets (keep more ewe lambs, or feed grain to stock) is a strategy to reduce risk. Decisions must be made early to optimise the outcome, before prices change or an opportunity is missed.

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[1]The basic economic analysis for cropping systems was undertaken using the *PIRSA Gross Margin Calculator* developed by Barry Mudge and funded by SAGIT in conjunction with Rural Solutions SA and GRDC. The livestock *Gross Margin Calculator* was partially funded by Grain and Graze 3. Both calculators will be available as free downloads from the PIRSA, GRDC and SAGIT websites, and the livestock calculator will be available on the Grain and Graze 3 website www.grainandgraze3.com.au