Peas for a more reliable protein supply to the Pork industry in the north

1B-104

Report prepared for the

Co-operative Research Centre for an Internationally Competitive Pork Industry

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November 2009

Established and supported under the Australian Government's Cooperative

Executive Summary

The aim of this project was to produce and develop field pea germplasm for use as a stable and reliable source of protein for the pork industry in northern NSW and southern Queensland.

Locally produced sources of plant derived protein suitable for inclusion in pig rations in the north have been limited and erratic. Field pea has long been recognised internationally as a desirable protein source for inclusion in pig rations. However, field pea was not a crop normally grown in the region and available varieties from southern Australia were phenologically unadapted, low yielding and susceptible to the major disease risks in the region. This meant that field pea was not a viable economic option for graingrowers in the region.

The project was commenced in 2006 utilizing the existing expertise and some germplasm from the University of Sydney field pea program, with additional germplasm being identified and developed during the life of the project. The project consisted of components which targeted breeding, germplasm evaluation, grain quality evaluation, extension services and marketing. A management team comprising representatives from the Pork CRC, researchers and supporting organisations was established to oversee the progress and implementation of the project.

As with any field based research program continuity of and reliability of data and germplasm is seasonally dependant. Due to prolonged adverse seasonal conditions during the project some changes were made in methodology (eg. site location for experiments) in an attempt to ensure minimal data loss and to maximise germplasm progression. However, the major challenge which has confronted this project has not been the plant breeding and research but the extension and market components. Pork producers in the north and their nutrition consultants know the value of peas as an alternative protein source for their pig diets, but are constrained by the limited supply. Until new varieties that have been proven to be superior in yield and/or quality are commercially available, grain growers are unlikely to be convinced to grow new crops and varieties. The efforts in the subsequent projects will be designed to implement these new varieties of field peas into farming systems in the north so that they can be grown economically and sufficient supplies are available at a reasonable price to the pork industry in these northern regions.

The key outputs of this project have included:

- the first commercial production of the new variety “Maki” in 2009
- the development of high yielding, stable, disease resistant, adapted germplasm focussed on meeting the requirements of pork producers.
- a limited crossing program that has produced F2’s targeting earliness and disease resistance.
- phenology and agronomic experiments that have enabled the development of extension packages,
- screening of advanced germplasm for Trypsin Inhibitor Activity (TIA) that has identified low TIA lines
- communication of the results and achievements of the project to graingrowers (some of whom are pork producers). This communication of the progress of the project has occurred through advisor and grower updates, field days and crop inspections, articles in rural and popular press, radio and television.

This project has identified and developed a germplasm pool which will form the basis for the development of new lines in subsequent projects (both ongoing and new) that can be grown in commercial quantities in northern Australia to satisfy the requirements of Pork CRC and the pork producers.

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1. Introduction

Background and Rationale for conducting the research

The overall aim of this project was to develop field pea as a viable option for the pork industry in northern NSW and southern Queensland. This was to be achieved through:

a) Field experimentation

- Evaluation of a range of field pea germplasm to develop adapted high yielding and disease resistant varieties for the pork industry in the region.
- Agronomic evaluation of identified adapted germplasm, resulting in the development of recommendation packages for growers throughout the region.

b) Breeding

- The establishment of a limited crossing program targeted at incorporating specific requirements of the pork industry into existing adapted varieties.

c) Grain quality evaluation

- Through feeding experiments to ensure pea quality meets the needs of the pork industry

d) Extension services

- The establishment of clearly identifiable paths to provide ongoing extension information to both pig producers and graingrowers.

e) Marketing

- The development of viable trading relationships between pig producers and graingrowers in northern NSW and southern Qld.

f) Project management

- The establishment of a Project Management Group consisting of representatives from all parts of this project.

The GRDC funded a field pea evaluation program at PBI Narrabri (PBIN) from 1997 to 2001. The aim of this project was to identify the major constraints to production and develop field pea cultivars suitable for commercial production in northern NSW and southern QLD.

Germplasm was sourced from all Australian pea breeding programs and the NZ Crop & Food program. The NZ germplasm proved to be the best adapted material. The majority of the testing and selection was conducted at USPBI Narrabri, with some limited regional evaluation of advanced lines at sites from southern QLD through to the central west of NSW.

The new variety "Yarrum" was commercially grown in 2005 for the first time. It was considered that the primary role for field pea produced in the northern region would be for stock feed rations.

Pulse (chickpea, faba bean and field pea) production in the northern region has been erratic due to variable seasonal conditions, diseases and agronomic production problems. A summary of recorded pulse production in Silo groups in NE & NW New South Wales (NSW DPI "NSW Grains Reports") appears in **Table 1**. The production of chickpeas has increased dramatically in the last three years because of the extraordinary prices of chickpeas for export and human consumption. Until 2005, the production of field pea in the north was further exacerbated by poorly adapted varieties. The release of Yarrum in 2005 and Maki in 2009 will provide stable high yielding cultivars which will form the basis for a successful field pea industry in the north.

Table 1 Pulse production in Northern NSW between 1993 to 2008 (tonnes produced Silo Group North)

Year	Chickpea	Faba bean	Field pea
1993	34,609	18,308	4,180
1994	8,420	5,330	200
1995	39,600	14,665	1,780
1996	51,930	21,525	2,010
1997	43,080	23,655	2,580
1998	41,560	3,965	2,310
1999	70,520	15,480	3,408
2000	62,620	29,350	2,100
2001	155,024	39,490	2,585
2002	33,705	1,394	472
2003	64,665	8,036	3,574
2004	88,930	76,563	4,585
2005	83,940	44,670	11,855
2006	194,156	50,702	3,020
2007	217,100	7,701	2,125
2008	312,445	42,062	7,074
Average	**93,894**	**25,181**	**3,366**

However, for field pea to be competitive, it must deliver an economic return to grain growers equivalent to, or higher than, the existing northern pulses. As the price per tonne paid to growers for field pea is usually lower (in some years significantly lower) than chickpea and approximately equivalent to faba bean (**Table 2**) then the comparative yields for field pea must be higher, for peas to be economically attractive to the grain grower.

Table 2. Grower selling prices for pulses delivered to Narrabri ($ per tonne)

Year	Chickpea	Faba bean	Field pea
2007	540	340	375
2008	670	615	590
2009	465	315	415

The major thrust of this project was to breed and identify germplasm suitable for production in the northern region. This germplasm would have a high and stable yield, be phenologically adapted to the range of environments in the region, be resistant or tolerant to the major disease risks which limit yield (and quality) potential and be of acceptable grain quality to pork producers.

Varieties developed based on this methodology and subject to these outcomes will permit grain growers to consider field pea as a viable alternative pulse species, particularly as the price of the alternative pulses have decreased just recently.

2. Methodology

The methods adopted for the implementation of this project were:

a) Field experimentation

- Yield and disease evaluation of existing varieties and advanced germplasm throughout those parts of the region which were within approximately 300km of major pork producing centres. These experiments sought to identify germplasm suitable for viable field pea production. These experiments were replicated (3x) randomized complete block (RCBD) designs consisting of advanced germplasm and selected check varieties.
- Phenology experiments using a number of planting times were used to identify adapted germplasm for the range of agro-climatic zones within the region. These experiments were replicated (3x) RCBD designs consisting of advanced germplasm and selected check varieties.
- Agronomic experiments initially targeting plant population (density) and row space using the best five yielding lines plus check varieties. Experimental design was a replicated (3x) split plot.
- Disease evaluation experiments concentrated on diseases already identified as potentially important in the region. All germplasm was selected for powdery mildew resistance. Emphasis was also placed on germplasm which exhibited resistance or tolerance to viral diseases. This testing was conducted in conjunction with the NSWDPI virus screening program conducted at Tamworth.

Data obtained from these experiments will be used to develop variety management packages (VMP) for field pea relevant to pork producers in the region.

Experimental sites were selected based on the following criteria:

- Sites to be representative of all cropping areas of the region outlined (climate, environment, soils
- Sites to be relevant to the pork industry in the region
- Sites to be serviceable from PBI Narrabri
- Where possible, to be co-located with NSW/Qld DPI experimental or demonstration plots

Original sites selected are outlined in the table below:

Site number	Site	Latitude	Longitude	Elevation (m)	Average Rainfall (mm)	Road distance & direction from Narrabri (km)	
1	Pittsworth Qld	S27.61895	E151.87179	608	699	401	NE
2	“Lundarva” Qld	S28.06461	E150.14872	260	556	287	N
3	Weemelah NSW	S29.07924	E149.02577	160	507	204	NW
4	North Star NSW	S29.94496	E150.42807	244	582	191	NE
5	PBI Narrabri NSW	S30.27041	E149.80408	237	620	0	

b) Breeding

A limited breeding program was established at PBIN to incorporate agronomic, disease resistance and/or grain quality characters identified as desirable and not currently present in existing germplasm.

c) Grain quality evaluation

Initially grain quality evaluation focused on screening existing and new germplasm for the major potential anti-nutritional factor in peas, Trypsin Inhibitor Activity (TIA). It was originally thought that the most advanced germplasm would also be screened for its feeding quality (acceptability and pig performance) using replicated weaner feeding experiments. However, budget constraints and seed quantities required precluded these experiments.

Germplasm was also to be screened for grain protein however, the cost of this testing and the lack of an appropriate NIR calibration meant that this was not possible.

d) Extension services

Extension activities relevant to this project were initially to be developed by Pulse Australia's Northern Program Manager, John Slatter, and were to include:

- The promotion of field pea in the north at annual grower and advisor updates with particular emphasis on the emerging requirements of the pork industry for a reliable supply source
- Organisation and conduct of field days at target experimental sites and grower crops
- In conjunction with researchers, collation of experimental data and its inclusion into promotional information to be made available to grain growers and pork producers
- The development and publication of case studies of leading grain growers experiences in all aspects of field pea production in the north
- The development of Variety Management Packages (VMP) which target specific field pea varieties and their interaction with all areas in the region

The untimely death of John Slatter meant that a number of these activities were not completed during the period of this project. The delay in his replacement also has slowed the progress of both components d & e. However these components are now an integral part of the new and continuing Pork CRC projects

e) Marketing

Establishment of trading relationships between grain growers and pork producers was to be promoted and facilitated by Pulse Australia.

f) Project Management Group

The Project management group was established in late 2006 and first met in 2007. This group consisted of representatives from University of Sydney, QDPI&F, NSWDPI, Pulse Australia, CMH group and was chaired by the Program Leader. The group has acted as a formal monitoring and reporting structure for the project and has met at least once each year.

3. Outcomes

Summary

- Release of the new field pea variety "Maki" by AGT Seeds for commercial production in 2009. Approximately 150 tonnes of the 800 tonnes available were planted from northern NSW to SA
- Identification of a number of high yielding adapted lines for potential future releases. Three lines, PRL95, PRL131 and PRL417 are currently undergoing pre-release seed production. It is expected that based on all data available at the end of 2009 one of

these lines will be released in 2010 and made available for commercial production in 2011

- Agronomic data used to develop optimal row space and plant densities. Data obtained over several years at a number of sites suggests that the optimal row space for planting is 33cm and that plant density should be at least 60 live plants per m^2
- Confirmation of optimal planting times for the current germplasm pool & collection of initial data for development of a phenology model. Current data for the existing germplasm pool suggests that the optimal planting window is from mid May to mid June. However, it is expected that further development of the phenology model will enable planting dates for the range of environments in the region to be more accurately predicted
- Development of F2's produced from crosses made at PBIN targeting earliness
- Establishment of testing procedure for Trypsin Inhibitor Activity (TIA) and 2 site, 2 season screening of advanced germplasm
- Development and dissemination of extension packages

Detailed research results (reported as per methodology section)

a) Field experimentation was conducted across a range of sites in the region in all years of the project. Planting for the 2009 season was completed by early July which will enable a seamless accumulation of data for projects 1A-105 & 1A0108. Yield performance for advanced S4 experiment germplasm evaluated in each of the years 2006, 2007 and 2008 at all sites appears in **Appendix 1.**

Some reorganization of sites was necessary during the course of the project. This was due to poor seasonal conditions, changes in grower co-operators, staff changes in collaborative organisations and an expansion of the regional trialling network with the start up of project 1A-105. The name, number of sites and experiment type are outlined in **Table 3** with the locations of sites for 2009 listed on the map in **Appendix 2**. Note that the number of sites has increased in 2008 and beyond from the original five planned for this project

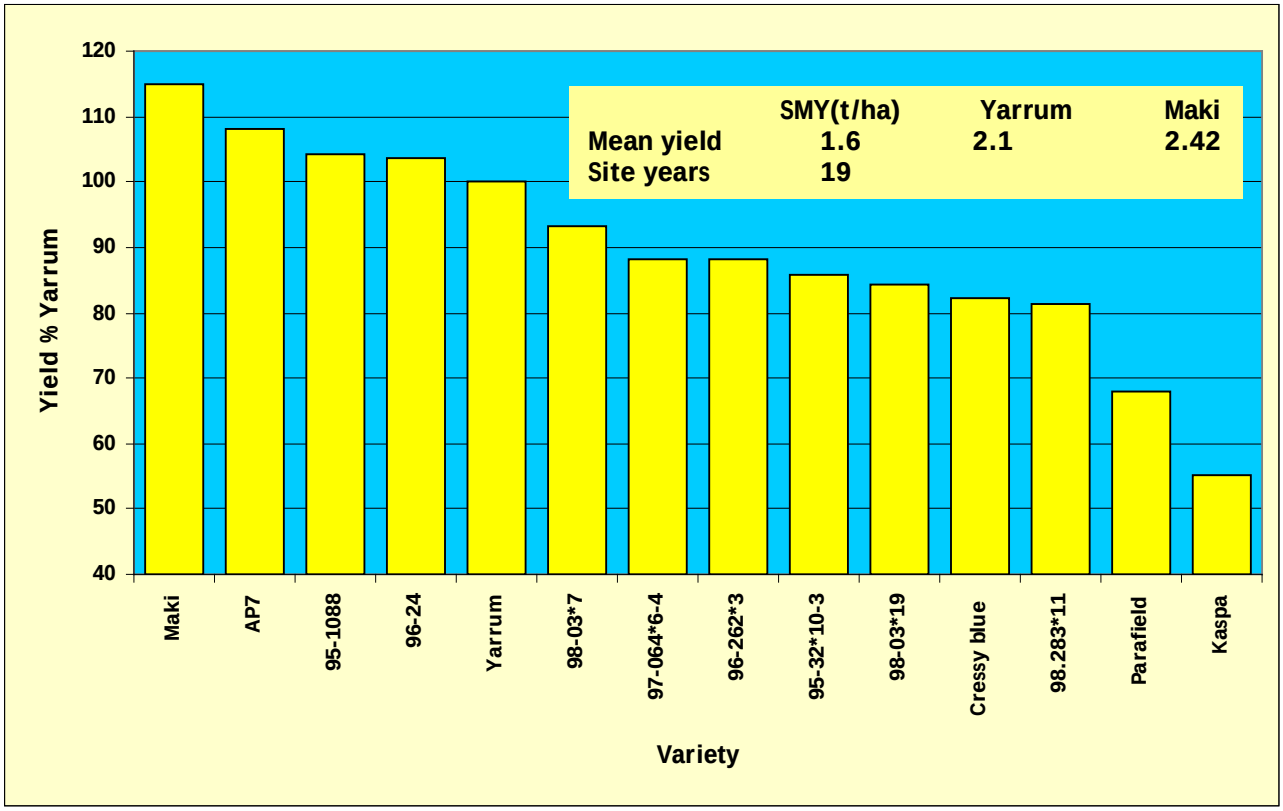
Table 3. Experimental Sites Project 1A-1040506

