PHOTO: K Fisher

Areas with the best prospects for high percentages of the farm under lucerne are those:

- *in medium to high rainfall agro-ecological zones*
- *with a high percentage of suitable soils*
- *with only minor technical constraints*
- *with the ability to make changes to the livestock system.*

Regional outlook

Across the Australian wheatbelt the need and potential for widespread lucerne adoption varies markedly. Regions within each State differ in terms of the profitability of lucerne on mixed farms, the size of the salinity threat, the impact on rising groundwater of reduced recharge, and the obstacles to integrating lucerne into existing farming systems. Detail for each region follows this section in pages 31–53.

Table 7 (see over page) summarises the main findings across all seven regions.

Challenges with integration

The case studies included in the following sections provide clear examples of producers who have successfully integrated lucerne into their mixed farming enterprises with the benefits of greater profits and reduced salinity risk.

These examples highlight the opportunities for more producers to increase their lucerne area to an economically optimum level. They show how these producers have met challenges such as:

- Lack of infrastructure and managerial experience for livestock production and fixed commitment to cropping infrastructure
- Lack of knowledge and confidence in managing lucerne pastures
- Risks associated with establishment and removal of lucerne stands and initial yield penalties for grain crops
- Low livestock numbers in areas affected by drought
- Time lag in the emergence of herbicide resistance requiring the establishment of a pasture phase within crop-based systems
- Lifestyle and workload expectations that mitigate against more intensive livestock systems.

TABLE 7: Summary of the drivers influencing widespread adoption of lucerne across seven regions. See pages 31 to 53 for detailed analysis of each region

	Central Wheatbelt WA	South West WA	South Coast WA	Wimmera/Mallee SA/Victoria/NSW	Mid-north and Yorke Peninsula SA	SW Slopes NSW and Riverine Plains NSW/Vic	Central West NSW
Area of agricultural land (Mha)	5.2	4.0	3.4	7.8	2.2	9.0	9.1
Mean annual rainfall (mm)	350-450	450-650	325-450	300-450	350-550	450-600	400-650
Area moderate-highly suitable for lucerne on basis of soils and climate (%)	48	65	63	60	85	85	77
Expected increase in salt-affected land	High	High	High	Low	Low	High	Low
Potential impact of lucerne on local groundwater levels if widely grown	Low	Medium	High	Medium-High	High	Medium	Low
Economically-optimum area of lucerne on typical mixed farms[1] (%)	4-30	15-30	18-25	N/a[2]	N/a[2]	N/a[2]	10-20
Increase in whole-farm profitability from 0 to optimum lucerne area	$28,000 (prime lambs) $6,000 (prime lambs and wool)	$95,000 (prime lambs) $65,000 (prime lambs and wool) $20,000 (wool)	$50,000 (prime lambs) $35,000 (prime lambs) and wool) $20,000 (wool)				$55,000 (prime lambs and wool)
Major managerial constraints to greater adoption of lucerne	Poor profitability compared with cropping, high establishment costs or lack of confidence	Lack of confidence and knowledge in integrating lucerne into cropping systems	Poor profitability compared with cropping, unreliable summer production	Large paddocks/ grazing management/ persistence, establishment risk	Poor profitability compared with cropping, lack of livestock, infrastructure and commitment	Poor establishment	Difficult establishment, unreliable removal and crop penalties
Overall prospects for widespread adoption of lucerne	✔	✔✔	✔✔✔	✔	✔✔✔	✔✔✔	✔

[1] range depends on the type of livestock enterprise employed [2] N/a – information not available

Central Wheatbelt Western Australia

This region, encompassing the drier parts of the Grains Research and Development Corporation (GRDC) WA Central Zone, and the southern part of the WA Northern Zone, covers about 5.2 Mha under mixed farming. Areas such as the eastern wheatbelt and north-eastern agricultural region were not included here because of the general perception that lucerne has limited prospects. But there will be cases where targeted use of lucerne in these regions is justified such as with subtropical grasses in the northern region, and in valley floors in the eastern wheatbelt.

A conservative estimate of the current level of salt-affected land in this region is about 300,000 ha. Total salinity hazard is almost 1 Mha, as estimated by revised Land Monitor calculations, so there is significant potential for salinity to spread. Much of the salinity hazard area will not be at risk of salinity by 2020 and so this is an upper estimate.

Lucerne can impact on hillside seeps within the region as groundwater flow systems are often local, meaning salinity is within the control of producers with small-scale seeps. But until lucerne areas approach 50% of the landscape, or are better targeted in areas of risk, their impact in valleys is likely to be localised and the benefit restricted to delaying the impact of salinity.

The current area of lucerne in this region is about 48,000 ha, which is considerably below the 2.5 Mha estimated as moderately to highly suitable. Unsuitable soils have low pH or are in marginal rainfall areas. On typical mixed farms of the region, lucerne could be grown across 4–30% of farm area depending upon the livestock enterprises.

Adoption at these levels requires confidence and knowledge regarding the integration of lucerne into cropping systems, increased livestock numbers and improved profitability compared with cropping.

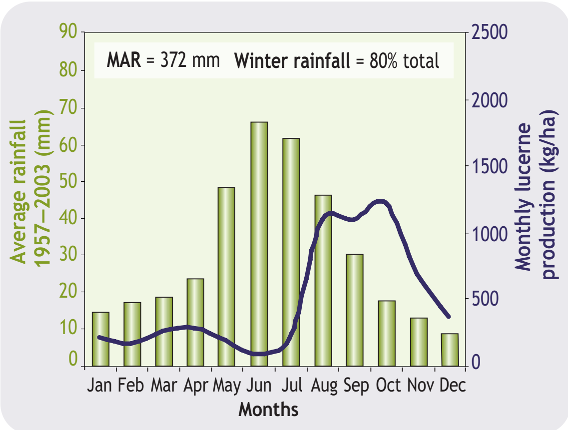
Using lucerne to help manage herbicide-resistant weeds, along with the reduced risk in frost-prone landscapes such as valley floors, are key future drivers for adoption in this region.

Central Wheatbelt Western Australia	
Main GRDC Agro-ecological Zone	WA Central
Rainfall	350–450 mm/yr (low to medium rainfall)
Soils	Deep and shallow duplex, sandplain, red and grey clays
Total agricultural area	5.2 Mha
Area currently saline	309,400 ha
Expected increase in salt-affected land	High
Area moderate-highly suitable for lucerne	48% (2.5 Mha)
Current area of lucerne	48,000 ha
Dominant groundwater flow system	Local
Drivers for widespread adoption	Local and immediate impact on hillside seeps
	More profitable livestock production, with increasing prices for prime lambs
	Management of herbicide-resistant weeds Less frost risky than cropping in valley floors
Constraints to widespread adoption	Poor profitability compared with cropping
	High establishment costs even if the overall economics are good in the long run
	Low and erratic summer rainfall leads to unreliable summer production
	Engineering solutions currently favoured for salinity management
	Lack of knowledge or confidence in integrating lucerne into cropping systems. The cropping agenda dominates social and industry extension

Rainfall and potential production

Rainfall and potential lucerne production for Cunderdin, in the Central Wheatbelt represents the low to medium rainfall zone within WA (see Figure 15). Mean annual rainfall (MAR) in the region varies from 350 to 450 mm, with 80% falling from April to October. Long-term mean simulated potential second-year lucerne production for Cunderdin on a reasonable soil type is about 5.7 t/ha/yr.

FIGURE 15: Rainfall and potential lucerne production for Cunderdin



Economic analysis for a representative farm

Profitability was assessed using whole-farm economic modelling configured to represent a typical farm of the region, at Cunderdin.

Crops and prices: wheat ($200/t), barley ($200/t), lupins ($190/t), canola ($375/t)

Livestock: Merino sheep for wool production (720 c/kg) and prime lamb ($3/kg) production

Farm size: 2000 ha

Soil types: deep and shallow duplex, sandplain, red and grey clays

The profit-maximising area of lucerne on a whole-farm basis is 4-30% (see Figure 16). The profit sacrifice from going to higher areas is small. The broadness of the optimum means there is scope for trade-offs between current production and future salinity management benefits.

Permanent lucerne and companion cropping systems are equally effective at reducing leakage to minimal levels, while with phase farming there is some risk of leakage during the cropping phase. Leakage declines from 80 to 5 mm as the area of the farm under lucerne goes from 0 to 70%. Under lucerne-based rotations it is less than 5 mm/yr.

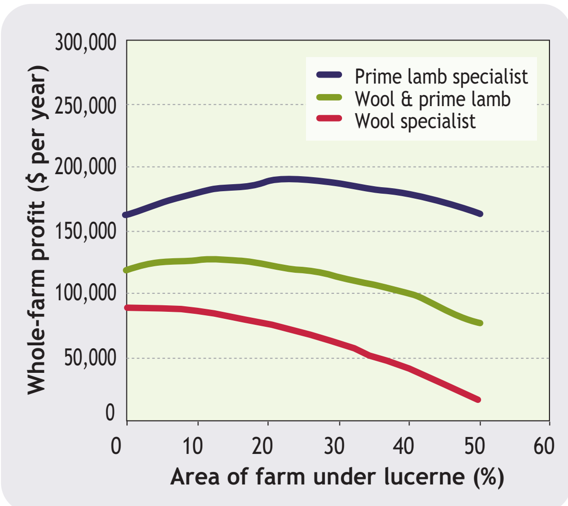
Companion cropping, if practised every year reduces grain production to 70% of continuous cropping. Tactical companion cropping, which only occurs in favourable seasons, does not offer better prospects for overall grain production.

Lucerne profitability depends strongly on the type of sheep enterprise. In a production system based on wool and Merino crossbred lambs whole-farm profit increases by $6,000 when changing from no lucerne to 12%. For a prime lamb specialist the profit gain could be $28,000 based on about 25% lucerne. But with a wool specialist enterprise, the optimum area of lucerne reduces to 4%. In this instance the increase in profit is negligible showing the extra profit earned is not enough to warrant learning new skills and extra management.

