PROFITABLE AND SUSTAINABLE LUPIN PRODUCTION: A WA GROWER'S PERSPECTIVE

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ABSTRACT

- **Lupins are a valuable component of WA farming systems – they offer a sustainable and beneficial cropping rotation system for the longer term.**
- **Cropping techniques used on Geraldine farm are designed to produce the highest yield averages possible (> 2.0 t/ha).**
- **Lupins bolster wheat profit. Lupin profitability requires defining exactly where the gross margin profits come from. Are the profits generated in the wheat phase or lupin phase?**
- **There is a need for lupin varieties with resistance to broad spectrum herbicides such as glyphosate. Current lupin varieties have a small degree of tolerance to existing herbicides. With unpredictable growing season rainfall, the reliance on soil moisture active herbicides affects production potential.**
- **We need an environmentally friendly, simple, drought resistant legume that gives growers organic N benefits in our fragile farming system.**

KEYWORDS

lupin production, Mingenew, weed management, glyphosate-tolerant lupin

INTRODUCTION

'Geraldine Farm' is located in the Shire of Mingenew in the Mid West agricultural region of Western Australia. It is 100 km from Geraldton and 400 km north of Perth. It is a typical sand plain farm with a variety of soil types, ranging from good yellow sands to coarse grey non-wetting sands. Soils are naturally acidic (pH 4.8-5.8), have low fertility and are prone to nutrient leaching. The size of the farm is 4700 ha, which is within the average range for the region. Wheat and lupins are the main crops together with some barley, canola and a decreasing number of livestock.

Average annual rainfall is 425-450 mm; however since 2005 we have received only approximately half of this annual rainfall during the growing season. The drier seasons has seen a significant reduction in livestock carried in the region due to low economic returns and the need to maintain 'ground cover' on the paddocks. This is because of the increased grazing pressure on the paddocks and the lack of pasture growth due to insufficient rainfall.

Our farming enterprise is a family operated business with casual staff employed during the planting and harvesting period. All members of the family are engaged in the business. Physical and logistical operations are led by myself and my son Daniel, while accounting and office management are controlled by my wife Jan.

VALUE OF LUPINS IN WA FARMING SYSTEMS

Including lupins in a cropping rotation has major benefits for the long term sustainability of farming systems in Western Australia. The fragile nature of our soils and the inconsistent rainfall means producing sufficient ground cover for the summer months is essential. The vulnerability of our farmland to wind erosion has become even more apparent with the recent dry seasons making it difficult to establish enough ground cover. Fortunately a healthy and robust lupin plant can produce more biomass on the deep, sandy, acid soils of our farm than other legumes available in Western Australia. The residue remaining after harvest is able to withstand WA's harsh summer temperatures (35-45°C) and winds (20-50 km).

With its decreasing profitability, livestock is becoming more incompatible with a cropping system. The physical effects of grazing livestock on WA soils in the recent parched years have resulted in potential damaging soil erosion occurring. Farmers will continue to remove livestock from the system unless there are major improvements in livestock returns. The resultant consequence is a major long term change to the farming system which means lupins as a 'break' crop becomes more essential in a long term sustainable and environmentally responsible farming systems.

An observation of the benefits of lupins is the higher yields produced by the subsequent years' wheat crop. Wheat planted after lupins often yields up to 1 t/ha more than wheat planted after non-lupin crops (i.e. pasture, canola or wheat). Protein and quality specifications are usually improved in the following wheat crop resulting in higher grade returns for that wheat.

IN J.A. Palta and J.B. Berger (eds). 2008. 'Lupins for Health and Wealth' Proceedings of the 12th International Lupin Conference, 14-18 Sept. 2008, Fremantle, Western Australia. International Lupin Association, Canterbury, New Zealand. ISBN 0-86476-153-8.

Lupin cropping does not require any specialist planting or harvesting equipment, and can be planted using the same machinery and techniques as wheat. Planting crops at the optimal time is a major contributor to the success of a crop. Inconsistent rainfall events at the beginning of the season in WA mean that good seeding opportunities could only last four to five days. Timely planting is essential for good establishment into marginal soil moisture. This method of using large and multifunctional planting and harvesting equipment produces significant expenditure savings to our farming practices. Lupins provide that flexibility to a multi-cropping system.

The value of lupins in the international food chain must also be considered. Concentrated forms of protein will be needed to feed the world either directly as plant protein, or feed to animals and converted into animal protein. Lupins are an especially high-quality source of feed for livestock. The possibility of lupins being used directly in food and medical products such as lupin flour and dietary supplements has not been fully explored. The benefit of a legume producing protein in a cropping rotation cannot be underestimated in a world overusing its natural resources.