Site name	2006	2007	2008	2009
PBI Narrabri #1	A, C	A, B, C	A, B, C	A, C
PBI Narrabri #2	A, C	A, B, C	A, B, C	A, C
Weemelah	A	A		
North Star	A	A	A	
Lundavra (Qld#1)		A	A	A
Clifton (Qld#2)				A
Mungindi			A	A
Tamworth			A	
Spring Ridge			A	A
Ulamambri			A, B	A

A –Replicated yield evaluation experiments, B – Agronomy experiments, C – Phenology experiments

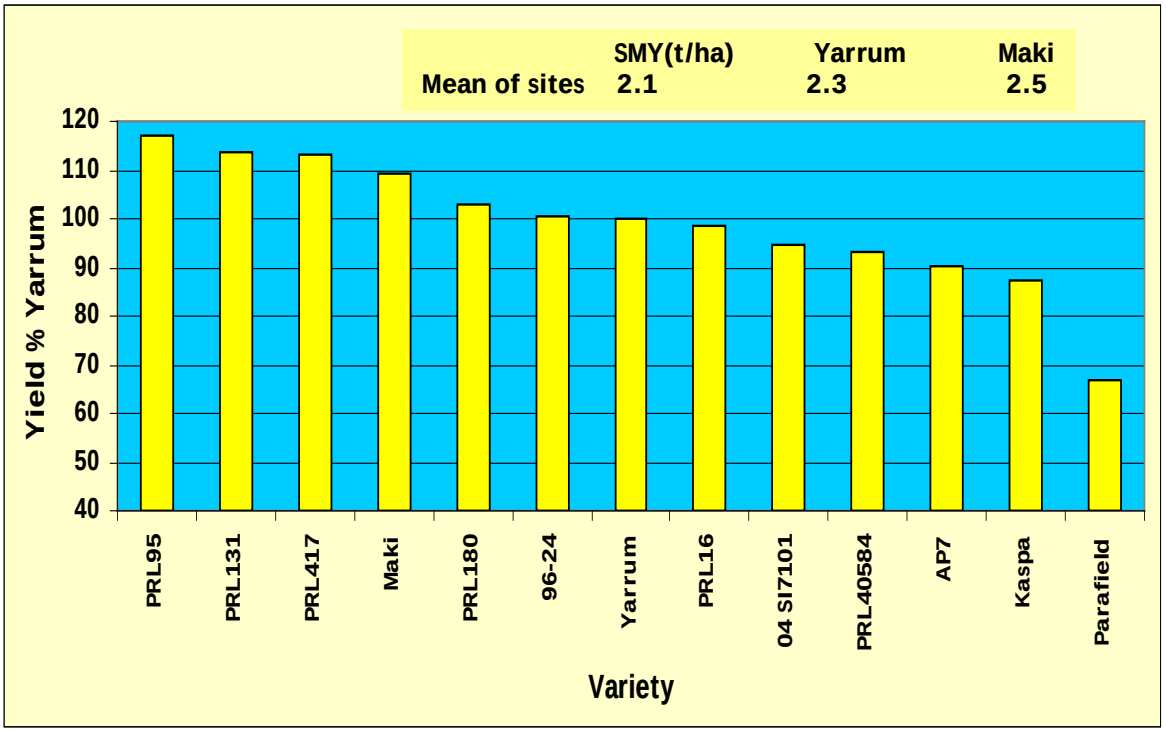
i) **Replicated yield and disease evaluation experiments** were conducted during each year of this project. During the 3 year period from 2006 to 2008 approximately 1000 lines were evaluated. Germplasm was initially tested at PBI Narrabri with the best performing lines promoted into in S4 regional evaluation experiments. Based on performance compared with standard cultivars, lines which performed poorly or displayed erratic performance across sites and/or years were rejected, with newly selected lines replacing them. This resulted in the release of the variety "Maki" for commercial production in 2009. The yield of Maki was consistently 10-15% higher than the benchmark Yarrum at PBI Narrabri and across all sites over the three years 2006-2008. A summary of the best performing lines (& standard cultivars) for all three years across all sites is outlined in **Figure 1**.

Figure 1: Mean yield as % Yarrum (all sites) S4 - 2006 to 2008



In addition to the release of Maki a number of promising lines have been identified at PBI Narrabri as potential releases in subsequent years. Three of these lines (PRL95, PRL131 and PRL147) are undergoing extensive evaluation and preliminary seed production in 2009 (**Figure 2**).

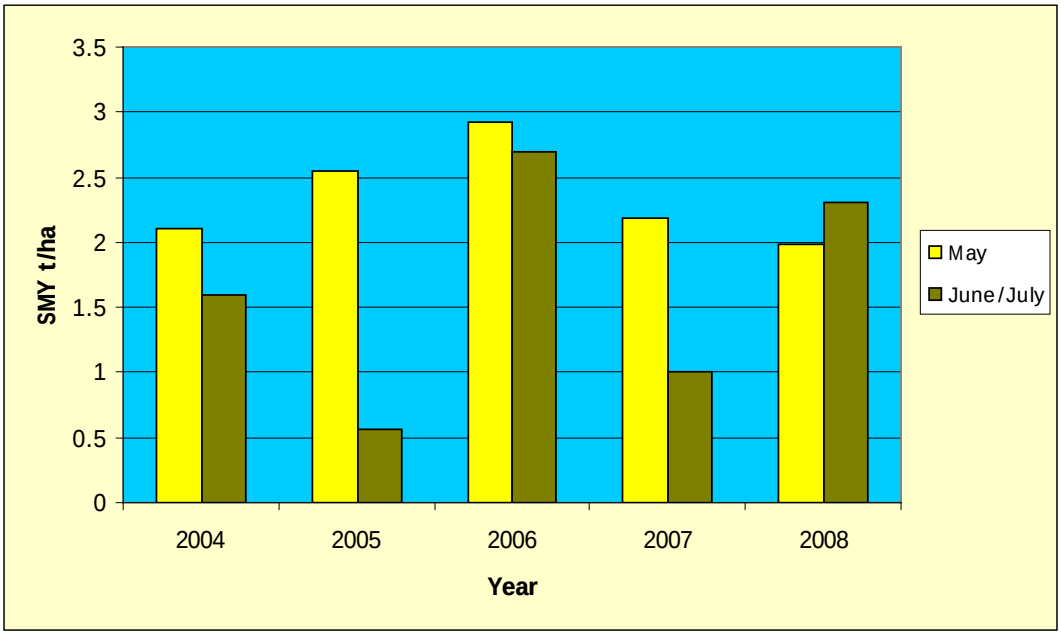
Figure 2: Mean yield for selected lines as % Yarrum 2005-2008 PBI Narrabri



Disease scoring of all germplasm was conducted at PBIN and at off station sites on an opportunity basis. Selection for resistance or tolerance to powdery mildew and leuteoviruses (the two major disease threats to field pea in the region) was successfully conducted at PBIN in each year of the project. Selection for Aschochyta blight and Bacterial blight was possible at PBIN and the southern sites in the region during the 2008 season. While these diseases are not considered endemic to the region the ability to screen for these diseases on an opportunity basis may assist project 1A-108 with selection of germplasm for other regions of Australia.

ii) Phenology experiments – Time of planting experiments have been conducted at PBIN each year since 2004 (and at off station sites opportunistically) to determine optimum phenology for the germplasm under evaluation. Yield performance of all time of planting experiments for all sites & years appear in **Appendix 3**. Experimental mean yield of these experiments highlights the necessity for appropriate planting time (**Figure 3**).

Figure 3: Mean Yield (t/ha) Time of Planting Experiments PBI Narrabri



Successful flowering and pod survival and development in the northern region is largely dependant on timing flowering to occur between the end of the high frost risk period during late winter and before the rapid onset of high temperatures in early spring. Sub zero temperatures will abort flowering nodes and floral and pod abortion will occur once maximum temperatures are consistently 30^0C and above. The optimal flowering window is therefore limited at either end by these events which can vary from season to season and according to location as indicated in **Appendix 4.** The literature suggests that the initiation of flowering in field pea is controlled by a combination of heat sums and accumulated solar radiation. The manipulation of time to first flower by altering planting is a key part of maximizing grain yield. Studies to date indicate that for Narrabri the optimal planting date for Maki is 7 to 10 days later than Yarrum whose optimal planting date for yield maximization is from julian day 138. Studies currently being conducted are expected to lead to the development of a phenological model which could be used throughout the region to predict optimum planting dates.

iii) **Agronomy experiments** were conducted in each year of the project at PBIN (and some off station sites) to determine optimum row spaces and plant densities. Grain yields for all agronomy experiments for all sites & years appear in **Appendix 5**. Experiment mean yields for row space experiments at PBI Narrabri appear in **Figure 4** and for plant density experiments in **Figure 5**. Based upon these results the recommended row space and plant density for the pea varieties is 33cm and no less than 60 live plants per square m, respectively.

Figure 4: Mean yield Row Space experiments PBI Narrabri

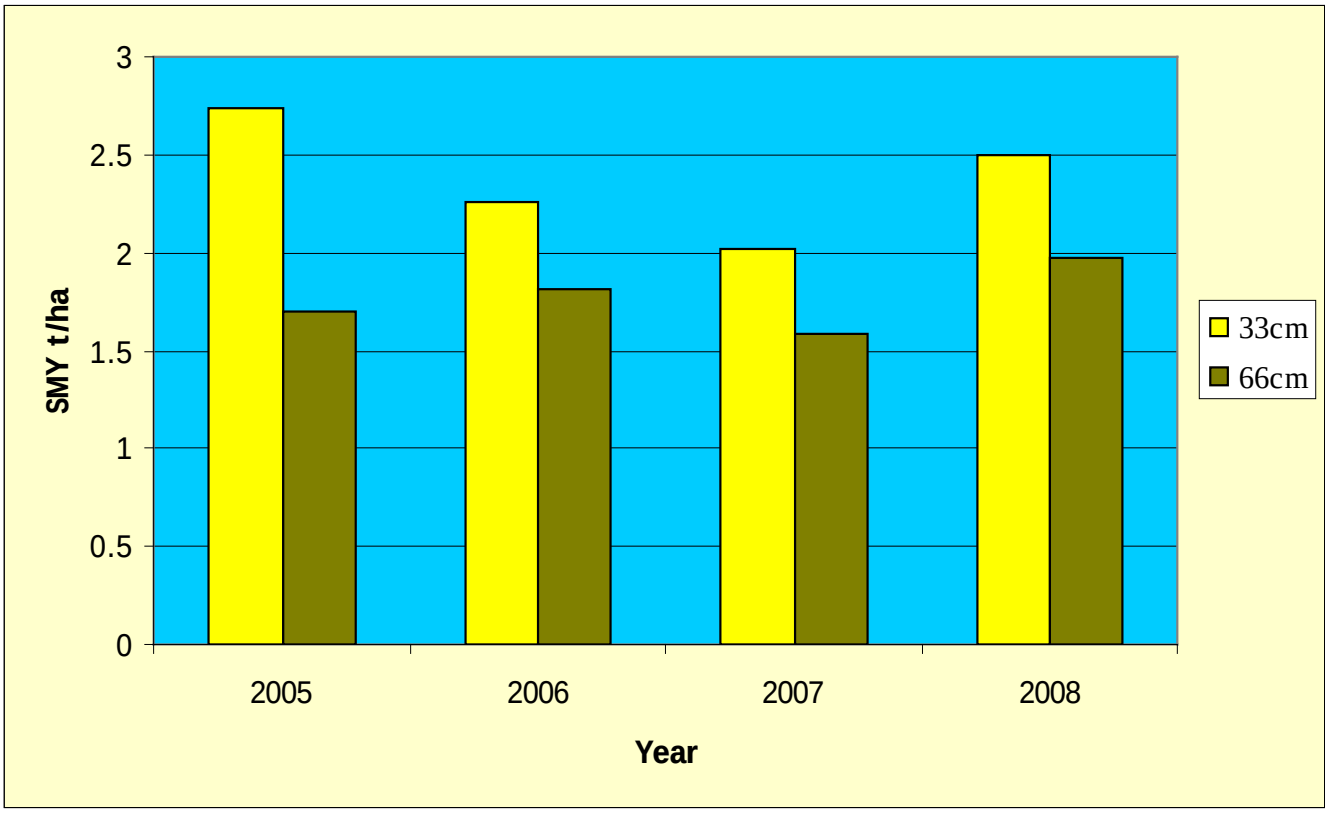
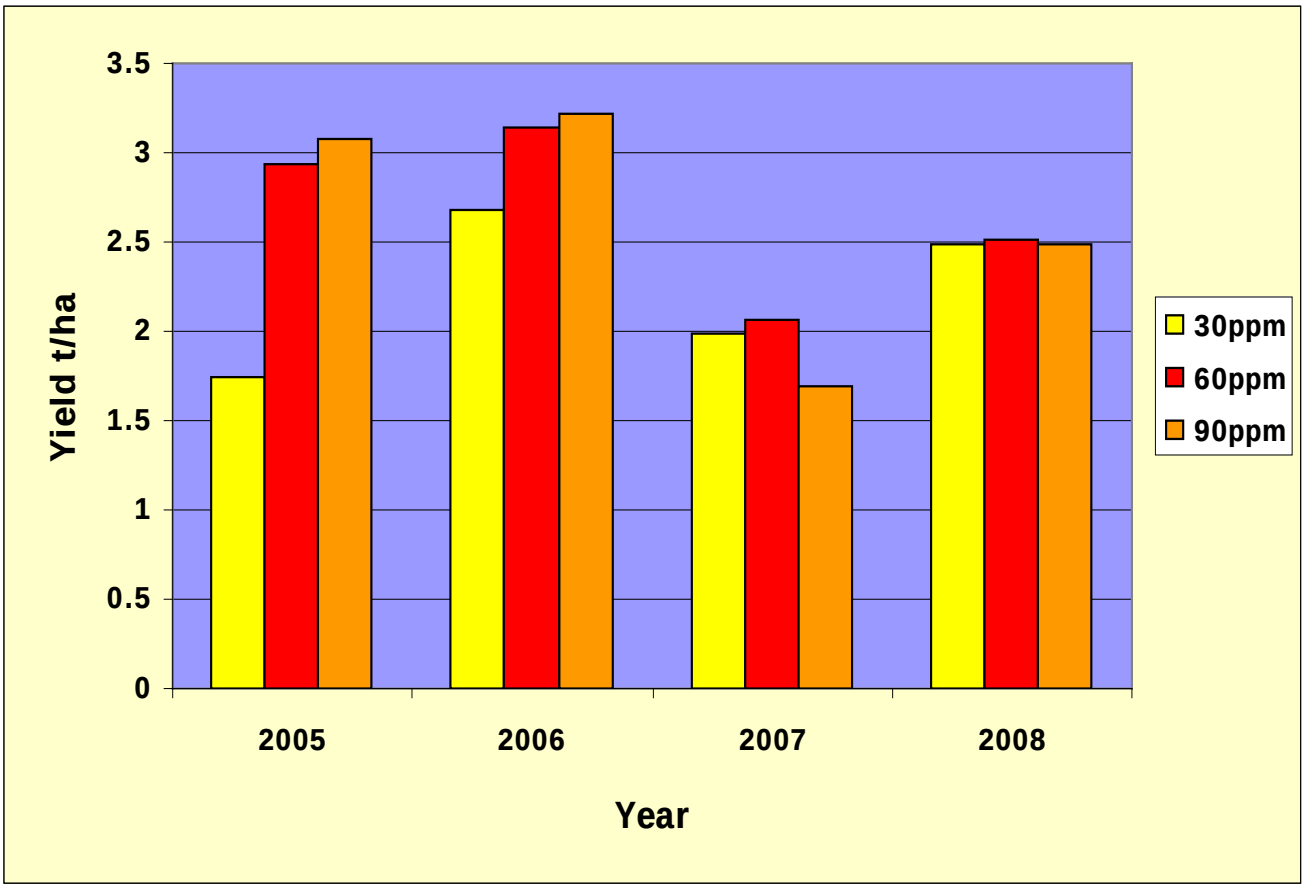