When lucerne was included there were a number of changes to rotations depending on the soil type. For example, on one soil type the lucerne phase replaced a crop phase, while at the same time a crop phase replaced an annual pasture phase on another soil. Further modelling showed both of these rotational changes were important for improving profit. Assuming the wool and prime lamb enterprise, if lucerne was only able to replace an annual pasture rotation then there was actually a decrease in profit of 6%. Conversely, if lucerne replaced the crop rotation only and there were no other changes there was almost no change in profit.

This shows that moving to lucerne does not involve simply substituting it for annual pastures. Crop sequences and the soil types upon which they occur will often have to change as well.

FIGURE 16: Optimum area of lucerne on a representative farm at Cunderdin varies with type of livestock enterprise



case study

Lucerne proves timely opportunist

farm information

- **Farmers**
  Robert, David and Glenn Beard
- **Location**
  Meckering, North Cunderdin, WA
- **Property size**
  4000 ha (three properties)
- **Enterprises**
  Cropping and sheep (1800 breeding ewes)
- **Annual rainfall**
  325-350 mm (75% between May and October)
- **Soil type**
  Grey clay to sandplain over gravel and clay

The benefits of lucerne, particularly in years with high summer rainfall, are obvious for wheat and sheep producers, Robert, David and Glenn Beard at Cunderdin.

"Long-term research is needed to understand the costs and benefits of this system across a range of seasons, but the economic and environmental benefits of lucerne in a year with some out-of-season rain are quite clear," says Robert.

In an eight-month trial, two grazing systems were compared to evaluate the economics of lucerne and its impact on sheep production. One mob of ewe weaners was grazed on a traditional system with annual stubbles and pastures and compared with a mob grazing on pastures also incorporating lucerne.

Weaners on the lucerne-based pastures were rotationally grazed through four paddocks with no supplementary feed. The mob on the annual pastures grazed on stubbles and was hand fed with grain and hay during the summer and autumn as required.

The lucerne system proved more profitable than the traditional pastures because it produced more wool and meat and did not require supplementary feeding (see Table 8).

A learning curve

When first trialling 60 ha of lucerne during 2000, the Beards hoped the perennial pasture legume would maintain farm productivity while dealing with waterlogging and salinity. But due to a lack of experience and knowledge of how to manage the pasture species, the Beards' first trial suffered significant insect damage and competition from weeds. "But we now know that to get establishment right, good weed and insect control is absolutely essential," explains Robert.

With increased experience and knowledge, the Beards now have about 10% of the farm under lucerne and will probably maintain this level until they see a need to plant more on other areas of the farm.

Currently they are looking at how to mix phase farming, intercropping and ley farming to find the smartest way to get the best overall result.

(Case study courtesy of Diana Federenko, DAFWA)

TABLE 8: Average meat and wool production per hectare during the experimental period under two farming systems: traditional annual stubbles/pastures and the same system with lucerne

	Annual system	Lucerne system
Stocking rate (animals/ha)	6.0	9.0
Live weight gain (kg)	186.0	297.0
Greasy fleece weight (kg)	20.5	31.5
Clean fleece weight (kg)	12.8	19.6
Fibre diametre (micron)	18.0	18.5
Hand feeding ($/animal)	5.17	0.00

South West Western Australia

The South West region of WA takes in the wetter parts of the GRDC WA Central and the WA Sandplain Zones and covers 4 Mha under mixed farming.

A conservative estimate of current salt-affected land is about 65,000 ha. Total salinity hazard is about 0.5 Mha, as estimated by revised Land Monitor calculations, so there is potential for salinity to spread. Significant areas of valley hazard could already be saline, or become saline during the next 20 years.

Lucerne can have a large and short-term impact across the region because groundwater flow systems are often local. But in this medium to high rainfall environment a farm would still not become leak-proof with whole-farm adoption of rotations of three years lucerne followed by three years of cropping. This is because of the considerable risk of leakage during the cropping phase and potential for leakage under lucerne in wetter years.

The current area of lucerne grown in the region is about 74,000 ha, considerably below the 65% of the area considered to be moderately to highly suitable. Unsuitable soils generally have low pH.

On typical mixed farms of the region lucerne could be grown at 10-40% of farm area depending on the type of livestock enterprises. Such levels of adoption require increased confidence and knowledge about lucerne integration into cropping systems.

The emerging threat of herbicide-resistant weeds is a key future driver for adoption of lucerne as a management tool in this region. The risk of frost in valley floors could also drive the uptake of lucerne in these areas.

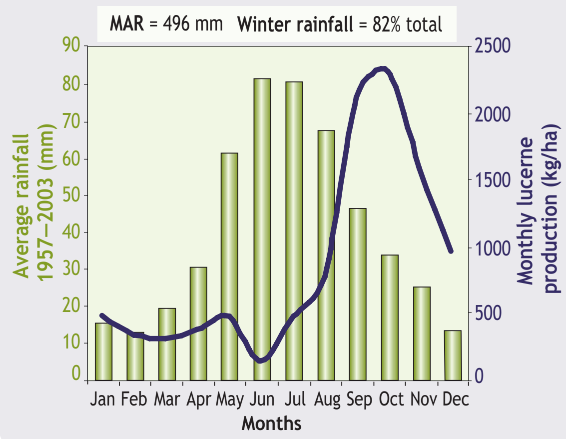
region at a glance

South West Western Australia	
Main GRDC Agro-ecological Zones	Wetter end of WA Central and some of WA Sandplain
Rainfall	450-650 mm/yr (medium to high rainfall)
Soils	Deep and shallow duplex, sandplain, red and grey clays
Total agricultural area	4.0 Mha
Area currently saline	65,000 ha
Expected increase in salt-affected land	High
Area moderate-highly suitable for lucerne	65% (2.6 Mha)
Current area of lucerne	74,000 ha
Dominant groundwater flow system	Local
Drivers for widespread adoption	Management of herbicide-resistant weeds
	Large and short-term impact on high water tables because groundwater flow systems are usually local scale, especially nearer the coast
	More profitable livestock production, with increasing prices for prime lambs and beef
	Less frost risky than cropping in valley floors
Constraints to widespread adoption	Lack of knowledge or confidence about integrating lucerne into cropping systems. The cropping agenda dominates social and industry extension
	Low and erratic summer rainfall leads to unreliable summer production
	Engineering solutions are currently favoured for salinity management

Rainfall and potential production

Rainfall and potential lucerne production for Kojonup represents the medium to high rainfall zone in South West WA (see Figure 17). Mean annual rainfall varies from 450 to 650 mm, with 82% falling from April to October. Long-term mean simulated potential second-year lucerne production for Kojonup is about 7.2 t/ha/yr.

FIGURE 17: Rainfall and potential lucerne production for Kojonup



Economic analysis for a representative farm

Profitability was assessed using a whole-farm model configured to represent a typical farm of the Kojonup district within the region.

Crops and prices: canola ($375/t), barley ($200/t), oats, wheat ($200/t), lupins ($190/t) and other legumes

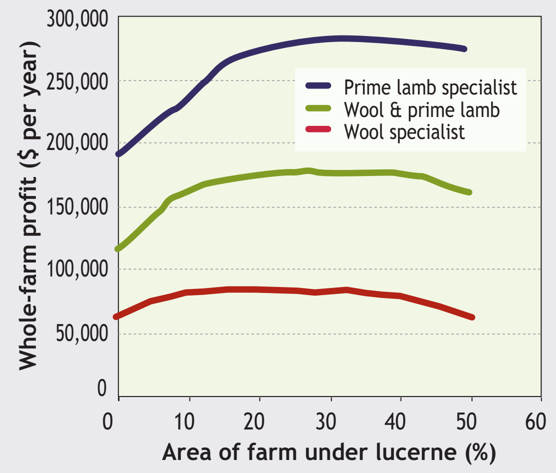
Livestock: Merino sheep for wool (720 c/kg) and prime lamb ($3/kg) production

Farm size: 1000 ha

Soil types: deep sands, duplexes

The optimum area of lucerne on a whole-farm profit basis varied from 9 to 30% depending upon the type of livestock enterprise (see Figure 18). With a wool specialist enterprise profitability increased by $20,000 from no lucerne to the optimum area of 25%, but with a production system based on wool and Merino crossbred lambs profitability increased by $60,000 when increasing lucerne area from 0 to 30%. Greater increases in profitability are possible if the sheep enterprise is predominantly based on prime lambs.

FIGURE 18: Optimum area of lucerne on a Kojonup farm varied from 15 to 30% depending upon type of livestock enterprise



More importantly, the profit shows little sensitivity to the area of lucerne. For example, whole-farm profit under prime lamb production is within 5% of the maximum at lucerne areas up to about 50%. This means areas of lucerne greater than the optimum could be grown for recharge control, without greatly sacrificing whole-farm profit. While it has not been modelled, a similar profile might be expected for a beef enterprise.

Groundwater leakage declines from about 120 to 50 mm as the area under lucerne goes from 0 to 50%. But because of the risk of leakage during the cropping phase and under lucerne in high rainfall years, the farm would still not become leak-proof under three-year lucerne and three-year cropping rotations across the whole farm.

If carried out each year, companion cropping reduces grain production to 70% of continuous cropping. Tactical companion cropping in favourable seasons still does not appear to offer better prospects for overall grain production, but this should be evaluated in the light of profit earned from the lucerne.

case study

Lucerne repairs waterlogging damage

Rex Measday is following the lead set by previous farm manager Jim Bailey to use lucerne successfully to dry out the soil profile of cropping paddocks that tend towards waterlogging in years of high rainfall. Jim considered the moisture content of the upper soil profile had noticeably improved under lucerne and he continued to plant more land to lucerne to reap the economic and landcare benefits it provided. He also found lucerne reduced the susceptibility of the sandy soils to both water and wind erosion and provided a useful flush of quality feed after a summer rainfall event.

Rex also appreciates the additional benefits lucerne brings including those associated with nitrogen fixation, better weed control and a soil moisture buffer. Lucerne also provides high quality summer feed for stock and protects the property's sandy soils from erosion.

