FarmLink
Research Report 2013

04

Grain and Graze 2 Southern NSW
Perennial Shrubs

Project Partners

FarmLink Research

NSW Government Department of Primary Industries

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Executive summary

Previous studies in central western New South Wales determined that the incorporation of permanent plantings of woody perennials into existing, mixed farming systems had the potential to improve the reliability of forage supply in low rainfall environments and to re-establish water use patterns similar to those of the original landscape. It was expected this would reduce livestock production risk and increase total farm productivity. What was lacking was a long term comparison of animal performance. To test the proof of concept, a large scale trial was commissioned at Condobolin in central western New South Wales.

The trial compared two farming systems, one with and one without the addition of old man saltbush (OMSB). Farming system one ('No saltbush') operated a crop/pasture rotation which was similar to that used in the central west of NSW. Farming system two ('Saltbush') had an identical crop/pasture rotation, but each paddock had 20% of its area replaced with belts of OMSB.

Crop grain yield and animal performance were measured over five years. At the conclusion of the trial, there were few significant differences between the two systems. The most important difference was a significant reduction in conception rate of Merino ewes from the Saltbush system. Wool production and body characteristics between the ewe bloodlines were significantly different but were as expected – the contrasting bloodlines had been bred that way.

If belts of OMSB are incorporated into low rainfall mixed farms and managed in a similar manner to that tested here, it is unlikely that any worthwhile productivity benefits will result.

Introduction

On Australian farms, saltbush is used in two main ways. One is to reclaim land affected by dryland salinity and the other is to produce forage that is available over a long period. Whilst there is often an overlap between these uses, it is usually planted for one main use with the other an added benefit.

The majority of research to date on saltbush has been conducted on saline land, mainly in Western Australia. Saltbush has also been used and studied on non-saline land. Typically this has been in the arid regions of Australia where it occurs naturally. Little research has been done with saltbush in a non-saline, mixed farming situation.

Previous studies in central western New South Wales (NSW) (Milthorpe *et al.* 1998; Milthorpe *et al.* 2001) determined that the incorporation of permanent plantings of woody perennials, (such as old man saltbush, OMSB), into existing, mixed farming systems had the potential to improve the reliability of forage supply in low rainfall environments and to re-establish water use patterns similar to those of the original landscape. The result should be reduced livestock production risk, and an increase in total farm productivity. This same work also concluded that future research should 'monitor changes in a range of animal performance attributes for stock grazed with and without forage shrubs' (Milthorpe *et al.* 1998) and 'quantify the benefits of forage shrubs for a range of management options in whole farm systems' (Milthorpe *et al.* 2001).

To investigate these issues, a large, long term trial was set up at Condobolin, NSW. It was designed so it had direct applicability to commercial mixed farms in the region.

From the outset, this trial was expected to run longer than one funding cycle. The trial was initially funded and implemented under the Grain and Graze Phase 1 project. Funding under the current project was due to continue until the end of 2013. However, the Grain and Graze 2 Project Steering Committee directed that field work be ceased early. This report is a synthesis of relevant information from both Grain and Graze Phase 1 and Grain and Graze Phase 2.

Trial Methodology

Location

The trial was located at Condobolin in central western New South Wales, Australia (latitude 33.07degrees S, longitude 147.23 degrees E). This location was representative of a broad swathe of the low rainfall mixed farming zone of NSW.

Climate

Condobolin has a relatively low median annual rainfall for a cropping region. Rainfall is equiseasonal in distribution with April having the lowest median rainfall of any month (Table 1).

Table 1. Rainfall over the life of the trial (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2006	Trial stocked in October 2006									0	11.5	12.9	
2007	38.8	47.7	29.4	16.7	48.8	56.2	20.5	13.7	0.8	6.2	107.5	111.8	498.1
2008	28.2	84.5	10.6	9.2	7	27.2	29	21.4	23.2	23	57.6	28.4	349.3
2009	4.2	60.6	28.8	45	14.2	52.6	23.2	10.7	16.6	34.2	17.2	90.6	397.9
2010	16.6	158.6	55.4	33	38.3	25	48.9	26.3	38	76.9	81.3	50.6	648.9
2011	20.8	59.6	86	30	30.4	8.2	13.9	37.5	18.2	51.1	108.6	109.4	573.7
2012	32.4	123.8	86.7	3.8	Trial destocked in April 2012								
Median 1954-2013	**29**	**32.1**	**26.4**	**16.7**	**27.4**	**27**	**35.8**	**29.6**	**24.5**	**36.1**	**30.8**	**25**	**423.6**

Paddocks

The trial compared two farming systems, one with and one without the addition of OMSB. Each system was set up as a mini farm totalling 150 hectares each. Farming system one ('No saltbush') operated a crop and pasture rotation which was similar to that used in the central west of NSW. Farming system two ('Saltbush') had an identical crop and pasture rotation, but each paddock had 20% of its area replaced with belts of OMSB.

Adjacent paddocks with the same size and similar landscape features were paired. One paddock in each pair was randomly allocated to the No saltbush system and the other to the Saltbush system.

Rotation phases (Table 2) were semi-randomly allocated to paddock pairs. Existing lucerne pasture paddocks were randomly allocated to P2 and P3. If existing paddocks were not utilised, implementing pasture treatments of the correct age would have resulted in a pre-trial time lag of up to three years. This was deemed too long so the compromise of using some existing paddocks was implemented.

