

22. Integrated Farming Systems in the Medium Rainfall Zone

Amanda Pearce, SARDI Struan, amanda.pearce@sa.gov.au

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KEY MESSAGES

- Research funded by the GRDC- SARDI Bilateral Research Agreement.
- Focus on 'Integrated Farming Systems in the Medium Rainfall Zone'.
- Three field components, long-term rotational trials, targeted agronomic trials and focus paddocks.

Trial Background

As part of the GRDC- SARDI Bilateral Research 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, particularly 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 for improving crop performance in integrated farming systems in the MRZ. Long-term monitoring of focus paddocks across the MRZ of South Australia has also commenced.

Provided in this report are preliminary trial results of the long-term rotational trials (data is still being 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. The replicated block trials will evaluate different crop sequences over a four-year period, comparing single and double break options (Table 1). 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). Varieties of each crop type sown in 2017 are listed in Table 2.

The trials 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?

The agronomic and economic performance of each sequence, individually and over the course of the sequence will be evaluated. A sensitivity analysis will be undertaken, allowing for

crop commodity prices, grain quality and grade classification to be considered, to prevent any biasing of a particular crop and/or rotation.

Measurements taken to date include initial soil chemistry and moisture, PreDicta B, crop early and hay biomass production and feed test analysis, weed assessment, grain yield and quality, stubble residue biomass and feed quality, post-harvest soil nitrogen and moisture.

Management of plots followed region best practice, with an aim to maximise production and minimise weeds, pests and diseases. Annual ryegrass plants were counted in spring and raw data is presented in Table 3. The Sherwood trial had higher annual rye grass numbers; consequently, to manage the weed pressure oat plots were cut for hay.

At both sites, crop types were assessed for hay production. Dry matter produced (t/ha) and feed quality were measured. Table 4 and Table 5 present the results from the two locations, showing variations in production and quality between crop types and trial sites.

Average grain yield ranged from barley 4.61 t/ha at Bordertown to 0.91 t/ha canola at Sherwood (Table 6). Wheat grain yields are below expectation, possibly due to the cereal on cereal rotation. The pasture results are yet to be calculated. Tables 7-11 present the grain quality for harvested crops.

Table 1. Crop sequences being evaluated over the duration of the project and the rotation name given to the crop sequence.

Farmer Sown 2016	PROJECT YEAR				Rotation
	1	2	3	4	
	2017	2018	2019	2020	
Wheat	Wheat	Wheat	Wheat	Wheat	Continuous Cereal
Wheat	Barley	Wheat	Wheat	Wheat	Barley Single Break
Wheat	Oat	Wheat	Wheat	Wheat	Oat Single Break
Wheat	Lupin/Lentil	Wheat	Wheat	Wheat	Lupin/Lentil Single Break
Wheat	Faba Bean	Wheat	Wheat	Wheat	Faba Bean Single Break
Wheat	Canola	Wheat	Wheat	Wheat	Canola Single Break
Wheat	Canola	Clover Pasture	Wheat	Wheat	Canola + Clover Double Break
Wheat	Balansa Clover	Wheat	Wheat	Wheat	Balansa Clover Single Break
Wheat	Balansa Clover	Balansa Clover	Wheat	Wheat	Balansa Clover Double Break
Wheat	Balansa Clover	Balansa Clover	Balansa Clover	Balansa Clover	Continuous Balansa Clover
Wheat	Burr Medic	Wheat	Wheat	Wheat	Burr Medic Single Break
Wheat	Burr Medic	Burr Medic	Wheat	Wheat	Burr Medic Double Break
Wheat	Burr Medic	Burr Medic	Burr Medic	Burr Medic	Continuous Burr Medic
Wheat	Sub. Clover	Wheat	Wheat	Wheat	Subterranean Clover Single Break
Wheat	Sub. Clover	Sub. Clover	Wheat	Wheat	Subterranean Clover Double Break
Wheat	Sub. Clover	Sub. Clover	Sub. Clover	Sub. Clover	Continuous Subterranean Clover

Table 2. Varieties of crop types sown at Bordertown and Sherwood, 2017.