Low recharge farming systems

Subasio Downs, in the Gnowellen Catchment, was cleared from the early 1960s through to 1978.

During August 1997 the previous manager, Jim Bailey, planted lucerne in paddocks susceptible to waterlogging in years of high rainfall. This area still has a sufficient slope for surface drainage and he considered three to four years of lucerne should dry out the soil profile and prepare the paddock for cropping again. Experience showed that this was indeed the case (see Figure 19). Other benefits Jim sought included the ability to control weeds before cropping, nitrogen fixation and increased drainage through the deep penetration of the lucerne roots into the sodic clay layer.

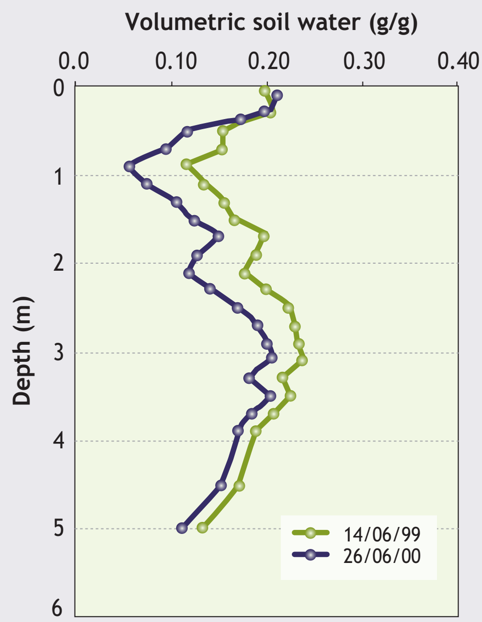
Jim kept the proposed lucerne area relatively weed-free from the time of break of season until just before sowing, when he sprayed with a knockdown herbicide just before direct drilling at a depth of 10 mm. Initially Jim combined four varieties (Aquarius, Eureka, Sceptre and Hunterfield) but Rex has continued with just Sceptre and Eureka.

case study

farm information

- **Farmer**
  Rex Measday (manager)
- **Location**
  Gnowellen, WA
- **Property size**
  4290 ha
- **Enterprises**
  Cropping (75%), sheep (20%) and cattle (5%)
- **Annual rainfall**
  450 mm
- **Soil type**
  Sand over sodic clay with some deep sand ridges, gravel over clay on some crests

FIGURE 19: The soil moisture profile under lucerne was drier in June 2000. The reduction in soil moisture at 0-2 m depth was 85 mm and 0-5 m was 165 mm compared with a neighbouring lupin crop which showed a 10 mm increase at 0-2 m



After the initial stand of lucerne was established (November 1997) Jim rotationally grazed according to the health of the stand. He calculated the total cost to establish lucerne in the first year to be about $130–140/ha (1997).

Benefits and lessons learnt

During lucerne establishment (first 12 months) Jim experienced some problems with radish and melon control. He sprayed the paddock with 2,4-DB to control these weeds. Jim kept an eye on weeds in the lucerne paddocks and Rex continues this vigilance, spraying with Diuron and SpraySeed® for autumn weeds when needed. However, Rex finds that grazing pressure from livestock has made weed control a much easier proposition.

South Coast Western Australia

This region encompasses the GRDC WA Sandplain Zone, covering about 3.4 Mha under mixed farming.

A conservative estimate of current salt-affected land in this region is about 72,000 ha. Total salinity hazard is about 0.3 Mha, as estimated by revised Land Monitor calculations, which indicates a large potential for salinity to spread. Significant areas of valley hazard could already be saline, or become saline during the next 20 years.

Much of the salinity risk relates to inland areas where lucerne is less suitable. But the adoption of lucerne could have a significant and short-term impact across the region because groundwater flow systems are usually at local scale, especially nearer the coast.

South Coast Western Australia	
GRDC Agro-ecological Zone	WA Sandplain and wetter end of WA Central
Rainfall	325-450 mm/yr (low to medium rainfall)
Soils	Deep and shallow duplex, sandplain, red and grey clays
Total agricultural area	3.4 Mha
Area currently saline	72,000 ha
Expected increase in salt-affected land	High
Area moderate-highly suitable for lucerne	63% (2.1 Mha)
Current area of lucerne	28,000 ha
Dominant groundwater flow system	Local
Drivers for widespread adoption	Management of herbicide-resistant weeds
	Large and short-term impact on high water tables across the region because groundwater flow systems are often local scale, especially nearer the coast
	More profitable livestock production, with increasing prices for prime lambs
	Less frost risky than cropping in valley floors
Constraints to widespread adoption	Perceived profitability and management dificulties of lucerne compared to cropping. The cropping agenda dominates social and industry extension
	Low and erratic summer rainfall leads to unreliable summer production

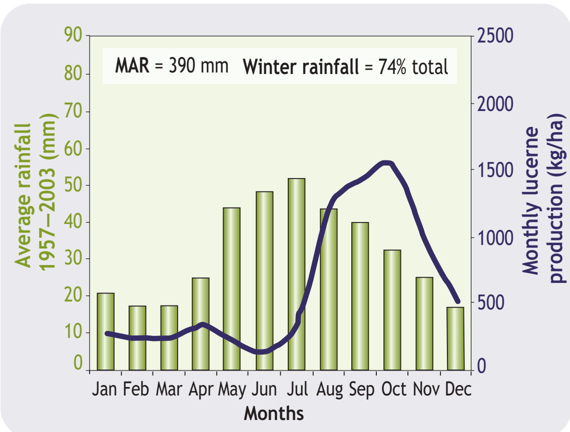
The area under lucerne is about 28,000 ha, considerably below the 2.1 Mha (63% of the area) moderately to highly suitable. Unsuitable soils generally have low pH.

On typical mixed farms of the region lucerne could be grown at 18 to 25% of farm area depending upon the type of livestock enterprise (see Figure 21). Adoption at these levels is possible with few technical constraints to lucerne integration identified. A key driver for adoption could be the ability to use lucerne to manage the emerging threat of herbicide-resistant weeds. In frost-prone landscape positions, such as valleys, lucerne adoption could be driven by its lower risk compared with cropping.

Rainfall and potential production

Rainfall and potential lucerne production for Borden represents the South Coast region. Long-term mean simulated potential second-year lucerne production for Borden is around 6.5 t/ha/yr.

FIGURE 20: Rainfall and potential lucerne production for Borden



Economic analysis for a representative farm

Profitability was assessed using whole-farm modelling. The model was configured to represent a typical farm of the Borden district.

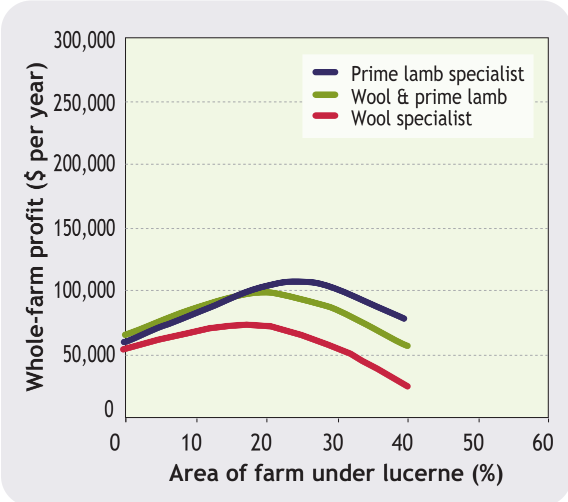
Crops: barley ($200/t), wheat ($200/t), oats, canola ($375), lupins ($190)

Livestock: Merino sheep for wool (720 c/kg) and prime lamb ($3/kg) production

Farm size: 2500 ha

Soil types: Deep sands, waterlogging-prone duplexes, red-brown loams and clays, grey loams and clays (poorly drained and sodic), and medium-depth sandplain duplexes

FIGURE 21: On a representative farm at Borden, the optimum lucerne area varied from 18 to 25% depending upon the type of livestock enterprise



The optimum area on a farm with a wool specialist enterprise is 18%, but with a production system based on wool and Merino crossbred lambs, not only does the profit from lucerne increase from $68,000 at no lucerne to $104,000 but the optimum area also rises to 20%. Greater areas of lucerne are possible (25%) if the sheep enterprise is based entirely on prime lambs, associated with profit increases of $50,000 compared with no lucerne. For each scenario the profit is moderately sensitive to the area under lucerne.

As the on-farm lucerne area increases from 0 to 50%, leakage declines from about 60 mm to less than 10 mm.

Modelling indicates that companion cropping every year reduces grain production to 50% of that expected from continuous cropping. Tactical companion cropping, which only occurs in favourable seasons, does not appear to offer better prospects for overall grain production, but to this must be added the value of the lucerne crop.

case study

Lucerne protects farm sustainability

Integrating lucerne into their mixed farming system has helped increase whole-farm sustainability on Colin and Fiona Pither's 4000 ha property at Ongerup, WA.

The Pithers initially relied heavily upon wool production before making the switch to continuous cropping. The transition worked well for a while but was not sustainable due to problems with frost and waterlogging. With the introduction of lucerne they have now moved to a more balanced and resilient farming system with a number of diverse income streams including cereals, canola, pulses, wool and meat.

Such diversity has allowed them to reduce the impact of unpredictable seasons, protect their soils from wind and water erosion, lessen financial risk, and control waterlogging without contour banks. Lucerne, along with other changes in the farm system such as no tillage and controlled traffic, has played a part in making the system more robust, durable and less risky.

Lucerne brings multiple advantages

The Pithers started growing lucerne during the early 1990s and now have 25% of the farm under lucerne-based pastures. The advantages of lucerne include the ability to control weeds prior to the cropping phase, increased nitrogen and organic matter levels and, they believe, improved soil structure. The lucerne dries out soils, which has reduced waterlogging in crops following the lucerne phase, and also provides out-of-season pasture production.

The lucerne-based pasture, which lasts for four to six years, is followed by continuous cropping for about eight years. In order to establish lucerne as economically as possible they cover crop lucerne with barley or canola.