Crop and pasture

Both systems had a 2 year crop, 3 year lucerne pasture rotation. This was replicated 3 times in a design produced by NSW DPI staff. Every instance of each rotation year was represented in each replicate. Figure 1 contains a field plan which provides a representation of treatment and paddock layout.

Saltbush

Genetically unselected OMSB seedlings were obtained commercially. Seedlings were planted in Saltbush paddocks as belts 15 m wide. These comprised 5 rows with 3 m between rows. Within a row, plants were spaced at 1.5 m giving a final planted density of 2200 seedlings per hectare.

Approximately half were planted in December 2004 and the remainder plus replants in September 2005. Saltbush belts were not mechanically pruned during the experiment.

Table 2. Rotation phase details

Rotation description	Rotation code	Crop and pasture details	Crop and pasture sowing rate	Fertiliser and rate
Crop year 1	C1	Wheat[2]	30 kg/ha	50 kg/ha MAP[1]
Crop year 2	C2	Wheat + lucerne[3]	15 kg/ha + 2.5 kg/ha	50 kg/ha MAP
Pasture year 1	P1	Lucerne	Not sown	Nil
Pasture year 2	P2	Lucerne	Not sown	Nil
Pasture year 3	P3	Lucerne	Not sown	Nil

[1]MAP, mono ammonium phosphate, [2]wheat variety was Livingston, [3]lucerne variety was Aurora

Paddock design summary

The paddock elements consisted of two farming systems, five rotation years, three replicates and 5 years of operation. The experimental unit was a single, paired paddock.

Animals

Livestock measurements were made on the trial from 2007 to 2011. The trial was rotationally grazed by 200, 4-8 year old Merino ewes from two contrasting bloodlines. The bloodlines were a Locally Adapted bloodline (LA) and a Conventional Wool bloodline (CW). LA is a large framed, plain bodied sheep producing a moderate amount of fine wool. CW is a medium framed, heavy wool cutting bloodline with moderate body wrinkle and broader fibre diameter than LA. One hundred ewes grazed the No saltbush system and 100 grazed the Saltbush system. Each system had similar numbers of LA and CW ewes.

Once allocated to a system each animal stayed in this system until it exited the trial. This way, “No saltbush animals” always grazed lucerne based pasture or crop stubbles and “Saltbush animals” had continual access to OMSB belts. Additionally, “No saltbush” and “Saltbush animals” always grazed both paddocks in a pair concurrently. Both groups of animals were moved to a fresh pair of paddocks on the same day.

Animal management

Animals were not grazed within replicates but grazed in paired paddocks across all replicates. As such, there were no spatial replicates of the animal component of the experiment. Consequently, each year of trial operation provided only one replicate of animal data. With five years of animal measurements, there were five replicates of animal data over the life of the trial.

Paddocks were grazed such that the animals in both systems were always grazing the same paddock pair. This also ensured that stock from both systems were always grazing the same phase of the rotation (eg both grazed neighbouring second year lucerne, both grazed neighbouring first year crop stubble etc).

In October or November each year, ewes were assessed for physical defects and reproductive failure. Approximately one quarter of each mob was removed from the trial and replaced with younger (3-5 year old) ewes from commercial flocks of the same bloodline.

Ewes were mated to Poll Dorset rams in the first week of January each year. Rams were randomly allocated and introduced to each system at 2–3 rams per hundred ewes for six weeks. Ewes were pregnancy scanned by the same contractor each year 90–110 days after the commencement of mating. Lambing commenced in the first week of June each year.

Lambs were marked after the completion of lambing. Shortly after marking, lambs were split into bloodlines using creep gates and tagged appropriately. This method of determining the maternal bloodline of the lambs was used in 2007-2009. In 2010 and 2011, ewes were split into bloodlines prior to lambing, negating the requirement for creep gate separation.

Weaning occurred 12-15 weeks after the commencement of lambing. Weaned lambs grazed paired paddocks in a similar manner to ewes until they were sold for meat. Lambs were sold in two blocks each year. Timing and number sold on each occasion were seasonally dependent. Target live weight at sale was 55 kg.

When conventional feed was exhausted as a result of drought, both No saltbush and Saltbush animals received supplementary feed. In some instances this was in external feeding paddocks but predominantly it was in the usual treatment paddocks.

Animal measurements

Ewes were weighed and fat scored each year during the mating period and every 1-2 months during the rest of the year. Lambs were weighed at weaning and every 1-2 months until sale.

Animal design summary

The animal component had two farming systems, two bloodlines and five years of operation (replicates). The experimental unit was a single, paired paddock.

Soil water

A neutron probe was used to measure soil water periodically in a subset of paddocks for the life of the trial. Aluminium neutron probe access tubes were installed to 2.8 m depth in 3 out of 5 rotation years. Access tubes were installed in both the OMSB belts and the rotationally cropped alley between belts. Not all paddocks had access tubes installed as it was determined adequate data could be obtained from the scheme implemented at reduced cost.

