20. Integrated Farming Systems in the Medium Rainfall Zone

Amanda Pearce, *SARDI*, (amanda.pearce@sa.gov.au)

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KEY MESSAGES

- Annual medic had lower levels of soil N (kg/ha) remaining in the soil post-harvest compared to balansa clover and subterranean clover at Sherwood.
- Annual ryegrass establishment was greater in crops following wheat, compared to crops following a pasture break crop.
- Overall pasture biomass production was greater at Bordertown compared to Sherwood.
- Wheat yields at Sherwood were greater following balansa clover and subterranean clover, compared to following canola and cereals options, wheat, barley and oats.
- Grain barleys Compass and Rosalind have demonstrated a capacity to produce biomass as a forage or hay option; feed tests need to be considered to ensure they are as favourable as forage options for livestock production.

Project Background

As part of the GRDC- SARDI Strategic Partnership Agreement (Program 5, Regional Agronomy Capacity) a new project titled 'Integrated Farming Systems in the Medium Rainfall Zone (MRZ)' commenced in 2017, with a research focus in the Upper South East (USE).

The expected outcome of the project is that by 2021, growers in the MRZ of the South East and their advisors will have access to new relevant information on diverse crop rotations and integrated farming systems, particularity the incorporation of a pasture phase. This will allow for better crop sequencing decision making, with the aim of increasing farm sustainability, diversity and ultimately profitability, through the adoption of improved rotations and break crop management options.

The project has four components:

i. Collaboration and communication with industry stakeholders.
ii. Development of the skills and capabilities of the Regional Research Agronomist.
iii. The completion of a research gap analysis into the use of break crops in integrated farming systems in the MRZ.
iv. An improved understating of break crop options in the MRZ integrated farming systems and the evaluation of diverse crop sequences and their agronomic and economic performance, with a focus on the incorporation of a pasture phase and the publication of research findings.

To achieve component (iv) long-term rotational trials have been established in the MRZ of the South East, as well as targeted agronomic trials focusing on key research questions aimed at improving crop performance in integrated faming systems in the MRZ. Long-term monitoring of focus paddocks across the MRZ of South Australia has also commenced.

Provided in this report are key results from the long-term rotational trials (data is still be processed and analysed by biometricians), results from the targeted agronomic trials and information on the focus paddocks.

Long-Term Rotational Trials

Two long-term rotational trials were established at Bordertown and Sherwood in 2017, and sown to the second year sequence in 2018. The trials aim to improve understating of break crop options in the MRZ integrated farming systems and evaluate diverse crop sequences and their agronomic and economic performance, with a focus on the incorporation of a pasture phase and the publication of research findings.

The replicated block trials evaluate 16 different crop sequences over a four-year period, comparing single and double break options to continuous cereal and pastures. Crops to be evaluated and incorporated into the sequences include wheat, barley, canola, faba beans, subterranean clover, annual medic, balansa clover, lupin (Sherwood) and lentil (Bordertown). Measurements taken to date include soil chemistry and moisture, PreDicta B, crop early and hay biomass production and feed test analysis, peak biomass N fixation, weed assessment, grain yield and quality, stubble residue biomass and feed quality.

The trails will test the following:

i. What is the magnitude of impact of an annual pasture legume in the integrated farming system rotation in the MRZ of the USE on subsequent crops?
ii. Is the break effect (environmental, agronomic, economic and risk) of an annual pasture legume phase comparable to that of pulse and canola break crops?
iii. Do double breaks increase subsequent wheat yields compared to single breaks?
iv. Does the break effect impact on the second wheat crop and beyond?

Provided in this report is a selection of key data generated from the long-term rotational trials.

Soil nitrogen (N kg/ha (0 - 60 cm)) was measured post-harvest in 2017 (Table 1). Soil N kg/ha tended to be higher at Bordertown than at Sherwood. At Bordertown lentil had significantly higher post-harvest soil N (kg/ha) than the cereals, canola and balansa clover, but not significantly higher soil N (kg/ha) than faba bean and subterranean clover. At Sherwood balansa clover had significantly higher post-harvest soil N (kg/ha) than the cereals, canola and subterranean clover, but not significantly higher soil N (kg/ha) than faba bean and lupin. Annual medic had lower levels of soil N kg/ha post-harvest than the other pastures at Sherwood. Soil nitrogen (N kg/ha (0 - 60 cm)) post-harvest of 2018 crops is currently being calculated.