LUPIN FARMING ON 'GERALDINE FARM'

Wheat:lupin planting ratio on our farm has not changed fundamentally in recent years thus reflecting the importance of lupins in our farming system (Fig. 1). The Mid West region is recognised as a highly profitable farming region, which I deem is a consequence of farmers maintaining a consistent proportion of lupins within their system. In contrast, the total amount of lupins planted in Australia has decreased over the past 10 years, although this trend is likely to change as artificial N fertiliser becomes increasingly expensive (Fig. 2).

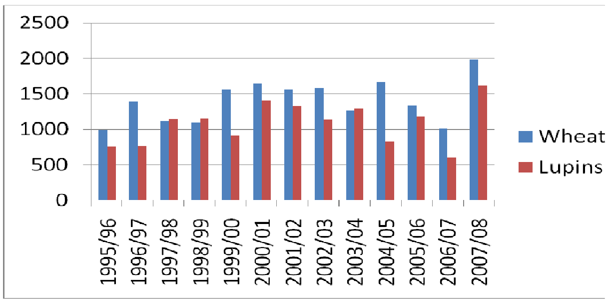

Fig. 1. Total hectares of wheat and lupins sown annually at 'Geraldine Farm'.

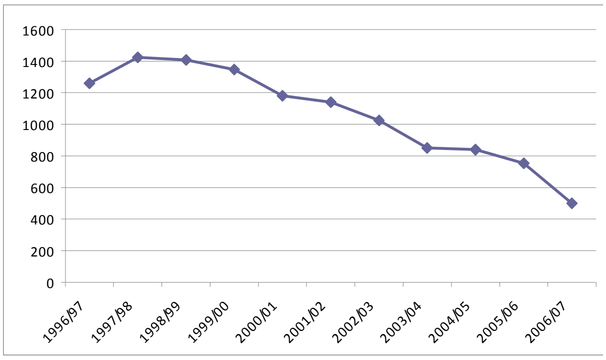

Fig. 2. Total hectares of lupins planted in Australia. (*Source: ABARE Australia*).

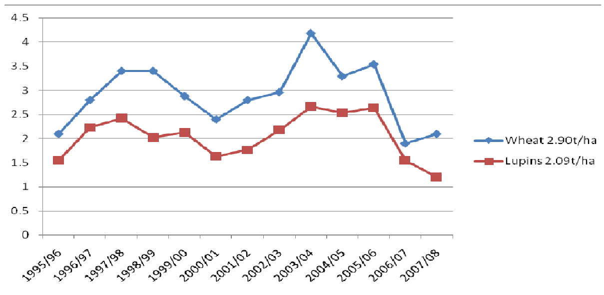

Fig. 3. Lupin/wheat yields on 'Geraldine Farm' from 1995-2007.

Long term lupin average yields of 2 t/ha is attainable in the sandy soils of the Mid West of WA. As shown in Figure 3 the trend for lupin yields on Geraldine farm was increasing except in 2006 and 2007 which only had 50% average rainfall. A fall in yields between 1998 and 2000 we believe could be partly explained by the cutting back of phosphorus fertiliser inputs and increased severity of the disease anthracnose. Since then, higher anthracnose disease tolerant lupin varieties have been developed and adopted successfully into our farming systems (e.g. Mandelup). High lupin yields requires adequate nutrient inputs especially phosphorus and to a lesser extent potassium.

It is important to manage lupins as a primary crop. Lupin farmers in the Mid West generally believe if adequate fertiliser is applied to a lupin crop it will reward you back with higher yields at harvest. Adequate nutrition has reduced the effect of early root and leaf diseases on the crop. We use 14-17 units of phosphorus based on the information developed over many years by industry and government research (Table 1).

Table 1. Rates of phosphorus required for a typical sandplain soil.

Yield (t/ha)	Soil test levels of P (ppm)		
1.0	21	6	0
2.0	28	14	1
3.0	32	17	5

Source: Luigi Moreschi, CSBP Regional Agronomist.

