



Department of
Primary Industries

Pulses

Putting life into the farming system

An insight from growers who are making pulses work



By Dr Eric Armstrong and Di Holding

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Photos

All photos by the authors unless otherwise noted.

Cover photo

Kym Eckermann and his son, Nick, long term advocates of using pulse crops as an integral component of a sound farming system, and long term cooperators, hosting the largest on-farm pulse trial site in southern NSW and major pulse crop field days since 1996.
Photo by Dr Eric Armstrong.

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (January 2015). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the user's independent adviser.



Introduction

Pulses in the farming system

Pulses are valuable break crops in all Australian cropping systems, and their role has increased in importance over the past 50 years as cropping programs intensify. Farming systems in southern NSW are unique, having evolved on acidic soils under a ley-farming system involving pastures, livestock and cereals. Recently, they have moved to more intense cropping, focusing on sequences of cereals, oilseeds and pulses.

These changes follow huge investments into plant breeding, agronomy, marketing and education by state agencies, the Grains Research and Development Corporation and private enterprise. Increased cropping intensity has been supported by new herbicide technologies, soil liming, mechanisation, direct drilling and stubble retention, and more recently GPS guidance and controlled traffic farming.

Crop sequences in southern NSW need to be dynamic, diversified, flexible, profitable and sustainable, incorporating balances of cereals, oilseeds, pulses or forages best suited to the local producer.

The pulse component (lupin, field pea, faba bean, chickpea and lentil) brings many advantages including:

- **Disease breaks.** Different sequences of crops/species interrupt most disease cycles of the crop out of phase, thereby diminishing or eliminating the causal pathogens.
- **Symbiotically fixed nitrogen.** Rhizobia colonise root nodules of pulses and biologically convert N_2 gas (80% of the atmosphere) into a more available plant form (ammonia – NH_3). This process benefits N-farming in three ways:
 1. the pulse is independent of applied fertiliser N;
 2. soil mineral N is “spared” during the pulses growth; and
 3. residual N fixed by the pulse is available for uptake by following crops. This organic form of fixed N has the advantage of being more stable and “slow release” in nature compared to fertiliser N.
- **Reduced dependence on the use of fertiliser N** over the whole farm. Fertiliser N fluctuates greatly in price as its production is linked directly to fuel price and worldwide demand. In addition, its utilisation efficiency is often poor due to challenges with the timing of application and losses from volatilisation.
- **Weed management opportunities.** Alternate herbicide groups and weed control tactics can be employed in

pulse crops to tackle hard to kill weeds and herbicide resistant populations.

- **Soil moisture conservation.** Shallow-rooted and early maturing pulses such as field pea and faba bean are less exploitative of soil moisture and often leave some moisture for following crops. This is improved further by crop-topping and brown manuring.
- **Efficient utilisation of machinery.** Different developmental patterns of diverse crops allow the same sowing, spraying and harvest machinery to be used more efficiently over longer periods.
- **Efficient utilisation of time.** Sowing, management and harvest windows are widened when a diversity of crops are adopted.
- **Marketing.** Marketing a wide range of crops can open additional markets and reduce price risk exposure.

Opportunities for weed management

Adding diversity to cropping sequences creates additional opportunities for weed control tactics such as using herbicides from different mode of action groups, crop-topping to stop weed seed set, and pre-

Pulse Research and Development at Wagga Wagga Agricultural Institute

A team of researchers at Wagga Wagga Agricultural Institute focus on the pulse component of this system in southern NSW. Their aim is to improve and strengthen the reliability of this phase and the flow-on benefits to the whole cropping system. Simply put, they are developing superior, reliable pulse varieties coupled with agronomy packages to maximise production and profit.

The Wagga Wagga team operate within Pulse Breeding Australia (PBA) with the goal to improve adaptation, yield, seed quality, plant type and disease resistance of five winter pulses — field pea, lupin (narrow leafed and albus), chickpea (desi and kabuli), faba bean and lentil. Closely linked to this breeding and evaluation is an agronomy project developing management guidelines to provide technical support to the industry and to accompany release of each new pulse variety. This work is run in collaboration with Victorian and South Australian state government agencies and operates under the banner of “Southern Pulse Agronomy”.

Funding for the Wagga Wagga components of these programs is shared between the NSW State Government and the Grains Research and Development Corporation.

sowing double knock treatments in later sown crops (two separate applications, applied a week or so apart of two knockdown herbicides with different mode of action groups). For example field peas, with a late sowing window and early harvesting relative to weed maturity, assist weed management by giving longer periods for control before sowing and crop-topping options prior to harvest.

Pulse crops can be used specifically to target grass weeds in the system, particularly annual ryegrass and wild oats. A well planned program beginning prior to sowing the pulse crop and finishing with crop-topping and windrow burning greatly reduces the weed seed bank.

Pulse inoculation

Each pulse has its own specific strain of rhizobia which colonise legume roots to form nodules. The rhizobia convert atmospheric gaseous nitrogen (N_2) to plant available ammonia (NH_3). Most pulses and their rhizobia have evolved under alkaline soil environments and the acidic soils of southern NSW can be hostile to their survival, with numbers declining rapidly after the pulse phase. Therefore it is essential to inoculate at each new pulse sowing. Natural populations of rhizobia do exist for field pea, faba bean and lentil, but generally result in less effective nodulation than inoculum rhizobia.

Rhizobia inoculants are available in a number of formulations:

- moist peat, the traditional and most commonly used form of inoculant in Australia. Applied as a slurry

directly to the seed or a diluted and filtered slurry directly injected into the seeding furrow.

- granular, made from peat or clay. Applied directly into the seeding furrow using a separate bin on an airseeder.
- liquid, a water-suspension of rhizobia. Diluted product is used for direct injection of inoculant into the seeding furrow into moist soil only, within six hours of mixing with water.
- freeze-dried powder, a concentrate which is reconstituted prior to application. Allows for direct injection of inoculant into the seeding furrow or coating the seed immediately (less than five hours) prior to sowing into moist soil.

The proven method of slurry inoculating the seed through an auger just prior to sowing still appears to be the cheapest and most reliable method. Alternative delivery methods using clay-based granules or water injection through micro-tubes are equally effective but considerably more expensive. These latter methods are best used when using sowing fungicide-dressed seed, to separate the rhizobia from the chemical.

Growers are encouraged to assess nodulation of their pulse crops by following procedures outlined on page 6. Effective and active nodules should be pink inside.

Remember, NO nodules equals NO nitrogen fixation equals POOR pulse crop yield and NO nitrogen benefits to following crops.

Keys to success with peat-based slurry inoculum

- Slurry coverage and rate are important. Rhizobia must be in sufficient numbers and on each seed to effectively form nodules on all seedlings. Always apply at least the recommended rate. Increase the rate if conditions are adverse to rhizobia survival e.g. marginal soil moisture.
- Remember Rhizobia are living organisms.
- Follow directions on the package for storage and handling. Store in a cool, dry place.
- Adhere to use-by dates.
- Mix with cool, potable (rain or drinking) water only. DO NOT mix with other chemicals.
- Use clean equipment. Avoid contact with chemicals such as seed-dressing fungicides and herbicide residues when mixing rhizobia.
- Allow seed to dry sufficiently so that it will flow and not bridge in the air cart.

- Sow within 24 hours of application. Keep seed as cool as possible and out of direct sunlight (use a tarp to cover seed).



One method of inoculating pulse seed with peat-based slurry up an auger. The peat is mixed with cool water in a clean bucket then poured down a PVC tube.

Nitrogen fixation

Symbiotic nitrogen fixation is the mutually beneficial relationship between the pulse (or any legume) host and *Rhizobium* bacteria. These bacteria colonise roots during seed germination then multiply rapidly to form root nodules within 4 to 10 weeks. They are dependent on the host plant for water, nutrients and energy, but in return supply the plant with nitrogen (ammonium, NH_4^+) for direct uptake. This “fixed” nitrogen is derived from the enormous N_2 gas resources of the earth’s atmosphere (around 80%) – the same source used by the Haber and Bosch process to manufacture compound N fertiliser.

