Grain Legume and Oilseed Evaluation in Tasmania

Summary
This project has made considerable impact and progress on the trialling, development and recommendation of a suite of pulse and oilseed crops for Tasmania (TAS) with an emphasis on high value crops aimed at niche markets for human consumption. Where commercial production has been reached (lupini beans, marrowfat peas, tick beans, green lentils, borlotti beans, kabuli chickpeas, canola, linseed and borage), a number of agronomic trials have been undertaken to optimise yield and quality, in particular through irrigation, rhizobia and plant growth regulator research. Agronomic and variety information from trials has been compiled in grower guides.

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Conclusions
The production of niche market crops such as lupini and marrowfat peas has proven profitable options for TAS cropping rotations. Kabuli chickpeas, large green lentils, borage and borlotti beans also show potential and production has commenced.

TAS is free from some pests (anthracnose in lupins, ascochyta in chickpeas and pea weevil).

The other (more limited) option is to produce crops that are currently imported into the state. Avoiding shipping freight costs amounts to $40 per tonne extra return for local producers. Tick beans offer the greatest potential to replace stockfeed pulse imports with high yields and marketing advantages over faba beans. Canola remains the most important break crop for dryland cropping rotations and herbicide tolerant varieties are a particularly effective weed break.

Lupini, marrowfat peas, kabuli chickpeas, broad beans and green lentils have benefited from irrigation. Yields of broad beans, lupini, lentils and marrowfat peas increased in direct proportion to biomass i.e. a constant harvest index. The harvest index of chickpeas increased from 0.32 to 0.42 with irrigation. This suggests chickpeas have a higher minimum water threshold than the other spring sown crops, peas and lentils. The increased height observed in irrigated lentils ensures easier harvesting. Seed size in chickpeas, broad beans and lupini increased with irrigation.

Recommendations
A number of crops can be recommended for different regions of the state characterised by constraints or advantages.

1. Winter waterlogging (generally on duplex soils) can be overcome by improved drainage, in particular raised beds and by delaying sowing to spring. Canola, lupini and tick beans have shown the greatest potential on raised beds. Linseed, green lentils and field peas have yield well with spring sowing.

2. Late frosts (and generally lower rainfall). Faba, broad and tick beans with thick pod walls have shown the greatest adaptation in these areas. Field peas sown at the end of July and early August generally avoid frost damage at flowering and severe drought stress at the end of the season with yields as high as 4t/ha. Fodder peas cut for silage, as an alternative to grain production, also have potential. Canola with a prolonged flowering pattern can compensate from some frost damage but severe frosts will cause considerable damage.

3. Capacity to irrigate. The higher value crops where large seed size is generally important (lupini beans, marrowfat peas, kabuli chickpeas) have performed well under irrigation. Borlotti beans and borage have also shown potential. General recommendations on appropriate varieties and agronomy within each species can now be made.

It is recommended that further niche market crop germplasm evaluation is conducted. More agronomic work is required to maximise yield and grain quality for a number of pulse crops. With niche market crops in particular, it is important that the links between breeding and germplasm evaluation and marketing are close. Businesses involved with the marketing of these generally high value crops should be encouraged to provide financial input for the development of such crops.
High yielding broad beans continue to show potential in TAS but the market is dominated by South Australian (SA) production and unless there is positive market feedback little further work should be carried out. Similarly, variety evaluation in field peas, narrow leaf and albus lupins should be scaled back as there has been little increase in production of these pulses for stockfeed rations.

Some of the recommendations from agronomic work are:

Sowing rates: The optimum sowing rate in TAS for marrowfat peas is between 75 and 90 plants/m$^2$ and for broad beans, 15 plants/m$^2$.

Time of sowing: Sow chickpeas after the end of September to avoid the risk of cold damage. Yield does not appear to be decreased by later sowings but water use will be increased.

The optimum sowing time for broad beans is before the end of May with significant yield penalties from sowing later.