Figure 5: Mean Yield Plant Population experiments PBI Narrabri

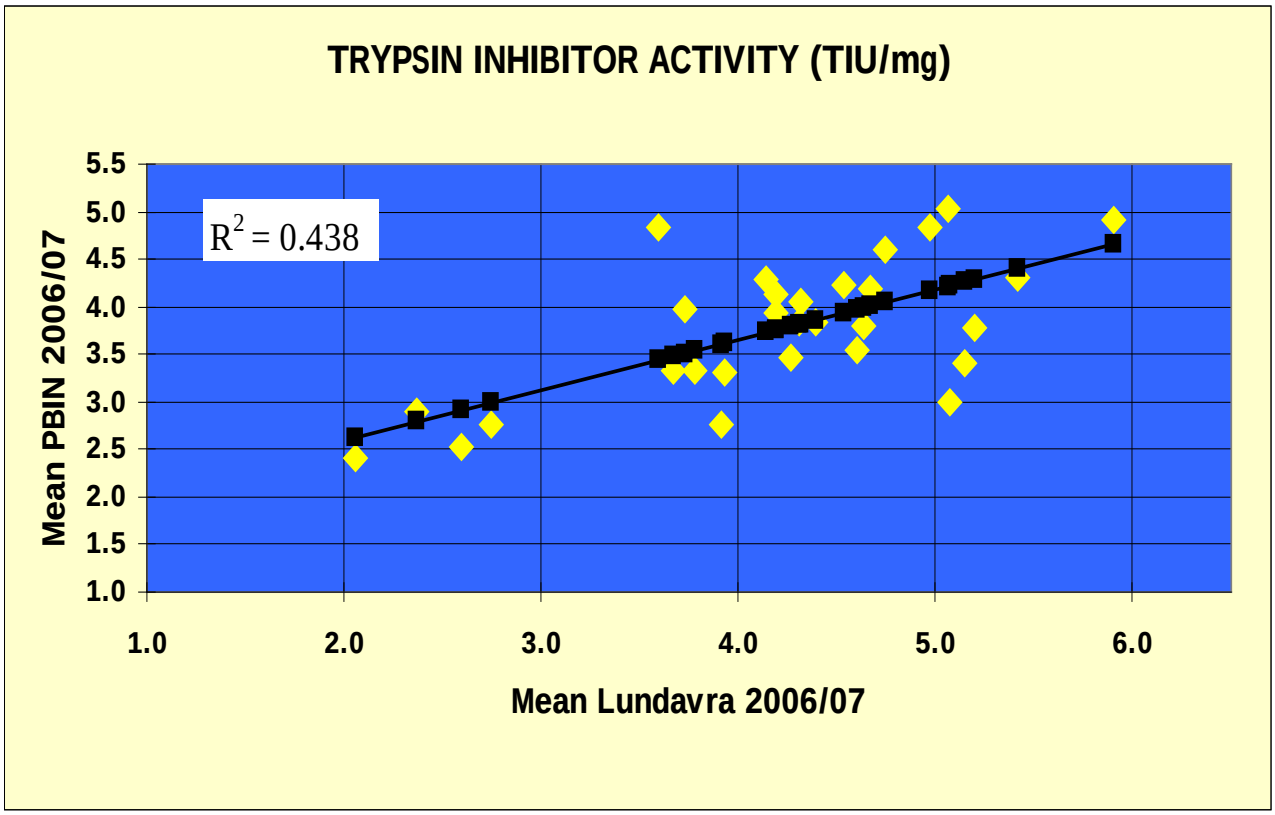


b) Breeding

During the first year of the project a number of accessions were obtained from the Australian Temperate Field Crops Collection (ATFCC) in Horsham Victoria in 2006. Data from these lines for flowering time and grain yield with a view to selecting suitable lines for inclusion in a crossing program targeting earliness. In addition, a number of crosses were made between the best performing named varieties at the time. F1's from selected crosses were produced at PBIN in 2007 and F2's produced in the field in 2008. These F2's have been planted in the field at Narrabri and F3's will be selected for suitable phenology, agronomic type and disease resistance in 2009. A list of the crosses currently at the F2 selection stage appears in **Appendix 6**.

c) Grain quality evaluation during this project was limited to screening of advanced lines for determination of Trypsin Inhibitor Activity (TIA). The literature suggests that TIA levels in field pea are a major anti-nutritional factor in pigs. As the test for TIA in field pea is relatively simple and inexpensive it was decided that this would be the appropriate use of the funds allocated in project 1A-104 for this purpose. Literature further suggests that TIA levels are influenced by genotype, environment and year so testing was conducted on a subset of the standard S4 experiment at two geographically different sites (PBIN, NSW and Lundavra, Qld) in 2006 and 2007. TIA levels for all experiments are listed in **Appendix 7**. These data suggest that there is variability across both year and environment. However, regression analysis of common varieties at both sites in 2006 & 2007 indicates some trends in that higher yields may be associated with higher levels of TIA, (**Figure 6**), although in almost all cases the TIA levels are less than 6 TIU/mg which should not affect pig performance when peas are included in practical pig diets.

Figure 6: Regression Analysis of TIA Activity



It is expected that ongoing screening of advanced lines and potential parents at one site should be sufficient to ensure that TIA levels in the germplasm produced by this breeding program will remain at low and acceptable levels.

In addition to the challenges of the plant breeding and variety development components of the project (**a, b, & c**), the major problem faced by this project has revolved around the slow uptake by graingrowers of a new crop species in the region and the associated flow-on effect to pork producers of inconsistent grain supply in an environment of poor or disastrous seasonal conditions. In addition, the "chicken and egg" implications of pork producers understandably unwilling to commit to a changed feed regime while there is no guarantee of supply continuity and on the other hand, graingrowers reluctant to produce a crop for which they may not get a reasonable return compared to alternative pulses and crops has reduced the impact of the project in the component areas of extension services and marketing (**d & e**). Projects 1A-105 and 1A-108 will continue to concentrate on the delivery of the "message" to both graingrowers and pork producers

d) **Extension services** during the project have concentrated on developing close contact with graingrowers through GRDC and Pulse Australia cropping updates, grower and extension officer updates workshops, field days, articles in the popular press, radio and television interviews and face to face contact with growers and potential growers. A list of the major extension efforts undertaken appear as **Appendix 8**. As previously mentioned, uptake of field pea in the north has been slow with seasonal conditions impacting on grower confidence in a new crop species with its own particular agronomic challenges. There is however an increasing number of graingrowers throughout the region that have tried field pea and the area under production will continue to expand subject to seasonal conditions, market availability and price per tonne. In the north, the main pulse competitors for field pea are Chickpea and Faba Bean. In order for field pea to be competitive it must achieve gross margins equivalent to or better than these crops. Calculations for break even yields and gross returns have been calculated for southern Queensland and Northern NSW and appear as **Appendix 9**. These calculations have been made using a "ready reckoner" that has been prepared for the project in excel spreadsheet format. This spreadsheet may be used to compare the profitability of

growing peas versus chickpeas and the required yield/price that needs to be attained for peas relative to chickpeas to results in peas being a more attractive crop for the grower.

e) **Marketing** of germplasm developed by the project has also been severely impacted by environmental conditions over a number of seasons. However, the new variety "Maki" which was released for commercial production in 2009 is being marketed by AGT Seeds Pty Ltd. A copy of the marketing brochure appears as **Appendix 10.**

f) The **Project Management** team was established at the commencement of project and has met once each year. The Management team consists of the Sub Program Leader, Principal Researchers, representatives of involved organizations and invited guests. The Management Team has monitored the progress of the project and input from all involved has encouraged and recommended redirection of project components as required. Input and assistance from all parties involved in this project is gratefully acknowledged. In particular, the ongoing assistance of the sub program leaders, Dr Mike Taverner and Dr Ray King, has been vital in the implementation of the project.

4. Application of Research

Application of the research findings in the commercial world.

The primary application of the research undertaken by this project has been the development of stable, high yielding field pea germplasm which will provide pork producers an ongoing source of protein with low levels of anti-nutritional factors.

In addition, this research has provided grain growers in the northern region with an alternative pulse species for crop rotations with a clear and recognizable market for the grain.

Opportunities uncovered by the research

The extensive evaluation of germplasm in this project in a wide range of environments in the region has produced varieties which are widely adapted. Preliminary examination of data produced in NVT experiments throughout Australia indicate that these varieties may also have a place in other pork producing areas, particularly in southern regions of the country. Projects 1A-105 & 1A-108 seek to capitalize on this advantage by utilizing project 1A-104 developed germplasm and developing new germplasm using a similar model.

The phenology component of the project has highlighted the need for the development of a robust model for germplasm produced to aid yield stability across a range of environments.

Whilst grain quality evaluation has been limited in this project the ability to test for anti-nutritional factors, characters such as TIA provides the opportunity to screen germplasm to ensure that newly developed varieties remain within acceptable levels. Screening of any new potential parents will reduce the likelihood of introducing germplasm with unacceptable levels of TIA.

Commercialization/Adoption Strategies

The commercialisation/adoption will depend on both pork producers and grain growers. As previously mentioned both of these sectors have differing requirements of expectations from field pea as a crop species in the northern region. The key component of the strategy is dependent on both of these sectors entering into collaborative arrangements for the supply and use of peas and includes such issues as acceptable price, tonnages required, distance to delivery point etc.

- **Potential benefits to cost of production** are twofold. For the pork producer it is a locally produced protein source that is of consistent and good quality and is available in adequate supply. For the grain grower it is a stable high yielding alternative pulse in the north with a guaranteed market.

- **Ease of adoption by producers** is relatively straightforward.
    - For the pork producer, field pea as a protein source can replace existing local and imported protein sources. Projected levels of inclusion of field pea in rations in the north are at least 10%. As pig rations are calculated on a "least cost" basis then for the pork producer in the north, inclusion of field peas in their diets would be determined by cost per tonne of peas against competing protein sources and a guaranteed continuity of supply.
    - For the grain grower adoption of field pea into rotations offers advantages in terms of herbicide use, residual nutrient value and differing disease spectrums to existing pulse alternatives. A grain grower's decision will largely be dependent on gross margins of production compared with other pulses (or crops), a guaranteed market and price stability.
- **Impact of the research** will be most significant if peas can be established as a viable and sustainable crop in the north. The major focus of further work is to implement the results of this project so that the new varieties are economically grown in the north and sufficient quantities of peas are available to pork production at competitive prices and on a continuing basis.

5. Conclusion

The most significant achievement of this project has been the development of high yielding, adapted field pea germplasm to be used as a locally produced reliable source of protein for the pork industry in northern NSW & southern Qld.

Original project deliverables:

Field pea will be established as a viable crop for the north ensuring a cost effective, reliable source of protein for the pork industry in northern NSW and southern Qld. Contributing to this deliverable will be these components:

- ***Commercially available field pea varieties selected for high yield and disease resistance in the region with other characteristics suited to the pig industry*.**

The new variety Maki was released for commercial production in 2009. Three advanced lines PRL95, PRL131 and PRL417 are undergoing pre-commercialisation seed production at PBIN in 2009. It is expected that one of these lines will be will be selected for large scale seed production in 2010 for commercial release in 2011

- ***Packages of agronomic and market support for graingrowers to encourage their participation in pork industry supply chains.***

Development of agronomic packages and market support is partly completed and will be more fully addressed in following Pork CRC projects.

- ***Best practice guidelines for establishing supply chain arrangements for field peas*.**

Development of guidelines for establishing supply chain arrangements are still being formulated and will continue to be addressed by subsequent Pork CRC projects.

The project deliverables have been addressed by:

- Development and release of the new variety "Maki" to supplement the existing variety "Yarrum". Both these varieties are stable, high yielding and process low levels of TIA. In addition, ongoing testing of newer germplasm has produced a number of adapted lines which are considered suitable for release.
- The implementation of a crossing program with limited objectives which will provide ongoing projects with segregating populations from which to make selections for disease resistance and earliness.

- Agronomic experiments conducted during this project have confirmed preliminary data collected prior to the commencement of the project. These data suggest that wide rows and sub optimum plant densities can have a significant impact on grain yield.
- The implementation of a screening test for TIA will permit cost effective monitoring of germplasm and parents to maintain populations at low levels.
- Preliminary phenology studies undertaken in this project will form the basis for the development of a model which will assist grain growers in selecting appropriate planting windows to maximize grain yield. When complete, this model will be trialled in southern Australia, NZ and the USA to test its robustness.

Ongoing plant breeding research coupled with an integrated extension and marketing program through projects 1A-105 and 1A-108 will continue to complement the successes of this project.

