Office Use Only

Project Code	AAC114
Project Type	Research

FINAL REPORT 2016

Applicants must read the *SAGIT Project Funding Guidelines 2016* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be emailed to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.

PROJECT CODE :	**AAC114**

PROJECT TITLE (10 words maximum)
Assessing the adaptation of long season wheats in South Australia

PROJECT DURATION

*These dates **must** be the same as those stated in the Funding Agreement*

Project Start date	**15/03/2014**					
Project End date	15/03/2016					
SAGIT Funding Request	2013/14	$	2014/15		2015/16	

PROJECT SUPERVISOR CONTACT DETAILS

The project supervisor is the person responsible for the overall project

Title:	**First Name:**	**Surname:**
Mr	Jeffrey	Braun
Organisation:		
Agrilink Agricultural Consultants (Australia) Pty Ltd		
Mailing address:		

Telephone:	**Facsimile:**	**Mobile:**	**Email:**

ADMINISTRATION CONTACT DETAILS

The Administration Contact is the person responsible for all administrative matters relating to the project

Title:	**First Name:**	**Surname:**
Mr	Michael	Faulkner
Organisation:		
Agrilink Agricultural Consultants (Australia) Pty Ltd		
Mailing address:		

Telephone:	**Facsimile:**	**Mobile:**	**Email:**

PROJECT REPORT

Provide clear description of the following:

Executive Summary (200 words maximum)

A few paragraphs covering what was discovered, written in a manner that is easily understood and relevant to SA growers. A number of key dot points should be included which can be used in SAGIT communication programs

Over the term of the project, we were able to identify the following key learnings:

- There are longer season wheat varieties and breeding lines, both long season spring types and winter types, that are well suited to very early sowing at two representative South Australian environments.
- The drivers of phenology are an important consideration. The genetic control of maturity driven by temperature, photoperiod, vernalisation and earliness per se must be considered when changing sowing time
- Adapted long season varieties sown very early yielded equal to or higher than main season wheat varieties that were sown at their current recommended time
- The traditional sowing window can be extended 4-6 weeks earlier to make the most of early seasonal breaks and opportunities with the right combination of genetics for phenological development
- Profitability could be enhanced by growing long season wheat where farmers' have large areas to sow and the opportunity to sow early outweighs the penalty of sowing main season wheat varieties too late
- Sowing long season wheat may provide an opportunity for earlier sowing where frost is a risk
- Deliverable quality of at least ASW was required for long season wheat varieties to ensure profitability equivalent to achieving APW/AH with early to mid-maturity varieties sown at their main season timing

Project Objectives

A concise statement of the aims of the project in outcome terms should be provided.

The aims of this project were to determine:

1) Can the profitability of wheat in South Australia be improved by sowing long season varieties early when the opportunity arises?

2) Are there any varieties currently available that are adapted to South Australia's unique combination of soils and climates?

3) Is there potential to improve whole farm profitability by ensuring that all wheat/other crops are sown in their respective "optimum" sowing window?

Overall Performance

A concise statement indicating the extent to which the Project objectives were achieved, a list of personnel who participated in the Research Project including co-operators, and any difficulties encountered and the reasons for these difficulties.

The project objectives were achieved by this project over the two years. Trial sites were contrasting, yet representative of a wider area of South Australia. Results obtained are highly relevant to growing wheat over a wide area of South Australia and should influence cultivar choice and sowing time to take advantage of early seeding opportunities .

There were two trial sites in each year; Paskeville and Riverton. Collaborators involved were Mick Faulkner and Jeff Braun, Agrilink, managers of the Riverton site and Leighton Wilksch, Agbyte, manager of the Paskeville site.

Difficulties encountered in this project were driven by the distance between the trial sites. Monitoring of site and environmental conditions and collaborator performance at Paskeville was difficult.

There was poor establishment at Paskeville due to mice (2014) and significant volunteer wheat contamination in 2015. Both factors influence the value of results obtained at this site. There was a difference in the management of trials between collaborators with Paskeville being below expectations. In hindsight, the expectations and operations of the Paskeville site should have been more fully articulated and monitored to ensure industry standards were met. Environmental conditions affected the results of the trials with frost at Riverton (2014 & 2015) and very dry seasonal conditions (2015) at Paskeville having a very severe effect on plot yields and overall results. However, it could be stated that these seasonal conditions are what could be expected over a normal range for each site.

The fact that frost adversely affected yields of the very early sown plots at Riverton in both years, indicates the outcome of sowing main season wheat varieties too early.

The dry seasonal conditions at Paskeville in 2015 resulted in little variation in yield, making it difficult to determine the rank of varieties. These conditions did, however, prove that there are a number of longer season varieties adapted to terminal drought conditions.

Key Performance Indicators (KPI)

*Please indicate whether KPI's were achieved. The KPI's **must** be the same as those stated in the Application for Funding and a brief explanation provided as to how they were achieved or why they were not achieved.*

KPI	*Achieved (Y/N)*	*If not achieved, please state reason.*
Establish 2x replicated trial sites (YP, Mid North) 2014	Y	
Harvest and analyse results from the trial sites 2014	Y	
Interim progress report completed and accepted 2015	Y	
Extend research findings to broader agricultural community 2015	Y	
Refine treatments in trials based on initial findings, establish 2x replicated trials sites (YP, Mid North) 2015	Y	
Harvest and analyse results from the trial sites 2015	Y	
Final report completed and accepted by SAGIT 2016	N	Dependent upon this report being accepted
Extend research finding to broader agricultural community 2016	Y	

Technical Information (Not to exceed **three** pages)

Provide sufficient data and short clear statements of outcomes.

2014 YIELD

Yield varied between sites, both with highly significant variety x time of sowing (TOS) effects. The yield results for Paskeville (**Figure 1, Appendix 1**) and Riverton (**Figure 2, Appendix 1**) are displayed in the attached Appendix.

***TOS 1 Paskeville (02/04/2014)*:** The yields of the mid-late season spring wheats Beaufort, Bolac, Gazelle, Lancer, Trojan and Yitpi were significantly higher than all other varieties at this time of sowing. This result demonstrates that well adapted varieties, such as Mace, can be sown too early, resulting in yields lower than if they were sown later, in their preferred time window. The winter types and some of the late spring varieties did not perform well, indicating they may be poorly adapted to the soil type.

***TOS 2 Paskeville (29/04/2014)*:** The yields of Trojan and Yitpi were significantly higher than most other varieties demonstrating how well adapted they are to this environment. Both varieties have photoperiod responsive developmental triggers, which allows them to be planted early, but "hold back" development.

***TOS 1 Riverton (30/03/2014)*:** Yields were highly variable, in part due to frost events during August and September. Early-mid and many of the mid-late spring wheat varieties were frosted during early head emergence, pre flowering, at flowering or during grain fill , resulting in very low yields. Late season varieties Beaufort, Eaglehawk, Forrest, Wedgetail and Whistler, irrespective of their phenological drivers, were all able to produce yields in excess of 5.5 t/ha indicating significant potential for early sowing

***TOS 2 Riverton (28/04/2014)*:** Well adapted, early-mid (Cobra, Mace) and mid-late (Trojan) produced the highest yields proving the value of sowing well adapted, main season varieties on time. The winter and late spring lines generally produced slightly lower yields, with the exception of Beaufort, Wedgetail, Rosella and Whistler which yielded in excess of 5.5 t/ha.

2014 GRAIN PROTEIN

Grain protein (**Table 1, Appendix 1**) at Paskeville was generally lower at the first time of sowing than the second. As grain fill occurred in cooler conditions for many varieties and there was adequate soil moisture, this result was somewhat predictable. High yields also resulted in protein dilution.

At Riverton, the protein was very high at the first time of sowing for varieties that suffered yield loss due to frost, Varieties that yielded well had significantly lower grain protein levels. Grain yield and protein were used for a simple financial analysis in addition to the maximum grade achievable for that variety in South Australia. Prices used are listed in **Table 2, Appendix 1**.

2014 ECONOMICS

Grain yield and protein were used to produce a simple financial analysis (See **Figure 3 & Figure 4, Appendix 1**). Other grain quality parameters such as screenings or test weight were not used to grade varieties for this analysis. It is acknowledged that there are potential downgrades due to higher screenings and lower test weight, especially for those varieties that were frost affected at Riverton.

From this simple analysis, very early sowing (TOS 1) of mid-late season varieties that could achieve APW grade or better was most profitable at Paskeville. The exception was Beaufort (Feed in SA)., Its very high yield at TOS 1, produced a high return highlighting the contribution that yield makes to financial return.

The second time of sowing at Paskeville (TOS 2) showed well adapted varieties (Mace, Yitpi, Trojan, Kiora, Estoc) resulted in the highest gross income. The profitability of these varieties at TOS 2 equaled, or exceeded, those of many longer season varieties at TOS 1.

The Riverton site proved that sowing varieties whose phenological drivers result in early maturity can result in catastrophic financial implications. The main driver for this result is the damage due to frost but there also are potential impacts of low radiation or inadequate biomass production. At this site however, some of the late season varieties at TOS 1were able to perform similarly to early-mid season varieties sown at TOS 2.