Sow lupini before the end of May as later sowings have a marked negative effect on seed size. Late sowings also require substantially more irrigation and will incur significant yield reductions if not fully watered.

Irrigation: Lupini, marrowfat peas, kabuli chickpeas, broad beans and green lentils have benefited significantly from irrigation. There was an additional benefit of increased seed size in lupini, broad beans and chickpeas.

Rhizobia: Yield responses to rhizobia were only found in faba beans that had experienced waterlogging. Since faba beans are autumn sown and generally grown on heavier soils, it is prudent to inoculate faba beans to reduce the impact of waterlogging should it occur. The decision on whether to inoculate lentils and peas should probably be based on soil nitrogen (N) levels.

Outcomes

The lupini industry provides an example of potential returns. From initial germplasm screening trials, lupini production has expanded to an industry worth over $1 million directly to producers as well as shipments to Portugal, Italy and USA. Last year saw a downturn in markets but with refinements in crop agronomy to produce a greater proportion of large seeds and the recent purchase of a colour sorter to remove seed with blemishes, it is anticipated that production will expand to $2 million.

Marrowfat peas also have the potential for high returns to growers. Freedom from pea weevil is a major advantage for TAS as well as lower rates of grain bleaching and the capacity to irrigate. A New Zealand (NZ) exporting company was encouraged to commence production in TAS and in 2005-06 one crop achieved the Japanese premium quality grade of $550/t. On the basis of this work, the NZ variety, Midichi, is being grown commercially with yields over 4t/ha in irrigated crops. Sown areas in 2006-07 have decreased due largely to lack of irrigation water but the industry is set to expand in 2007-08 with returns of over $2 million to growers.

Currently approx. 2,000 tonnes of large green lentils are imported into Australia from Canada. With the release of the TAS variety, Tiara, production in the high rainfall zone (HRZ) of south east (SE) Australia should be worth approx. $1 million by 2009.

Production of kabuli chickpeas (up to 1,000t), borlotti beans (up to 500t), linseed (up to 500t) and pulses for stockfeed (up to 5,000t) will also contribute significantly to grower income and the rural economy.

Canola production is set to expand from the current 2,500 tonnes per annum with a premium to be paid by a Japanese company for genetically modified (GM) free grain in addition to using a local crushing plant.

The main environmental benefit of this work is provision of break crops for the Central Midlands area. Low winter temperatures and late frosts in this region limit dryland cropping options. There has been a rapid increase in root and leaf disease and grass weeds without alternative crops to cereals. Break crops of canola, and to a limited degree field peas sown at the end of winter, have assisted in overcoming such problems. Field peas sown in autumn solely for silage production overcome the frost problems and also provide a double cropping option with irrigation or good late spring rains.

Introduction of pulses into the cropping system also has the potential to reduce fertiliser N inputs.

Achievements/Benefits

There is a critical need to develop sustainable cropping rotations in a range of environments within agricultural areas of TAS and similar cool temperate areas in other states. In the lower rainfall central region of the state, cold winters and late frosts have so far limited crop options. A pulse and/or oilseed crop will provide a valuable role as a break crop in cereal rotations for
disease and annual grass control. In higher rainfall areas, excess precipitation over winter combined with shallow duplex soils commonly leads to waterlogging damage. With the recent introduction of raised bed and controlled traffic farming techniques, waterlogging is greatly reduced and soil structure improved. This change in soil-plant environment has the potential to significantly improve pulse production and improve overall productivity.

Concurrent with these developments, expansion of the poppy industry has led to increased cropping in those areas of the state with the capacity to irrigate. Growers recognise the need for additional high value crops in their rotation.

Over the past three years, field trials have been conducted at approx. eight sites per year across the state from Cambridge in the south-east to Westbury in the north. The most suitable species and varieties within these environments have now been determined and are listed in the ‘Recommendations’ section of this report.