Furrow seeding techniques and seed placement in our non-wetting soils is critical for plant establishment under soil conditions that lack adequate moisture for germination of the larger seeded crops such as lupins. This procedure requires placing the seed directly behind the seeding boot, 10-20 mm under the soil and pressing the soil with a 100-150 mm rubber press wheel to leave a furrow in the sand. This means the rainfall will run off the peak of the furrow and into the valley and directly on top of the seed. Four millimetre of rain can be now concentrated in the furrow to be as effective as 8 to 12 mm. A lesser rainfall event which would not usually be enough to swell up and germinate the larger lupin seed could now germinate and emerge the seedling. Non-wetting soils create a significant challenge to the establishment of a lupin crop as we move away from dry seeding techniques of the past. Most lupins were seeded before the break of the season into completely dry soil and then selective herbicides used to extinguish weeds instead of waiting for initial weed germination and using a non-selective herbicide. As herbicide resistance continues to increase there is an increasing demand on seeding equipment modification and new technologies of weed control to be invented. The challenge for the future is to move away from our dependence on chemicals and more towards mechanical weed control.

The general planned inputs used and stages in the growing of a lupin crop on ‘Geraldine Farm’ in 2008 are shown below (Fig. 4). The direct input costs are approximately $163/ha. Added to this is operating costs of $96/ha, machinery depreciation of approximately $60/ha and assume interest cost for six months of approximately $14/ha. A major increase in these costs throughout 2008 is expected with fuel and fertiliser rising by an estimated $30/ha. This will increase the total operating costs to $363/ha.

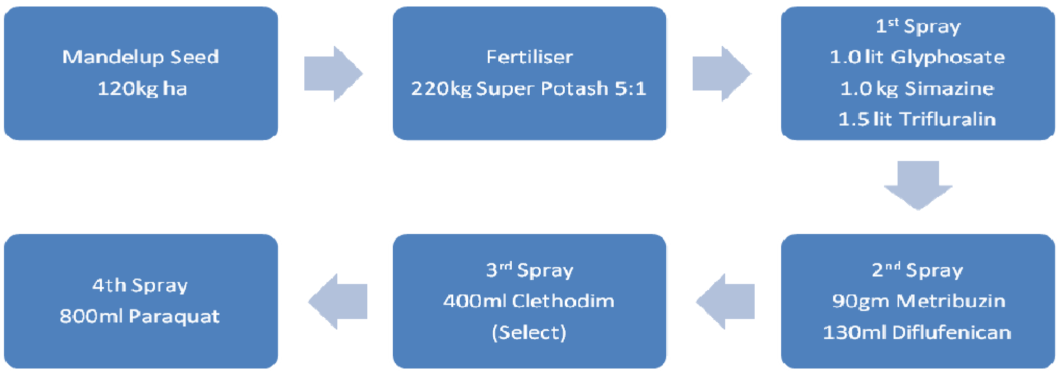

Fig. 4. Flowchart of lupins for a lupin crop on ‘Geraldine Farm’.

The gross margin for lupins on ‘Geraldine Farm’ in 2008 indicates a lupin breakeven yield of 1.21 t/ha at $330 tonne delivered port (Table 2).

Table 2. Lupin gross margins per ha planned for Geraldine Farm in 2008.

Port Price	t/ha										
	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8
$180	-242.33	-211.33	-180.33	-149.33	-118.33	-87.33	-56.33	-25.33	5.67	36.67	67.67
$210	-218.33	-181.33	-144.33	-107.33	-70.33	-33.33	3.67	40.67	77.67	114.67	151.67
$240	-194.33	-151.33	-108.33	-65.33	-22.33	20.67	63.67	106.67	149.67	192.67	235.67
$270	-170.33	-121.33	-72.33	-23.33	25.67	74.67	123.67	172.67	221.67	270.67	319.67
$300	-146.33	-91.33	-36.33	18.67	73.67	128.67	183.67	238.67	293.67	348.67	403.67
$330	-122.33	-61.33	-0.33	60.67	121.67	182.67	243.67	304.67	365.67	426.67	487.67
$360	-98.33	-31.33	35.67	102.67	169.67	236.67	303.67	370.67	437.67	504.67	571.67
$390	-74.33	-1.33	71.67	144.67	217.67	290.67	363.67	436.67	509.67	582.67	655.67
$420	-50.33	28.67	107.67	186.67	265.67	344.67	423.67	502.67	581.67	660.67	739.67

Source: David Bedbrook, Bedbrook Johnson and Williams, agricultural consultants.

LUPINS UNDERPIN WHEAT PROFITS

The lack of legumes in the current continuous cropping system is becoming increasingly unsustainable as the cost in nitrogen fertilisers increases. Wheat yields after lupins can produce yield increases of up to 1.0 t/ha as previously stated, though this is more an observation and is difficult to quantify. Organic nitrogen supplied by a previous lupin crop increases gross margins for wheat and goes somewhat towards replacing purchasing urea. This should be factored as a benefit of lupins and reflect in the planning of planting different crops.

Table 3. Nitrogen from a lupin crop on the following wheat crop expressed as a gross margin per ha.

