Flexible crops and end-uses for the Mallee

Aim

To demonstrate a range of crop types and end-uses that could have a role in the low rainfall farming systems of the Mallee.

Take home messages

- *Cereals yield well relative to other crop types under low rainfall conditions, but use all available water and nitrogen*
- *Grain legumes do not yield well in dry seasons but can fix valuable amounts of nitrogen if brown manured*
- *Forage legumes (vetch and forage peas) can produce profitable amounts of dry matter in dry seasons*
- *Research in higher yielding environments has shown that break crops provide significant yield benefits to subsequent wheat crops. Benefits to subsequent crops should be accounted for when making decisions regarding break crop options and end-uses.*

Method

A range of break crops were sown at Curyo and Manangatang. They were split into two demonstrations, one looking at grain yield of some novel broadleaf break crops (Table 1), the other looking at different end uses of reasonably well established crops in the Mallee (Table 2).

Looking beyond the fact that all crops were sown at each site on a single date that may not have been optimal for each species, they were managed according to district 'best practice'. Soil water and nitrogen were measured under the different crops during the growing season to determine what level of benefit they would provide a subsequent wheat crop. Dry matter was estimated by cutting 1m of crop row at different times during the growing season to assess the value of different crops for grazing or hay production. Most crops were harvested on 18 November at Manangatang and 5 December at Curyo and grain yield recorded.

Location:	Curyo and Manangatang
Replicates:	1 (Demonstration)
Sowing date:	7 May at Manangatang and 21 May at Curyo
Seeding density:	Various
Crop type:	Broadleaf break crops
Seeding equipment:	Smale seeder bar with narrow points and 300mm row spacing. Trimble (Case IH) auto-steer (2cm accuracy).

Table 1. Novel broadleaf break crops grown at Curyo and Manangatang.

Crop type	Cultivar
Chickpeas	Genesis 090
Forage peas	Morgan
Fenugreek	Might
Fenugreek	Power
Crambe	94500
Crambe	94504
Mustard	K9209
Canola	Cobbler
Canola	Tawrific
Canola	8032RR

Table 2. Break crops sown at Manangatang and Curyo and their different end-uses, which determined what measurements were taken during the growing season.

Crop type	Cultivar	End uses			
		Grazing	Brown manure	Hay	Grain
Oats/medic	Wintaroo/Jaguar	✓	✓	✓	✗
Medic	Jaguar	✓	✓	✓	✗
Vetch	Morava	✓	✓	✓	✓
Chickpeas	Genesis090	✗	✓	✗	✓
Lentils	Nugget	✗	✓	✗	✓
Field peas	Kaspa	✗	✓	✓	✓
Canola IT	44C73	✗	✓	✓	✓
Barley	Hindmarsh	✗	✓	✓	✓
Wheat	Yitpi	✗	✓	✓	✓
Chemical fallow	-	✓	✓	✗	✗

Results

This demonstration is not replicated so it is impossible to tell if differences in yield and other parameters are due to the effect of individual treatments or the result of paddock variability and chance.

At Manangatang, none of the novel broadleaf crops could be harvested for grain, but as of 22 October 2008, the forage peas, mustard and conventional canola produced 2.0-2.5t/ha of dry matter. At Curyo, forage peas achieved a grain yield of 1.1t/ha and chickpeas 0.7t/ha. All other crops produced only marginal yields or were not harvested. Dry matter, plant available water, available nitrogen and final grain yield for Manangatang and Curyo are shown in Tables 3 and 4.

Table 3. Dry matter, plant available water (PAW), nitrogen and yield of crops with different end-uses grown at Manangatang.