6. Limitations/Risks

There are a number of limitations associated with this project:

- Plant Breeding and variety development – the limitation/risks associated with this component of the project is the possibility of a race change in one or several of the major identified diseases rendering existing resistances ineffective or the appearance of a new disease.
- Extension and marketing – the limitation/risks associated with this component are a lack of significant uptake of this new crop species for the north and therefore a lack of continuity of supply for pork producers. Specifically this risk is being addressed in the new and ongoing projects by greater engagement with pork producers, grain growers, agronomists and marketers. Identification of pork producing regions and the grain growing environments in these regions will allow for the selection of lines/varieties of peas that are specifically developed for these regions

7. Recommendations

Many of the recommendations arising from project 1A-104 were included in the strategies developed for projects 1A-105 and 1A-108. These include:

- The fast tracking of the development of adapted germplasm via the use of shuttle breeding techniques at three locations in USA, NZ and Australia.
- A crossing program incorporating desirable grain quality characters eg. Low trypsin inhibitor activity.
- The development of sufficient quantities of seed to enable feeding studies to evaluate and validate lines purported to have high levels of metabolisable/digestible energy.
- The evaluation of fixed lines developed for the northern program in appropriate areas of southern Australia as potential releases in pig producing areas of southern Australia.
- The evaluation of segregating populations in southern Australia specifically targeting the agronomic and disease issues in those areas.

In addition to those already incorporated into new projects, the following recommendations are suggested:

- For all the project target regions, key agronomists should be identified and consulted in the development of agronomic packages and identification of suitable markets
- There should be much greater interaction between pork producers, pulse growers and commercial agronomists and key researchers to develop closer relationships to provide a

stable ongoing supply of protein to the pork industry. These interactions could be both formal and informal and would probably be best facilitated through the Pork CRC.

- To facilitate the uptake of the new varieties, commercializing partners must be encouraged to play a greater role in all aspects of the project.
- A formal approach by the Pork CRC to the extension and information dissemination activities of GRDC and perhaps state-based grower organisations would assist with the uptake of outputs from these projects.
- Consideration should be given to obtaining or developing NIR testing calibrations for field pea grain protein, if not already available, and perhaps Metabolisable Energy content. PBI Narrabri has recently purchased an Infratec NIR1241 Grain Analyzer which could be utilized to test germplasm if NIR calibrations for field pea could be developed or obtained.

APPENDIX 1: YIELD RESULTS FOR S4 EXPERIMENTS

(expressed as % Yarrum)

2006

Planted	4/08/06	19/07/06	16/05/06	19/06/06	21/06/06	18/05/06	21/06/06	
Harvest	30/11/06		17/10/06	24/10/06	20/10/06	18/10/06	26/10/06	
Name	Hermitage Qld	Lundarva Qld	Weemelah TOS1	Weemelah TOS2	North Star	PBIN TOS1	PBIN TOS2	Mean
95-1088	175	167	125	114	71	120	76	121
AP7	125	174	104	128	100	102	98	119
AP18	136	141	110	123	119	114	88	119
96-262*3	133	111	114	126	71	112	74	106
92-104*6	114	171	107	114	48	88	80	103
98-64*2	129	137	109	129	42	93	82	103
98-275*4	139	127	103	117	70	89	76	103
OZP0610	105	134	85	125	75	102	94	103
97-64*2-7	151	118	85	111	75	103	77	103
Cressy blue	125	189	78	101	82	88	53	102
97-064*6-4	128	155	89	107	82	78	76	102
98-03*4	105	186	99	95	75	84	64	101
89P166-5-2	135	164	92	86	89	76	65	101
Yarrum	100	100	100	100	100	100	100	100
97-223*2-1	84	152	100	119	58	105	80	100
98-03*19	98	107	123	118	73	102	74	99
97-222*1W	75	133	127	117	48	102	85	98
98-67*18	135	133	96	98	59	85	79	98
98-03*7	89	125	110	121	68	93	79	98
Boreen	89	147	81	116	82	86	77	97
92-102*17-2-4	137	130	103	88	63	83	67	96
95-032*10-3	119	148	76	106	53	90	73	95
Sturt	123	158	81	107	74	57	63	95
97-212*3-4	106	126	93	120	56	74	77	93
97-236*1-6	91	144	104	111	52	79	68	93
97-170*3-11	133	138	83	99	58	66	69	92
98.283*11	56	144	117	109	73	72	64	91
98-276*3	119	112	95	97	72	70	69	91
98-389*1	129	127	99	83	51	79	63	90
97-241*6-4	65	108	92	119	54	106	82	89
99-059*13	92	99	107	106	58	80	83	89
97-230*6-1	109	95	94	113	57	81	75	89
Parafield	94	134	81	86	76	76	60	87
98-276*1	87	119	102	93	57	77	72	87
97-223*2-3	72	100	88	122	41	104	74	86
97-333*2-1	70	121	89	115	65	65	69	85
97-226*3-7	102	118	81	93	45	86	67	85
99RS-2-3-16	108	130	93	84	60	53	64	84
99-188*5	75	104	93	109	63	71	66	83
97-340*4-1	114	95	78	93	41	75	70	81
98-319*11	75	92	83	87	38	88	81	78
Moonlight	105	84	57	92	34	83	80	76
97-218*1-3	101	105	75	86	33	57	73	76
97-398*1-6	75	68	94	91	48	76	72	75
99-239*11	37	81	85	103	53	83	77	74
Mukta	49	86	94	84	65	67	64	73
Kaspa	85	70	56	74	30	70	56	63
Yarrum (t/ha)	**0.629**	**0.73**	**2.00**	**1.40**	**2.08**	**3.39**	**3.62**	**1.98**
Site MY (t/ha)	**0.66**	**0.92**	**1.88**	**1.47**	**1.31**	**2.88**	**2.68**	**1.68**
CV %	**15.13**	**12.61**	**9.17**	**7.73**	**13.40**	**10.56**	**8.06**	**10.95**
lsd	**0.11**	**0.15**	**0.29**	**0.18**	**0.24**	**0.42**	**0.29**	**0.24**

2007

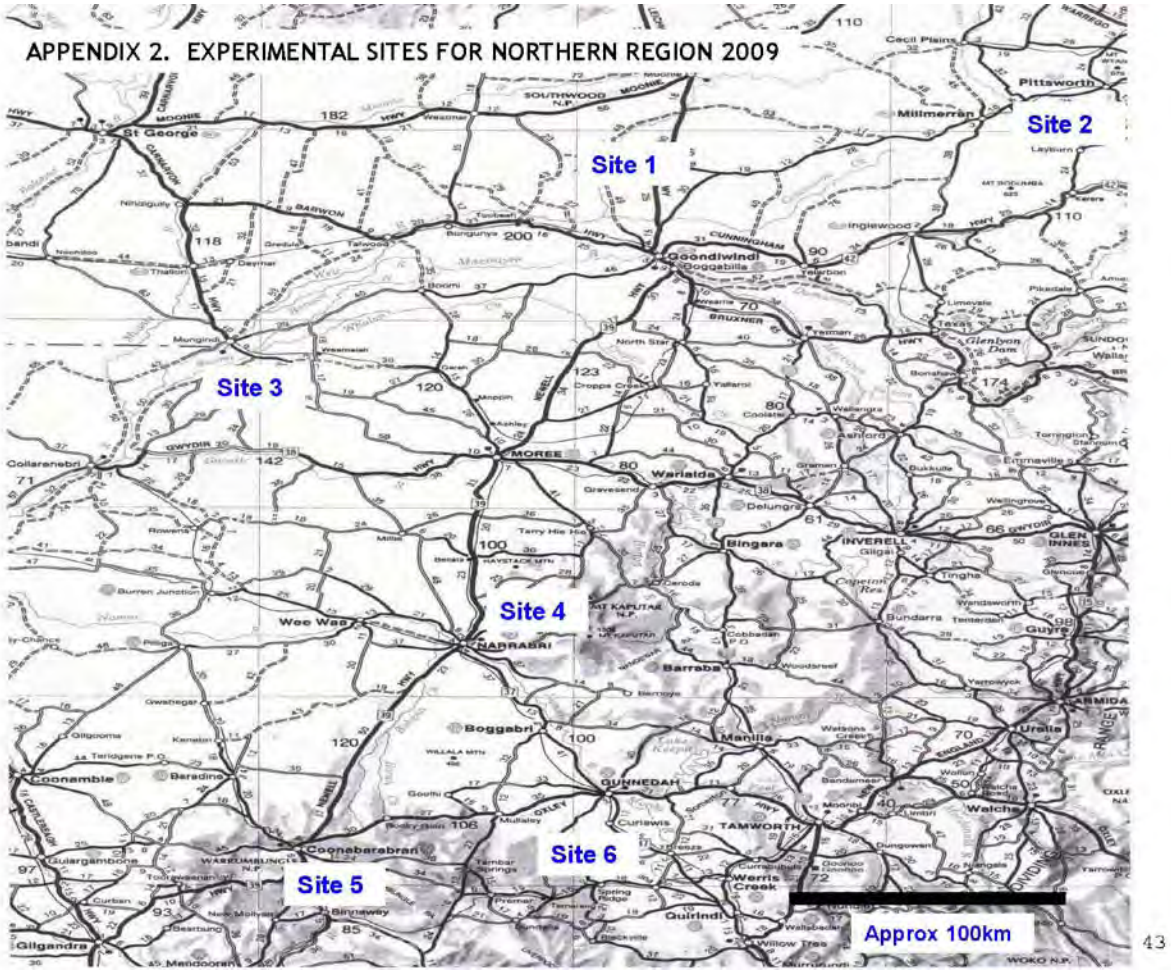
Name	Qld #1	Weemelah	PBIN TOS1	PBIN TOS2	North Star	Mean
AP18 (Maki)	108	154	102	99	261	145
95-1088	127	156	86	98	238	141
PRL417	92	134	101	78	246	130
AP7	106	122	81	105	226	128
98-03*7	99	150	82	101	200	126
PRL131	90	150	102	107	179	126
96-262*1	110	151	89	78	180	122
OZP0610	92	120	88	104	170	115
98-067*19	92	108	81	83	175	108
98-283*11	122	138	84	69	125	107
Alezan	115	139	90	85		107
98-03*19	97	136	83	82	123	104
99-048*14	88	125	88	65	152	104
95-032*10-3	101	125	54	78	157	103
98-64*2	78	134	73	87	130	100
Yarrum	100	100	100	100	100	100
Sturt	122	82	60	57	177	100
92-104*10-1	90	110	87	87	125	100
Bundi	133	119	106	37	97	98
96.33	77	110	95	81	125	97
97-064*2-7	92	110	83	91	103	96
97-064*6-4	98	113	91	73	102	95
96-262*3	86	122	93	72	103	95
97-241*6-4	91	103	91	66	123	95
92-105*1-2	90	104	59	75	144	94
97-223*2-5	87	116	67	72	123	93
98-67*18	82	101	65	87	130	93
98-274*6	94	98	72	73	123	92
Boreen	71	89	61	83	143	89
97-222*1W	71	110	77	52	131	88
97-064*4-7	86	89	78	72	113	88
97-223*2-1	92	105	80	73	82	86
98-275*4	86	93	71	60	107	84
92-104*6	65	84	68	67	131	83
98-03*4	100	104	70	72	67	82
97-223*4	71	97	59	66	113	81
Cressy Blue	94	106	56	100	49	81

Name	Qld #1	Weemelah	PBIN TOS1	PBIN TOS2	North Star	Mean
97-236*1-6	86	111	65	69	75	81
98-316*10	57	67	62	82	130	80
98-274*10	77	60	82	78	97	79
Parafield	99	116	44	52	77	78
97-236*1-5	60	89	77	60	90	75
97-298*2-2	53	90	68	47	111	74
98-308*26	55	62	61	95	67	68
Kaspa	85	95	77	31	49	67
Excel	68	84	80	26	44	60
98-063*2	55	48	65	72	54	59
98-311*7	57	53	59	46	34	50
Yarrum (t/ha)	**1.43**	**1.22**	**2.82**	**1.34**	**0.61**	**1.48**
Site MY (t/ha)	**1.27**	**1.33**	**2.18**	**1.00**	**0.76**	**1.3**
CV %	**11.99**	**9.25**	**12.79**	**14.51**	**28.78**	**15.46**
LSD	**0.25**	**0.20**	**0.45**	**0.24**	**0.35**	**0.3**

2008

Planted:	18-	24-	17-Jun	12-	26-	25-Jun	6-Jun	17-Jun		
Harvested:	24-	11-	5-Nov	14-	17-	26-Nov	10-Dec			
Name	**PBIN TOS1**	**PBIN TOS2**	**Mungindi**	**North Star**	**Nowley**	**Tamworth**	**Ulamambri**	**Lundavra**	**Mean**	**GxE**
96.24	91	112	92	95	116	101	91	108	100	0.38
Yarrum	100	100	100	100	100	100	100	100	100	2.06
PRL95	102	104	105	106	54	100	102	92	99	1.14
PRL101	92	112	91	114	80	108	81	100	98	0.85
PRL131	88	115	89	112	174	78	68	100	98	0.24
Maki	88	110	84	102	100	115	88	93	97	1.13
PRL100	78	110	88	101	148	93	101	85	96	1.29
96-29	81	108	84	87	89	84	149	89	96	0.88
PRL102	88	107	71	115	69	124	95	95	96	0.86
PRL417	93	127	93	100	91	69	77	92	94	0.59
AP7	87	102	85	100	97	107	81	92	93	0.28
96.33	68	88	84	74	108	94	170	81	93	0.67
96-9	79	105	76	100	85	94	112	92	93	1.95
PRL103	81	109	99	97	48	105	66	84	89	0.76
PRL40584	80	61	82	94	101	127	80	93	87	0.20
04 SI7101	62	38	100	127	117	108	79	104	87	1.03
PRL107	90	117	70	88	63	83	75	87	87	1.32
Alezan	91	87	87	84	72	86	49	92	82	1.10
97-064*6-4	79	98	80	66	101	62	62	89	79	2.36
92-104*10-1	68	76	67	79	120	59	94	83	78	1.97
95-1088	52	40	52	111	75	128	123	70	77	1.55
96-262*1	71	84	106	70	105	53	41	92	77	0.31
98-03*7	69	65	54	92	107	62	107	78	76	0.26
96-262*3	71	91	95	67	82	60	56	83	76	1.03
99-048*14	69	99	85	64	114	49	42	82	74	0.68
98-184*17	81	0	89	96	74	68	107	92	74	0.52
Cressy Blue	56	46	71	101	91	88	100	67	74	0.51
95-32-10-3	46	92	70	93	66	67	66	80	73	0.28
98-067*19	56	112	56	81	88	42	53	78	71	0.30
99-060*10	84	84	70	74	92	35	38	79	70	1.80
99-059*5	67	101	69	61	78	50	42	74	69	0.35
97-064*6-3	83	84	66	48	62	72	41	77	69	1.19
98-03*19	58	56	60	69	97	70	76	83	68	1.13
98-183*8	55	83	74	66	40	54	72	70	66	1.11
99-059*14	64	87	65	76	54	37	47	82	66	1.27
98-182*6	59	76	64	73	30	52	80	75	66	1.00
97-098*2-4	87	79	69	58	85	36	37	66	65	0.95
98-283*11	52	89	77	76	80	41	31	73	65	1.17
99-133*1	68	88	64	75	39	43	41	64	63	1.19
02-288-7	57	88	63	58	26	54	59	70	63	1.14
98-17*9	58	93	61	63	37	44	47	72	63	2.58
99-099*5	69	86	56	65	47	27	34	76	61	3.00
99-232*10	54	75	48	80	14	54	51	80	61	2.40
99-075*7	69	85	58	67	30	44	41	62	61	3.15
97-414*2-9	24	58	76	87	70	49	50	76	59	1.01
02-176-5	55	30	68	78	72	63	42	79	59	1.04
99-098*3	61	84	60	58	1	40	52	69	58	0.65
Parafield	30	34	57	70	27	65	71	65	52	0.71
Bundi	40	34	67	70	12	35	17	79	47	2.12
Excel	23	21	64	70	23	49	28	72	44	2.23
Kaspa	31	18	76	72	20	22	22	79	44	2.32
Yarrum	**2.99**	**2.86**	**2.33**	**2.07**	**1.06**	**1.93**	**2.17**	**2.71**	**2.27**	
SMY (t/ha)	**1.99**	**2.31**	**1.74**	**1.73**	**0.75**	**1.33**	**1.50**	**2.24**	**1.70**	
CV %	**12.66**	**11.0**	**7.58**	**15.2**	**24.63**	**14.02**	**12.18**	**8.75**	**13.2**	
lsd	**0.54**	**0.55**	**0.35**	**0.57**	**0.39**	**0.50**	**0.50**	**0.42**	**0.48**	

