QUALITY WHEAT
CRC PROJECT REPORT

Program 2  Growing and Storing Quality Wheat

Growing More Quality Wheat

Bob Cracknell $^{1,2}$ and Colin Wrigley $^{2,3}$

1. Australian Wheat Board
2. Quality Wheat CRC Limited
3. CSIRO Plant Industry

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GROWING MORE QUALITY WHEAT

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GROWING MORE QUALITY WHEAT

- R.L. Cracknell and C.W. Wrigley

Proceedings of a one-day workshop, held on Tuesday, 28th April, 1998, at CSIRO Plant Industry, Canberra, to review some of the projects in Program 2 of the Quality Wheat CRC.

Introduction

At the outset of discussions about the need for a Quality Wheat CRC, there was the request from the processing industry for research on achieving consistency of wheat quality, combined with assurance of a continuing supply of quality grain. An associated request from the growers has been for access to premium payments for their grain. These general objectives combine in several of the projects in Program 2 of the Quality Wheat CRC, with the aim of achieving specific quality targets in the field. This involves ...

• knowing how to manage agronomic aspects on the farm,
• providing management tools for use on-farm, and
• passing on this information to growers and buyers.

These were the three aspects of the topic of “Growing More Quality Wheat” described in presentations delivered at a workshop held on Tuesday, 28th April, 1998, at CSIRO Plant Industry, Canberra. In particular, the workshop provided the opportunity to review several projects in Program 2 of the Quality Wheat CRC, including an assessment of the readiness of some project results for extension to the wheat-growing and wheat-processing industries.

During the life of the CRC, there have been annual workshops of researchers from around Australia to discuss progress towards these objectives, because this work has required considerable interaction between scientists spread across the continent. The aim of the 1998 workshop was to provide interaction between research workers involved in improving grain-quality attributes, thus to maximise returns to growers and to provide better consistency of quality to processors. A particular focus of the Workshop was on the results of the project “Prime Hard in the South” (DAN 279, funded by the GRDC and managed for the GRDC by the Wheat CRC), and associated research conducted in the Wheat CRC. Several staff of the Australian Wheat Board and of NSW Agriculture were invited, for comment on how best to implement findings from this research at the farm level. This publication provides a summary of the day’s presentations in the form of copies of the overhead films used by each speaker.
PART 1. Three years of “Prime Hard in the South”

A major focus of this workshop was the project “Prime Hard in the South” (DAN 279, funded by the GRDC and managed for the GRDC by the Wheat CRC), and associated research conducted within the Wheat CRC’s portfolio of research. This project has involved extensive field trials during 1995, 1996 and 1997. This workshop was intentionally timed to draw upon the immediate results from the completion of the final year of the field trials. Nevertheless, the quality results were not available for the 1997 harvest, nor was the full assessment of the overall relationships indicated by this ambitious set of experiments. Importantly, however, the workshop provided the opportunity for the public announcement of the Australian Wheat Board’s quality testing of the first commercial receivals of Prime Hard grain at southern NSW sites, results that proved the value of the whole of the “Prime Hard in the South” project.

This project was prompted by controversy about the quality characteristics of high-protein wheat grown south of the traditional regions for Prime Hard grain. Anecdotal information had earlier suggested that if wheat is grown in southern regions to yield grain with over 13% protein content, it would not have the milling and dough-mixing qualities expected of the Prime Hard grade.

Results from the first two years of the project over-turned this myth. These results had been presented as interim reports on the progress of the field trials to the 46th and 47th Australian Cereal Chemistry Conferences by Oliver et al. (1996 and 1997). The great extent of cooperation required for these trials is indicated by the long list of co-authors for these papers (see reference list below). John Oliver’s talk in this workshop provided an overview of the progress made in the whole of the Prime Hard in the South project.

These results prompted the Australian Wheat Board to open five silos in southern NSW in 1997 for the receival of high-protein wheat of appropriate varieties. Bob Cracknell’s talk in this workshop described the satisfaction of the AWB with the quality of this grain, as well as the satisfaction of the markets to which the grain was exported from the Port Kembla terminal.

The talks by John Angus and Wal Anderson described the agronomic practices that had been adopted to achieve premium quality in both NSW and Western Australia, respectively.

John Skerritt’s talk described the parallel research on the biochemical and genetic research that was part of the original concept of Prime Hard in the South. Though not funded in the GRDC grant, these aspects are throughly incorporated into ongoing CRC research, thereby underpinning the more practical aspects of the project, and providing a basis for extending the results for the four varieties used in the field trials to a much wider range of genotypes.

References

PART 1. Three years of “Prime Hard in the South”

Commercial trial of “Prime Hard in the south”; 1997 AWB receival of PH grain at five silos in southern NSW

Bob Cracknell

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
PART 1. Three years of “Prime Hard in the South”

Success of management practices in achieving protein and yield targets for premium grades in Western Australia

Wal Anderson

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
Projects on Managing Grain Quality at the Field Level

Quality Wheat CRC - Program 2

Funded by GRDC and AgWA

[Development of an Australian Prime Hard wheat grade in Western Australia. Nicole Kerr, Geraldton. Terminated, June, 1996.]


- Potential for quality improvement in wheat produced in the Albany and Esperance port zones. Rebecca Evans, Esperance. Terminates, Dec., 1997


- On-farm implementation of Quality Assurance. Nicole Kerr, Geraldton. On-going, funded by AgWA.
The High Protein Wheat Package

- Select high quality clay loam soils
- Use a legume rotation (pasture or grain legume)
- Control grass weeds before cropping
- Choose high quality varieties and sow at appropriate times
- N requirements are minimal on good clays after legumes
- Use more N fertiliser on early sown crops
Grain protein response of Wilgoyne wheat to rotation, N fertilizer and sowing time.