Figure 1. Schematic of trial paddocks

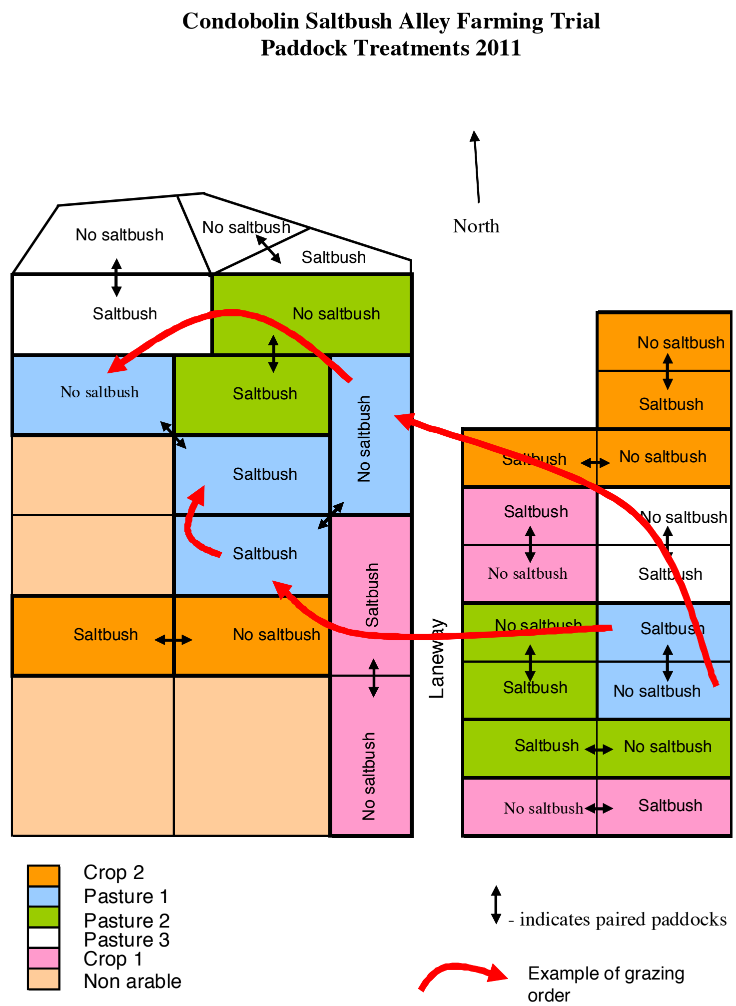
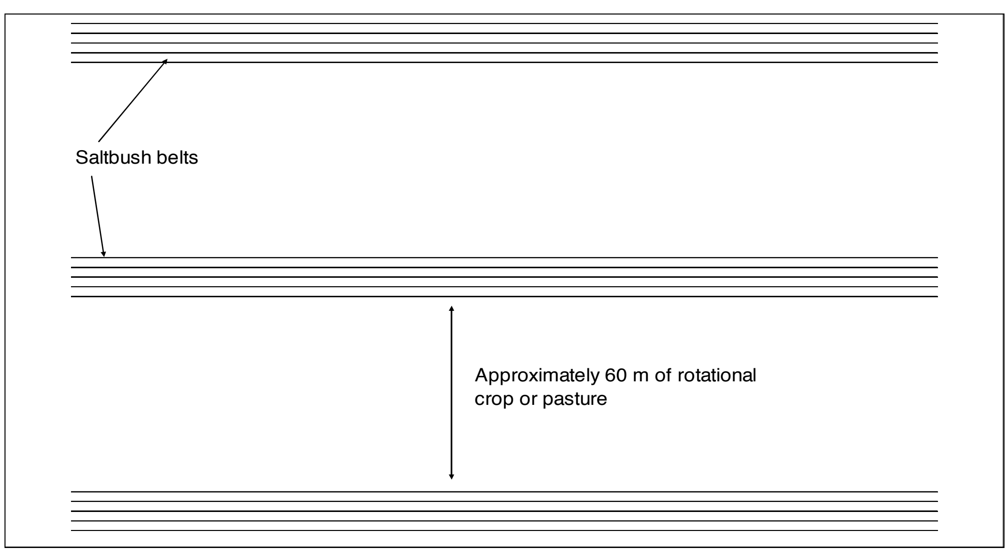


Figure 2. Representative saltbush configuration



Results

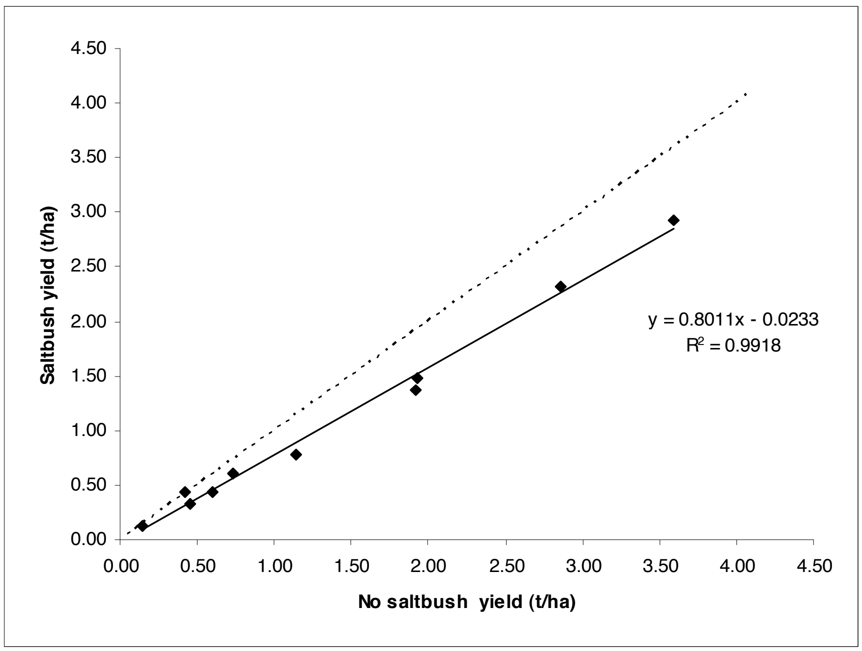
Crop

Only wheat was sown on the trial so comments about grain yield relate to wheat only.