Establishment of annual ryegrass (ARG) was counted late June 2018. At both sites, crops following cereals had higher ARG plant numbers, on average 34 ARG plants/m2 at Bordertown and 225 ARG plants/m2 at Sherwood, compared to plots following a pasture break crop, on average 23 annual ARG plants/m2 at Bordertown and 47 ARG plants/m2 at Sherwood.

Table 1. Soil N kg/ha (0 – 60cm) post-harvest of 2017 crops, at Bordertown and Sherwood.

2017 Crop	Bordertown		Sherwood	
Balansa clover	50	bcd	50	d
Barley	42	ab	30	abc
Canola	21	a	31	bc
Faba bean	64	bcde	41	cd
Lentil	88	e	-	-
Lupin	-	-	44	cd
Medic	45	ab	16	a
Oat	40	ab	17	ab
Subterranean clover	65	bde	34	c
Wheat	47	bc	24	ab
Site Mean	***51***		***32***	
P value	0.006		< 0.001	
LSD	30		13	

Pasture biomass production was measured early in the season (August) and also at peak biomass (October). At the time of writing the data was being compiled to be statically analysed. Mean peak biomass production (Table 2) of the annual pastures appeared to be greater at Bordertown compared to Sherwood but this requires confirmation following statistical analysis.

Table 2. Mean peak pasture biomass (t/ha) at Bordertown and Sherwood, and the previous sown crop (2017), at Bordertown and Sherwood.

	Bordertown (t/a) 2018 Crop			Sherwood (t/ha) 2018 Crop		
2017 Crop	Balansa Clover	Annual Medic	Subterranean Clover	Balansa Clover	Annual Medic	Subterranean Clover
Canola	-	-	4.06	-	-	2.89
Annual medic	-	4.40	-	-	1.68	-
Subterranean clover	-	-	4.52	-	-	3.64
Balansa clover	3.69	-	-	1.76	-	-
Wheat	3.01	3.78	5.21	1.57	1.59	3.32

Crop yields from 2018 are currently being compiled for statistical analysis. Mean harvest data for 2018 is presented in Table 3.

Table 3. Mean harvest data (grain t/ha) for 2018 crops, showing previous crop at Bordertown and Sherwood.

		Bordertown	Sherwood
2017 Crop	2018 Crop	t/ha	t/ha
Wheat	Barley	5.37	4.00
Subterranean clover	Barley	5.39	4.66
Lupin	Canola	-	1.12
Lentil	Canola	2.50	-
Wheat	Canola	2.32	1.32
Oat	Faba bean	2.75	1.49
Wheat	Faba bean	1.95	1.77
Barley	Lupin	-	1.50
Wheat	Lupin	-	1.63
Barley	Lentil	1.90	-
Wheat	Lentil	1.33	-
Canola	Oat	3.75	2.16
Wheat	Oat	2.34	2.41
Wheat	Wheat	5.15	3.32
Lupin	Wheat	-	3.40
Lentil	Wheat	5.80	-
Barley	Wheat	5.89	3.49
Canola	Wheat	4.90	3.60
Oat	Wheat	5.19	3.62
Medic	Wheat	5.20	3.69
Faba bean	Wheat	5.23	3.86
Subterranean clover	Wheat	5.42	4.10
Balansa clover	Wheat	5.39	4.17

At Bordertown wheat yields averaged 5.35 t/ha, and were not greater following a legume break crop compared to following a cereal break crop (Table 4). At the lower grain yielding site, Sherwood, subsequent wheat yields were responsive to legume break crops (Table 4). Sherwood wheat yields in 2018 were greater following balansa clover and subterranean clover, compared to the break crop canola and cereal options. There was up to a 26 % increase in wheat yields following balansa clover, compared to a wheat on wheat rotation.