<table>
<thead>
<tr>
<th>Sowing time</th>
<th>N Applied (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

6 sites with a good legume history

<table>
<thead>
<tr>
<th>Sowing time</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late May</td>
<td>13.3</td>
<td>14.0</td>
</tr>
<tr>
<td>Early June</td>
<td>13.4</td>
<td>13.8</td>
</tr>
</tbody>
</table>

7 sites with a poor legume history

<table>
<thead>
<tr>
<th>Sowing time</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late May</td>
<td>10.2</td>
<td>10.9</td>
</tr>
<tr>
<td>Early June</td>
<td>10.5</td>
<td>11.0</td>
</tr>
</tbody>
</table>
NB: all experiments grown after good legume pasture.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>N required to achieve Grain Protein $&gt;11.5%$ (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friable clay loams</td>
<td>0</td>
</tr>
<tr>
<td>Hard setting clay loams</td>
<td>0-60</td>
</tr>
<tr>
<td>Sandplain</td>
<td>35-60</td>
</tr>
<tr>
<td>Duplex</td>
<td>-</td>
</tr>
</tbody>
</table>
The Noodle Wheat Package

- Select good quality sandy loams, sands or duplex soils (protein is more difficult to manage on clay soils)

- Use a good legume rotation (W/L or W/clover)

- Control grass weeds before cropping (they reduce yields and protein)

- Choose high quality varieties and sow at their optimum times (Cadoux from mid-May, Eradu and Arrino later)

- Apply N up to 20 kg/ha in a good legume rotation, up to 50 kg/ha otherwise

- Adjust seed rates according to soil fertility, sowing time and variety.

March, 1998
Soil Type and Legume History affect Noodle Premiums
[data from 40 expts., 1994-1997]

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Legume History</th>
<th>Nopt (kg/ha)</th>
<th>Pr. Grain Protein &gt;9.5&lt;11.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCL</td>
<td>Good</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>36</td>
<td>0.25</td>
</tr>
<tr>
<td>BGCL</td>
<td>Good</td>
<td>38</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>48</td>
<td>-</td>
</tr>
<tr>
<td>DP</td>
<td>Good</td>
<td>22</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>52</td>
<td>0.6</td>
</tr>
<tr>
<td>SP</td>
<td>Lupin</td>
<td>19</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Clover</td>
<td>38</td>
<td>0.85</td>
</tr>
</tbody>
</table>
## High Quality Agronomic Packages

<table>
<thead>
<tr>
<th>Grade</th>
<th>Success rate in Experiments (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Hard</td>
<td>70</td>
</tr>
<tr>
<td>Noodles</td>
<td>80</td>
</tr>
<tr>
<td>Australian Soft</td>
<td>65</td>
</tr>
</tbody>
</table>
## Percentages of the Western Australian Wheat Crop Received into Various Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>'90-93</th>
<th>'94</th>
<th>'95</th>
<th>'96</th>
<th>'97</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASW</td>
<td>74</td>
<td>63</td>
<td>58</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>GP</td>
<td>10</td>
<td>3</td>
<td>3</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Feed</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>(0.02)</td>
</tr>
<tr>
<td>APW</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>A. Hard</td>
<td>3</td>
<td>13</td>
<td>7</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>A. Soft</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Noodle</td>
<td>7</td>
<td>16</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

"Premium"

| Grades | 15 | 33 | 37 | 51 | 45 |

WKA. April, 1998
The High Screenings Package

➤ Choose a hopeless soil
    shallow, hard-setting, compacted
    potash and trace element deficient

➤ Sow after a long legume pasture phase

➤ Don't control grasses
    plenty of root diseases

➤ Choose a small grain variety (eg Janz, Tincurin)

➤ Sow it too late (or too early)

➤ Use a high N and a high seed rate

➤ Sow in a frost-prone location

➤ Pray for leaf diseases (septorias, rusts, BYDV)

➤ Reduce air on header, hope for a still day.
PART 1. Three years of “Prime Hard in the South”

Summary of three years of “Prime Hard in the South”

John Oliver

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
High Protein, High Quality Wheats in Southern Australia

Collaboration between
• Quality Wheat CRC
• CSIRO PI
• NSW Agriculture
• Agriculture WA
• Incitec Fertilizers
• PISA
• Pivot Ltd
• University of Adelaide
• Agriculture Victoria

Funded by
• GRDC
• QWCRC

Objective:

To establish if the quality of PH varieties grown to PH protein levels under minimal stress outside traditional PH regions is equivalent.
For Quality Analyses

Agronomists had to produce samples at equivalent protein content.
1997: Protein x Site

N.NSW

1997: Protein x Site
13.5% protein grp.

N.NSW
1995: Test weight (kg/ha)  
13% protein grp.

1995: Kernel weight (g/1000 kernels)  
13% protein grp.
1995: Flour Extraction (%)  
13% protein grp.

1995: Test weight (kg/hl)  
15% protein grp.
1995: Kernel weight (g/1000 kernels)
15% protein grp.

1995: Flour Extraction (%)
15% protein grp.
1996: Test weight (kg/hl)
13% protein grp.

1996: Kernel weight (g/1000 kernels)
13% protein grp.
1996: Flour Extraction (%)
13% protein grp.

1997: Test weight (kg/hl)
13% protein grp.
Conclusions

- Generally quality is equivalent
- Some anomalous results with no obvious pattern
- Seasonal effects influencing results

What now?

- Need to complete final year's quality analyses
- Explain anomalies
  - relate to environment measurements
  - relate to molecular composition
- Develop integrated extension message to ensure consistency of supply
PART 1. Three years of “Prime Hard in the South”

Biochemical and genetic aspects of “Prime Hard in the South”

John Skerritt

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
Recently, we commenced three GRDC/ QWCRC - supported initiatives:

- Flexibility of variety use: genetic and biochemical studies (Luch Hac)
- Within-paddock variation in wheat quality: precision agriculture (Peggy Kooij)
- On-farm diagnostics for wheat quality (Russell Heywood)

Each project involves extensive collaboration with other researchers and industry and attempt to define effects of specific management practices on wheat quality
Collaborators:

NSW Agriculture, Wagga (John Oliver/ Helen Allen)
NSW Agriculture, Tamworth (Mike Sissons)
CSIRO Plant Industry (John Angus)
QDPI Leslie Research Centre (Paul Brennan/ Steve Kammholz)
University of Sydney PBI Narrabri (Frank Ellison)
Prime Hard wheats

