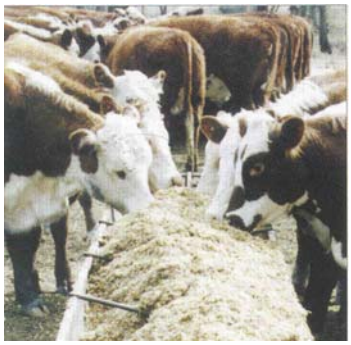
Feed Grains Workshop

Report



A Collaborative Project between Plant Science, Animal Science and Industry Development and Adjustment Department of Primary Industries & Fisheries

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Queensland Government
Department of Primary Industries and Fisheries

Executive Summary

The intensive livestock and grains industry value chain is estimated to have a combined farm gate value of over 2.5 billion dollars to the Queensland economy.

A squeeze in profit margins of grain growers due to flat grain prices, increasing costs, limited yield increases due to a food quality focus and increasingly variable climate conditions has reflected in lower cropping areas and unstable feed grain supply. Feed grains security, supply and quality have been identified as significant issues for the continued growth of the intensive livestock industries in Queensland.

Feedlots in particular are expected to grow, with increasing demand from both domestic and export markets for a consistent supply of high quality beef. Queensland's feedlot turn off in 2005 reached 1.45m head and the current annual demand for feed grain by the intensive livestock industries is estimated to be 2.036 million tonnes.

The DPI&F Animal and Plant Science groups instigated a scoping project to identify issues for research, development, extension and policy and to improve the communication within the two industries. This workshop pulls together a range of key stakeholders within the grains and livestock industries to identify and prioritise the issues. Representation at the workshop included, MLA, GRDC, AgForce, lot feeders, dairy, pork and poultry producers and stockfeed manufacturers. While not excluding other issues the main focus of the workshop was on feed grain quality.

Key areas identified include:

- The main grains are sorghum, wheat, barley and to a lesser extent maize
- Past focus has been strongly on food grains, need increased focus on feed grains
- A disparity between requirements for animal nutrition and current measures for feed grain trading
- The most important grain trait for all animal species is energy, particularly energy per unit cost. Other traits vary according to animal species and ability to process
- A need to improve yields and supply of winter cereals through both agronomy and breeding
- Sorghum provides good yields but presents a number of issues with processing and net energy availability
- NIRS (Near Infrared Spectrometry) provides a tool for rapid measurement of feed quality but requires accurate calibration and industry cohesion for adoption
- Various issues involving improvement in supply chain co-ordination e.g. logistics, segregation, storage and market signals
- A wide range of issues and grain traits were identified and a process for determining their relative economic viability was needed
- The potential for genetic modification was also identified as important for ensuring that the grains industry remains profitable in the future, but the limitations because of segregation and market sensitivity were noted.

The five most important issues identified at the workshop were providing a winter feed grain crop, addressing some of the digestibility and processing characteristics of sorghum, developing NIRS to determine nutritive value, improving the agronomy of current winter cereals and developing standards for feed grain trading.

Participants in the workshop were asked to break into groups and address one of these issues by identifying what needs to be done, who needs to be involved and what should be the first steps.

This workshop confirmed past reports on the burning issues related to the need to improve the feed grain supply demand imbalance. In order to facilitate continued growth within the grains and intensive livestock industries, the two industries need to take a co-ordinated approach to addressing these issues. This workshop has brought together a wide cross section of industry with key Plant and Animal Science researchers to initiate a discussion on how some of these issues could be addressed. In particular, areas such as boosting yields and supply and an improved ability to measure, trade and target feed grain quality are seen as vital to further development in the value chain.

FEED GRAINS WORKSHOP AGENDA

Chairperson – Kym McIntyre
Workshop Facilitator – John Daniels

Objective of Workshop

To identify -

- the quality attributes of feed grains for the Intensive Livestock Industries; and
- the actions required to enhance growth of the feed grains and livestock industries.

Welcome and introductions – David Hamilton, Kym McIntyre

(i) Setting the Scene

What are the main grains used by the different intensive livestock industries?
What are the most important grain attributes for each intensive livestock industry?

Facilitated by John Daniels

(ii) What is happening in the feed grains and intensive livestock industries?