APPENDIX 2: EXPERIMENTAL SITES FOR NORTHERN REGION 2009



APPENDIX 3: TIME OF PLANTING EXPERIMENTS GRAIN YIELD (t/ha) 2004 TO 2008

2004 – PBI NARRABRI

Planted: 13/05/04		**Planted:** 12/06/04
Harvested: 30/10/04		**Harvested:** 2-3/11/04
Variety	**TOS 1**	**TOS 2**
89P166-5-2	1.76	1.68
95-032-*10-3	1.97	1.86
95-1088	2.18	2.01
96-24	3.5	2.70
96-262*1	2.02	1.51
96-262*3	2.22	1.70
96-29	2.26	1.88
96-33	2.29	1.19
96-35	2.33	1.50
97-064-*6-4	2.21	1.53
97-212-*3-4	2.2	1.90
97-218*1-4	2.04	1.62
97-398-*1-6	2.51	1.35
98 - 03-*8	1.6	1.95
98 - 276-*3	2.31	1.38
98 - 319-*11	2.51	1.51
98 - 390-*11	1.42	1.00
98- 64-*2	2.23	1.92
98 - 01*4	1.91	1.60
98 - 03*7	2.17	2.06
98 - 182*12	2.19	1.34
98 - 275*7	2.09	1.70
98 - 67-*14	1.87	1.04
98 - 67*18	2.08	2.03
92 - 104-*10-1	1.8	1.99
97-160-*1D	1.78	1.19
97-165-*6-4	1.78	1.24
97-170-*3-11	1.69	1.60
97-170*3-13	2.4	1.57
97-212*3-2	2.09	1.79
97-223-*2-1	2.6	1.85
97-223-*2-3	2.2	2.05
97-223*2-5	1.72	1.49
97-227-*3-9	2.49	1.45
97-230*6-1	2.31	1.80
97-232-*4-8	2.41	1.62
97-333-*2-1	2.61	1.35
98 - 03-*1	2.27	1.66
98 - 03-*19	2.38	1.89
98 - 03-*3	1.99	1.66
98 - 276-*1	2.46	1.38
98 - 310-*3	1.41	1.54
98 - 389-*1	2.29	1.32
98 - 67-*1	1.91	1.14
98 - 184-*17	2.28	1.70

Planted: 13/05/04		**Planted:** 12/06/04
Harvested: 30/10/04		**Harvested:** 2-3/11/04
Variety	**TOS 1**	**TOS 2**
98 - 03*12	2.6	1.49
98 - 03*18	1.94	2.06
98 - 115*8	1.66	1.58
98 - 186*25	2.17	1.18
98 - 67*15	1.73	0.79
98 - 67*5	1.3	1.26
Yarrum	3.19	1.84
Parafield	1.22	1.31
92-104*6	1.82	1.43
Cressy Blue	1.88	1.73
Boreen	1.12	1.66
Mukta	2.39	1.70
Santi	1.34	0.85
96-29	2.67	1.31
SMY	**2.10**	**1.58**
CV %	**11.64**	**14.00**
lsd	**0.4711**	**0.44**

2005 – PBI NARRABRI

Variety	**TOS 1**	**TOS 2**
89P166-5-2	2.11	1.16
92-104*10-1	2.25	0.61
95-032*10-3	2.15	0.41
95-1088	2.67	0.72
96-262*1	3.15	0.39
96-262*3	2.86	0.48
96-33	2.36	0.61
96-35	2.59	0.71
96-48	2.35	0.81
97-064*6-4	3.58	0.73
97-170*3-11	2.2	0.83
97-212*3-4	2.33	0.61
97-223*2-1	2.96	0.72
97-223*2-3	2.87	0.41
97-223*2-5	2.68	0.72
97-227*3-9	2.62	0.23
97-230*6-1	3.46	0.61
97-231*4-1	2.33	0.64
97-232*4-8	1.94	0.15
97-333*2-1	1.88	0.9
97-398*1-6	2.36	0.44
98-01*4	2.38	0.65
98-03*18	2.54	0.46
98-03*19	2.39	0.28
98-03*7	2.4	0.58
98-03*8	2.04	0.57
98-115*8	2.37	0.75

Variety	TOS 1	TOS 2
98-182*12	2.07	0.44
98-184*17	2.38	0.42
98-275*7	2.33	0.54
98-276*1	3.13	0.44
98-276*3	3.08	0.54
98-319*11	3.56	0.42
98-389*1	2.15	0.85
98-64*2	2.58	0.63
98-67*18	2.93	0.63
92-102*17-2-4	2.7	0.47
97-218*1-3	1.97	0.59
97-222*1W	2.98	0.5
97-226*3-7	2.75	0.6
97-236*1-6	2.5	0.26
97-241*6-4	2.91	0.49
97-340*4-1	2.03	0.4
97-64*2-7	2.52	0.94
AP7	2.81	1.45
98.283*11	2.46	0.58
98-03*4	2.31	0.52
Maki	3.15	1.22
98-275*4	2.24	0.56
98-276*9	1.86	0.34
99-059*13	2.71	0.48
99-188*5	2.01	0.58
99-239*11	2.67	0.36
99RS-2-3-16	2.21	0.47
96-24	3.75	0.23
Yarrum	3.22	0.13
Parafield	1.82	0.56
92-104*6	3.28	0.25
Cressy Blue	1.95	0.57
Boreen	3.31	0.74
Mukta	1.82	0.08
Santi	1.77	0.26
96-29	2.76	0.52
SMY	**2.55**	**0.56**
CV%	**14.07**	**22.94**
lsd	**0.69**	**0.31**

2006 - PBI NARRABRI & WEEMELAH

	NARRABRI		WEEMELAH	
Planted	18/05/06	21/06/06	16/05/06	19/06/06
Harvest	18/10/06	26/10/06	17/10/06	24/10/06
Variety	**TOS1**	**TOS2**	**TOS1**	**TOS2**
AP18	3.88	3.18	2.21	1.73
AP7	3.46	3.55	2.08	1.79
95-1088	4.07	2.76	2.49	1.59
Yarrum	3.39	3.62	2.00	1.40
96-262*3	3.79	2.67	2.28	1.76
OZP0610	3.45	3.39	1.70	1.75
98-03*19	3.45	2.69	2.47	1.65
97-222*1W	3.46	3.07	2.54	1.64
97-223*2-1	3.55	2.88	2.00	1.67
97-64*2-7	3.49	2.79	1.69	1.56
98-64*2	3.16	2.96	2.18	1.81
98-03*7	3.16	2.86	2.19	1.69
98-275*4	3.02	2.75	2.06	1.64
92-104*6	3	2.89	2.14	1.60
97-241*6-4	3.58	2.97	1.83	1.67
97-064*6-4	2.65	2.75	1.79	1.50
Boreen	2.92	2.79	1.62	1.63
98-03*4	2.86	2.33	1.98	1.34
98-67*18	2.87	2.86	1.92	1.37
89P166-5-2	2.59	2.35	1.83	1.21
99-059*13	2.72	3	2.14	1.48
Cressy blue	2.99	1.92	1.55	1.42
97-223*2-3	3.53	2.67	1.76	1.71
92-102*17-2-4	2.81	2.43	2.06	1.24
95-032*10-3	3.04	2.63	1.51	1.48
97-212*3-4	2.5	2.77	1.86	1.67
98.283*11	2.45	2.31	2.34	1.53
97-236*1-6	2.69	2.47	2.07	1.55
97-230*6-1	2.73	2.73	1.89	1.58
98-276*3	2.36	2.5	1.90	1.35
98-276*1	2.62	2.61	2.03	1.30
98-389*1	2.68	2.29	1.97	1.16
97-170*3-11	2.23	2.5	1.66	1.39
Sturt	1.93	2.29	1.63	1.50
97-333*2-1	2.2	2.48	1.79	1.61
Parafield	2.59	2.17	1.63	1.20
98-319*11	3	2.94	1.65	1.22
97-226*3-7	2.91	2.44	1.63	1.30
99-188*5	2.39	2.38	1.86	1.53
99-239*11	2.83	2.8	1.70	1.45
97-398*1-6	2.57	2.59	1.87	1.27
97-340*4-1	2.54	2.55	1.55	1.30
Moonlight	2.81	2.89	1.14	1.29
99RS-2-3-16	1.8	2.3	1.87	1.17
Mukta	2.27	2.3	1.88	1.18
97-218*1-3	1.94	2.65	1.51	1.20
Kaspa	2.37	2.04	1.12	1.04
SMY	**2.88**	**2.68**	**1.88**	**1.47**
CV %	**10.56**	**8.06**	**9.17**	**7.73**
lsd	**0.4186**	**0.2938**	**0.29**	**0.18**

2007 – PBI NARRABRI

Variety	TOS 1	TOS 2
92-104*10-1	2.46	1.16
92-104*6	1.91	0.90
92-105*1-2	1.66	1.01
95-032*10-3	1.51	1.04
95-1088	2.42	1.31
96.33	2.68	1.08
96-262*1	2.51	1.05
96-262*3	2.61	0.97
97-064*2-7	2.33	1.22
97-064*4-7	2.21	0.96
97-064*6-4	2.57	0.98
97-222*1W	2.18	0.70
97-223*2-1	2.25	0.98
97-223*2-5	1.88	0.97
97-223*4	1.67	0.89
97-236*1-5	2.17	0.80
97-236*1-6	1.83	0.92
97-241*6-4	2.56	0.88
97-298*2-2	1.93	0.63
98-03*19	2.34	1.10
98-03*4	1.96	0.96
98-03*7	2.30	1.35
98-063*2	1.84	0.96
98-067*19	2.29	1.11
98-274*10	2.32	1.04
98-274*6	2.03	0.98
98-275*4	2.01	0.81
98-283*11	2.38	0.92
98-308*26	1.71	1.27
98-311*7	1.66	0.62
98-316*10	1.75	1.10
98-64*2	2.05	1.16
98-67*18	1.84	1.16
99-048*14	2.48	0.87
Alezan	2.54	1.14
Maki	2.88	1.33
AP7	2.28	1.41
Boreen	1.73	1.11
Bundi	3.00	0.50
Cressy Blue	1.59	1.34
Excel	2.26	0.35
Kaspa	2.17	0.41
OZP0610	2.47	1.39
Parafield	1.25	0.70
PRL131	2.88	1.43
PRL417	2.86	1.04
Sturt	1.70	0.77
Yarrum	2.82	1.34