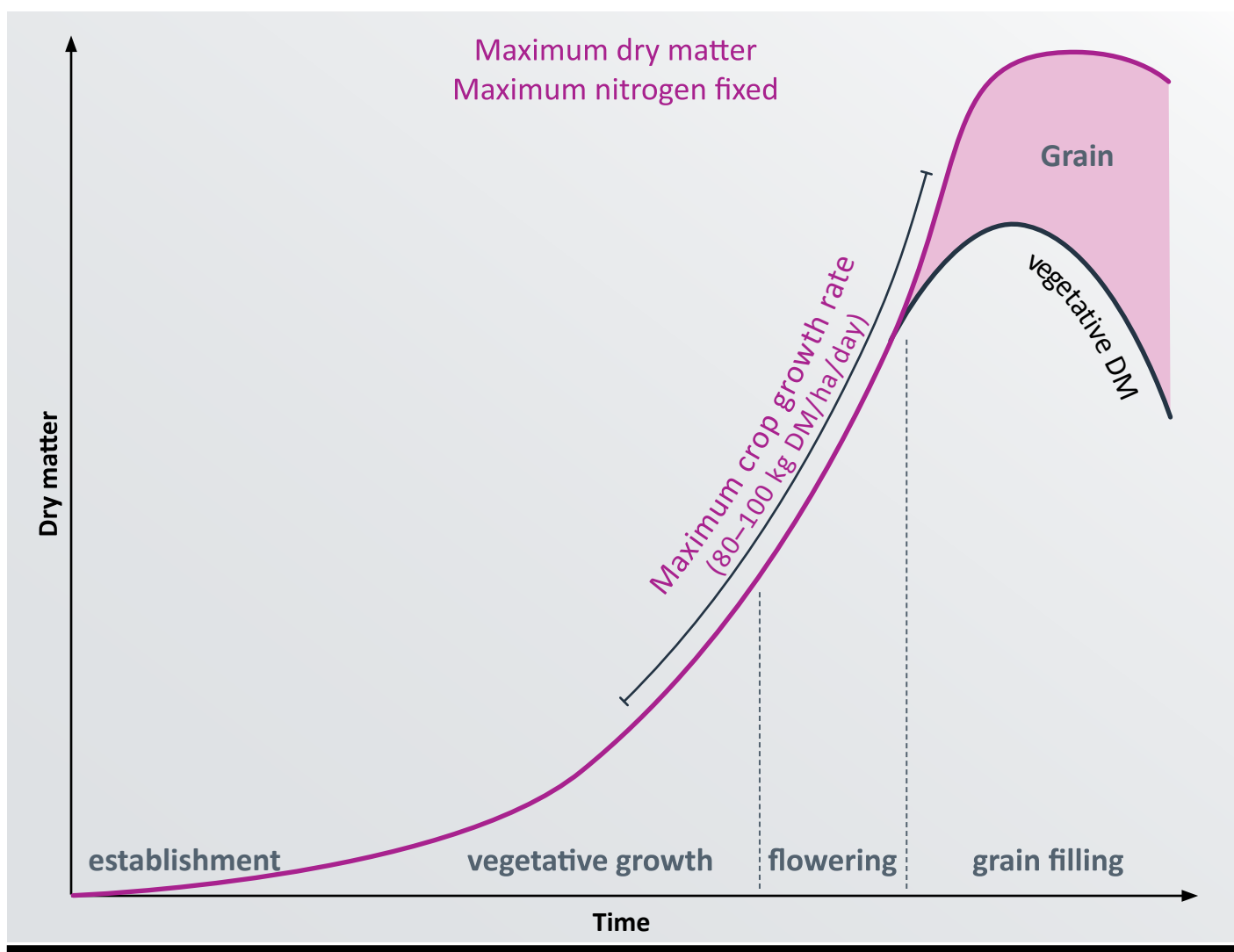
Pulses (and pasture legumes) play an essential role in the nitrogen supply chain of field crops, especially since nitrogen is one of the most limited plant nutrients worldwide. By fixing their own nitrogen during growth, pulses become independent of soil mineral nitrogen and thereby conserve or spare it. When combined, these two sources (fixed and spared N) produce large amounts of residual nitrogen for following crops, boosting both their

grain yield and grain protein. Compared to manufactured nitrogen fertiliser, biologically fixed nitrogen is:

- less volatile;
- more stable;
- “slow release”;
- environmentally sustainable;
- less energy demanding to manufacture;
- cost effective;
- not subject to supply restrictions or price fluctuations; and
- not subject to the challenges of application timing and utilisation efficiency.

Estimating fixed nitrogen

The amount of nitrogen fixed by a pulse is directly proportional to its growth, estimated at 20 to 25 kg N fixed per tonne of dry matter (DM) produced.



Dry matter production pattern of pulses. Towards the end of the growing season vegetative dry matter is remobilised into grain.

$$\text{Total Fixed N (kg/ha)} = \text{Maximum DM (t/ha)} \times 25 \text{ (kg N/t)}$$

Maximum DM, hence maximum fixed N, occurs just prior to physiological maturity, when pods are almost filled and start to yellow (see *graph* on page 4). Farmers can ensure their pulse DM is maximised by adopting best management practices, especially inoculation, sowing time, establishment, weed control and disease management.

A simple tool growers can use to estimate DM of their pulse crop is to apply harvest index to their **actual harvested grain yields**. Harvest index (HI) is the percentage of grain in total above ground DM. Reported HI in pulses varies from 20% to 50%.

$$\text{Maximum DM (t/ha)} = [\text{grain yield (t/ha)} \times 100] \div \text{HI \%}$$

Growers need to interpret HI from visual assessment of how well their crop has grown during spring, taking into account management factors such as agronomy, weeds, pests, disease and environmental factors (e.g. frosting, lodging). Tall, bulky crops with poor pod set have low HI (less than 25%), while short well podded crops have high HI (greater than 40%).

Estimating residual nitrogen

The residual nitrogen benefit can be estimated by subtracting nitrogen exported in grain from estimates of nitrogen fixed (as described above).

$$\text{Residual N (kg/ha)} = \text{total fixed N (kg/ha)} - \text{N removed in grain (kg/ha)}$$

Estimates of residual nitrogen for chickpea, field pea, faba bean, lentil, narrow leafed lupin and albus lupin are presented in the table on page 6.

Assumptions

- These estimates consider above ground biomass only. Approximately one third of total fixed N is found below ground.
- Estimates apply only to “run-down” soils with low mineral N, forcing optimum efficiency of nitrogen fixation. Such soils occur late in the cropping cycle, the traditional position for pulses in the cropping sequence.
- Effective nodulation and optimum rhizobia numbers.
- Pulse DM becomes fully decomposed over time and available plant ammonia and nitrate is fully released by biological activity. Environmental conditions inevitably

lead to losses from the system and affect the rate of decomposition.

- 25 kg N fixed per tonne DM.
- Grain protein: chickpea – 19%; field pea, faba & lentil – 24%; narrow leafed lupin – 29%; albus lupin – 34%.
- Harvest index (HI) generally varies from 20 to 40%, but can be outside this range.

Conclusion

Fixed N will always be subject to assumptions and variables beyond the grower’s control. Therefore, the calculations presented above are only estimates of potential N fixed. Grower and advisor experience is required to refine and make practical sense and application to their specific circumstances. Differences in fixed N estimated in the accompanying table may not necessarily reflect actual soil nitrate levels at sowing of the following crop.

In reality, the best assessment of the benefit of pulse fixed N is in the grain yield and protein response of the following crops, and in associated benefits to sustainability and profitability of the whole farming system.

Since substantial responses in cereals after all pulses are well known, tactically it is best for farmers to focus choice of pulse more on adaptation, performance, marketing and profitability of the pulse in their specific farming system rather than on potential to fix nitrogen.



Inoculation of faba bean here has failed and resulted in severe nitrogen deficiency and stunting. Note the circled plants which have successfully nodulated.

Assessing nodulation

Nodules will have developed and be easily located from 8 to 10 weeks after sowing. Nodule assessment should occur any time from this point through to the end of flowering. For practical reasons, crops are more easily traversed when plants are young, and it is best to dig when the soil is moist and friable, allowing it to be easily crumbled from the roots.

Select four to five representative sites in the crop. At each site dig up four individual plants from separate locations, to a depth of 10 to 15 cm, remembering the majority of nodules are found in the surface soil. Carefully shake and remove soil from the roots, leaving nodules intact. Washing roots can help but is not essential.

Well nodulated pulses will have nodules in the crown region (where the root meets the shoot) or along the tap root and lateral roots, or in both locations. Slurry inoculated seed generally produces nodules in clusters around the crown, while water injected, granular applications or natural background infections result in more scattered nodules.

To assess nodulation, use a 0 to 5 scale and use the photos on pages 7 to 9 as a guide.

Nodule scores	
0–1	inadequate
2–3	adequate
4–5	abundant

Estimates of above-ground nitrogen fixed (kg/ha) by a pulse crop based on harvest index (HI).

Grain Yield (t/ha)	Chickpea			Field pea, faba bean, lentil			Narrow leaved lupin			Albus lupin		
	HI 20%	HI 30%	HI 40%	HI 20%	HI 30%	HI 40%	HI 20%	HI 30%	HI 40%	HI 20%	HI 30%	HI 40%
0.40	38	21	13	35	18	10	31	15	6	28	12	3
0.60	57	32	19	52	27	14	47	22	10	42	17	5
0.80	76	42	26	69	36	19	63	30	13	56	23	6
1.00	95	53	32	87	45	24	79	37	16	71	29	8
1.20	114	64	39	104	54	29	94	44	19	85	35	10
1.40	132	74	45	121	63	34	110	52	23	99	41	11
1.60	151	85	51	139	72	39	126	59	26	113	46	13
1.80	170	95	58	156	81	43	141	66	29	127	52	15
2.00	189	106	64	173	90	48	157	74	32	141	58	16
2.20	208	116	71	191	99	53	173	81	35	155	64	18
2.40	227	127	77	208	108	58	189	89	39	169	69	19
2.60	246	138	83	225	117	63	204	96	42	184	75	21
2.80	265	148	90	242	126	67	220	103	45	198	81	23
3.00	284	159	96	260	135	72	236	111	48	212	87	24
3.20	303	169	103	277	144	77	252	118	52	226	93	26
3.40	322	180	109	294	153	82	267	126	55	240	98	28
3.60	341	191	116	312	162	87	283	133	58	254	104	29
3.80	359	201	122	329	171	92	299	140	61	268	110	31
4.00	378	212	128	346	180	96	314	148	64	282	116	32

Notes

The figures in this table are based on harvest index (HI). Growers need to interpret HI from visual assessment. Tall, bulky crops with poor pod set have low HI (less than 25%); short well podded crops have high HI (greater than 40%).