Crop type	Dry matter (t/ha)		PAW (mm)	Available N (kg/ha)	Grain yield (t/ha)
	15 August	5 October	7 October	7 October	
Oats/medic	1.8	2.5	17	65	-
Medic	0.1	0.9	20	91	-
Vetch	0.1	0.2	36	173	-
Chickpeas	0.2	0.7	17	111	-
Lentils	0.1	0.3	40	184	-
Canola IT	0.8	0.6	-6	70	-
Barley	1.6	1.3	-3	84	1.5
Wheat	1.4	1.2	-4	133	1.4
Chemical fallow	-	-	8	287	-

Table 4. Dry matter, plant available water (PAW), nitrogen and yield of crops with different end-uses grown at Curyo.

Crop type	Dry matter (t/ha)		PAW (mm)		Available N (kg/ha)		Grain yield (t/ha)
	4 August	3 October	27 August	3 October	27 August	3 October	
Oats/medic	0.78	4.1	81	59	17	29	-
Medic	0.39	3.1	80	82	52	56	-
Vetch	0.46	2.9	43	27	61	50	-
Chickpeas	-	2.4	41	49	66	57	-
Lentils	0.25	2.8	7	70	61	51	0.5
Field peas	0.46	4.1	34	70	63	49	0.6
Canola IT	1.02	2.4	-13	49	28	38	0.9
Barley	2.23	5.7	2	-37	23	33	2.1
Wheat	1.15	3.7	9	29	30	43	1.4
Chemical fallow	-	-	40	101	77	84	-

Interpretation

At Manangatang, where only 115mm of rain fell, all novel broadleaf break crops grew poorly and could not be harvested. However, dry matter at 22 October 2008 shows that forage peas, mustard and canola had grown a useful amount of biomass that could have been baled as hay or grazed. At Curyo, where 140mm of rain fell, the chickpeas and forage peas achieved reasonable grain yields.

For the crops with different end-uses at Manangatang, only wheat and barley were harvestable for grain. Wheat, barley and the mix of oats and medic produced useful amounts of dry matter that could have been baled or grazed (Table 3). There was 21mm of available water and 127kg/ha of available nitrogen measured at the site on 23 May. This indicates that although lentils and vetch grew very little dry matter and no grain, they seemed to contribute around 50kg/ha of nitrogen and 15-20mm of stored soil water by 7 October. This 'brown manure' effect would almost certainly contribute to an increase in yield of a subsequent wheat crop. Canola and chickpeas failed to yield or contribute water and nitrogen for use by a following crop. Around 120kg/ha of nitrogen became available under the chemical fallow, although not much water.

At Curyo, the lentils, field peas, canola, barley and wheat were all harvested and achieved reasonable yields given the low growing season rainfall. All crops grew useful amounts of dry matter that could have been grazed or cut for hay (Table 3). There was 11mm of available water and 69kg/ha of available nitrogen measured at the site on 22 May. This indicates that only the chemical fallow contributed positively to available nitrogen with 15kg/ha becoming available by 3 October. The chemical fallow also had the most amount of available water by 3 October, but all crops except for barley would have contributed positively had they been sprayed out for brown manure or cut for hay.

A simple economic analysis of the data shows that profitability of each of the crop types can change drastically with end use (Table 5 and 6). It also shows that if nitrogen and soil water are given a potential dollar value based on fertiliser price and yield increase in a subsequent crop respectively, brown manuring and chemical fallow returned positive gross margins at both sites. A slightly surprising result is that chemical fallow at Curyo had one of the best overall gross margins due to the large amount of soil water accumulated over the fallow.

Table 5. A simple economic analysis of crops with different end uses at Manangatang*.