Presentations from DPI&F General Managers and Meat and Livestock Australia

- Dr. Greg Robbins, General Manager, Animal Science, DPI&F
- David Hamilton, General Manager, Plant Science, DPI&F
- Des Rinehart, Project Manager Feedlots, Meat & Livestock Australia

(iii) How do we describe and measure quality?

Presentations from industry participants and research scientists

- Dr Mike Tavener, GRDC, Pork CRC and Premium Grains for Livestock Project
- Glen Fox, Plant Science, DPI&F, Toowoomba, Qld
- Dr. Rob Dixon, Animal Science, DPI&F, Rockhampton, Qld
- Dr. Neil Gannon, Ridley Agri Products, Toowoomba, Qld

(iv) What are the main issues surrounding feed grains and intensive livestock industries?

Whole group discussion and two votes from each participant to prioritise issues.

(v) Discuss the four main issues (Other issues recorded and will be dealt with in future)

Break into four groups and discuss each issue under the following areas:

- What needs to be done?
- Who needs to be involved?
- What is the first step?

(vi) Presentations from four groups on the main issues

(vii) Conclusions

- Dr Greg Robbins
- John Daniels

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I. Background to Project and Workshop

The industries relying on feed grains have grown substantially in recent years and security of supply has become very important. Currently, demand is expected to outstrip supply in three to five years out of every ten.

Increasing, local supply capacity and greater reliability of supply are vital for the Queensland economy, as well as the intensive livestock (beef cattle, dairy cattle, pork and poultry) and ethanol industries as these industries expand their capacity. Other supply chain solutions may be developed, such as increased capacity to store grain, better forward contracting and market risk management practices. A further alternative may be to import grain either from interstate or overseas if costs and import protocols allow.

While an increase in reliable supply of feed grain is of utmost importance, changing the focus from the food grains to feed grains and identifying longer term quality requirements which can improve animal feeding efficiencies is also a priority. Recent work conducted both in Australia and overseas indicates a greater ability to measure "feed grain quality" and make diets more efficient.

Therefore, a project was developed to focus on productivity improvement, better predictability and reliability of feed grain supply and increased feed grain quality through:

1. A thorough needs analysis conducted with stakeholders – Grain producers; intensive livestock producers (beef cattle, dairy cattle, pork and poultry); feed manufacturers; lot feeders; meat processors; scientists (DPI&F, CSIRO and University of Queensland) and extensions officers (DPI&F); Queensland Government Departments (DPI&F (Industry Development and Adjustment, Strategic Policy Group, Emerging Technologies, Biosecurity, Regional Delivery Groups and R&D Strategy) and Coordinator General's Department.); AgForce (Grains Industry and Beef Policy) and R&D Corporations (GRDC; MLA; APL; Pork CRC).
2. Enhancement and realignment of plant breeding programs (maize, barley, sorghum and wheat) with an emphasis on increasing the feed grains focus.
3. Development of models to predict feed grain supply and demand.
4. Improved water use efficiency in production systems.
5. Improved feed grain qualities for increased animal production to better match market needs.
6. Enhanced animal production systems using feed grains.

Tasks completed include:

1. A comprehensive needs analysis has been conducted with key grain and intensive animal industries stakeholders and a report prepared and presented to the Department of Primary Industries & Fisheries,' Industry Development and Adjustment's (IDA) Beef and Field Crops Portfolio Groups for discussion.
2. A Progress Report was presented to DPI&F's Senior Executive Team for discussion.

As a consequence of the needs analysis, a Feed Grains Workshop was planned with key industry (grains and intensive livestock) and government stakeholders to evaluate and validate findings from the needs analysis. This would formulate a coordinated action plan to develop future initiatives that would ensure the future growth and national and international competitiveness of these Queensland industries.

II. (i) What are the main grains used by the different intensive livestock industries?

Whole Group Discussion

Table 1. Identification of main grains used by different intensive livestock industries

Grain/ Animal Industry	Sorghum	Wheat	Barley	Corn	Grain Legumes	Pearl Millet	Triticale	Oats	Rice
Cattle	✓✓	✓✓	✓✓	✓					
Sheep	✓✓	✓✓	✓✓	✓					
Poultry	✓✓	✓	✓		✓	✓	✓		
Pork	✓✓	✓✓	✓✓		✓	✓	✓		
Aquaculture		✓✓			✓				
Ethanol	✓✓	✓	✓	✓		✓	✓		
Horse		✓✓	✓✓	✓✓				✓	
Pet Food		✓		✓✓					

(ii) What are the most important grain attributes for each intensive livestock industry?