The figures presented in this table are a guide only and should be used as such. Fixed N estimates will always be subject to assumptions and variables beyond the grower's control. Grower and advisor experience is required to refine and make practical sense and application to their specific circumstances. These fixed N estimates may not necessarily reflect differentials in soil nitrate levels at sowing of the following crop. N fixed will be optimised by growing the pulse best adapted to the environmental conditions using sound agronomic practices.



Active nodules on the roots of a field pea plant.



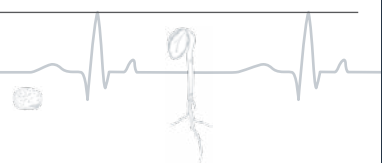
Large nodules on the roots of a faba bean plant.



Nodule scores for these chickpeas above were 0, 1, 2, 3, & 4 respectively (left to right). The two plants on the left have inadequate nodulation, and further investigation is required to identify the causes.



Nodule scores for these lupins above were 1, 1, 2 & 3 respectively (left to right). The two plants on the left have inadequate nodulation, and further investigation is required to identify the causes.





A range of nodulation in faba beans. The plants would be scored 0, 3 and 5 from the left. The centre plant has adequate nodules, while the plant on the right has abundant nodules.



Field pea has quite a fibrous root system. This plant has adequate nodules (score 2). Note, nodules are spread down the root system as expected from liquid injection or granular inoculation.



Lupin root system and nodules look quite different to other pulse crops. These lupin plants are well nodulated (score 3, adequate). The nodulation concentrated on the taproot from seed applied slurry inoculation



Chickpea plant with inadequate (score 1) nodulation.



Chickpea plant with adequate (score 3) nodulation.



Faba bean plant with just adequate (score 2) nodulation.



Faba bean plant with abundant (score 5) nodulation.

Drew Farming

Background

Gary and Heather Drew run a mixed farm just west of Brocklesby in the southern Riverina. There are three parts to the business:

1. a Merino wool enterprise;
2. a terminal sire prime lamb enterprise; and
3. a cropping enterprise (1100 ha each year).

The Drews manage a range of soil types from well-draining red loams to heavier clay loams, which have a tendency to become waterlogged during winter.

Farming system

Ideally the Drews grow eight years of crop followed by four years of a legume based pasture, however some paddocks are continuous crop, and a few small ones are only suitable for pasture and grazing.

A long history of legume based pastures and break crops means weed seedbank numbers are low, and weed management does not drive the system. Forecast price and market availability are more important considerations.

The Drews current cropping system uses narrow points for direct drilling with autosteer. Management of stubble varies from paddock to paddock and year to year. The majority of wheat stubbles are burnt in autumn, allowing hassle-free sowing, some control of weed seeds and stubble-borne wheat diseases. In general, stubble is retained in:

- wheat in a dry year, when stubble load is low;
- wheat in a good year when it is cut low, with the harvester spreaders disengaged and straw is baled behind the header;
- canola, which is harrowed prior to sowing to allow trash flow at seeding;
- lupins and faba beans.

In the past couple of years prices have influenced crop choice and the canola area has increased at the expense of the pulses.

Canola is sometimes used as the first crop after pasture. This decision is often made if the price of canola is high or crop areas need to be adjusted and as a result, weed management in the final year of pasture has not been adequate.

At a glance

Location

Brocklesby, southern Riverina

Rainfall

Annual 515 mm winter dominant

Area managed

1500 ha

Main soil types

Red clay loams to heavier grey clays

Key enterprises

Cropping, prime lambs and Merino wool

Area cropped

1100 ha (50% wheat, 25–40% canola, 10–25% pulses)

Pulses grown

Narrow-leaved lupins, albus lupins and faba beans, occasionally field peas

Pulses in the system

Crop sequence

The types of crops grown by the Drews has changed over the years. In the past they grew a four year sequence of cereal crops (wheat–wheat–barley–oats) and then pasture was sown. The inclusion of a pulse crop in the sequence extended the crop rotation to six years (wheat–wheat–pulse–wheat–wheat–oats). The pulse crop was the only break crop until canola was introduced, when the crop sequence became continuous (wheat–canola–wheat–pulse repeated) and now wheat is only grown after a break crop. Continuous cropping will be maintained until the paddock needs a pasture phase for weed management or a change to fit in with the rest of the farm's program.

Lupins are the main pulse and are grown each year. Faba beans are only sown if the autumn break allows timely sowing (see *Making pulses work: sowing time*, page 12). If the rain comes too late for faba beans, field peas may be grown instead.

Varieties

The Drews grow Luxor albus lupins, Mandelup narrow-leaved lupins and Rana faba beans, which make up the 10–25% pulse component of the annual cropping program.

The variety of each pulse crop grown is selected partly on performance in National Variety Testing (NVT) trials

which the Drews have hosted for nearly 20 years. In addition disease resistance to reduce production risk, and grain type is considered. If there is demand by an end user for a specific variety then the Drews will consider that variety if the agronomy package fits.

Weed management and disease break

Pulses provide flexibility in herbicide usage and the cereal disease break enables the crop sequence to be continuous. The Drews do not grow any wheat-on-wheat, strongly believing that diversity is reducing their production risk in all crops. Diversity may create some logistical challenges but it also has benefits for the cropping system as a whole.

Benefits

The Drews include pulses in the farming system because they:

- extend herbicide usage by adding diversity to the mode of action groups used;
- are cheap to grow;
- do not reduce the soil nitrogen levels; and
- extend the cropping rotation.

Like many dedicated pulse crop growers, Gary Drew finds it difficult to rank the individual benefits of including a pulse crop in the system. Gary says, “It is a combination of all the benefits that is the key. Pulses take the pressure off the fertiliser usage and reduce the input costs. Having more crops in the system also reduces, or avoids, the need to grow wheat-on-wheat”.

Making pulses work

The Drews believe there are different skill levels required to grow pulses successfully (see *table* on page 13). Faba beans they consider the most advanced pulse crop they grow. Gary says, “Management has to be spot on! You can not miss any step in the production process or you will face significant disappointment”.

The Drews recommend that new growers talk to experienced growers to avoid making mistakes. Gary says, “These issues used to be addressed at grower meetings and field days, but now they are talked about at the football!”

Planning and herbicides

The Drews plan their pulse paddocks at least a year ahead and take care with the herbicides used in the year prior to the pulse. The regular use of residual herbicides means care needs to be taken with observing and planning for plant-back periods with in-crop and summer fallow applications.

Seed

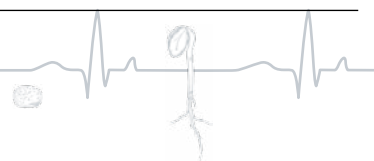
The Drews recommend using a belt elevator rather than an auger to move pulse seed. The belt is gentler on the seed, minimising cracking.

Inoculation

The Drews engineered a liquid inoculation system to avoid the need to treat seed during the busy sowing period, and to improve nodulation. Peat inoculum contained in a stocking is added to a water tank working



The Drews have hosted the National Variety Testing pulse trials for almost 20 years. They use the trial data and varietal characteristics such as disease resistance and seed type to select the best variety to grow.



similarly to a 'tea-bag', and a pump and small tubes deliver the inoculum liquid directly into the seed furrow.

Sowing time

Sowing time is one of the most important and manageable agronomic factors for growing pulse crops. The Drews will only sow faba beans into moist soil. It must be sufficiently moist for the beans to germinate and establish. If this can not be done by 25 April then faba beans will not be planted and lupins or canola will be substituted.

Lupins are sown later now than the Drews did in the past. They find that the risk of high levels of disease, particularly sclerotinia, is too high when sown into moisture in April. Lupins are sown in early to mid May and will be sown dry if necessary.

Row spacing

The Drews airseeder is currently set up with 225 mm (9") row spacing. Cereals and canola are sown at 225 mm row space, but faba beans and some lupin crops are sown at 450 mm (18") row space. They feel this may be too wide and plan to update the airseeder to a 300 mm or 12" row space. This would then suit all the break crops and the wheat will be sown using paired rows to optimise yield. This results in less tynes, better trash flow and the best row space for all the crops grown.



The Drews currently use 450 mm or 18" row spacing for pulse crops.

Harvesting

When the Drews grow field peas they are the first crop to harvest. They mature earlier than other crops and must be harvested the day they are ready to minimise harvest losses and cracking of seed.

Faba beans are more tolerant to delayed harvest than field peas but should be harvested soon after they are ready to avoid discolouration.

Lupins are the last crop to harvest and will be done on a dewy morning or after a shower of rain if possible, to minimise harvest losses off the cutter-bar.

Storage

The Drews store pulses on farm, but move human consumption product as soon as possible, with the shortest time between harvest and delivery, and minimal handling being an advantage. They are more willing to store lupins on farm for longer periods. There can be good value in storing them, achieving a better price than at harvest. Lupins are easy to store and maintain quality for years.

The Drews use a belt elevator to move all pulses (rather than an auger) and store lupins in upright silos and in grain silo-bags.

