

# Pulses in low rainfall rotations: Case study 2

## DYNAMIC CROP SEQUENCES

The Department of Agriculture and Food Western Australia (DAFWA) in partnership with farmers, grower groups and the GRDC has been very successful in developing the lupin, pulse, oilseed and oat industries. Through applied agronomy projects focused on each of these commodities, robust management packages have been developed and a rigorous understanding of the factors driving their adoption has been gained.

The principles providing the foundation for these management packages apply to farming systems throughout southern Australia. In conjunction with *Australian Grain*, DAFWA presents a series of farm case studies outlining the practical and profitable inclusion of break crops into various southern Australian farming systems.

*Dr Peter White, Project Manager, DAFWA*

### THE CASE STUDY FARM

#### FARMERS

Ron and Kerry Longbottom, Cape Lagoon Farms.

#### PROPERTY SIZE

Around 6000 hectares.

#### LOCATION

Grass Patch, 85 kms north of Esperance, WA.

#### ENTERPRISES

Grain (wheat, barley, field peas, opportunity canola).

#### AVERAGE RAINFALL

Annual: 350 mm. Growing season rainfall: 250 mm.

#### SOIL TYPE

Grey clay moving into gilgi soil types. Areas of duplex sand over clay.

#### SOIL pH

Typically 7–8, but small pockets of soil down to 4.5 in CaCl.

#### HISTORY

Cape Lagoon Farms is situated 85 km north of Esperance – the area is typically a reliable low rainfall environment. The soil types are quite variable across the farm but are mainly heavier soils with subsoil constraints which limits rotational options and crop types. The major constraint is boron toxicity which hinders rooting depth and has consequences for plant growth in dry years. There are small patches of non-wetting sands which cause a variable germination of both crops and weeds.

Ron and Kerry moved more into cropping following the decline of wool in the late eighties and began taking pasture out of the rotation. In 1992 field peas were introduced in an attempt to arrest root diseases in wheat. Initially pea yields were highly variable. After persevering with field peas they now average around 1.3–1.4 tonnes per hectare even in the less favourable seasons.

In 1994 the decision was made to get entirely out of sheep and shift into a continuous cropping program of which field peas regularly make up 30 per cent.

Ron and Kerry have always had a strong focus on soil health and fertility. They commenced no tillage farming practises in the eighties, reduced their use of sulfonylurea herbicides in the nineties and recently moved into tramline farming systems. Their aim has always been to minimise soil compaction, maximise infiltration and improve soil structure on their largely sodic soils. Trace elements have also been an influential factor in increasing yields, with annual use of zinc and manganese sulphate.

The current farming system on Cape Lagoon Farms has served it well for the past 10–15 years integrating a regular pulse phase in the rotation. This has led to a steady increase in wheat yields in a challenging low rainfall environment with difficult soils. Different pulse crops have been trialled over the years and now field peas are the mainstay of a sustainable system.

A regular pulse crop aims to address several long term issues on the farm:

- Cereal root disease;
- Nematodes; and,
- Resistant ryegrass.

Field peas are a non host plant which has dramatically reduced cereal root disease in Ron's program. The later time for field peas (Ron's target sowing date is May 25) and the ability to crop-top them, means resistance ryegrass can be effectively managed during this phase of the rotation.

Faba beans were tried for three years but were found unreliable compared to field peas. Vetch was also introduced and has been a successful green manure crop on the farm but mainly used to target areas of low fertility or high weed burden. Vetch is also used to keep the area of field peas to harvest down to a manageable level.

The nitrogen boost from either crop is equally important, especially in times of high nitrogen prices.

Canola has been trialled on and off for the past decade and Ron considers his farm is still a little too marginal for this

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Ron (on the right) inspects last year's crop of Kaspia field peas with his neighbour, Geoff Sanderson.

<v...CASE STUDY

oilseed. It is still treated as an opportunity crop when soil moisture is good at the start of the growing season.

Ron believes that canola will play a more significant role on the farm in the future especially with recent developments of shorter season varieties. Not only will canola raise the profitability, but it will also give the opportunity for two successive break crops to seriously reduce grass weeds and root diseases during the cereal phase of the system.

In 2007 the crop program consisted of basically a third each of wheat, barley and field peas and in 2008 barley was cut back and replaced with canola.

The wheat-barley-pea rotation is the one which has been followed in recent years and Ron believes that this rotation gives a good mix between profitability and sustainability.

In 2008, around 10 per cent of the farm was sown to canola largely at the expense of barley (Table 1).

**BREAK CROP CHOICE**

Field peas have been the break crop of choice on Cape Lagoon Farms due to their adaptability to the heavier soils. The inclusion of field peas from one year to the next is based on a set rotation: wheat-barley-field peas.

Field peas also have the advantage of a more flexible seeding window in a tough mallee environment where the break can be quite variable.