Crop Type	Variety Sown in 2017
Wheat	Scepter (AH)
Barley	Compass (Feed)
Oat	Mitika (Milling)
Lupin	PBA Jurien
Lentil	PBA Hurricane XT (Small Red)
Faba Bean	PBA Samira
Canola	Hyola 559 TT
Balansa Clover	Cobra
Burr Medic	Cavalier
Subterranean Clover	Antas

Table 3. Annual rye grass plants/m² per crop type at Bordertown and Sherwood, 2017.

Crop Type	Bordertown	Sherwood
Annual Rye Grass Average Plants/m ²		
Wheat	7	65
Barley	4	100
Oat	2	128
Lupin	-	72
Lentil	0	-
Faba Bean	6	13
Canola	1	52
Balansa Clover	1	13
Burr Medic	1	39
Subterranean Clover	1	9

Table 4. Hay assessment, production (t/ha) and quality, Bordertown 2017.

Variety	Wheat	Barley	Oats	Balansa Clover	Burr Medic	Sub. Clover	Faba Beans	Lentil	Canola
Date Cut	26 Oct	17 Oct	10 Oct	3 Oct	3 Oct	17 Oct	17 Oct	7 Nov	3 Oct
DM (t/ha)	5.82	6.84	5.27	3.61	2.95	2.42	6.84	5.15	6.07
Dry Matter (DM) (%)	90.9	88.3	86.5	84.7	84.1	80.3	84.4	92.4	83.9
Moisture (%)	9.1	11.7	13.5	15.3	15.9	19.7	15.6	7.6	16.1
Crude Protein (% of DM)	6.2	6.3	6.6	20.4	17.7	19.8	22.5	18.2	17.4
Acid Detergent Fibre (% of DM)	27.9	26.7	23.5	25.1	18.3	17.3	20.9	23.1	23.6
Neutral Detergent Fibre (% of DM)	54.6	49.8	43.3	32.0	26.5	27.5	29.4	38.8	31.4
Digestibility (DMD) (% of DM)	61.9	66.6	71.9	72.8	83.6	83.7	79.9	70.2	76.9
Digestibility (DOMD) (Calculated) (% of DM)	59.3	63.2	67.7	68.5	77.6	77.7	74.5	66.3	71.9
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	9.0	9.8	10.8	10.9	12.8	12.8	12.1	10.5	11.6
Water Soluble Carbohydrates (% of DM)	22.9	25.0	33.3	9.4	19.4	17.7	11.7	-	15.7
Fat (% of DM)	2.5	3.0	2.9	3.8	3.8	3.9	4.0	3.8	3.8
Ash (% of DM)	2.4	4.8	7.1	7.3	5.0	8.1	9.9	7.0	2.9

Table 5. Hay assessment, production (t/ha) and quality, Sherwood, 2017.

Variety	Wheat	Barley	Oats	Balansa Clover	Burr Medic	Sub. Clover	Faba Beans	Lupin	Canola
Date Cut	26 Oct	17 Oct	10 Oct	3 Oct	3 Oct	3 Oct	17 Oct	26 Oct	3 Oct
DM (t/ha)	6.86	7.22	5.42	3.00	0.72	2.89	7.61	5.23	4.63
Dry Matter (DM) (%)	94.0	88.5	87.0	82.4	85.8	83.0	86.0	89.5	85.5
Moisture (%)	6.0	11.5	13.0	17.6	14.2	17.0	14.0	10.5	14.5
Crude Protein (% of DM)	5.4	5.5	7.2	19.3	12.5	19.7	17.2	20.5	15.0
Acid Detergent Fibre (% of DM)	31.9	30.4	24.4	13.1	15.8	26.8	23.9	30.9	23.9
Neutral Detergent Fibre (% of DM)	57.9	58.7	45.8	25.8	25.6	33.6	31.8	33.3	32.4
Digestibility (DMD) (% of DM)	58.8	63.5	72.9	86.4	83.7	72.1	78.5	67.6	75.1
Digestibility (DOMD) (Calculated) (% of DM)	56.7	60.6	68.6	80.0	77.7	67.9	73.3	64.1	70.5
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	8.5	9.3	10.9	13.2	12.8	10.8	11.9	10.0	11.3
Water Soluble Carbohydrates (% of DM)	21.8	19.0	33.0	23.3	22.4	9.7	17.9	11.9	17.4
Fat (% of DM)	2.5	2.7	3.1	4.0	3.6	3.7	3.5	3.3	3.7
Ash (% of DM)	4.0	2.9	5.7	8.7	5.0	8.8	4.4	7.1	2.8