Marketing

The Drews aim to sell faba beans into the human consumption market. This is controlled by supply and demand factors – when the crop is larger it is harder to find a market for the beans, and when supply is tight both market access and price improve. Faba beans are also a stockfeed market friendly product.

The Drews do not use any hedging products or brokers to help with marketing pulses as they are a small part of the program.

The trigger price for selling pulse crops varies from season-to-season, but they have a good idea of cost of production developed from 15 years of detailed records. Lupins are the cheapest to grow at approximately \$250 per ha, while faba beans cost about the same as canola at \$400 to \$500 per ha, mainly due to high seed costs, herbicides and fungicides.

Pulse industry challenges

Like many pulse crop growers, the Drews believe that selling the product is the biggest issue facing the industry. It is hard to find an end-user willing to pay a high enough price on a consistent basis to make them economical to grow. For example, despite the fantastic feed qualities of lupins, they are still competing against other protein sources.

Gary says, "It is a challenge for the grower, because it is very hard to plant a crop without knowing you are going to have a home for it at the end of the season. On the other hand the market requires consistent and significant

The Drews recommend growers new to pulses start with a 'beginner' level crop and talk to experienced growers and advisers to avoid making mistakes.

Experience required	Crop	Reasons
Beginner	Narrow-leafed lupins	Best for first time growers Few things can go wrong Easiest pulse to market
Intermediate	Albus lupins	Large seed size. Check machinery can handle it (hoses, boots, and grouper) Targeting human food - insect management prior to maturity important
Advanced	Faba beans Field peas	Large seed size. Check machinery can handle it (hoses, boots, and grouper) May be targeting human food - insect management prior to maturity important Faba beans require foliar disease management program (fungicide application) Field peas require pea weevil management

supply, which is not going to come if the commodity price is too low”.

“The majority of growers are trying to keep their system simple. If a pulse crop requires more stringent management at a higher cost and production risk, then there needs to be greater financial rewards at the farm gate”.

The future

Pulse production, like all farming enterprises, is an ever developing process. The Drews will continue to adapt their production system to best suit the seasons and optimise profit while looking after the land.

The Drews are proud of the quality of the crops they produce and would like to see Australian pulses promoted more as human food rather than a protein source for stockfeed rations. The use of the clean, green story and the development and promotion of lupins as a food needs to be pushed in the domestic Australian market as well as in export markets.



Graham Farming

Background

The Graham family business includes Greg and Ann Graham and their two sons and daughters-in-law, Digby and Jody and Denzil and Michelle. The three individual farms are all managed and run as one operation. The Grahams have a sizable winter cropping program (60% cereals, 20-25% canola and 15-20% pulses) and breed first cross ewes, selling the male portion and culls into the prime lamb market.

Farming system

The Grahams run a mixed farming system dominated by annual winter cropping and incorporating sheep and pasture. Their cropping system is stubble retention and direct drill, except in years when lime is applied and stubble is burnt and lime incorporated. A legume pasture phase of approximately five years is included after about seven years crop, depending on seasons and markets.

Pulses in the system

The Grahams grow a mix of pulses as this enables diversification of marketing and storage.

Crop sequence

The Grahams have always had pulses in their farming system. All the pulses are grown for grain and there is no brown manuring. Crop sequence is often affected by the success of the pulse crop. However, a typical crop sequence may be canola–wheat–wheat–barley–pulse–wheat–canola.

The business runs a four to five year legume pasture (lucerne or lucerne/clover mixes) phase similar in area



Denzil (left) and Digby Graham grow faba beans on their heavier grey clay soils where they are well suited.

At a glance

Location

Coolamon and Methul district, eastern Riverina

Rainfall

Annual 400 mm winter dominant

Soil type

80% red brown earths running into lighter granite area or heavier grey clays

Area managed

Several individual farms (80% cropping; 20% grazed legume pasture)

Key enterprises

Annual winter crops and breeding first cross ewes/prime lamb market

Area cropped

60% cereals, 20-25% canola, 15-20% pulses)

Pulses grown

Narrow-leafed lupins, field peas, faba beans

to the canola program. This allows between 20 to 25% of the area to enter the cropping phase at the end of the cycle. The nitrogen from the lucerne tends to become available over a couple of years whereas the nitrogen from the pulses breaks down faster and does not seem to last as long.

The pastures are managed as a crop to keep weeds out and to maximise production. The pastures are kept as grass free as possible in the two years prior to entering the cropping phase. Importantly, where ever possible, herbicides used in the pasture phase are from different chemical mode of action groups than those used in the cropping phase.

Canola is usually chosen as the first crop in the sequence. This gives the Grahams:

1. an extra year to manage grasses in the paddock before a cereal crop is introduced; and
2. the opportunity to utilise accumulated nitrogen and “run the nitrogen down” a bit so that the paddock is not “too hot” for the cereals in drier years.

Varieties

Variety is selected according to market availability, ease of harvest and ease or availability of storage (see *table* opposite).

The Grahams feel that, in the majority of cases, there should be much greater consideration given before

varieties are released to ensure they are sufficiently improved on current varieties. Yield and desired traits must be significantly improved to warrant release and the effort and costs associated with changeover.

Weed management

Pulses are used as an opportunity to diversify the Grahams' weed management program. An integrated approach uses:

- as wide a range of herbicide mode of action groups as possible
- crop-topping to stop weed seed set in field peas
- the best possible sowing conditions and the highest realistic seeding rates to optimise crop competition.

Problem weed paddocks go into pasture.

Benefits

The Grahams find a number of benefits from having pulses in their cropping program. These include providing:

1. a cereal disease break during the crop sequence;
2. a broader range of weed control options;
3. nitrogen benefits;
4. an extended sowing window;
5. the ability to optimise machinery;
6. a source of stockfeed e.g. lupins
7. flexibility of selling if there is good storage e.g. lupins;
8. diversification of markets; and
9. stubbles for grazing e.g. sheep adjust well to grazing faba bean stubble and unharvested seed.

Making pulses work

Agronomy

There have been many trials on the Grahams farms over the years and the results enable their management practices to be fine tuned. Yield monitors and GPS have become invaluable tools to monitor and check their management decisions.

The Grahams select paddocks for pulses according to:

- nitrogen and weed status, pulses are usually sown into more run down paddocks;
- soil type, for example faba beans are sown on the heavier soils and lupins on the lighter soils; and
- access and suitability to get on to and around the paddock with a boom spray.

The Grahams have always endeavoured to keep up to date with the latest management issues and they feel very confident including pulses in their cropping program. Experience, appropriate agronomy and past successes reinforce their strategies and give them confidence that they are doing the right thing in their business.

Sowing time

As a sowing management aid, the Grahams cut straw low at harvest and retain stubble. Pulses fit well into this system, for example reducing the incidence of brown leaf spot in lupins. The wide sowing windows offered by their diversified cropping program means sowing clashes are minimised and yield and profit optimised for most crops.

Nodulation

The Grahams realise the importance of assessing nodulation on their pulse plants and are confident in

Adoption of pulse crops and varieties by the Grahams has been a continuous evolution driven primarily by seasonal conditions and market availability.

Crop	Year	Varieties	Reasons included in system
Lupins, narrow-leafed	1970s	Currently Mandelup	The traditional pulse crop still grown.
Chickpea		Amethyst	Adopted in late 1980s briefly
Faba beans	1995-1997	Barkool	Stopped growing faba beans due to drought years
	2011	Fiesta	Reintroduced to system due to new marketing opportunities created by a local grain trader. Faba bean markets have traditionally been hard to find.
Field peas	2000	Excell (blue)	A big improvement in field peas varieties has been seen over the last 10 years. Growth habit erect rather than crawling along the ground and improved disease resistance.

doing this. They believe that information relating to successful pulse inoculation is readily available and know that it is certainly worth the effort to inoculate the seed properly.

Disease management

Over the years, the Grahams have developed a good understanding and knowledge of pulse diseases and their management.

Harvesting

The Grahams have the experience and the machinery to harvest pulses. Rotary headers are used and any grain handling issues have been addressed. Sometimes there can be clashes at harvest time resulting in regrets and penalties if late!

Storage

All pulses are stored on farm using bulk shed and silos with belt elevators in and out of the storage facilities. Handling of pulses is critical throughout the production phase, including on-time harvest with the header set to minimise seed cracking, and gentle seed handling. The Grahams handling system has evolved and adapted over many years. Storing the pulses on farm means that they are able to hold off selling the pulses until prices are favourable, particularly lupins. Faba beans are the exception due to their discolouration in storage.

Keys to success

The Grahams focus on doing everything right in a step-by-step fashion i.e. planning and timing of operations is critical and unforgiving. They know that if anything is overlooked it is bound to 'bite you' later!

Their successes with pulses are largely due to:

- ensuring high levels of seed purity and germination;
- realising that the timeliness of operation is critical;
- seeking advice when required as there is no substitute for experience when it comes to growing pulses; and
- following the agronomy and well documented formulae for pulse production (including management that addresses plant population, weed control, inoculation, possible contamination of the spray cart, disease and insect control).

Marketing

The Grahams believe that it is essential to have on farm storage. Pulses can be stored and used to regulate cash flow as they can be sold throughout the year. They actively seek seed markets through brokers and focus on producing the best quality pulses, targeting human consumption markets with price premiums. The aim is to



The Grahams always inoculate their pulse seed just prior to sowing and assess nodulation. Large and numerous nodules are essential to the success of each pulse crop.

work off a minimum price but maintain some flexibility depending on cash flow and storage demands.