The results highlight the importance of varietal evaluation at two distinct environments within South Australia. Some varieties that appear to be poorly adapted at Paskeville have performed well at Riverton.

Some varieties that are adapted to interstate soils and environments appear less well adapted to the 1) soils and subsoils at Paskeville and 2) warmer temperatures that enhance phenological development but may not produce sufficient biomass essential for high yields.

2015 GROWTH STAGES

Detailed phenology data (Zadock's growth stages) was recorded at both sites for each time of sowing. This was used to assess each variety at the two sowing dates, to flower in the preferred "flowering window". , We have assumed an acceptable flowering window of 10 days at each site with the ideal window for Paskeville being the 1-10th September (Julian Day 244-253) and for Riverton being the 10th-20th September (Julian Day 253-263). These dates were derived using APSIM data courtesy of CSIRO. Growth stages by time of sowing and variety are presented for Paskeville in **Tables 3 & 4, Appendix 2** and Riverton in **Tables 5 & 6, Appendix 2**.

2015 YIELD

Yield varied dramatically between sites in 2015. Paskeville experienced one of its driest years on record, whereas Riverton recorded average rainfall for the year, albeit with below average spring rainfall. Despite this, both sites recorded highly significant TOS x variety effects.

Results for Paskeville and Riverton are displayed in **Figures 1** and **Figure 2** respectively in **Appendix 2**.

TOS 1 Paskeville *(30/03/2015)*: The yield of longer season spring wheats Beaufort, DS 08.0169 and Chara were the highest. despite poor seasonal conditions. The results highlight the importance and value of varieties that are adapted to the soil types and climatic conditions of the site. Each of these varieties demonstrated adaptibility by flowering early and filling grain prior to serious moisture deficit and heat stress.

TOS 2 Paskeville *(23/04/2015)*: Trojan, Estoc and Lancer were the highest yielding varieties. Each of these varieties has some photoperiod sensitivity, which has enabled them to flower and fill grain in the ideal window for this environment, despite the dry seasonal conditions. This result again shows the value of well adapted wheats sown in their ideal sowing window.

TOS 1 Riverton *(28/03/2015)*: Yield at Riverton was highly variable due to frost events in June, July and September. Yield varied from 2.5-6.5t/ha, with the lower yields associated with temperature sensitive (more rapid early development) varieties. These types were at a more advanced stage at, or prior to anthesis, when frost events occurred. Beaufort and Whistler again demonstrated their ability for high yield in this environment at very early times of seeding.

TOS 2 Riverton *(24/04/2015)*: Trojan, Cobra, Mace and Estoc produced the highest yields. Each of these varieties is well adapted and despite some flowering slightly earlier than is considered ideal, high yields were still able to be achieved. Even though spring rainfall was extremely low, these varieties were able to fill grain due to their earlier maturity and partly due to their adaptibilty.

2015 GRAIN PROTEIN

Grain protein (**Table 1, Appendix 2**) at Paskeville were again generally lower at the first time of sowing than the second. The conditions for grain development and ripening are likely to have been more favourable for TOS 1 than TOS 2.. Lower protein levels achieved at this site are a reflection of paddock history (low soil nitrogen) and dry conditions restricting nitrogen uptake.

At Riverton, the protein of varieties sown at TOS 1 were highly variable, ranging from 9.6-17.7% (See **Table 1, Appendix 2**). This is largely an effect of yield dilution, with higher protein plots experiencing yield loss due to frost. The range of protein between varieties at TOS 2 was considerably less, but there were differences in grain protein between varieties. There was an association with yield diliution, but not to the same extent as TOS 1.

Grain protein was used as the basis for a simple financial analysis with grain yield and the maximum grade achievable for each variety in South Australia. Prices used are listed in **Table 2, Appendix 2**. For unclassified varieties/breeders lines, it has been assumed that their minimum classification in SA, would be APW, in line with the majority of recent commercial releases in the state.

2015 FINANCIAL ANALYSIS

Grain yield and protein responses for each variety at both times of sowing have been combined to produce a simple financial analysis for each site (See **Figures 3 & 4, Appendix 2**). It is acknowledged that there are other factors (screenings, test weight, physical grain characteristics) that are used to assess grain quality, however the analyses of these factors was beyond the scope of this project. This simple analysis may inadvertently favour lower yielding treatments (i.e. frosted) as they tended to produce higher protein grain. In reality they may have been downgraded for other parameters had they been tested.

Using this simple analysis, it can be seen that very early sowing (TOS 1) of mid-late season varieties that could achieve ASW grade or better, was most profitable at Paskeville. The Dow Seeds breeding line 08.0169, Chara and Whistler produced the highest gross income at this

time of sowing. Each of these varieties exhibits mid-late maturity, making them well suited to early sowing in this warmer, shorter season environment.
The second time of sowing (TOS 2) at Paskeville showed the value of sowing well adapted varieties (Estoc, Lancer, Trojan) in their preferred seeding window (Late April). The profitability of these varieties sown at the second time of seeding matched and often exceeded many of the other longer season varieties sown at TOS 1.
The Riverton site again proved that sowing certain varieties too early can result in severely negative financial implications, due primarily to frost. Note that Riverton is generally not regarded as a location with a high incidence or risk of frost. Once again, varieties that could achieve ASW or greater quality are favoured in the financial analysis. The Riverton site, with cooler winters and longer spring, highlights the role for well adapted winter wheats in this, and similar, environments. The varieties Whistler, Wedgetail and Longreach Plant Breeders line 11.0032 are in the top 3 for yield and financial return at TOS 1. At TOS 2, the well adapted main season varieties Gazelle, Cobra and Trojan ranked in the top 3 for yield and financial return.
2014 Anthesis Dry Matter (**Table 3, Appendix 1)**, 2014 Harvest Index (**Table 4, Appendix 1**) and 2015 Harvest Index (**Table 7, Appendix 2**) data can also be seen in the Appendices.

Conclusions Reached &/or Discoveries Made (Not to exceed one page)

Please provide concise statement of any conclusions reached &/or discoveries made.

The results from both environments and seasons produced very similar over-all project conclusions:

1) There appears to be significant potential to sow long season wheat varieties in many environments in South Australia in response to early season rainfall. There is also an opportunity to use long season wheat to enable early sowing but to not advance maturity to reduce frost impacts. A simple analysis of Bureau of Meteorology rainfall data to determine a sowing opportunity (10mm of rainfall in a day, from 15th March – 15th April) for Riverton, Paskeville, Cummins and Bordertown, reveals that these conditions occur in 72%, 55%, 64% and 64% respectively for each location in the years 2006-2016. The adoption of well adapted winter or long season spring varieties could allow early seeding and provide yield increase and profitability of wheat in the state.

2) Very early (before Mid April), requires varieties with sufficient developmental "holds" to allow flowering in the appropriate window for optimal yield for each environment. Many growers are capable of sowing large areas in short periods of timewhich may negate the uptake of long season wheat in SA in favour of using main season varieties sown in a narrow time frame where possible. However, in environments where 1)frost is an issue, 2)time of seeding is unable to optimized due to scale or 3) waterlogging may be an issue,, well adapted long season varieties have a definite role.

3) 2014 results appeared to indicate that long season varieties from interstate programs were not adapted to growing conditions in SA. However, there has been consistency of performance in some of these varieties that could be used for higher yields and in breeding programs. The winter wheat Whistler (released by NSW DPI in 1998), as an example, appears well adapted and able to produce high yields at early times of seeding with acceptable deliverable quality (ASW). The results further emphasise that quality is important and that yield alone is not the only determinant of crop profitability.

4) To maximize the profitability of longer season wheats we have concluded that the lowest deliverable quality should be ASW. Feed wheats appear to have very high yield

potential (e.g. Beaufort), but over-all profitability per hectare is limited by the price differential at delivery unless pricing equivalent to ASW is achieved. Storage and delivery of feed wheat at acceptable prices really only an option for areas with a significant animal feed industry (Mid North, Yorke Peninsula, South East and to a lesser extent, Mallee regions).

Intellectual Property

Please provide concise statement of any intellectual property generated and potential for commercialisation.

N/A

Application / Communication of Results

A concise statement describing activities undertaken to communicate the results of the project to the grains industry. This should include:

- *Main findings of the project in a dot point form suitable for use in communications to farmers;*
- *A statement of potential industry impact*
- *Publications and extension articles delivered as part of the project; and,*
- *Suggested path to market for the results including barriers to adoption.*

Note that SAGIT may directly extend information from Final reports to growers. If applicable, attach a list of published material.

Communication of the results has largely been conducted electronically by sending each years results to industry contacts and asking to share them widely. These contacts include the Independent consultants group, farming systems groups e.g. Mid North High Rainfall Zone, Reseller agronomists, CSIRO, University of Adelaide and SARDI. We feel that this has given the project and findings sufficient exposure to a great percentage of the farming areas of South Australia.

In conjunction with electronic distribution, speaking roles at farming systems group field days e.g. Hart, Northern Sustainable Soils, Mid North High Rainfall Zone has exposed the results to other people that may not be covered by the electronic distribution method.