Table 6. Grain yield per crop type at Bordertown and Sherwood, 2017.

Crop Type	Bordertown	Sherwood
Grain Yield Average (t/ha)		
Wheat	3.84	2.90
Barley	4.61	2.65
Oat	4.33	-
Lupin	~	3.11
Lentil	1.89	~
Faba Bean	4.18	3.81
Canola	1.92	0.91
Balansa Clover	*	*
Burr Medic	*	*
Subterranean Clover	*	9

~ not sown

- not harvested (Sherwood oats were cut for hay)

* yet to be calculated

Table 7. Pulse grain quality, 100 grain weight (grams), faba bean, lentil and lupin harvested from Bordertown and Sherwood, 2017.

	Faba Bean	Lentil	Lupin
Bordertown	81.86	3.62	~
Sherwood	83.85	~	17.45

~ not sown

Table 8. Canola grain quality harvested from Bordertown and Sherwood, 2017.

	Moisture (%)	Oil (%)	Protein (%)
Bordertown	6.08	44.98	21.58
Sherwood	6.05	42.55	23.35

Table 9. Wheat grain quality harvested from Bordertown and Sherwood, 2017.

	Grain Weight (g/1000 seeds)	Test Weight (kg/hl)	Protein (%)	Screenings (% < 2.00mm)	Grade Achieved
Bordertown	47.3	81	11.3	0.1	APW1
Sherwood	44.0	79	10.5	0.5	APW1

Table 10. Barley grain quality harvested from Bordertown and Sherwood, 2017.

	Grain Weight (g/1000 seeds)	Test Weight (kg/hl)	Retention (% > 2.5mm)	Screenings (% < 2.2mm)	Moisture (%)	Protein (%)	Grade Achieved
Bordertown	53.1	66	98.5	0.2	10.5	12.0	FEED 1
Sherwood	46.1	64	96.2	0.4	10.8	11.2	FEED 1

Table 11. Oat grain quality harvested from Bordertown, 2017.

	Grain Weight (g/1000 seeds)	Test Weight (kg/hl)	Screenings (% < 2.2mm)	Moisture (%)	Protein (%)	Oil (fat) (%)	Groat (%)
Bordertown	40.2	52.4	0.4	10.0	13.1	7.3	74.3

Agronomic Trials

In 2017, five targeted agronomic trials were established in the MRZ of the USE. These 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:

- What is the agronomic and economic value of forage oats and barley in their own right?
- Assess the use of Gaucho® on lentil to reduce the occurrence and impact of Alfalfa mosaic virus.
- Comparison of pulse crop in the Keith and Sherwood region.
- Are broad beans an economically viable alternative to faba beans in the MRZ of the USE?
- 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? In another chapter of the MFMG Annual Results Book the other agronomic trials are reported.

On 23 May, two forage oats (Mammoth and Genie), one late hay oat (Forester), two forage barley (Dictator II and Moby) and one feed barley (Compass) were sown at Keith. Trial plots were split into three and managed for either forage, hay or grain production.

