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CSIRO Plant Industry & Quality Wheat CRC Ltd

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A World View of Cereal Chemistry:
Report on the 1999 Meeting of the American Association of Cereal Chemists

- C.W. Wrigley

The 1999 Meeting of the American Association of Cereal Chemists was held in Seattle from Sunday, 31st October to Wednesday, 3rd November, 1999 (one day shorter than previous years). This year’s meeting had an attendance of nearly 2,000, and a total of about 400 papers (oral and poster). With considerable representation from many countries beyond North America, these annual meetings have become the world’s major cereal-science event. In fact, the meeting is becoming too large, especially considering the shortened period of this year’s meeting (omission of the Thursday). Although many prominent cereal scientists were present, it was difficult to make all the contacts that would be desirable. Nor was it possible to hear all the relevant talks because there were up to six concurrent lecture sessions, together with poster sessions, trade displays, and many committee meetings.

Abstracts and program details are provided in the conference booklet (a copy is available), as well as in the July issue of Cereal Foods World (44, No.7, 490-503, 1999). Lectures were accompanied almost exclusively by slides. We had been notified beforehand that there would be no overhead projectors available. In fact, overhead projectors were provided in a few of the lecture rooms, but they were not used. I was surprised to find that there were hardly any presentations from computer projectors, although the facilities were provided in some of the rooms; yet these were used very effectively at the Australian Cereal Chemistry Conference in Melbourne a few weeks earlier.

AACC Awards

An Australian and some collaborators of Australian cereal chemists were honoured at the meeting:

**Bruce Wasserman Young Investigator’s Award.** The Biotechnology Division of the AACC recently instituted this award for scientists who are no older than 40 years in the June previous to the AACC meeting. This year’s award went to John Skerritt. A full hour was allocated in the program for John’s Award Address, entitled “Immunological tools and tests for cereal science: a 16-year journey”. He commenced with a photo of himself as a baby on Santa’s knee taken in 1959, to prove the claim of “Young Investigator”, according to the definition of the Division’s regulations. John provided a description of his research in CSIRO in developing test systems for grain analysis, based on immunological methods. He indicated that the three gluten- and coeliac-related tests total retail of over $1m annually. He also described recent tests for aspects of grain quality and genetic constitution, and current successes in recombinant antibody production. Challenges described include the development of sufficient specificity to distinguish between various gluten polypeptides and the goal of developing DNA-based tests that could be as simple to perform as the ELISA tests, such as the WheatRite card.

**Osborne Award.** The AACC’s research medal was awarded to Jerry Bietz of the USDA laboratories in Peoria. Jerry has long been active in the development of new techniques for protein fractionation. In the first half of his Osborne Address (“On the shoulders of giants – an adventure in cereal chemistry”), he provided an interesting summary of some of the less known
quotes and anecdotes related to T.B. Osborne. The second half was a review of his own experiences in cereal chemistry, in which he paid tribute to several Australian collaborators. He described several “Eureka moments” in his career, including his application of several fractionation technologies that were new to grain science at the time - moving boundary electrophoresis, ultracentrifugation, various extraction methods, SDS-gel electrophoresis, a few HPLC methods and capillary electrophoresis. Such have been his major contributions – the adaptation of new methods to cereal science, using them to obtain new insights into gluten genetics and function, and sharing his experiences with other cereal chemists so that they could also extend frontiers through his experience. In his parting message, he set out four demands required for success in research:

1. People, requiring a critical mass in a research group.
2. A suitable environment with adequate facilities and equipment.
3. Adequate support - financial and administrative.
4. A long-term commitment to research objectives.

AACC Fellow. Jean-Claude Autran was awarded the honour of AACC Fellow. He is based at the INRA laboratories at Montpellier, France. We have interacted with him on many occasions in relation to the analysis of grain-protein composition and varietal identification.