Key findings in the project have been:

- Many longer season varieties are well adapted to South Australia's climate and soil types, often producing yields when sown very early similar to or exceeding those of main season wheat varieties sown later.
- The opportunity exists to advance seeding by up to 6 weeks in 50-75% of years across a range of environments. Using long season wheat varieties has a major fit for very early sowing.
- Profitability of growers can be improved by sowing long season wheats early, especially in large seeding programs, areas with frost risk that would not normally be sown early and areas that may experience winter waterlogging.
- Choosing varieties that are able to be delivered as a minimum ASW quality ensures that profitability per hectare is optimized and often exceeds that of higher quality wheats (APW+) due to the yield advantages achieved by sowing very early.

These results have a large potential impact on the South Australian wheat growing industry due to:

1) The ability to sow a long season variety early and utilize out of season rainfall that may otherwise evaporate or be used by weeds. Current seeding systems allow seeding on smaller rainfall events.
2) Profitability has been improved by up to $200/ha where long season varieties sown early are able to be delivered as ASW quality or better.
3) Establishment of a crop in a period of time where many annual weeds e.g. annual ryegrass have not broken dormancy. Early sowing produces very competitive crops. .
4) Financial risk may be reduced by having a suite of varietal choice that develop in a different phenological way or have different inherent maturity to main season wheat varieties. This can reduce frost and seasonal risk, as well as allowing earlier seeding on a greater percentage of the cropping program

There have been two extension articles writing about the findings of the project: SAGIT Long Season Wheat 2014 and 2015. They are attached in addition to the Appendices.

Path to market is already established with progressive farmers taking the opportunity since the project inception to sow long season wheat early when the opportunity arises. This has been particularly relevant in 2016 where some farmers have adopted the findings of these trials and sown long season wheat as early as mid-March. This has largely been a strategy to 1) promote early growth on bare, fire affected ground as a result of the Pinery bushfire 2) to provide early livestock feed with dual purpose intent and 3) to maximize yield.

Commercial breeding companies realize that there is a potential market niche for such varieties as attested to by breeding lines RAC 2341 (AGT), Longreach LPB 11-0140 and Dow Seeds breeding lines. These varieties are undergoing local evaluation at the time of writing this report and there may be commercial releases over the next few seasons.

We believe that the barriers to adoption of this technology primarily revolve around the desire of many growers to keep their operations simplified e.g. one variety of wheat. There may also be some apprehension to adopt varieties that have been bred interstate, as they are perceived as being not adapted to local conditions. Similarly, AGT amongst other companies have an outstanding record of breeding varieties that are very well adapted to South Australian conditions, further limiting the uptake of some of the long season varieties. This may be set to change with locally adapted long season varieties currently being bred.

A further barrier to adoption is the risk of pest species and viral and fungal diseases associated with early sowing.

POSSIBLE FUTURE WORK

Provide possible future directions for the research arising from the project including potential for further work and partnerships.

As a result of the work in this project in 2014 and 2015, we felt there was further scope to improve the yields of long season wheat in South Australia by focusing on agronomic management of the varieties. The basis of this further research is based on canopy management work conducted by Agrilink over the last decade, in which specific management strategies have produced yield 20-30% higher than site mean yields. These management strategies would include pest and disease management, nitrogen rate and timing and plant growth regulator application, with the aim of producing variety

specific agronomy packages.
We applied for further SAGIT funding for the 2016 and 2017 seasons to continue this work, but were unsuccessful. Agrilink has chosen to pursue this work on a self-funded basis at this point in time, with the aim of increasing the value we can offer to our own client base.

AUTHORISATION
Name: Jeff Braun
Position: Senior Consultant
Signature:
Date: 19/05/2016

Submit report via email to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.

"Assessing the adaption of long season wheats in South Australia, 2014"

Jeff Braun and Mick Faulkner, Agrilink Agricultural Consultants Pty Ltd, jeffbraun@bigpond.com

Key Outcomes:

- Maturity drivers are an important consideration for wheat production. When opportunities arise to sow very early, some long season varieties yielded well. Mainstream varieties that are well adapted to sowing in May can perform poorly.
- Trojan wheat produced excellent yields at both sites, however suffered significant yield loss due to frost at Riverton when sown at the end of March.
- Optimum profitability was obtained by growing high yielding wheat. Quality was less important but still had some influence on profitability.

Trial Objectives:

1) To determine if the profitability of wheat in South Australia can be improved by sowing long season varieties early when the opportunity arises

2) Investigate if there are any long season varieties currently available that are adapted to South Australia's unique combination of soils and climates

3) To determine if there is potential to improve whole farm profitability by ensuring that all wheat/other crops are sown in their respective "optimum" sowing window

Trial Duration: 2014

Location: Navan **Farmer Co-operators**: Pat & Mary Connell

Soil Type: Red Clay Loam

Paddock History: 2013 – Faba Beans
2012 - Wheat

Monthly Rainfall:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	81	7	69.5	64.5	99.5	67.5	18.5	20	9	18.5	4.5

- **Yield Limiting Factors:** Below average spring rainfall
- **Type of Trial:** Replicated small plot trial
- **Trial Design:** Randomised Complete Block Design, split plots, 4 replicates

Treatments:

There were two trial sites sown, one at Paskeville (Avg ARF 400mm) and Riverton (Avg ARF 525mm). Each site had 2 times of seeding: Very Early (28th March, Riverton & 31st March, Paskeville) and Early (28th April, Riverton & 29th April, Paskeville). 20 varieties were sown in each trial (See **Table 1**). Each variety was treated with imidacloprid seed dressing to avoid BYDV infection. All varieties were sown at 100 seeds/m^2 and with 80 kg/ha MAP. Nitrogen was applied to all plots at a rate sufficient to prevent nitrogen becoming a limiting factor in the experiment. Plots were cut for dry matter a various stages during the year (data not shown), harvest indices taken for each variety (data not shown) as well as yield and grain protein. Other quality perameters were not recorded such as screenings and test weight.

Table 1: *Varieties sown in SAGIT long season wheat trials, Paskeville and Riverton, 2014*

Variety	Maturity / Type (Max Grade SA)	Variety	Maturity / Type (Max Grade SA)
Trojan	Mid Late Spring Wheat* (APW)	***Estoc***	Mid Late Spring Wheat (APW)
Mace	Early Mid Spring Wheat* (AH)	***Yitpi***	Mid Late Spring Wheat (AH)
Cobra	Early Mid Spring Wheat (AH)	***Kiora***	Mid Late Spring Wheat (AH)
Forrest	Late Spring Wheat (APW)	***Revenue***	Very Late Winter Wheat (FEED)
Chara	Mid Late Spring Wheat* (AH)	***Naparoo***	Late Winter Wheat (FEED)
Beaufort	Late Spring Wheat (FEED)	***Lancer***	Mid Late Spring Wheat (APW)
Osprey	Late Winter Wheat (AGP)	***Bolac***	Mid Late Spring Wheat (AH)
Rosella	Late Winter Wheat (AGP)	***Wylah***	Late Winter Wheat (APW)
Eaglehawk	Late Spring Wheat (APW)	***Whistler***	Late Winter Wheat (ASW)
Gazelle	Mid Late Spring Wheat (SF1*/AGP)	***Wedgetail***	Late Winter Wheat (APW)

* - Gazelle able to be delivered as Soft biscuit wheat (SF1) in Mid North

Results:

YIELD

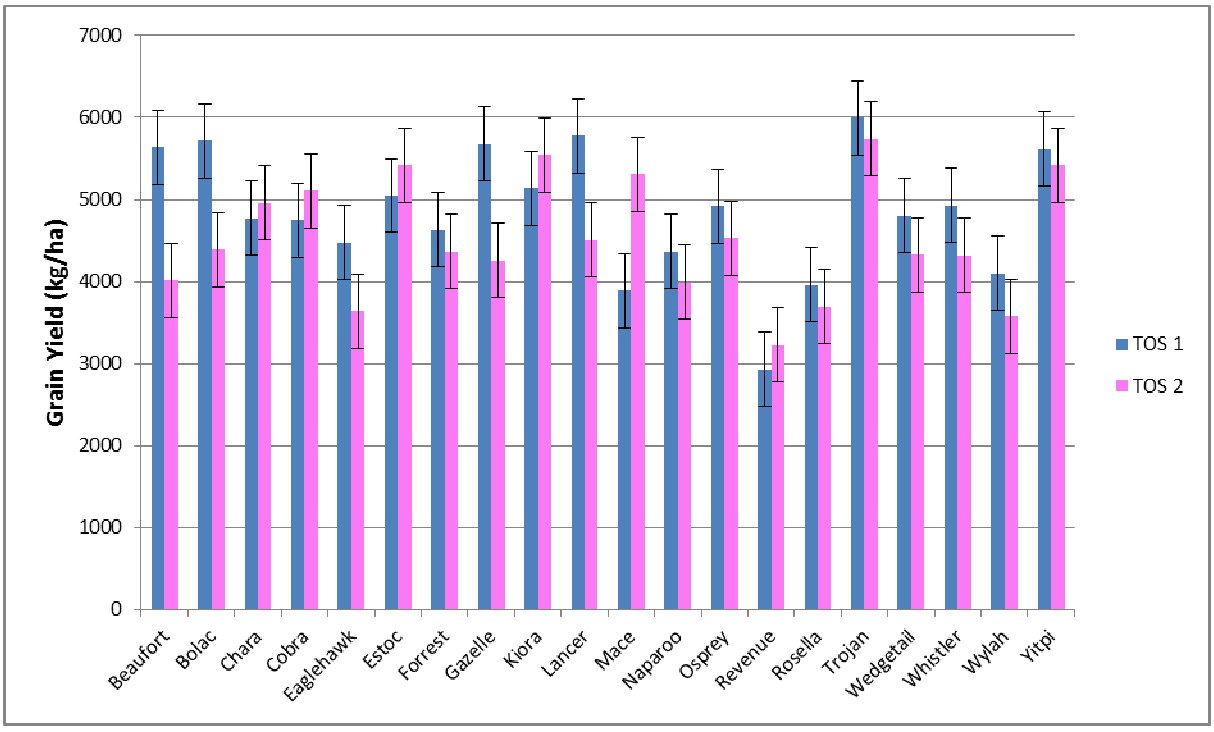
Yield varied between sites, both with highly significant variety x time of sowing (TOS) effects. The yield results for Paskeville (**Figure 1**) and Riverton (**Figure 2**) are displayed below.

