The impact of livestock on paddock health

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RESEARCH

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Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 3.96 t/ha (W)
Actual: 3.40 t/ha (W)
Paddock History
2013: Wheat
2012: Medic pasture
2011: Wheat
2010: Medic pasture
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam
Plot Size
3.5 ha
Soil Test
Organic C%: 1.0
Phosphorus: 11-41 mg/kg
Yield Limiting Factors
Nil
Livestock
Enterprise type: Self replacing merinos
Stocking rate: Rotational grazing and district practice
Environmental Impacts
Soil health
Soil structure: Stable
Compaction risk: Plus and minus grazing treatments
Ground cover or plants/m^2: Grazed to 1 t/ha pasture residue
Perennial or annual plants: Annual
Grazing pressure: High (1.5 DSE/winter grazed ha) and medium (0.75 DSE/winter grazed ha)
Water Use
Runoff potential: Low
Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2, N_2O_2, methane): Cropping and livestock

Key messages

- **There has been no evidence of any soil health or production losses with grazing after seven years, irrespective of whether crop or pasture inputs were increased or kept at district practice levels.**
- **In 2014 higher input systems showed how increased inputs and costs throughout the season can result in increased productivity and subsequent profitability.**

Why do the trial?

The majority of farms in low rainfall areas use sheep to provide enterprise diversity, however grazing also offers a range of other system benefits that are generally not accounted for in mixed farming enterprises. Studies have shown that grazing offers a useful tool for managing weeds and pests, improving crop nutrition and yields and providing an option to mitigate risk in pasture crop rotations. In these systems there is a perception of declining performance of the pasture ley, as a result of increasing cropping intensity. As a result, there has been work to show the benefits of increasing crop and pasture inputs, as opposed to district practice crop seeding and fertiliser rates and pasture regeneration from residual seed banks.

A long-term study was established at the Minnipa Agricultural Centre from 2008 to 2014 (EPFS Summaries 2008 to 2013) to assess the impact of grazing on crop and pasture production and soil health and also to evaluate this from a systems perspective. The seven year demonstration with a wheat, wheat, pasture (volunteer and sown annual medic), wheat, pasture (self-regenerating annual medic), wheat and wheat rotation was also established to determine whether productivity could be improved under a higher input system compared to a lower input and more traditional system and what affect this had on soil fertility.

How was it done?

In 2008, a 14 ha red sandy loam (pH_{CaCl} 8) portion of a paddock on Minnipa Agricultural Centre was divided into four 3.5 ha sections. Each section represented a system treatment: low input district practice - grazed, low input district practice – un-grazed, high input – grazed and high input – un-grazed. The pasture and grazing treatments were not imposed until 2010.

In 2014 the trial was sown to Mace wheat on 10 May at 50 kg/ha with 7 kg N/ha and 8 kg P/ha (45 kg/ha DAP) and 70 kg/ha with 13 kg N/ha and 15 kg P/ha (75 kg/ha DAP) for the low and high input treatments respectively. Weed control was imposed on all treatments as required in both summer and during the growing season.

Sampling for pre-sowing soil water content and chemical analysis was completed on 14 April and plant establishment counts were recorded on 3 July. Harvest biomass cuts, yield measurements and grain samples were taken on 31 October followed by post-harvest soil water contents on 5 December to estimate comparative water use efficiency.

Social/Practice
Time (hrs): No extra
Clash with other farming operations: Standard practice
Labour requirements: Livestock may require supplementary feeding and regular checking
Economic
Infrastructure/operating inputs: High input system has higher input costs
Cost of adoption risk: Low

What happened?

Prior to sowing each year, soil phosphorous, nitrogen and organic carbon content have been measured. In 2008, the paddock had an average Colwell P of 28 mg/kg in 0-10 cm, total mineral N of 104 kg/ha to 60 cm deep and average soil organic carbon of 1.2% (0-10 cm). Table 1 presents results for the last three years. Colwell P levels were generally higher in the low input system in both the grazed and un-grazed treatments and there has been a declining P trend in the high input system since 2008. Residual total mineral N figures trended higher in 2013 following the medic rotation and results in 2014 suggest a decline in levels after one year of wheat. Grazed treatments over the past three years have had higher mineral N figures than the un-grazed areas in both high and low input systems, which have also had lower N levels each year since initial recordings in 2008. Soil organic carbon levels are suggesting some decline in the 2014 low input figures, but not between grazing options, and have trended down steadily since the initial year of the study.

Figure 1 presents the 2014 grain yield and estimated water use efficiency figures for the demonstration. Yield results show differences of 0.7 t/ha more for the high input treatment between both the grazed and un-grazed areas. Water use efficiency was significantly higher in the high input treatments, which also produced more plants per m^2 at establishment and protein (av. 9%), screenings (av. 2%), grain test weight, moisture and plant dry matter at harvest results had no significant differences between treatments (data not presented).