SYMPOSIA OF SPECIAL INTEREST

The conference included some relevant sessions for the Australian wheat industry. Again this year, there were sessions on the impact of biotechnology on cereal production and utilisation. One of these was given highest profile by its inclusion as the lecture at the opening breakfast session – the only occasion when all delegates meet together. This was delivered by Roger Beachy under the title “The Post-Genomic Era”. He predicted what 21st Century agriculture would look like. It would involve greatly more genetic diversity as a result of our ability to insert genes by transformation. There would be much less use of agricultural chemicals, higher yields, increased resistance to disease, and much wider choice of quality.

Who will choose the directions that these innovations will take? Many groups, including social scientists and economists. Most important will be the business sector and consumers. Research in this area requires a ‘systems approach’, involving a wide range of disciplines: molecular biologists, environmental scientists, food and textile chemists, polymer chemists, and computer scientists.

On the science side, he described how genomic studies are providing new genes for resistance, for drought tolerance, for ability to grow in acid soils and for various quantitative traits, particularly quality. He emphasised the importance of genomic and proteomic studies for helping us to understand the molecular changes that occur Sequence-to-Structure-to-Function.

This involves a search for proteins with similar active-site sequences (relevant to a specific function), thus identifying novel sources of relevant genes with this function.


The Biotechnology Division ran a Symposium covering a wide range of gene studies, including many examples of transgenic advances that have increased disease tolerance, and yield (due to improved N assimilation). The rice genome project was described. As weed infestation is a primary concern for rice, RoundupReady rice will bring great advantages. The main
advantages of the mapping of the rice genome, however, relate to its use for ‘more intelligent’ breeding strategies.

John Scharingson (Zeneca Plant Science, Field Crops Manager, USA) predicted that biotechnology would have short-medium-term advantages on agronomic aspects of plant-based agriculture, particularly with respect to abiotic stresses. In the longer term, the advantages would be on quality traits, particularly cost savings for processors, novel premium foods for consumers, and improvements in animal feeds. To achieve these goals, there is the immediate need for research to determine the quality traits to target, and companies must ensure that they have the means to capture and retain the consequent value. He considered that the US consumer accepts the results of biotechnology, but that the US industry cannot ignore the fact that 50% of its food produce is exported, and that half of that goes to Europe, where there are marketing problems. He identified four steps to gaining consumer acceptance:

1. Identify relevant consumer groups.
2. Gain their understanding and trust – ‘their hearts as well as minds’.
3. Explain what are the advantages of GMO foods to the food chain.
4. Finally, not first, explain the technology and how it affects the products.

Virgil Smail (American Institute of Baking) described the results of a survey of bakers with respect to GMO ingredients. There appeared to be scepticism about any advantages to the baking trade. In addition, the US industry is ‘scared’ by developments in Europe. Nevertheless, he quoted a level of 80% acceptance of GMO foods by the US public. Desirable quality traits for the baking industry would be crumb texture, mixing tolerance, dough absorbance and mix time. There seemed to be no assurance that any of these would be improved by biotechnology. An over-riding consideration was their need for stability/consistency with respect to these aspects of quality.

Public confusion about GMO foods was epitomised by one speaker by the misguided consumer comment: “I wouldn’t eat any food with DNA in it!”

**Protein Division Symposium I: “A multidisciplinary study of the structures and functional properties of HMW subunits of wheat glutenin” (The Euro-wheat program) Abstracts 7-12.**

Peter Shewry was invited to arrange a symposium on behalf of the Protein Division describing progress in an EC set of projects on the structure and function of the high-molecular-weight (HMW) subunits of wheat glutenin. Peter commenced (Abstract 11) with a description of the isolation of the 1Dx5 gene, its expression in F. coli, and the purification of the expressed polypeptide, resulting in the production of (relatively) large amounts of the pure protein (hundreds of milligrams) for study by the several collaborating labs.

Peter Belton (Abstract 7) followed with a description of structural studies, but there were few results, mainly speculation.

Arthur Tatham (Abstract 8) described how they had been able to crosslink the HMW subunits with gamma radiation. Using thermoelasticity plots, he showed how the resulting polymers differed from elastin (previously used as a model for glutenin function). In preference, he suggested that spider web and silk are more similar to glutenin, having higher levels of glutamine. He claimed that the glutenin proteins may be the only elastic proteins in the plant kingdom.