This project has made considerable impact and progress on the trialling and development of pulse and oilseed crops for TAS with an emphasis on high value crops aimed at niche markets for human consumption. Variety screening has been undertaken in 15 different crops. Where commercial production has been attained, a number of agronomic trials have been undertaken to optimise yield and quality, in particular through irrigation, rhizobia and plant growth regulator research. Agronomic and variety information from trials has been compiled in grower guidelines. The project has been responsible for assisting in the development of canola, lupini beans, marrowfat peas, kabuli chickpeas, green lentils, linseed, tick beans and borage. In the pipeline is future production of field peas for silage.

An example of progress is the success of the lupini industry. From initial germplasm trials, lupini production has expanded to an industry worth approx. $1 million annually directly to producers. The existing industry has arisen from successful initial trials, a Department of Primary Industries (DPI) TAS workshop on lupini production and a committed producer. Clean seed of large size is critical to obtaining high prices. This is being largely achieved through the mild finishing conditions, irrigation and freedom from anthracnose in TAS. With little difference in yield and seed size between three lines of lupini, this project has focused on agronomic options to ensure large seed size. A shorter stature lupini was found in trial plots and is currently being multiplied. There has also been progress in selecting for a large seeded sweet lupini.

Irrigation trials using drip tape showed significant yield responses, as well as an increase in seed size. Larger seeds are produced on the lower inflorescences and there was a significant increase in the number of seeds in the second order. Seed size was reduced in time of sowing treatments sown after the end of May.

Marrowfat peas also have the potential for high returns to growers. Freedom from pea weevil is a major advantage for TAS, as well as lower rates of grain bleaching and the capacity to irrigate. A NZ exporting company was encouraged to commence production in TAS and in 2005-06, one crop achieved the Japanese premium quality grade of $550/t. A range of germplasm from interstate (Victoria (VIC), SA) and overseas (NZ) has been screened for adaptation, yields and quality under TAS conditions. Given the potential returns from marrowfat peas, most trials have been conducted under irrigation. Yields of lines have been comparable but NZ material has shown far larger seed size and greater resistance to seed bleeding and powdery mildew. On the basis of this work, the NZ variety, Midichi, is being grown commercially and yields have been over 4t/ha in irrigated crops.

In agronomic work, there were significant yield increases with irrigation but the effect on seed size was variable. Optimum plant density was between 75-90 plants/m² with no effect on seed size. In the three trials conducted, there were no significant responses to seed treatment with rhizobia in paddocks selected for no previous history of pea production.

Small areas of blue and maple peas are also currently being grown at a premium to other field peas. Yields of NZ varieties of blue peas in particular have been impressive in trials and commercially (over 5t/ha). Maple peas are produced in TAS for the national pigeon feed market and have historically been a valuable niche market for TAS producers. The current variety, Whero, produces a large seed free of wrinkles, however it is generally low yielding compared with other field pea varieties. Of the maple pea lines evaluated, two NZ lines have consistently outyielded Whero (over 25% higher long term mean). However, in this quality conscious market, both lines consistently produce seed that is too small and wrinkled.

The TAS large seeded green lentil variety, Tiara, has performed well in spring sowings. It has excellent early vigour and tall growth habit. It matures too late for the main grain growing areas of Australia but is well adapted to spring sowing in TAS with yields of approx. 1.7t/ha. In most spring sown trials, this line has consistently outyielded Australian lentil varieties which are not adapted to later sowing. In field trials, Tiara has yielded on average 60% higher than Australian red lentil varieties with spring sowings but 10% lower when planted in autumn. AWB Seeds has secured the rights to this variety and it is anticipated...
that commercial production in higher rainfall areas will allow replacement of imports into Australia.

In agronomy trials, irrigation resulted in significant yield increases through a higher number of pods per plant but seed weight was reduced. There were no significant responses to application of rhizobia in three field trials.