Paddock yield

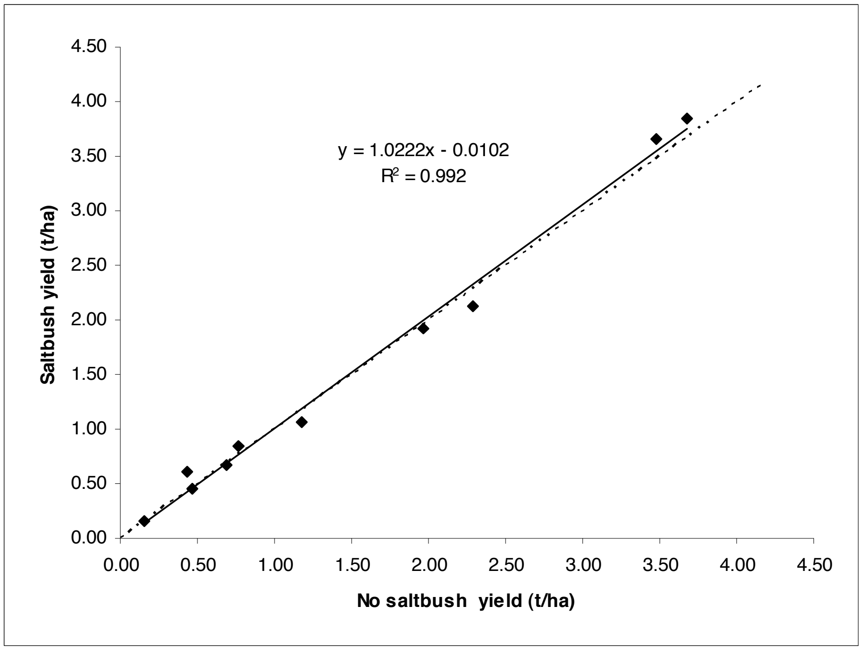
Wheat yield on a paddock hectare basis when saltbush was present was about 80 % of the yield when it was absent (Figure 3). This is sensible as saltbush took up approximately 20 % of the paddock area.

Figure 3. Wheat yield when calculated on the total paddock area



When No saltbush and Saltbush system wheat yields were compared on a cropped area basis, yields were very similar (Figure 4).

Figure 4. Wheat yield when calculated on a cropped area basis

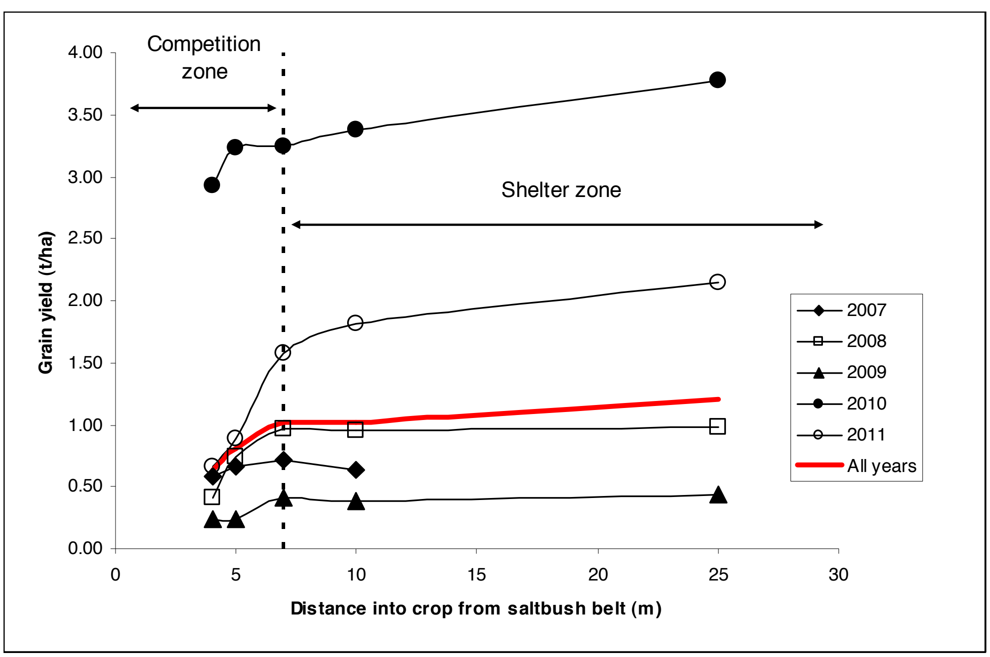


Yield at the interface with saltbush belts

Just as there is competition for resources between plants within a crop, there is also competition between OMSB and the crop where the two meet. This interface effect needs to be understood before an informed decision can be made on incorporation of OMSB into a farming system.

To investigate this, crop yield was measured by hand harvest in transects out from the saltbush belts (Figure 5).

