QUALITY WHEAT CRC PROJECT REPORT

PRODUCTION OF WHEAT TO GRAIN-QUALITY TARGETS

Proceedings of a one-day workshop

held on Wednesday 15th March 2000

Edited by RL Cracknell and CW Wrigley

Date: March 2000

QWCRC Report No: 39
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PRODUCTION OF WHEAT TO GRAIN-QUALITY TARGETS

This workshop was arranged to review recent research activities in Program 2, of the Quality Wheat CRC, entitled "Growing and Storing Quality Wheat", and to obtain feed-back on the research directions of the projects in Program 2. Presentations indicated the considerable extent of successes that have been achieved so far in the life of the CRC, particularly with research outcomes that have been implemented and that are producing significant economic returns for the wheat industry. This report provides a limited record of the proceedings of the workshop in the form of the overhead transparencies provided by the speakers.

Program for the day

GROWING QUALITY WHEAT (10 am to 11.30)

Eastern Australia's success in achieving grain quality targets in 1999/2000
-Bob Cracknell

Western Australia's success in achieving grain quality targets in 1999/2000
-Wal Anderson

Bench-marking quality for premium wheat grades
-Jennifer Pumpa

Changes in grain-protein composition during grain filling; the proteome of the wheat grain
-Daniel Skylas and Colin Wrigley

HARVESTING QUALITY WHEAT (12 noon to 1 pm)

Averting disaster in a bad frost season
-Helen Allen

Implementation of the WheatRite test card for sprout damage
-Russell Heywood

Prospects for rapid identification of wheat diseases
-Amanda Hill

Precision agriculture – can it improve grain quality?
-Amanda Hill

STORING QUALITY WHEAT (1.30 pm to 2.30 pm)

QA for the grains industry: assurance of quality for grower, processor and exporter
-Di Miskelly

Achieving consistent grain quality by aeration
-DAI Suter

PROCESSING and MARKETING QUALITY WHEAT (2.30 to 3.30 pm)

Achieving quality targets by appropriate blending of grain or flour
-Frank Bekes

Education in marketing and quality awareness
-Clare Johnson

GRDC's Grain Education Program
-Brondwen MacLean

SUMMARY and GENERAL DISCUSSION (3.30 to 4 pm)

– Bob Cracknell

GROWING QUALITY WHEAT

Eastern Australia's success in achieving grain quality targets in 1999/2000

-Bob Cracknell

97/98 Prime Hard Southern Receival Sites

- 20 sites used in Kembla zone
  - 15 Trad Northern sites
- approx. 78,000mt segregated in total
- 27,000mt segregated at 5 Southern sites
- Varietal Breakdown
  - 64.48% Janz
  - 25.96% Cunningham
  - 3.90% Sunco

[illegible]	[illegible]
GIRRAL	967.73
L CARGELLIGO	14,079.34
MERRIWAGGA	6,859.02
RANKINSPRING	3,789.56
TULLIBIGEAL	1,346.45
[illegible]	[illegible]

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Commercial trials - contd.

- 1997/98 - 27KT at 13.6% protein
  - comparable to N.PH except milling down 2%
  - shipped to Malaysia/Indonesia
  - no complaints
- 1998/99 - 13 sites
  - frost, disease and low proteins
  - only 10KT segregated
  - quality = or > Brisbane and Newcastle PH

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98/99 Prime Hard Southern Receival Sites

- 23 sites used in Kembla zone
  - 11 Trad Northern sites
- 27,000mt segregated in total
- 10,000 mt segregated at 12 Southern sites
- Varietal Breakdown
  - 65.73% Janz
  - 18.95% Sunbrook
  - 9.57% Batavia

	[illegible]ated
BARELLAN	1,865.82
BRUSHWOOD	640.64
CUNNINGAR	1,801.97
ILLABO	580.64
GRONG GRONG	486.60
KIKOIRA	370.83
L CARGELLIGO	610.32
MATONG	27.86
MERRIWAGGA	1,427.32
OLD JUNEE	954.21
PORT KEMBLA	1,202.32
PUCAWAN	66.92
	[illegible]

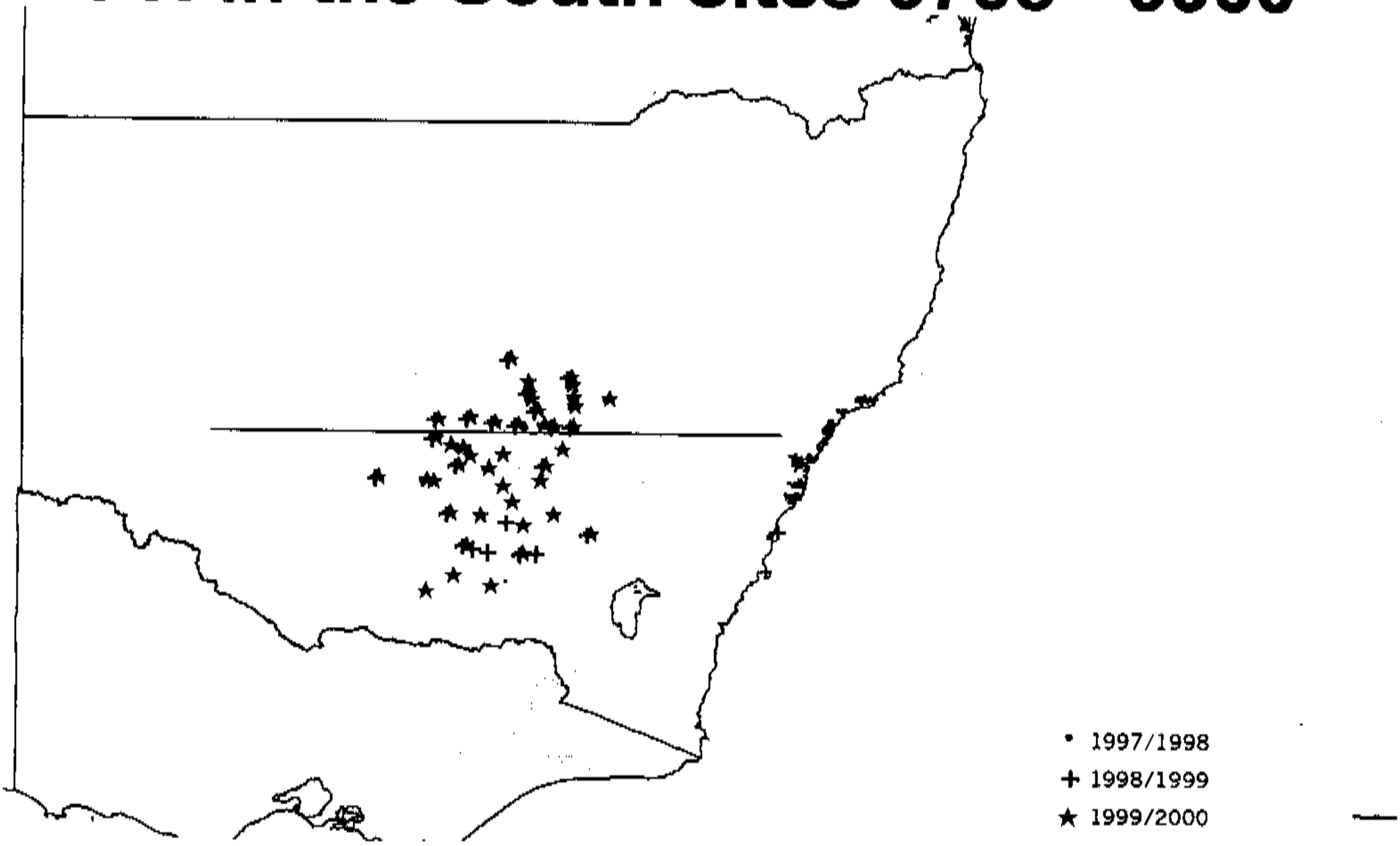
99/00 Prime Hard Receival Sites in Kembla zone

- **General**
- 42 sites received APH in Kembla zone
  - 17 Trad Northern sites
- approx 318KT segregated in total

- **Sth sites**
- approx 118KT segregated at 25 sites
- Varietal breakdown
  - 56% Janz
  - 19% Cunningham
  - 8.5% Sunstate

- **Nthn sites**
- approx 200KT segregated at 17 sites
- Varietal breakdown
  - 42% Janz
  - 17% Cunningham
  - 11% Sunstate

PH in the South sites 9798 - 9900



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Australian Prime Hard - New South Wales

Wheat	1999/00	1998/99
	Port Kembla	Port Kembla
Test Weight (kg/hl)	82.0	80.5
Thousand Kernel Weight (g)	35.4	32.9
Moisture (%)	10.5	10.6
Protein (%)(N x 5.7, 11%mb)	13.5	13.2
Screenings (%, 2.0mm)	2.0	3.7
Falling Number (sec)	434	439
Grain Hardness (PSI)	18	15
Ash % (11% mb)	1.40	1.44

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Australian Prime Hard - New South Wales

Flour	1999/00	1998/99
	Port Kembla	Port Kembla
Extraction	60	60
Protein (%)(N x 5.7, 14%mb)	12.4	11.9
Colour Grade (KJ)	-2.6	-2.0
Diastatic activity (mg)	166	237
Ash (%)(14% mb)	0.38	0.39
Minolta Flour Colour L	92.6	92.8
Minolta Flour Colour b	8.8	8.7

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Australian Prime Hard - New South Wales

Farinogram	1999/00	1998/99
	Port Kembla	Port Kembla
Water absorption (%)	62.0	63.8
Development time (min)	5.7	6.0
Stability (min)	>15.0	>15
Extensogram - 45 Min Pull		
Extensibility (cm)	24.6	21.7
Maximum height (BU)	370	455
Area (sq.cm)	128	137
Viscograph Peak (BU)	560	550

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RAMEN NOODLE EVALUATION

Southern Wales

Australian Prime Hard

60% extraction		1999/00		1998/99	
Port Kembla		30 mins	24 hrs	30 mins	24 hrs
Noodle sheet - Raw	L	80.6	71.4	80.1	72.7
	b	23.2	24.3	25.3	25.6
Noodle sheet - Cooked	L	73.3		72.1	
	b	28.6		26.8	

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Varietal composition- PH in Kembla zone

Variety	SNSW 97/98	SNSW 9899	SNSW 9900	NNSW 97/98	NNSW 9899	NNSW 9900
Banks	0.9%	-	2.07%	0.17%	0.20%	0.64%
Batavia	1.1%	9.57%	5.10%	2.14%	9.84%	8.53%
Cunningham	26.0%	1.38%	19.19%	6.27%	2.02%	16.73%
Hartog	-	-	0.16%	2.46%	1.05%	8.21%
Janz	64.5%	65.73	56.07%	45.76%	32.50%	42.07%
Miskle	0.2%	-	0.09%	1.24%	0.64%	2.10%
Sunbri	-	-	0.21%	2.48%	3.85%	1.47%
Sunbrook	-	18.95%	-	2.80%	6.40%	0.24%
Sunco	3.9%	-	0.95%	9.41%	13.22%	5.09%
Suneca	-	-	-	4.93%	3.80%	0.75%
Sunkota	-	-	0.03%	0.26%	2.73%	0.06%
Sunland	1.2%	-	0.14%	0.98%	0.20%	0.28%
Sunmist		-	-	2.21%	3.71%	0.95%
Sunstar	2.0%	2.50%	1.08%	0.13%	0.05%	0.03%
Sunstate	0.2%	0.30%	8.5%	13.41%	7.87%	11.17%
Sunvale	-	1.57%	5.74	4.39%	11.03%	1.65%
Other	-	-	0.67%	0.96%	0.89%	0.03%

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Technical Report

1999/00 Harvest Composite Wheat Quality Report No 37

Grade	**APH13**	APH13	APH13	APH13
Sample Code	**ZPCS**	ZFCS	ZFCS	ZFCS
Season	**99/00**	98/99	97/98	96/97
Zone	**Port Kembla**	Port Kembla	Port Kembla	Port Kembla
Sample No	**93437**	84919	79639	70474
Tonnes	-	26000	78000	99000
Wheat Results				
Test Weight (kg/hl)	82.0	80.5	81.0	83.0
Moisture %	10.3	10.6	10.2	9.5
Protein % (11% mb)	13.6	13.2	13.6	13.7
Ash % (11% mb)	-	1.44	1.31	1.39
Falling No (sec)	395	439	488	479
Hardness (PSI)	17	15	16	14
Screenings % (2mm)	2.4	3.7	3.9	2.6
Foreign Material %	0.21	0.45	0.16	0.14
1000 Kernel wt (g)	33.3	32.9	31.2	38.4
US Dockage %	0.25	0.32	0.29	0.25
US S & B %	0.24	0.36	0.64	0.38
US F M %	0.10	0.22	0.00	0.00
Screenings% (1.62mm)	0.5	0.7	0.6	0.9
Varietal Composition				
Batavia %	9	25	9	10
Cunningham %	20	4	22	17
Hartog %	6	4	5	6
Janz %	43	35	44	32
Miskle %	2	-	1	4
Sunbri %	1	2	1	2
Sunbrook %	-	11	1	-
Sunco %	4	2	4	6
Suneca %	1	3	1	2
Sunkota %	-	3	1	1
Sunmist %	1	-	1	1
Sunstate %	9	4	2	1
Sunvale %	2	5	-	-
Sample No	**93437**	84919	79639	70474

Flour Results				
Extraction %	76.7	75.2	74.5	76.9
Moisture %	13.6	13.9	13.4	13.5
Protein % (14.0% mb)	12.4	11.9	12.4	12.6
Colour Grade	-1.5	-1.6	-1.5	-0.8
Diastatic Activity	182	244	176	166
Ash % (14.0% mb)	0.46	0.44	0.47	0.42
Wet Gluten %	34.9	33.8	34.0	35.0
Gluten Index %	91	92	-	-
Zeleny Sedimentation Vol (ml)	-	59	66	-
Minolta Flour Colour L	-	92.7	92.9	92.6
Minolta Flour Colour a	-	-1.8	-2.1	-1.9
Minolta Flour Colour b	-	9	9.7	9.4
Minolta Paste Colour L	-	75.5	75.5	74.7
Minolta Paste Colour a	-	-0.9	-1.0	-0.9
Minolta Paste Colour b	-	9.1	9.7	8.8
Viscograph Peak (BU)	500	510	500	570
Gel. Temperature (^{0}C)	-	63	64	68
Gel. Breakdown (BU)	-	80	0	30
Water Absorption %	62.5	62.7	62.3	63.3
Development (min.)	4.8	5.1	7.6	6.0
Stability (min.)	6.7	14.7	11.3	14.6
Breakdown (BU)	60	20	20	35
Extensibility (cm) 45 min	24.0	21.5	20.7	24.2
Height (BU) 45 min	330	375	445	375
Area (cm^2) 45 min	113	112	126	130
Extensibility (cm) 135 min	-	22.2	21.0	21.0
Height (BU) 135 min	-	440	535	430
Area (cm^2) 135 min	-	136	153	127
Alveograph P (mm)	-	111	98	88
Alveograph L (mm)	-	88	134	136
Alveograph W (Jx10^{-4})	-	340	435	370
Alveograph G (ml)	-	20.8	25.7	-
Alveograph P/L	-	1.26	0.73	0.65

Need varieties

- Experiments successful
- Data in JFMA and AWB Crop reports
- To be commercially viable need
  - increased and more consistent production
    - good premiums
    - agronomic packages
    - adapted varieties

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GROWING QUALITY WHEAT

Western Australia's success in achieving grain quality targets in 1999/2000

-Wal Anderson

Producing Quality Wheat in Western Australia

Anderson, Shackley, Hoyle, Curtis,
Penny, Owen, Kerr, Morgan
Agriculture Western Australia

Aim

- 1. To conduct field-based agronomic research to improve the quality of wheat produced in Western Australia.
- 2. To extend relevant production and market information to wheat growers and to increase awareness about the importance of wheat quality for end products.

Outputs

- Production 'Packages'
- Courses for growers and industry
- Demonstrations, grower seminars, field days
- Media - print, radio

Performance Indicator

- To increase to proportion of the Western Australian wheat crop that is received into premium-paying grades to over 60% by 2005.

Noodle Agronomy Project

[Anderson, Shackley, Owen]

- The highest probability of obtaining premiums for noodle wheat was on the sandplain soils
- Choice of variety was more important than sowing time in achieving noodle quality
- Crops that followed lupins or legume pasture were more likely to achieve noodle quality at economic N rates

Choice of soil type and rotation affect noodle 'strike rate'

	Rotation	Nopt. kg/ha	Popt.%	>9.5<11.5
Clay loam	Good	30	12.0	17/33
	Poor	41	9.5	3/12
Duplex	Good	22	10.8	17/20
	Poor	52	9.4	11/18
Sandplain	Lupin	19	10.3	30/30
	Pasture	38	11.0	10/12

Variety>Soil Type>Sowing Time for Noodle Quality

Variety	Soil Type	E. May	Mid May	Late May	E. June	Mid June
Cadoux	CL	12.2	11.8	11.9	12.3	13.0
	DP	8.8	8.6	8.7	8.9	9.3
	SP	**9.8**	**10.6**	**11.2**	11.7	12.0
Arrino	CL	**11.1**	**11.4**	11.8	12.6	13.2
	DP	**10.5**	**10.5**	**10.6**	**10.2**	**10.1**
	SP	8.8	9.4	**10.0**	**10.2**	**10.1**

Wheat for Premium Markets Project

[Curtis, Penny, Morgan, Hoyle, Kupsch]

- High seed rates do not increase screenings
- Late sowing does increase screenings
- Variety-specific agronomy assists adoption
- 'Wheat Quality Awareness' Workshops
- 'Asian Wheat Uses and Markets' courses
- Printed booklets for durum, noodle, soft and hard wheat growers.