Pulse industry challenges

Marketing

The Grahams have found that the availability of pricing and market information for pulses is inadequate compared to wheat and canola. They would also like to see improved market competition and know that this will only come about with increased production, new marketing opportunities and an increase in buyer numbers.

Seed costs

The Grahams realise that there are challenges associated with starting to grow pulses or changing varieties, for example bulking up enough seed. The cost of seed can often be prohibitive and an impediment to rapid adoption.



The Grahams place a priority on harvesting Excell blue field peas to minimise weather damage and bleaching.

The future

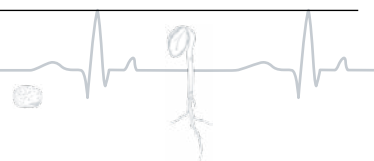
The Grahams will continue to include pulses in their cropping program. They have recently become involved with on-farm evaluations of new field pea and lentil varieties as collaborators with NSW Department of Primary Industries, Wagga Wagga.



The Grahams have recently become collaborators with NSW DPI Wagga Wagga hosting on-farm lentil evaluation trials.



A field pea evaluation trial at early flowering stage at the Grahams farm. These trials are part of the National Pulse Breeding Australia program.



Eckermann Farming

Background

The Eckermann family moved from South Australia to their farm between Yenda and Rankins Springs in the 1980s, bringing with them field pea seed and experience of growing pulse crops.

Nick and his wife Trisha, and his parents Kym and Judy now manage 11,000 ha of winter cropping with a strong reliance on pulse crops to keep the system sustainable.

The Eckermanns have been integral to the development of dryland pulse production in the short season environments of southern NSW. They have hosted extensive pulse crop trials and field days for many years in partnership with NSW Department of Primary Industries and the Central West Farming Systems group.

Farming system

The Eckermanns were traditional wheat and sheep farmers using long fallow and conventional cultivation. A gradual transition over the past 20 or so years has resulted in their operation being 100% cropping today. All their country is arable with no specialised areas suited only to grazing so they currently see no place for livestock.

Their system is no-till, full stubble retention, with 30 cm row spacing. They use RTK ± 2 cm GPS autosteering for all operations but do not run a controlled traffic system. They remain open and flexible with their system and will use strategic windrow-burning as a weed control tactic.

In the past the Eckermanns have grown lucerne managed as a crop. Annual pastures are too risky as they rely on significant early autumn rain which is a rare occurrence in the western cropping belt. Pastures also compromise long-term weed management, particularly spiny burr grass.

Livestock expose paddocks to wind erosion over summer, particularly field pea stubbles. When left alone field pea paddocks do not blow, particularly when the residue is mixed with remnant wheat stubble.

Pulses in the system

The Eckermanns grow pulse crops as an integral component of their 100% cropping system. They are finding that a three year gross margin including a pulse crop makes wheat and canola yields more stable and the whole system more sustainable—they have to be included to make it work.

At a glance

Location

Rankins Springs, northern Riverina

Rainfall

Annual average 382 mm, April to October 225 mm

Soil type

Red clay loam - ranges from sandy loam ridges and red clay loam country in between

Area managed

11,000 ha

Key enterprises

Annual winter cropping

Area cropped:

11,000 ha (50% wheat, 20–25% canola, 25–30% pulses and brown manure)

Pulses grown

Narrow-leaved lupins, chickpeas, field peas and vetch



Nick and Trisha Eckermann with their children Will and Keira, in a magnificent crop of Sturt field peas.

Pulses also stand alone as a positive gross margin and crop in their own right. The persistence with a sound rotation and more diversity is really paying off, especially in the canola yields. The best canola crops are grown on a wheat stubble following a pulse.

Crop sequence

There is no set rotation, rather a rough crop sequence: wheat–canola–wheat–pulse–wheat–vetch. The proportion of each crop remains flexible depending on phase of the rotation, prices and season. The key rule for success in pulse crops is not to grow the same pulse in the same paddock within a five year period.

In weedy situations, a double break from wheat is used (e.g. pulse or vetch then canola). Sometimes barley is added to the system, following wheat if the autumn break is late. Wheat is by far the preferred cereal as feed barley markets are not as strong nor stable as wheat, and it is not as lucrative as it was in the past.

Species and variety

The Eckermanns grow field peas, narrow leafed lupins, chickpeas and vetch for brown manure. They do not grow albus lupins primarily because the market is too variable. The ideal proportion of each pulse crop is listed in the table on page 20.

The actual ratio depends on:

- soil type and terrain in the paddock e.g. lupins on sandy soils; brown manure vetch on heavier rocky country;
- moisture content in the soil profile;
- timing of the opening autumn rains;

Benefits

The Eckermanns believe there are numerous benefits to growing pulse crops and they are now a strategic component of their long term system. Pulses:

- make money in their own right
- are a natural “ground-sweetener” or soil improver
- are a more sustainable way of farming economically
- assist grass weed control, particularly wild oats
- break the wheat disease cycle, reducing the likelihood and severity of wheat diseases occurring
- add diversity to the system managing price and production risk
- reduce the need for and sometimes replace bag nitrogen fertiliser
- use less moisture than a cereal or canola crop, conserving it for the following wheat, particularly field peas
- store well and easily without deterioration and insect pest problems
- have flow-on benefits into a second year after the pulse crop in some seasons

- previous crop history, particularly the last pulse crops; and
- projected pulse price, particularly when deciding on the inclusion of chickpeas.

Making pulses work

Paddock preparation

Paddock preparation for pulses is essential to avoid picking up sticks, rocks and clods of dirt during harvest as they are all harvested with the cutter bar close to the ground. Preparation includes removing sticks prior to sowing and rolling to level the surface and push down rocks after sowing field peas.

Inoculation

It is critical to inoculate the seed of each pulse just prior to sowing. The most effective and cheapest application method is to apply a slurry of peat inoculum and water to the seed as it is being augered. The Eckermanns have tried granular forms of inoculum through a third box on the airseeder, but delivery and calibration is poor due to the unevenness of the granules and it is three to four times the cost of peat.

Seeding rate

The Eckermanns always use recommended seeding rates and advise not to skimp. Low rates reduce competition with weeds and can cause problems with evenness of crop maturity and crop feeding into the harvester.

Sowing time

Sowing time of each crop is critical so there needs to be flexibility in the system. If breaking autumn rains are early or the soil moisture profile is full the lupin area will increase. After 10 May lupins will be substituted with vetch brown manure or field peas, while still keeping the system in balance. The Eckermanns understand you can only do what the season allows you.

Chickpeas present a problem as their preferred sowing time is 5 to 20 May, which is when you are trying to sow wheat. They are also only grown if the price outlook is promising and the soil moisture profile is full.

Field peas are more forgiving but the Eckermanns like to have them in a few days either side of 20 May.

If the season results in late sowing then the aim is to grow a crop with the maximum dry matter production to optimise the nitrogen benefit if yield potential is low.

Phosphorus

Pulses provide an opportunity to reduce phosphorus rates but the Eckermanns believe it is important to



Current pulse crop and varieties grown by the Eckermanns

Crop	Proportion	Current Varieties	Reasons included in system.
Field peas	35%	Sturt, Oura, Percy, Parafield	Grown on most country except rocky areas.
Vetch	30%	Morava, Rasina	Included as a brown manure crop to add soil nitrogen and to increase the length of the summer fallow (by starting it in mid spring, much earlier than when a crop is taken through to harvest) for soil moisture conservation. The advantages of using vetch compared to other legumes or pulses are its low seeding rate and its very competitive growth which makes the phase a good weed control tactic. A portion of the crop is grown though to maturity and harvested for seed for subsequent years.
Chickpea	20%	GEN509, Boundary	Only grown in seasons that start with a full profile of soil moisture at sowing.
Lupin, narrow-leaved	15%	Jenabillup, (shatters a bit) Mandelup, primarily because of its tolerance to metrabuzin	Grown on the sandier country where they are well adapted. They also tend to perform relatively well in a tough year. The lupins are included in the system primarily to add nitrogen.

increase the phosphorus rate applied in the following crop to maintain levels.

Lupins and chickpeas are sown with 30 kg MAP/ha below the seed with a tyned seeder.

Field peas are sown with 50–60 kg MAP, below the seed when sown with the tyned seeder, but when they are sown with the disc seeder the MAP goes with the seed. Placement of MAP and associated seedling damage seems to be less critical in field peas compared to lupins and chickpeas.

Weed management

The Eckermanns insist you have to get weed management right. The poor competitive nature of the crops means that any weed that is allowed to set seed becomes a problem.

Weed management in pulse crops has improved but it is still essential to plan well to get it right. The effectiveness of herbicides and risk of crop damage is dependant on factors such as soil type, soil pH, sowing equipment and rainfall so planning, good record keeping and good advice is essential.

Harvesting

The keys to successfully harvest pulse crops is to harvest as soon as they are ready, at 14% moisture.

Field peas have top priority and are started as early as possible. If you can avoid rainfall on them once they are mature it is much cleaner for machinery and optimises quality with minimal losses. Lupins are a lower priority

as they clash with wheat harvest and are more resilient than the other pulses.