- particular varieties
- protein > 13%, high dough extensibility and strength
- high milling yield, high Falling Number
- receival traditionally limited to QLD and N NSW (N of Condobolin)

*But late N application before rain shown by John Angus and collaborators to reliably produce high protein at southern sites*

Why expand the growth areas of Prime Hard wheat?
- maintain supply when usual areas subject to drought, weather damage
- enable market to be expanded
- allow growers in other areas to obtain higher premiums

*But do Prime Hard Wheats maintain Prime Hard Quality when grown in the South?*
“Prime Hard in the South” projects

Initial/ major project (from 1995; J Oliver and J Angus)

- Four Prime Hard varieties sown at 11 sites (1995) then 15 sites (1996 and 1997) with controls and test sites in several states
- Range of fertiliser treatments used to ensure Prime Hard protein is achieved
- Milling and dough testing of wheats that achieved over 13% protein suggests that southern sites similar in quality to Northern sites

Our “add - on” project (started in 1997)

- Establish biochemical basis for differences in dough properties between environments that was seen in the initial project (e.g. same cultivar and protein BUT different dough behaviour)
- Evaluate potential genetic basis of environmental variation/ stability
- Only four sites and a single fertiliser treatment, but more detailed crop/ weather/ anthesis monitoring
Aim 1: Investigate role of glutenin alleles in consistency of dough properties

- **Varieties studied in “Prime Hard in the South” project (1995-7):**
  - Hartog (1, 17+18, 5+10; b, h, e) Janz (1, 7+8, 2+12; b, b, b)
  - Kite (2*, 17+18, 2+12; e, b, b) Sunstar (2*, 7+8, 5+10; c, b, b)

- **Doubled haploid lines in PH wheats (P. Brennan) derived from:**
  - Hartog x Klastic - differs at only one gliadin/glutenin locus (Glu-A3)
  - Hartog x CD87 - differs at 5 of 6 loci

  **Advantages:** fixed background of doubled haploid lines
  **Disadvantages:** variation in maturity and height may also influence quality

- **Advanced lines from crosses between PH varieties (F. Ellison)**
  - Janz x Hartog; differ at 2 HMW-GS loci and 2 LMW-GS loci
  - Janz*2/ Dollarbird; differ at 2 HMW-GS loci and 1 LMW-GS locus
    - both crosses enable comparison of subunits 5+10 and 2+12

  **Advantages:** adapted and uniform agronomically, related to current varieties
  **Disadvantages:** other background genes are segregating
Genetic studies

FOUR POPULATIONS: Two sets of doubled haploids (grow in 1997 and 1998)
           Two sets of cross-breds (grow in 1998 and 1999)

NORTHERN SITES: Roma (Southern QLD) and Narrabri (N NSW)
SOUTHERN SITES: Ariah Park (S NSW) and Walpeup (Victorian mallee)

TESTING:

All samples: Protein content, hectolitre weight and 1000 kernel weight
            SDS sedimentation test

Most samples: Glutenin macropolymer content
              SE- HPLC (glut/ gli ratio, % unextractable polymeric protein)
              RP- HPLC (HMW-GS/ LMW-GS ratio)

Some samples: milling yield, dough mixing and extensograph
Role of glutenin alleles in consistency of dough properties: Initial results, 1997 season

Protein content

- Over 13% protein obtained at all sites for almost all lines
  - Roma and Walpeup (15-17% protein)
  - Narrabri and Ariah Park (13-14% protein)
- Enables comparison of high protein achieved in the south by drought (Walpeup) and by late N application (Ariah Park)
- Mean protein contents not different in lines with different allelic composition
  - thus allele - dough property interactions can be analysed directly

Physical grain analyses

- grain pinched and hecatolitre and 1000 kernel weight reduced at southern sites (especially Walpeup) due to dry finish

But what about “Protein Quality”?

- initial studies undertaken using SDS-sedimentation test
Protein quality of doubled haploid (Hartog x CD 87) lines:

- Effects of glutenin alleles were consistent for all 4 sites
  - HMW-GS Glu-B1b (7+8) gave higher sedimentation volumes than i (17+18)
  - HMW-GS Glu-D1d (5+10) > a (2+12) (minor effect)
  - LMW-GS bbc gave consistently higher SDS volumes

- At 13-14 % grain protein
  - sedimentation volumes at Ariah Park greater than Narrabri
  - better protein quality at southern site with late N application

- At 15-17 % grain protein
  - sedimentation volumes similar for Walpeup and Roma
  - sedimentation volumes higher than that at 13-14 % grain protein
  - high protein caused by drought may not detrimentally affect protein quality

- Initial Conclusion - protein quality of southern sites as good as, or better than the N sites. Need to confirm results with:
  - Hartog x Klasic (1997), Doubled haploid lines and cross-bred lines in 1998
  - limited direct tests of dough properties, other biochemical measurements
"Protein quality"
Hartog x CD87 lines at 13-14% protein

SDS sedimentation volume (mL)

HMP-WGS allele combination

Narrabri 97
Ariah Park 97
“Protein quality”
Hartog x CD87 lines at 15-17% protein

SDS sedimentation volume (mL)

- aba
- abd
- aia
- aid
- bba
- bbd
- bia
- bid

HMW-GS allele combination

Walpeup 97
Roma 97
Aim 2: Understand biochemical basis of variation in dough properties at constant protein content

Although acceptable dough properties usually obtained at both Northern and Southern sites, variation between locations was still marked for a given variety at fixed protein contents:

- **Biochemical studies**
  - Glutenin macropolymer content was more closely correlated with dough properties than SE-HPLC measurement of insoluble glutenin
  - total glutenin and gliadin/glutenin ratios weakly correlated with dough properties
  - HMW-GS/ LMW-GS ratio (by RP-HPLC) not correlated

- **Even at a constant protein level:**
  - Differences in dough extensibility *between samples* correlated with differences in glutenin macropolymer content and insoluble glutenin
  - Differences in dough resistance *between sites* correlated with differences in glutenin macropolymer content and insoluble glutenin

- Environmental variation in dough properties due to differences in glutenin MW distribution
  
  *Are differences due to environmental differences in grain endosperm development?*
Relationships between Glutenin macropolymer content and quality parameters

- 1995 - 13% protein
- 1995 - 15% protein
- 1996 - 13% protein

- Farinograph DDT
- Extensograph Ext
- Extensograph Rmax
- Grain hardness
- Total glutenin / total gliadin

Linear correlation coefficient ($r$)
Relationship between Glutenin macropolymer content and \( R_{\text{max}} \): 1996 trials
Performance of different antibody combinations in immunochromatography: reflectance

![Graph showing reflectance vs. Falling Number with different antibody combinations.](image-url)
Differences in dough resistance between sites
(1995 trial, 13% protein)
Differences in Glutenin Macropolymer content between sites (1995 trial, 13 % protein)

Glutenin macropolymer (mg per g flour)

Moree (N)
Condobolin (N)
Nangus (S)
Young (S)
Kylite (S/M)
Walpeup (M)
Ariah Park (S)
Horsham (M)
Environmental variation in wheat processing quality is as important as genetic variation.