Table 4. 2018 wheat grain yields (t/ha), following different crops sown in 2017 at Bordertown and Sherwood.

2017 Crop	Bordertown t/ha	Sherwood t/ha	
Wheat	5.15	3.32	a
Lupin	5.80	3.40	ab
Barley	5.89	3.49	ab
Canola	4.90	3.60	ab
Oats	5.19	3.62	ab
Annual medic	5.20	3.69	b
Faba bean	5.23	3.86	bc
Subterranean clover	5.42	4.10	c
Balansa clover	5.39	4.17	c
Site Mean	***5.35***	***3.69***	
P value	0.831	< 0.001	
LSD	NS	0.454	
CV%	14.28	8.12	

NS - Not Significant

Agronomic Trials

In 2018, five targeted agronomic trials were established in the MRZ of the USE. These trials expand on targeted agronomic trials sown in 2017. The trials endeavour to improve break crop/pasture performance through improved varieties and crop management practices, and hence enhance benefits to following crops in integrated farming systems in the MRZ. The five agronomic trials are:

i. What is the agronomic and economic value of forage oats and barley in their own right?
ii. Assess the use of Gaucho® on lentil to reduce the occurrence and impact of Alfalfa mosaic virus.
iii. Comparison of pulse crop in the Keith and Sherwood region.
iv. Are broad beans an economically viable alternative to faba beans in the MRZ of the USE?
v. Does the harvest index of lupin and faba bean, change with varying row spacing and/or sowing density at Sherwood?

This chapter will report on agronomic trial (i) what is the agronomic and economic value of forage oats and barley in their own rights?, as the other targeted agronomic trials are reported in another chapter of the MFMG Annual Results Book.

On 16 May 2018, two forage oats (Mammoth and Genie), one late hay oat (Forester), two forage barley (Dictator II and Moby), one malt barley (Compass), one feed barley (Rosalind) and one milling oat (Mitika) were sown at Keith. Three different agronomic practices were managed for forage, hay or grain production.

Forage Production

Forage plots were grazed (simulated by mowing) on 27 July 2018 for early forage production and then the regrowth was removed on 17 September 2018. Dry matter (DM t/ha) was calculated at each timing and a total DM removed (combination of both cuts) calculated (Table 5).

Table 5. Keith 2018 dry matter (DM) production (t/ha), early DM 27 July, regrowth DM 17 September 2018 and total dry matter calculation.

Variety		Early DM 27-Jul-18 t/ha		Regrowth DM 17-Sept-18 t/ha		Total DM t/ha removed	
Compass	Malt barley	1.97	a	6.94	d	8.91	e
Dictator II	Forage barley	2.05	ab	5.04	c	7.09	d
Forester	Late hay oat	2.74	c	2.02	a	4.76	ab
Genie	Forage oat	2.32	b	2.81	ab	5.13	bc
Mammoth	Forage oat	2.08	ab	1.81	a	3.89	a
Moby	Forage barley	2.03	ab	4.84	b	6.87	c
Mitika	Milling oat	2.16	ab	3.58	c	5.74	d
Rosalind	Feed barley	2.17	ab	5.53	c	7.70	d
Site Mean		**2.19**		**4.07**		**6.26**	
P Value		0.007		<.001		<.001	
LSD		0.319		1.102		0.927	
CV%		4.7		0.8		1.2	

In July Forester had the highest amount of biomass removed, 2.74 t/ha. The forage barley and forage oat varieties had similar production, between 2.32 t/ha (Genie) and 2.03 t/ha (Moby). There was no difference in the early forage production between the malt and feed barley varieties and milling oat.

As in 2017, Compass barley had the highest DM production (6.94 t/ha) in September. The forage oat and hay oat varieties were similar in production and tended to be lower than all other crop types. Dictator II had greater production (5.04 t/ha) compared to Moby (4.84 t/ha).

Compass had the highest total production of 8.91 t/ha, with the majority of this produced after the July graze. Mammoth forage oat had the lowest total production (3.89 t/ha), which was similar to Forester (4.76 t/ha). Forester had early production, but did not produce as much as other varieties in September. Barley varieties (except Moby) and Mitika were more productive overall than the forage oats. As a result of its September production, Dictator II had greater total DM (7.09 t/ha) compared to Moby (6.87 t/ha).