The Eckermanns budget to desiccate half the field pea crop to bring harvest forward a few days to assist with harvest logistics and get the bonus of controlling any late-germinating ryegrass plants.

The Eckermanns windrow a portion of their vetch seed crop to manage harvest logistics and minimise losses from shattering at the cutter-bar.

The Eckermanns do not have any specialist harvest or grain handling equipment. The only modification they have made is the addition of a cross-auger to their harvesters draper front to improve the feed of field peas in particular.

Belt augers may reduce cracking of pulses but the Eckermanns find that if they keep the auger pretty full and try not to auger the pulses too many times, damage can be minimised.

Storage and marketing

Storing pulse crops is quite straight forward without the issue of stored grain insects. The Eckermanns store their pulse crops in upright silos or grain silo-bags and have no issues.

Marketing on the other hand is a full time job. You have to be prepared to sell to anywhere there is demand in Australia for domestic or export use. This may mean sending loads 800 km or more to secure a sale.

There are only a few pulse buyers compared to the large number of wheat buyers and it is important to develop your own contacts and build relationships over time. The Eckermanns find it can be difficult to compete with Victorian and South Australian supply.

Keys to success

The Eckermanns keys to success are:

- adopt a crop sequence covering the whole farm;
- plan well in advance with careful paddock selection;
- manage weeds and plan management all the way through. Treat the pulses like you would your best wheat crop. Second rate management will result in second rate pulse crops;
- monitor the crops regularly and professionally; and
- avoid herbicide residue damage to pulses. Select, plan and rotate herbicides taking into account type of herbicide, plant-back periods, soil type and expected rainfall.

Pulse industry challenges

Varieties

Lupin yields appear to be stagnant. Varieties have not improved in yield over the past 20 years.

Chickpea varieties are continually getting better for resistance to disease, increased yield and improved seed type.

Field pea varieties have seen some major changes. The Kaspera type marked a big change in plant type and shattering resistance but they needed to be sown earlier than other field pea varieties due to lateness of flowering. This meant Kaspera was not suited to dry seasons.

The Eckermanns believe field pea varieties should not be released without resistance to bacterial blight, a disease which can result in 100% yield loss.

Varieties need a distinct and marked advantage before they are considered for release.

Harvestability is important for new varieties but not a high priority. The Eckermanns can handle scrambling field peas crops but find Oura (a semi-leafless erect type) to be easy to harvest.

Advice and support

There is a lot of information out there, but not a lot of hands-on experience among agronomists. There is a need to regularly train the network of agronomists to get them up to speed.



Judy and Kym Eckermann have hosted pulse trials and field days for many years.

In general the industry in southern NSW requires more support and information on:

- herbicides and fungicides—which ones can and can not be used and the best timing of application for efficacy and crop safety;
- marketing—it can be challenging to find markets and pricing information; and
- chickpea agronomy specific to southern NSW as current information and experience is from northern NSW where disease can react quite differently.

Grower experience

The emergence and evolution of pulse cropping in this area has been slow over time and with lots of experiences, both good and bad. No amount of technical information can beat experience.

Marketing

One of the big challenges that has always faced pulse crop growers in southern NSW is marketing. There is a need to accumulate larger tonnages of each crop to enable serious marketing, including exports. Traditionally there are lots of small parcels traded which restrict serious competition.

Due to this geographically fractured nature of supply and the lack of continuity from season to season there are no





The annual pulse crop field day hosted by the Eckermann family, NSW DPI and Central West Farming Systems has attracted large numbers of growers and advisors from a large area of the cropping belt for almost 20 years.

big traders in the region, and no infrastructure has been developed specifically for handling and storing pulses.

The future

The Eckermans are coming to realise that locally there is a huge domestic stock-feed market for pulses. Pulses are always in competition with soy meal and canola meal as a protein source in intensive livestock feed rations but pulses are often preferred. The local poultry industry is keen to use pulses in the ration and in recent years have been strong buyers in the market and take deliveries during harvest. For many growers delivery straight off the header is a big positive. After many years of targeting premium quality human food markets without getting a justifiably high premium price, stock-feed markets are becoming a reliable option. The local field pea crop is now producing reliable tonnage so they can be included as a regular component in feed rations. Growers always have the option of storing pulses if prices are not acceptable.



Nick Eckermann speaking to a large group of growers and advisors at the annual pulse crop field day they host at Rankins Springs each spring.

Background

Murray and Emma Scholz manage an aggregation of 1670 ha on undulating to hilly country, including some steep rocky outcrops, east of Culcairn. Murray's parents, Barry and Elaine, are officially 'retired' but still help out at busy times. Mark Hasler is a long-time employee working with Murray and one of the keys to their success.

The Scholz's business is split into two enterprises:

1. Continuous cropping (1200 ha is sown to annual crops including wheat, canola and Wonga narrow-leafed lupins); and
2. Beef cattle (country that is unsuitable for cropping, e.g. ground that is steep or has rocky outcrops, is used for grazing a herd of 200 Shorthorn cows).

Farming system

The Scholz's were early adopters of no-till farming and now use 2 cm RTK autosteer for all operations. They inter-row sow but usually have to burn cereal stubble so that sowing equipment can get through without blockages. Stubble is burnt as late as practical in the season. Maintaining this groundcover is essential to:

- minimise erosion risks, particularly on the steeper country; and
- retain soil moisture stored over the summer-autumn period.

Lupin or canola stubbles are not burnt but the practice of windrow-burning (removing straw spreaders from the header to place all chaff and straw in a windrow, and then burning them) in these crops as an integrated weed management tactic has recently been adopted.

Barry grew albus lupins about 30 years ago but experience has shown albus lupins are not suited to their acid soils that have a tendency to get a bit wet during winter. The Scholz's can not include field peas in the crop sequence as there are rocks present in many paddocks. Field peas are harvested with the cutter-bar very close to the ground surface so paddocks with rocks are unsuitable.

Lupins in the system

Crop sequence

The normal crop sequence is lupins-wheat-canola-wheat-wheat then back to lupins. That is sometimes modified due to soil nitrogen levels or if there is an issue with weeds, in particular annual ryegrass. If there is a ryegrass problem the third wheat is omitted and canola or lupins

At a glance

Location

Culcairn, eastern Riverina

Rainfall

Annual average 600 mm; average April to October 410 mm

Soil type

Red and yellow sodosols (have a strong texture contrast between surface (A) horizons and subsoil (B) horizons and the subsoil horizons are sodic)

Area managed

1670 ha

Key enterprises

Annual winter crops and beef cattle

Area cropped

1200 ha (60% wheat, 30% canola, 10% lupins)

Pulse crop grown

Narrow-leafed lupins

will be grown (lupin-wheat-canola-wheat-lupin or canola). If weed numbers are low and nitrogen levels are not run down, an extra canola-wheat may be grown prior to going back to lupins (lupin-wheat-canola-wheat-wheat-canola-wheat). Individual commodity price has little impact on the crop sequence or the ratio of crops grown. Murray believes if you chase commodity prices you end up backed into a corner at some stage.

Variety

The Scholz's have been growing narrow-leafed lupins for well over 30 years. Over this time they have adopted varieties that have demonstrated increased yield and improved disease (mainly brown leaf spot) resistance. Narrow-leafed lupins can be up to 25% of their cropping program and the variety Wonga is currently sown.

Weed management

The Scholz's are experimenting with brown manuring lupins with the aim of reducing the weed seed set of annual ryegrass (which had escaped in-crop herbicides), wild radish and wild oats. They are making half-paddock comparisons of lupin brown manuring compared to lupins harvested for grain. They use yield mapping to compare yields, and also assess weed numbers and the economics. They follow these paddocks for a number of years to determine the impact of the pulse on future crops and weed populations.



The Scholz's are also testing growing canola on lupin stubbles, both brown manured and harvested grain crops. In consultation with their agronomist, they are trialing the practice of a double break crop which is becoming more common across the southern Australian cropping belt. Their idea is that the canola can utilise the nitrogen from the lupins better than wheat, and it also gives them another year to really reduce the seedbank of annual ryegrass. This decision was not driven by the historically high canola price, but they may not have done it if canola was below \$420/t on-farm.

Benefits

The Scholz's strongly believe that a pulse in the continuous cropping system is needed for:

1. nitrogen input;
2. cereal disease break;
3. weed management; and
4. that undefined 'benefit' that only a pulse crop can add to the system.

Murray likes the nitrogen the lupins supply and says, "It does not have the downside risk in the following crop if the spring cuts off. It seems to be more sustainable. And the next wheat crop does better than just the nitrogen value. I am not sure why but they always are better!"

Making lupins work

Agronomy

When it comes to lupin agronomy, Murray says, "There is not much really". The plan is simple: inoculate, sow, manage weeds then see what is there at harvest. He finds lupins an easy crop to grow but one of the limitations is that you can not push the yield.

This simplicity makes them quite a cheap crop to grow, and their acid soils tolerance means they can be grown at the end of the liming cycle.

Inoculation

Inoculation is one of the most important steps in growing lupins, or any pulse. A pulse must be well nodulated for nitrogen fixation to occur.

The Scholz's initially treat the lupin seed with Rovral® fungicide (the active ingredient iprodione targets brown leaf spot and also suppresses *Rhizoctonia hypocotyl* rot). Late on the day prior to sowing the lupins are treated with a slurry of inoculum. They are treated as the seed travels up an auger into a chaser bin and they are allowed to dry. The chaser bin auger is then used to mix the inoculum with the lupins while loading the seed

into a truck. When ready to sow, the inoculated seed is loaded from the truck into the airseeder cart in the paddock.