TOS 1 Paskeville: The yields of the mid-late season spring wheats Beaufort, Bolac, Gazelle, Lancer, Trojan and Yitpi were significantly higher than all other varieties at this time of sowing. This result demonstrates that well adapted main season varieties like Mace can be sown too early, thereby not achieving their potential yield. The winter types and some of the late spring varieties tested did not perform well at this site at this time of sowing revealing they may be poorly adapted to the soil type.

TOS 2 Paskeville: The yields of Trojan and Yitpi were significantly higher than most of the other varieties. This result demonstrates how well adapted these varietal types are to this environment. Both varieties have photoperiod responsive developmental triggers, which allows them to be planted early, but "hold back" development to maximize the time they have to utilize water during the season.

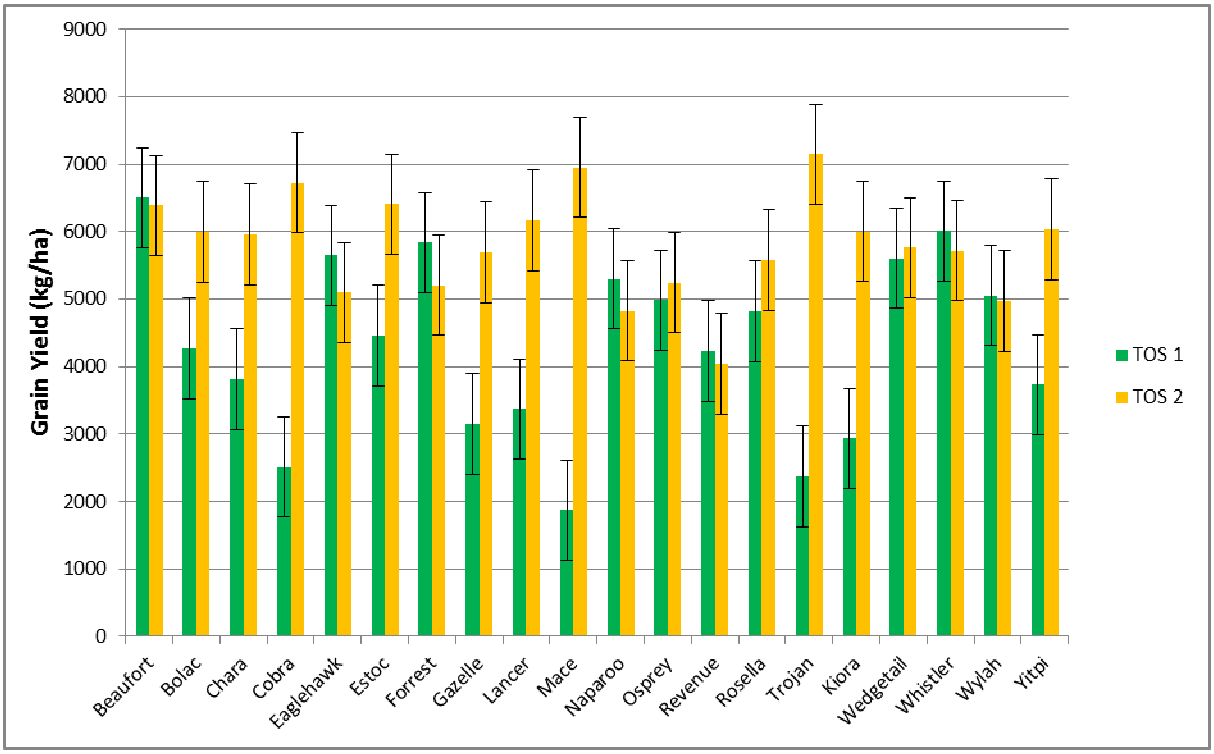
TOS 1 Riverton: The yields at Riverton were highly variable due to frost events that occurred during early August and September. Early-mid and many of the mid-late spring wheat varieties were frosted at flowering, during grain fill or during early head emergence, resulting in very low yields. The late season varieties Beaufort, Eaglehawk, Forrest, Wedgetail and Whistler were all able to produce yields in excess of 5.5 t/ha indicating they may have significant potential for early sowing *TOS 2 Riverton*: The well adapted early-mid (Cobra, Mace) and mid-late (Trojan) produced the highest yields. This shows the value of sowing well adapted, main season varieties on time. The winter and late spring lines produced slightly lower yields at this time of sowing, with the exception of Beaufort, Wedgetail, Rosella and Whistler which were still able to produce yields in excess of 5.5 t/ha.

Figure 1: Grain Yields vs. Time of Sowing and Variety at Paskeville, 2014



TOS x Variety LSD 5% - 451.99

Figure 2: Grain Yields vs. Time of Sowing and Variety at Riverton, 2014



TOS x Variety LSD 5% - 743.2

GRAIN PROTEIN

The grain protein content (**Table 2**) at Paskeville were generally lower at the first time of sowing than the second. This was expected as grain fill occurred under cooler conditions for many of the varieties at this time of sowing with adequate soil moisture. Additionally, many of the varieties tested at this first time of sowing were higher yielding, resulting in "protein dilution" in the grain.

At Riverton, the protein content of many varieties tested were very high at the first time of sowing, as a result of the frost and significantly lower grain yields producing less "protein dilution". Generally the varieties that yielded well at this time of seeding had significantly lower grain protein levels.

Grain protein was also used as the basis for a simple financial analysis along with grain yield and the maximum grade achievable for that variety in South Australia. The prices used can be seen in **Table 3**.

Table 2: Grain Protein Content (%) vs. Time of Sowing and Variety at Paskeville and Riverton, 2014

	Paskeville		Riverton	
Variety	**TOS 1**	**TOS 2**	**TOS 1**	**TOS 2**
Beaufort	11.0	11.2	9.2	10.4
Bolac	11.5	12.2	12.8	11.1
Chara	11.1	11.3	13.0	10.3
Cobra	11.3	10.3	15.4	9.9
Eaglehawk	12.0	11.4	10.1	11.1
Estoc	12.2	11.9	12.8	10.9
Forrest	11.8	12.3	10.6	11.7
Gazelle	11.1	11.0	11.0	8.1
Kiora	11.1	11.6	13.0	10.8
Lancer	12.2	12.1	15.1	10.6
Mace	11.0	11.3	16.0	9.0
Naparoo	12.4	13.1	10.4	13.5
Osprey	12.8	14.0	11.4	12.3
Revenue	13.2	13.1	11.3	12.7
Rosella	13.2	13.4	11.2	12.7
Trojan	10.7	10.4	14.7	10.1
Wedgetail	12.7	13.2	10.9	11.9
Whistler	12.1	12.6	10.4	11.6
Wylah	14.2	13.2	11.6	12.4
Yitpi	11.2	11.4	13.0	11.4
TOS x Variety LSD 5%	***0.39***		***1.59***	

Table 3: Wheat Prices and Grade Spreads, Dec 11th 2014, Delivered Port Adelaide

Grade	$/tonne
AH1	310
AH2	297
APW	285
ASW	270
AGP	265
FEED	245
SF1*	285

*Gazelle able to be delivered as Soft 1 (<9.5% Protein) in Mid North

ECONOMICS

The grain yield and protein for each variety at both times of sowing were combined to produce a simple financial analysis for each site (See **Figure 3 & Figure 4**). No other grain quality parameters such as screenings or test weight were used to grade the varieties for this analysis. It is acknowledged that there is likely to be potential downgrades based on higher screenings and lower test weight in certain varieties that were tested, particularly those that were frosted at Riverton.

From this simple analysis, very early sowing of mid-late season varieties that could achieve APW grade or better were most profitable at Paskeville. The exception to this was Beaufort wheat (Feed in SA), which yielded well at this time of sowing, highlighting the contribution that yield makes to $ returns.