Domenico Laflandra (Abstract 10) described (again) his electrophoretic analyses of glutenin subunits in gels containing a transverse gradient of urea, thereby demonstrating
distinctions between several subunits. As a result, subunit 10 is shown to be more stable to
denaturation than is subunit 12. In genetic studies, he has succeeded in producing lines having
additional numbers of HMW subunits, up to the full complement of six subunits, in many cases
incorporating genes from primitive wheats.

Ives Popineau (Abstract 12) reported experiments on Greg Lawrence’s multi-null lines,
relating composition to function in dough (two-gram Mixograph), largely similar to what we have
previously reported. Some of his sonicated extraction involved pH 8.5 borate buffer (rather
alkaline?).

Protein Division Symposium II: “Protein characterization: from basic research to
industrial application” (Abstracts 23-31)

This topic was pursued following discussions, at last year’s AACC meeting, involving the
Protein Division and Colin Wrigley and Fin MacRitchie. Fin and I were invited to co-chair the
symposium for the 1999 Meeting and to arrange speakers. Interactions with all speakers have
continued during the past year, encouraging them to make their contributions relevant to the
overall theme of identifying key proteins that would serve as markers of quality attributes, and
thence providing a basis for developing simple quality tests for routine use by industry.

During the intervening year, a summary of industry needs (Appendix 1) was provided by
the key industry spokesman, Bill Atwell (Pillsbury Technology Center, Minneapolis) to motivate
the more academic speakers to fill the perceived gap between “basic research” and “industrial
application” (the terms used in the title of the symposium). Also circulated was a table
(Appendix 2) of quality attributes and test systems applicable at various levels of interest. As
well as providing the table as a basis for developing interaction between speakers beforehand, it
was intended for use in the final discussion session. In the end, this did not prove practicable as
re-allocation of session times reduced discussion time. Nevertheless, it illustrates the range of
points that we were trying to make in the symposium. Fin and I have been invited to prepare a
paper for Cereal Foods World summarising the points made in the Symposium.

An essential starting point was the opening talk by Bill Atwell (Pillsbury Technology
Center, Minneapolis) about the requirements of industry—“Protein-related problems in the
cereal industry” (Abstract 23). His major accent was to say that consistency of quality is
everything (nearly) for industry. (I have the PowerPoint file of his presentation.) He claimed that
only one third of the quality variation is due to genotype, compared to two thirds being the result
of environmental variation. His further points were:-

- Inconsistency (variation) in wheat-grain quality is the basis of the problem; it is due to …
  - Genotype (varieties differ in their intrinsic attributes)
  - Environment (growth and storage conditions)
- What variations?
  - Protein content (mainly growth environment)
  - Protein (dough) quality (due to both ‘G’ and ‘E’)
  - Enzyme activity (e.g. sprout damage)
  - Hardness (variable starch damage and water absorption)
- Bill’s wish list
  - Consistent protein content
  - Consistent protein quality
  - Low/consistent levels of specific enzymes
- Consistent hardness
- Work to solve these problems by ...
  - Prediction of quality changes
  - Understand causes for changes
  - Industry-wide communication

Rob Hamer continued in a similar vein ("Wheat quality: solving the specification problem") (Abstract 24) by describing difficulties in Europe in defining the quality requirements for specific processes and products. He advocated "dedicated production chains", the growing and segregation of wheat of certain quality types suited to these processing needs - not a new concept to us in Australia! He described the predictive power of the combination of protein content and the level of glutenin macropolymer (GMP) in relation to dough properties. He went on to provide a diagrammatic model of GMP dynamics, as changes occur during the wetting, mixing, (over-mixing) and resting of dough.

John Skerritt launched into "New insights to glutenin structure in flour processing" (Abstract 25), with a description of his collaboration with PhD student Megan Lindsay on the ultrastructure of dough using different microscopic approaches, combined with the specificity of antibodies, to distinguish the roles of the gluten fractions in dough rheology.