Crop type	Variable costs /ha	Hay gross margin /ha	Potential value of brown manure N and PAW /ha	Grain price /t	Grain gross margin /ha
Oats/medic	$150	$80	-$280	-	-
Medic	$120	-	-$195	-	-
Vetch	$180	-	-$44	$300	-$215
Chickpeas	$200	-	-$261	$600	-$235
Lentils	$180	-	-$5	$1,000	-$215
Canola IT	$200	-	-$449	$500	-$230
Barley	$150	-$31	-$362	$200	$120
Wheat	$150	-$40	-$294	$250	$170
Chemical fallow	$75	-	$94	-	-

** Economic analysis assumes;*

- *Variable costs are for planting and management up to hay cutting, harvest or brown manuring*
- *Hay yield is 65 percent of dry matter in October plus 13 percent moisture and hay can not be made if dry matter in October is less than 1t/ha*
- *Hay price is $200/t for cereal, $220/t for canola and $300/t for legume hay*
- *Cost of hay making is $75/t*
- *Potential value of nitrogen assumes nitrogen available in October is available in the next growing season if crop is brown manured, and nitrogen fixed by legumes is equivalent to fertiliser nitrogen and is $1.50/kg*
- *Potential value of soil water assumes soil water available in October is available in the next growing season if crop is brown manured, and benefit to subsequent wheat crop is calculated as 22kg/ha/mm with price of wheat $250/t*
- *Brown manure requires knockdown herbicide at a cost of $15/ha*
- *Grain harvest costs are $30/ha for cereals and $35/ha for pulses*

Table 7. A simple economic analysis of crops with different end uses at Curyo*.

Crop type	Variable costs /ha	Hay gross margin /ha	Potential value of brown manure N and PAW /ha	Grain price /t	Grain gross margin /ha
Oats/medic	$150	$226	$39	-	-
Medic	$120	$392	$236	-	-
Vetch	$180	$299	-$136	$300	-$215
Chickpeas	$200	-	-$24	$600	-$235
Lentils	$180	-	$103	$1,000	$285
Field peas	$180	$498	$99	$400	$25
Canola IT	$200	$56	-$53	$500	$220
Barley	$150	$373	-$483	$200	$240
Wheat	$150	$190	-$105	$250	$170
Chemical fallow	$75	-	$428	-	-

Application

In terms of grain yield, cereal crops will always outperform potential break crops in tough seasons and use more available nitrogen and water. Grain legumes are particularly susceptible to dry conditions, but can contribute significant amounts of nitrogen and forage legumes can grow profitable amounts of biomass in dry seasons whilst providing all the benefits of legume break crops. If the potential value of stored water and nitrogen are accounted for, chemical fallows can compare favourably to break crops.

Break crops are known to provide significant benefits to subsequent wheat crops. From a review of existing literature, Angus *et al.* 2008 have defined what these yield advantages are likely to be in absolute terms relative to a 4 t/ha wheat crop (Table 8). Whilst all the mechanisms listed in this table operate with break crops available in the Mallee, it is unlikely that the absolute yield benefits reported here would apply to our typical yields. This makes break crop selection in the Mallee even more uncertain as advantages to subsequent crops cannot be accounted for in decision making.

Table 8. Sources of the break crop effect and estimates of their value at a wheat yield level of 4t/ha from Angus *et al.* (2008).

Mechanism	Additional wheat yield (t/ha)
Take-all suppression	0.5
Suppression of other root diseases	0.3
Net nitrogen benefit of canola	0.1
Hydrogen fertilisation by legumes	0.4?
Suppression of arbuscular mycorrhizal fungi	0-0.1
Net nitrogen benefit of legumes	0.5

Break crop selection in the Mallee is difficult. As demonstrated by the results of this demonstration, all break crops have their problems, and often perform nowhere near as well as wheat and barley, particularly in drier environments and seasons. However, as the simple economic analysis above shows, break crops with flexible end-uses can compete economically with cereals, provided that their commodity prices are high and farming system benefits (eg. fixed nitrogen and stored soil water) are accounted for.

BCG will commence a fully replicated break crop experiment in 2009 that aims to assess the benefits that break crops have on subsequent wheat crops, and quantify the value of farming systems services that they provide in economic terms. Results from this experiment will help define the role of break crops in the Mallee, and help growers make informed decisions about crop selection, agronomy and end uses.

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References

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