Sowing time

The Scholz's like to have the lupins in by the end of April as they have found early sowing is critical to success. If seasonal conditions do not allow sowing in April they will still sow through May, but know that yield will be reduced. If lupins are not sown by June fallowing is considered.

Phosphorus

In the past, the Scholz's have used double super but logistically that was too challenging. Keeping a small quantity of a different product on-hand (delivery and storage) and having to change product during sowing (time) was more difficult than the benefits gained. In recent years the Scholz's have been applying up to 60 kg/ha MAP (12 kg P/ha).

Research trials across southern NSW over many years have found lupins to be quite unresponsive to phosphorus so in 2012 the Scholz's sowed a few strips without any phosphorus fertiliser. The nil phosphorus strips could not be seen in the yield maps, so they now sow all their lupins without fertiliser.

Herbicides

Weed management with triazine herbicides is reasonably straight forward, but the Scholz's now look at the option of brown manuring as a planned opportunity, rather than just a salvage operation if weed numbers blow out for some reason. This is even more appealing when production costs are reduced by sowing without fertiliser.

Harvesting

Harvesting lupins as soon as they are at 13% moisture is the ideal but in practice that does not always happen. If wheat is ready for harvest it gets priority. They know that the longer the lupins are left in the paddock, the higher the cutter-bar losses will be. If harvest is stopped by a light rain event, the lupins are usually able to be harvested before the wheat has dried down sufficiently. While the lupin plants are still damp they are tough, and cutter-bar losses can be minimised.

Storage

The lupins are stored on farm, usually for about three months. Lupins are easy to store and do not really require any special equipment. The Scholz's have developed a good relationship with a regional feed mill and they cart the lupins themselves.



Wonga narrow-leaved lupins are well suited to the acid soils, some with rocks, which the Scholz's manage.
 Photo: Murray Scholz

Keys to success

The Scholz's keys to success with lupins are:

- use of good quality seed;
- timely sowing to get lupins established during early- to mid-May;
- good inoculation to ensure effective nodulation;
- timely and effective herbicide application as they are not competitive with weeds; and
- timely harvest i.e. as soon as the lupins are ready.

Pulse industry challenges

Marketing

Selling pulses is one of the biggest challenges facing the industry. However the Scholz's see marketing as a chicken and egg situation i.e. production will be sporadic until there is a stable market, and while production is unreliable from year to year, the markets and end uses cannot be developed.

Competitiveness

The poor competitive nature of lupins, and other pulses, can be a challenge, particularly considering one of the key reasons to grow them is to manage weeds, so using alternate weed management tactics and herbicides is essential.

The future

Lupins will continue to be part of the system at the Scholz's. They would also consider growing albus lupins if these were more regularly used in stockfeed rations making the market broader and more reliable.

The option to brown manure and growing lupins without fertiliser is making lupins much more versatile and attractive in the whole crop system. The Scholz's are currently working out the economics of brown manuring lupins compared to harvesting them for grain.

The Scholz's have found that the use of GPS and yield mapping has made on-farm comparisons much more user-friendly. The ability to assess yield responses after harvest rather than during such a hectic period is very appealing and provides excellent information on which to base future farming decisions.



Schirmer Farming

Background

Neil and Marg Schirmer manage a 100% winter cropping enterprise 12 km northeast of Lockhart in the heart of the Riverina. The Schirmers do not own any livestock but run sheep on agistment on summer crop stubble for up to eight weeks. If it rains the sheep are moved off to protect the soils when they are more prone to damage.

The Schirmers have included pulses in their rotation continuously since the mid-1970s.

Pulses are regularly the top performers (in gross margin) for the Schirmers, with lupins being one of their most profitable crops.

Farming system

The Schirmers operate a no-till, direct drill cropping system using autosteer and retaining stubble. They prefer not to burn stubbles but will occasionally do so in order to sow or as a strategic weed control tactic.

Pulses in the system

Crop sequence

The normal crop sequence for the Schirmers is canola–wheat or barley–wheat or barley–pulse–wheat or canola, although they do not grow canola after lupins due to the risks of the fungal disease sclerotinia (*Sclerotinia minor*).

At a glance

Location

Lockhart, Riverina NSW

Rainfall

Annual average 466 mm, April to October 290 mm

Soil type

Majority red loam, with 200 ha red duplex soil with a sodic layer at 10 cm depth

Area managed

766 ha

Key enterprises

Annual winter cropping

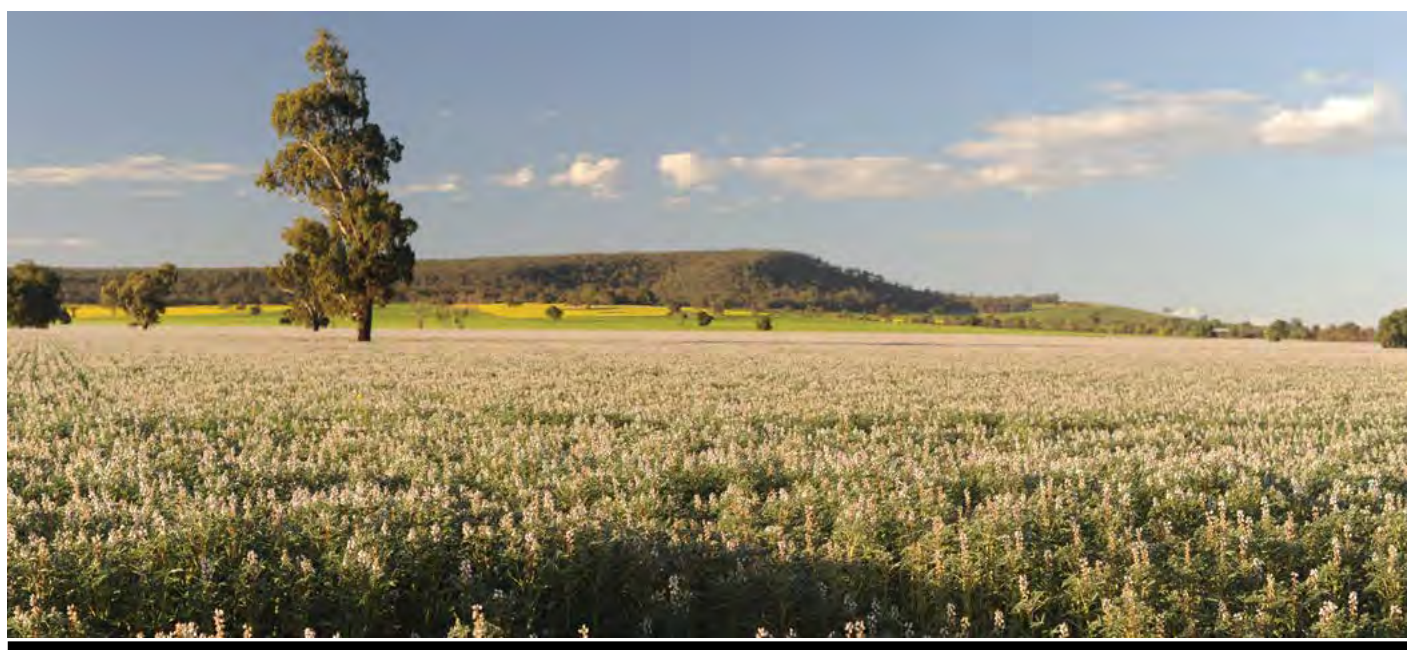
Area cropped: 700 ha (50% cereal, 50% pulses or canola)

Pulses grown

Field peas, faba beans and albus lupins

The decision of which crop to grow depends primarily on soil type, the time of opening seasonal rains, forecast price and what seed is on hand.

The decision of whether to include a pulse crop in a particular paddock is based on crop sequence history and the overall balance of each crop in that season so that the whole system remains in balance and sustainable.



Albus lupins have a good fit in the Schirmer's farming system, well suited to the lighter rising red loam soils.

Photo: Jocelyn Carpenter

Benefits

The Schirmers see five key benefits to including a pulse or two in their cropping program:

1. profitable crop;
2. crop nutrition or free nitrogen;
3. risk management (price and production);
4. disease break for all crops; and
5. herbicide rotation to reduce the risk of herbicide resistance.

“Pulses, especially faba beans and lupins, have a soil conditioning effect that is hard to quantify or put into words”, Neil says. “They just seem to sweeten the soil. The fibrous root system of faba beans and the lupin taproot that punches through the soil helps too. And the retained cereal stubbles—it is a whole farming system.”

Varieties

Varieties are selected on traits including maturity, disease resistance and yield relative to those currently grown. The Schirmers currently grow Luxor albus lupins, Farah faba beans and Morgan field peas.

Making pulses work

The Schirmers are guided by many years of experience when it comes to optimal sowing windows for pulses and when to make the call to change crops.

Inoculation

The Schirmers always inoculate pulses—it is essential and so simple. They apply a slurry of peat inoculant as the pulse seed is being augered into the grouper. Even if lupins are being grown in the same paddock after only four years break they inoculate to ensure effective nodulation.