"Industrial applications of wheat antibodies" (Abstract 26) was presented by Michel Lauriere (INRA, de Grignon, France). Much of his presentation was a review of CSTRO-developed test kits, with a lengthy description (and recommendation) of the WheatRite test card. His own research on the development of anti-gluten antibodies came as a last-minute mention. His presentation was therefore a generous commendation of our work.

Domenico Lafiandra presented "Structure/function relationships of glutenin subunits" (Abstract 27), describing recent research on attempts to identify the full range of gluten polypeptides involved in the formation of SS bridges relevant to dough structure. Obvious candidates are the glutenin subunits, but he also emphasised the D-subunits, which are similar to the omega-gladiins but with cysteine incorporated. He made special mention of the recent paper of Clarke and Appels, describing the consequent generation of two cysteine residues as a result of a frame shift. This and other results were interpreted in terms of the effects on dough function due to 'chain-terminator' or chain-continuation mechanisms.

Craig Morris presented what he sees as being a pretty complete picture of the biochemistry of grain hardness "Puroindolines: the molecular-genetic basis for wheat grain hardness" (Abstract 28). After a good summary of earlier studies and false starts, he described the puroindolone family, with several minor differences in amino-acid sequence, as the main basis of hardness, these several variants being represented by 'ancestral' varieties. For example, many North American hard wheats get their hardness gene from the old variety "Turkey Red". Other ancestral sources include the Australian wheat Falcon, Proline 60, and Hard Red Calcutta.

Bob Graybosch's paper (with John Skerritt), "Analysis of waxy proteins of wheat and oats: applications in breeding" (Abstract 29), described the development of antibodies for use in discriminating between the various semi-waxy marker proteins. The antibodies have been used to classify many US wheats on the basis of their genetic constitution with respect to the waxy genes. He also spoke of attempts to extend the waxy-wheat studies to oats (also hexaploid). This situation is proving to be more complex than the case of wheat. He has identified three functional loci, resulting in eight variants, but no success has yet been achieved in obtaining a waxy oat genotype.
Ken Preston described his recent successes in improving resolution with Field Flow Fractionation (FFF) "Use of flow field-flow fractionation and mass spectrometry for characterization of wheat proteins" (Abstract 30). His major improvement is the provision of a "frit inlet" and a "frit outlet", giving a ten-fold concentration of protein in the outlet, thereby improving sensitivity, reproducibility and quantitation. He uses a sequential extraction of flour proteins, involving acetic acid, then acetic acid with sonication, and finally acetic acid with 1% DTT in 50% propanol. Analysis of the protein extracted with this last solvent indicates that only about 2% of the flour protein is left after the acetic-sonication step. Normal extraction is at room temperature, but he includes a 65°C treatment to inactivate proteases. Ferritin is still the largest protein he has been able to use for calibration. He calculates Stokes diameter for the glutenin proteins to range up to 50nm, or well over 30 million Daltons. FFF analysis of fractions from SE-HPLC indicated that they were not homogeneous in size, some of the larger fractions also containing smaller proteins (probably due to protein-protein interactions at the high protein concentrations present in SE-HPLC). He has obtained good correlations between FFF results and the dough-development times of a range of flour samples, with r = 0.80 for the largest FFF fraction and r = 0.82 for the FFF fraction of medium size. Finally, he described the use of MALDI-TOF mass spectrometry (MS) with a range of gluten fractions, and advocated MS as an ideal means of variety identification, claiming that there will soon be small portable MS equipment. Abstracts 289 (David Schofield) and 290 (Ken Preston) give further details of FFF research.

My paper (with Kath Tilley and Fin MacRitchie, "Analysis of protein-related aspects of wheat quality" Abstract 31) was an attempt to draw together the several threads concerning the identification of quality-related proteins, and indicate how all these presentations related to practical quality identification in industry. This included consideration of delivery systems, such as NIR and the WheatRite card, for simple use by industry. This led to general discussions, in which there was some comment from an industrial spokesman, requesting a single 'black box' that would provide him with all quality information. Perhaps NIR holds some promise for approaching that seemingly impossible dream. The Protein Division has requested us to prepare a paper summarising the Symposium for submission to Cereal Foods World.