Management of Noodle Varieties

Variety	TS	Pl/m^2	Y/N	S%	P/N
Arrino	M-L	100-150	-	L	H
Calingiri	E-M	50-100	L	L	M
Cadoux	Mid	50-100	L	M	M
Nyabing	M-E	50-100	-	L	-

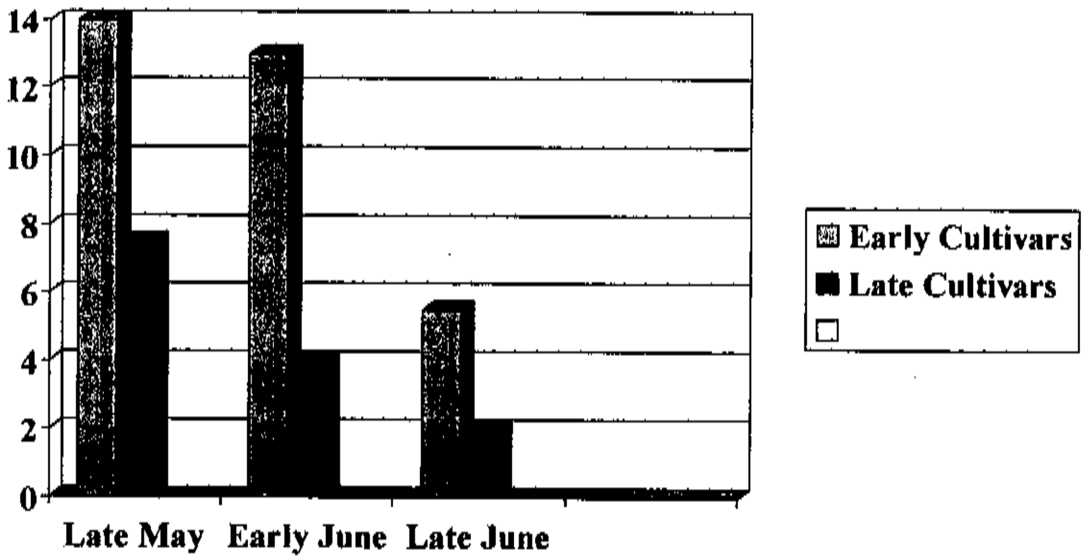
Black Point Project

[Hoyle, Devenish]

- Cultivar response to Black Point (BP) in the field is consistent
- Cultivar and sowing time selection is the key to management in susceptible areas
- Effects of BP on end products needs more research
- Need a rapid, objective test at receival points

Cultivar x Sowing Time affects Black Point (%),

1997, 3 sites

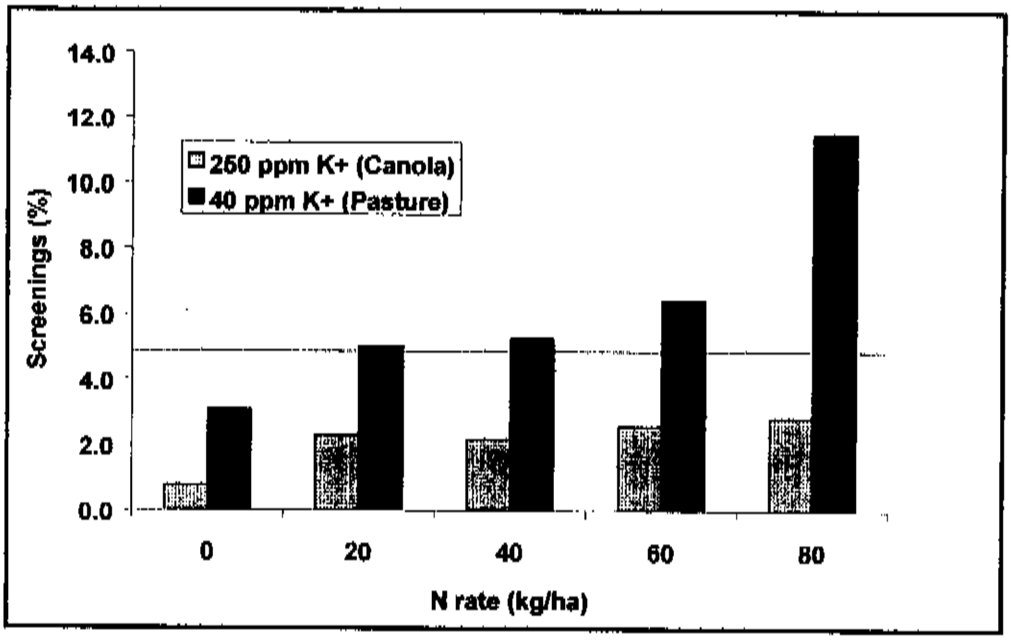


REASONS for DOWNGRADING

[Shackley, Tugwell]

- In the southern areas variety was a major cause of small grain screenings.
- Grain shape was often associated with high screenings
- Potassium deficiency, especially after canola, was also associated with screenings
- Booklet on 'Management to reduce small grain' in preparation

Influence of nitrogen application and soil K+ on screenings, Gnowangerup 1997

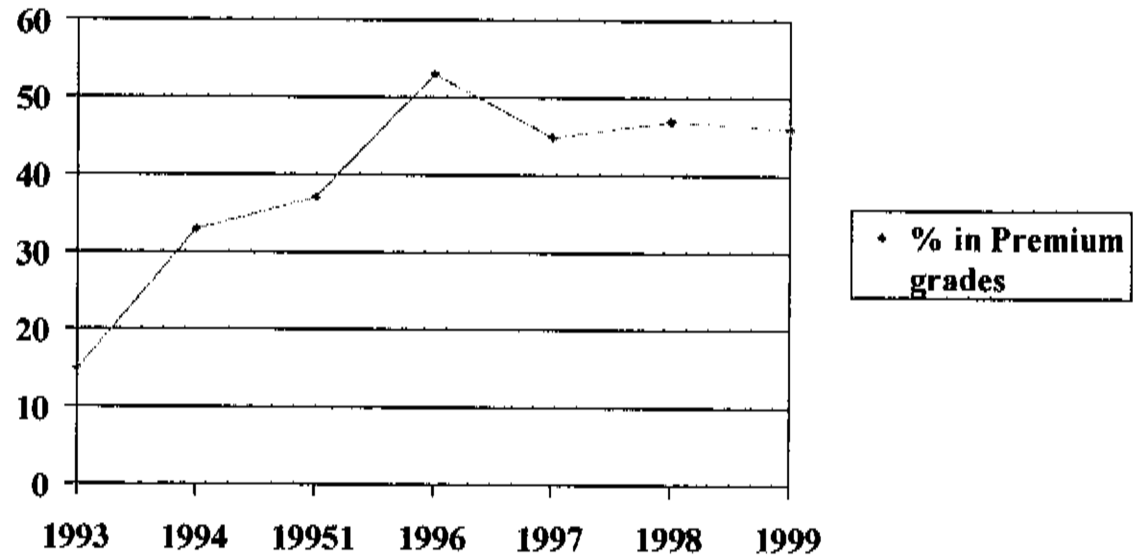


Developments in Quality Assurance

[Kerr]

- Quality Assurance Workshops - Noodle and Soft wheat pilot groups, Weston Milling key growers
- Development of 'Great Grain' from Pulse Australia and QWCRC systems
- 'Great Grain' and SQF 1000 now 'co-badged' allowing all farm enterprises to be included under one QA system.

Percent of the Western Australian wheat crop in Premium-paying Grades



Future Plans

- Cereal Chemist - trace elements x quality, review GxE, set up laboratory at CCS
- Initiate Regional Quality Workshops
- Reinforce quality messages (demonstrations, high quality packages)
- Add extra 'in-kind' (Impiglia, Amjad, Sharma, Del Cima, Williams)

GROWING QUALITY WHEAT

Bench-marking quality for premium wheat grades

-Jennifer Pumpa

Flexibility of Wheat Use Benchmarking Across Australia

Helen Allen and Jennifer Pumpa

NSW Agriculture

Grains Research & Development Corporation

15 lines (11 hard and 4 soft varieties) were selected from each Australian breeding program.

HARD VARIETIES:

Wilgoyne and Amery	Western Australia
Krichauff and Frame	South Australia
Meering, Ouyen and Goldmark	Victoria
Dollarbird and Sunco	New South Wales
Janz and Hartog	Queensland

SOFT VARIETIES:

Rosella and M5631	New South Wales
Cadoux and Eradu	Western Australia

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This work is supported by the GRDC and The Quality Wheat CRC.

Trials were sown at 12 sites around Australia

Queensland	Roma and Dalby
Northern NSW	Narrabri and Moree
Southern NSW	Wagga Dryland and Wagga Irrigated
Victoria	Horsham and Woomelang
South Australia	Roseworthy and Palmer
Western Australia	Wongan Hills and Newdegate

Due to the severe late frost in October 1998, grain suitable for quality testing was only available from 9 of these sites.

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This work is supported by the GRDC and The Quality Wheat CRC.

Grain characteristics were determined by:

% screenings
% blackpoint
test weight
1000 kernel weight
hardness
protein content

Starch pasting properties were determined by:

Rapid ViscoAnalyser

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This work is supported by the GRDC and The Quality Wheat CRC.

Milling quality:

Buhler flour extraction
Flour colour index

Physical dough characteristics:

Farinograph
Extensograph

PDT data was supplied by SARDI, Adelaide

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This work is supported by the GRDC and The Quality Wheat CRC.

Product Quality:

Pan bread	**WWAI, Wagga Wagga**
Flatbread	**SARDI, Adelaide**
Yellow Alkaline Noodle	**VIDA, Horsham**
Starch quality testing	**AWA, Perth**

Due to the seasonal conditions in the eastern states leading to a smaller sample size and a larger protein range than expected, it was preferable to conduct full starch quality testing on the soft varieties rather than white salted noodles.

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This work is supported by the GRDC and The Quality Wheat CRC.

Quality Results

- **Grain quality**
  - # Northern NSW sites had low test weights.
  - # W.A. sites had high screenings and low test weights.
  - # There was a high level of blackpoint in the southern NSW sites.
  - # Some sites in southern NSW and Victoria experience a severe frost.

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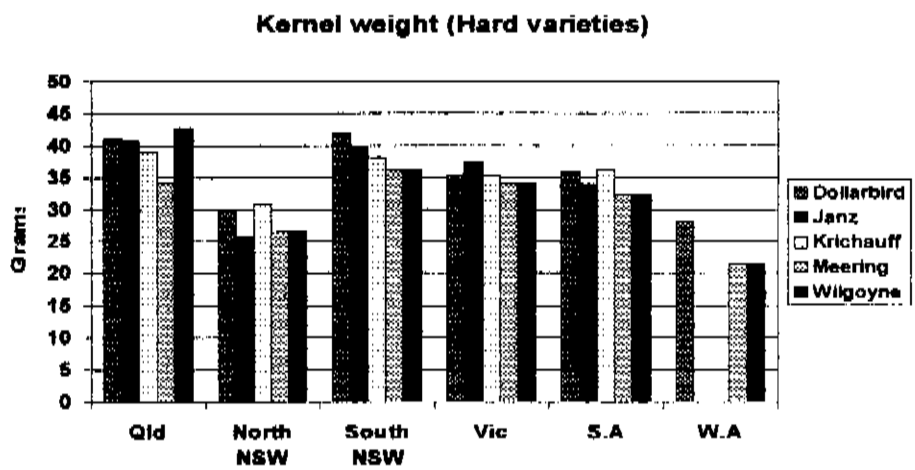

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Quality results

- **Milling quality**
  - # Small pinched grain from the W.A. sites had the effect of lowering the flour extraction rates.
  - # Northern NSW samples milled well, considering their grain size
  - # Flour extraction rates between all other sites were comparable.
  - # Uniform flour colour was detected across all sites.

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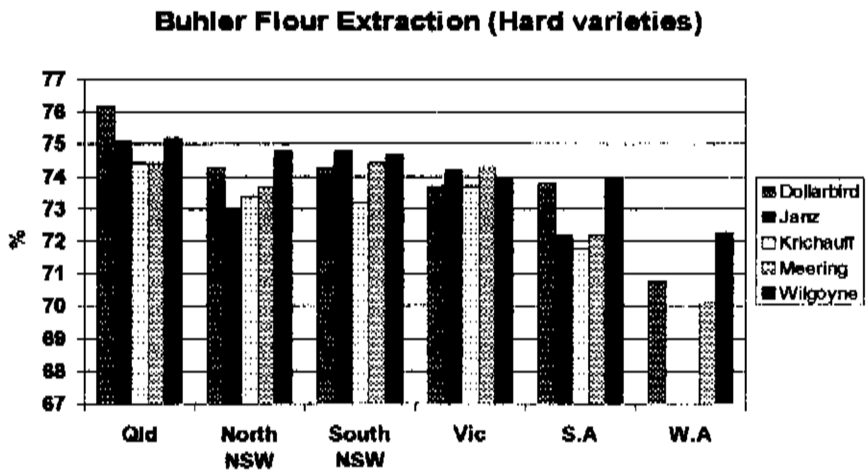

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Quality results

◆ **Dough characteristics**

Physical dough tests highlighted the differences between the sites.

No one site was consistently better than any other, for all of the parameters tested.

When extensibility is expressed per unit of protein for each sample, there is very little difference between all sites for both the hard and soft varieties.

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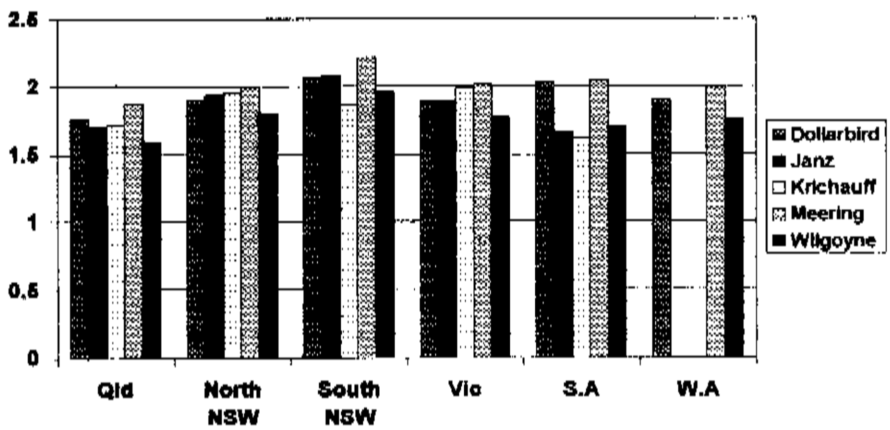
Extensibility per unit protein



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Product testing

◆ **Pan bread**

The Victorian and W.A samples had consistently larger loaf volumes and higher bake scores.

The southern NSW samples had low loaf volumes and bake scores, due to lower protein than other sites.

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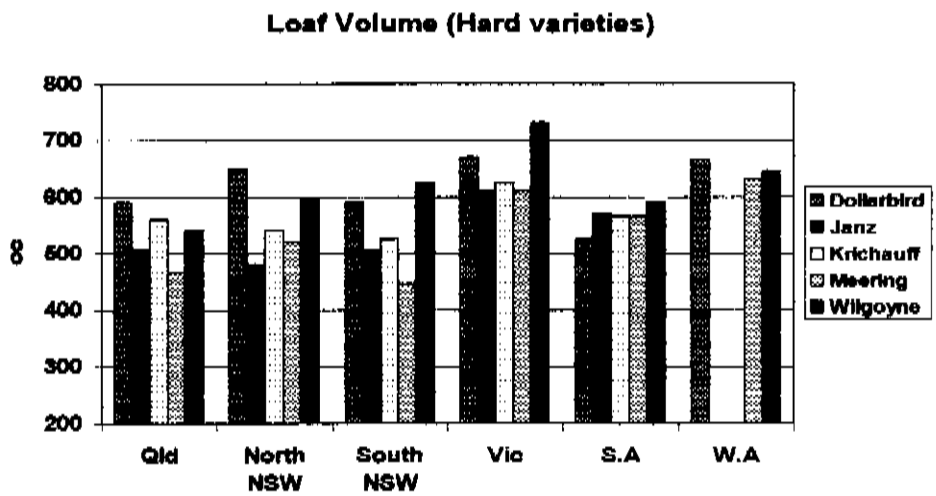

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Product testing

- **Yellow Alkaline Noodles**
  - # Noodle sheets were the brightest at the southern NSW, Victorian and S.A sites.
  - # Sheet colour and colour stability were poor at the northern NSW and Qld sites.
  - # The varieties Amery, Krichauff and Sunco displayed good colour stability at all sites.

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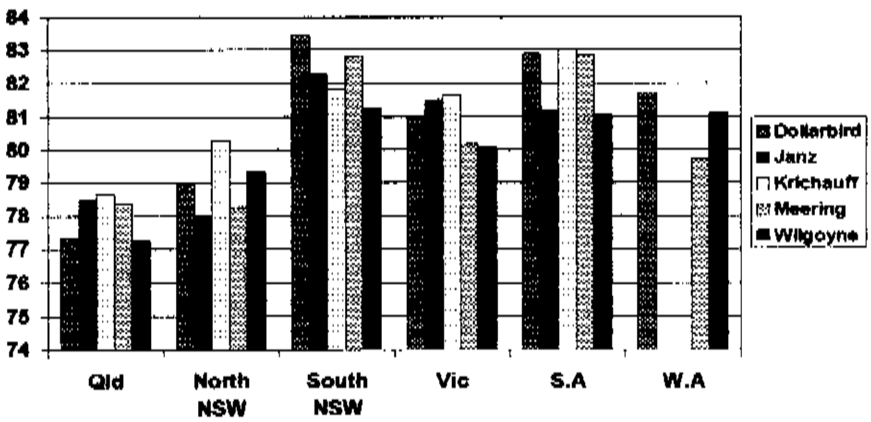
This work is supported by the GRDC and The Quality Wheat CRC.

YAN L* (0.5 hr)



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Product testing

- **Flatbreads**
  - # Flatbread baking scores were consistently higher for most varieties at the S.A and southern NSW sites.
  - # All other sites performed poorly. However, protein levels for these sites were above the ideal protein for flatbreads.