These projects add a “processing quality” focus to on-going work, and aim to help growers by:

- understanding basis of variation in quality between defined environments (within-paddock, between region)
- helping to establish whether Prime Hard varieties wheats can be grown in southern, high yielding environments
- determining the role of variable Nitrogen application in affecting wheat protein content and processing
- developing diagnostics for growers to measure within- and between-paddock variation in protein content and quality

The work helps to maximise grower and national returns through ensuring that a higher proportion of premium-paying grain is produced.
PART 2. Management tools to improve grain quality on-farm

The three talks in the second part of the workshop described (and demonstrated) tools that are being developed in CRC collaborative research to assist in management on-farm and at-harvest to improve specific aspects of grain quality.

The first of these related to identifying localities that are particularly at risk of high temperatures during grain filling. This process involves two approaches: firstly, the analysis of historic climate data for localities in the wheat belt, combined with estimates of the likely anthesis and harvest dates (variety-dependent), and secondly, the use of ‘real-time’ climate data during the growing season to determine the degree of exposure of crops to heat stress as harvest approaches. This is being combined with experimental information about the susceptibility of commonly grown Australian varieties to the detrimental effects of heat stress on grain quality, thereby to provide both growers and buyers with information about the predicted processing value of specific grain crops.

Nicole Kerr described a comprehensive quality-assurance system that has been developed in Western Australia, using HACCP principles, to assist growers in achieving quality targets.

Finally, in this session, there was a demonstration of test kits that have been developed to provide rapid estimates of the degree of weather damage of grain either on-farm at harvest or at the silo. These kits take the form of antibody-coated tubes or a sophisticated card device, in which colour is developed, the degree of coloration being related to Falling Number. Interim reports of these developments have already been provided by Skerritt et al. (1996 and 1997).

References
Southern NSW
Prime Hard 1997/98

Bob Cracknell - Senior Wheat Quality Consultant, AWB

Today's Presentation
- Key factors
  - Interchangeability with Northern PH
  - Consistency of production and quality
- Southern receival sites
- Quality and varietal composition
- Tonnage segregated and destinations
- Future potential
  - Expansion - S.NSW and other States

1997/98 Prime Hard
Southern Receival Sites
- Lake Cargelligo (3 years)
- Merriwagga - 1st year
- Tullibigeal - 1st year
- Rankin Springs - 1st year
- Girral - 1st year

Southern APH Sites 1997/98
AWB Receivals & Allocations

<table>
<thead>
<tr>
<th>Site</th>
<th>Tonnage Received</th>
<th>Designated Market</th>
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<tbody>
<tr>
<td>L Cargelligo</td>
<td>13,278</td>
<td>Indonesia</td>
</tr>
<tr>
<td>Mwagga</td>
<td>11,346</td>
<td>PNG / Indonesia</td>
</tr>
<tr>
<td>Tullibigeal</td>
<td>1,931</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Rankin Springs</td>
<td>6,552</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Girral</td>
<td>885</td>
<td>Malaysia</td>
</tr>
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</table>
**1997/98 Basic Quality of Southern APH Sites**

<table>
<thead>
<tr>
<th>Site</th>
<th>Protein 11%mb</th>
<th>Screenings below 2mm</th>
<th>Falling Number</th>
<th>Dominant Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. Cargelligo</td>
<td>14.0</td>
<td>4.8</td>
<td>416</td>
<td>Janz 45%</td>
</tr>
<tr>
<td>Merriwagga</td>
<td>13.72</td>
<td>4.31</td>
<td>445</td>
<td>Janz 87%</td>
</tr>
<tr>
<td>Tallibigeal</td>
<td>13.51</td>
<td>5.28</td>
<td>442</td>
<td>Cunngham 69%</td>
</tr>
<tr>
<td>Rankin Springs</td>
<td>14.64</td>
<td>3.44</td>
<td>449</td>
<td>Janz 83%</td>
</tr>
<tr>
<td>Girrai</td>
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<td>402</td>
<td>Cunngham 36%</td>
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<td>488</td>
<td>Janz 43%</td>
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**1997/98 Crop Quality Comparisons - Key Factors**

- Seasonal conditions not conducive
- Newcastle comparison invalid - Port Kembla
- Milling quality = Pt Kembla, 2% < Newcastle
- Dough strength = or > Pt Kembla PH
- Baking quality acceptable
- Ramen and Hokkien style noodles acceptable
- Influence of dominant varieties

**Southern APH - Future Potential**

- Trial successful
  - Quality comparable
  - Shipped to discerning customers
  - No adverse customer feedback
- Expand area to consolidate supply
- Varietal composition to change
  - Agronomy
- Export market development
  - Southern States
### 1997/98 Season Southern NSW APH

<table>
<thead>
<tr>
<th>Site/Zone</th>
<th>Lake Cargelligo</th>
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<th>Newcastle</th>
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#### Wheat Results

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<td>Falling No (sec)</td>
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#### Varietal Composition

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<td>Sunbrook %</td>
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<td>Sunco %</td>
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<td>Texture Score %</td>
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<td>Crumb Colour Score %</td>
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PART 1. Three years of "Prime Hard in the South"

Success of management practices in achieving Prime Hard protein and yield targets in eastern Australia

John Angus

Summary of presentations at a one-day workshop on "GROWING MORE QUALITY WHEAT"
Tuesday, 28th April, 1998
Background to the Prime Hard Wheat in the South Project

1992 \{ \}
Southern NSW wheatgrowers topdressed N ~ anthesis to boost protein because of the high premiums. Some southern grain delivered to northern silos.

early 1994 Seminar on grain quality in Canberra. Angus and Richards discussed crop management to improve grain quality and the shaky evidence that northern grain had higher quality.