Dry matter production feed quality is presented in Table 6 and Table 7.

Table 6. Feed test results of dry matter (DM) removed on 27 July 2018 at Keith.

	Compass	Dictator II	Forester	Genie	Mammoth	Moby	Mitika	Rosalind
Dry Matter (%)	94.5	95.8	94.6	93.9	94.9	95.2	94.7	95.1
Moisture (%)	5.5	4.2	5.4	6.1	5.1	4.8	5.3	4.9
Crude Protein (% of dry matter)	26.1	25.4	21.6	23.5	21.7	23.3	24.4	24.6
Acid Detergent Fibre (% of dry matter)	20.6	19.6	20.5	22.4	21.0	21.5	23.7	22.6
Neutral Detergent Fibre (% of dry matter)	46.9	47.9	48.9	46.4	48.6	49.8	48.1	48.6
Digestibility (DMD) (% of dry matter)	67.6	62.5	58.1	65.3	54.8	61.6	59.8	63.2
Digestibility (DOMD) (Calculated) (% of dry matter)	64.1	59.7	56.0	62.1	53.3	59.0	57.5	60.4
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	10.0	9.1	8.4	9.6	7.8	9.0	8.7	9.3
Water Soluble Carbohydrates (% of dry matter)	6.4	4.4	2.5	4.7	1.8	4.3	3.6	4.3
Fat (% of dry matter)	4.1	4.0	3.8	3.9	3.8	3.9	4.0	3.9

Table 7. Feed test results of dry matter removed on 17 September 2018 at Keith.

	Compass	Dictator II	Forester	Genie	Mammoth	Moby	Mitika	Rosalind
Dry Matter (%)	86.5	85.7	86.2	91.6	87.4	86.2	85.7	87.9
Moisture (%)	13.5	14.3	13.8	8.4	12.6	13.8	14.3	12.1
Crude Protein (% of dry matter)	16.9	19.8	23.4	23.1	23.9	19.2	21.3	17.2
Acid Detergent Fibre (% of dry matter)	28.1	26.1	21.4	21.9	22.6	24.5	24.0	31.3
Neutral Detergent Fibre (% of dry matter)	59.3	54.2	48.8	49.3	49.3	52.4	51.6	58.3
Digestibility (DMD) (% of dry matter)	65.3	66.4	69.2	69.1	68.5	68.3	66.7	61.3
Digestibility (DOMD) (Calculated) (% of dry matter)	62.1	63.1	65.5	65.3	64.8	64.6	63.3	58.7
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	9.6	9.8	10.3	10.3	10.2	10.1	9.9	8.9
Water Soluble Carbohydrates (% of dry matter)	3.2	3.6	3.8	4.0	3.9	3.5	3.8	3.4
Fat (% of dry matter)	10.5	14.1	12.0	17.7	17.3	13.9	16.4	14.0

Hay Production

When grain was at the watery-dough growth stage, a hay cut was completed. This timing varied between varieties (Table 8). Hay production averaged 9.04 t/ha, with Compass having the greatest production, 10.83 t/ha (Table 8). The feed barley, Rosalind had the second highest production 9.61 t/ha, similar to Genie (9.45 t/ha). The other varieties tended to be similar in hay production.

Hay removed was quality tested (Table 9). Quality ranged from Rosalind A1 to Genie C3. The remaining varieties were either B1 or B2 (Table 9).

Table 8. Hay cut date and hay production (t/ha) at Keith, 2018.

Variety		Date Hay Cut	Hay t/ha	
Compass	Malt barley	5-Oct	10.83	d
Dictator II	Forage barley	5-Oct	8.80	ab
Forester	Late hay oat	30-Oct	8.60	a
Genie	Forage oat	30-Oct	9.45	bc
Mammoth	Forage oat	30-Oct	8.34	a
Moby	Forage barley	5-Oct	8.45	a
Mitika	Milling oat	5-Oct	8.22	a
Rosalind	Feed barley	5-Oct	9.61	c
Site Mean			***9.04***	
P Value			<.001	
LSD			0.798	
CV%			1.7	

Table 9. Hay cut date and quality at Keith, 2018.