Figure 5. Crop yield at the interface with OMSB



The effect of OMSB on crop yield at the interface conformed to the relationship found when using trees as windbreaks (Cleugh *et al.* 2002; Bennell and Verbyla 2008). There is a zone of competition that extends into the crop 1-4 times the height of the tree where yield is reduced. Beyond this, out to 10-20 times the height of the tree, there is a zone of unchanged or slightly increased yield.

Given the OMSB bushes were 1-2 m high, this competition zone should extend up to 8 m into the crop in this trial. Figure 5 indicates this was the case. The dashed vertical line on Figure 5 represents yield measured 7 m distant from the saltbush. Within each year, all yields to the left of this line were below the yield 7 m out from the bushes. To the right of this line, yields within a year were similar or slightly higher (except for 2007). If all years are considered together (thick red line, Figure 5), the 7 m line is a clear demarcation between the competition and the shelter zones.

Crop summary

Figures 3, 4 and 5 together indicate that, at this site at least, any yield reductions at the interface and any slight increase towards the centre of the cropped alley cancelled each other out. This resulted in grain yields from No saltbush and Saltbush paddocks being very similar when expressed on a per cropped hectare basis.

Soil water

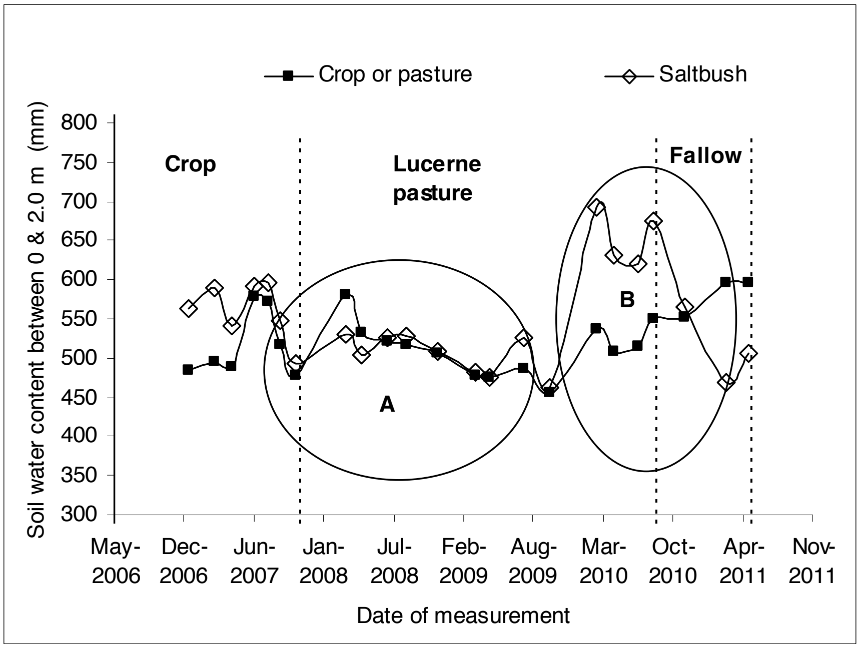
A subset of data is presented in Figures 6 and 7 to indicate the broad trends from the trial.

Access tubes that were located in the rotationally cropped areas measured different treatments depending on what phase of rotation the paddock was in at the time. At one period they would be measuring soil water under crop. When the crop phase finished, water use measured was of the lucerne based pasture. Finally, when the pasture was terminated, soil water under fallow was measured before the paddock reverted to crop for the start of the next rotation.

With this in mind, Figures 6 and 7 have vertical lines overlaid to indicate where different rotation phases commenced and finished. Because soil water measurements in the saltbush belts always measured saltbush water use, these delineators should be ignored for saltbush data.

Prior to planting saltbush seedlings, a period of fallow was implemented to store moisture. Examining water in the top 2 m of soil (Figure 6) when measurements commenced in December 2006, it is evident there was a substantial difference between the fallowed saltbush area and the adjacent cropped area. After substantial rainfall in late 2007, both the lucerne pasture and the saltbush soil water increased before declining at a similar rate during the low rainfall years of 2008 and 2009 (Figure 6, area A).

Figure 6. Soil water content from 0-2.0 m in saltbush and adjacent, rotationally cropped land