Yield losses are up to 1 t/ha in wheat after lucerne in dry years, but during wetter years following lucerne the Pithers have obtained wheat yields of up to 5 t/ha, aided by reduced waterlogging.

Complete removal before cropping

The message for the Pithers has been to ensure complete removal of all lucerne plants in the spring, before going into a cropping phase the following autumn.

farm information

- **Farmers**
  Colin and Fiona Pither
- **Location**
  Ongerup, WA
- **Property size**
  4000 ha
- **Enterprises**
  Cropping (cereals, canola and pulses), wool and prime lambs
- **Annual rainfall**
  450 mm
- **Soil type**
  Sandy duplex

Lucerne is removed using herbicides and cultivation if necessary. The first crop after lucerne is wheat followed by canola, barley and a pulse crop, then repeated. Wheat is first in the rotation because it benefits from high nitrogen and grass-free conditions to minimise crop loss to take-all.

Canola comes next because it allows sowing into standing stubble to minimise wind erosion but the trade-off is the need for higher levels of nitrogen fertiliser. Barley then follows canola to take advantage of the grassy weed control following canola and it requires a low nitrogen soil status. Pulses are the final crop in the phase because the soil nitrogen status is low and there is plenty of stubble to reduce wind erosion.

Another long-term benefit of including lucerne in the cropping rotation is that expenditure on chemicals is reduced as they usually get four years of weed-free crops following lucerne. But, the final four crops in the rotation require the use of herbicides and the rotation allows the use of four distinct herbicide groups.

(Case study courtesy of WA Lucerne Growers)

Wimmera/Mallee South Australia, Victoria and New South Wales

This region, within the GRDC SA VIC Mallee and the SA VIC Bordertown-Wimmera Zones covers about 7.8 Mha under mixed farming. The projected increase in salt-affected land is low during the next 20 years, as estimated by the National Land and Water Resources Audit (NLWRA) in 2000. However, in the long-term, groundwater recharge in the Mallee area of SA is forecast to have a significant impact on the salt levels in the River Murray.

For Victoria, groundwater monitoring indicates that future salinity extent will depend on climate. If conditions remain dry, salinity may retract slightly, but if wetter conditions return, salinity may expand.

Lucerne could have a medium impact in those parts of the region with local or intermediate groundwater flow systems. Permanent lucerne pasture could reduce leakage to less than 5 mm/yr.

About 200,000 ha is currently sown to lucerne, but is considerably less than the 60% of the area thought moderately to highly suitable. Unsuitable soils are either shallow or in low rainfall areas.

In the Mallee there is a niche for lucerne on the high-recharge sandhills that make up 30% of the landscape, where it will also assist with weed competition and erosion control. The swales or valleys are often unsuitable due to calcrete or calcareous soils.

On typical mixed farms of the region lucerne could be grown on up to 20% of farm area depending upon the type of livestock enterprise. Such levels of adoption depend firstly on increasing the profitability of lucerne relative to cropping, but need to be supported by a solid understanding of the challenges of integrating lucerne into cropping systems, improved establishment options and better persistence of lucerne stands in dry areas.

Wimmera/Mallee South Australia, Victoria and New South Wales	
Main GRDC Agro-ecological Zones	SA VIC Mallee and SA VIC Bordertown-Wimmera
Rainfall	300-450 mm/yr (low to medium rainfall)
Soils	Grey self-mulching clays, shallow red duplex clays (Wimmera), deep sands, calcareous sandy loams, sandy clay loams (Mallee)
Total agricultural area	7.8 Mha
Area currently saline	35,000 ha
Expected increase in salt-affected land	Low
Area moderate-highly suitable for lucerne	60% (4.7 Mha)
Current area of lucerne	200,000 ha
Dominant groundwater flow system	Local, intermediate and regional in Victoria, regional in SA and NSW
Drivers for widespread adoption	Management of herbicide-resistant weeds
	More profitable livestock production, with increasing prices for prime lambs
	Awareness of spreading risk by diversifying into other enterprises
Constraints to widespread adoption	Difficulties with establishment in the drier areas and associated financial risks
	Low and erratic summer rainfall leads to unreliable summer production
	Perceived profitability and management dificulties of lucerne compared with cropping. The cropping agenda currently dominates social and industry extension
	Rotational grazing management and persistence is difficult with current paddock and flock sizes

Rainfall and production

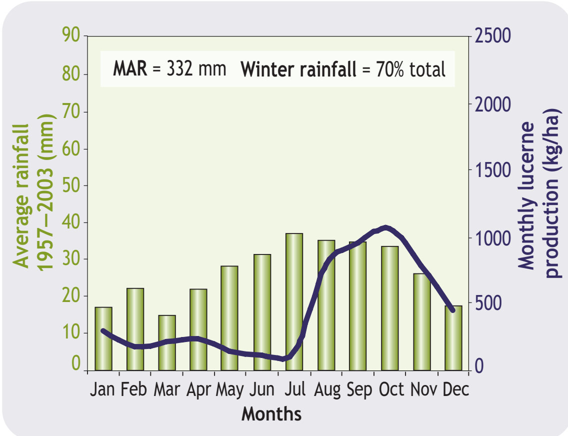
The region is characterised by a winter-dominant rainfall pattern, with 70% falling between April and October (see Figure 22). Long-term mean simulated second-year lucerne production for Pinnaroo (SA Mallee) is about 5.4 t/ha/yr.

Impact of replacing annual pastures with lucerne in the cropping rotation

Four farms in the Mallee and Wimmera of Victoria were studied during 2003 (see Table 9). They ranged in annual average rainfall 320–360 mm (April to October 210–240 mm) and area varied from 1350 to 3000 ha in size. All farms had moved from an annual pasture system to lucerne with the area of the farm under lucerne extending from 8 to 27%. These farms represent the upper end of lucerne adoption in the region.

Changing from annual pastures to lucerne increased profitability on all farms studied, ranging from 15 to 58% over two to three years as measured by discounted cash flow analysis. But the main benefit was an increase in paddock-scale profit from the grazing enterprise. The impact on cropping was neutral or slightly negative.

FIGURE 22: Rainfall and potential lucerne production for Pinnaroo



In all cases the livestock enterprise was altered with the introduction of lucerne. In some cases there was a move towards increased prime lamb production, while in one case cattle were introduced. Lucerne enabled increased stocking rates in all cases.

Reasons for establishing lucerne included improving soil health issues, controlling summer weeds, improving profitability, increasing available feed and as a means to control waterlogging.

TABLE 9 Results of four farm case studies in the Mallee and Wimmera of Victoria, comparing farm profitability of an annual pasture- versus a lucerne-based system and the changes in livestock production system that accompanied the change

Farm	Farm size (ha) lucerne area (%)	Annual pasture-based system	Lucerne pasture-based system	Profitability increase with move to lucerne (%)	Change in enterprise gross margin	
					Crop	Grazing
Nyah West[1]	1700 (8)	–	Merino ewes for prime lamb production, April-May lambing (110%)	15	Decrease	Increase
Rainbow	1350 (22)	Merino ewes for prime lamb production, March lambing (70%)	Merino ewes for prime lamb production, March lambing (100%) Finishing lambs, September lambing (100%)	58	No change	Increase
Underbool	2995 (27)	Merino ewes for prime lambs on medic Merino wethers on fallow, April-May lambing (85%)	Cattle breeding herd for heifer and steer production Finishing lambs and agistment cattle, June-July calving	51	No change	Increase
Wood Wood[1]	1600 (20)	–	Crossbred ewes for prime lambs, autumn and spring lambing (140%)	37	No change	Increase

[1] No systematic change in moving to a lucerne-based pasture system

Source: T Clune, DPI Victoria

Drought-proofing with lucerne

Lucerne has allowed Kevin Clugston, Victoria to increase his sheep numbers by 300%, from 250 to 1000 ewes (from 4 to 6 DSE/ha).

Introducing a perennial legume pasture has also enabled Kevin to have two lambings (average 100%); the main one (500-600 ewes) during March and the second (300-400 ewes) during September. March-born lambs are usually sold by the end of July, when they reach heavy carcass weights of 22 kilograms. The September-born lambs are usually sold the following February, again at 22 kg carcass weight. Previously lambs were sold as suckers at 18-19 kg.

Kevin is aware of the other benefits of lucerne such as a drought-proofing component and using summer rain. In the drought, lucerne paddocks were the only pastures available for grazing. He also believes lucerne prevents erosion during summer and manages the small patches of salinity on the farm. But using excessive growth of lucerne after a significant rainfall is sometimes a challenge. If seasonal conditions are favourable Kevin buys in store lambs during October, shears them in November and sells them by the March lambing.

Lucerne is typically grown for three to five years, followed by five to six years of cropping. Kevin's aim is to keep at least 30% of the farm under lucerne at any one time.

Establishment and removal

Kevin pays special attention to lucerne establishment but particularly during the past two dry seasons when he only had a 40% success rate. He admits this is low and probably due to crop competition.

Kevin controls hogweed and ryegrass with herbicides and undersows the lucerne at 2.5–3.0 kg/ha, dresses and inoculates with wheat at 70 kg/ha. Post-emergent broadleaf herbicides and insecticides are used to control insects and wild oats.

To remove lucerne before the cropping phase, Kevin uses chemical and mechanical means plus heavy grazing. He applies a knockdown herbicide mix in early August, then a blade-plough after rain, after which all available sheep (up to 1000) in one mob are used to over-graze the lucerne.

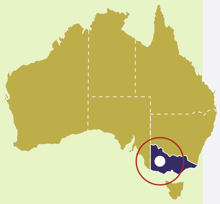
Lucerne management

Rotational grazing is integral to maintaining lucerne production. To overcome the problem of 'uneven' grazing of his 60 ha lucerne paddocks, Kevin uses electric fencing to strip graze 20 ha at one time. Sheep remain in each strip for about a week and return after four to five weeks.

Herbicides are used early post-emergence once a year to manage wild radish and capeweed, which are the main weeds during the lucerne phase. In some years, grazing pressure eliminates the need for further chemical applications.