SOME FURTHER COMMENTS RELEVANT TO OUR RESEARCH

USDA, Albany: Francis Dupont is doing well with the dough-function analysis of their grain samples, using the two-gram Mixograph. Their growth-environment studies are now showing that heat stress causes dough-weakening, provided they do not over-fertilise (as they had done previously in glass-house studies). They are now studying these interactions during grain filling. They are also using the resulting immature grain for proteome analyses (two-dimensional isoelectric focusing – SDS electrophoresis), to reveal differences in the full set of grain proteins due to environmental differences. I gathered that their proteome studies are well behind ours.

WheatRite test cards: There was great interest in the test kits, both at the CRC table top, with Alan Ellis in attendance, and following several talks that described it (Abstracts 26, 31, 372). I had to deliver John Skerritt’s lecture due to his need to leave the meeting early (change in flight time). Following my presentation, many of the audience came forward to take sample cards. Collaborative discussions progressed during the meeting with groups from both North America and Europe. A paper was requested for submission to Cereal Foods World to describe the kit and the results of the international trials.
N fertiliser effects on gluten composition: Dr Zhu (North Dakota State University, Abstract 368, collaborative with Lindsay O’Brien) described his fertiliser studies on the biotypes of the Australian variety Warigal, which provides iso-genic lines with either HMW subunits 5+10 or 2+12. When grown at 0 and 200 kg N/ha, they did not differ in overall gluten composition, but multi-stacking SDS gel electrophoresis showed that they differed, in response to fertilisation, in the size of the glutenin polymers. A description of this project has just appeared in Cereal Chemistry 76, 915-919.

Small-scale flour mill: Abstract 175 describes a small flour mill (the CD-1), with a minimum capacity of 25 grams of wheat, manufactured by Chopin, France. The authors are from Pullman, Washington.

Transgenic wheats with gluten genes: Ann Blechl (Abstract 367, collaborative with Frank Bekes) reviewed their last few years of dough results with transgenic wheats. Results ranged from unexpectedly augmented levels of HMW subunits, and in other cases, to the switching off of all HMW subunits (Co-suppression of gene action). She thus concluded that the HMW subunits are “essential” to gluten properties.

NIR analysis of waxy wheats: Steve Delwiche (Abstract 371) reported that he could distinguish between the several classes of partial waxy wheat lines using NIR, probably due to the differences in amylose content. He claimed 100% accuracy for the null allele, and 80% accuracy for the intermediate alleles.

Waxy wheats: There were several papers mentioning the testing of function in waxy (or partial waxy) wheats, with the general conclusion that their main potential lies with non-bread uses. I have a copy of the poster by Guo, Graybosch and Shelton (Abstract 275) “Characterization of waxy wheat flours”. Other abstracts relating to waxy wheats include numbers 228, 237 and 360. Abstract 359 relates to the ratio of A to B granules.

PROTEIN DIVISION MEETING

New office bearers are:
   Chair: Francis Dupont
   Chair-elect: Fin MacRitchie
   Sec./Treasurer: John Skerritt
   Student Representative: Rachel Benjamin (Kansas State University)

- Student Travel Awards went this year to students from Washington State University and Saskatchewan University.
- Student members are invited to contribute to a logo design competition for the Division, with a prize of US$100 offered. The deadline is March 30, 2000. I have further details.
- A new brochure about the division has been produced; I have several copies.
- An on-line poster contest is proposed for post-graduate students.
- An international student travel fund was proposed.
- Finances in the past year have gone to pay student travel awards and to subsidise symposium speakers.
- Symposium topics for next year’s AACC Meeting were discussed. Suggestions are still being taken.
BIOTECHNOLOGY DIVISION
The Biotechnology Division's Newsletter (copies available) featured John Skerritt as winner of the Division's 1999 Award. It also has a good article (by Jan Van der Kamp, TNO, Zeist, the Netherlands) contrasting the differences in acceptance of genetically modified foods in Europe versus the USA, and providing a profile of the current situation in Europe.