Variety	TOS 1	TOS 2
SMY	2.18	1.00
CV%	12.79	14.51
lsd	0.45	0.23

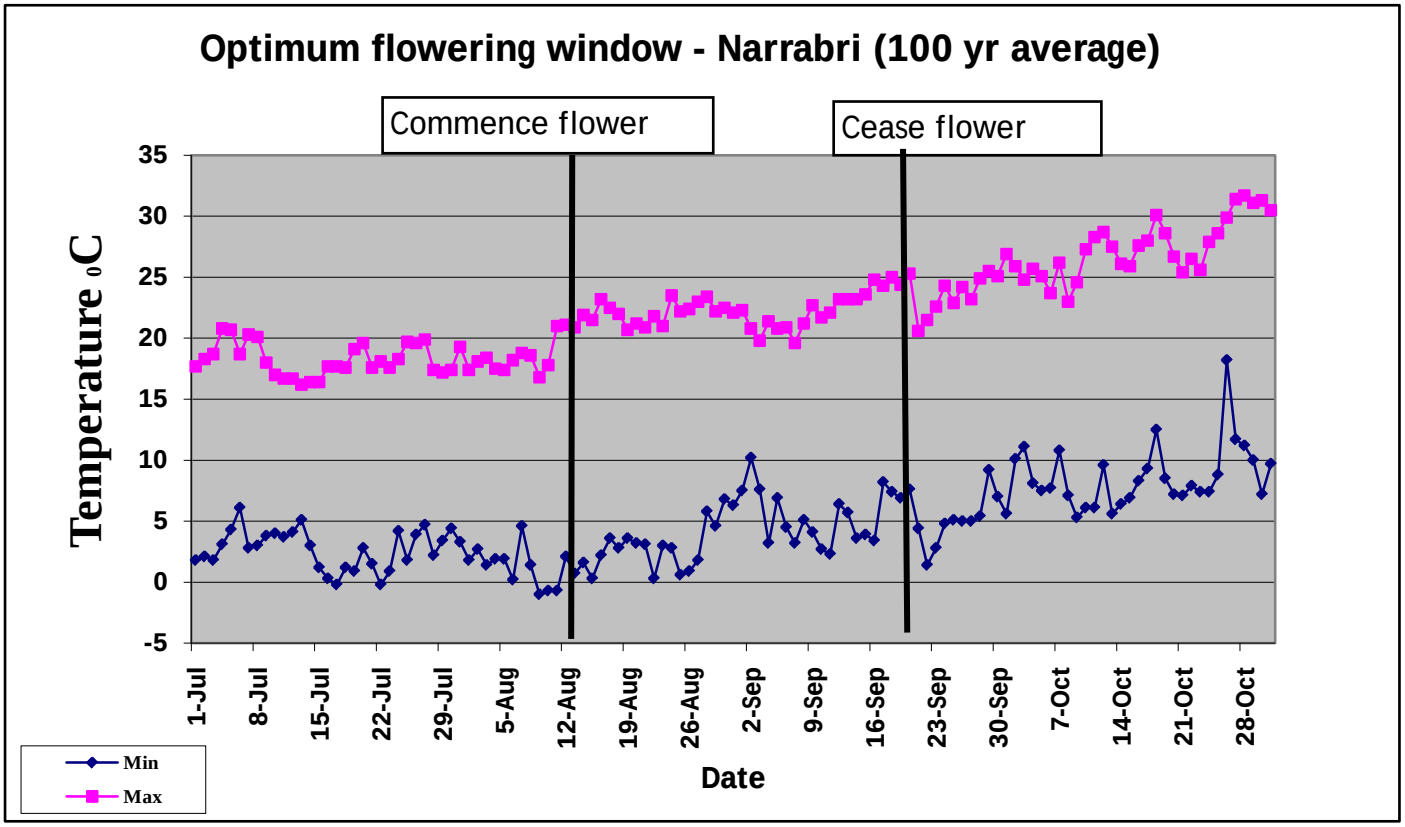
2008 – PBI NARRABRI

Planted:	18-May	24-Jun
Harvested:	24-Oct	11-Nov
Variety	TOS1	TOS2
92-104*10-1	2.04	2.16
96.33	2.02	2.51
96-262*1	2.11	2.41
96-262*3	2.11	2.61
97-064*6-4	2.35	2.79
98-03*19	1.73	1.59
98-03*7	2.05	1.85
98-067*19	1.66	3.19
98-283*11	1.54	2.54
99-048*14	2.07	2.82
PRL131	2.62	3.28
PRL417	2.79	3.64
02-103-7	0.75	1.31
02-176-5	1.64	0.86
02-288-7	1.70	2.51
04 SI7101	1.84	1.10
95-032*10-3	1.38	2.63
95-1088	1.55	1.15
96-29	2.43	3.09
96-9	2.36	3.00
97-064*6-3	2.47	2.40
97-098*2-4	2.61	2.27
97-414*2-9	0.73	1.65
98-17*9	1.74	2.67
98-182*6	1.76	2.16
98-183*8	1.63	2.37
98-184*17	2.42	0.00
99-059*14	1.90	2.50
99-059*5	2.00	2.89
99-060*10	2.52	2.40
99-075*7	2.05	2.44
99-098*3	1.81	2.41
99-099*5	2.06	2.47
99-133*1	2.03	2.51
99-232*10	1.62	2.14
Alezan	2.71	2.49
AP7	2.61	2.91
Bundi	1.21	0.96
Cressy Blue	1.68	1.31
Excel	0.68	0.60
Kaspa	0.92	0.51
Parafield	0.91	0.96

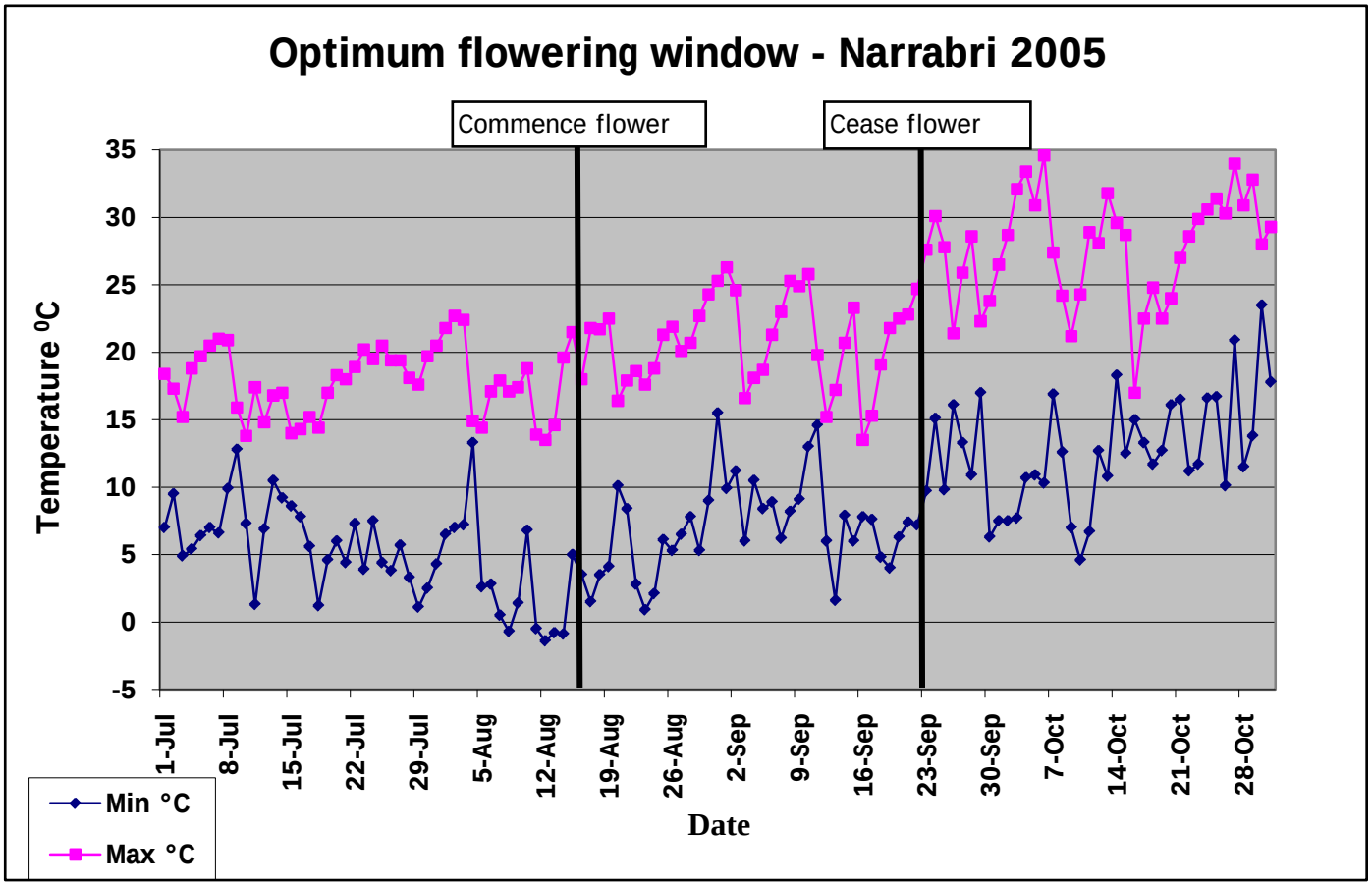
Planted:	18-May	24-Jun
Harvested:	24-Oct	11-Nov
Variety	**TOS1**	**TOS2**
PRL100	2.33	3.15
PRL101	2.76	3.20
PRL102	2.64	3.06
PRL103	2.42	3.13
PRL107	2.69	3.36
PRL40584	2.38	1.75
PRL95	3.06	2.98
Yarrum	2.99	2.86
96-24	2.73	3.20
Maki	2.63	3.15
SMY	**1.99**	**2.31**
CV %	**12.66**	**11.03**
lsd	**0.54**	**0.55**