Other niche lentil types such as French green, Spanish brown, black beluga and zero tannin have been evaluated and could also be produced in small quantities depending on markets. Red lentil yields have been reasonably good, but only in autumn plantings which carry a greater frost risk. Overall, it is unlikely that TAS growers can compete with the economies of scale offered in major red lentil growing areas of Australia.

With large seed size and associated premiums, the focus of chickpea work has been on kabuli types. The variety, Bumper, in particular has excellent seed size (20% of seeds greater than 10mm diameter) and under irrigation in trials has yielded over 3t/ha. As TAS is free of ascochyta at this stage it has a major production advantage. Clean seed of Bumper was grown under quarantine and multiplied for commercial production. Extensive grazing by deer has proven a problem but commercial production is expected to build up again in 2007 at selected sites.

In time of sowing trials, yields in autumn sown plots were reduced by low temperatures in early spring. Irrigation increased yield through a higher number of seeds per pod and increased seed size.

Broad beans for dry seed harvest have produced very good yields in trials. The variety Aquadulce has been tested extensively and has generally matched the yield of Fiesta faba beans, with a mean of over 5t/ha. Several very large seeded selections from the National Faba Bean Improvement Program have been evaluated and appear promising. However, while there are no competitive advantages over SA production, there is limited potential for production in TAS.

The optimum sowing rate was 15 plants/m² but higher sowing rates of 20 plants/m² were beneficial when plants were subject to severe waterlogging, as in 2005. Seed size was reduced by the lowest sowing rate, five plants/m², but unaffected at higher rates. Broad beans showed a consistent decrease in yield (50%) with later sowings but seed size tended to increase. Yields were significantly increased with irrigation largely due to an increase in the number of pods per plant.

Two trials have evaluated a range of navy bean varieties, in particular borlotti beans, for maturity and yield potential under local conditions. Commercial yields of 3t/ha are expected. Azuki beans have also been screened but require further work to define regions not prone to cold damage during flowering.

Currently approx. 9,000 tonnes of pulse stockfeed are imported into TAS. New faba bean, field pea, albus and narrow leaf lupin varieties are higher yielding than older varieties and have the potential to replace imports. Commercial adoption, however, has been disappointing, except for tick beans, small faba beans traditionally used in horse rations. Previous tick bean production has been intermittent and with poorer disease resistance, they have generally not yielded as well as newer faba bean releases in trials. However, with a good fungicide program and high spring rainfall in 2005-06, commercial tick beans achieved yields as high as 6.5t/ha. Tick beans have greater potential than faba beans in stockfeed markets due to easier processing (smaller grain) and higher protein content (29%). Markets as a fishmeal replacement are currently being investigated. Approx. 300ha are being grown in 2006-07.

Faba beans proved responsive to rhizobia but only when plants experienced waterlogging. Nodulation responses were present whether or not waterlogging occurred.

Finding pulse genotypes suitable for production in the central Midlands area of TAS has proven difficult. Cold winters result in slow early growth with poor competition against weeds. Characteristic severe late frosts damage developing reproductive organs in most pulses. Rainfall is relatively low and unreliable over spring and summer, therefore spring sowings are not an option without irrigation. One idea investigated in the previous project was to avoid frost sensitive stages through production of fodder crops. In field trials, vegetative growth of field peas was outstanding with a mean dry matter production of over 9t/ha. However, for the first commercial crops, an unusually wet spring in 2001 resulted in serious problems in drying and interest in this option dwindled. In 2005, trialling recommenced with cutting for silage rather than attempting to dry as hay. In 2006, field peas are also being trialled in mixtures with triticale. This system is also a good option for removing weeds prior to seed set and for double cropping under irrigation.

Herbicide resistant canola has proven to be a valuable component of dryland cropping rotations in TAS. The variety, ATR Grace, was the predominant variety grown until its demise due to CM contamination. Variety trials conducted as part of this
project were able to provide growers with information on the yield potential of two likely alternative varieties, ATR Summit and Bravo TT.