Whole Group Discussion

Table 2. Identification of most important grain attributes for each intensive livestock industry

Beef Cattle/Sheep	Poultry	Dairy Cattle	Pork
Price $/MU	✓	✓	As for poultry
Energy	✓ Energy intake	Protein (not a trade off) Starch	
Grain size			
Plump grain	Depends on processing	✓	
Reliable supply	✓	✓	
Density/Test weight	**?**	✓	
Ease/$ Cost of processing	✓	**?**	
Not Protein			
Avoidance of digestive problems	✓ Different		
Fibre - Dietary - - Hull Fibre (non starch polysaccharide		Hull fibre - NDF	
Amino Acids		✓	
Standards		✓	

III. What is happening in the feed grains and intensive livestock industries?

This section is a summary of the key issues in the presentations, more comprehensive notes are available in Appendix D.

(i) Demand for feed grains from intensive livestock industries.
Dr. Greg Robbins, General Manager, Animal Science, DPI&F

Key Issues from presentation:

- There is a large and growing demand for feed grains
- Intensive livestock industry growth has been consistent and expected to continue

(ii) Grain industry perspectives and what Plant Science is doing to address the needs of feed grains industries.
David Hamilton, General Manager, Plant Science, DPI&F

Key Issues from presentation:

- The combined feed grains and intensive livestock industries should be looked at as a whole value chain and are a large contributor to the value created in the QLD rural economy around $2.5 billion at farm gate.
- Greater gains have been made in sorghum yield increases than wheat (winter cereal) yields due largely to a focus on milling quality traits, which restricts the available germplasm base.
- There are a range of ways to increase production (genetics, WUE, agronomy, disease in insect management) and we need to take an integrated approach to the process.
- Water Use Efficiency (WUE) is important, both within crops and between crops, breeding and agronomic issues can contribute to improved WUE.
- DPI&F are putting a greater emphasis on feed grain breeding in their breeding programs, changed focus in barley, appointment of feed wheat breeder, continued support for sorghum and maize.

(iii) Feed Grains and Quality - A Lot feeders perspective
Des Rinehart, Project Manager Feedlots, Meat & Livestock Australia

Key Issues from presentation:
Priority Issues for MLA Feedlot Program

- Feed stuff security is a serious issue – especially grain
- Alternative feedstuffs (Distillers grain)
- Superior feedstuffs
- Rapid tests of grain quality

Areas to address

- Breeding specialist feed grains varieties
  - Address agronomic requirements – disease resistance etc
  - Yield, Yield and more Yield
- Starch not readily available in sorghum unless processed
- Development of rapid NIRS tests for grain quality
  - Concerns about cost and maintenance of calibrations across diverse range of individual operations
  - Energy value of grains and mixed diets – Net Energy more use than Metabolisable Energy

IV. How do we describe and measure quality?

This section is a summary of the key issues in the presentations, more comprehensive notes are available in Appendix E.

(i) Dr Mike Tavener, GRDC, Pork CRC and Premium Grains for Livestock Project

Premium Grains for Livestock Program (PGLP)

Key Issues from presentation:

- A number of key NIR calibrations have been determined to measure feed quality
- Measures are different for different livestock species
- Yield is still the driving force but scanning of a wide range of samples indicates there is no negative correlation between yield and the "energy" traits measured.
- Both digestible energy and intake impact on livestock production and they do not seem to be closely correlated
- Intake is particularly important for pork and poultry industry.
- Current trading parameters for feed grains bear little relationship to available energy content of the grain but do impact on the processability of the grain
- Screening for breeding or selection is one thing but we need a trading standard if it is to be fully adopted – it is up to industry to validate robustness for commercial use.

(ii) Glen Fox, Cereal Chemist, Plant Science, DPI&F, Toowoomba, Qld

What is feed quality? Can we select/breed for feed quality?

Key Issues from presentation:

- In barley up to 13% difference in calculated ADG (Average Daily Gain) has been measured between commercial varieties – for ruminants.
- NIRS provides a robust tool for selecting feed quality, but still have a lot to learn.