Spring 1994 PRPs from Prime Hard Wheat in the south group and SA – Eyre Peninsula

Autumn 1995 GRDC phone discussion about allocation of resources

1995 Experiments at 12 locations
1996 “ “ 17 “
1997 “ “ 18 “

Spring 1996 GRDC/CRC meeting in Sydney to discuss Flexibility Projects
Potential yield response to applied N

\[ \frac{\Delta Y}{\Delta N} = \frac{e_{fert} HI_N 5.7}{P/100} \]

Potential grain protein response to applied N

\[ \frac{\Delta P}{Y \Delta N} = \frac{e_{fert} HI_N 5.7}{Y 10} \]

Where

- Y is grain yield in t/ha
- P is grain protein in %
- N is applied N fertiliser in kg / ha
- \( e_{fert} \) is the proportion of applied N recovered in the crop
- HI_N is the proportion of crop N in the grain
- 5.7 is the factor to convert grain N to grain protein

For profitable response of grain yield to applied N:

\[ \frac{\Delta Y}{\Delta N} > \frac{N_{cost}}{Y_{price}} = \frac{\$0.70 / kg N}{\$0.15 / kg grain} \]

For profitable response of grain protein to applied N:

\[ \frac{\Delta P}{Y \Delta N} > \frac{N_{cost}}{P_{price}} = \frac{\$0.70 / kg N}{\$5 / % protein/tonne grain} \]
Grow 4 cv with known HMW subunits / 12 locations / 3 years / managed to produce a range of protein %

For all grain samples:
- NIR scans
- test weights
- screenings %
- kernel weight

Identify NIR subset using principal components

Measure protein % on subset, calibrate and predict all samples

Select ~13% samples and measure:
- flour extraction
- water absorption
- extensibility
- extensograph height
- dough development
- loaf volume
- paste viscosity

Measure on subset and calibrate:
- flour extraction
- water absorption
- extensibility
- extensograph height
- dough development
- loaf volume
- paste viscosity

Predict for all samples

Regression/covariance analysis of quality with protein % temperature cultivar
PART 2. Management tools to improve grain quality on-farm

Pre-harvest prediction of quality loss due to heat stress by mapping the wheat belt for temperature variations

Maarten Stapper

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
Pre-harvest prediction of quality loss due to heat stress . . . . .

Definition of heat stress for paddock application:
- temperature source
- maximum temperature dependent factor
- maximum temperature limit
- period of crop development
- variety sensitivity
- interaction water stress (?)

calibrated with dough quality from field crops.

Pre-harvest prediction:
- using daily climate files
- national coverage
- paddock inputs
Locality: Narrabri (Narrabri West Po)
Source File: C:CLIMATE\MET-DATA\053030.MET
Latitude: 30° 20' South
Longitude: 149° 45' West
Altitude: 212m

Maximum Temperature Limit = 32.0
Tolerance = 10%
Years with Temperature = 32

1 = Average Temperature
2 = Grain Period (Degree Days)
3 = Percentage of days above Max Limit
4 = Heat stress degree days squared
5 = Highest maximum temperature in period.
6 = Average maximum temperature in period.
% = % probability of exceedence.

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</table>
Locality: Narrabri (Narrabri West Po)
Source File: C:\CLIMATE\HEAT\053030.MET
Latitude: 30° 20' South
Longitude: 149° 45' West
Altitude: 212m

Years with Temperature = 33
Maximum Temperature Limit = 32.0 degrees C
Length of Grain Filling/Ripening Period = 450 degree days
Tolerance = 10% missing days

1 = Percentage of days > Maximum Limit
2 = Percentage of days > Maximum Limit + 3
3 = Sum of (Max Temp - Max Limit) where Max Temp > Max Limit
4 = Sum of (Square of (Max Temp - Max Limit)) where Max Temp > Max Limit
5 = Highest Maximum Temp in period
6 = Average Maximum Temp over period
7 = Rolling 3-day average.
8 = Percentage of years with >10 deg days above Maximum Limit.
Med = Median or 50% probability.
10% = 10% probability of exceedence.

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Parameter = Sum of (Square of (Max Temp - Max Limit)).

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Mean sum squared degree-days above 32 °C during grain filling and ripening

Anthesis Date
10% decile of sum squared degree-days above 32 °C during grain period

The graph shows the accumulation of sum squared degree-days above 32 °C during the grain period, with data points for different locations indicated by various lines on the graph.
Summary table, including calculated heat stress factors for the target flowering periods and 'optimum' (yield) flowering in these locations. The mean and 10% probability of exceedence are given. The heat stress factor is the sum of (Tmax-32)^2 squared over the grain filling and ripening period.

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<tr>
<th>Location</th>
<th>Target Flowering</th>
<th>10%</th>
<th>'Optimum' Flowering</th>
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<td>30</td>
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<td>Narrabri</td>
<td>early Nov</td>
<td>100</td>
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<td>late Oct</td>
<td>20</td>
<td>130</td>
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<tr>
<td></td>
<td>mid Nov</td>
<td>35</td>
<td>180</td>
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<td>early Nov</td>
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<td>Wongan Hills</td>
<td>mid Oct</td>
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PART 2. Management tools to improve grain quality on-farm

Pilot use of a quality assurance system for WA noodle and soft-wheat growers

Nicole Kerr

Summary of presentations at a one-day workshop on "GROWING MORE QUALITY WHEAT"
Tuesday, 28th April, 1998
Wheat Industry Quality Assurance

- 10 month project co-ordinated by the Wheat Quality CRC
- funded by Department of Industry, Science and Tourism and the Australian wheat industry
- finished May 30

Aim

To develop ‘through chain’ HACCP based quality assurance systems in all sectors of the Australian Wheat Industry, from primary production to end market

What is Quality?