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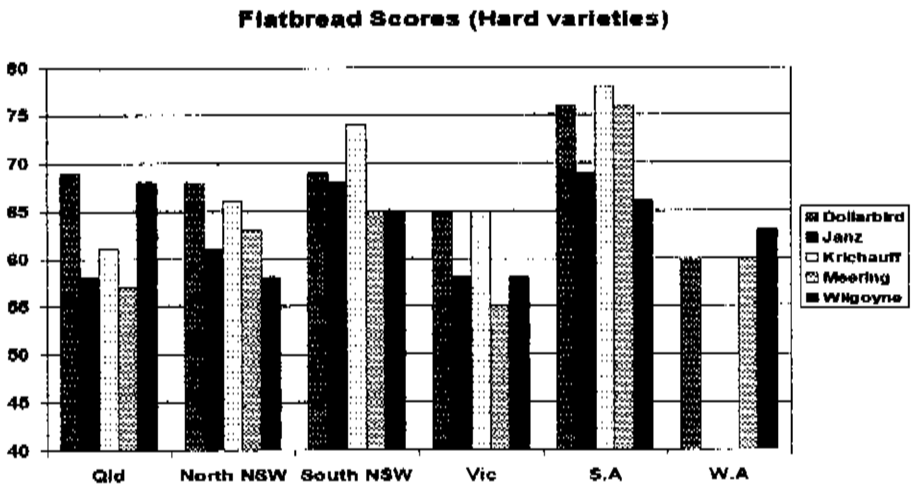

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Product testing

◆ **Starch analysis**

Seasonal effects meant that very few samples met the criteria for producing white salted noodles (sound grain, 10.0 - 10.5% protein)

Starch quality analysis was conducted instead.

Isolated starch was subjected to Flour Swelling Volume FSV) and RVA tests

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This work is supported by the GRDC and The Quality Wheat CRC.

Product testing

◆ **Starch analysis**

Starches isolated from Eradu, M5631 and Rosella samples from NSW and Victoria were very similar or slightly higher in FSV and RVA peak viscosity than those from W.A.

These are seen as desirable starch characteristics for the production of white salted noodles

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This work is supported by the GRDC and The Quality Wheat CRC.

Summary of research

As there has only been one year of full quality testing completed to date, it is too early to report on any discoveries made.

Continuation of the comparisons in future years will establish if the results obtained are consistent.

Seasonal effects are having an influence on results.

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This work is supported by the GRDC and The Quality Wheat CRC.

GROWING QUALITY WHEAT

Changes in grain-protein composition during grain filling; the proteome of the wheat grain

-Daniel Skylas and Colin Wrigley

THIS PRESENTATION WAS A PRE-RUN OF AN ORAL PRESENTATION THE GLUTEN 2000 WORKSHOP IN BRISTOL, UK, IN APRIL. THE CONFERENCE PAPER IS PROVIDED BELOW

WHEAT-GRAIN PROTEOMICS; THE FULL COMPLEMENT OF PROTEINS IN DEVELOPING AND MATURE GRAIN

W.G.Rathmell[1], D.J.Skylas[1-4], F.Bekes[1,2] and C.W.Wrigley[1,2]

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[2] CSIRO Plant Industry, North Ryde (Sydney), NSW 1670, Australia
[3] Australian Proteome Analysis Facility, Macquarie University (Sydney), NSW 2109
[4] University of Sydney, NSW 2006, Australia

1 INTRODUCTION

For any specific grain sample, the functional properties of gluten in the resulting dough are the result of the interaction of genotype with growth and storage conditions. Knowledge of the gluten-coding genes involved thus provides only half the story that is needed to understand (and thus to predict) gluten function at the molecular level. The 'other half of the story' requires knowledge of environmental factors and their effects on a further set of genes – those that have a regulatory role. Such factors determine the manner of synthesis of the gluten-forming polypeptides during grain development, the manner in which these are (or are not) associated into polymeric structures and the effects of other proteins that may influence these processes.

Study of regulatory genes and of environmental factors has proven to be difficult. A promising approach to understanding such matters is analysis of the full complement of polypeptides in the developing and mature grain, thereby to catalogue the full complement of proteins synthesised.[1,2] This full set of polypeptides has become known as the 'proteome' of the tissue involved, being the expression of the part of the genome that was appropriate to that tissue, to the stage of development, and to the conditions of growth.

A proteomic study involves the extraction, separation and identification of proteins from a specific tissue of an organism. In applying this approach to wheat endosperm, novel extraction buffers and fractionation conditions were developed. A key part of this new technology is the analysis of the components by N-terminal sequencing, followed by database searching to indicate the likely identities of the many component proteins. However, even this approach goes only part way to elucidating the molecular aspects of gluten function, since it is restricted to primary structure; knowledge of higher-level structure is also needed, such as disulfide bondings. We have thus supplemented proteomics with a study of the polymerisation of glutenin subunits throughout grain filling, thus to elucidate the sequence and rate of polymerisation of specific polypeptides.

2 METHODS

For the proteome studies, grain of the wheat variety Wyuna was grown under day/night temperatures of 24/18°C, with samples being taken at 17 days post anthesis (DPA) and at maturity (45 DPA). Endosperm (isolated from immature grain and freeze-dried) or flour (milled from mature grain) were extracted with 10% trichloroacetic acid and 0.07% 2-mercaptoethanol in cold acetone to remove components that interfere with solubilisation and fractionation.[3] This material was extracted with solubilisation buffer (7M urea, 2M thiourea, 2mM tributyl-phosphine (TBP), 4% CHAPS, 1% carrier ampholytes, 40mM Tris and 0.001% Orange G dye) by vortexing and sonication. Nucleic acids were digested with endonuclease (Sigma).

The first dimension (isoelectric focusing) was performed on Immobiline® DryStrips (Amersham Pharmacia Biotech, Sweden), either for pH 4-7 or pH 6-11. These resulting strips were used for second-dimension fractionation in large-format SDS-PAGE gels, with a gradient of 8-18%T and 2.5%C piperazine diacrylamide as crosslinker. Analytical SDS-PAGE gels were stained with diamine silver. Preparative SDS gels were electroblotted to PVDF membranes[4,5]. SDS-PAGE gels were scanned using the Molecular Dynamics Personal Densitometer SI. Automated Edman degradation was performed on a Hewlett Packard G1005A Protein Sequencer employing Routine PVDF 3.1 chemistry. PTH amino acids were separated and analysed with an online Hewlett Packard Series II 1090 LC using the PTH_4.M HPLC method. N-terminal sequence data was processed using the software tools TagIdent (http://expasy.proteome.org.au/tools/tagident.html) and Fasta3 version 3 at the European Bioinfomatics Institute (EBI) (http://www2.ebi.ac.uk/fasta3) to interrogate SWISS-PROT (release 35) and TrEMBL databases.

To quantify the accumulation of the major protein classes, wheat plants (variety Wyuna) were grown under day/night temperatures of 18/13°C (16-hour days), with samples being taken at four-day intervals from 4 DPA to maturity. Size-exclusion (SE)-HPLC methods[6,7] were used for assessing the main size classes of endosperm proteins. Changes in the size distribution of polymeric proteins were characterised during endosperm development by field-flow fractionation (FFF)[7] and by SE-HPLC-based determination[8] of the amounts of unextractable polymeric protein (UPP). The accumulation of high- and low-molecular-weight (HMW and LMW) glutenin subunits were monitored by reversed phase (RP)-HPLC.[9]

3 RESULTS AND DISCUSSION

About 690 polypeptide spots were resolved in the acidic range (pH 4-7) for immature grain; an additional 610 basic components were resolved in the range pH 6-11 (Figure 1). The results provide renewed insight into the complex nature of wheat-grain endosperm proteins. It was not possible to attempt N-terminal sequencing of all of the components observed. Altogether, 321 proteins were submitted for post-separation characterisation. From this total, 177 (55%) proteins were identified, 55 (17%) proteins were not matched and 89 (28%) proteins did not yield any N-terminal sequence data (because of N-terminal blockage or insufficient material).

Examples of the types of polypeptides identified in the immature endosperm are shown in Table 1. As expected, many were gluten-forming components (gliadins and polypeptides of glutenin). Nine HMW subunits of glutenin were identified across the top of the pH 4-7 pattern; none were identified in the pH 6-11 range. A total of 80 gliadin components was identified, covering much of the molecular-weight range (36 and 44 in the acidic and basic ranges, respectively). There was a prominent grouping of 14 isoforms of protein disulfide isomerase[10] on the upper acidic side of the pH 4-7 pattern, presumably important in determining aspects of gluten function related to disulfide-bond formation.[11,12] Across the smaller molecular-weight region of both pH ranges, there was a large number (38) of components identified as having homology to amylase/trypsin inhibitors.

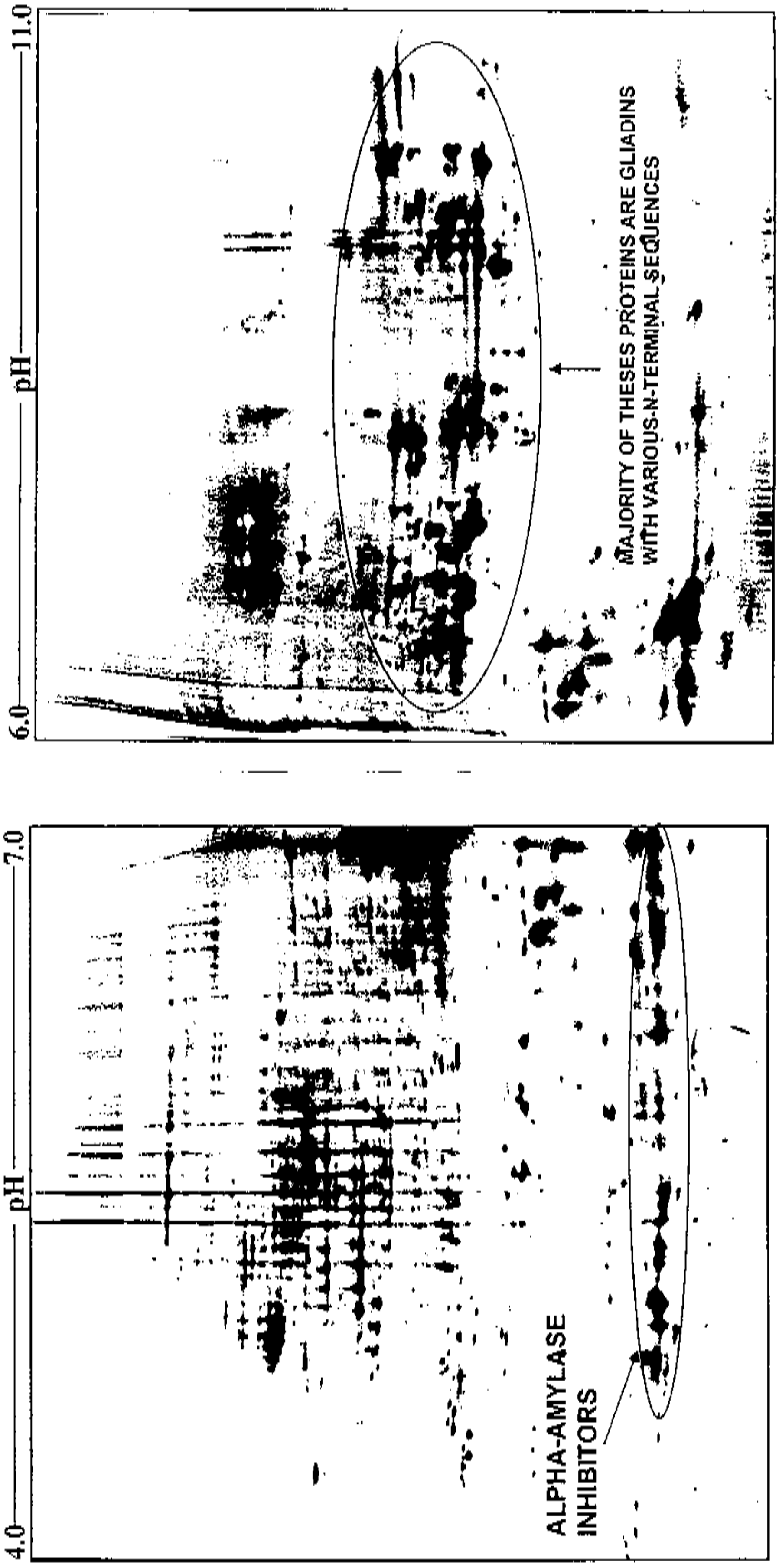

Figure 1. Two-dimensional maps of polypeptides extracted from immature endosperm of wheat (cv. Wyuna) in acidic and basic pH ranges.

When proteome patterns were compared for immature and mature endosperms, it was evident that there were slightly fewer polypeptides resolved for mature grain (about 650 in the acidic range and 470 basic polypeptides). Presumably there are many polypeptides involved in the synthetic mechanisms of the developing grain that are broken down during ripening. For example, amongst those missing in the mature endosperm were the several of the isoforms of protein disulfide isomerase.

Table 1. Examples of polypeptides (pH 4-7 range) identified in the proteome analyses. (Spot numbers refer to a paper submitted for publication by Skylas *et al.*)

Spot No.	N-Terminal sequence	Gene-product	% Identity	Organism
1	KTITLEVE	Ubiquitin (UBQ1 gene)	100% in 8 aa	*T. aestivum*
2	SQAQGSVQ	Alpha/beta-gliadin	100% in 7 aa	*T. aestivum*
9	SGPWSWXD	Alpha-amylase inhibitor 0.28	100% in 6 aa	*T. aestivum*
11	GRLLSPRGKE LHTPQEEFPQ QQQFP	Omega-gliadin	46% in 24 aa	*T. monococcum* Einkorn wheat
16-30	VRVPVPQL	Alpha/beta-gliadins	100% in 8 aa	*T. aestivum*

These results illustrate the potential of the proteomics approach to provide detailed information that complements genome studies.[13] The resulting array of polypeptides displays the 'reality' of the phenotype, providing a first indication of the performance of a specific genotype (genome) with respect to a particular combination of tissue and growth environment. As the first products of gene action, the polypeptides[11] are critical to elucidating gene-function relationships, as well as gene-environment interactions[12]. Proteome analysis therefore promises to provide a complementary approach to molecular-marker analyses that have hitherto focused on the DNA level.

The next step of critical importance to elucidating gluten function is the processing of the newly synthesised polypeptides. Proteome studies offer to help at this level by the identification of proteins that may act, for example, as chaperones during processing,[10,11] but more direct studies are also warranted to examine the processing of the polypeptides. This stage is especially important for the glutenin polymers, which are inactive in dough-forming properties as individual polypeptides. To elucidate this aspect of gluten structure, protein composition was studied throughout grain filling.

During the very early stages, SDS-soluble proteins accounted for almost all the material in the 'polymeric' protein class, indicating relatively small glutenin polymers. Differences started to appear after several days (at about 16 DPA), when polymeric proteins grew in size, making them impossible to solubilise without the aid of sonication, resulting in significant proportions of 'unextractable' polymeric protein (UPP). By maturity, the proportion of UPP had risen to nearly 40%. The changes in the size distribution of the UPP was contrasted by FFF analysis, which showed how much smaller was the size distribution for the UPP from immature endosperm. In parallel studies, involving lines deficient in genes for HMW glutenin, the presence of both extractable and unextractable polymeric protein was observed as glutenin polymers formed in the developing endosperm. This result supports earlier reports (Singh and

Shepherd[14] and others) that it is possible to have glutenin polymers consisting solely of LMW glutenin subunits.

The amounts of glutenin and gliadin increased steadily during grain development. The glutenin/gliadin ratio was highest at the very early stages of maturity. The relative proportions of the three main protein classes reached a plateau at 20-23 DPA, coinciding with the end of the cellular-division period. The synthesis of HMW subunits commenced slightly before that of the LMW subunits. The different timing of the biosynthesis of HMW and LMW subunits may provide an important indication about the polymeric structure of native glutenin in the mature grain. The relatively higher proportion of HMW subunits, synthesised earlier than the appearance of LMW subunits, suggests that a polymeric structure may form with a backbone of HMW subunits, onto which LMW-subunit branches may be attached. This would not necessarily require a highly sophisticated regulatory mechanism.

The combination of proteome studies with analysis of the glutenin-polymerisation process offers the promise of further elucidation of the molecular basis of gluten function, as it is determined in the developing endosperm, under the combined influence of genotype and environment. New technologies have become available to facilitate these advances, particularly, the proteome approach and the wider range of protein-size distribution that can now be analysed with field-flow fractionation. The new science of proteomics demonstrates the 'reality' of the genome for a specific situation. This will lead to the identification of protein markers that are likely to indicate the 'reality' of gluten quality for actual combinations of genotype and environment, plus the promise of markers (possibly causes) of tolerance mechanisms to stress situations.