(Case study courtesy of DPI Victoria)

farm information



- **Farmer**
  Kevin Clugston
- **Location**
  Northern Wimmera-southern Mallee, Victoria
- **Property size**
  1440 ha
- **Enterprises**
  Cropping (1000 ha with 300 ha under lucerne) and 800–1000 sheep
- **Annual rainfall**
  365 mm (growing season — April to October rainfall 245 mm)
- **Soil type**
  Mainly sandy loams with grey clay in the lower layers, with an average pH_W 6.7 for the topsoil and 8.1 for the subsoil

Mid-north and Yorke Peninsula South Australia

This region is within the GRDC SA Midnorth-Lower Yorke Eyre Zone, and covers about 2.2 Mha under mixed farming. The extent of salt-affected land is at or near equilibrium and any changes in the next 20 years will depend on rainfall.

Lucerne could have a medium-term impact across the region as groundwater flow systems are often local or intermediate.

Lucerne is well established in the region and the current area is about 40,000 ha. Nonetheless, this is considerably below the 85% of the area considered moderately to highly suitable. Unsuitable soils are generally shallow. Adoption of lucerne at significant levels is possible if profitable livestock systems can be identified. Use of lucerne to manage the onset of herbicide-resistant weeds is a key future driver for adoption.

Rainfall and potential lucerne production

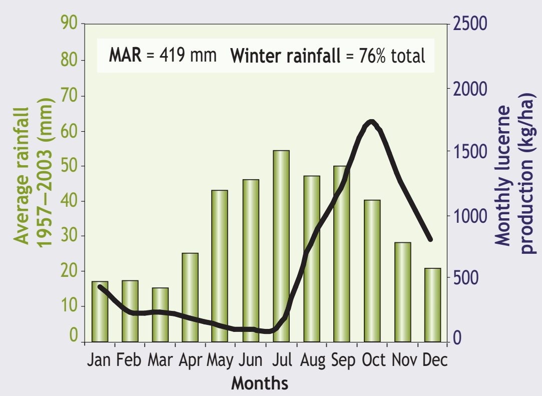
The region is characterised by a winter-dominant rainfall pattern, with 76% falling between April and October (see over page for Figure 23). Long-term mean simulated second-year lucerne production for Spalding (in the Mid-north of SA) is about 7.2 t/ha/yr.

Mid-north and Yorke Peninsula of South Australia	
Main GRDC Agro-ecological Zone	SA Midnorth-Lower Yorke Eyre
Rainfall	350–550 mm/yr (low to medium rainfall)
Soils	Calcareous sandy loam to clay loam, red-brown earth, deep gradational loam, deep siliceous sand
Total agricultural area	2.2 Mha
Area currently saline	30,000 ha (too saline for grain crops)
Expected increase in salt-affected land	Low
Area moderate-highly suitable for lucerne	85% (1.9 Mha)
Current area of lucerne	40,000 ha
Dominant groundwater flow system	Local and intermediate
Drivers for widespread adoption	Management of herbicide-resistant weeds
	More profitable livestock production, with increasing prices for prime lambs and beef
	More awareness of spreading risk by diversifying into other enterprises
	Supply of nitrogen in crop rotations in the face of rising fertiliser costs
	Additional income from seed and hay production
Constraints to widespread adoption	Cropping is low risk and profitable and many rotation options are available
	Lack of livestock, infrastructure and commitment
	Unreliable methods for removing lucerne and penalties to crop production in phased rotations
	Rotational grazing management and persistence are difficult with current paddock and flock sizes

Permanent lucerne and companion cropping systems are equally effective at reducing leakage to minimal levels, but there is some risk of leakage during the cropping phase. Modelling shows that leakage declines from 70 to 10 mm as the area of the farm under lucerne goes from 0 to 70%.

Grain production could be reduced to 70% of continuous cropping if companion cropping was employed annually. The alternative of tactical companion cropping in favourable seasons does not offer better prospects for overall grain production, but this is partly offset by the profit from the lucerne pasture.

FIGURE 23: Rainfall and potential lucerne production for Spalding



case study

Profits rise as water table falls

Lucerne has lowered the water table and significantly increased profitability for Neil and John Bridger, South Australia.

Located near Hilltown, just north of Clare, Mid-north of SA, the Bridgers' farm is a second-generation business. The property receives a median annual rainfall of 473 mm. The topography is undulating with a mosaic of red-brown earths and highly fertile black soils. The relatively reliable rainfall and fertile soils enable a number of cropping and livestock enterprises and the operation is productive enough to support two families and three full-time workmen.

The property consists of 1012 ha, most of which is arable. Currently 891 ha (88%) is cropped annually and 121 ha (12%) used for grazing. Of the business's total gross margin, 58% is derived from cropping and 42% from livestock. Of the arable land, 11% is under lucerne for either grazing, seed or hay production. Crops include APW and durum wheat, malting barley, triticale, peas, certified clover seed, canola, vetch and lucerne seed. Hay is grown using oats/vetch, lucerne and wheat. Livestock enterprises include cattle, boer goats and pigs. Boer goats and vealers are finished in a feedlot.

case study

farm information

- **Farmers**
  Neil and John Bridger
- **Location**
  Hilltown, Mid-north SA
- **Property size**
  1012 ha
- **Enterprises**
  Mixed livestock and cropping
- **Annual rainfall**
  473 mm
- **Soil type**
  Mosaic of red-brown earths and highly fertile black soils

Depending on the season and yearling prices, vealers are traded and finished off in the feedlot.

The role of lucerne on the property

Lucerne was first sown in 1999 with an additional area sown in 2000 to give a total of 52 ha. These paddocks are in a low part of the landscape that was often very wet, creating problems for cropping. In wet years the water table would come to the surface and further down the subcatchment, surface salinity was spreading. The aim of the lucerne enterprise was to lower the water table, dry out the soil, and generate cash flow.

At the time of sowing lucerne, a surface drain was also constructed through the salt-affected area and coinciding with a run of dry seasons the water table dropped below 2-3 m in the low parts of the landscape. The salt-affected area was sown to tall wheatgrass and is no longer expanding.

The Bridgers' lucerne enterprise has met their hydrological aims and has also been very profitable.

Given their initial success the Bridgers have sown another two paddocks to lucerne bringing their total area to 112 ha. These more recent paddocks are primarily used by cattle under a rotational grazing system.

Lucerne hay, seed and grazing

The Bridgers employ a system of lucerne management common to the more productive land in the Mid-north to generate income from lucerne seed, hay and grazing. The annual cycle of management is shown in Table 10.

The lucerne (cv. Venus) was sown with a six-year contract for growing seed. It may be possible to harvest lucerne seed for a few more years, but then the paddock will be cropped for a few years before sowing lucerne again for another period of six or more years. Currently the stand is growing well and the density is still high meaning a few more years of lucerne could be possible, giving a lifespan of seven to eight years.

TABLE 10: Annual cycle of management

July	Remove grazing cattle to allow lucerne to grow
October	Take a hay cut around first flower (3 t/ha @ $120/t)
Oct-Dec	Opportunistic grazing if conditions permit
December	Remove grazing cattle to allow lucerne to grow
Feb-March	Harvest lucerne seed (200 kg/ha @ $2.50/kg)
March-July	Valuable grazing over the autumn/early winter period

Profitability of lucerne

A whole-farm budget was calculated to assess the impact of increasing the area of lucerne beyond the current 11% of the cropping land, taking account of the reduced cropping program. While Neil and John do not consider the additional lucerne area is necessary for salinity management, they are open to the idea of increasing the lucerne as a form of risk management against unreliable crop production, which has been an issue in recent seasons. Whole-farm profitability decreased slightly with 18% of the arable land under lucerne, compared with 11%. Each extra hectare of lucerne for grazing means less cropping, which currently is a more profitable option.

The analysis also considered the impact of shifts in the prices for lucerne seed and hay on the expected whole-farm profitability. A 20% variation in prices results in a relatively insignificant change in whole-farm profitability, reflecting the relatively small dependence on lucerne for income compared with the other crop and livestock enterprises.

Boosting profits and managing salt

Having trialled a number of strategies, Ben Wundersitz has found lucerne to be the best option to manage salinity, while at the same time boosting whole-farm profitability.

Ben's property is located on the Yorke Peninsula of SA, in a region of the State known for its reliable rainfall (annual average of 450 mm) and premium barley production. The topography is undulating and soils are variable although generally fertile. The property's cropping program consists of 2300 ha, which includes both owned and leased land. The land owned is mainly arable and has been continuously cropped for more than 35 years. Crops include APW wheat, feed barley, lentils, peas, canola, and cereal/lucerne hay. Of the business total gross margin, 35% is derived from wheat and 22% from barley.

The farm has two paddocks covering an area of 290 ha that have experienced waterlogging for the past 30 years. These paddocks form part of a 900 ha catchment shared by three farmers, and in recent years this catchment has formed a perched water table. Salinity has been an issue here for the past 15 years. As this property is in one of the richest farming regions of the State, land lost to dryland salinity is critical.

The role of lucerne on the property

Salinity has appeared as a series of scalds, greatly reducing the yield potential of the paddock. In wet seasons the scalds become small ponds on the landscape, after which it is difficult to re-establish groundcover. Ben used lucerne on 50 ha of the higher parts of the salt-affected paddocks and the scalds are becoming noticeably smaller and grain productivity has significantly improved. Both winter-dormant and winter-active lucerne varieties have been used with similar effect.

The 10-year plan is for this stand not to be increased in size, but be progressively moved down the paddock toward the bottom of the catchment. The hope is the water table will be better managed and the salt scalds should become a problem of the past.

Strip grazing lucerne is an option, but returns from livestock will have to significantly increase for this to be a financially-preferred strategy. The challenge is that livestock, particularly sheep, tend to camp on the salt scalds and bear them out. This exposes them to wind erosion and capillary action, which further exacerbates salinity.

Profitability of lucerne

While there is not a large area of salt scald, a whole-farm budget analysis indicated the significant increase in productivity has greatly improved profits. But Ben suggests these benefits stem partly from a combination of lucerne and reduced tillage techniques which have broken up the hardpan, as well as leaving the crop residue on top of the soil protecting the salt scalds.