	Compass	Dictator II	Forester	Genie	Mammoth	Moby	Mitika	Rosalind
Date Hay Cut	**5-Oct**	**5-Oct**	**30-Oct**	**30-Oct**	**30-Oct**	**5-Oct**	**5-Oct**	**5-Oct**
Dry Matter (%)	89.1	88.0	86.0	86.9	86.4	87.8	88.5	89.8
Moisture (%)	10.9	12.0	14.0	13.1	13.6	12.2	11.5	10.2
Crude Protein (% of dry matter)	7.8	7.6	8.5	5.9	10.3	9.4	10.6	10.4
Acid Detergent Fibre (% of dry matter)	31.1	33.3	29.4	35.4	32.5	31.7	28.3	27.4
Neutral Detergent Fibre (% of dry matter)	57.5	58.0	59.0	65.2	60.5	58.7	53.7	52.9
Digestibility (DMD) (% of dry matter)	61.4	60.2	63.6	54.3	62.2	62.5	64.6	66.9
Digestibility (DOMD) (Calculated) (% of dry matter)	58.8	57.8	60.7	52.8	59.6	59.8	61.5	63.5
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	8.9	8.7	9.3	7.7	9.1	9.1	9.5	9.9
Water Soluble Carbohydrates (% of dry matter)	16.3	18.0	12.4	8.9	8.6	13.8	14.3	15.9
Fat (% of dry matter)	2.7	2.5	3.0	2.7	3.0	2.7	2.9	3.1
Ash (% dry matter)	5.9	5.1	6.7	6.8	7.3	6.0	7.9	6.4
AFIA Grade for cereal hay + silage	B2	B2	B2	C3	B1	B2	B1	A1

Hay Production

Grain was harvested on the 6 December 2018. For barley varieties Compass (4.86 t/ha) and Rosalind (5.14 t/ha) grain production was greater than all other varieties (Table 10). Mitika, 3.85 t/ha, produced less grain than the feed barley Rosalind and malt barley Compass, but more than the forage and hay varieties, which had low grain production between 1.72 (Mammoth) and 0.52 t/ha (Dictator II). Grain is undergoing quality analysis and results were not available at time of publishing.

Biomass production and quality of forage and hay varied between varieties at Keith in 2018. The trial in 2018, as in 2017, demonstrated that end use is an important consideration when selecting crop types and varieties. If a grower wants an early forage option, particular varieties are more suited, but if a grower wants to graze more than once then a different variety may have greater overall production. Grain barleys Compass and Rosalind have demonstrated a capacity to produce biomass as a forage or hay option. Feed test results must be considered to ensure they are as favourable as forage options for livestock production.

Table 10. Grain production (t/ha) at Keith, 2018.

Variety		Grain Yield t/ha	
Compass	Malt barley	4.86	d
Dictator II	Forage barley	0.52	a
Forester	Late hay oat	1.23	ab
Genie	Forage oat	0.93	a
Mammoth	Forage oat	1.72	b
Moby	Forage barley	0.92	a
Mitika	Milling oat	3.85	c
Rosalind	Feed barley	5.14	d
Site Mean		***2.40***	
P Value		<.001	
LSD		0.757	
CV%		5.6	

Focus Paddocks

Monitoring of focus paddocks in the MRZ of South Australia will occur for the duration of the project and data gathered will provide information on which crop sequences are used in different regions and the advantages of different sequences. Protocols for these paddocks incorporate the GRDC National Paddock Survey Project (BWD00025) protocols to allow for collaboration and incorporation of data into this national dataset. Measurements taken include pre-sowing soil, crop plant counts, weed counts, general paddock observations, grain yield (provided by grower), post-harvest stubble height and quality. At the conclusion of the project, data collected will be used to understand which paddocks and soil types are better suited to which break crop option, enabling growers to make more informed break crop rotation decisions. Focus paddock results are not presented in this report.

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