Sowing depth

Sowing depth is critical in albus lupins. The seedling has to push the cotyledons (whole seed) out of the ground so never sow lupins too deep (no more than 40 mm) – you can not chase moisture. Faba beans are a different story. The cotyledons remain below ground with just a shoot emerging. The Schirmers will happily sow faba beans a bit deeper (up to 60 mm) to chase moisture and get them up and established on time.

Soil moisture at sowing

The Schirmers recommend not to sow into ‘half’ moisture. Either sow dry or into moisture. If there is not enough moisture to get the large seeds to germinate and

establish it is better to wait. Albus lupins, in particular, will rot if sitting in damp soil.

Sowing time

The Schirmers will not sow albus lupins too early (before mid April) as they grow too much bulk without yield. This results in lots of nitrogen being fixed for the next crop but reduces the yield potential. In general, if there is not sufficient soil moisture by 15 May, the switch is made to faba beans as they handle the late sowing better than the albus lupins. If the soil type does not suit faba beans then canola is grown.

During winter, paddocks that are on a hill experience higher temperatures (both day and night) than lower country, so the Schirmers sow lupins in the hill paddocks a week later than the rest of their country as crops will make up growth during the year.

Sowing rate

Seeding rate of albus lupins is increased as time goes by during the sowing window. In mid April they are sown at 95 kg/ha while in early May they are sown at 115 kg/ha.

Phosphorus

Over the years phosphorus rates have been reduced on pulse crops while the soil phosphorus levels have risen to at least 45 ppm (Colwell). MAP is applied with the seed at 8 kg P/ha. The Schirmers have never sown pulses without phosphorus and doubt they ever will.

Weed management

The Schirmers have found that one of the biggest drawbacks with growing pulses is their lack of competition. Unlike canola, pulses can not be used to compete with weeds. This, and the limited available herbicide options for broadleaf weeds, makes planning and paddock choice for pulses essential. The Schirmers plan which paddocks are going into a pulse crop two to three years ahead. Sticking with a consistent but flexible crop sequence is the key to success.

Fumitory (*Fumaria* sp.) is the one problem weed the Schirmers can not control in pulses so they avoid paddocks where it is likely to be a problem.

Harvesting

The Schirmers stress that pulses are best harvested as soon as they are ready. They will start at 15% moisture and happily store them in unsealed upright silos where they dry down to less than 12% prior to delivery. Pulses are too valuable to leave until they are bone dry. Faba bean harvest slots in nicely between canola and wheat. However to harvest lupins on time you have to pull out of



wheat which means they sometimes get left. They can be harvested after a rain event before you can get back into wheat.

The Schirmers would consider windrowing a tall crop of lupins to help manage harvest logistics.

Storage

The Schirmers admit it would probably be better to use a belt-elevator to move the grain but they use an auger with a worn flight as the next best option to minimise damage to the pulse seed. They store all pulses in unsealed upright silos and are gradually increasing their storage capacity. They are always looking at ways to improve on-farm grain storage.

Marketing

Over the many years growing pulses the Schirmers have developed good relationships with a number of grain buyers and end users who they sell to regularly. They have used a broker in the past when a marketing opportunity presented itself for faba beans. They see nothing wrong with going through a broker but it is sometimes hard with pulses as the brokers often do not have the contacts with pulse markets.

The price of lupins going into the stockfeed market generally increases throughout the year and in their experience there is a low risk of a price crash. They generally track with the soy meal market.

The Schirmers use regular contacts to source their own pricing information by phone.

Keys to success

The Schirmers believe one of the most important factors to success with pulses is to select the pulse best adapted to the soil type. For example, albus lupins are not suited to duplex soil types with a tendency to be waterlogged during winter, whereas faba beans are not suited to the light textured sandy red loam.

Another key consideration is the proximity to other crops (in time and space) including the residue of previous pulse crops of the same type. For example, keep each lupin crop as far away as possible from paddocks with lupin stubble still present. This basic principle is essential for minimising the risk of disease in all break crops.

Success with faba beans relies on regular and effective monitoring for disease, especially chocolate spot. The Schirmers advise not to book a holiday for September. You have to be in your crop checking it and then applying fungicide when required to prevent disease spread.

Anyone can grow a brown manure crop but a lot more attention to detail is required to successfully grow a pulse crop for grain.

Challenges

Timing of the autumn break can be problematic if it leads to a need to swap from an early sown species, such as lupins or faba beans, to a later sown crop, such as field peas. The logistics of having sufficient seed on hand for such a change create storage and cash flow issues.

Marketing can become an issue if a particular pulse crop becomes oversupplied. This happened with albus lupins in 2010, when the finite human consumption market was oversupplied due to high yields. If your financial position is solid, pulses can be carried forward without deterioration of quality in storage.

Pulse industry challenges

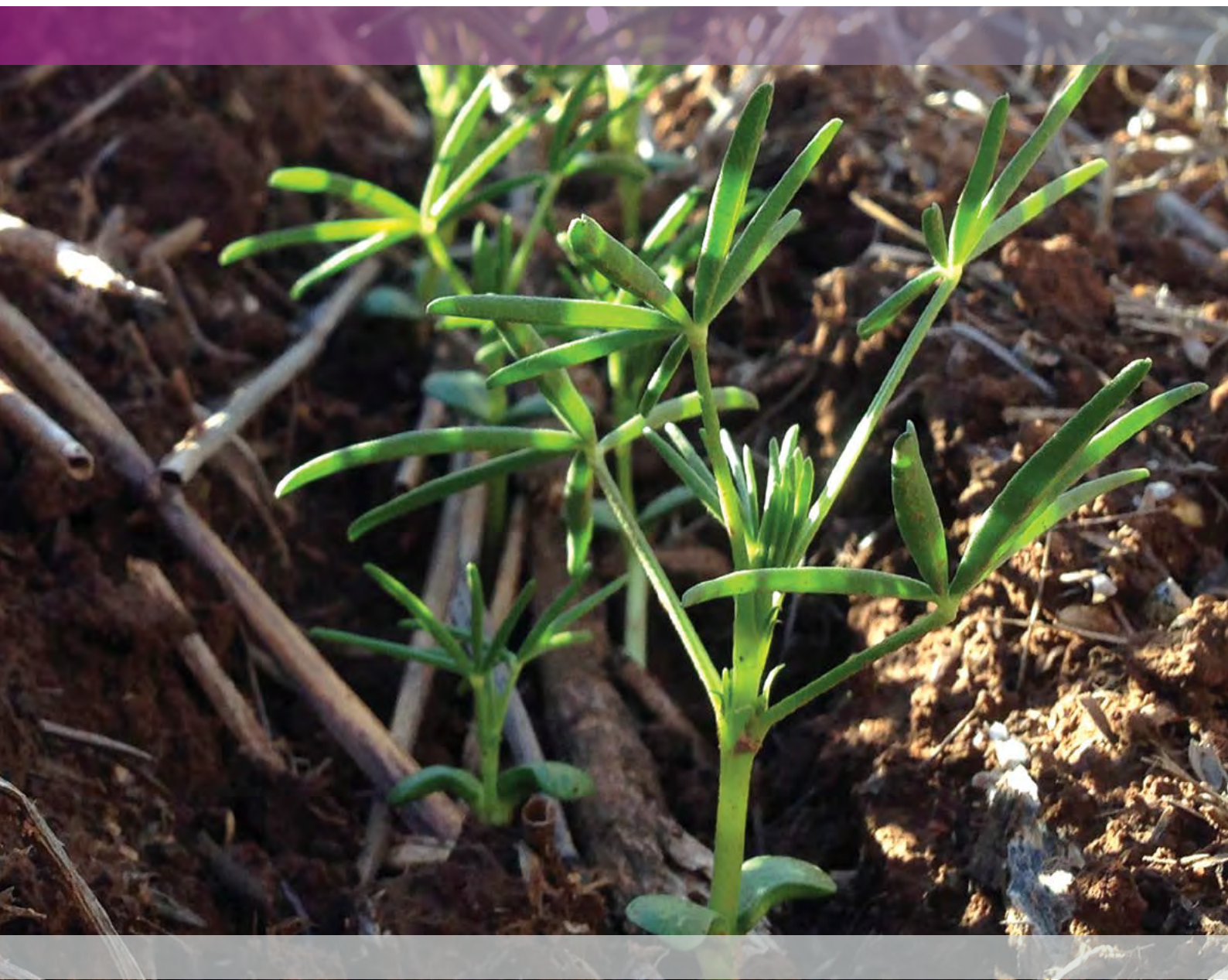
The Schirmers see one risk that could face the pulse industry in southern NSW is disease risk as the pulse crop area increases. This happened in the Victorian Wimmera with chickpeas in the late 1990s. Good management, sound crop sequencing and production using the most disease resistant varieties and best practice agronomic management will all help to minimise this risk.

The future

Continued improvement in varieties and management skills will gradually reduce the production risk of growing pulse crops. Over the past ten years improved albus lupin varieties have been released with superior yield and no bitterness problems. (Former varieties were contaminated with bitter lupins which contained high levels of alkaloids which make seed taste bitter, less palatable and the seed may be toxic to humans and livestock).

Faba bean varieties are continuously improving giving growers higher and more stable yield and increased disease resistance compared to varieties grown in the past.

The Schirmers have seen an improvement in the information available and knowledge among growers and advisers over time due to greater experience with the crops.



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