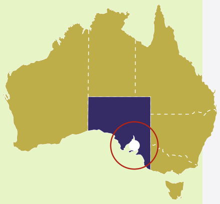
Lucerne was introduced to improve the management of the dryland salinity, but an oat/lucerne hay enterprise also contributes positively to the property's gross margins. The estimated gross margin per hectare for oat/lucerne hay is equivalent to canola and feed barley and ahead of peas.

Results indicate that expanding the lucerne area from 50 to 100 ha would decrease the business's expected overall profitability, but not significantly. This presents Ben with two possible options:

case study

farm information

- **Farmer**
  Ben Wundersitz
- **Location**
  Yorke Peninsula, SA
- **Property size**
  1849 ha plus leased land
- **Enterprises**
  Continuous cropping for more than 35 years with wheat, feed barley, lentils and peas
- **Annual rainfall**
  450 mm
- **Soil type**
  Undulating hills with fertile soils



1. The opportunity cost of establishing additional lucerne is not significant, so if it greatly increases the ability to manage the waterlogging and dryland salinity, then expansion would seem to be the prudent approach; or
2. It is uncertain what a larger lucerne stand would do for the dryland salinity challenge and the current rotation is managing the salinity well, so stay with the current planting of 50 ha of lucerne as this is providing the best whole-farm profit.

Both options have merit and at this stage there is insufficient knowledge to give certainty to the final decision.

Due to the relatively small dependence of the property on lucerne production, the sensitivity of the whole-farm profitability to variations in hay prices is not significant.

South-West Slopes New South Wales and Riverine Plains NSW and Victoria

This region, encompassing parts of the GRDC NSW VIC Slopes and VIC High Rainfall Zones, covers about 9 Mha under mixed farming. The projected increase in salt-affected land is high.

Due partly to the extended drought, water tables in some parts of NSW and Victoria have fallen and salinity appears to have stabilised, especially in Slopes and Tablelands areas where local groundwater flow systems are responsive to rainfall.

South-West Slopes New South Wales and Riverine Plains NSW and Victoria	
GRDC Agro-ecological Zone	NSW VIC Slopes and VIC High Rainfall
Rainfall	450-600 mm/yr (medium to high rainfall)
Soils	Red-brown earths, yellow duplex, and some grey clays
Total agricultural area	9 Mha
Area currently saline	133,000 ha
Expected increase in salt-affected land	High
Area moderate-highly suitable for lucerne	85% (7.6 Mha)
Current area of lucerne	800,000 ha
Dominant groundwater flow system	Local and intermediate
Drivers for widespread adoption	More profitable livestock production, with increasing prices for prime lambs and beef
	More awareness of spreading risk by diversifying into other enterprises
	Supply of nitrogen in crop rotations in the face of rising fertiliser costs
	Improving soil health
	Summer weed control
	Control of waterlogging on heavy soils
Constraints to widespread adoption	Lack of livestock is rated as a moderate constraint after the 2002 drought, as livestock numbers fell
	Unreliable removal of lucerne and penalties to crop production in phased rotations
	Current paddock and flock sizes hinder rotational grazing
	Poor establishment
	Acid soils

Groundwater monitoring indicates that future salinity extent will depend on climate. If conditions remain dry, salinity may retract slightly, but if wetter conditions return, salinity may expand.

Depending upon soil type, permanent lucerne pasture could reduce leakage from 40 mm to less than 5 mm/yr. Lucerne can have a medium-term impact across the region because groundwater flow systems are often local and intermediate.

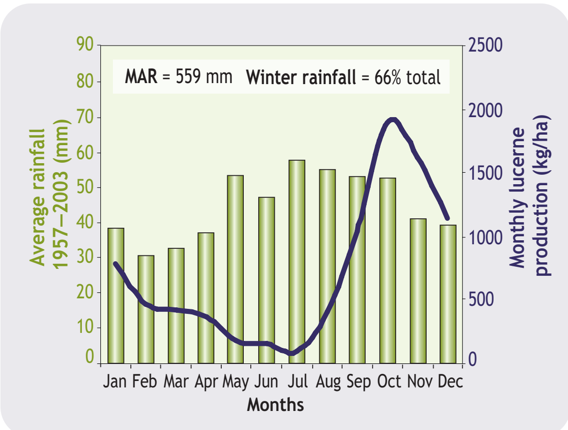
Lucerne is well established in these farming systems and the current lucerne area is about 800,000 ha. Nonetheless this is considerably below the 40% of the area moderately to highly suitable. Unsuitable soils generally have low pH.

Surveys of producers who have moved to a lucerne-based system show that up to 40% of the farm area can be profitable under lucerne, supporting high performing livestock systems. This and reduced nitrogen costs for cropping will be a major future driver for adoption.

Rainfall and potential lucerne production

Long-term mean simulated second-year lucerne production for Corowa, NSW is about 8.4 t/ha/yr. The region is characterised by a winter-dominant rainfall pattern (see Figure 24) extending from Wagga Wagga to west of Bendigo, while the area north of Wagga Wagga to Cowra receives more summer rainfall.

FIGURE 24: Rainfall and potential lucerne production for Corowa



Permanent lucerne and companion cropping systems can reduce leakage to minimal levels, but there is still some risk of leakage in the cropping phase with phase farming. Leakage declines from 40 to 10 mm/yr as the area of the farm under lucerne goes from 0 to 70%. Under lucerne-based rotations it is less than 5 mm/yr suggesting there is the potential to leak-proof farms with the right rotation.

Companion cropping, if practised annually, reduces grain production to 70% of that for continuous cropping. A more tactical approach does not offer better prospects for overall grain production, but returns from the lucerne pasture offset some of this profit loss.

Impact of replacing annual species with lucerne in the cropping rotation

Nine farm case studies in the Riverine Plains of northern Victoria were analysed during 2003 as part of GRDC project *Increasing Lucerne Adoption in Mixed Farming Systems*. Farms ranged in annual average rainfall from 380 to 580 mm (April to October, 260-380 mm) and area varied from 440 to 1900 ha (see Table 11). All had made a change from an annual system to lucerne with the area of the farm under lucerne varying from 11 to 50%. These farms represent the upper end of lucerne adoption in this region.

The effect on business profitability was positive, ranging from 9 to 45%. In each case, replacing annual pastures with lucerne in cropping rotations increased business profitability as measured by discounted cash flow analysis. The main benefit was seen in increased profit from the grazing enterprise, with a neutral or slightly negative impact on cropping. In three cases there was increased revenue from hay production with the switch to lucerne.

In all cases the livestock enterprise was altered with the introduction of lucerne. In some cases there was a move towards increased prime lamb production, while in one case cattle were introduced to the farming system. Lucerne enabled all farmers to increase stocking rates.

TABLE 11: Results of nine farm case studies in northern Victoria, comparing farm profitability of an annual- versus a lucerne-based system, and the changes in livestock production system that accompanied the change

Farm	Farm size (ha) lucerne area (%)	Annual pasture-based system	Lucerne pasture-based system	Profitability increase with lucerne (%)	Change in enterprise gross margin		
					Crop	Grazing	Hay
Bridgewater	660 (39)	Merino wethers	Crossbred ewes for prime lamb production, July-August lambing (130%)	15	Decrease	Increase	–
Charlton	1100 (21)	Merino ewes joined to Border Leicester rams for first cross ewe production, April-May lambing (95%)	Merino ewes joined to Border Leicester rams for first cross ewe production **OR** Crossbred ewes for prime lamb production, April-May lambing (110%)	43	Increase	Increase	–
Corowa	780 (38)	Bond ewes for prime lamb production from terminal sires, July-August lambing (105%)	No change	35	Increase	Increase	–
Dookie	670 (19)	Merino self-replacing flock, June-July lambing (90%)	No change	22	Increase	Increase	–
Maryborough	440 (20)	Merino self-replacing flock, Autumn lambing (86%)	Merino ewes for prime lamb production **OR** Lucerne hay, August-September lambing (89%)	45	No change	Increase	Increase
Rutherglen	1800 (15)	Breeding cows for vealers, February-March calving **OR** Crossbred ewes for prime lamb production, April-May lambing (110%)	Breeding cows for vealers (February-March) **OR** Crossbred ewes for prime lamb production, April-May lambing (110%) **OR** Lucerne silage and hay	33	Increase	Increase	Increase
Serpentine	1000 (40)	Merino ewes joined to Border Leicester rams for first cross ewe production, April-May lambing (80%)	No enterprise change, but wether lambs sold as prime lambs and ewes sold as lambs ready for joining	38	No change	Increase	–
Tungamah	1900 (11)	Merino self-replacing flock, August-September lambing (95%)	Merino self-replacing flock **OR** Lucerne hay, August-September lambing (95%)	9	Increase	Increase	Increase
Wedderburn	800 (50)	Merino self-replacing flock, May-June lambing (75%)	Merino self-replacing flock **OR** Merino ewes for prime lamb production, July-August lambing (86%)	63	Decrease	Increase	–

Source: T Clune, DPI Victoria

Nitrogen boost lifts grain quality

John Cooper of Yarrawonga, Victoria has increased whole-farm profitability by 11% with the introduction of lucerne into his cropping rotation. He comments that lucerne provides what he describes as an "extra couple years of nitrogen" when returning to his cropping phase. Wheat crops following lucerne now have higher protein contents and John has been able to increase his stocking rates, make more hay and reduce his supplementary feeding bill.

John grows lucerne in five-year phases as part of a cropping rotation that includes wheat, canola, oats and barley in conjunction with his Merino wool enterprise. He has been growing lucerne since 1995 and half of the paddocks sown to lucerne have since been returned to crop.

A further advantage with a lucerne phase has been its ability to improve wild radish control. Lucerne is chemically cleaned in the first year and then in every alternate year.

Getting lucerne up and running

Lucerne was originally sown with a triticale cover crop during autumn, but because of establishment failures it is now sown without a cover crop during spring. After the crop phase, grazing oats are direct-drilled during autumn, heavily grazed during winter and sprayed with a knockdown herbicide in late August. Lucerne and subclover seed are then direct-drilled.