The second time of sowing at Paskeville indicated sowing well adapted varieties (Mace, Yitpi, Trojan, Kiora, Estoc) in their preferred seeding window resulted in the highest gross income. The profitability of these varieties sown at the second time of seeding matched, and often exceeded, those of many longer season varieties sown earlier.

The Riverton site revealed that sowing certain varieties too early can result in catastrophic financial implications, particularly due to yield reduction by frost. At this site however, some of the early sown, late season varieties were able to perform similarly to early-mid season varieties sown later.

These results highlight the value of testing varieties in two distinct environments within South Australia. Some varieties that have poor adaptation at Paskeville (albeit after 1 seasons trials), have performed well at Riverton.

Many of the interstate varieties appear less well adapted to the 1) soils and subsoils at Paskeville and 2) warmer temperatures that may not allow some of the longer season varieties to build plant structures essential for high yields.

Figure 3: Gross Income ($/ha) of wheat varieties vs. Time of Sowing at Paskeville, 2014

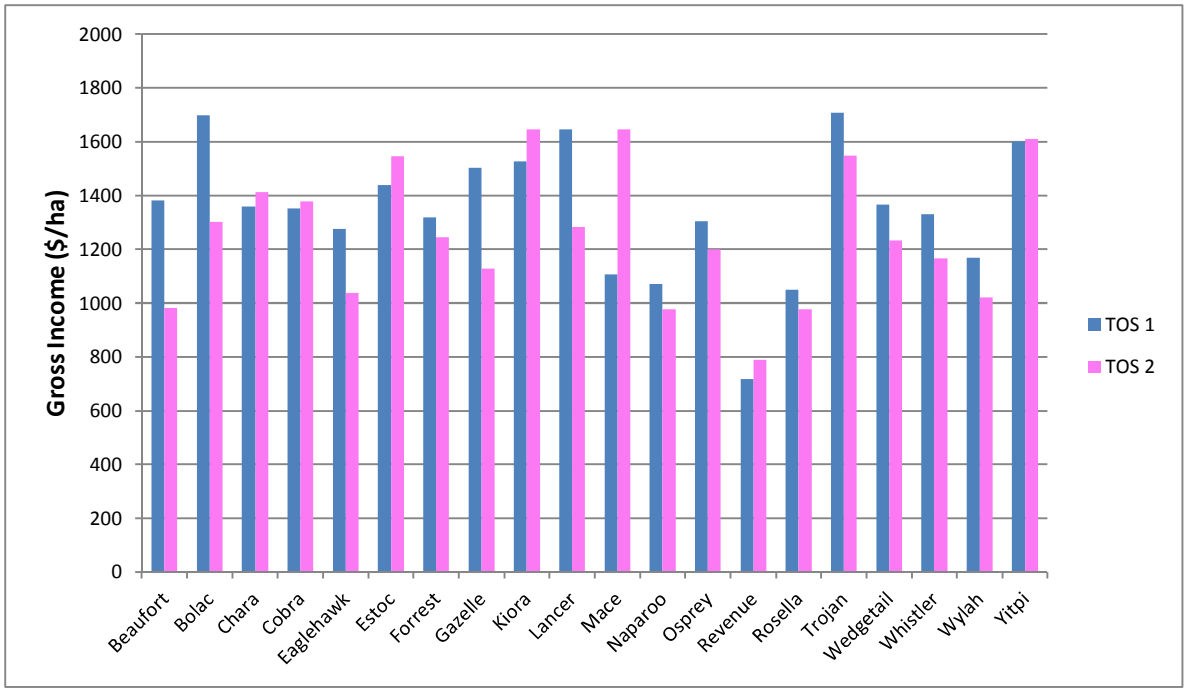
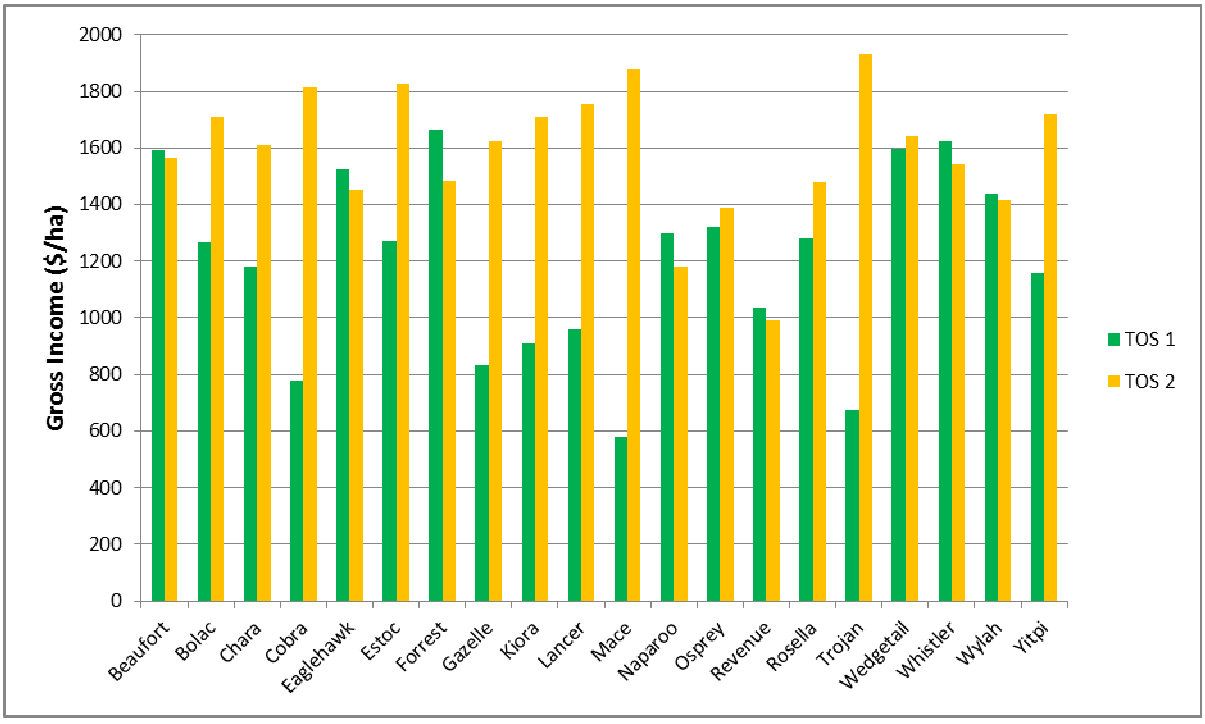


Figure 4: Gross Income ($/ha) of wheat varieties vs. Time of Sowing at Riverton, 2014



Comments:

- The current practice of sowing well adapted varieties at their optimum time is well suited to SA. However, there may be opportunities to utilize longer season varieties in some environments, or where large seeding programs prevent sowing all varieties in their optimum planting window.
- Long season varieties sown early have a definite role in environments that can experience significant frost events early in the season.
- Profitability can be similar when sowing wheat very early, provided varieties are chosen that are adapted to their growing environment.

Acknowledgements

South Australian Grains Industry Trust for supporting the trials

Pat & Mary Connell for the use of their land for the trials at Riverton

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Peter Telfer, SARDI for harvesting the trials at Riverton

Dr James Hunt, CSIRO for assistance with variety selection and supplying seed

"Assessing the adaption of long season wheats in South Australia, 2015"

Jeff Braun and Mick Faulkner, Agrilink Agricultural Consultants Pty Ltd, jeffbraun@bigpond.com

Key Outcomes:

- Despite the dry seasonal conditions at Paskeville, early sown long season wheats performed well comparative to well adapted main season cultivars
- Frost at the Riverton site again showed that sowing too early can result in severe yield losses. Despite this, early sown longer season varieties still produced outstanding yields when sown early.
- Deliverable quality of the variety has a significant effect on profitability, with ASW appearing to be the minimum quality needed.
- Trojan was again the outstanding variety when sown at the end of April. It performed very well at this time of seeding at both sites.

Trial Objectives:

1) To determine if the profitability of wheat in South Australia can be improved by sowing long season varieties early when the opportunity arises

2) Investigate if there are any long season varieties currently available that are adapted to South Australia's unique combination of soils and climates

3) To determine if there is potential to improve whole farm profitability by ensuring that all wheat/other crops are sown in their respective "optimum" sowing window

Trial Duration: 2015

Location: Navan **Farmer Co-operators**: Pat & Mary Connell

Soil Type: Red Clay Loam

Paddock History: 2014 – Faba Beans
2013 - Wheat

Monthly Rainfall:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
69.5	4	1	70	52	23	56.5	82.5	30.5	9	80.5	36.5

- **Yield Limiting Factors:** Frost, Below Avg. spring rainfall, high temperatures in spring
- **Type of Trial:** Replicated small plot trial
- **Trial Design:** Randomised Complete Block Design, 4 replicates

Treatments:

There were two trial sites sown, one at Paskeville (Avg ARF 400mm) and Riverton (Avg ARF 525mm). Each site had 2 times of seeding: Very Early (28th March, Riverton & 29th March, Paskeville) and Early (24th April, Riverton & 25th April, Paskeville). 20 varieties were sown in each trial (See **Table 1**). Each variety was treated with imidacloprid seed dressing to avoid early BYDV infection. All varieties were sown at 100 seeds/m^2 and with 80 kg/ha MAP + 1% Zinc. Nitrogen was applied to all plots at a rate sufficient to prevent nitrogen becoming a limiting factor in the experiment. Zadocks growth stage data was taken for all varieties across all times of sowing at regualr intervals during the year (data not shown), harvest indices taken for each variety (data not shown) as well as yield and grain protein. Other quality perameters were not recorded such as screenings and test weight. It is aknowledged that these factors may have had a futher significant effect on the quality outputs of each variety, given the seasonal conditions experienced.