APPENDIX 4. OPTIMUM FLOWERING WINDOWS FOR NORTHERN REGION

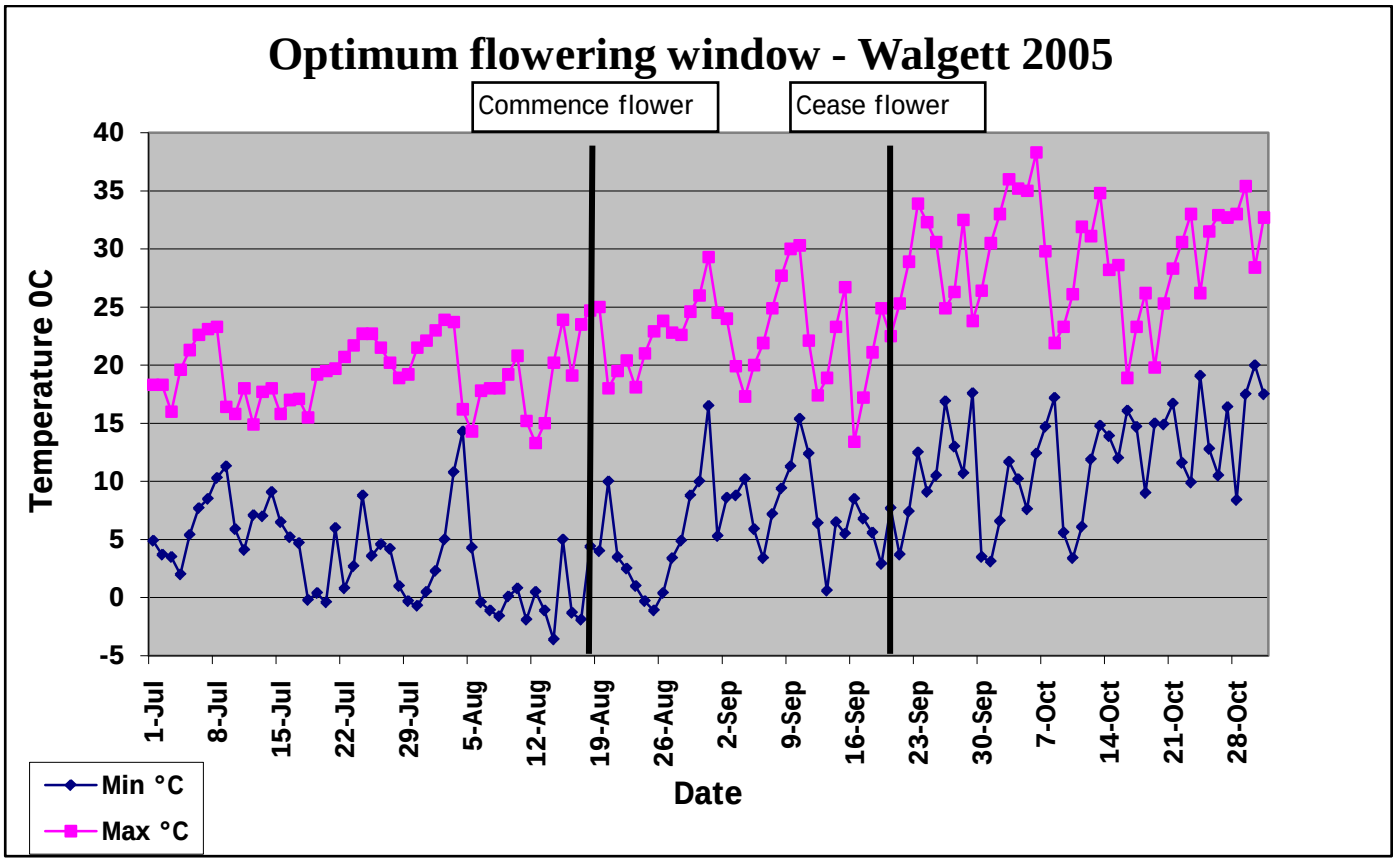
NARRABRI 100 YEAR AVERAGE



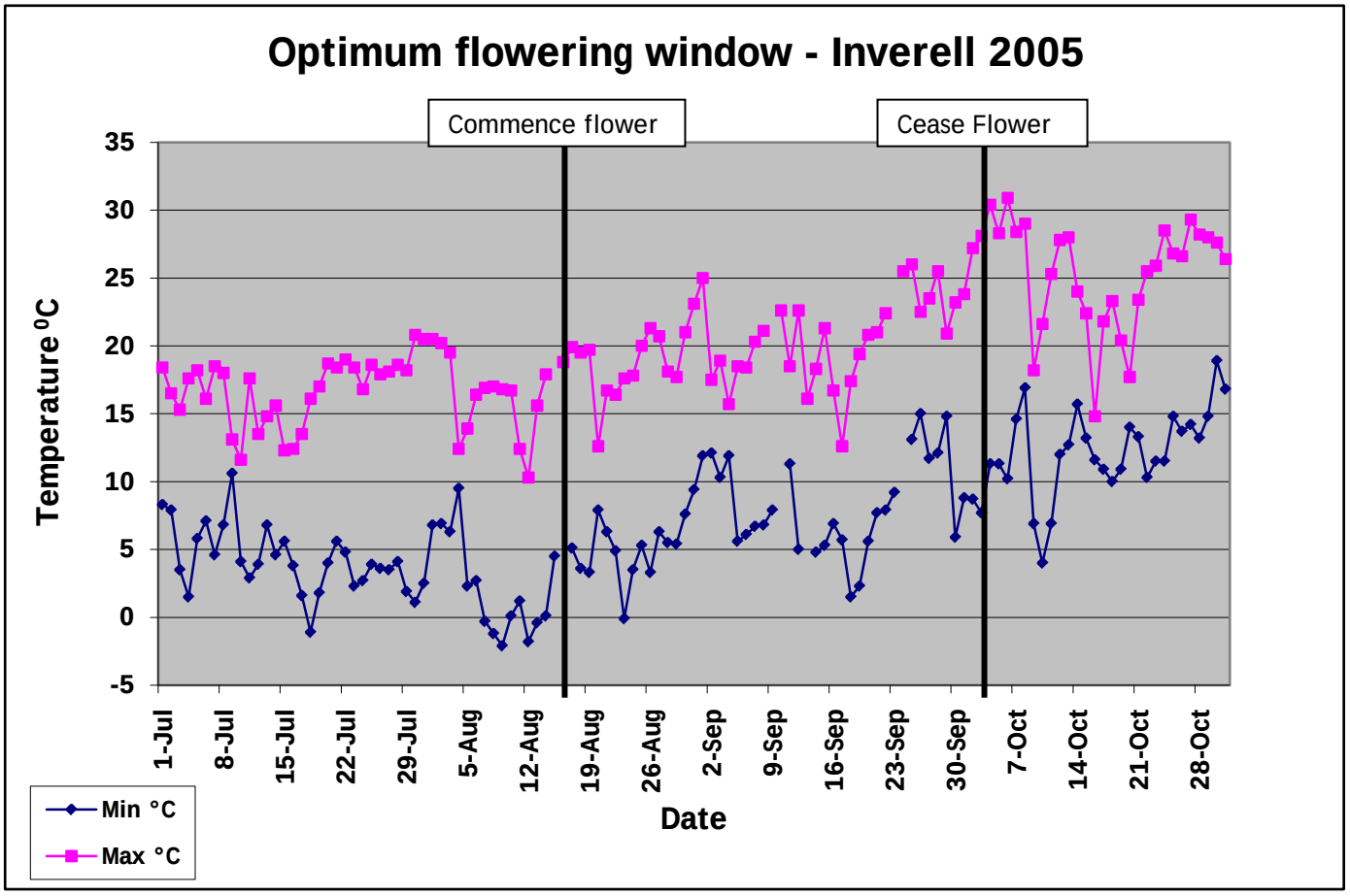
NARRABRI 2005



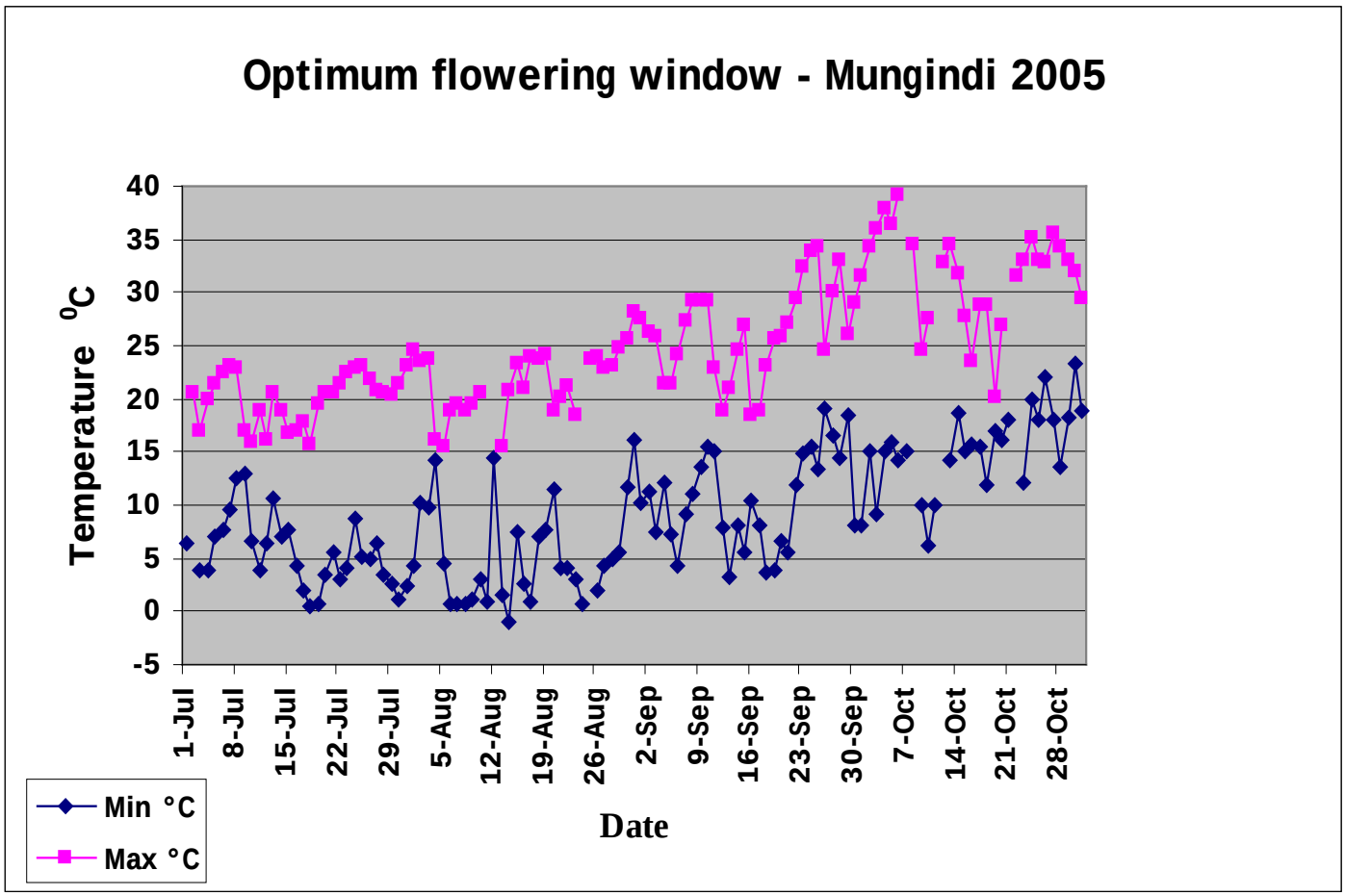
WALGETT 2005



INVERELL 2005



MUNGINDI 2005



APPENDIX 5: GRAIN YIELD (t/ha) AGRONOMY EXPERIMENTS 2006-2008

2006

Plant population experiments

SP (variety)	MP (plants /m^2)	Coonamble	Curban	Walgett	PBIN	Weemelah
Yarrum	**30**	1.37	0.39	0.46	3.52	1.55
	60	1.42	0.39	0.37	3.77	1.67
	90	1.44	0.35	0.30	3.48	1.53
96.24	**30**	1.20	0.43	0.46	2.37	1.76
	60	1.18	0.45	0.40	3.38	1.85
	90	1.25	0.47	0.41	3.67	1.83
Boreen	**30**	1.14	0.32	0.41	2.08	1.45
	60	1.29	0.39	0.42	2.35	1.88
	90	1.40	0.37	0.43	2.56	1.93
Parafield	**30**	1.35	0.41	0.33	2.76	1.35
	60	1.37	0.50	0.36	3.06	1.50
	90	1.36	0.56	0.33	3.18	1.30
lsd MP*SP		**0.056**	**0.078**	**0.035**	**0.337**	

Row space experiments

SP (variety)	MP (row space cm)	Coonamble	Curban	Walgett	PBIN	Weemelah
Yarrum	**33**	1.39	0.49	0.29	3.13	1.47
	66	1.04	0.09	0.44	2.59	1.11
96.24	**33**	1.15	0.83	0.42	2.71	1.69
	66	0.93	0.19	0.55	2.21	1.42
Boreen	**33**	1.31	0.85	0.36	0.97	1.69
	66	0.96	0.22	0.53	0.65	1.44
Parafield	**33**	1.37	0.62	0.31	2.82	1.50
	66	0.98	0.21	0.47	2.03	1.27
lsd MP*SP		**0.115**	**0.068**	**0.091**	**0.25**	**0.112**

2007

Plant population experiments

SP (variety)	MP (plants /m^2)	PBIN
Yarrum	**30**	2.15
	60	2.43
	90	2.42
96.24	**30**	1.84
	60	2.47
	90	2.19
Boreen	**30**	1.01
	60	1.34
	90	1.44
Parafield	**30**	1.63
	60	1.86
	90	1.95
AP18 (Maki)	**30**	1.81
	60	2.22
	90	1.99
lsd MP*SP		

Row space experiments

SP (variety)	MP (row space cm)	PBIN
Yarrum	**33**	2.39
	66	1.94
96.24	**33**	2.47
	66	2.05
Boreen	**33**	1.38
	66	1.05
Parafield	**33**	1.94
	66	1.42
AP18 (Maki)	**33**	2.09
	66	1.62
lsd MP*SP		

2008

Plant population experiments		
SP (variety)	MP (plants /m^2)	PBIN
Yarrum	**30**	3.24
	60	3.30
	90	3.09
PRL95	**30**	3.35
	60	3.05
	90	2.83
PRL131	**30**	2.76
	60	2.67
	90	2.92
Parafield	**30**	1.46
	60	1.22
	90	1.11
AP18 (Maki)	**30**	2.63
	60	3.10
	90	2.86
Alezan	**30**	2.21
	60	2.76
	90	2.68
lsd MP*SP		**0.592**

Row space experiments		
SP (variety)	MP (row space)	PBIN
Yarrum	**33**	3.49
	66	2.76
PRL95	**33**	3.84
	66	2.81
PRL131	**33**	2.92
	66	2.68
PRL417	**33**	2.98
	66	2.23
Parafield	**33**	1.32
	66	0.87
AP18 (Maki)	**33**	2.80
	66	2.42
Alezan	**33**	2.98
	66	2.26
Bundi	**33**	1.66
	66	1.26
lsd MP*SP		**0.639**

APPENDIX 6: F2'S FOR SELECTION PBIN 2009

	Male			Female				
F2	**name**	**Leaf**	**Seed**	**name**	**Leaf**	**pedigree**	**ATFCC**	**Progeny**
SUNP001-1-1	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Dun/Maple
SUNP001-1-2	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Maple
SUNP001-1-3*1	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Maple
SUNP001-1-3*2	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Maple
SUNP001-3-1*1	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Maple
SUNP001-3-1*2	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Maple
SUNP001-3-1*3	Yarrum	SL	Dun	ATC07002	C	PI 193843	3430	Maple
SUNP002-1-2	Boreen	SL	White	ATC07003	C	PI 212916	1044	White
SUNP003-1-1	Yarrum	SL	Dun	ATC07009	C	CGN 3222	1306	Dun
SUNP003-1-2*1	Yarrum	SL	Dun	ATC07009	C	CGN 3222	1306	Maple/Dun
SUNP003-1-2*2	Yarrum	SL	Dun	ATC07009	C	CGN 3222	1306	Dun/Maple
SUNP003-1-3	Yarrum	SL	Dun	ATC07009	C	CGN 3222	1306	Dun
SUNP006-1-1*1	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	Blue/White
SUNP006-1-1*2	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-1-1*3	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-2-1*1	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	Blue
SUNP006-2-1*2	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-2-3	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	Blue
SUNP006-4-1*1	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White/Dun
SUNP006-4-1*2	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-4-2*1	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	Dun/White
SUNP006-4-2*2	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-4-3	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-5-2*1	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP006-5-2*2	Boreen	SL	White	ATCU07004	C	Rem-shou-da loi wam-da	3799	White
SUNP008-1-1*1	Yarrum	SL	Dun	ATCU07011	C	PI 193839	1299	Maple/Dun
SUNP008-1-1*2	Yarrum	SL	Dun	ATCU07011	C	PI 193839	1299	Maple/Dun
SUNP008-2-1	Yarrum	SL	Dun	ATCU07011	C	PI 193839	1299	Maple
SUNP009-2-1	Yarrum	SL	Dun	ATCU07012	C	JI 166	1395	Maple
SUNP037-1-1	95 - 1088	SL	White	Dawo			3489	Maple
SUNP037-1-2	95 - 1088	SL	White	Dawo			3489	Maple
SUNP038-1-1	Yarrum	SL	Dun	JI 594			1057	Maple
SUNP045-1-1	Bundi	SL	White	Yarrum	SL			Dun/White
SUNP045-1-2	Bundi	SL	White	Yarrum	SL			Dun/White
SUNP045-2-1	Bundi	SL	White	Yarrum	SL			Dun/White
SUNP045-2-2	Bundi	SL	White	Yarrum	SL			Dun
SUNP045-2-3	Bundi	SL	White	Yarrum	SL			Dun
SUNP045-3-2	Bundi	SL	White	Yarrum	SL			Dun
SUNP045-3-3	Bundi	SL	White	Yarrum	SL			Dun
SUNP045-4-1	Bundi	SL	White	Yarrum	SL			Dun/White
SUNP045-4-3	Bundi	SL	White	Yarrum	SL			Dun
SUNP046-1-1*1	Bundi	SL		Yarrum	SL			Dun/White
SUNP046-1-1*2	Bundi	SL		Yarrum	SL			Dun
SUNP046-1-2	Bundi	SL		Yarrum	SL			Dun
SUNP048-1-1	Yarrum	SL	Dun	Boreen	SL			Maple
SUNP048-1-2*1	Yarrum	SL	Dun	Boreen	SL			Dun/Maple
SUNP048-1-2*2	Yarrum	SL	Dun	Boreen	SL			Maple
SUNP048-3-1	Yarrum	SL	Dun	Boreen	SL			Maple/White
SUNP049-1-4	Yarrum	SL	Dun	Boreen	SL			White/Maple
SUNP049-2-1	Yarrum	SL	Dun	Boreen	SL			Maple
SUNP050-1-1	Yarrum	SL	Dun	95-1088	C			Maple/Dun
SUNP050-12-1	Yarrum	SL	Dun	95-1088	C			Dun
SUNP051-1-1	Yarrum	SL	Dun	95-1088	C			White
SUNP051-2-1	Yarrum	SL	Dun	95-1088	C			Dun
SUNP052-1-1	Boreen	SL	White	Kaspa	SL			Dun
SUNP053-1-1	Boreen	SL	White	Kaspa	SL			Dun
SUNP053-1-2	Boreen	SL	White	Kaspa	SL			White
SUNP053-2-1	Boreen	SL	White	Kaspa	SL			Dun/White
SUNP053-2-2	Boreen	SL	White	Kaspa	SL			Dun/White
SUNP053-2-3	Boreen	SL	White	Kaspa	SL			Dun/White
SUNP053-2-4	Boreen	SL	White	Kaspa	SL			Maple
SUNP053-3-1*2	Boreen	SL	White	Kaspa	SL			Dun/White
SUNP053-4-1	Boreen	SL	White	Kaspa	SL			Dun
SUNP053-5-1	Boreen	SL	White	Kaspa	SL			Dun
SUNP055-1-1	Boreen	SL		Yarrum	SL			Maple
SUNP056-2-1	Boreen	SL	White	Yarrum	SL			Dun
SUNP056-2-2	Boreen	SL	White	Yarrum	SL			Dun