According to John, "You do not want to sow lucerne too heavy; three or four kilos seems the best, it seems to grow better where it is thinner."

Lucerne is used in a five to six year rotation for grazing and fodder conservation and John aims for two cuts of hay in the five years of a lucerne phase — with each cut yielding between 2.5 and 4 t/ha.

Benefits and challenges

Incorporating lucerne in the cropping rotation has enabled John to increase the range of crops grown to include oats and barley. He expects some yield reduction in wheat immediately following lucerne, particularly in dry years, but feels that in wetter years yields may well be higher than for other crops.

The early lucerne paddocks were removed during autumn, but John now prefers a chemical fallow in the previous spring followed by cultivation. The first working is with narrow points, followed by wider points. He says "I think you have to take the lucerne out in the spring when you are going into the cropping phase."

John runs a medium-wool Merino enterprise of 1100 self-replacing ewes, with wethers sold at three years of age. Incorporating lucerne into his farming system has enabled John to increase his stocking rate by one-third and move to a spring lambing production system. August/September-born lambs are now weaned straight onto lucerne without supplementary feeding.

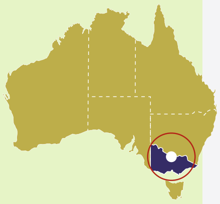
John has found that 'sink holes' of varying sizes have appeared in several lucerne paddocks on both undulating clay loams and the heavy clay soils. They are thought to be associated with the combined effects of lucerne roots drying out the soil and the run of dry seasons. John comments "It's a nightmare dodging holes when spraying and spreading super. I have to cultivate to fill in the holes before sowing, whereas before lucerne I was able to direct-drill all my crops."

John has also experienced problems with sheep deaths on pure lucerne stands, presumably due to red gut syndrome.

case study

farm information

- **Farmer**
  John Cooper
- **Location**
  Yarrawonga, Victoria
- **Property size**
  1900 ha
- **Enterprises**
  Merinos and cropping (wheat, canola, oats and barley)
- **Annual rainfall**
  515 mm
- **Soil type**
  Undulating country from gravelly hills to cracking grey flats



Central West New South Wales

This region encompasses the GRDC NSW Central Zone and covers about 9.1 Mha under mixed farming. It includes the drier western areas out to the 400 mm isohyet, where lucerne is not widely grown, and up to the 650 mm isohyet in the wetter slopes areas in the east, where lucerne has historically been part of the farming system and grazing dominates land use. Intensively irrigated and highly productive areas of lucerne pasture, primarily in the eastern half of the region, are cut for hay.

The NLWRA predicted that this region is one of the least under threat from salinity during the next 20 years, particularly in the western areas. The Audit predicted an average 0.09 m water table rise per year, but due to the extended drought, water tables in some parts of NSW have fallen and salinity appears to have stabilised, especially in the Slopes and Tablelands where local groundwater flow systems respond to rainfall.

In the eastern areas there is potential for salt to mobilise under annual farming systems and there is a dominance of slowly responding groundwater flow systems, which require large-scale impact on recharge. A high proportion of the landscape would need to be under lucerne for it to have a significant impact on rising groundwater levels. While lucerne has the potential to reduce the threat of dryland salinity it also could adversely affect stream salinity through reductions in flow. Presently, the exact impact of this is uncertain.

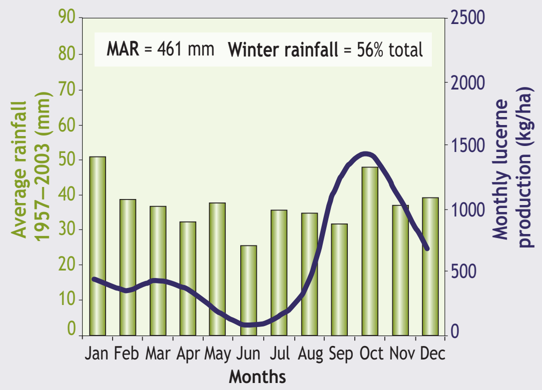
It is estimated that 77% per cent of the soils in the region are suitable for lucerne production. Unsuitable soils are generally found in eastern areas where acid soils are common. During 2001 the Central West had an average of 12% of agricultural land established to either pure or mixed lucerne pastures. In the eastern areas up to 20% of a farm could be under lucerne at economically optimum levels. But achieving these levels requires the adoption of more profitable livestock systems and taking advantage of other regional drivers such as weed management and nitrogen inputs into cropping systems.

Central West of NSW	
GRDC Agro-ecological Zone	NSW Central
Rainfall	400–650 mm/yr (medium to high rainfall)
Soils	Red-brown earths, red earths, cracking clays
Total agricultural area	9.1 Mha
Area currently saline	4,000 ha
Expected increase in salt-affected land	Low
Area moderate-highly suitable for lucerne	77% (7.0 Mha)
Current area of lucerne	1 Mha
Dominant groundwater flow system	Intermediate and regional
Drivers for widespread adoption	Lucerne as a tool to combat troublesome weeds such as skeleton weed, saffron thistle, heliotrope and melons
	Supply of nitrogen in crop rotations in the face of rising fertiliser cost
	More profitable livestock production
Constraints to widespread adoption	Difficulties with establishment in the drier western areas and associated financial risks
	Unreliable removal of lucerne and penalties to crop production in phased rotations
	Risk of erosion
	Acid soils

Rainfall and potential lucerne production

The region is characterised by an almost uniform rainfall pattern, with 56% falling between April and October (see Figure 25). Long-term mean simulated second-year lucerne production for Condobolin in the western drier areas of the region, is about 6.8 t/ha/yr.

FIGURE 25: Rainfall and potential lucerne production for Condobolin



Profitability of lucerne

There is little information available on the profitability of lucerne in the west of this region, where it is currently not widely grown. In the eastern areas, of which the Little River district is representative, the whole-farm profitability was assessed with the MIDAS model. A representative farm of the region was configured:

Crops: barley ($200/t), wheat ($200/t), oats, triticale, canola ($375/t), lupins ($190/t)

Livestock: Merino sheep for wool (720 c/kg) and prime lamb ($3/kg) production

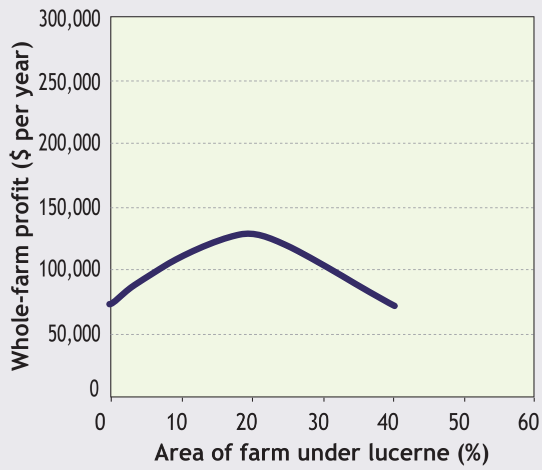
Farm size: 900 ha

Soil types: Shallow soils on crests (Lithosols), non-calcic brown, red podzolic, red solodic, red-brown earths, siliceous sands, yellow solodic, and yellow podzolic

The results showed that lucerne can be grown profitably on 20% of this typical mixed farm with profit increases of $55,000 compared with no lucerne (see Figure 26). Greater areas of lucerne reduce profitability because of the higher returns from alternative land uses on the better soil types.

All lucerne-based systems are equally effective at reducing leakage from 60 mm/yr to minimal levels under annual cropping systems. Companion cropping in this region, if practised every year, reduces grain production to 50% of continuous cropping. Companion cropping only in favourable seasons does not offer better prospects for overall grain production.

FIGURE 26: Optimum area of lucerne on a representative farm at Little River in the east of the Central West



case study

Lucerne maintains productivity levels

Graham McDonald at Condobolin believes that without the constant input of nitrogen from lucerne-based pastures he could not maintain his consistent standard of sheep and cereal production.

While acheiving 1.9 t/ha average wheat yields for more than 10 years is impressive, the notable feature is Graham's wheat quality with 25% going Prime Hard, 30% Australian Hard, 35% Australian Premium White and 10% Australian Standard White.

The farm is in partnership between Graham and his brother David on 2800 ha of mallee country north-west of Condobolin. Paddocks are large, about 200 ha, but lucerne has still been successfully incorporated into the farming system in a pasture mix. All paddocks are undersown with lucerne in their final year of cropping.

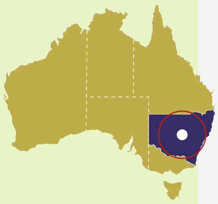
The farming system

Cereal crops underpin the farm income, but pastures contribute significantly to the whole-farm performance and so are managed carefully to maintain density and quality. Cover crop rates are reduced to 20 kg/ha for oats and 25 kg/ha for barley allowing pastures to dominate the year after cropping ceases.

A typical rotation is three crops, the last undersown to pasture, followed by four years of pasture. A typical pasture mix is lucerne (1.0 kg/ha), barrel medic (1.25 kg/ha) and subclover (1.25 kg/ha). Pasture cleaning is used when required in the year before fallowing to limit saffron thistle and grass incursion in the pastures.

farm information

- **Farmers**
  Graham and David McDonald
- **Location**
  Condobolin, Central West NSW
- **Property size**
  2800 ha
- **Enterprises**
  Cropping and sheep
- **Annual rainfall**
  420 mm
- **Soil type**
  Red earth



Medium-wool Merinos are run using a rotational grazing system. There is only one watering point per paddock, yet the density of lucerne usually exceeds 8-10 plants/m^2 after four years. The carrying capacity is conservatively 2.5 DSE/ha.

Graham finds removing lucerne when fallowing for the next cropping phase challenging.

(Case study courtesy of NSW DPI)

Global influences

Lucerne's future as a widely-grown perennial in the wheatbelt depends on a number of external influences beyond the direct control of producers or the Australian agricultural industry.