CEREAL CHEMISTRY JOURNAL: EDITORIAL BOARD MEETING
Over 30 people attended this meeting, emphasising the range of Associate Editors (who handle the reviewing of manuscripts, plus some Headquarters staff). The meeting saw the handover of Editor-in-Chief job from Vladimir Rasper (located in Guelph, Canada) to Jon Faubion (based at AACC Offices, and thus closer than Vlad has been to the production staff).

Plans were announced to make a gradual transition to make Cereal Chemistry an electronic journal, with the date 2005 as the deadline for it to be completely electronic, with no hard copy. Initial steps, however, relate to greater accents on using electronic means to accelerate the pre-processing of manuscripts, as well as Internet access to published papers and a CD-ROM of all issues being produced at the end of each year.

During the past year or so, the volume of papers submitted and published has increased greatly, even though the proportion rejected has also increased slightly. The number of pages per volume has also increased. The average paper length was 5.9 journal pages in 1999, compared to 5.5 in 1998. The split of US papers (about 60%) versus 'others' (40%) has remained constant in recent years.

A new committee structure in the AACC will place all publications under one committee the "Publication Panel", including both AACC journals together with all books and the AACC web site. Kathy Tilley (Kansas State University) will have an important role in this development.
APPENDIX 1

Protein Related Issues
-a listing of US-industry problems, provided by Bill Atwell for background to all speakers during their preparation for the Protein Division Symposium “Protein Characterization: From Basic Research to Industrial Application” (Abstracts 23-31)

Milling
Protein Level – high protein during droughts, low during wet seasons
Hardness – variation in kernel hardness causing variable tempering requirements, variable milling efficiencies, variable starch damage and variable granulation
Disease Resistance – general grain quality variations due to molds and other diseases
Sprout Damage – germination of the seeds before milling

Dough-Based Products (Processing Issues)
Water Relationships – variable flour-water ratios required to meet processing rheology requirements (e.g., variable Farinograph absorption)
Mixing Properties
- Mix time: variation in the work input needed to mix dough to its optimum gas holding state (e.g., variable Farinograph peak time)
- Resistance to work input: variation in the resistance to extended work input in the mixer and during further processing (e.g., variable Farinograph tolerance index, stability breakdown)
Rheological Properties of Optimally Mixed Dough
- Elasticity: variation in the amount dough “snaps back” after cutting or molding;
- Extensibility: variation in the flow properties during processing

Batter-Based Products (Processing Issues)
Water Relationships – variable flour water ratios required to meet viscosity targets
Viscosity – variable (generally declining) viscosity during processing

Frozen and Refrigerated Dough Products (Storage Issues)
Rheology – variable rheology, generally more extensible less elastic doughs with storage time
Graying Dough – appearance variations in dough due to polyphenol oxidase

Bread-Type Products (Initial/Shelf Life Quality)
Baked Specific Volume – variation in size/density
Appearance – variation in the degree of browning, variation in surface uniformity, variation in crumb cell structure
Eating Quality – variation in the chewiness, crumb stickiness, and general mouthfeel
Staling – variation in texture (i.e., firming) and flavor with storage time

Cake and Other Batter Products (Initial/Shelf Life Quality)
Baked Specific Volume – variation in size/density
Shape – variations such as the concave or convex conformation of the top of the product
Eating Quality – variation in the dryness, crumb stickiness, and general mouthfeel
Staling – variation in texture (i.e., firming) and flavor with storage time

**Cookie Type Products (Initial/Shelf Life Quality)**
Spread – variation in the diameter/thickness of cookies

**APPENDIX 2**
The following table was prepared as a basis for developing interaction between speakers beforehand, and for use in the final discussion session of the Protein Division Symposium: “Protein Characterization: From Basic Research to Industrial Application” (Papers 23-31)