Forage Production

Forage plots were grazed (simulated by hand cutting) on 7 Aug for early forage and then the regrowth was removed on 26 Sept. Dry matter (DM t/ha) was calculated for individual cuts, and as a total DM removed (combination of both cuts) (Table 12).

At the early cut the three barley varieties produced greater DM (t/ha) compared to the forage oat varieties. Compass feed barley had the highest DM production (6.16 t/ha), which was similar to Moby forage barley (4.79 t/ha), but greater than all other varieties in September. Overall DM production was greatest with Compass feed barley (7.72 t/ha), which was greater than the oat forage and hay varieties.

Dry matter removed was quality tested and results are presented in Table 13 and Table 14. There are differences between varieties, crop types and timing of sampling.

Table 12. Dry matter production (t/ha), early cut 7 Aug, re-growth cut 26 Sept and total dry matter production at Keith in 2017.

Variety		Early Cut 7 Aug DM t/ha	Re-growth 26 Sept DM t/ha	TOTAL DM kg/ha production
Compass	Feed Barley	1.56	6.16	7.72
Dictator II	Forage Barley	1.44	4.16	5.60
Forester	Late Hay Oat	1.16	3.11	4.27
Genie	Forage Oat	0.68	3.37	4.05
Mammoth	Forage Oat	0.82	3.31	4.14
Moby	Forage Barley	1.55	4.79	6.34
Site Mean		1.20	4.15	5.35
P Value		<0.001	0.009	0.002
LSD		0.30	1.52	1.54

Table 13. Feed test results of dry matter removed on 7 August 2017 at Keith.

Variety	Compass	Dictator II	Forester	Genie	Mammoth	Moby
Dry Matter (DM) (%)	96.3	93.4	94.1	92.3	93.4	94.5
Moisture (%)	3.7	6.6	5.9	7.7	6.6	5.5
Crude Protein (% of DM)	28.7	27.4	25.4	24.9	26.8	27.4
Acid Detergent Fibre (% of DM)	20.6	22.7	23.0	21.9	21.6	23.1
Neutral Detergent Fibre (% of DM)	41.1	42.1	43.4	45.2	42.5	44.0
Digestibility (DMD) (% of DM)	83.5	82.9	81.1	78.6	80.6	79.1
Digestibility (DOMD) (Calculated) (% of DM)	77.6	77.0	75.5	73.4	75.1	73.9
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	12.7	12.6	12.3	11.9	12.2	12.0
Water Soluble Carbohydrates (% of DM)	4.0	4.3	3.7	-	3.6	2.9
Fat (% of DM)	4.1	4.1	3.9	3.8	4.0	4.0
Ash (% of DM)	11.0	11.1	12.6	13.2	13.1	11.4

Table 14. Feed test results of dry matter removed on 26 September 2017 at Keith.

Variety	Compass	Dictator II	Forester	Genie	Mammoth	Moby
Dry Matter (DM) (%)	84.9	87.2	84.9	81.8	83.2	85.2
Moisture (%)	15.1	12.8	15.1	18.2	16.8	14.8
Crude Protein (% of DM)	12.9	11.9	18.7	18.8	19.1	13.3
Acid Detergent Fibre (% of DM)	30.4	28.8	22.8	21.5	21.0	29.6
Neutral Detergent Fibre (% of DM)	57.1	53.1	45.0	43.2	41.8	54
Digestibility (DMD) (% of DM)	64.5	68.7	78.3	80.3	81.2	66.1
Digestibility (DOMD) (Calculated) (% of DM)	61.5	65.0	73.2	74.9	75.6	62.8
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	9.5	10.2	11.9	12.2	12.4	9.8
Water Soluble Carbohydrates (% of DM)	11.6	17.1	12.5	14.7	14.8	12.7
Fat (% of DM)	3.0	3.0	3.7	3.6	3.8	3.1
Ash (% of DM)	8.0	9.1	10.4	9.1	10.4	10.1

Hay Production

Hay was cut when grain was at the milky-dough stage, which altered between varieties. Hay production averaged 8.20 t/ha and there was no significant difference between varieties and the amount of hay produced (P Value 0.91) (Table 15). Hay removed was quality tested (Table 15) and differences were observed between varieties and crop types.