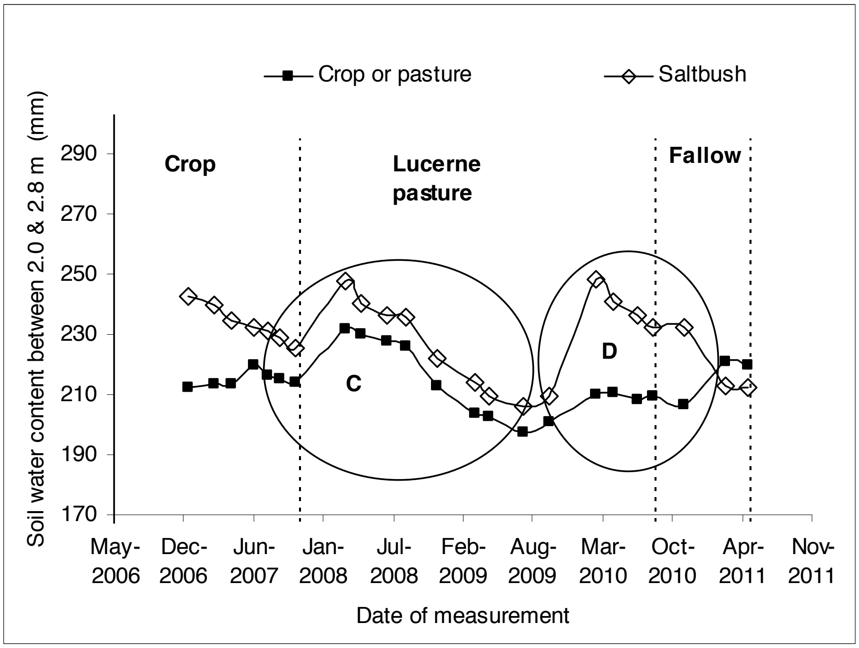
Following substantial rain again in late 2009 and early 2010, soil water under both lucerne pasture and saltbush rose. However, soil water present under saltbush was far greater than that under lucerne (Figure 6, area B). It is believed there were two predominant reasons for this difference in soil water. One is that there was more bare ground in the lucerne stand than there was in the saltbush belts so there was less water infiltrated into the lucerne stand. The second is that lucerne used water more rapidly than saltbush giving a flush of growth over a relatively short period. Rather than having a short period of rapid growth until soil water is depleted, OMSB continues growth at a slower rate over an extended period (Honeysett *et al.* 2004).

The lower soil profile showed similar trends (Figure 7) but with a smaller range (Figure 6, 230 mm vs Figure 7, 51 mm amplitude). These deep soil drying capabilities of lucerne and OMSB are broadly in line with Lodge *et al* (2010) who reported a number of deep rooted perennials had a similar ability to dry the soil profile.

Soil water summary

Both lucerne and OMSB are capable of using soil water to at least 2.8 m at this location. Both used water at a similar rate under dry conditions but, under high rainfall conditions, lucerne appeared to have reduced moisture infiltration and/or a more rapid use of soil water.

Figure 7. Soil water content from 2.0-2.8 m in saltbush and adjacent, rotationally cropped land



Ewe reproduction

Farming system treatment significantly affected the number of ewes that were pregnant when scanned. The Saltbush system contained significantly fewer pregnant ewes than the No saltbush system (Table 3). This translated to lower net reproduction in the Saltbush system (significance level not determined). There was also a trend towards the Saltbush ewes being less fecund (*P*<0.1). Farming system had no significant effect on any other measured reproductive variable. This included the number of lambs weaned, lamb weaning weight and lamb fat score at weaning. There was no significant effect of ewe bloodline on any reproductive measure.

Table 3. Ewe reproductive performance

	Farming system			Bloodline		
Variable	**No saltbush**	**Saltbush**	**Significance level[A]**	**Locally Adapted**	**Conventional Wool**	**Significance level**
Conception rate	0.91	0.86	**	0.88	0.89	n.s.
s.e.[B]	0.05	0.06		0.06	0.05	
Fecundity	1.44	1.37	+	1.42	1.39	n.s.
s.e.	0.05	0.05		0.05	0.05	
Embryo survival to weaning	1.16	1.12	n.s.	1.17	1.11	n.s.
s.e.	0.07	0.07		0.07	0.07	
Net reproduction	1.03	0.93	Not tested	0.99	0.97	Not tested

[A]n.s., not significant; +, *P*<0.1; *, *P*<0.05; **, *P*<0.01; ***, *P*<0.001.
[B]s.e, standard error.

Reproduction explanatory factors

Fat score or live weight at mating were not significantly different between farming systems (Table 4) although fat score and live weight were significant covariates for pregnancy rate and fecundity respectively.

LA ewes were significantly heavier and fatter than CW ewes at mating. The LA bloodline has been bred to be a larger, more robust animal than CW so it is reassuring that this work confirms what is found commercially.

Table 4. Body condition at mating

	Farming system			Bloodline		
Variable	**No saltbush**	**Saltbush**	**Significance level[A]**	**Locally Adapted**	**Conventional Wool**	**Significance level**
Fat score at mating	3.2	3.1	n.s.	3.3	3.0	***
s.e.[B]	0.2	0..2		0..2	0..2	
Live weight at mating	71.7	71.7	n.s.	74.6	68.8	***
s.e.	1.9	1.9		1.9	1.9	

[A]n.s., not significant; +, *P*<0.1; *, *P*<0.05; **, *P*<0.01; ***, *P*<0.001.
[B] s.e, standard error.

Interaction of farming system and bloodline on ewe live weight at mating

Whilst farming system did not affect live weight directly, there was a significant interaction between farming system and bloodline (Table 5). Whilst LA ewes were heavier at mating in the No saltbush system than the Saltbush system, CW ewes were heavier in the Saltbush system.

Table 5. Live weight at mating – farming system x bloodline interaction

Means followed by the same letter are significantly different at *P*=0.05

Farming system	Bloodline	Live weight at mating (kg)	s.e.[B]
No saltbush	Locally Adapted	75.5[a]	1.9
No saltbush	Conventional Wool	67.9[d]	1.9
Saltbush	Locally Adapted	73.6[b]	1.9
Saltbush	Conventional Wool	69.8[c]	1.9

[B]s.e, standard error.

The significant interaction was unexpected. It is this interaction that resulted in there being no significant difference in live weight at mating between farming systems.