Control of weeds and crop diseases has been the main driver for tight rotations between pulse crops.

**TABLE 1: Crop mix on Cape Lagoon Farms as a percentage of total crop area**

	Wheat	Barley	Field peas	Canola
2007	33	33	33	0
2008	35	25	30	10

**TABLE 3: Summary of recent average yields, production costs and returns for Cape Lagoon Farms, Grass Patch**

	Wheat	Barley	Field peas	Canola
Cost of production (2007)/ha	\$221	\$202	\$212	\$203
Average yield t/ha	2.53	2.69	1.26	0.85
Gross income	\$1038	\$982	\$524	\$595
Average net return/ha	\$817	\$780	\$312	\$392
Average yields last 5 years t/ha	2.60	2.20	1.30	

Last year a small area of canola sneaked into the program as an opportunity to increase the frequency of broadleaf crops grown. Canola replaced some barley in the rotation and these paddocks are usually chosen due to higher grass populations, and to a lesser extent, disease.

Summer weeds can also have some influence on the break choice with field peas being easier to manage where weeds have got away over summer.

What amount of the whole system is sown to pulses is influenced by the proportion of the farm which can handle a lower but reliable profit margin. The carryover benefits of field peas are also taken into consideration when working out the profitability of each paddock in the system.

**ROTATION DRIVERS AND PROFITABILITY**

Over the past eight years Cape Lagoon Farms' wheat yields have improved from around 1.2 tonnes per hectare to over 2.3 tonnes at present. The focus has always been to increase yields – which is the main profit driver – in the most economic and sustainable way.

Ron attributes the yield increases to the effect field peas have on root diseases, soil fertility and nematode suppression. All things being equal, he estimates they add an extra 0.75 tonnes per hectare to wheat compared to wheat on wheat in their environment – a crop sequence he rarely does.

Field pea yields have remained around 1.2 tonnes per hectare since the early nineties with black spot being the biggest challenge.

Recent studies have shown that field peas rarely respond to phosphorus and as a result of this research, no fertiliser was applied to peas in 2008. This has dramatically increased profit margins for field peas but Ron does not think a production system of no fertiliser under field peas will be sustainable.

Wheat following field peas generates the best profit margin across the farm given the lower nitrogen requirement and disease break. A good season in 2007 – combined with strong commodities prices – saw wheat net over \$800 per hectare. Field peas averaged just over \$300 per hectare with yields of 1.26 tonnes per hectare (Table 3).



Field peas were originally introduced to the Cape Lagoon Farms' rotation to help arrest wheat diseases.

**TABLE 2: Key agronomic factors why each crop is in the rotation**

Wheat	Barley	Field peas	Vetch	Canola
Historically highest net return	Very well suited to low rainfall environment	Non host for many cereal diseases	Very good green manure crop	Profitable broad leaf which recently suits area
Varietal maturities that suit the area	Profitable rotational choice	Nitrogen acquisition, improve fertility	Prolific growth of vegetative matter	Soil fumigation dramatically reducing disease
Wheat reduces diseases that penalise barley	Rotates well with wheat reducing wheat disease	Best suited pulse crop known for the area	Produces as much or more N than field peas	Harvest comes in earlier than other crops
		Market availability		
		Option to either harvest or green manure		

# Hybrid lupin world first

Last year's production was down slightly with wheat yield averaging 2.30 tonnes per hectare and field peas down to 0.70 tonnes per hectare. Barley suffered wind and some hail damage in 2008 to average a disappointing 1.30 tonnes per hectare.

Two paddocks of Tanami canola averaged 0.85 tonnes per hectare in 2007 but with canola prices hovering around \$800 per tonne, their net return was approximately 25 per cent more than field peas.

In 2008 the profitability of canola and field pea crops was on a par as yields dropped to 0.90 and 0.70 tonnes per hectare respectively.

Though follow-on benefits have to be taken into consideration, a lot of thought goes into determining the most profitable pulse component into the rotation in any one year.

## FUTURE SYSTEMS

Ron and Kerry are happy with how far the farm has come over the past two decades and see that any changes in the near future will revolve around fine-tuning the present rotation. Canola will start to play a bigger role on the farm and provide extra management options.

Another legume similar in characteristics to faba beans would be ideal. A legume which performs as well as field peas and attracts higher commodity price, would give the business extra options and hopefully increase profits.

Variable Rate Technology (VRT) is likely to be another addition to the management options and applied to sowing, spreading, and spraying operations. VRT would potentially lower production inputs and increase productivity by placing inputs where they are most needed.

Genetically modified crops in the future may provide the opportunity to offset risk from environmental influences such as frost, drought, and salinity.

Ron is enthusiastic about GM use in herbicide resistant crops but warns that very careful management is needed. He believes managing weeds through the system is a more sustainable way to go.