APPENDIX 7: TRYPSIN INHIBITOR ACTIVITY PBI NARRABRI & LUNDAVRA

2006

	PBI Narrabri		Lundavra		
Name	Average I%	TIU/mg	Average I%	TIU/mg	Mean TIU/mg
98-276*1	43.68	4.96	54.08	6.14	**5.55**
92-104*10-1	47.39	5.38	49.94	5.67	**5.53**
98-184*17	43.16	4.90	51.49	5.85	**5.38**
98-276*3	37.65	4.28	55.71	6.33	**5.30**
Parafield	41.79	4.75	51.17	5.81	**5.28**
99-239*11	37.60	4.27	55.06	6.25	**5.26**
97-218*1-3	40.83	4.64	50.36	5.72	**5.18**
97-226*3-7	38.79	4.41	48.97	5.56	**4.98**
96-262*1	38.71	4.40	48.56	5.52	**4.96**
97-398*1-6	37.09	4.21	48.91	5.56	**4.88**
98-03*4	39.36	4.47	46.64	5.30	**4.88**
99RS-2-3-16	37.76	4.29	47.95	5.45	**4.87**
97-212*3-4	39.01	4.43	45.99	5.22	**4.83**
Mukta	41.85	4.75	43.07	4.89	**4.82**
97-223*2-5	37.28	4.23	47.58	5.40	**4.82**
92-104*6	37.35	4.24	47.09	5.35	**4.80**
97-236*1-6	38.76	4.40	45.17	5.13	**4.77**
97-340*4-1	36.52	4.15	46.45	5.28	**4.71**
Kaspa	33.03	3.75	49.67	5.64	**4.70**
97-241*6-4	36.42	4.14	46.17	5.24	**4.69**
OZP0610	34.35	3.90	46.70	5.30	**4.60**
97-223*2-1	32.25	3.66	48.37	5.49	**4.58**
98-03*7	35.21	4.00	44.78	5.09	**4.54**
Moonlight	29.92	3.40	50.00	5.68	**4.54**
97-170*3-11	38.31	4.35	41.26	4.69	**4.52**
98-64*2	37.25	4.23	41.54	4.72	**4.47**
98-03*19	32.26	3.66	46.18	5.25	**4.45**
Sturt	34.91	3.96	43.40	4.93	**4.45**
98-03*18	30.48	3.46	46.66	5.30	**4.38**
99-188*5	34.54	3.92	42.56	4.83	**4.38**
97-223*2-3	34.46	3.91	42.39	4.82	**4.36**
96-262*3	30.86	3.51	44.46	5.05	**4.28**
97-64*2-7	33.89	3.85	41.06	4.66	**4.26**
96-48	28.40	3.23	46.03	5.23	**4.23**
97-230*6-1	30.03	3.41	43.86	4.98	**4.20**
98-389*1	26.57	3.02	47.29	5.37	**4.19**
Yarrum	31.26	3.55	41.82	4.75	**4.15**
97-222*1W	31.58	3.59	41.26	4.69	**4.14**
97-333*2-1	26.73	3.04	46.04	5.23	**4.13**
98.283*11	37.90	4.30	33.65	3.82	**4.06**
89P166-5-2	26.18	2.97	45.26	5.14	**4.06**
96-35	30.52	3.47	40.75	4.63	**4.05**
98-319*11	29.39	3.34	40.51	4.60	**3.97**
92-102*17-	27.71	3.15	41.90	4.76	**3.95**
98-275*4	29.78	3.38	38.20	4.34	**3.86**
95-1088	29.67	3.37	36.09	4.10	**3.73**
96-33	27.16	3.08	32.56	3.70	**3.39**
98-276*9	22.77	2.59	35.89	4.08	**3.33**
97-064*6-4	28.76	3.27	29.29	3.33	**3.30**
99-059*13	26.13	2.97	31.51	3.58	**3.27**
98-67*18	16.75	1.90	40.42	4.59	**3.25**
95-032*10-3	23.86	2.71	29.01	3.29	**3.00**
Boreen	21.25	2.41	30.10	3.42	**2.92**
AP7	26.36	2.99	22.69	2.58	**2.79**
Cressy Blue	13.34	1.52	33.43	3.80	**2.66**
Maki (AP18)	21.88	2.49	13.34	1.52	**2.00**
Mean	**32.80**	**3.73**	**42.86**	**4.87**	**4.30**

2007

	PBI Narrabri		Lundavra		
Name	**Average I%**	**TIU/mg**	**Average I%**	**TIU/mg**	**Mean TIU/mg**
95-032*10-3	51.66	5.87	43.95	4.99	**5.43**
92-104*6	51.32	5.83	42.04	4.78	**5.30**
92-104*10-1	39.02	4.43	53.97	6.13	**5.28**
92-105*1-2	42.70	4.85	43.70	4.96	**4.91**
96-262*1	46.47	5.28	39.00	4.43	**4.85**
98-03*4	36.31	4.12	48.78	5.54	**4.83**
97-223*2-1	48.89	5.55	35.24	4.00	**4.78**
96-262*3	35.71	4.06	47.04	5.34	**4.70**
99-048*14	39.58	4.50	42.42	4.82	**4.66**
97-064*4-7	38.61	4.38	42.20	4.79	**4.59**
Excel	48.41	5.50	31.87	3.62	**4.56**
98-316*10	38.50	4.37	41.62	4.73	**4.55**
98-067*19	29.48	3.35	50.10	5.69	**4.52**
98-311*7	45.97	5.22	33.06	3.75	**4.49**
98-283*11	27.85	3.16	49.17	5.59	**4.37**
97-236*1-5	35.11	3.99	40.20	4.57	**4.28**
97-222*1W	39.64	4.50	34.77	3.95	**4.23**
98-308*26	34.76	3.95	37.03	4.21	**4.08**
97-223*2-5	36.48	4.14	34.57	3.93	**4.04**
Sturt	50.27	5.71	19.94	2.26	**3.99**
98-03*19	34.65	3.94	35.50	4.03	**3.98**
95-1088	40.43	4.59	29.53	3.35	**3.97**
Yarrum	21.43	2.43	47.45	5.39	**3.91**
97-064*2-7	33.59	3.82	34.77	3.95	**3.88**
Kaspa	27.04	3.07	41.00	4.66	**3.86**
96.33	31.20	3.54	36.64	4.16	**3.85**
98-64*2	35.41	4.02	32.20	3.66	**3.84**
98-274*6	27.44	3.12	38.47	4.37	**3.74**
Alezan	29.93	3.40	35.89	4.08	**3.74**
97-064*6-4	29.79	3.38	35.40	4.02	**3.70**
98-03*7	34.20	3.88	29.06	3.30	**3.59**
97-241*6-4	30.99	3.52	31.19	3.54	**3.53**
Parafield	32.58	3.70	28.71	3.26	**3.48**
PRL417	24.98	2.84	35.67	4.05	**3.44**
PRL131	21.21	2.41	39.35	4.47	**3.44**
98-063*2	26.30	2.99	33.90	3.85	**3.42**
98-67*18	31.70	3.60	28.50	3.24	**3.42**
97-236*1-6	23.68	2.69	35.85	4.07	**3.38**
97-298*2-2	24.93	2.83	33.58	3.81	**3.32**
98-275*4	28.75	3.27	28.38	3.22	**3.24**
98-274*10	25.73	2.92	30.68	3.48	**3.20**
OZP0610	26.76	3.04	28.45	3.23	**3.14**
97-223*4	26.51	3.01	24.18	2.75	**2.88**
Boreen	27.51	3.12	18.29	2.08	**2.60**
Bundi	22.71	2.58	22.13	2.51	**2.55**
AP7	24.63	2.80	19.06	2.17	**2.48**
Cressy Blue	31.21	3.54	12.34	1.40	**2.47**
Maki (AP18)	20.52	2.33	22.89	2.60	**2.47**
Mean	**121.68**	**4.51**	**40.14**	**4.56**	**4.53**

COMMON VARIETIES BOTH SITES 2006 & 2007

	2006		2007				
Name	PBIN TIU/ mg	Lundavra TIU/mg	PBIN TIU/mg	Lundavra TIU/mg	Mean PBIN 2006 & 2007	Mean Lundavra 2006& 2007	Mean sites/years
92-104*10-1	5.38	5.67	4.43	6.13	4.91	5.90	**5.40**
92-104*6	4.24	5.35	5.83	4.78	5.04	5.06	**5.05**
96-262*1	4.40	5.52	5.28	4.43	4.84	4.97	**4.91**
98-03*4	4.47	5.30	4.12	5.54	4.30	5.42	**4.86**
97-223*2-1	3.66	5.49	5.55	4.00	4.61	4.75	**4.68**
96-262*3	3.51	5.05	4.06	5.34	3.78	5.20	**4.49**
97-223*2-5	4.23	5.40	4.14	3.93	4.19	4.67	**4.43**
Parafield	4.75	5.81	3.70	3.26	4.22	4.54	**4.38**
Kaspa	3.75	5.64	3.07	4.66	3.41	5.15	**4.28**
98-03*19	3.66	5.25	3.94	4.03	3.80	4.64	**4.22**
Sturt	3.96	4.93	5.71	2.26	4.84	3.60	**4.22**
95-032*10-3	2.71	3.29	5.87	4.99	4.29	4.14	**4.22**
97-222*1W	3.59	4.69	4.50	3.95	4.04	4.32	**4.18**
98-64*2	4.23	4.72	4.02	3.66	4.13	4.19	**4.16**
97-241*6-4	4.14	5.24	3.52	3.54	3.83	4.39	**4.11**
97-236*1-6	4.40	5.13	2.69	4.07	3.55	4.60	**4.07**
97-064*2-7	3.85	4.66	3.82	3.95	3.83	4.31	**4.07**
98-03*7	4.00	5.09	3.88	3.30	3.94	4.19	**4.07**
Yarrum	3.55	4.75	2.43	5.39	2.99	5.07	**4.03**
OZP0610	3.90	5.30	3.04	3.23	3.47	4.27	**3.87**
95-1088	3.37	4.10	4.59	3.35	3.98	3.73	**3.85**
96.33	3.08	3.70	3.54	4.16	3.31	3.93	**3.62**
98-275*4	3.38	4.34	3.27	3.22	3.32	3.78	**3.55**
97-064*6-4	3.27	3.33	3.38	4.02	3.33	3.67	**3.50**
98-67*18	1.90	4.59	3.60	3.24	2.75	3.91	**3.33**
Boreen	2.41	3.42	3.12	2.08	2.77	2.75	**2.76**
AP7	2.99	2.58	2.80	2.17	2.90	2.37	**2.63**
Cressy Blue	1.52	3.80	3.54	1.40	2.53	2.60	**2.56**
Maki (AP18)	2.49	1.52	2.33	2.60	2.41	2.06	**2.23**
Mean	**3.61**	**4.61**	**3.92**	**3.82**	**3.77**	**4.21**	**3.99**

APPENDIX 8: MAJOR EXTENSION EFFORTS

Year	Type	Date	Location	Comments
2006	Grower/Advisor update	28th February	Goondiwindi	GRDC
	Field Day	25th September	Narrabri	Univ of Sydney
	Field Day		Weemelah	NSWDPI
	Field Day		North Star	NSWDPI
2007	Grower/Advisor update		Goondiwindi	GRDC
	Field Day	25th September	Narrabri	Univ of Sydney
	Field Day		Weemelah	NSWDPI
	Field Day		North Star	NSWDPI
	Field Day		Coonamble	
	Field Day		Billa Billa	QDPI
	RAC Meeting	4th September	Narrabri	RAC
2008	Grower meetings	19th February	Coonamble	NSWDPI/PA
	Grower meetings	19th February	Walgett	NSWDPI/PA
	Grower meetings	20th February	Narrabri	NSWDPI/PA
	Grower meetings	21st February	Garah	NSWDPI/PA
	Grower meetings	21st February	Warialda	NSWDPI/PA
	Field Day	23rd September	Narrabri	Univ of Sydney
	Field Day	17th October	Purlewaugh	NSWDPI
	Field Walk	21st October	Clifton	QDPI

APPENDIX 9: COMPARISON OF CHICKPEA AND FIELD PEA RETURNS

Southern Queensland

	Yield (t/Ha)		*Price ($/t)*		*Costs ($/t)*	*GM ($/Ha)*
Chickpea Average:	1.4	@	$400	less	$350	$210
Field Pea	2.0	@	$255	less	$300	$210
Comparison:	1.5	@	$340	less	$300	$210

For field pea to be competitive gross return $/t

$255 to **$340**

Northern NSW (East)

	Yield (t/Ha)		*Price ($/t)*		*Costs ($/t)*	*GM ($/Ha)*
Chickpea Average:	1.5	@	$450	less	$441	$234
Field Pea	2.0	@	$283	less	$331	$234
Comparison:	1.5	@	$377	less	$331	$234

For field pea to be competitive gross return $/t

$283 to **$377**

APPENDIX 10:

MAKI PBR
field pea

AGT
Australian Grain Technologies

fact sheet for eastern Australia

Key Features

- Green seeded blue pea
- Mid maturing variety
- High and stable yield
- Powdery mildew resistant and downy mildew tolerant
- Suitable for stock feed or human consumption

Plant Characteristics

Maki is a mid season maturing, semi leafless field pea with white flowers. Maki has a very erect growth habit of medium height. See Table 2 for detailed characteristic information.

Adaption and Yield

Maki was first tested in the National Variety Trial (NVT) program in 2008, across New South Wales. Table 1 presents the yields of Maki and comparator varieties in a number of trials across NSW in 2008, highlighting the varieties yield potential in different environments.

Grain Quality

Maki is a green seeded blue type pea, that is suitable for human consumption or stock feed. The variety produces samples with a low hard seed count, and shows good resistance to seed bleaching.

Disease Profile

Maki has a good level of resistance to downy mildew, and, unlike many currently available pea varieties, is resistant to powdery mildew. Maki is also resistant to pea seed-borne mosaic virus, and has a high level of resistance to bean leafroll virus. See Table 2 for detailed disease data.

Breeding

Maki was tested in Australia as AP18.

SEEDS FOR SUCCESS

MAKI data February 2009

Table 1. Yield of Maki and control varieties (% of site mean) across New South Wales sites in the National Variety Trial program 2008.

Variety	Goonumbla	Trangie	Brocklesby	Temora	Condobolin	All NSW
Maki	**119**	**140**	**88**	**96**	**89**	**114**
Bundi	99	90	78	120	102	99
Excell	63	60	-	59	48	-
Kaspa	100	77	106	83	102	90
Morgan	81	63	105	86	110	82
Parafield	81	84	121	92	130	92
Sturt	86	91	79	114	137	98
SW Celine	126	141	122	122	117	128
Yarrum	120	132	107	81	106	112
Site Mean t/ha	2.7	2.9	1.0	2.3	0.8	1.9

Table 2. Disease ratings and plant characteristics for Maki and control varieties.

Variety	Plant Characteristics			Disease		
	Type	Leaf Type	Height	Bacterial Blight*	Downy Mildew	Powdery Mildew
Maki	**Blue**	**SL**	**M**	**S**	**MR-MS**	**R**
Bundi	White	SL	M	S	S	MS
Excell	Blue	SL	M	S	MR	S
Kaspa	Dun	SL	M	S	MR	S
Morgan	Dun	SL	T	MR	R	S
Parafield	Dun	C	T	MR-MS	S	S
Sturt	White	C	T	MR-MS	MS	S
SW Celine	White	SL	M	S	MR-MS	S
Yarrum	Dun	SL	M-S	MR-MS	S	R

R = Resistant, MR = Moderately Resistant, MS = Moderately Susceptible, S = Susceptible, VS = Very Susceptible, SL = Semi-leafless, C = Conventional, T = Tall, M = Medium, S = Short. * Resistance only demonstrated to the Bacterial blight pathovar *Pseudomonas syringae pv syringae*.
Source: NSW DPI Winter Crop Variety Sowing Guide 2009.

Seed Availability

Commercial quantities of Maki seed will be available for 2009 through an AGT Affiliate: Agrigrain: (02) 6889 2200, Auswest Seeds: (02) 6852 1500, Baker Seed Co.: (02) 6032 9484, Hart Brothers Seeds: (02) 6924 7206, Highleaze Seeds: (03) 5345 6431, Superior Seed Co.: (03) 5881 6689, or your local retailer.

Plant Breeders Rights

Maki is protected by PBR and all production (except seed saved for planting) is liable to an End Point Royalty (EPR), which funds future plant breeding. Maki growers will be subject to a Growers Licence Agreement that acknowledges that an EPR of $4.00/tonne plus GST has to be paid on all production other than seed saved for planting.

Acknowledgements

Maki was bred in New Zealand by Plant Research NZ Ltd., and identified and tested by the University of Sydney Plant Breeding Institute (PBI), Narrabri. This program was supported by the Pork CRC.

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