Future market prospects

Meat & Livestock Australia research indicates that with solid rates of Gross Domestic Product (GDP) growth, high population levels and economies rapidly developing from a low base, South Asia provides strong opportunities for Australian-grown red meat and live sheep and cattle exports in the medium- to long-term. This could drive demand for pasture-derived products and encourage the wider use of perennial pasture species such as lucerne.

As markets become more aware of the environmental impacts of agriculture they may demand products produced by farming systems with minimal environmental impact, although there is little evidence of this yet.

Changes in commodity prices for wool, sheep meat and grain (see Table 12) will impact on the optimum profitable area of lucerne on the farm.

For a typical farm in the medium rainfall zone in WA at Cunderdin (see Figure 27a), the optimum area for lucerne is more sensitive to likely changes in grain price than to changes in meat prices and even more so compared with wool prices. If both sheep meat and wool increase to their estimated 'high' and grains decrease, then the optimum lucerne area would increase from 12 to 30%.

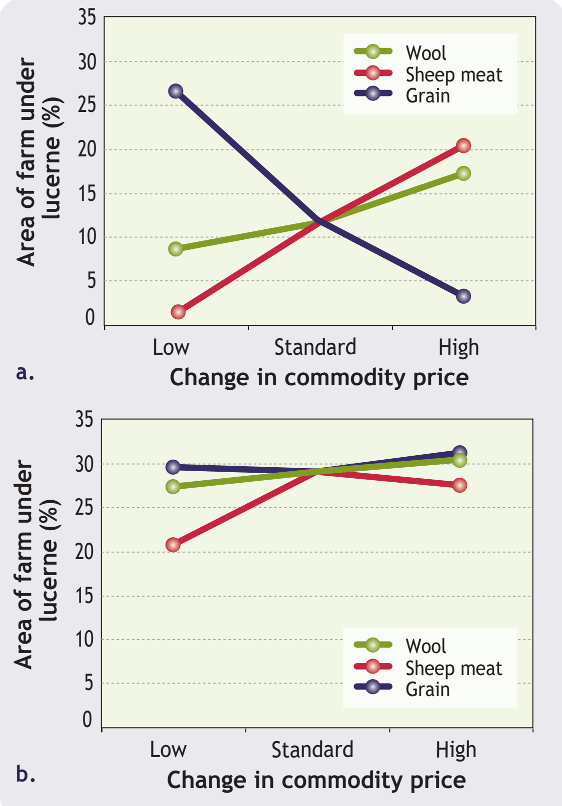
TABLE 12: Commodity prices used to determine the impact on lucerne area

	Low	Std	High
Wheat (APW) $/t	160	200	240
Barley (malting) $/t	160	200	240
Barley (feed) $/t	120	160	200
Canola $/t	325	375	425
Lupins $/t	150	190	230
Cast-for-age ewe $/head	20	40	60
Lamb $/kg	2	3	4
Wethers >18 months $/head	20	50	80
Wool (WMI) c/kg	520	720	920

When livestock prices are low, the area of lucerne as a proportion of total pasture decreases (i.e. the area of lucerne decreases by a bigger percentage than the area of annual pasture). Lucerne will only be selected if there is high-value use, because it is more expensive to manage than annual pasture.

On the other hand, in the high rainfall zone at Kojonup in WA (see Figure 27b) there is a greater emphasis on livestock production and the lucerne area is less sensitive to changes in grain and livestock prices than regions with an emphasis on grain production. In this case the lucerne area is most sensitive to a reduction in sheep meat prices (and could be expected to show similar sensitivity to beef prices). Changes in prices for grain and wool have almost no impact on the profitable lucerne area. If both sheep meat and wool increase and grain decreases, then lucerne area would increase from 29 to 37%.

FIGURE 27: Changes in economically optimum area of lucerne on farm at Cunderdin (a) and Kojonup (b) in response to changes in commodity prices (see Table 12)



influences

Climate change

Climate change scenarios for the Australian wheatbelt indicate a greater proportion of dry seasons, which may or may not favour perennial pastures and associated livestock production over grain growing.

In drier regions, it is possible that small areas of lucerne would be replaced by continuous annual pasture rotations because the lower productivity of lucerne, together with its higher establishment costs, could make it uneconomical.

In medium rainfall areas, lucerne areas could increase if cropping becomes more unreliable and profit margins fall.

It is feasible to assume that in higher rainfall regions, under a drying climate trend, the area of cropping will expand at the expense of pastures, including lucerne. However, this could be further influenced by changes in the seasonal patterns of rainfall.

Fodder industry

The continued expansion of intensive livestock production increases the demand for high quality fodder. Domestic and export markets add significantly to the traditional importance of fodder as a defence against drought and represent a significant opportunity for increased lucerne adoption. While markets for fodder expand, the required feed quality standards rise. Both interstate and international quarantine restrictions, along with certified feed-test data, require a professional approach to successful entry into the fodder market.

The Rural Industries Research and Development Corporation estimated during 2004 that 20,000 producers on 46,000 properties across all States produced between 5.5 and 6.5 million tonnes of hay and about 3 Mt of silage per year – an increase of about 50% compared with the previous decade.

Lucerne made up about 13% of this production, but because of the quality of lucerne fodder it would be a significantly higher proportion of the estimated total annual farm gate value of $1.1 billion.

The domestic markets are principally the dairy, horse and feedlot industries.

The estimated value of the animal feeds industry in East Asia is A$13 billion, to which Australian exports contribute about 0.4%. There is potential for many new export opportunities for high quality fodder for which lucerne is an excellent candidate.

Seed industry

If lucerne became widespread in the wheatbelt for high performance livestock and fodder production, the seed industry could supply the seed required for expansion.

The low-value, high-volume export trade currently consumes most of the production and this could be diverted for domestic use. Quarantine issues for entry to WA, where the lucerne area has the greatest potential to expand, would need to be addressed. This would inherently increase the cost of production for the low-value end of the market, placing some demand on producers having their crops certified and inspected for declared weeds and diseases, raising the costs of production. An alternative flow-on effect would be the development of a seed production industry in WA.

The biggest immediate threat to the profitability of lucerne seed production is the cost of production and in particular the cost and availability of irrigation water. Land values in the traditional irrigated lucerne seed production areas in south-east South Australia have risen dramatically during the past five years. This has and will continue to put significant upward pressure on lucerne seed contracts as producers seek greater returns for their capital investment from other crops and enterprises. This pressure is exacerbated by the reluctance of end-user farmers to pay more for seed. The alternative is to rely on a larger portion of production from dryland crops, which are often unreliable and high risk because they either don't produce enough or produce a glut in a good year. Hence, irrigation is not a necessity for seed production but is essential for continuity of supply.

Breeding for wider adaptation

Until recently lucerne breeders have focused on disease and pest resistance, herbage production and persistence. The contribution that lucerne makes to sustainability would be enhanced by improving attributes such as water use, along with tolerance to acid soils, waterlogging, salinity and grazing pressure. Progress on breeding for better tolerance to these constraints should improve the potential area of lucerne adaptation in the wheatbelt.

Acid tolerance

Lucerne can perform well on acid soils where aluminium and manganese are not present at high concentrations, but aluminium and manganese toxicities can severely inhibit root growth, limiting access to subsoil moisture and nutrients, as well as nodulation and survival of rhizobia in soils.

If soil pH_{Ca} is between 4.8 and 5.5 lucerne production may be reduced, but below 4.8 it is difficult to successfully establish and grow. Subsurface acidity can adversely affect growth as much as surface acidity, but acidity at depth is more difficult, expensive and slow to fix.

The best way to manage acidity is to monitor surface and subsurface pH and start liming early to maintain a surface pH_{Ca} above 5.5. The longer liming is delayed or the lower the soil pH is allowed to get, the harder and more expensive it is to fix with remedial treatments.

In many cases liming, particularly for subsurface acidity is not practical or economic. In these cases lucerne cultivars with superior acid tolerance could help. Researchers with the CRC for Plant-based Management of Dryland Salinity have shown that selections of lucerne exhibit significant differences in root growth when grown in a high acid, high aluminium solution. This provides a sound basis for plant selection and the development of more tolerant cultivars — an important development, as poor root growth can seriously limit lucerne performance in hostile and aluminium environments.

Successfully incorporating acid tolerance into new lucerne varieties is likely to increase the suitable area by 10%. This would add half a million hectares to the national target of 7 million hectares of lucerne sown.

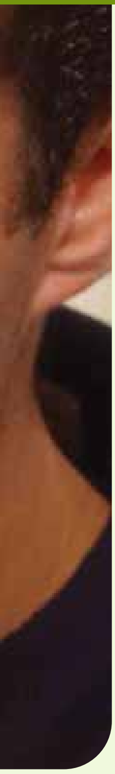


PHOTO: N Parsons

Grazing tolerance

Grain producers have developed broadacre farming systems with limited internal fencing. This limits their ability to control grazing pressure by rotational grazing as they have a small number of large paddocks. However, there is a belief that low and broad crown morphology might confer greater grazing tolerance, especially with sheep enterprises. There has been some progress in identifying germplasm with higher grazing tolerance than current commercial cultivars.

Winter activity

Most lucerne varieties grown in Australia tend to be moderately to highly winter-active. Despite this, the relatively low winter growth of lucerne compared with annual pastures can limit its optimum area on a farm. Increasing lucerne winter growth through breeding more winter-active cultivars reduces the trade-off between lucerne and annual pasture.

The high energy demands during November-December, to ensure the finishing of prime lambs and vealers, place a high value on the available feed at this time. Increased winter activity does not preclude summer production but it could reduce quality (due to greater stem to leaf ratios) and lucerne longevity or persistence.

Whole-farm economic modelling that deals with feed supply and demand through the year can indicate the likely returns from improved herbage production and quality from lucerne during winter only, summer only or throughout the year. For example an increase of 10% in lucerne productivity from a mixed farm at Kojonup, WA, would have its greatest impact if it occurred during summer rather than winter.

PHOTO: Kondinin Group

Lucerne varieties with higher grazing tolerance could increase adoption by livestock producers

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CRC FOR
PLANT~BASED
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