<table>
<thead>
<tr>
<th>Analysis of protein-related aspects of wheat quality</th>
<th>Table of test systems for unifying presentations at AACC Meeting, Seattle, 1999.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic concepts</td>
<td>Reference method</td>
</tr>
<tr>
<td>General requirements: Meaningful relationships</td>
<td>Accepted method</td>
</tr>
<tr>
<td>Protein content</td>
<td>Many small samples, low labor cost, modest speed</td>
</tr>
<tr>
<td>Varietal identity Distinct aspect of genotype</td>
<td>Low capital cost</td>
</tr>
<tr>
<td>Hardness Key protein – purinoindolines</td>
<td>Speed (&lt; 10 min.)</td>
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<tr>
<td>Sprout damage Amylase activity</td>
<td></td>
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<tr>
<td>Dough strength Key proteins, Mol. Markers</td>
<td></td>
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<tr>
<td>Extensibility Key proteins, Rye chromatin</td>
<td></td>
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<tr>
<td>Baking quality Weight gain in animals</td>
<td></td>
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<tr>
<td>Feed quality Weight gain in animals</td>
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<tr>
<th>Early generation in breeding</th>
<th>On-farm N.</th>
<th>At mill or elevator</th>
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<tbody>
<tr>
<td>Dumas, Kjeldahl</td>
<td>NIR, molecular markers</td>
<td>NIR, simple test needed</td>
</tr>
<tr>
<td>PAGE, HPLC, CZE, DNA test</td>
<td>PAGE, molecular markers</td>
<td>Knowledge of seed bought</td>
</tr>
<tr>
<td>PSI, NIR, grinding test</td>
<td>NIR, molecular markers</td>
<td>Visual exam’n</td>
</tr>
<tr>
<td>Falling No, Stirring No, Dough testing</td>
<td>Wheat Rite, Mol. Markers</td>
<td>Visual exam’n</td>
</tr>
<tr>
<td>Mixograph, Antibody kits</td>
<td>WheatRite</td>
<td>WheatRite</td>
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<tr>
<td>Mol. Markers</td>
<td>Mixograph</td>
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<tr>
<td>Mol. Markers</td>
<td>Antibody kits</td>
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<td>NIR</td>
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<tr>
<th>NIR, simple test needed</th>
<th>Knowledge of seed bought</th>
<th>Visual exam’n</th>
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<tr>
<td>Visual exam’n</td>
<td>Method needed</td>
<td>Visual exam’n</td>
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APPENDIX 3
Wrigley Itinerary to Contribute to AACC Meeting in Seattle, Oct-Nov., 1999

October, 1999
Fri. 22/10  Depart Sydney on Air New Zealand NZ 14 at 3.35 pm
           Arrive Los Angeles at 12.15 pm
           Transfer to hotel arranged with United airport bus phone 800 772 5299
Accommodation at Fairfield Inn (Marriott), Anaheim. In Fri 22/10 – out Mon 25/10
Mon. 25/10 to Fri. 29/10  Holiday
Sat. 30/10  Depart Los Angeles on Alaska Airways ASAS 469 at 12 noon
           Arrive Seattle at 2.36 pm
           Accomp. at Crowne Plaza Hotel, 1113 Sixth Avenue, Seattle WA 98101-3048
           Phone 1 206 464 1980  Fax 1 206 461 5853; in Sat. 30/10; out Thurs. 4/11

Sun 31/10 to Thurs. 4/11…..

Annual Meeting of American Association of Cereal Chemists, Seattle
Sun. 31/10  Cereal Chemistry Editorial Meeting
           Set up poster papers
Mon. 1/11  Poster on CSIRO/CRC WheatRite test kit
Tues. 2/11  Protein Division Symposium:
            ‘Protein Characterization: From Basic Research to Industrial Applications’
            Chairs: Colin Wrigley and Fin MacRitchie
            Lecture and Discussion: ‘Analysis of protein-related aspects of wheat quality’
            - C.W. Wrigley, K Tilley and F. MacRitchie
Wed. 3/11
Thurs. 4/11  Depart Seattle on Alaska Airways ASAS 482 at 5.21 pm
           Arrive Los Angeles at 7.49 pm
           Depart Los Angeles on Air New Zealand NZ 4815 at 10.15 pm
Sat. 6/11  Arrive Sydney at 7.40 am