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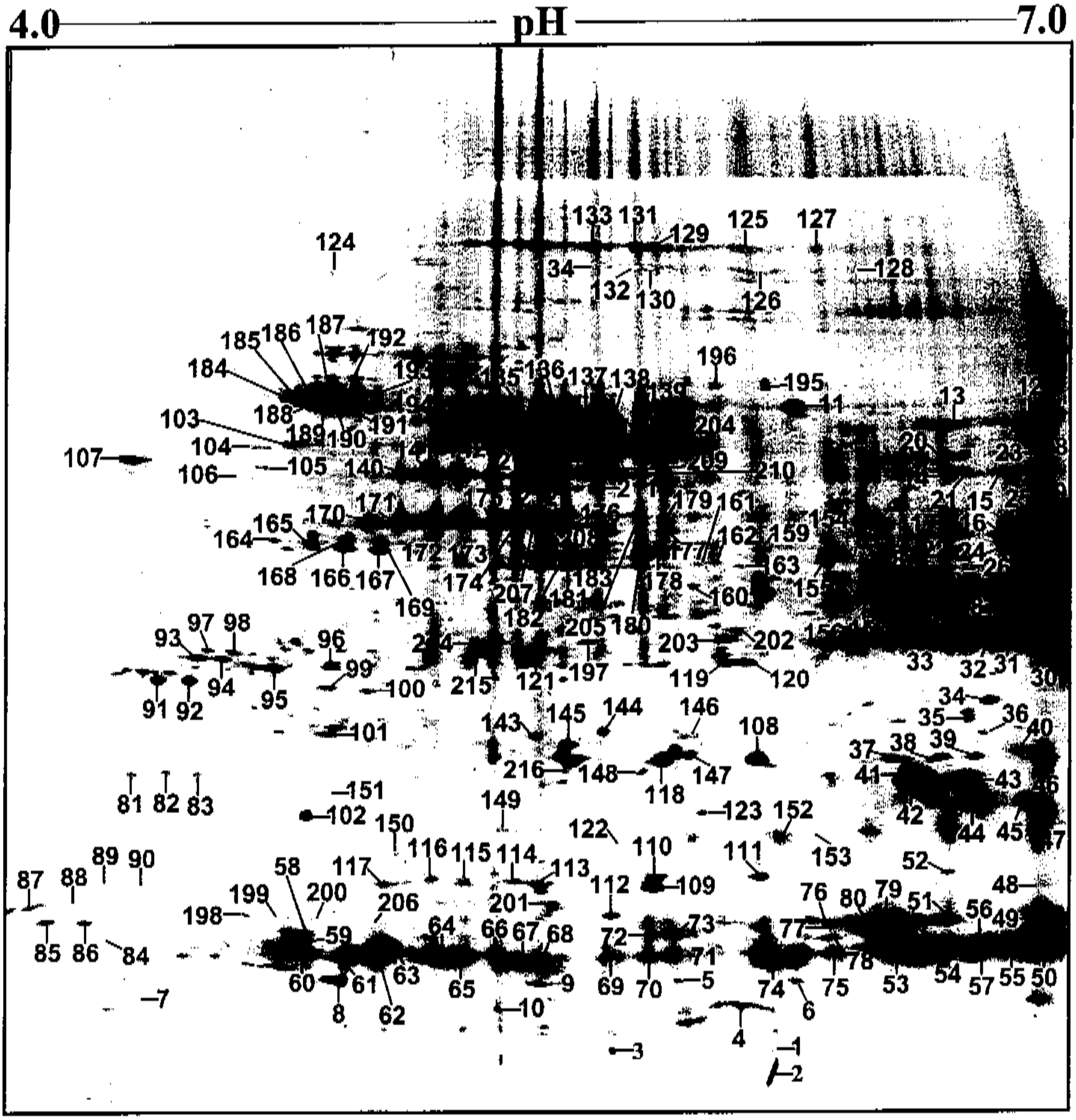

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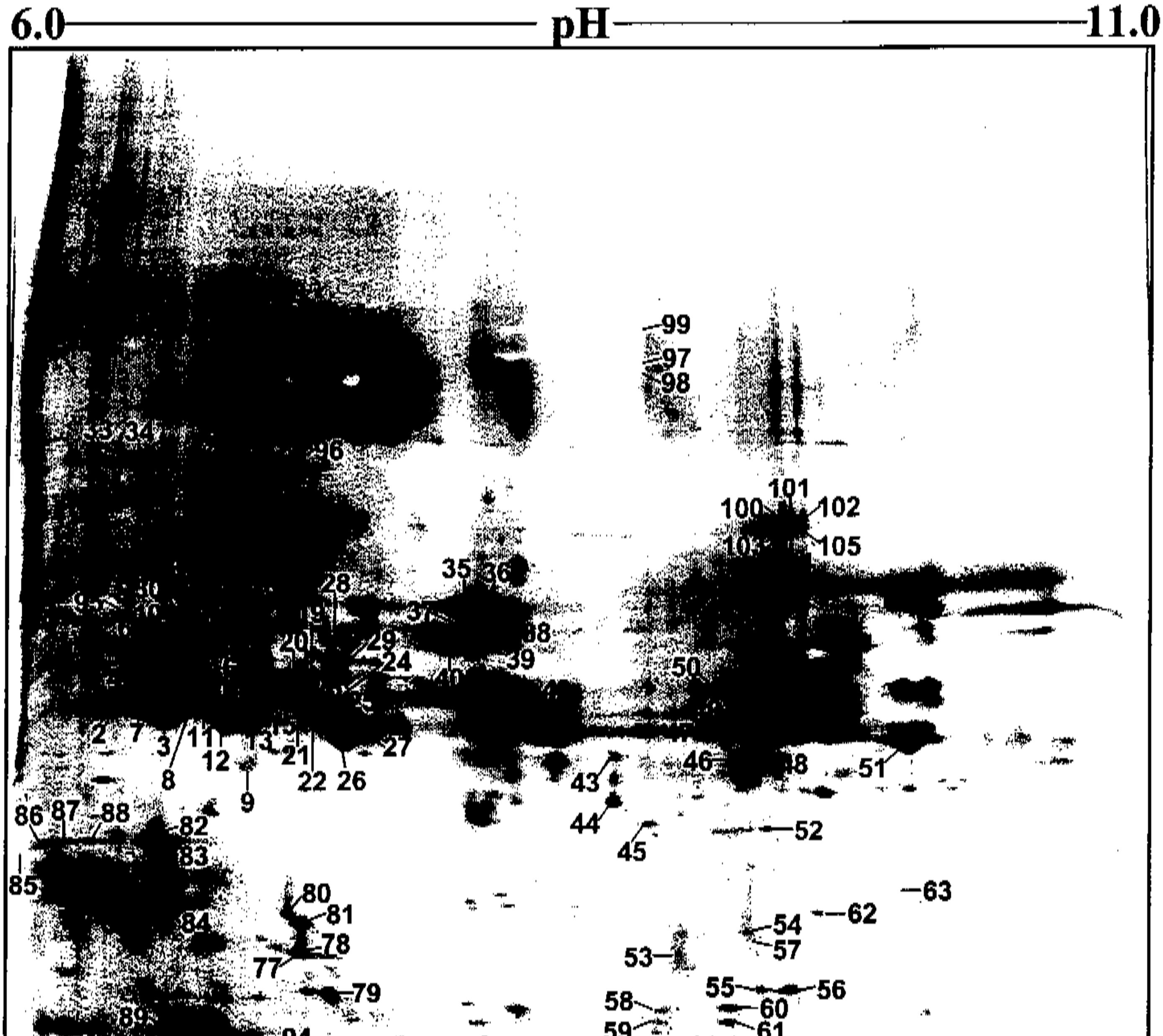
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Levels of studying gluten	*Analysis of …*
Genes	**GENOME**
Environment	**CLIMATE, SOIL**
Polypeptides	**PROTEOME**
Native proteins (glutenin polymers)	**SIZE DISTRIBUTION**
Gluten	**DOUGH**

PROTEOME – all the proteins expressed by the GENOME for a specific …

- **tissue**
- **stage of growth**
- **growth environment**
- **genotype**

PROTEOME – all the proteins expressed by the GENOME for a specific …

- **tissue** - ***endosperm***
- **stage of growth** - ***17 DPA and mature***
- **growth environment** - ***24 /18°C (day/night)***
- **genotype** - ***Wyuna wheat variety***

PROTEOME STUDIES involve ...

- **polypeptide extraction,** including SS rupture
- **Fractionation,** IEF + SDS-PAGE ... **2D map**
- **Blot to PVDF membrane, and cut out spots**
- **N-terminal sequencing** of many spots
- **[Partial proteolysis and mass spectrometry]**
- **Search protein databases for identity**

METHODOLOGY

Defat and precipitate protein with 10% TCA + ME in acetone

Extraction – 7M urea, 2M thiourea, 2mMTBP, 4% CHAPS,
1% carrier amplolytes, 40mM Tris, 0.001% Orange G dye.

Digest nucleic acids with endonuclease

1st dimension – IEF in range pH 4 7 or pH 6 - 11

2nd dimension – SDS-PAGE, 8-18% T, 2.5% C (piperazine diacrylamide)

Analytical gel – Silver stain

Quantitative Scan – Molecular Dynamics Personal S1

Preparative gel – Stain with Coomassie blue

Blot to PVDF membrane - cut out spots (robotic)

N-terminal sequencing – Automated Edman, HP G1005A
Sequencer

or **Partial proteolysis and mass spectrometry**

Search protein databases for identity – TagIdent – SWISS-PROT

Proteome analysis of immature wheat endosperm
(17 DPA cv. Wyuna, no stresses)

	No. of spots	% of spots sequenced
Total no of components	***1,300***	
Submitted to sequencing	**321**	100%
Identified on database	**177**	55%
Not matched on database	**55**	17%
Sequences not obtainable	**89**	28%

Most common identities in immature endosperm

Identity	**pH 4 – 7**	**pH 6 - 11**
	Numbers of components	**Numbers of components**
Total spots	**690 immature** ***[650 mature]***	**610 immature** ***[470 mature]***
Gliadins	**36**	**44**
Glutenin subunits	**9**	**0**
Protein disulfide isomerase	**14**	**0**
Amylase/trypsin inhibitors	**28**	**10**

PROTEOME STUDIES

- **the "reality" of the genome**
- **identification of 'chaperone'-type proteins**
- **that may regulate protein quality**
  - **providing markers of stress tolerance**
- **'real' molecular markers, involving G and E**
  - **providing quality markers**
    for protein-based testing of quality

ADD POLYMERISATION STUDIES

- **to elucidate protein size distribution**

HARVESTING QUALITY WHEAT

Averting disaster in a bad frost season

-Helen Allen

Flexibility of Wheat Use
Frost Damage and Grain Quality

Helen Allen and Jennifer Pumpa

NSW Agriculture

GRDC Grains Research & Development Corporation

WHEAT CRC

Why do the Research?

- Growers were left with large tonnage of unsaleable wheat due to frost damage.
- This resulted in huge losses to Growers incomes and it was a request from Growers that prompted this research
- The general perception was that high levels of frost damaged grain was unsuitable even as feed quality.

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Flexibility of Wheat Use

Frosted Grain Sample

NSW Agriculture

GRDC Grains Research & Development Corporation

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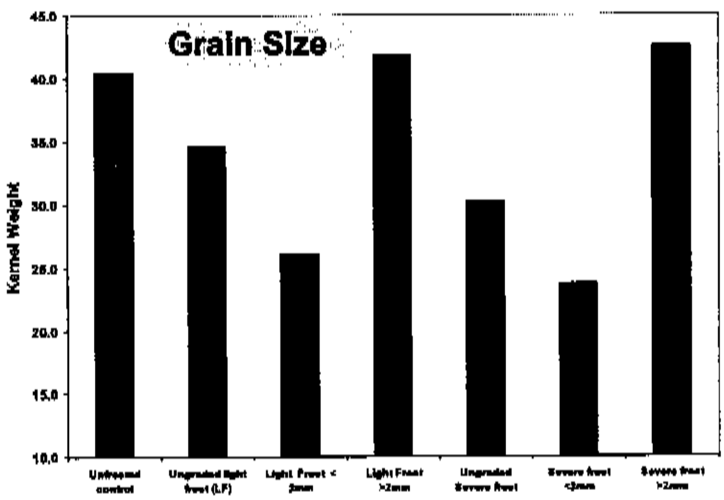
Flexibility of Wheat Use



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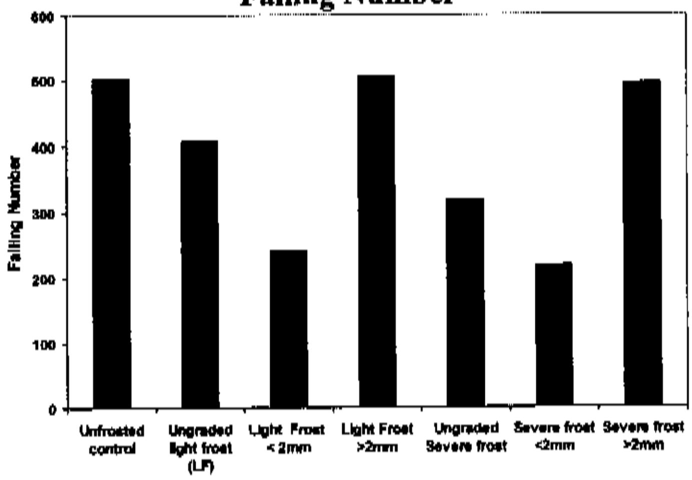
Flexibility of Wheat Use

Falling Number



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Flexibility of Wheat Use

Grain Quality - Most affected parameters

Screenings
Grain size - kernel weight
Test Weight
Falling Number
α - amylase

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Quality Results

- **Large grain fraction**
  - # Grain quality meeting receival standards
  - # All quality parameters suitable for APH
  - # Small fraction was suitable to feed to ruminants

Commercial Trial

After the initial research a QWCRC partner purchased some frosted wheat.

Used a grader and aspirator separated the grain into fractions.

The large fraction was used for milling and biscuit production.

Commercial Mill Results

Grading resulted in the test weight improving from 64 kg/hl to 77 kg/hl.

Falling number from 142 to 376 sec.

Grain size from 17.2 to 39 g.

Recovery of good quality grain made grading a viable option for processors.

This grain was subsequently milled into flour and used for normal processing.
J.Dines (Personal comm.)

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Results of Feeding Trial

In this project, no difference was found in dry matter digestibility (DMD) for frost damaged wheat compared with unfrosted wheat when fed to sheep at a maintenance level. ***(Richardson et al 2000)***

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Wheat	DOMD (%)	Estimated ME (MJ/kgDM)
Unfrosted control	92.0	14.4
Ungraded lightly frosted	89.0	13.9
LF - Large Fraction	89.7	14.0
LF - frosted + screenings	89.2	14.0
Ungraded severely frosted	86.5	13.5
SF - Large Fraction	89.7	14.0
SF - frosted + screenings	84.8	13.3
Average standard error of difference	2.25	0.35

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Conclusion - Feeding trial

Estimated ME values for all of the wheat samples fell within the expected range for wheat grain (12.3 - 14.7 MJ/kg DM.

There would be no major penalty in feeding frost damaged grain compared to unfrosted grain as a supplementary feed stuff to ruminants.

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Results demonstrate that:

- The very frosted component of the grain can be removed.
- The remaining grain meets silo receivals standards.
- Grain quality of the large fraction was equal to an unfrosted sample.
- Any of the fractions were suitable for feeding to ruminants.

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Large fraction had:

- High germination levels.
- High test weight.
- Good physical dough parameters.
- Good Product quality.

In all characteristics, it had APH quality

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Future Options

- **Growers should grade frosted wheat**
  - # It is economic up to 35% frosted grain
  - # **Grading is needed for germination**
- **Processors can use frosted grain large fraction**
- **Small fraction can be fed to stock**

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HARVESTING QUALITY WHEAT

Implementation of the WheatRite test card for sprout damage

-Russell Heywood

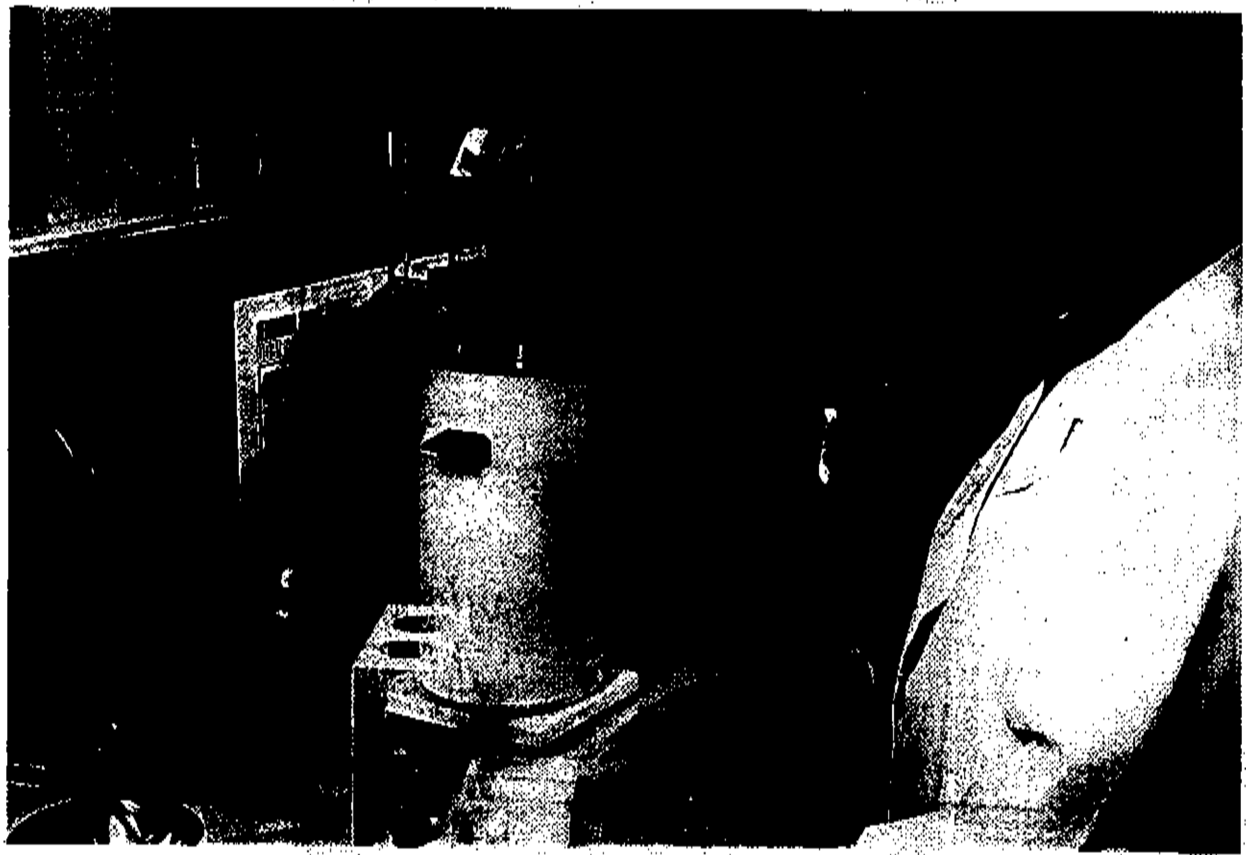
Field evaluation of an immunochromatography test (WheatRite™) for preharvest sprouting

J.Skerritt *, R.Heywood, A.Ellis, W.Rathmell and C.Wrigley

* ACIAR, Canberra
Quality Wheat CRC Ltd
and CSIRO Plant Industry

Preharvest sprouting

- due to significant rain at harvest or just before grain ripens
- whether, and how much sprouting occurs hard to predict
  - degree of sprouting is not just related to total rainfall, but also temperature, humidity, cloud cover
  - on-farm factors also very important in determining sprouting extent
- grain is significantly downgraded before there are any visual signs of sprouting
- sprouting causes problems with bread and noodle colour and texture so grain cannot go to premium export markets
- thus sprouted grain is downgraded and grower payments are reduced, depending on the degree of sprouting



WHEAT CRC

The WheatRite test for Pre-harvest sprouting

- Detects Alpha-amylases which cause low Falling Numbers
- Quantitative, correlates with the official Falling Number method
- Results independent of wheat variety, growth site