There are two possible suggestions as to why this occurred but no firm explanations. Firstly, it is possible the CW bloodline has an undocumented genetic pre-disposition for better OSMB utilisation. However, if this were the case, it would be expected that CW ewes would have performed significantly better than LA ewes on the Saltbush farming system. This was not the case.

Secondly, it is possible the CW ewes have learnt to eat OSMB and have become adapted to it. Learning is an important process in diet selection by grazing animals (Provenza *et al.* 2003). However, because replacement CW and LA ewes were bred on the commercial portion of the farm where the trial was conducted, this too, is unlikely to be the reason for the result. Whilst the commercially managed mobs from both bloodlines were grazed in separate groups, both bloodlines had access to the same paddocks on different occasions during any given year. Once again, this suggestion is unlikely to be the cause of the result. Further research would be required to determine the reason for this finding.

Shelter

Shelter can significantly increase the survival of newborn lambs if the weather is cold at lambing (Pollard 2006). Belts of OMSB such as used in this experiment can be very useful for shelter. However, because each year of animal data was a single replicate, we were unlikely to see consistent benefits from shelter in this experiment. This is because, in this environment where severe cold weather is rare, high lamb losses due to weather are infrequent. If there was a year when shelter was of benefit, this information would have been lost during analysis as between replicate variation.

Summary of ewe reproduction

From anecdotal evidence, it was expected that incorporating OMSB into the Saltbush farming system would improve body condition of animals in that system. It was also expected this would lead to higher ewe conception rates, multiple births and increased lamb weight and survival. None of these expectations were proven in this experiment. In fact, the opposite was true. Whilst many measures of reproductive performance were unchanged, there was a small but significant decrease in the conception rate in the farming system that incorporated OMSB.

Table 6. Commercially important wool characteristics

Variable	Farming system: No Saltbush	Farming system: Saltbush	Significance level[A]	Bloodline: Locally Adapted	Bloodline: Conventional Wool	Significance level
Clean fleece weight (kg)	4.2	4.1	n.s.	3.7	4.5	***
s.e. [B]	0.1	0.1		0.1	0.1	
Fibre diameter (microns)	20.2	20.0	n.s.	19.9	20.2	***
s.e.	0.2	0.2		0.2	0.2	
Staple strength (N/ktex)	34.3	36.4	**	33.7	37.0	***
s.e.	1.7	1.6		1.6	1.6	
Staple length (mm)	94.8	96.1	n.s.	95.5	95.4	n.s.
s.e.	1.3	1.3		1.3	1.3	

[A]n.s., not significant; +, $P<0.1$; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.
[B]s.e., standard error.

Ewe wool production

The only significant difference in measured wool characteristics that are of commercial importance was for staple strength (Table 6). Saltbush ewes had significantly stronger wool than their No saltbush contemporaries. However, this significant difference was small in commercial terms and would not warrant planting saltbush on its own.

The only other significant difference between farming systems was for fibre curvature (*P*<0.001). Saltbush ewe wool had 2 % less curvature than No saltbush wool. As with staple strength, this difference is of little commercial importance.

The largest number of significant differences in wool characteristics were between bloodlines (Table 6). LA ewes produced less wool with lower staple strength but finer micron than CW ewes. This simply shows that both bloodlines conformed to the breeding goals of the stud they were derived from.

Whilst the clean fleece weight figures in Table 6 are on an individual animal basis, because there were similar numbers of ewes in each group, the significance of each result is unlikely to change when expressed on a per hectare basis.

Summary of ewe wool production

The incorporation of OMSB into the farming system did not improve any wool characteristics to an extent that would be commercially useful.

Lamb results

As discussed under 'Ewe reproduction', there was no significant difference in the number of lambs weaned, lamb weaning weight or fat score at weaning between farming system or animal bloodline (Table 7). In addition to weaning data, Table 7 lists weights immediately prior to the sale of the first draft of lambs. Lambs were sold in two drafts. When one truck load (approximately 150 animals) reached 55 kg live weight, they were sold. Typically this was in mid December each year. The remainder were sold when they, too, reached 55kg live weight.

Because the animals sold were not proportionally selected from each farming system or bloodline, lamb production after this time is likely to have been biased. Consequently, only data up until this first sale of lambs is presented.

Individual animal weight and fat score did not differ significantly between farming system or bloodline. Lamb live weight per hectare at weaning and at the first sale date are also presented in Table 7. These have not been statistically tested. To express results on a per hectare basis, the number of animals was multiplied by their weight and divided by the area of the farming system. Because there was no significant difference in lambs weaned or lamb weight at either measurement date and because both farming systems contained the same area, it is unlikely there would be significant differences in lamb production when expressed on a per hectare basis.

Table 7. Lamb data

Variable	Farming system			Bloodline		
	No saltbush	Saltbush	Significance level[A]	Locally Adapted	Conventional Wool	Significance level
Lambs weaned	101	91	n.s.	99	94	n.s.
Standard error	8	8		8	8	
Lamb weaning weight (kg)	34.9	34.3	n.s.	34.6	34.6	n.s.
Standard error	1.1	1.1		1.1	1.1	
Total lamb live weight at weaning (kg/ha)	24	21	Not tested	23	22	Not tested
Weaned lamb fat score	2.2	2.2	n.s.	2.3	2.2	n.s.
Standard error	0.2	0.2		0.2	0.2	
Individual lamb weight at first sale (kg)	50.7	51.3	n.s.	51.3	50.7	n.s.
Standard error	1.9	1.9		1.9	1.9	
Total lamb live weight at time of first sale (kg/ha)	34	31	Not tested	34	32	Not tested
Fat score at first sale	2.9	3.0	n.s.	3.0	3.0	n.s.
Standard error	0.3	0.3		0.3	0.3	

[A] n.s., not significant; +, $P<0.1$; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.