Unfortunately, the site at Paskeville was sown into wheat stubble, which received no pre-sowing rain to germinate volunteer wheat. Consequently, there was a substantial contamination of volunteer wheat present in the trials which (along with extremely low rainfall), may have affected the quality of the data.

Table 1: *Varieties sown in SAGIT long season wheat trials, Paskeville and Riverton, 2014*

Variety	Maturity / Type (Max Grade SA)	Variety	Maturity / Type (Max Grade SA)
Trojan	Mid Late Spring Wheat (APW)	***Estoc***	Mid Late Spring Wheat (APW)
Mace	Early Mid Spring Wheat (AH)	***Cutlass***	Mid Late Spring Wheat (APW)
Cobra	Early Mid Spring Wheat (AH)	***Kiora***	Mid Late Spring Wheat (AH)
Chara	Mid Late Spring Wheat (AH)	***LPB11-0032***	Mid Late Spring Wheat (AH)
Beaufort	Late Spring Wheat (FEED)	***RAC 2341***	Mid Winter Wheat (APW**)
DS Pascal	Mid Late Spring Wheat (APW)	***Lancer***	Mid Late Spring Wheat (APW)
DS 11.9419	Late Spring Wheat (APW**)	***Bolac***	Mid Late Spring Wheat (AH)
DS 08.0169	Mid Late Spring Wheat (APW**)	***VO 7041-39***	Late Spring Wheat (APW**)
Eaglehawk	Late Spring Wheat (APW)	***Whistler***	Late Winter Wheat (ASW)
Gazelle	Mid Late Spring Wheat (ASF1/2*/AGP)	***Wedgetail***	Late Winter Wheat (APW)

* - Gazelle able to be delivered as Soft biscuit wheat (ASF1/2) in Mid North

** - Unclassified at the time of publication. For the purpose of the financial analysis it has been assumed that these lines would be released as MINIMUM APW.

Results:

GROWTH STAGES

Detailed Zadock's growth stages were recorded at both sites for each time of sowing across the season. This was used to assess the adaptability of each variety in terms of its ability to flower in the preferred "flowering window" for each site, depending on time of sowing. We have assumed an flowering window of 10 days for each site with the ideal window for Paskeville being the 1-10th (Julian Days 244-253) of September and the 10th-20th (Julian Days 253-263) of September for Riverton. These figures can be seen in **Tables 1 & 2** (Paskeville) and **Tables 3 & 4** (Riverton) below. **NB:** Cells highlighted in green denote variteies that were able to flower in the ideal window, yellow highlighted cells have flowered within a week of the ideal window.

Table 1: Growth Stages vs. Julian Day, TOS 1, Paskeville, 2015

Variety	GS 30	GS 39	GS 49	GS 60	GS 70
ADV 2 (11.9419)	204	246	260	269	281
ADV 3 (08.0169)	143	157	161	197	246
Beaufort	156	177	200	211	266
Bolac	141	153	170	196	230
Chara	148	170	190	196	230
Cobra	146	161	183	196	240
Cutlass	146	177	220	240	260
DS Pascal	141	165	177	197	230
Eaglehawk	146	211	226	244	266
Estoc	147	161	188	204	246
Gazelle	143	158	168	204	246
Kiora	141	161	188	204	240
Lancer	146	166	190	195	240
LPB 11.0032	141	230	244	252	268
Mace	146	161	177	193	230
RAC 2341	190	230	238	248	266
Trojan	141	164	184	211	246
VO 7041-39	146	170	220	243	274
Wedgetail	170	230	238	255	268
Whistler	170	218	230	244	265

Table 2: Growth Stages vs. Julian Day, TOS 2, Paskeville, 2015

Variety	GS 30	GS 39	GS 49	GS 60	GS 70
ADV 2 (11.9419)	211	251	266	277	285
ADV 3 (08.0169)	177	220	240	256	273
Beaufort	177	228	248	259	273
Bolac	161	190	213	246	273
Chara	161	197	218	242	264
Cobra	161	218	228	256	267
Cutlass	170	197	224	240	266
DS Pascal	161	218	228	238	268
Eaglehawk	170	224	246	260	274
Estoc	155	197	218	240	266
Gazelle	170	197	213	229	264
Kiora	177	218	233	246	272
Lancer	170	204	215	244	269
LPB 11.0032	170	240	255	263	274
Mace	161	197	214	240	264
RAC 2341	170	238	248	260	272
Trojan	170	214	222	230	263
VO 7041-39	161	240	253	261	270
Wedgetail	170	235	249	262	271
Whistler	185	244	245	257	269

Table 3: Growth Stages vs. Julian Day, TOS 1, Riverton, 2015

Variety	GS 30	GS 39	GS49	GS60	GS70
ADV 2 (11.9419)	181	220	261	274	F
ADV 3 (08.0169)	155	176	199	219	F
Beaufort	159	182	214	240	256
Bolac	146	177	191	210	F
Chara	139	176	190	203	F
Cobra	148	174	191	204	F
Cutlass	153	173	196	210	F
DS Pascal	136	178	191	211	F
Eaglehawk	156	199	243	261	271
Estoc	138	176	191	215	F
Gazelle	136	170	187	202	F
Kiora	138	176	190	212	F
Lancer	138	171	197	201	F
LPB11-0032	153	201	245	265	273
Mace	144	169	185	200	F

RAC 2341	176	212	237	249	260
Trojan	146	175	188	202	F
VO 7041-39	138	183	200	236	262F
Wedgetail	176	216	241	258	265
Whistler	176	211	228	250	260

F = Frost, therefore difficult to distinguish end of flowering

Table 4: Growth Stages vs. Julian Day, TOS 2, Riverton, 2015

	GS 30	GS 39	GS 49	GS 60	GS70
ADV 2 (11.9419)	219	260	271	276	285
ADV 3 (08.0169)	175	231	253	271	278
Beaufort	200	237	251	265	272
Bolac	194	228	250	266	270
Chara	182	224	247	259	266
Cobra	178	218	235	250	257
Cutlass	176	226	246	263	268
DS Pascal	176	220	244	258	267
Eaglehawk	200	258	271	278	279
Estoc	178	227	242	258	267
Gazelle	177	216	247	264	270
Kiora	176	226	243	265	271
Lancer	175	220	246	264	269
LPB11-0032	190	240	272	277	279
Mace	171	215	233	249	257
RAC 2341	195	233	250	264	268
Trojan	176	221	241	255	263
VO 7041-39	192	240	256	274	277
Wedgetail	197	245	255	269	275
Whistler	200	241	254	267	270

YIELD

The yield results varied dramatically between sites in 2015. Paskeville experienced one of its driest years on record, whereas Riverton recorded average rainfall for the year, albeit with below average spring rainfall. Despite this, both sites recorded highly significant TOS x variety effects. The yield results for Paskeville (**Figure 1**) and Riverton (**Figure 2**) are displayed separately.