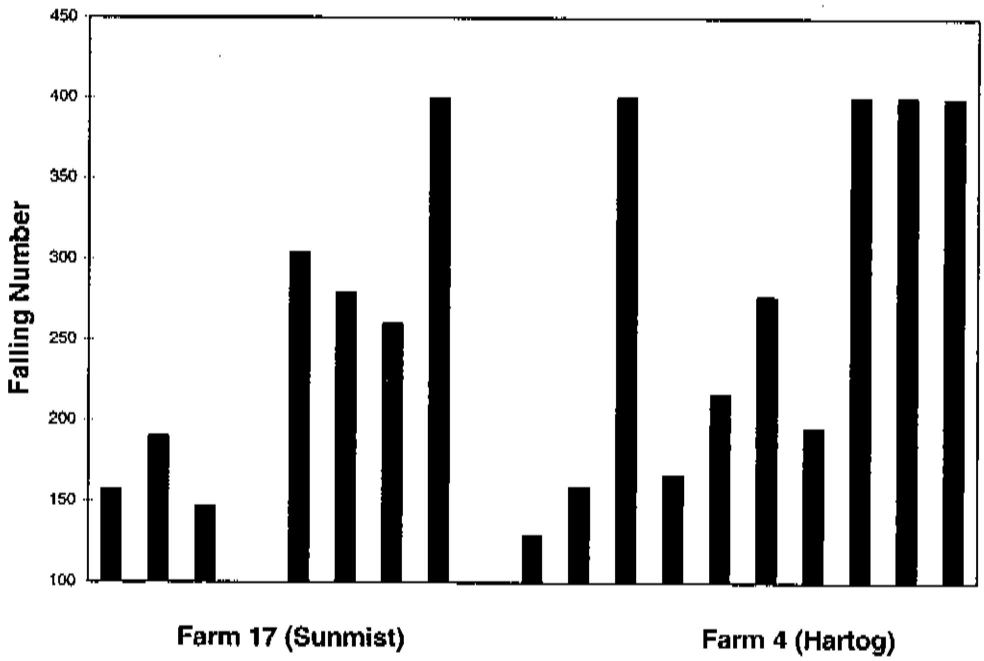
Silo receival - potential use

- Faster, less expensive than Falling Number machine
- Can be made available at all receival sites in wet harvests

On-farm - potential use

- Sprouting can vary significantly within and between paddocks, but the variation can be managed by harvesting separately
- Mild to moderate sprouting cannot be reliably detected by eye
- Thus growers can harvest and bin sound and damaged grain separately

Variation in Falling Number within paddocks



WheatRite™ test method

Grind wheat sample to be tested
Add flat scoop to test tube

↓

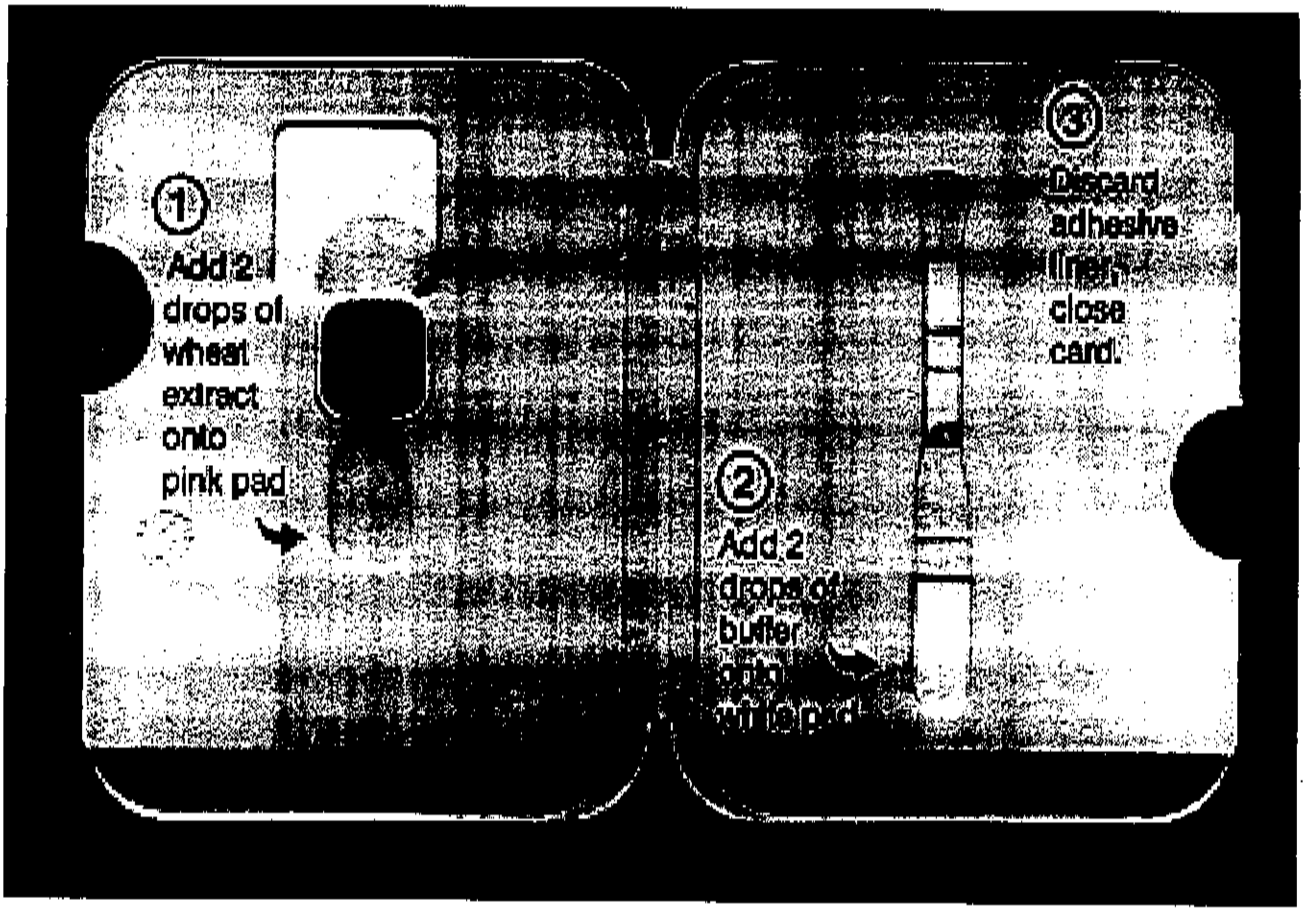
Shake ground wheat in salt solution - 15 seconds

↓

Add 2 drops to test card
close card, wait 5 minutes

↓

Read result, compare with colour card or use reader



Field studies

- 1996 (Roma, QLD; Liverpool Plains, NSW), 1997 (Tara, QLD)
- 1998 (Southland, NZ; Central QLD; Ravensthorpe, WA)
- Develop suitable sampling methods/ guidelines
- Analyse degree of variation within/ between paddocks
  - measure sprouting at 4-9 places within paddock
  - compare sprouting between paddocks in same farm/ area
  - establish minimum sample size (5, 10, 20, 50 heads)
  - variation in results between repeat samples 2 m apart
  - variation in sample results when returning to similar areas of paddock 1-2 hours after initial sample

Fieldwork: results

- sprouting can vary significantly between paddocks
  - factors: variety, sowing date, drainage
- sprouting varies within-paddock (SD > 50 FN units) only 25 % of the time
  - poorly drained or tree-shaded parts have higher damage
  - where paddocks sloped, upper areas had lower damage
- samples taken 2m apart only vary slightly in FN
  - where FN > 150, mean difference = 17 +_8 (22 sites)
  - where FN < 150, neighbouring sample FN < 150 (36/36 sites)
- samples taken 1-2h later at approximately same site vary more
  - where FN > 150, mean difference = 22 +- 16 (22 sites)
  - where FN < 150, neighbouring sample usually FN < 150 (23/ 36 sites)
- samples of 20 heads from 3-5 plants give representative results

Effect of varying number of heads in a sample on test precision

Data shown are test imprecision estimates in Falling number units for duplicate samplings of 5, 10 or 20 heads

	Low FN paddocks (7)			High FN paddocks (15)		
Mean	5 heads	10 heads	20 heads	5 heads	10 heads	20 heads
Within-paddock SD	51	26	28	29	29	24
Range of Duplicates	54	28	32	30	28	28

Paddock Sampling

- **How Much Sampling ?**

- When sprouting is present, paddocks that are reasonably flat and with similar soil types and drainage throughout usually have relatively uniform weather damage.
- 2-4 well spaced samples per paddock

- Where sprouting is present , paddocks that have significant areas that are : poorly drained,have heavy moisture holding soils,sloping, tree-lined for a reasonable distance, or discoloured are likely to exhibit significant variation in levels of weather damaged grain. In these circumstances separate harvesting of different parts of a paddock could provide a significant economic gain.
- 5-9 samples (corners and / or sides and centre) minimum - depending on degree of lack of paddock uniformity.

Where to Sample

- Grain can be analysed from the harvester / truck and binned appropriately or field sampled

- **How to field sample**
- go 10 m into the crop avoiding obviously atypical spots eg headlands (oversown areas), small localised water-logged depressions
- cut 20 heads from 5 - 10 plants in a 360 ° sweep
- do not only select the top tillers
- avoid immature or frosted grain
- avoid lodged heads

- Rub grains from the tillers and grind to test

FALLING NUMBER FIELD MAP

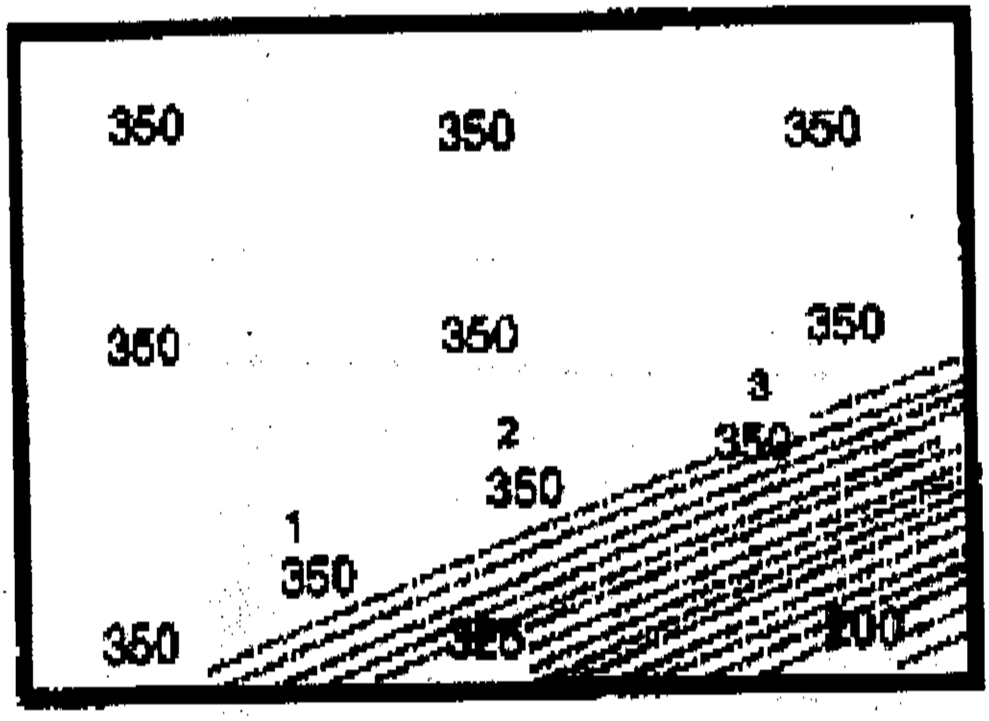


Fig 4. "Final" FN Field Map. Shaded area harvested separately

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Wheat harvest cheque $40,000 higher thanks to sprouting test

J. Dinas, Defiance and Quality Wheat CRC

A test that identifies pre-harvest sprouting (rain damage) in wheat has proven to be a most valuable farming tool for one northern cereal farmer this harvest. By being able to distinguish and harvest the better quality grain before additional rain set in causing further crop damage, one farmer near Lightning Ridge in north west NSW has been able to increase his return by $40,000.

WheatRite is a cost-effective on-the-spot field detection kit which identifies weather damaged grain quickly and accurately. Its benefits were put to the test recently when approximately 160 mm of rain fell over a two-week period right at harvest time. The grower took samples from the whole crop and identified that the later sown portion, that was on drier ground and would normally be harvested first, was in fact a poorer quality grain, already showing the effects of rain damage (sprouting). This allowed the better quality grain (classified as APW) to be segregated and harvested first, before a further 12 mm of rain fell, with the potential to further downgrade the quality of the grain.

As the extent of preharvest sprouting after rainfall can vary markedly, the fast and accurate testing capability of the testing kit enables the segregation of not only different paddocks, but different quality grain within the one paddock, thereby avoiding losses associated with contamination and down-grading of the whole crop. With the current volatile wheat prices, savings such as that achieved by the Lightning Ridge grower are even more valuable, especially as each test costs less than $10.

WheatRite is distributed by Graintec in Toowoomba, QLD, and was developed from a research program funded by Quality Wheat CRC Limited. The test is entirely portable and can be performed in the field with results available within five minutes. No special equipment or training is required and the result can be kept as a permanent record.

For further information on *WheatRite*, contact Graintec on 07 4638 7677, or Quality Wheat CRC on 02 9490 8488.

Using the sprouting test to guide selective harvesting.

HARVESTING QUALITY WHEAT

Prospects for rapid identification of wheat diseases

-Amanda Hill

CRC

ON FARM DIAGNOSTICS FOR DEFINITIVE IDENTIFICATION OF CEREAL DISEASES AFFECTING QUALITY AND YIELD

• develop specific ICT tests for key soil and leaf diseases

- early detection and correct identification ⟶ management strategies

- potential for on-site screening (specific, sensitive, quick)

- confirm visual symptoms, detect early infection (no visible symptoms), secondary fungi

CRC

CHALLENGES

• antibody availability

• antibody specificity

• antigen extraction (soil, tissue interference)

• conversion to ICT format

CRC

RHIZOCTONIA BARE PATCH

- Caused by fungus R. solani
- distinct edge to patch;change from diseased to healthy plants in centimetres
- plants stunted, short roots, can die prematurely
- rotation not effective - all crops susceptible
- cultivation only effective damage control

CRC

LEAF DISEASES

Septoria leaf and glume blotch

Leaf rust

BYDV

Smut

Yellow spot

Black point

IDENTIFY KEY DISEASES

- grower decision whether control is warranted → commercial benefit
- affect yield
- affect marketability - quality
- correct disease identification - apply appropriate measures
- available antibodies

TEST VIABILITY - INCREASE PROFIT MARGIN OF CROP

Annual cost of wheat disease = $500million

PROJECT MILESTONES

- identify key diseases
- develop collaborations/contracts for antibodies
- assess performance in field situation
- develop ICT prototype
- test validation

HARVESTING QUALITY WHEAT

Precision agriculture –
can it improve grain quality?

-Amanda Hill

CRC

Within paddock variation in wheat quality:
measurement and implications for management

John Skerritt

Simon Cook, Matthew Adams (CSIRO Land & Water, Perth)
Russell Heywood, Greg Naglis, Helen Olsen (CSIRO Plant Industry)

CRC

This project is investigating three issues :

- To what extent does protein content and grain quality vary WITHIN A PADDOCK, especially for similar levels of fertiliser input ?
- Within paddocks, is there a relationship between grain yield, protein content and quality ?
- If extra nirogen or seed is used on responsive parts of the paddock to boost yield, does GRAIN PROTEIN CONTENT DECREASE ?
- How are these parameters affected by soil characteristics, plant nutritional status, crop development, or variation in fertiliser and seed rate inputs ? CAN THE RESPONSE BE PREDICTED ?

In initial work, we have examined 11 paddocks, from two WA and one NSW locations and four quality grades of wheat.

The paddocks also differed significantly in fertility, management inputs and grain yield and protein profiles.

Testing of paddocks and samples

CRC

Crop testing — establishment, crop stem and tiller counts, spike counts; weed density, root diseases, anthesis dates (one paddock)

Soil testing — organic carbon, soil nitrate, ammonia; potassium, phosphorus, micronutrients (Mg, Zn, Cu)

Tissue testing — Nitrogen, major elements and micronutrients

Relate paddock fertiliser/ seed inputs and crop/ soil tests to:

Grain testing — yield, physical tests: hectolitre weight, 1000 kernel weight; protein content and grain sulfur content; glutenin content and molecular weight distribution; starch swelling (Cadoux only)

Quality testing — SDS-sedimentation volume; SE-HPLC for glutenin molecular weight distribution; Starch paste viscosity (RVA) on subset (Cadoux only)

1996/7 field studies: consistent findings

CRC

- Within-paddock variation in protein content and protein quality often is very significant and as large as between-paddock variation for the same wheat type/ cropping environment
- Areas of higher yield usually do not provide lower protein content or protein quality. Thus use of precision agricultural methods to increase yield does not result in a protein content/ quality penalty
- Within-paddock variation in wheat quality is often greater than within-paddock variation in protein content
- In 1997, soil characteristics (pH, organic carbon, nitrate) had a more significant effect on grain protein content than variation in fertiliser application or seed rate
- Testing of samples from 1998 season will obtain more data on other paddocks with variable fertiliser inputs, to establish whether the trends noted in 1997 are able to be generalised

STORING QUALITY WHEAT

QA for the grains industry: assurance of quality for grower, processor and exporter

-Di Miskelly

National quality assurance onfarm - Project 2.2.5

QA for the grains industry: assurance of quality for grower, processor and exporter

WHEAT

CRC

ACTIVE COLLABORATORS

- **Nicole Kerr, AgWest**
- **Kirrily Smith, NSW Ag**
- **John Lacy, NSW Ag**
- **Di Miskelly, Goodman Fielder**
- **Bob Cracknell, AWB**
- **Clare Johnson, QWCRC**
- **John Dines, Goodman Fielder**
- **Graham White, QDPI**

ANTICIPATED OUTCOMES

- qa systems
- implementation of qa by pilot growers
- qa wheat available
- trained HACCP facilitators
- increased awareness qa
- improved consistency of wheat quality
- increased returns to growers
- greater access to markets
- satisfy end user requirements
- qa paddock to plate

ACTIVITIES

- Great Grain manual and launch
- Queensland pilot grower group
- associated activities - QFA, GCA

GREAT GRAIN

- quality management program
- joint venture
  - » Quality Wheat CRC
  - » Australian Oilseeds Federation
  - » Pulse Australia

AREAS COVERED IN GREAT GRAIN

- raw materials (farm inputs)
- product traceability
- chemical use and handling
- physical and microbiological contaminants
- machinery/equipment hygiene and maintenance
- training
- seed quality

MANAGEMENT OF QUALITY - SAFETY AND QUALITY HAZARDS

- food safety
- delivery quality
- customer quality

OTHER ISSUES

- must have pull through supply chain
- domestic market main target at present
- incentives to encourage growers
- need to segregate qa and non qa grain
- GMO's
- identity preservation and traceability
- GCA Graincare

PILOT GROUP

- co-ordination and grower training, and grower visits by John Dines and Graham White
- promotions at Toowoomba show, GF growers
- 10 NSW and Qld growers
- commenced in April, 1999
- record pro formas distributed for evaluation and comment
- grain drying document added

PILOT GROUP

- further grower visits
- audits
- experience to date with growers
  - » paperwork!
  - » good paddock and spray records
  - » chemical storage needs improvement

Great Grain

PO Box R818
Royal Exchange NSW 1225
Ph: 1800 226 125

Cereals • Pulses • Oilseeds

Great Grain

Cereals • Pulses • Oilseeds

An On-Farm
Quality Management Program

Great Grain

Your Questions Answered

What is *Great Grain*?