Break crops on Ron and Kerry's farm are here to stay. An increase in the use of break crops as part of the farm's rotation is likely to occur in the near future. Ron constantly sees an increased grain production as a result of his pulse crops. Pulses have greatly increased the productivity and profitability of Cape Lagoon Farms.

**Acknowledgement to Tim Pohlner, Farm and General, Esperance for the original article. ■**

A dainty pink flower with a tinge of yellow is one characteristic of a hybrid plant representing a genetic pathway to transfer best plant characteristics between narrow-leafed and yellow lupins.

The hybrid, a world first, is the result of 1600 crosses made during 2008 by researchers based at the Centre for Legumes in Mediterranean Agriculture (CLIMA) at The University of Western Australia (UWA).

Dr Jon Clements, Project Leader for the Grains Research and Development Corporation (GRDC) supported project, said the aim was to transfer desirable characteristics from yellow lupin (*Lupinus luteus*) to narrow-leafed lupin (*Lupinus angustifolius*).

"Narrow-leafed lupin is the most important grain legume in WA due to its adaptation to infertile sandy soils, reasonable tolerance to pests and diseases and its use as a break crop," Jon said.

"Yellow lupin has superior seed quality to narrow-leafed lupin, but is susceptible to anthracnose and aphid damage.

"This breakthrough in producing flowering hybrid plants between these two species creates the opportunity to transfer traits from *L. luteus* to *L. angustifolius* and vice versa," he said.

Confirmation of the hybrids was made by visually intermediate plant characteristics and also through molecular marker analysis.

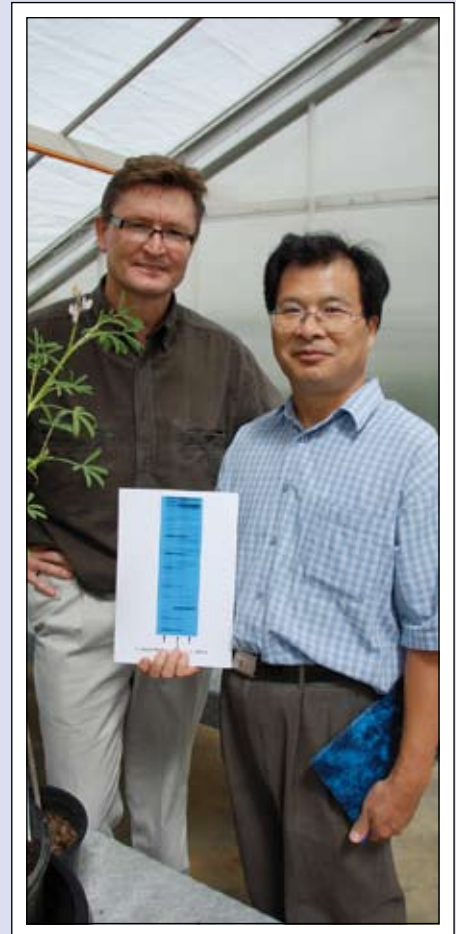
Jon emphasised that achieving the hybrid cross had been a team effort by John Quealy, Leah Chong, Dr Larissa Prilyuk, Dr Hua'an Yang and Gordon Francis – the group who crossed thousands of flowers and tissue-cultured hundreds of embryos to generate a few individuals.

He also acknowledged the valuable input from past team member Dr Julia Wilson and collaborators Dr Heather Clarke, Dr Bevan Buirchell, Professor Craig Atkins, Dr Mark Sweetingham and Professorial Fellow John Kuo.

"One challenge to be overcome is crossing lupin species with differing numbers of chromosomes," Jon said.

The next step will be backcrossing the hybrids to lupin cultivars and incorporating them into the breeding program managed by Bevan Buirchell, Senior Lupin Breeder at the Department of Agriculture and Food WA (DAFWA).

The introgressed genes would then be



**In UWA's glasshouse working on the GRDC supported hybrid lupin project are Project Leader Dr Jon Clements of UWA and Dr Hua'an Yang of DAFWA.**

tracked using molecular marker assisted breeding in molecular geneticist Dr Hua'an Yang's laboratory at DAFWA and further cytogenetic work would be done at UWA, depending on funding.

Brondwen MacLean, GRDC Manager for Pulse and Oilseeds, said growers were keen to see lupins become more valuable.

"While the breeding program is clearly focussed on increasing yield, yield potential must be considered in the context of cultivars requiring traits which ensure grower adoption and market acceptance.

"As lupins are price benchmarked against the dominant market positions of soybean meal and canola meal, increasing protein and sulphur amino acids in narrow-leafed lupin is important to increase the price paid," Brondwen said.

Jon will present on the new hybrid at the 14th Australian Plant Breeding Conference at Cairns in August. ■