Table 15. Hay cut date, production (t/ha), and quality at Keith, 2017.

Variety	Compass	Dictator II	Forester	Genie	Mammoth	Moby
Date Cute	17-Oct	26-Oct	2-Nov	2-Nov	2-Nov	17-Oct
Hay DM (t/ha)	8.98	8.95	9.19	7.52	7.02	7.56
Dry Matter (DM) (%)	88.4	87.1	87.0	86.6	89.5	87.2
Moisture (%)	11.6	12.9	13.0	13.4	10.5	12.8
Crude Protein (% of DM)	7.4	7.6	9.6	10.3	9.4	7.8
Acid Detergent Fibre (% of DM)	31.5	29.0	26.5	29.5	26.7	29.1
Neutral Detergent Fibre (% of DM)	55.6	52.8	51.9	55.6	52.7	54.2
Digestibility (DMD) (% of DM)	59.9	64.3	68.6	64.6	69.9	62.6
Digestibility (DOMD) (Calculated) (% of DM)	57.5	61.3	65.0	61.5	66.0	59.8
Est. Metabolisable Energy (Calculated) (MJ/kg DM)	8.7	9.5	10.2	9.5	10.4	9.1
Water Soluble Carbohydrates (% of DM)	17.3	20.1	18.7	13.0	18.2	18.3
Fat (% of DM)	2.8	2.7	3.2	3.1	3.2	2.8
Ash (% of DM)	8.9	6.6	6.1	7.2	6.9	5.2

Grain Production

Grain was harvested on the 5 Dec 2017. The feed barley variety, Compass, had significantly greater grain yield (5.23 t/ha) compared to all other varieties (Table 16). Grain quality was measured for all varieties and is presented in Table 16.

Table 16. Grain production (t/ha) and grain quality at Keith, 2017.

Variety	t/ha	Grain weight (g/1000 seeds)	Test Weight (kg/hl)	Retention (% > 2.5 mm)	Screenings (% < 2.2 mm)	Moisture (%)	Protein (%)	Oil (fat) (%)	Groat (%)
Compass	5.23	44.6	64	85.9	2.4	11.0	12.2	-	-
Dictator II	2.04	38.5	59	52.0	9.7	-	-	-	-
Forester	1.50	25.8	46	-	35.4	11.7	16.2	5.6	71.7
Genie	1.44	22.4	43	-	67.4	11.8	15.8	6.0	69.5
Mammoth	1.82	25.8	44	-	27.9	11.8	14.5	6.3	71.2
Moby	2.89	30.2	56	40.1	22.8	11.0	13.3	-	-
Site Mean	2.49	*	*	*	*	*	*	*	*
P Value	< 0.001	~	~	~	~	~	~	~	~
LSD	0.67								

- not tested for this quality trait

* has mix of crop types in trials

~ grain quality is a bulked sample of the variety across replicates, not statistically analysed

Biomass production and quality of forage and hay varied between varieties and timings in 2017 at Keith. The trial in 2017 demonstrated that end use is an important consideration when selecting crop types and varieties. Compass feed barley demonstrated a capacity to produce biomass as a forage or hay option, but feed test results indicate it may not be as favourable as the forage options for livestock production.

Focus Paddocks

Two focus paddocks are being monitored in the USE and one each in the Mid North and Lower Eyre Peninsula. Monitoring of these paddocks will occur for the duration of the GRDC-SARDI Bilateral Agreement incorporating the GRDC National Paddock Survey Project (BWD00025) protocols to allow for collaboration and incorporation of data into this national dataset. Data gathered from the focus paddocks will provide information on what crop sequences are being used in each region and the advantages of different sequences in different regions. 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.

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