Summary of lamb results

Providing continual access to OMSB did not have any significant effect on the number of lambs weaned, their weight or fat score at weaning. There were also no significant differences in live weight or fat score by the time the first lambs were sold each year.

Discussion of findings

As with all trials, the method of treatment testing is open to criticism. Supporters of OMSB suggest stocking rate should be increased to utilise the additional feed that should be available from OMSB. However, simply increasing stocking rate has long been known to increase per hectare productivity in the absence of other factors (Langlands *et al.* 1984a, 1984b, 1984c). To avoid this effect, No saltbush and Saltbush farming systems were stocked with the same number of ewes.

OMSB followers also suggest that the majority of biomass from saltbush should be grazed before animals are moved to fresh paddocks. If we implemented this approach, pasture or crop stubbles in the alleys between saltbush belts would have been completely denuded before animals were removed. This is not representative of best practice and was also something to be avoided.

Consequently the decision to graze No saltbush and Saltbush animals in adjacent pairs of paddocks and move them to fresh paddocks at the same time was deemed an appropriate trade off. It was determined this would allow the Saltbush system adequate opportunity to express any benefit whilst not penalising the No saltbush system. When rain produced green feed, both No saltbush and Saltbush sheep had access to a lucerne based diet but the Saltbush sheep were able to combine this with OSMB as desired. When conventional green feed was scarce, No saltbush sheep only had dry feed available whilst the Saltbush animals had green forage available as OMSB. When conventional feed was exhausted, both systems received supplementary feed as grain – the perfect opportunity for the Saltbush system to excel. Similarly, when half the cropped area was eaten off near maturity by sheep in 2007 and again in 2009, any grain in the head and freshly senesced leaf should have been a good complement for OMSB in the Saltbush system.

The lack of any positive increases in productivity from this trial is disappointing. There was an expectation that provision of year round green feed in the form of OMSB would increase farm livestock productivity. Such a result would have opened up the possibility of livestock production increases across the eastern Australian wheatbelt. The comprehensive review of Ben Salem *et al* (2010) provided support for this expectation when they stated '…it is clear that old man saltbush alley-cropping could greatly reduce soil erosion, restore organic matter, boost crop yields and provide high returns on farmers' investments' . However, Unkovich *et al* (2003) concluded the opposite when they found '….in lower rainfall environments (<350 mm), alley farming is likely to be dogged by competition for water between crops and perennials'.

There are three suggestions as to why there were no positive production responses to OMSB in this trial. The first is that there was always at least some lucerne in all the pasture paddocks. Whilst stock did not have access to lucerne when grazing crop stubbles and failed crops, these were for relatively short periods of the year. Except when it was extremely dry, there was always a small amount of lucerne available for grazing in both systems. This may have provided enough readily digestible material to offset the value provided to Saltbush sheep by OMSB.

Secondly, there may have been too much OSMB planted in the saltbush treatment paddocks. Any potential benefit of OMSB may have been overshadowed by there being too little conventional feed to complement it. Whilst this work was set up with best bet calculations at the time, more recent work has found that benefits from OMSB can be achieved when the proportion of farm area is less than that planted here (Monjardino *et al.* 2010).

Thirdly, this low rainfall mixed farming zone may not be where saltbush is most beneficial. The potential for alley-cropping described in Ben Salem *et al* (2010) should be kept in context. Much of their discussion about its suitability was related to arid regions with annual rainfall <300 mm. This is less than the 424 mm median rainfall for the site in this study. Whilst Unkovich *et al* (2003) found the largest effects of competition when annual rainfall was <350 mm, they also found significant interface grain yield decreases at their wetter site with similar rainfall to this trial location. Whilst alley cropping originated in the tropics, as Stirzaker and Lefroy (1997) put it, 'once alley cropping research moved out of the wet tropics, tree/crop competition made it unacceptable'. Very low rainfall makes any forage worthwhile and high rainfall makes alley cropping worthwhile because there is no competition for water between annual and perennial plants.

Whilst the crop yield decreases at the crop and OMSB interface didn't reduce total cropped area yield in this experiment, the question of suitability of alley farming with OMSB is still relevant. In this region there are other options for green forage on productive farmland over summer and autumn. Lucerne in particular can be grown reliably and sub-tropical grasses are becoming increasingly popular as a forage source. Whilst neither of these can provide green forage for the extended period of OMSB, they are inherently more palatable to stock. Given this, it may be more useful for farmers to concentrate on higher productivity pastures on their arable land and experiment with alternatives on less productive land where the opportunity cost is lower.

Conclusion

There was substantial expectation that this trial would demonstrate clear and positive benefits for farms using OMSB in a similar way to that tested in this experiment. Whilst OMSB visually and on paper seems a convenient way of providing forage during dry periods of the year, this trial has cast doubt on its usefulness in low rainfall mixed cropping. Whilst the plants grew well, allowing stock continual access to belts of OMSB did not improve any commercially useful components of the Saltbush system as tested.

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