Urea $/tonne	1.0 t/ha Lupin yield	2.0 t/ha Lupin yield	3.0 t/ha Lupin yield
$200	$8.60 h	$17.20	$25.80
$400	$17.40	$34.80	$52.20
$600	$26.00	$52.00	$78.00
$800	$34.80	$69.60	$104.40
$1000	$43.40	$86.80	$130.20
$1200	$52.50	$104.40	$156.60

(Assumes 1.0 t/ha lupin produces 20 kg/ha of 'N' in the following wheat crop.)

The highlighted gross margin amount of $86.80 should be partially offset against the input costs associated with the lupins. Current input costs for our lupin crop in 2008 are planned at $363/ha. With freight costs also included this means we have to achieve a yield of 1.21 t/ha given a port delivered price of $330 per tonne. The reduction of $86.80 reduces our break even yield to 0.96 t/ha. At the yield average of 2.09 t/ha our gross margin increases to $290 ha. This compares to $203 ha gross margin if N is not factored in. Accounting for the nitrogen benefit of lupins does not change the overall income received in the lupin: wheat rotation system but it helps show the benefits of the different components of the rotation and helps us maximise these benefits.

For example, in 2006 and 2007 wheat grown after a lupin crop received no top-up N except for the compound fertiliser (approx. 15 units of N) applied during the seeding operation. The wheat didn't need extra fertiliser N because the season remained dry and the N in the soil from the previous lupin crop was sufficient. Similarly at the beginning of 2008 no 'top up' N was planned on wheat grown on lupin stubbles because of another dry start. This flexibility represents significant seasonal 'risk savings' going into another uncertain year. Lupin stubbles give greater flexibility to manage seasonal variability. Because the N is also in an organic form in the soil it is less prone to leaching out of our sandy soils if we get heavy pre-growing season rainfall.

THE FUTURE NEED FOR MORE ROBUST HERBICIDE OPTIONS

As shown there are many factors involved in the decision making process for establishing a lupin crop. One of the biggest impediments for growing lupins is the lack of herbicide options that don't damage the crop. All lupin herbicides rely on specific ideal weather conditions to work effectively on weeds. This restriction severely restricts and in some cases eliminates any effective spraying opportunity. Lupins demonstrate a variable degree of tolerance to existing herbicides unlike TT canola or commonly used herbicides in cereal crops.

Most modes of actions of herbicides commonly used in lupins are very dependent upon moisture in the soil or favourable weather conditions to work effectively. It is a risk each time we spray a crop that adverse weather and soil conditions will see the lupins go backwards and the weeds continue to thrive and compete. The inadequate starts to the growing season due to inconsistent rainfall events has meant in-crop herbicide management decisions have been extremely difficult.

The lupin industry needs a lupin that is highly tolerant to a broad spectrum herbicide (e.g. a glyphosate-tolerant lupin). Unlike TT canola we have no alternative options. The changing climate means existing lupin production is becoming more difficult. Growers are opting to not crop paddocks and then apply glyphosate to remove weeds and conserve moisture. I believe a better alternative is planting a glyphosate tolerant lupin and spraying glyphosate over the crop. The cost of development of this technology for lupins would not be prohibitively expensive compared with the benefits it would bring. It could be the saviour of the lupin industry. The international prices received for protein has been declining in real terms for many years because Roundup-Ready soybean production costs are lower. Lupin growers need the same tools to compete internationally against soybean.

CONCLUSION

Lupin production has declined in recent years due to a number of reasons. The main problem has been its ability to return favourable gross margins when compared against other crops within the WA farming system. As herbicide resistant weeds become more common, lupins are being blamed for speeding up the process, rightfully or wrongly. As more weed species are becoming tolerant to our traditional wheat herbicides there is a growing recognition of the need to use alternate chemical groups. There is a compelling case for the development of a glyphosate tolerant lupin compared to developing similar technology in other crops such as canola and wheat.

The global demand for oil is seriously affecting agricultural production methods. The change in input costs, especially N, in the future, will see farmers re-evaluate lupins as a crop within their system. Lupins were originally introduced primarily for its nitrogen fixing capabilities and as summer grazing for stock. While the paddock grazing is disappearing, the protein demand of intensive livestock feeding systems will, in the future, ensure increasing demand for lupins as a feed source.

The value adding of lupins in human dietary supplements and using lupin flour to combat obesity issues needs to be robustly pursued. Lupins need promotion and commercialisation in a world where food will be limited in the future.

We need an environmentally friendly, carbon neutral, simple, drought resistant legume that gives growers organic N benefits in our fragile farming system.