Giving the customer what they want
- does not necessarily mean the best
- quality means the product has a predictable degree of uniformity at an appropriate cost

Quality Assurance

- planned procedures are put in place before production to ensure requirements are met
- are we doing it right?

SQF 2000™ Quality Code

A quality code for the food industry based on HACCP
HACCP

- Hazard Analysis of Critical Control Points
- Is a risk management system which emphasizes prevention rather than after the fact detection of quality problems

HACCP - how does it work?

- actual or potential hazards to production are identified (biological, physical, chemical or quality)
- preventative measures are put in place to avoid hazards occurring
- if the process gets out of control, corrective actions are implemented

Pilot studies - two key sectors

- Soft and Noodle wheat for export
  (AGWEST Trade and Development)
- Milling wheat for domestic processing
  (CSIRO Division of Food Science and Technology)

Soft and Noodle wheat pilot study

Scope - from seed to ship

- growers - seed to receival point
- CBH - receival point to loading ship

On-farm QA system

A TYPICAL SQF2000 QUALITY SYSTEM

- Quality Manual
- Production Manual
- Records Manual

- Codes of practice
- Formmulars, Procedures, Training etc.
Hazard

- A hazard is any biological, chemical, or physical substance or property that can cause a food to be:
  - unsafe for consumption
  - is not what the customer requires

Hazard - examples

- Biological
  - mould
- Physical
  - insects, sticks, stones
- Chemical
  - chemical residues
- Quality
  - seed size, insect damage, protein levels

Determine the significance of Hazards

- Likelihood
  - the risk or probability that the hazard will occur
- Severity
  - impact on consumer health or product quality

HACCP Plan

Codes of Practice - eg. silos

- Check silos regularly for signs of collapsing
- Only load silos from the central top hatch
- Only empty from the bottom central opening
- Workers should not enter a silo to work on top of a stack of grain
- Silos should only be entered to clean up residues

Internal Audit Checklist

<table>
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<td>22 Product control</td>
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<td></td>
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<tr>
<td>23 Source control</td>
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Check lists - eg. harvest

Every two hours check the following:
- tyres - wheel studs
- bolts
- chains
- tensioner pulleys
- sieves - walkers
- bearings - fan, drum, elevator, main countershaft
- look for anything out of place or line
- during operation listen for odd noises or squeaks
- during operation smell for anything hot

Records - eg training record

Progress with on-farm QA

- Agriculture Western Australia
  - desi chickpea group (Pulse Australia system)
  - group of wheat supplies to a local flour mill
- Pulse Australia
  - mungbeans in Q, D
  - The Lentil Company
  - interest in other states

A typical SQF2000 Quality System for broadacre cropping

A Typical SQF2000 Quality System for a Mixed Farming Operation

Storage and Handling - CBH
CBH Quality Assurance system

- CBH is currently ISO9002 certified for their port facilities at Kwinana, Geraldton, Esperance and Albany
- In approximately 2 years, all receival points will be certified to ISO 9002
- Rob Lake and Ed Griffin helped conduct a HACCP analysis of CBH operations as part of the Quality Wheat CRC project

Milling wheat

- HACCP plans have been developed for two mills
  - Goodman Fielder (Tamworth)
  - Westons (Brisbane)
- Staff training in HACCP currently underway
- Implementation at both mill in the next 6 weeks
- Industry wide workshop (37 mills) September 3

Quality Farms Australia

- Industry advisory body to coordinate policy and standards for QA with broadacre industries
- Membership
  - Pulse Australia
  - Australian Oilseeds Federation
  - Quality Wheat CRC
  - Australian Cotton Industry Committee
  - GRDC, GCA
  - Fodder and rice later???

Market pressures

- demands for assurances from end-users are increasing
  - eg millers, Quality Assured Cereal for weetabix suppliers
- more quality discerning markets
- increased awareness in some markets to chemicals
  - eg wheat destined for South Korea
- competitors starting to consider QA systems
  - eg. Scottish Quality Cereals scheme
PART 2. Management tools to improve grain quality on-farm

Demonstration of an on-farm test kit to predict rain damage.

John Skerritt

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
Simple field test for Pre-harvest sprouting

- Detects Alpha-amylases: either or both high and low pl isozymes
- Quantitative, correlates with standard method (Falling Number)
- Able to discriminate minor sprouting from sound grain
- Results independent of variety, growth site

Silo receival use
- Faster, less expensive than falling number machine
- Can readily be made available at all receival sites in bad years

On-farm application
- Sprouting can vary significantly within and between paddocks
- Mild to moderate sprouting cannot be reliably detected by eye
- Avoid binning sound and damaged grain together - maximise grower returns
Field test for pre-harvest sprouting - tube kit method

1. Shake ground wheat in salt solution
2. Add 3-5 drops of antibody pre-coated tube, containing enzyme-labelled antibody
3. Wash, add enzyme substrate/chromogen
4. 5 or 10 min
5. 3 or 5 min

Stop. Read in portable photometer
ELISA absorbance versus Falling Number for grain from Roma silo
Variation in Falling Number within paddocks

Falling Number

Farm 17 (Sunmist)  Farm 4 (Hartog)
Immunochromatography field tests

1. Extract grain by shaking in salt solution

2. Apply sample to lower zone; starts upwards movement of solution front

2. Complexes of amylase in sample and gold-labelled anti-amylase antibody form and move upwards

3. Complexes captured by capture antibody. Pink-coloured band forms

4. Control (anti-species) antibody binds excess unlabelled gold-labelled Ab

Positive test: two bands
Negative test: one band (control only)
Test time: 3-7 minutes
Detection of Pre-harvest sprouting using a 5-minute immunochromatography test
A simpler testing format for pre-harvest sprouting?