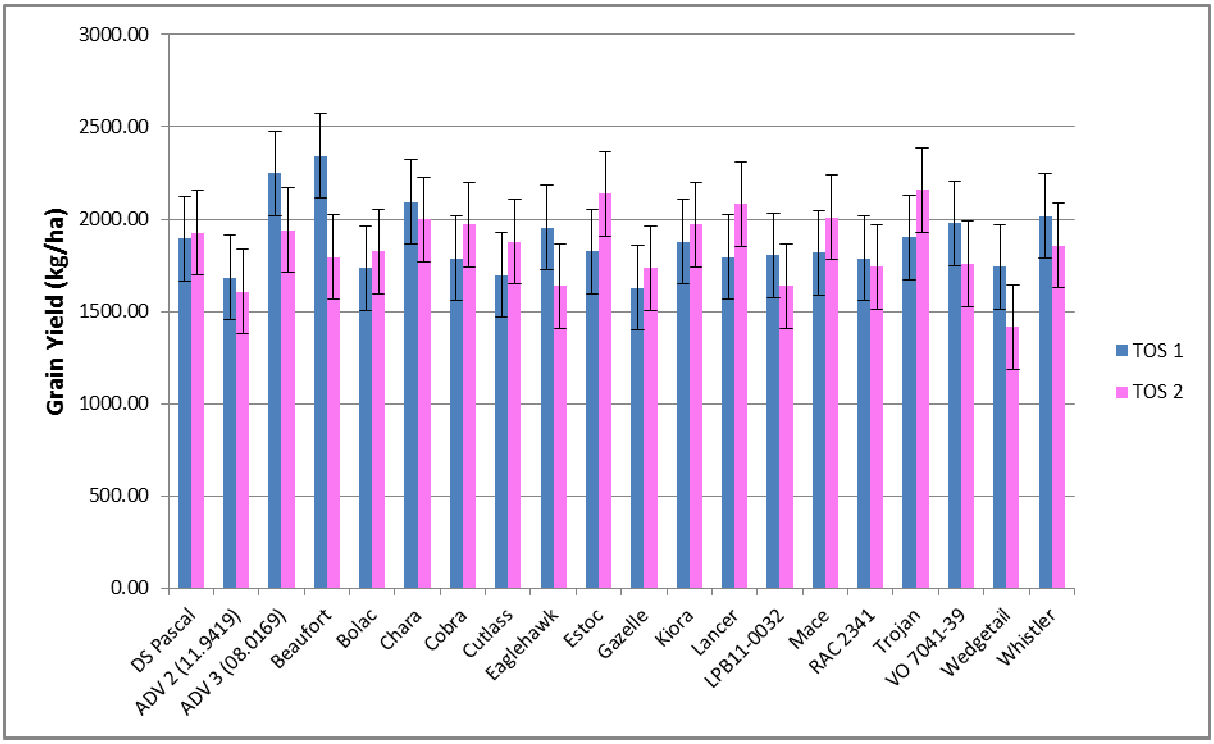
TOS 1 Paskeville: The yields of the longer season spring wheats Beaufort, DS 08.0169 and Chara were the highest in the trial at this time of sowing. Despite the poor seasonal conditions, these yield results highlighted the value of varieties that are adapted to the soil types and climatic conditions in which they are grown. Each of these varieties demonstrated versatility by flowering early and filling grain prior to serious moisture defecit and hot weather in spring.

TOS 2 Paskeville: Trojan, Estoc and Lancer were the highest yielding varieties at this time of sowing. Each of these varieties demonstrates some photoperiod sensitivity, which has enabled the maturity of these varieties sown at this time of sowing to flower and fill grain in the ideal window for this environment, despite the dry seasonal conditions. Once again, this result shows the value of well adapted wheats sown in their ideal sowing window.

TOS 1 Riverton: The yields at Riverton at this time of sowing were again highly variable due to frost events in June, July and September. Yields varied from 2.5-6.5t/ha, with the lower yields coinciding with the temperature (more rapid early development) sensitive varieties producing the lowest yields as they were at a more advanced reproductive stage when the frost events occurred. Beaufort and Whistler again demonstrated their ability to yield in this environment at very early times of seeding. This concurs with results seen at this time of sowing at Riverton in 2014.

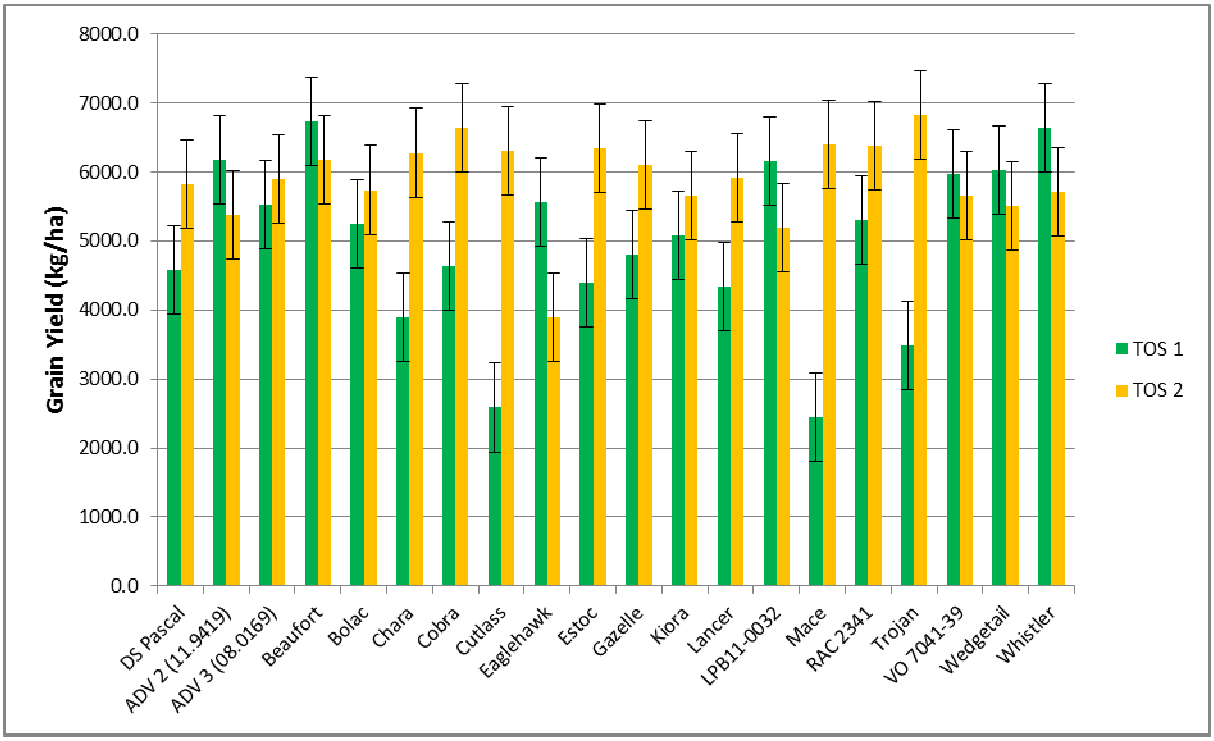
TOS 2 Riverton: Trojan, Cobra, Mace and Estoc produced the highest yields at this time of sowing. Each of these varieties is well adapted to this environment and produced excellent yields at the same time of sowing in 2014. Despite some of these varieties flowering slightly earlier than is considered ideal in this environment, high yields were still able to be achieved, as spring rainfall was all but non-existent, allowing these varieties to fill grain under conditions of less moisture and heat stress.

Figure 1: Grain Yields vs. Time of Sowing and Variety at Paskeville, 2015



TOS x Variety LSD 5% - 229kg/ha

Figure 2: Grain Yields vs. Time of Sowing and Variety at Riverton, 2015



TOS x Variety LSD 5% - 641kg/ha

GRAIN PROTEIN

The grain protein contents (**Table 6**) at Paskeville were again generally lower at the first time of sowing than the second. The conditions for grain experienced by the early TOS are likely to have been more favourable due to their early maturity. The over all lower protein levels achieved at this site are a reflection of paddock history (wheat stubble) and also dry conditions resulting in less overall nitrogen uptake.

At Riverton, the protein levels of plots sown at TOS 1 were highly variable ranging from 9.6-17.7% (See **Table 6**). This is largely a yield dilution effect, with many of the higher protein plots experiencing yield loss due to frost and consequently less grain protein dilution. The protein range at TOS 2 was considerably less, but highlighted the differences in vareties grain protein content. This was also associated with yield diliution, but not to the same extent as seen in TOS 1.

Grain protein was used as the basis for a simple financial analysis along with grain yield and the maximum grade achievable for that variety in South Australia. The prices used can be seen in **Table 5**. For unclassified varieties/breeders lines, it has been assumed that their minimum classification in SA, would be APW, in line with the majority of recent commercial releases in the state.

Table 5: Wheat Prices vs. Grade Spreads, Glencore Cash Prices, Nov 25th 2015, Delivered Port Adelaide

Grade	Price ($/t)
AGP	229
APW	254
ASW	244
AUH2	252
AUW1	222
FEED	208
H2	261
H1	268
SF1	299
SF2	289

*Gazelle able to be delivered as Soft 1 (<9.5% Protein) in Mid North

Table 6: Grain Protein Content (%) vs. Time of Sowing and Variety at Paskeville and Riverton, 2015

	Paskeville		Riverton	
Variety	**TOS 1**	**TOS 2**	**TOS 1**	**TOS 2**
DS Pascal	10.3	11.5	14.4	10.3
ADV 2 (11.9419)	10.5	11.5	9.8	9.6
ADV 3 (08.0169)	9.9	11.6	12.9	10.7
Beaufort	9.3	11.5	9.6	9.4
Bolac	10.1	11.3	14.0	11.4
Chara	10.6	10.8	15.2	10.7
Cobra	10.1	11.0	16.2	11.0
Cutlass	9.7	10.7	16.8	9.9
Eaglehawk	9.9	11.5	10.7	12.5
Estoc	10.7	11.9	14.7	10.8
Gazelle	10.0	11.1	11.3	8.2
Kiora	10.4	11.2	13.5	11.4
Lancer	10.9	12.2	15.3	12.0
LPB11-0032	9.4	11.0	10.6	11.3
Mace	9.6	11.4	17.7	9.2
RAC 2341	10.0	10.7	12.9	11.3
Trojan	9.5	10.5	15.7	8.9
VO 7041-39	9.7	11.5	11.7	10.4
Wedgetail	10.1	11.3	10.6	12.1
Whistler	9.7	10.8	11.1	10.6
TOS x Variety LSD 5%	***TOS x Var NS TOS 1 0.54 TOS 2 0.87***		***1.71***	

FINANCIAL ANALYSIS

The grain yield and protein responses for each variety at both times of sowing have been combined to produce a simple financial analysis for each site (See **Figures 3 & 4**). It is acknowledged that there are other factors (screenings, test weight, physical grain characteristics) that are used to assess the quality of grain at the receival point, however the time and equipment involved to perform these analyses were beyond the scope of this project. This simple analysis may inadvertently favour lower yielding treatments (i.e. frosted) as they tended to produce higher protein grain, which may have been downgraded on other characteristics if delivered in a real world situation.