Great Grain is a quality management program, combining an agreed standard with independent verification, allowing producers of cereals, oilseeds and pulse crops to demonstrate to customers and consumers that they are growing crops safely and responsibly.

Great Grain is a joint venture between Quality Wheat CRC, Australian Oilseeds Federation and Pulse Australia to provide a single, on-farm quality management program.

The *Great Grain* program is based on the Pulse Australia Pulse Performance Program and the Quality Wheat CRC Quality Assurance Program. Both these programs have been developed using the Codex HACCP principles and thus, *Great Grain* reflects the principles of HACCP. Terminology used, and presentation of the *Great Grain* program have been designed to provide grain growers with a user friendly system.

For further information on the *Great Grain* program, phone the freecall hotline: 1800 226 125

Why is it Necessary?

The *Great Grain* program will safeguard consumer confidence and allow producers as well as others in the supply chain, to demonstrate that practices meet food safety requirements. Developed to be consistent with the Quality Farms Australia and ANZFA draft standards, *Great Grain* provides a single industry standard, avoiding the creation of range of competing systems.

Great Grain is compatible with other on-farm programs, avoiding duplication of record-keeping.

Is the Standard Achievable?

This is not an elite program. It has been set at a level that is achievable by all producers. The *Great Grain* Manual sets out the basic requirements for growers participating in the program.

The areas covered in the program include:

- raw materials (farm inputs)
- product traceability
- chemical use and handling
- physical and microbiological contaminants
- machinery / equipment hygiene and maintenance
- training
- seed quality

Will There be a Premium?

The Program's objective is to maintain and secure markets for producers who are achieving a required standard. Over time, those achieving the standard may become preferred suppliers in these markets.

Some growers may increase their returns through access to higher value markets and on-farm productivity improvements.

How will the Audit Process Work?

Independent verification is the key to delivering consumer confidence. All growers participating in the Program will receive guidance on what the auditor will expect to see during an inspection.

Accreditation under the Program will be dependent upon growers achieving a satisfactory result following an on-farm inspection. Growers will be required to have an audit every year. However, in years two and three, this will be a maintenance audit involving a less intensive process than the accreditation audit.

How Much does the Program Cost?

Membership of the Program is $500 in the first year, with an ongoing registration cost of $120 per annum. Additional costs include the initial training day ongoing assistance and auditing, which will vary dependent upon grower's location and requirements.

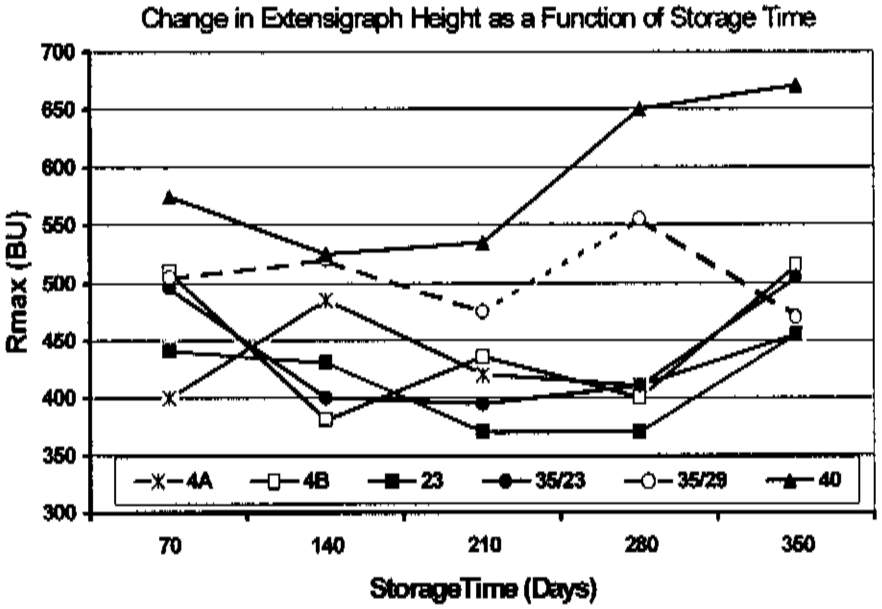
Cereals • Pulses • Oilseeds

STORING QUALITY WHEAT

Achieving consistent grain quality by aeration

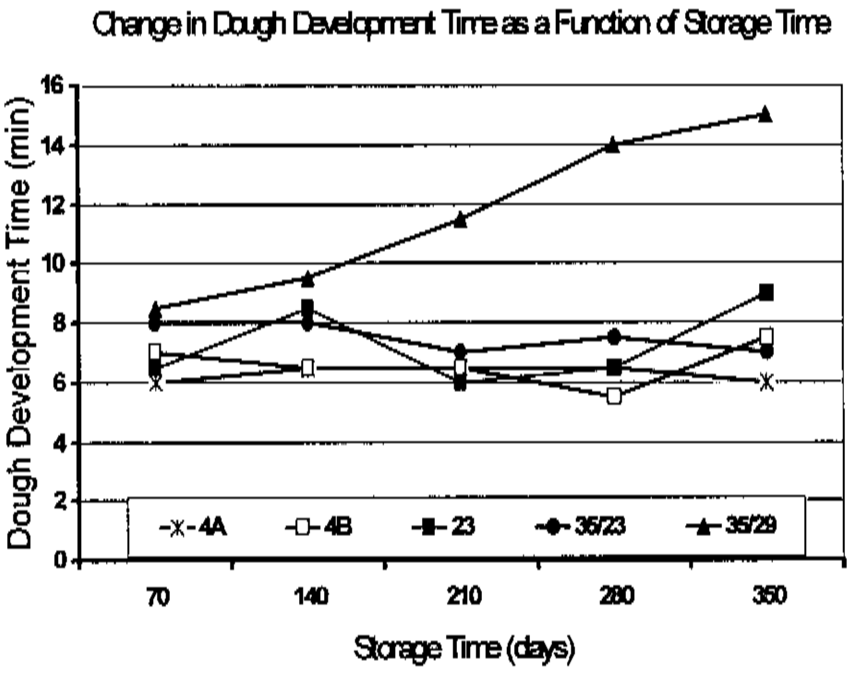
-DAI Suter

The Effect of Storage on Extensigraph Height 1999



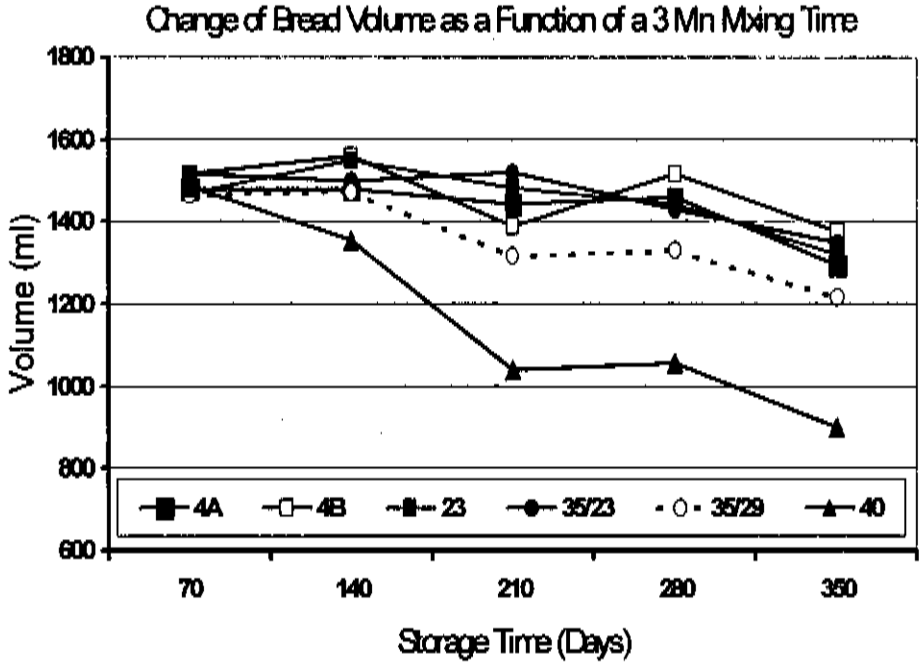
Grain stored at high temperatures becomes stronger

The Effect of Storage on Dough Development Time 1999



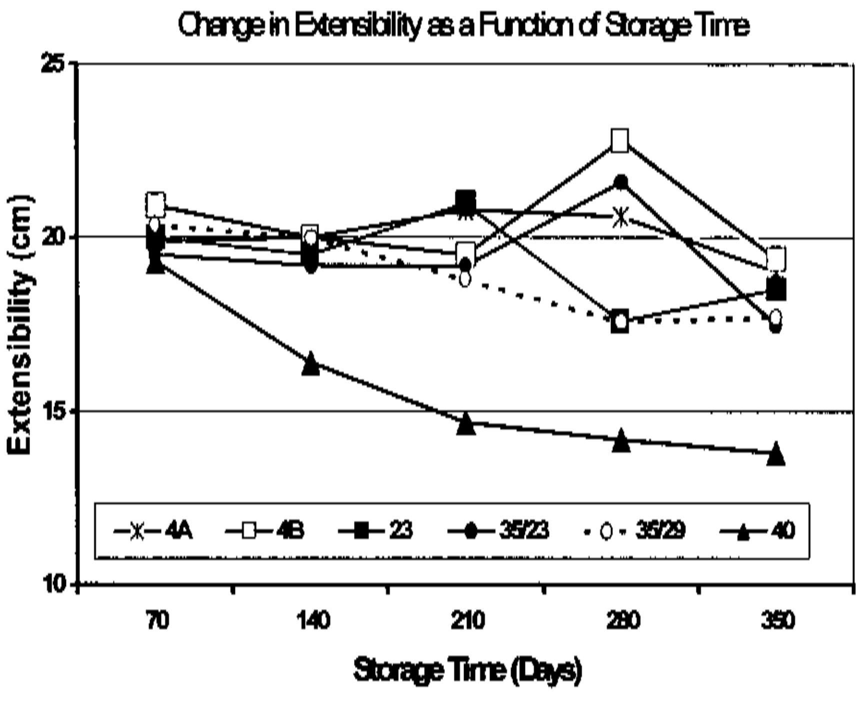
Lowering the temperature to 30C does not stop change in grain quality. 23C arrests change in grain quality.

The Effect of Storage on Bread Volume 1999



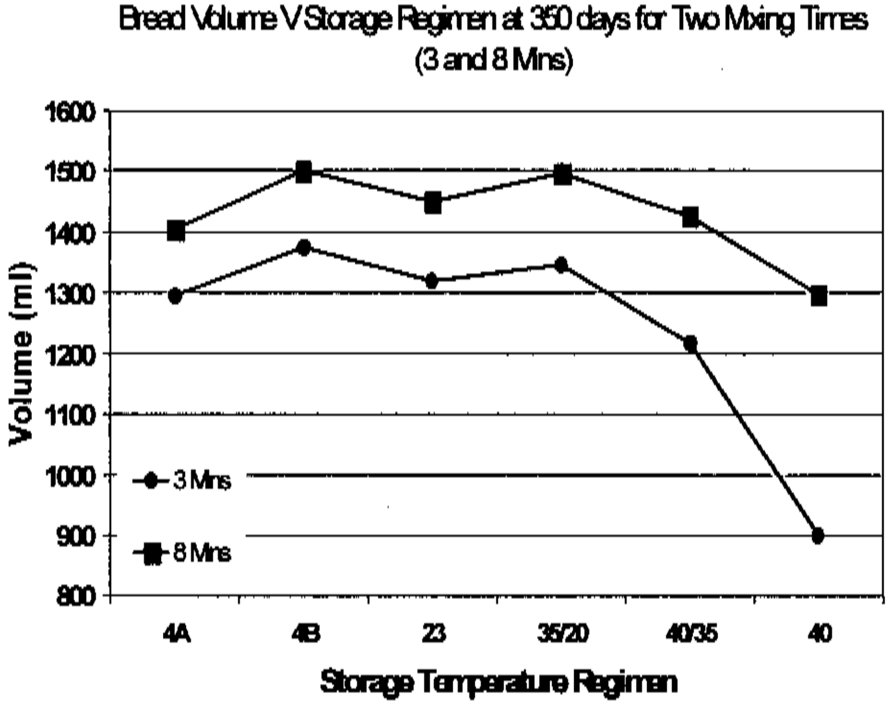
Grain Stored at high temperatures shows rapid loss of baking quality

The Effect of Storage on Extensibility 1999



Grain stored at high temperatures becomes less extensible

The Effect of Storage on Bread Volume 1999



The effects of high temperature storage are are most evident when doughs are not mixed for excessively long periods (8 mins).

2000 Experiment

Method:Grain stored at 30, 34, 38 & 42C will be sampled at 70 day intervals for the usual Milling and Baking on Industry and laboratory scales.

Expected Outcome: A method which give soundly-based requirements on how grain should be stored for minimum quality change.

2000 Experiment

Aim: To estimate the effect of temperature on rate of quality change

Background: Previous experiments have shown that storage at low temperatures inhibits change in quality. By using four temperatures that are known to cause quality change, a predictive model of the rate of change can be developed.

2000 Experiment (2)

Aim: To determine whether the changes observed during storage are dependant on protein content and/or wheat variety.

Rationale: Since changes in quality are manifested by changes in the size of the flour proteins, it will be interesting to know if the rate of change depends on amount or type of protein.

2000 Experiment (2)

Method:Small samples (1KG) of grain of several cultivars, each at four levels of protein, will be held at 38C and tested at 70 day intervals on very small scale.

Expected Outcome: Ability to define which varieties and protein contents require aeration to minimise change.

Summary (1)

- Storage at low temperatures maintain all aspects of grain quality.
- Taken with results obtained in previous experiments the conclusion is that " grain held longer than 70 days at high temperatures (>30C), should be cooled to maintain harvest quality"

Summary (2)

- For reasons associated with insect control, grain kept at aeration to 23C or lower (within 70 days after harvest) can be expected to maintain harvest quality for 12 months.

PROCESSING and MARKETING QUALITY WHEAT

Achieving quality targets by appropriate blending of grain or flour

-Frank Bekes

Blending of Quality Types

Principles and Predictions

Project 5 of GRDC and Quality Wheat CRC 2.1.5

FLEXIBILITY OF WHEAT USE

Aims:

1) Develop strategies to maximise $ returns by blending wheats

2) Determine relationships between
   - simple measured aspects of composition blending components and
   - processing properties of blends

3) Establish procedures to predict qualities of blends in situations that offer economic advantage

Anomalies in quality parameters of blended flours

In 10-15% of the cases of industrial blending:

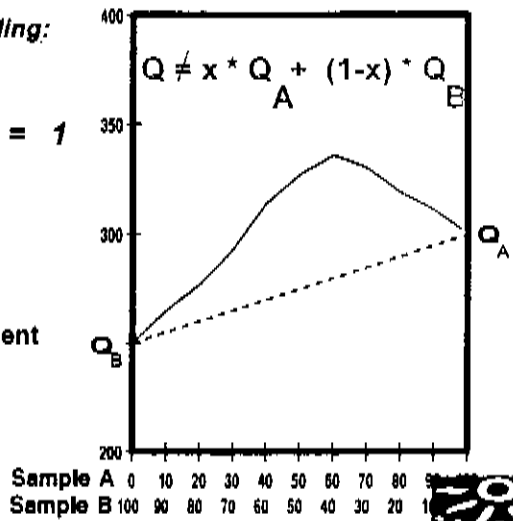
$$Q \neq \sum_{i=1}^{n} x_i * Q_i \qquad \sum_{i=1}^{n} x_i = 1$$

Q - quality parameter of the blend

Q_i - quality parameter of the i-th component

x_i - mass fraction of the i-th component

n - number of components in the blend



Summary of quality aspects for study

QUALITY ATTRIBUTE	RELEVANT ASPECT OF COMPOSITION
1) Dough properties	
Water Absorption	Protein content
Extensibility	Glu/Gli ratio
Dough strength	HMW/LMW ratio
Dough stability	Size distribution of glutenin proteins

Test methods used

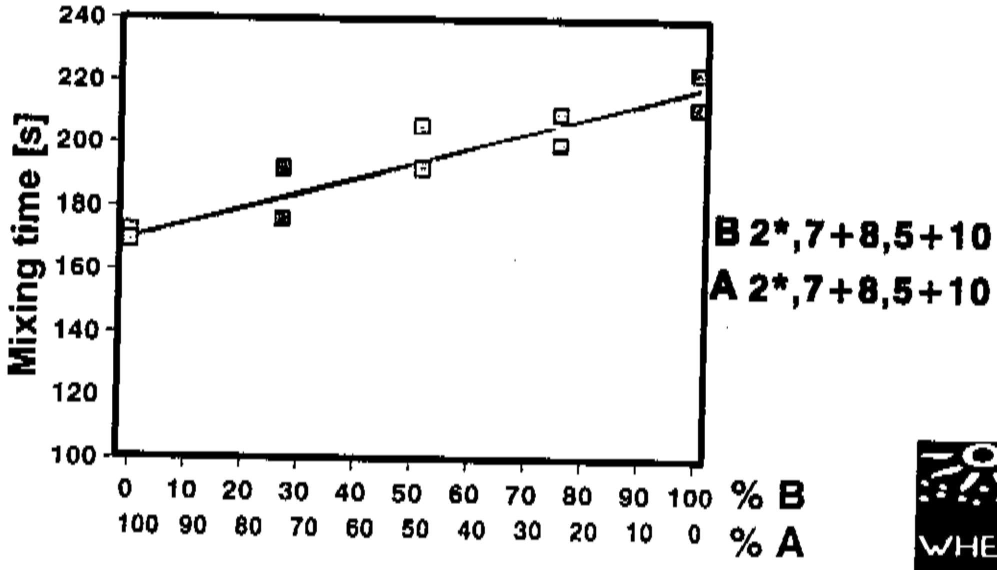
Wheat testing:	**- protein and moisture content**
	- test weight
	- Falling Number
	- psi
	- single kernel analysis for size and hardness
Flour testing:	**- protein and moisture content**
	- starch demage
	- color grade
	- Farinograph test
	- Extensograph test
	- Alveograph test
Small-scale tests	**- 2g Mixograph**
	- Micro-Extension Tester
Chemical analysis:	**- SE-HPLC for glutenin:gliadin:alb.globulin content**
	- RP-HPLC for HMW/LMW ratio
	- RP-HPLC for HMW glutenin subunit composition
	- RP-HPLC for gliadin composition