- Tube based kit works well in field trials
  - sensitive, accurate, reproducible
  - but: 5 method steps, minimum 10 min test time, test kits are bulky

- Immunochromatography has several potential advantages
  - 2 steps, simple/faster test, less bulky kits, permanent results

- Test performance characteristics to check
  - Test speed? Test sensitivity?
  - Is the method quantitative? (discriminates levels of sprouting)
  - How reproducible are results?
  - Which antibody combinations are best?
  - How stable are the test materials?
  - Are test results affected by ambient temperature?
Performance of different antibody combinations in immunochromatography: reflectance
Within-day precision: 5 tests

Reflectance

Antibody combination

A+D  B+D  B+C

154  275  382
Between-day precision
Ratio test band: control band (C H+L/ G H+L)
PART 3. Getting the message across

Because all the above research developments are nearing the stage of implementation, it was an accent of this workshop to request advice from a range of people involved in training and extension activities. There was good attendance of District Agronomists, especially from NSW and WA. They expressed their enthusiasm for passing on the research messages of the workshop to growers, especially for being able to offer access to premium payments for a wider range of wheat-growing regions.

Presentations by Clare Johnson and by John Oliver (on behalf of Martin May) described methods and avenues for “getting the message across”, leading into discussions of appropriate procedures to pursue next. There was general agreement that there was still the need for further development of the management procedures used in the Prime-Hard-in-the-South trials before passing them on to growers. This is being pursued in ongoing meetings involving the research staff from the project, interacting with extension officers. As a result of the workshop, a successful application has been made to the GRDC for modest funding to facilitate this process, thus extending the project for another year (to June, 1999). A final presentation on all aspects of the work is planned for the 1999 Australian Cereal Chemistry Conference in September in Melbourne.

Discussions at the workshop also indicated the need for the Wheat Board to provide growers with the assurance that there would be ongoing receivals of Prime Hard grain in southern regions. As a result of the workshop, the following Press Release has been issued by the AWB.

AWB Press Release ..... 18.5.98

AWB Encourages Prime Hard production in the Port Kembla Zone

Southern NSW wheat growers who delivered into new Prime Hard receival sites in 1997/98 more than justified their participation in the Prime Hard pool. Speaking after a recent forum to discuss Prime Hard wheat issues, AWB Senior Wheat Quality Consultant, Mr. Bob Cracknell complimented NSW growers who participated in the commercial trial in 1997/98. "The right varieties and attention to detail to achieve the required 13% protein level, resulted in excellent samples of Prime Hard wheat from the five new Port Kembla zone sites," he said.

Following the trial of these sites in 1997/98, the AWB now plans to extend the number of services available to growers in the 1998/99 season. The AWB’s NSW office is supporting this concept and is discussing possible locations of additional Prime Hard receival sites with GrainCorp and grower groups.
These moves have been prompted by an extensive research project carried out in the southern region over the past three seasons. The project entitled "Prime Hard in the South" was funded by the GRDC, managed by the Quality Wheat Cooperative Research Centre, and undertaken by NSW Agriculture Cereal Specialist John Oliver and CSIRO Plant Industry Research Agronomist, John Angus.

Initially they compared the milling and baking quality of Prime Hard varieties grown at several sites in southern NSW with that of the same varieties grown in traditional Prime Hard production areas in northern NSW.

Other than the inevitable minor seasonal effects, the trials showed no appreciable difference in quality between the southern and northern samples, with the southern material being superior in some instances. Subsequently the trial has been expanded to include sites in Victoria, South Australia and Western Australia.

Commenting on these very encouraging results, Mr. Cracknell, who is also the CRC Program Leader, applauded the GRDC for funding what was viewed in some circles as a controversial project. "These results may have ended the myth that Prime Hard quality wheat can only be grown in a northern environment," he said. The project has paved the way for further extension of the limited Prime Hard zone in NSW which should greatly improve our ability to guarantee supply of this highly sought-after product.

Mr. Cracknell cautioned growers in South Australia, Western Australia and the Victorian Mallee not to expect rapid changes to their delivery options. Because the existing Prime Hard quality cultivars do not generally perform well agronomically in these southern and western environments, segregation and marketing from these regions will depend on the development of a suite of new varieties with the necessary quality and agronomic characteristics. "Consistent tonnage at the required quality is a key element in developing viable segregations in any production zone. But once breeders begin to produce adapted varieties, I have little doubt limited Prime Hard segregations will be established in other regions in the future," Mr. Cracknell said.
PART 3. Getting the message across

The range of approaches being considered by the Wheat CRC for training

Clare Johnson

Summary of presentations at a one-day workshop on “GROWING MORE QUALITY WHEAT”
Tuesday, 28th April, 1998
Quality Wheat CRC

Approaches to Education and Training

Clare Johnson

Courses

- Sponsor BRI milling/baking courses
  - key influencers

- Quality Wheat for Quality End Products (EA)
- Meeting Market Requirements (WA)
  - progressive farmers

- Short courses for graduate staff/students
Implementation:
Milling for Non-Millers Course

- Mainly agronomists
- Great background information
- Suggestions:
  - Grain markets (AWB)
  - Tie-in for extension

Overall, I have used the knowledge gained

Not At All
Not Much
A Little
Extensively
Often

- Respondent n=13
- Surveyed n=18

Implementation:
Quality Wheat for Quality End-Products Course

- Mainly growers
- Excellent end use information
- Suggestions:
  - How? - More on agronomic practices

Overall, I have used the knowledge gained

A Little
Extensively
Often

-Surveyed n = 19
(Horsham and Toowoomba courses)
- Respondent n = 12
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<tr>
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<td>• Video</td>
<td>• Milling</td>
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<td>• Fact sheets</td>
<td>• Receiptal tests, quality</td>
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<td>• Web page</td>
<td>• Link participants, contact, E&amp;T, FAQ, research, publications</td>
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<tr>
<td>• CD-ROM/course</td>
<td>• Grain storage, quality</td>
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**Messages to Deliver:**

- General scope of the QWCRC
- Prime Hard in the South
- Nitrogen / protein management
- Waxy wheat - special processing qualities
- The rain damage kit: on farm assessment of sprout damage
- Maintaining processing quality during grain storage
- Quality windows: which wheat for which market and end-use?
- Explaining grain quality testing
- How do you make particular products?
- What are the new varieties? Where do they fit in?
- Small scale testing
- Quality Assurance (HACCP)
- Glossary
Descriptions of CRC Research:

- Understanding pasta quality to improve durum breeding
- Developing soft biscuit wheats for growing on cotton stubble
- Minimising the effects of high temperatures on wheat quality

Landcare Groups

- NSW and WA Agriculture agronomists/extension staff
- Topcrop
- Birchip
Kondinin Group

- Database 20,000 farmers
- Monthly publication “Farming Ahead”
- Evaluation: “Choice Magazine” of farming
- Series of 6 articles
- Market research service: FAQ
- CSIRO 10-12 pages/issue
- CRC logos accepted

Other Publications

- Australian Grain (Toowoomba)
- Australian Good Taste (Woolworths magazine)
- Quality Wheat Developments
- Market education, e.g.
  - waxy wheat
  - high amylose
  - Australian non-durum pasta
Which media are most effective?