Table 1 Colwell P (mg/kg 0-10 cm), total mineral nitrogen (kg N/ha 0-60 cm) and soil organic carbon (%, 0-10 cm) in April 2012, 2013 and 2014 following wheat, annual medic and wheat respectively

System	Colwell P (mg/kg)			Total mineral nitrogen (kg/ha)			Soil organic carbon (%)		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
Low input - grazed	34	34	36	64	111	78	1.3	1.3	1.0
Low input - un-grazed	30	27	24	59	84	39	1.0	1.2	0.9
High input - grazed	23	18	16	72	118	85	1.2	1.2	1.1
High input - un-grazed	30	22	18	60	74	54	1.2	1.1	1.1

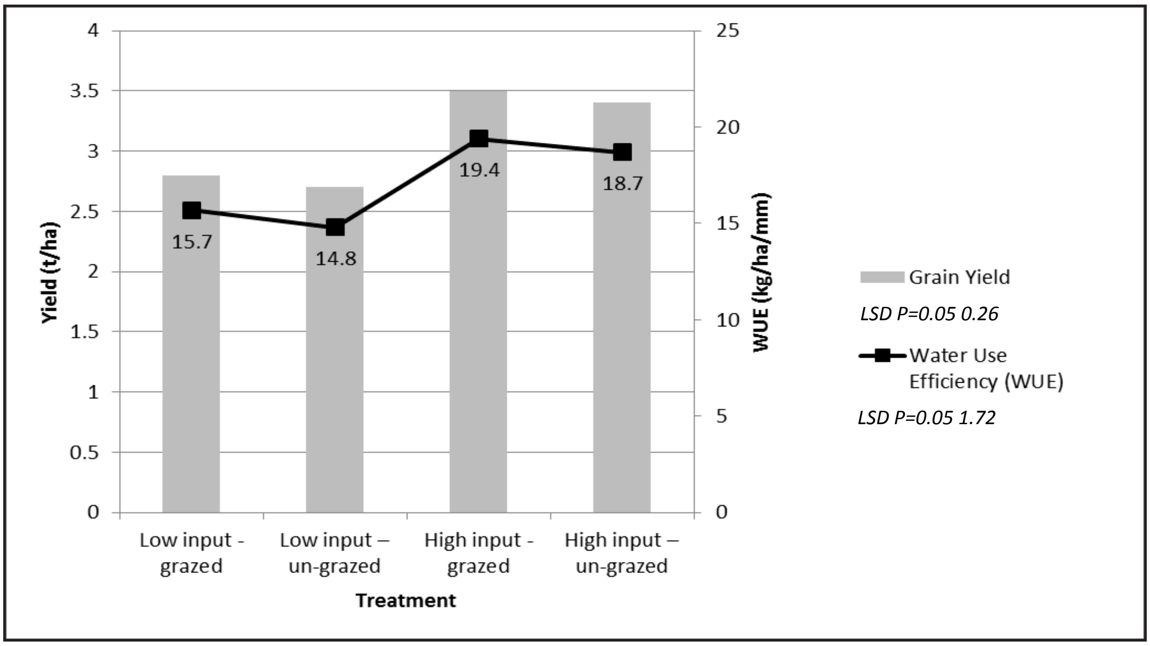

Figure 1 Grain yield (t/ha) and water use efficiency (WUE, kg/ha/mm of plant available water) for 2014 wheat

Farming Systems

What does this mean?

Similar to previous years, in 2014 the high input treatment has performed better compared to the district practice low input system in grain yield and water use efficiency. Residual total mineral N figures trended higher in 2013 following the medic rotation and results in 2014 suggest a decline in levels as a consequence of the 2013 wheat. Results from the grazed treatments have shown consistently higher total mineral N than the un-grazed areas in 2012, 2013 and 2014. Concerns that grazing can damage soil structure by reducing soil organic matter from the rotational system and induce increased weed germination have not been observed in this demonstration thus far, in fact the impact of grazing has generally been positive, with measured higher N mineral supply in the last three years of the trial in the grazed versus un-grazed treatments. This could be attributed to an increased rate of nutrient cycling due to the grazing animal.

Increased water use efficiency was measured in the grazed areas, which may be the result of weed control through grazing over summer. Other observed benefits throughout the trial in the grazed treatments include less summer weeds (less spraying required), reduced snail numbers and the added benefit of value-adding to stubbles by grazing. Grazing at the rates imposed has not detrimentally reduced the groundcover due to flattening of the stubble, with a 5% and 1% reduction in groundcover for the low input grazed and high input grazed treatments respectively, and therefore has not increased erosion potential. In a low rainfall mixed farming system sheep can also help growers better manage the economic impacts of seasonal variability; stock are important for resilience and should be considered from a systems perspective as opposed to comparing to a cropping system alone.

The 2014 higher input systems portrayed how increased inputs and costs throughout the season can result in increased productivity and subsequent profitability as a result of higher residual N, higher yields and better water use efficiency. Colwell P levels were lower when compared to the district practice system; however this is likely due to greater use of P by the pastures and crops in the higher input treatments.

Soil organic carbon levels remain largely unchanged in 2012 and 2013 from the initial 2008 measurements; however 2014 results show that in the low input treatments soil organic carbon declined. Soil organic carbon changes are slow. Whether the 2014 figures are a long term trend which could be attributed to less production, thus less biomass decomposed and subsequent cycling in the soil or a short term anomaly will be determined in subsequent years. As livestock graze, they remove the biomass that normally decomposes into the soil and contributes to the carbon pool; however in this trial there have been no measured differences in soil organic carbon between the grazed and un-grazed areas.

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