WHEAT

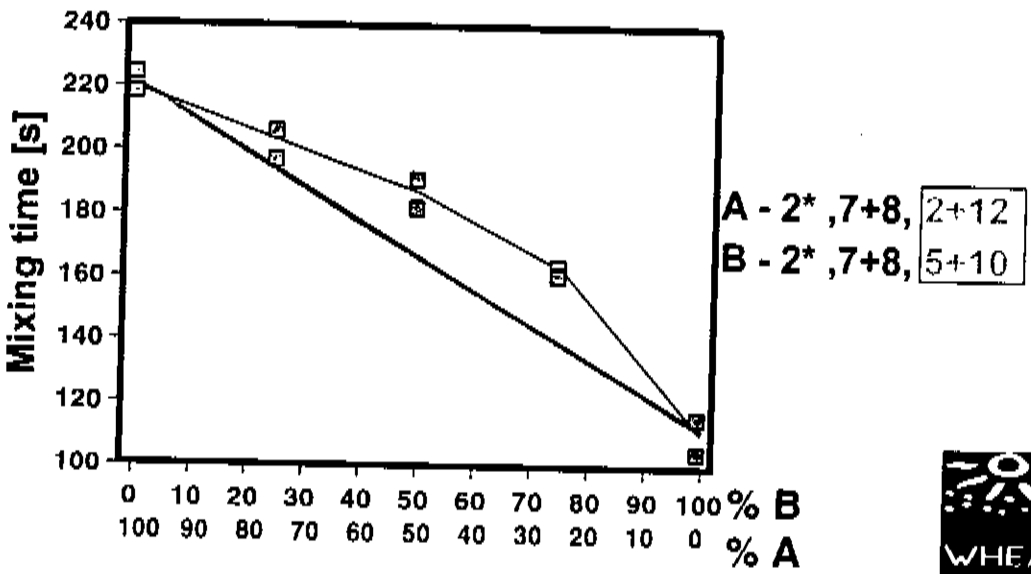
Contributors:

CSIRO PI :	Colin Wrigley
	Ferenc Békés
	Oscar Larroque
	Anna Nikolov
WA Agriculture:	Graham Crosbie
	Economists
BRI Australia:	Brian Osborne
AGT-AWB:	Peter Hart
Bungi/Defiance:	Mark Baczynski
George Westons:	Bernie O'Riordan
Goodman Fielder:	Di Miskelly

The effect of protein composition on the non-linearity of **mixing time** in two-component blends



The effect of protein composition on the non-linearity of **mixing time** in two-component blends

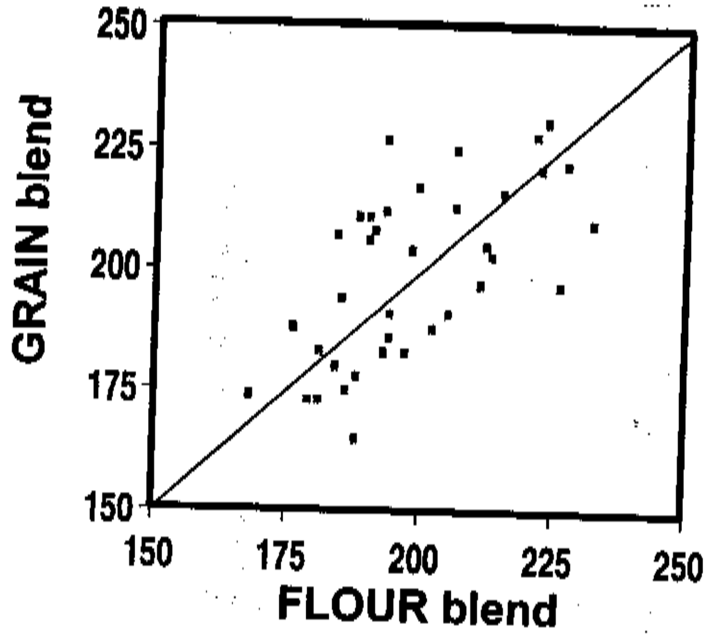


	HMW-GS			LMW-GS		
	Glu1-A	Glu-B	Glu1-D	Glu3-A	Glu3-B	Glu-D
Cunningham	a	b	a	c	b	b
Sunco	a	b	a	b	b	b
Sunvale	a	b	a	b	b	b
Pelsart	a	b	a	c	b	b
Batavia	a	b	a	c	b	c
Janz	a	b	a	b	b	b
Sunland	a	b	a	c	b	b
Sunbri	a	b	a	b	b	b
Meering	b	b	a	b	b	b
Ouyen	b	b	a	c	b	b
perouse	b	b	a	b	b	b
Tasman	b	b	a	b	d	a
Condor	c,b	b	a	c,b	b	b
Cammamah	b	c	a	c	d	c
Aroona	a	c,b	a	c	b	c
Eradu	a	i	a	c	b	b
Machete	b	i	a	b	b	b
Blade	b	i	a	b	b	b
Kite	b	i	a	e	b	b
Miskle	b	i,b	a	b	b	b
Meteor	b&a	i&b	a&d	b&e	b	b
Perenjori	b	i	a,b	d	b	a
Amery	b	i	c	e	b	b
Hartog	a	i	d	b	h	e
Sunstate	a	i	d	b	h	e?
Dollarbird	a	i	d	b	h	b
Sunbrook	a	i	d	b,d	h	b
Suneca	a	i	d	d	h	e?
Rowan	a	i	d	c	h	e?
Wilgoyne	b	i	d	d	h	b?
Silverstar	a	i	d,a	b,c	h	b
Mercury	b	d	d	e	b	b
Halberd	a	c,e	d	e	c	c
Spear	a	c	d	c	h	c
Kalannie	b,a	c	d,a	b,c	b	b,c
Barunga	a	b	d	c	b	c
Frame	a	b	d	c	h	c
Stilletto	a	b	d	c	h	c
Sunlin	a	b	d	c	h	c

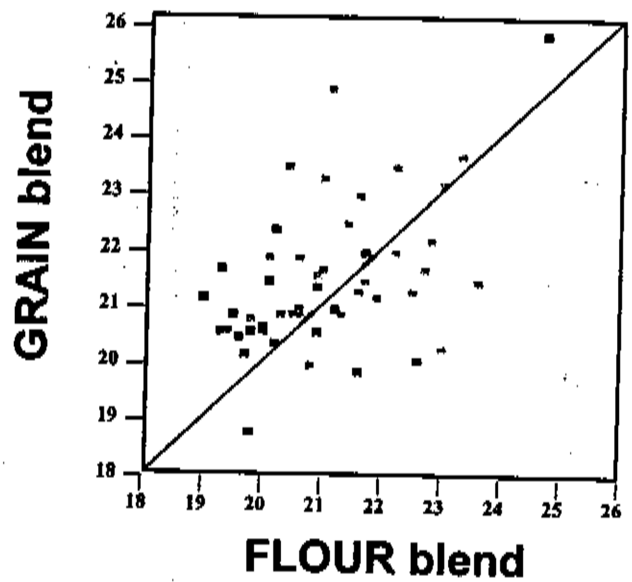
Group A Wheat				
QLD	VIC	S.A.	W.A.	N.S.W.
Cunningham	Meering		Machete	
Sunco	[illegible]		Cammamah	
Sunvale	[illegible]		Sunco	
Pelsart			Aroona	
Batavia			Blade	
			Eradu	

Group B Wheat				
QLD	VIC	S.A.	W.A.	N.S.W.
Hartog	Silverstar		Amery	
Sunstate	[illegible]		Wilgoyne	
			Kalannie	
			Halberd	
	[illegible]		Spear	
	[illegible]		Perenjori	
	[illegible]		Stiletto	

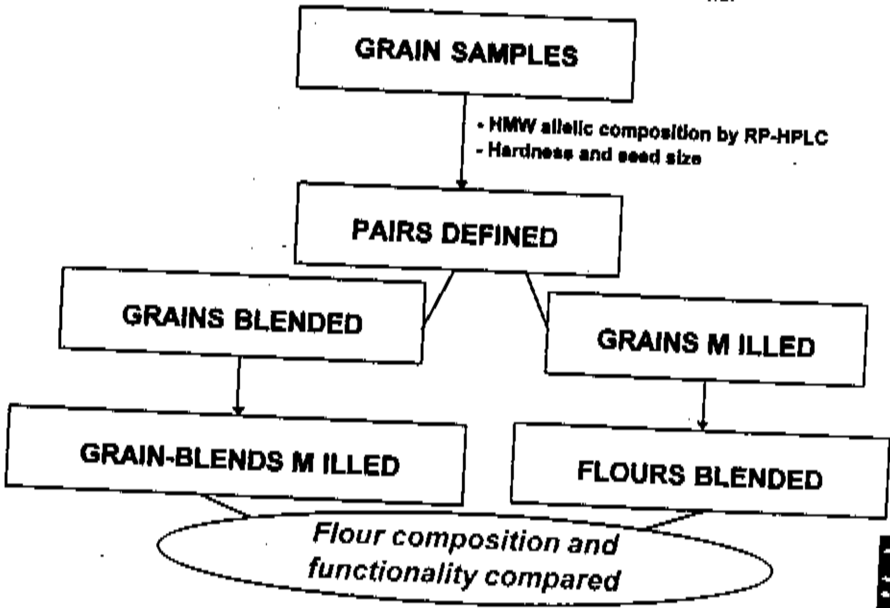
Comparison of the MIXING TIMES of flour and grain blends



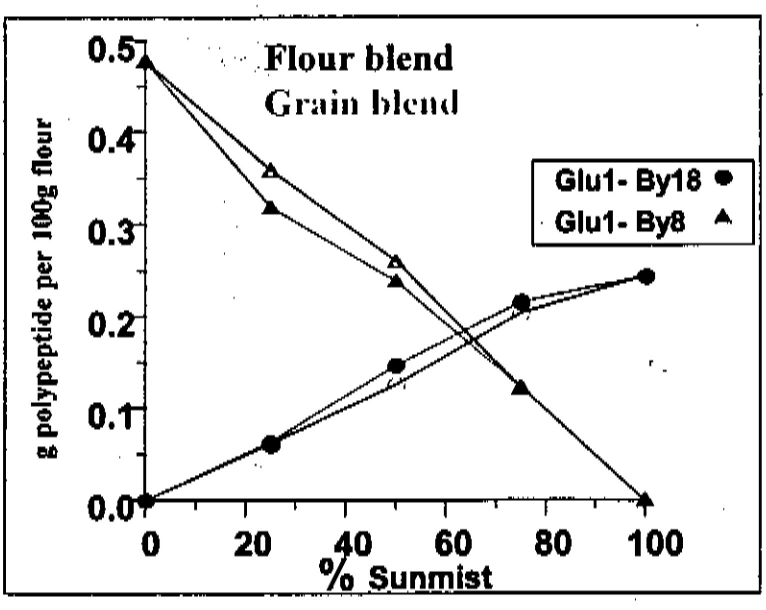
Comparison of the EXTENSIBILITIES of flour and grain blends



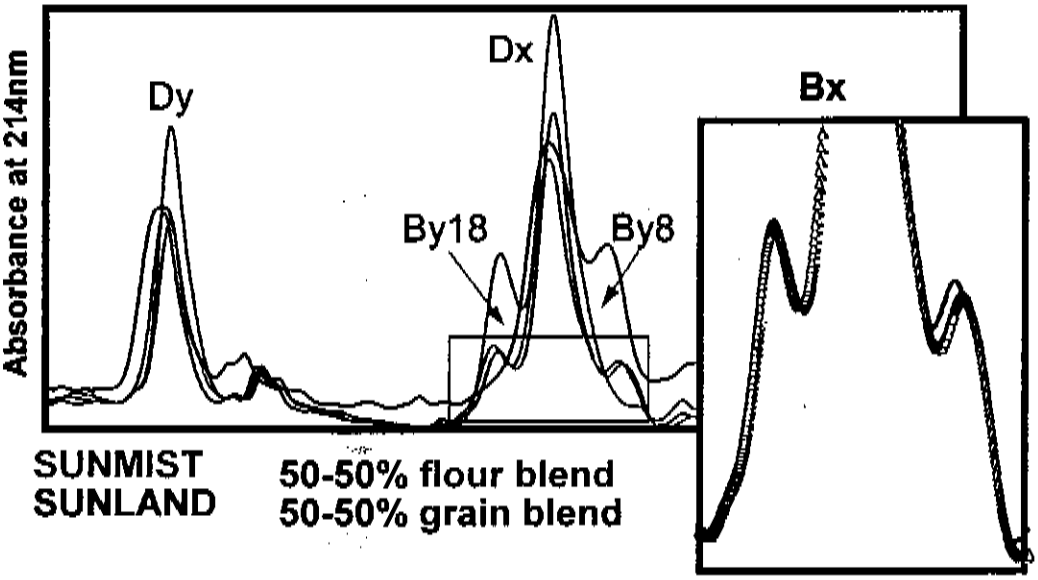
COMPARING GRAIN AND FLOUR BLENDS



Comparing the chemical composition of flour and grain blends



RP-HPLC separation of HMW glutenin subunits isolated from flour and grain blends



Mathematical model of predicting the functional properties of flour blends

Protein content: $q_{pr} = \sum_{i=1}^{n}(x_i*[protein]_i)$

Glu/Gli ratio: $q_{glu/gli} = \sum_{i=1}^{n}(x_i*[glu]_i)/(x_i*[gli]_i)$

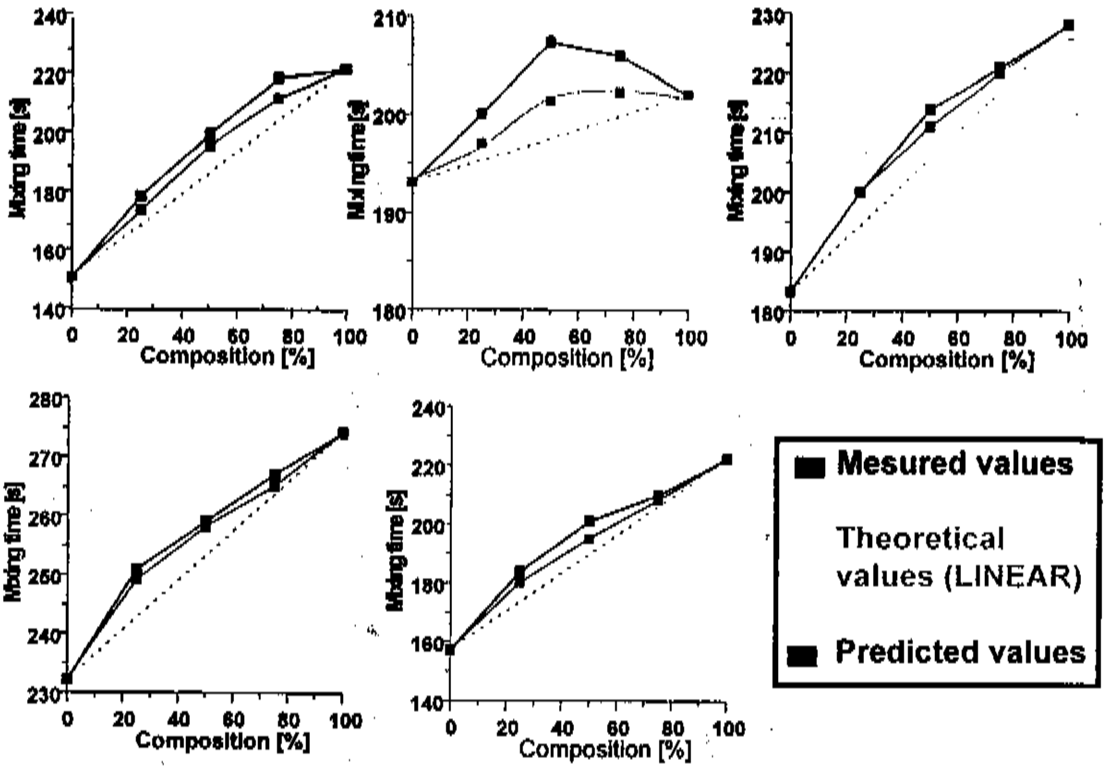
HMW/LMW ratio: q_{HMW} [illegible] $*[LMW]_i$

HMW alleles: $q_{HM} = \prod_{j=1}^{m_H}\{[H]_j / \sum_{j=1}^{m_H}([H]_j)\}^{e_{Hj}} = \prod_{j=1}^{m_H}\{\sum_{i=1}^{n} x_i*[H]_{i,j} / \sum_{i=1}^{n}\sum_{j=1}^{m_H} x_i*[H]_{i,j}\}^{e_{Hj}}$

LMW alleles: $q_{LM} = \prod_{j=1}^{m_L}\{[L]_j / \sum_{j=1}^{m_L}([L]_j)\}^{e_{Lj}} = \prod_{j=1}^{m_L}\{\sum_{i=1}^{n} x_i*[L]_{i,j} / \sum_{i=1}^{n}\sum_{j=1}^{m_L} x_i*[L]_{i,j}\}^{e_{Lj}}$

$PV = q_0 + e_{pr}*\ln(q_{pr}) + e_{glu/gli}*\ln(q_{glu/gli}) +$ [illegible] $\ln(q_{HMW/LMW}) +$