- Print:
  - Newspapers/ Newsletters
  - Brochures
  - Fact sheets
- Radio/TV
- CD-ROM
- Web sites
- Farm advisers/agronomist-run farmer groups
  - slides, video
  - workshops, on-farm experiments
PART 3. Getting the message across

The role of district agronomists and farm advisers in extension to improve grain quality

Martin May and John Oliver

Summary of presentations at a one-day workshop on "GROWING MORE QUALITY WHEAT"
Tuesday, 28th April, 1998
Role of Extension Agronomists

Government & Agriculture
A Partnership for the Future

An open letter to the clients and stakeholders of the NSW Department of Agriculture and Departmental staff.

The provision of Government services to the Agriculture sector in NSW has been under close scrutiny for almost two decades.

NSW Agriculture in response to this scrutiny and to changing community perceptions and requirements, has reshaped its services and service provision. A major component of these changes has been decentralization. This has allowed financial and human resources to be strategically located where agriculture industries need them most – in the country.

Since the Carr Labor Government took office 12 months ago, we have sought information and we have listened. Listened to advice from various government agencies. Listened to advice from

March 1996
Enhancing the position of extension services

In the last decade, changes in the business environment of agricultural industry suppliers and service providers, have resulted in global effects on the agricultural and agribusiness sector.

Agricultural and agribusiness companies such as Elders, Woolworths-Dalgety, SRS-IAMA, Combonba Rural Traders, Stock and Station Agencies to name but a few, are fast becoming in their own right retailers of a wide range of services. These include services which, in the past, were not considered the responsibility of the private sector. But customer or client service, business imperatives such as competitiveness and market share, have seen these companies embrace such services as core components of their business.

The role of NSW Agriculture

For several years NSW Agriculture has consulted widely with many of these companies, industry associations and the agriculture sector as a

The Role of NSW Agriculture

“...A major role for NSW Agriculture's Extension Service is to facilitate better two-way communication and information transfer between consumers, retailers and wholesalers, manufacturers and producers”

Government and Agriculture: March 1996
The Role of NSW Agriculture

"It is clear that there is indeed room for private sector participation in extension service provision. Many of the mentioned companies now incorporate their own fully trained advisers."

Government and Agriculture: March 1996

The Role of NSW Agriculture

"But it is also clear there remains a demand and a role for Government, through NSW Agriculture, to maintain its "unaligned", independent brokerage of information up and down the agricultural and agribusiness marketing chain."

Government and Agriculture: March 1996
'Whole of Industry' Technical Specialists

- 'Wholesalers' of technology to the private sector.

- Responsibility of providing direct feedback to the research team.
‘Whole of Industry’ Technical Specialists

- 'Wholesalers' of technology to the private sector.
- Responsibility of providing direct feedback to the research team.
- Must be key members of the research effort at the local level.

Network of Extension Agronomists

- Strategically located across complete wheat belt
Role of NSW Agriculture’s Extension Network

- Help rural communities identify and solve practical problems.
- Continue to act as effective two-way communicators between research and industry.
- Assist NSW Agriculture achieve its community service obligations.
- Minimise any adverse impact of agriculture on the environment.

Methods

- Consultative:
  - Traditional 1:1

- Facilitative:
  - Action learning groups
Linking Research and Industry

Research Output: Demonstrated equivalence of quality
Outcome: Segregations established

New Outcome: Continuity of supply.

Outputs required:
*Extension network* - develop & disseminate a coordinated and consistent message to growers on best management practices and tools to achieve targets

*Research* - ?

Management Packages

Principally designed to maximise yield.

For Quality
- NSW: PH/ Durum- maximise protein
- SNSW: Biscuit wheats on irrigation- minimise protein
- WA: Noodle wheat packages target protein window
Gaps

- Management packages for targeting quality in agri-ecological regions
- Understanding of N cycle
- Collation of available information on N management
- Demystification lexicons
- Evaluation of predictions

Caution!

Operation Quality Wheat failed because
- of wrong timing.
- it was imposed.
- benefit-reward not in place.
- extension message was not coordinated.
- of perceptions of regional differences.
PART 3. Getting the message across

General discussion

Learning Pyramid page provided by Ben Curtis, Agriculture W A
Quality and Marketing Learning Pyramid for the Grain Industry

Market Place Tours
(AWB, Grain Pool)
Growers visiting the international market place to see their grain and the quality requirements expected of it

Asian Food Experience
(AGWA)
A short course at the Bakery Industry Training Center in Singapore. Participants will attend workshops making Asian foods made from different qualities of wheat. Market place and industry visits are also included.

Millers for Non-Millers
(BRI)

Bakers for Non-Bakers
(BRI)

Wheat Quality Workshop
(AGWA, AWB, ACT, CAM)
A regional course designed to participants to learn more about wheat quality, milling and some market issues.

Barley Quality Workshop
(AGWA, Grain Pool, CAM)
A course for WA industry to learn more about barley quality, milling, brewing and market requirements.

Working with market focused grower groups
(AGWA)
There are several grower groups in Western Australia focusing on the markets and their requirements. AGWA is working with and supporting these groups in a number of ways. These groups include the South East Premium Wheat Growers Association, Noodle Growers Association and Soft Wheat Growers Association.

Field Day quality information
(AGWA, AWB, Grain Pool)
Ag Memo Articles
(AGWA)
Agronomic packages for quality
(AGWA)
Market awareness information
(AGWA, AWB, AGT, CAM)