From this simple analysis, we can see that very early sowing of mid-late season varieties that could achieve ASW grade or better were most profitable at Paskeville. The Dow Seeds breeding line 08.0169, Chara and Whistler were highest gross earning varieties at this time of sowing. Each of these varieties exhibits mid-late maturity, making them well suited to early sowing in this warmer, shorter season environment.

The second time of sowing at Paskeville again revealed the value of sowing well adapted varieties (Estoc, Lancer, Trojan) in their preferred seeding window (Late April). The profitability of these varieties sown at the second time of seeding matched and often exceeded many of the other longer season varieties sown earlier.

The Riverton site again revealed how sowing certain varieties too early can result in severely negative financial implications, particularly when there is a risk of frost (NB Riverton NOT generally classified as a frosty environment). Once again, the value of varieties that could achieve ASW or greater quality at harvest is apparent in the financial analysis. The Riverton site, with its cooler winters and longer spring, has also enabled us to see that there is a place for well adapted winter wheats in this environment, with the varieties Whistler, Wedgetail and Longreach Plant Breeders line 11.0032 in the top 3 for yield and financial return at TOS 1. There were slightly better yields and financial returns seen at TOS 2, with the well adapted main season varieties Gazelle, Cobra and Trojan ranking in the top 3 in yield and financially. It is worth noting at this time of sowing that outstanding financial performance of Gazelle was achieved by producing grain of ASF1 (Biscuit Wheat) standard, which commanded a premium in 2015 in response to the seasonal conditions.

These results from the second year of testing these varieties across two environments have reinforced the learnings of the first year. If sowing very early (<Mid April), the variety must have sufficient developmental “holds” to allow the variety to flower in the appropriate window for optimal yield in each environment. The other factor is that many growers are now well capitalized in terms of seeding machinery, allowing large areas to be sown in short periods of time. If this is the case, there appears to be very little evidence to support the uptake of long season wheat in SA. However, in environments where frost is an issue, time of seeding is unable to optimized due to

scale or where waterlogging may be an issue early in the season, well adapted long season varieties have a definite role to play going forward.

It was felt following the results of last year that long season varieties from interstate programs were not adapted to the unique growing conditions experienced in SA. Upon reflection on the results however, there has been some consistency of performance in some of these varieties that could be built on to produce higher yields from both an agronomic and breeding perspective.

Figure 3: Gross Income ($/ha) of wheat varieties vs. Time of Sowing at Paskeville, 2015

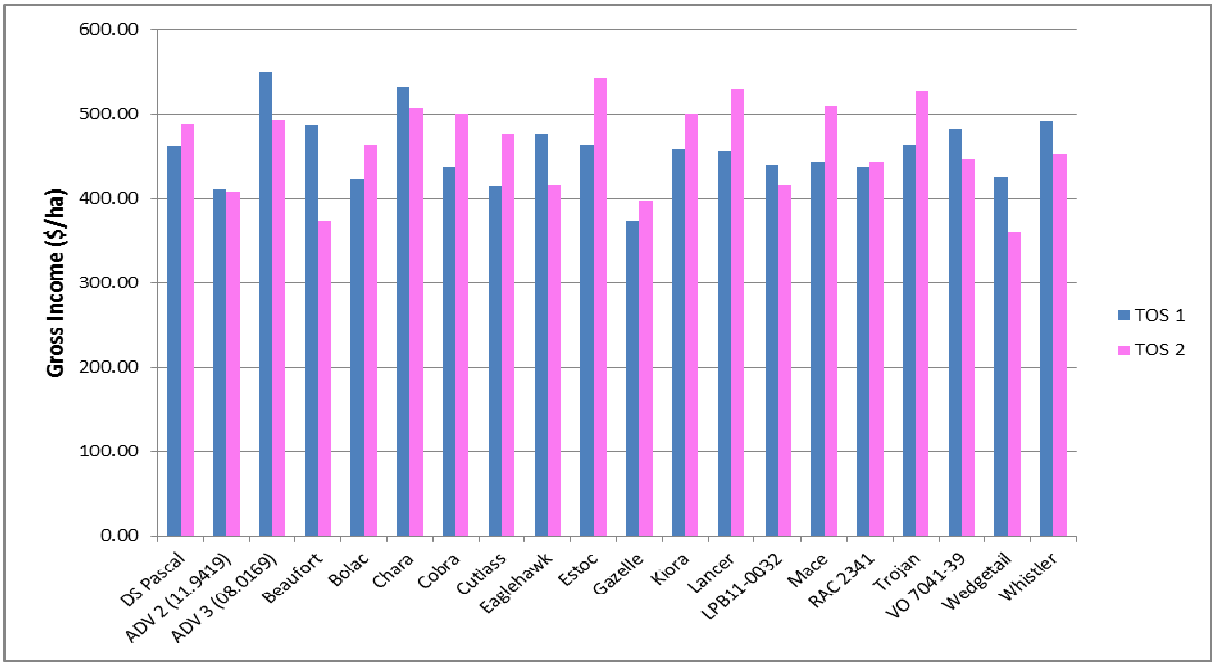
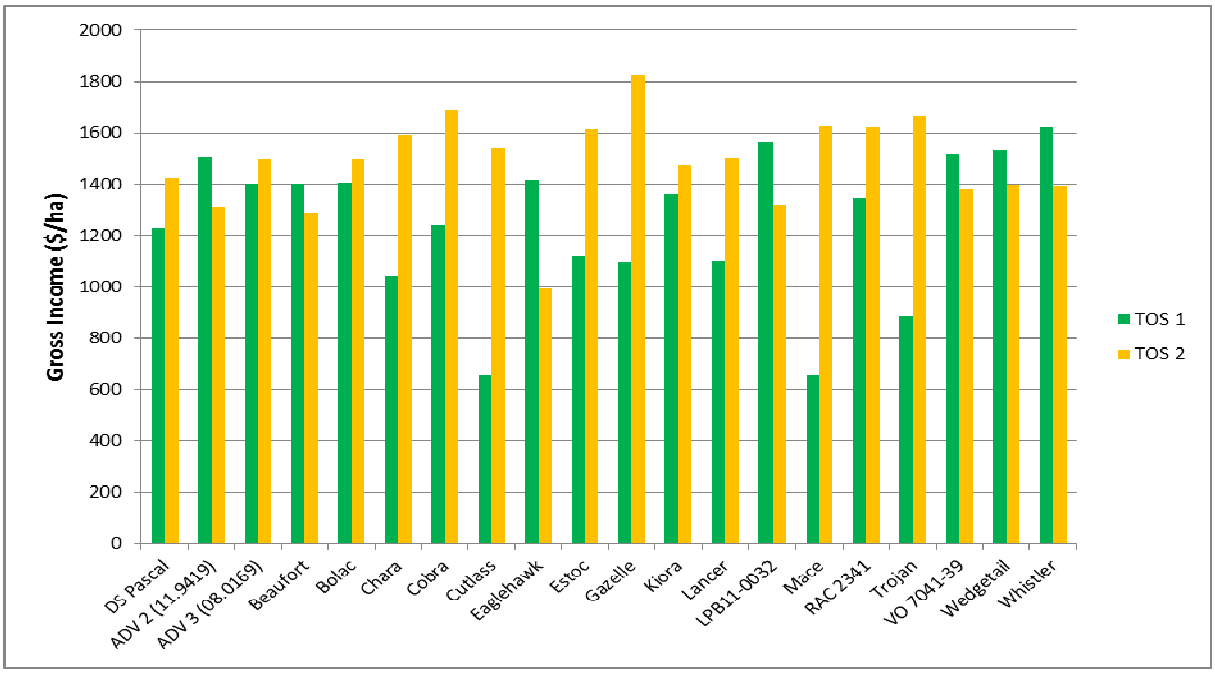


Figure 4: Gross Income ($/ha) of wheat varieties vs. Time of Sowing at Riverton, 2015



Comments:

- There are long season varieties commercially available that are well adapted to South Australian conditions.
- These varieties are able to produce similar financial returns to established main season benchmarks, providing the grain quality at harvest is a minimum of ASW.
- Growers looking at adopting long season varieties need to consider their seeding operation and its timeliness, frost and waterlogging risk.

Acknowledgements:

South Australian Grains Industry Trust for supporting the trials

Pat & Mary Connell for the use of their land for the trials at Riverton

Mick Faulkner for monitoring the trial and recording growth stages

Leighton Wilksch, Agbyte for conducting the trial program at Paskeville

Peter Telfer, SARDI for harvesting the trials at Riverton

Dr James Hunt, La Trobe University, for assistance with variety selection and supplying seed