$+ e_{size}*\ln(q_{size}) + e_{HM}*\ln(q_{HM}) + e_{LM}*\ln(q_{LM}) +$



Linear approach:

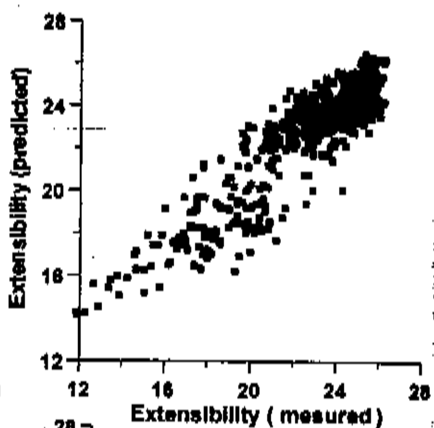
EXT = weighted mean of EXTs of the components

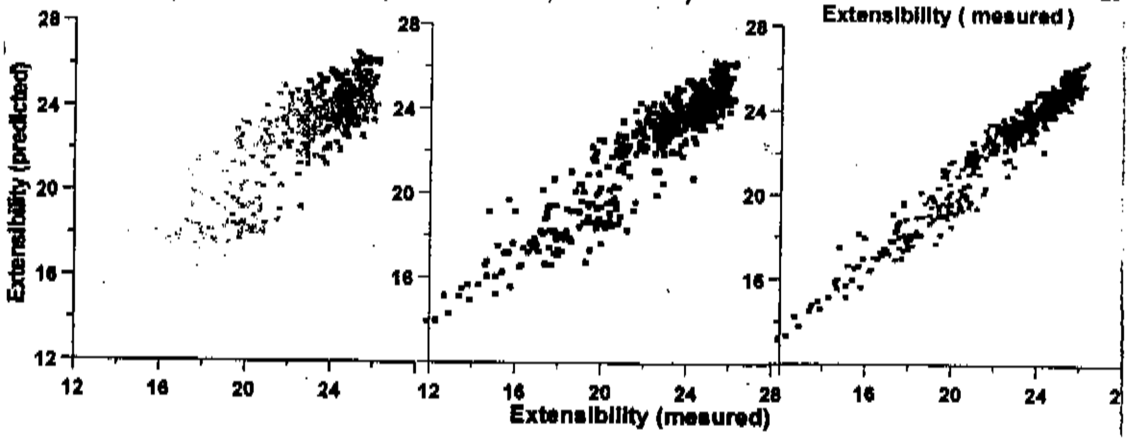
Prediction from the chemical data of the components:

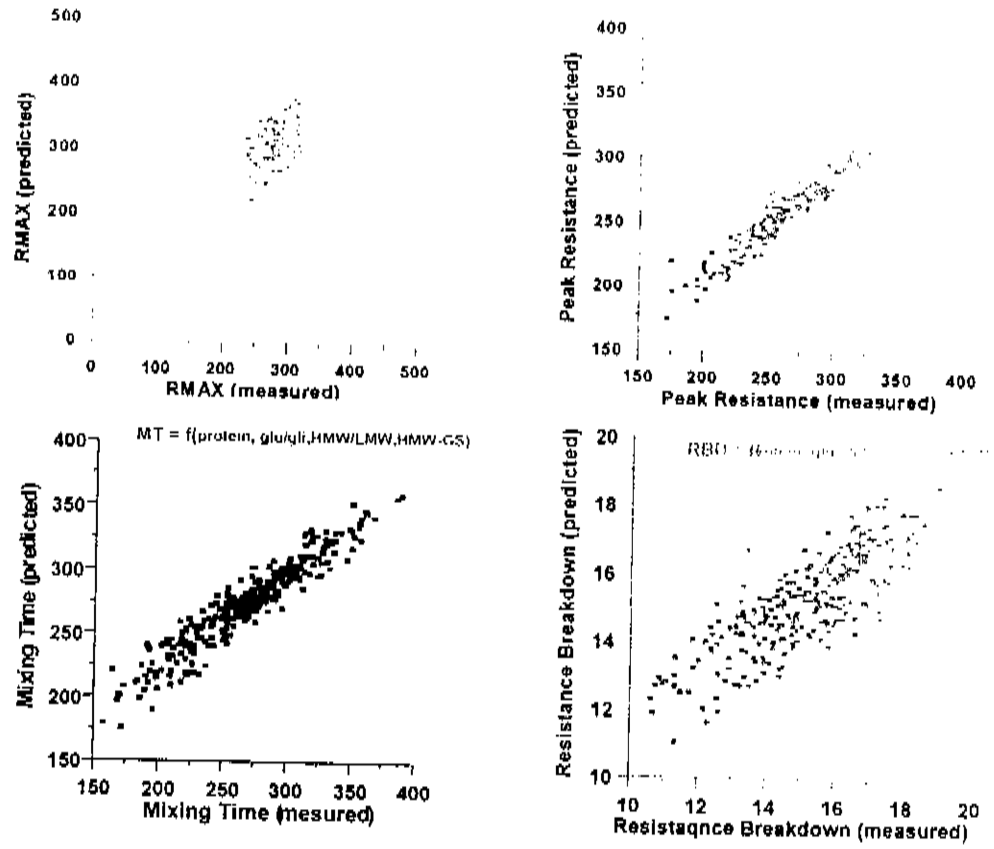
EXT = f(protein)

EXT = f(protein, Glu/Glu)

EXT = f(protein, Glu/Gli, HMW/LMW, HMW-GS)







Summary

METHODS

- Mathematical models to describe the quality attributes [y] of a flour blend as the function of the chemical composition of the components and the formula of the blend have been developed for Mixograph – parameters (mixing time [y_{MT}], peak resistance [y_{PR}] and resistance breakdown [y_{RBD}]), for Extensograph parameters (maximum resistance [y_{RMAX}] and extensibility [y_{EXT}]).

- Preliminary models have been developed for Alveograph and Farinograph parameters (including water absorption [y_{WA}]) on significantly smaller sample populations.

- Chemical composition of the flour components have been characterised by protein content [x_{Prot}], glutenin to gliadin ratio [x_{GluGli}], the overal size distribution of the polymeric proteins in the flour, estimated by the amount of un-extractable glutenin protein fraction [x_{UPP}], the ratio of HMW to LMW glutenin subunits [x_{HL}], and by the quantitative composition of the HMW subunits [x_{H5}],. [x_{H2}], [x_{H10}], [x_{H12}], [x_{H7}],... etc.

- Multiple linear regression of applying the above [y] and [x] parameters and/or their derivates have been applied to describe the [y] = f ([x_1], ([x_2],... ... ([x_n]) relationships.

- Applicability of the different models have been tested by comparing the measured and calculated quality attributes by statistical methods.

CONCLUSION

- In general, it was found that reasonably good models, describing the nonlinearity of quality attributes ($r^2 > 0.7$) can be found only by involving the HMW glutenin components ([x_{H5}],. [x_{H2}], [x_{H10}], [x_{H12}], [x_{H7}],... etc) in the models.

- For several quality attributes (MT, RBD, RMAX) the amount of glutenin in the flour (derived from protein content and the glutenin to gliadin ratio), its size (characterised by the UPP%) and its composition (characterised by HMW-components) seemed to be satisfactory to get r^2 values over 0.7.

- For extinsibility and water absorption, the amounts of the monomeric proteins and the amounts of both HMW and LMW glutenin subunits had to be involved to got reasonably good relationships between measured and predicted quality attributes.

- In case of grain blends, it was proven that if grain samples significantly different in milling characteristics are blend together, further non-linear effect is superimposed on the top of the non-linearity caused by the chemical composition.

- To estimate these effects, further parameters of the components (hardness, measured by PSI index and average grain size) were involved in the models. The preliminary results show that reasonably good predictive models can be developed for also grain blending. However, results for grain blends show significantly weeker then for flour blends. A systematic study involving the optimal conditioning technology for grain blends is required to further improve these relationships.

FUTURE WORK

<u>Ongoing experiments:</u>

- Validation of models by using 2-component and multiple component flour and grain blends

<u>Proposal for the continuation of the project:</u>

Aims:

1) To apply already available predicting methods on specific industry problems such as a) the investigation of blending characteristics of Australian varieties blended with overseas (US and Argentinean) b) the investigation of the utilising grain samples with quality defects.

2) To further develop the already available predicting procedure for a cheaper and faster methodology by replacing the HPLC-based determination glutenin to gliadin and HMW to LMW GS determination NIR-based novel techniques

3) To introduce a novel concept blend formulation where the data input is the chemical composition of the wheat stock components, available and aim function is the maximum market value of the blends. This new method, analogous to the least-cost optimalisation used in the feed-stuff industry, is mathematically the inverse version of the already available predicting procedure.

PROCESSING and MARKETING QUALITY WHEAT

Education in marketing and quality awareness

-Clare Johnson

2.2.3 Information for Growers and Advisers

- Prime Hard in the South Booklet launched
- Expos, field days
- 12 articles in farm journals
- Glossary
- Adviser network
- Factsheet updates
- Distribution of demos on CD

2.1.7 Premium Quality Wheat SA Extension

- Newsletter
- Trial sites
- Wheat Quality Ute Guide
  - market and QA focus added
- TopActive

2.2.2 Quality Wheat for Quality Foods/Market awareness courses

Courses held in

- Northam (2)
- Walgett (3)
- Goondiwindi (2)
- Plans include Moree, Parkes
- Advertising improved

2.2.1 Milling for non-Millers sponsorship

- Sponsor 6 "Key influencers"
- Follow up with other wheat quality literature
- Course late March

2.2.4 Grain storage CD

- Completion, launch
- Sales
- Advertising and articles
- Flyer, poster and network promotion at update series
- TopActive workshops

Free of chemical residues

Free of insects

Free of mould

CD-ROM Guide to Delivering Quality Grain

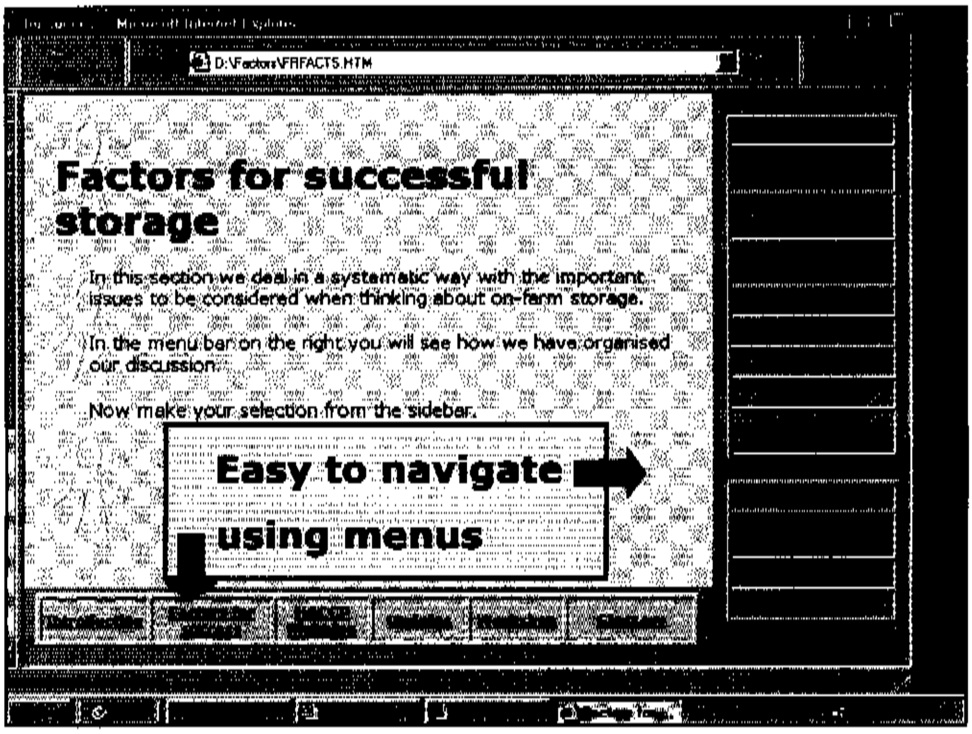
Free of foreign seeds

Free of animal and foreign matter

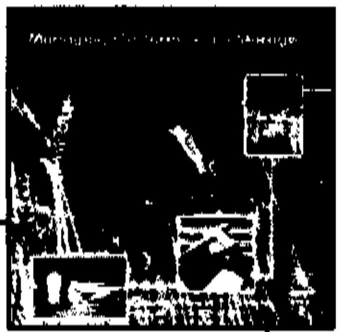
WHEAT CRC

CD-ROM contents: for successful storage

- ✦ Standards & inspection
- ✦ Storage structures
- ✦ Moisture and temperature
- ✦ Practical pest control
- ✦ Insect pests of storages
- ✦ Surface treatments
- ✦ Grain hygiene
- ✦ Safety on farm
- ✦ Commodity information



CD-ROM:



Managing On-farm Grain Storage

Information for Delivery of Quality Assured Products

Available:

Graintec	**ph 07 4638 7677**
Rural Connect	**ph 1800 110 044**
Tocal College	**ph 1800 025 520**

2.2.5 QA on-farm

- **Grower groups**
- **Facilitators**
- **Record pro-forma revision**
- **Audit**
- **Documented case study will assist (crop check $ benefit)**

GRDC Education Program

- TopCrop and Updates
- Rural Connect publications
- Scholarships and awards
- BRI Research Horizons and Milling for non-Millers

GRDC Education Program

- "Learning industry" - value chain model for change management
- Grains Education Foundation - Rural Industries Framework, review Agricultural Training Package
- Consumer drive - critical structures, relationships and processes
- High level national forum (24) (SWOT and gap analysis, strategy/network definition)

PROCESSING and MARKETING QUALITY WHEAT

The GRDC's Grain Education Program

-Brondwen MacLean

Current GRDC "Developing the Skills Base Program"

To support Australia's research capacity and increase innovation, the GRDC invests up to $0.7 million of new funds annually in training awards; this includes providing researchers and growers with opportunities for travel both within Australia and overseas.

The current suite of Training Awards, aimed at developing the skills and information bases required to achieve the GRDC's objectives, are:
- Grains Industry Undergraduate Honours Scholarships
- Grains Industry Research Scholarships (for PhD students)
- Grains Industry Post-doctoral Fellowships
- Grains Industry Senior Fellowships
- Grains Industry Visiting Fellowships
- Grains Industry In-service Training Awards
- Grains Industry Development Awards (for those not involved in R&D activities)

In addition there are over 60 PhD students funded within GRDC projects.

More information is available on the GRDC's website: www.grdc.com.au

The GRDC also supports the following:

Australian Rural Leadership Program (ARLP)

The ARLP Program is funded through scholarships provided by a range of rural and related industries, industry bodies, State and Federal Government agencies and research and development organisations. The GRDC sponsors one Scholarship for the Grains Industry. Currently, scholarships cost $37,500 each.

Selection is competitive for the 30 to 32 positions on each course. The Program is for the development of men and women who will lead rural and regional Australia. It comprises a part time course of some 60 days, conducted over 2 years.

Australian Nuffield Farming Scholars Association (ANFSA)

Scholarships are awarded annually by the ANFSA to enable established farmers to travel to other countries for the purpose of increasing their knowledge of practical farming and the broader issues of agricultural production and marketing.

Commencing in 2000, the GRDC will support three Scholarships for practising Australian graingrowers. The GRDC's contribution is $25,000 per Scholarship.

Milling for Non-Millers Course

BRI Australia Ltd (Sydney) offers a 3-day non-residential course designed to familiarise participants with wheat quality evaluation and how differences in the wheat quality influence the milling process. Currently the course fee is $1,650 per person, with a minimum of 10 participants.

Research Horizons Course

The "Research Horizons for Grain Policy Leaders" course was developed jointly by the GRDC and BRI Australia Ltd. The concept for the course arose from a need to introduce growers who may wish to offer themselves to serve on bodies such as the GRDC's Regional Panels. A total of 48 growers have participated in the three courses delivered since 1996.

In 1998 the course was restructured into two sections of three days each over two years. The first year covers quality and marketing issues and R&D inputs to these. The second year concentrates on leadership skills. The budget is $120,000 *per annum*.

Australian Centre for Intellectual Property in Agriculture

The Centre, at the Australian National University's Faculty of Law is to be set up with an investment of $3M over five years by the GRDC. The Commonwealth Government, in recognition of the relevance of the work of the Centre beyond the grains industry will provide additional funding of $0.4M.

The ANU Law Faculty will be joined by the ANU's Research School of Biological Sciences in developing education and training programs based on contemporary case studies. The Centre will also form partnerships with other centres of excellence to develop a national network in intellectual property law and policy. Appointment of a Director is underway.

The Grains Education Program

The Grains Research and Development Corporation (GRDC) has given considerable attention over the last year to the ways in which it might enhance the skills base of Australia's $7 billion grains industry. Arising out of this process, the GRDC decided to establish a Grains Education Program (GEP) to bring together in one discrete program structure its existing education and training activities, which currently involve an investment of some $3.6 million a year.

At the same time the GRDC decided to establish a Grains Education Advisory Group (GEAG) as a specialist advisory body to provide high level strategic advice on matters relevant to the Corporation's education and training activities.

As part of its consideration of options for enhanced investment in the fields of education, training and learning, the GRDC Board has also examined the idea of establishing a Grains Education Foundation (GEF), as an enduring organisation specifically dedicated to education in the grains industry, which over time would have the capacity to make a substantial contribution to development of the skills base. It was implicit in forming the GEAG that it could become the Board of the GEF at some future stage.

The intention in establishing the GEF was to achieve the following outcomes:

- provide a clear signal of the GRDC's commitment to the development of the human capital base for the grains' industry by adding to the resources available to fund, education, training and learning;

- establish an on-going, stable and independent source of funding, specifically dedicated to the grains' industry, which is not vulnerable to longer term fluctuations in the GRDC's recurrent income;

- create an organisation with a substantial capital base which would be able to leverage other sources of funds;

- harness outside expertise in education, finance, industry and philanthropy etc., through membership of the GEF Board

The GRDC should not duplicate existing activities or replace funding from other sources. The investment should be a long term commitment and be integrally linked to a broader strategy for building the skills base of the grains industry as a whole.

A comprehensive Grains Education Program should have as its vision the creation of a 'learning industry' an industry with explicit structures and processes for creating and transferring knowledge and information in the pursuit of success and innovation. A GRDC Grains Education Program can help build the 'learning culture' to underpin this vision.