The GM-free status in TAS has also recently provided a competitive edge with a Japanese company currently in the process of signing ongoing contracts with growers for GM-free canola.

In the past two years, a further two agricultural companies have issued contracts to grow linseed for human consumption and bird seed markets. A new CSIRO linseed line has yielded 92% of canola yields and with autumn sowing, yields higher than older standards.

With the current GM-free status, a Japanese company is also keen to source condiment mustard. Yields of two yellow (Brassica juncea) mustard lines were equivalent to spring sown canola and 5-10% lower than autumn sown canola. White mustard (Sinapis alba) lines showed little variation in yield with sowing time and were significantly lower yielding than autumn sown canola. In agronomy trials, a delay in sowing from the end of April to mid July resulted in yield decreases in canola, yellow mustard and white mustard of 43%, 22% and 10%, respectively.

Of the specialty oilseeds, borage shows the greatest potential and several paddocks were sown in 2005-06 (70ha).

The main outcomes of this project are recommendations on a suite of pulse and oilseed species and varieties for different environments and a range of markets. Agronomic and management information on those crops now being grown commercially has been compiled in grower guidelines. Information has been released through field days and crop option seminars and various articles and reports in Southern Farming Systems -Trial Results Booklets, TAS Country newspaper, Australian Farm Journal, GRDC Research Update and Ground Cover.

Results from this project will provide significant benefits for cropping rotations and grower profitability. Although trialling and production have targeted TAS, some results will be applicable to other higher rainfall cool climate areas of Australia including south west (SW) VIC, SE of SA, the New South Wales (NSW) Tablelands and those areas with the option of irrigation.

Other research

Results emanating from this project suggest further research and development in a number of areas:

Further germplasm evaluation of the niche market crops, lupini beans, marrowfat and blue peas, green lentils, kabuli chickpeas and summer pulses should be conducted. Specifically:

Lupini beans - continue selection for large seed size, multiply a shorter stature lupini bean isolated in 2005 and possibly develop large seeded sweet albus lupins for Asian markets.

Summer pulses - further investigate the potential of borlotti and azuki beans. The greatest limitation is number of heat units and consequently faster maturing germplasm is being selected. Canola can be included as a niche market crop if GM freedom can be satisfied. Continue evaluation of interstate germplasm with the emphasis on herbicide tolerant material. Grazing canola also has potential and winter germplasm can be trialled with early sowing under irrigation. The emerging canola quality mustards require evaluation, particularly in the lower rainfall districts of TAS.

Depending on markets, further develop tick beans for fishmeal and fodder peas for silage production. In particular, three pea lines with high dry matter production have been identified.

There may be opportunities to develop additional crops, provided there is industry support, therefore it is necessary to maintain a watching brief on these crops.

The lack of tolerance of pulses to many environmental stresses is a major limitation to yield and a source of frustration to growers. In the cool climate, high rainfall zone, two of the major environmental limitations are waterlogging and acid soils. Further work should screen pulse germplasm for tolerance to waterlogging and acid soils. Protocols for both have been recently developed by the Tasmanian Institute of Agricultural Research (TIAR), Launceston with screening of Chinese barley germplasm.

Further agronomic work is required to ensure high yields and good grain quality. It is important that in addition to high yield, maximum seed quality is produced. Research should include:

- Determine best irrigation practice in regard to crop yield and quality, in particular optimum timing and frequency/quantity. Irrigation tailored towards producing large grain size will be particularly beneficial in lupini beans, kabuli chickpeas and
marrowfat peas.
- Determine appropriate rhizobia strains to use for faba and tick beans, marrowfat peas and lentils.
- Determine suitable post-emergent herbicides to apply in lentils, broad, faba and tick beans.
- Reduce excess vegetative growth, which often results in crop lodging and harvesting difficulties, particularly in lupini beans, faba and tick beans, and canola.