(iii) Dr. Rob Dixon, Animal Science, DPI&F, Rockhampton, Qld

Possible roles for NIRS to evaluate and/or investigate feeding value of grains

Key Issues from presentation:

- NIRS analysis of faeces of ruminants (faecal NIRS) has been developed to measure the diet selected by grazing ruminants.
- There appears to be little reason to develop faecal NIRS to measure characteristics of grain-based diets.
- Faecal NIRS could have roles to measure starch in faeces, for monitoring nutrients in waste from intensive animal operations, and for understanding variation in the nutritive value of various grains.

(iv) Dr. Neil Gannon, Ridley Agri Products, Toowoomba, Qld

How do we describe/measure feed grain 'quality' attributes?
Current grain standards - what are they, what do they mean, how applicable are they?

Key Issues from presentation:

- Livestock industries need relevant and rapidly measurable quality parameters (current grain trading standards do not reflect ration formulation needs).
- Requires a change in breeding, agronomic and trading parameters.
- In some cases, premiums may be paid, in other cases having a market for the grain may be the reward.
- Providing segregation for quality may be one of the big challenges.
- Pipe dream may be to buy on MJ/ha.

V. What are the main issues surrounding feed grains and intensive livestock industries?

(i) Whole Group Discussion

After group discussion the following issues were identified as significant issues. There appeared to be some confusion about exactly what was involved in some issues and in particular it was suggested that issues 6, 10,11 12 and 14 had a lot of cross over but consensus was to keep them as separate issues. In order to prioritise the issues for further discussion each participant was give two votes.

Table 3. List of Issues Identified by Group and Weighting of Issues

Issue	No of votes
1. Provide a winter feed grain crop (e.g. wheat, barley as specific to milling or malting) • Higher yielding varieties with improved $ returns • Access new gene pools	**20**
2. Fix sorghum • Increase and stabilise YIELD • Improve digestibility of starch • Improve ability of grain to absorb water during processing • Decrease variability in grain size	**11**
3. Develop NIR Standards to determine nutritive value • accessible and reportable • quick and reasonably priced • simple and robust	**11**
4. Improve agronomy of current crops (especially winter cereals) • Develop packages to support varietal work, water use efficiency • Gives improvement in short term	**10**
5. Develop standards for feed grain trading • through NACMA	**9**
6. Improve signals for market value • What determines profitability? • Address any stigma about producing feed grain as opposed to food grain	**4**
7. Produce viable alternative crops • e.g. Peas, millet	**2**
8. How to prioritise options for improvement	**2**
9. Silage, improved varieties and improved information.	**1**
10. Encourage contracts (supply chain arrangements) and marketing signals	**1**
11. Logistics of moving grain • within Australia and from overseas.	**1**
12. Segregation of feed grains	**1**
13. Genetic Modification • presents opportunities for improved varieties • presents threats for segregation and marketing	**1**
14. Storage • short and long term • insect control, mycotoxins	**0**
15. Communication and Education • through GRDC, CRC	**0**

Comment: No votes or a small number of votes did not mean that the issue was not important just that other issues were considered more important or issues which were of particular interest to the group present.

(ii) Break into four groups and discuss four main issues

Discuss each issue under three areas

a. What needs to be done?
b. Who needs to be involved?
c. What is the first step?

(iii) Presentations from four groups

Group 1 – Development of dedicated winter crops for feed grains. (Includes Issues 1 & 4)

Participants: Ken Bruerton, Ray Shorter, Lindsay Krieg, Gino De Stefani, Paul Mason, Brad Beckman, Tracey Lindsay, Mark Weier, Phil Banks, Rex Williams, Errol Corsan

a. What needs to be done?

Dedicated feed grain breeding

- Increase yield as the most important trait
- Improve yield stability
- Maintain starch availability
- Achieve consistent large grain size
- Maintain quality parameters for animal nutrition, not milling.

Develop/define best management practices (BMP) and whole farm systems consistent with high yields.

Educate growers/advisors etc in risk management and encourage a target of feed production vs. food production.

b. Who needs to be involved?

- Research organisations
- Plant breeders (QDPI&F, CSIRO etc)
- Feed industry

c. First step

- $$$ - then germplasm development.

Group 2 – Strategy for Development of NIRS (Issue No. 3)

Participants. Peter Martin, David Hamilton, Mike Taverner, Gen Fox, Graeme Busby, Warwick Lee

a. What needs to be done?

- Develop a process for the adoption, support and validation of NIR technology to measure feed grain quality.

b. Who needs to be involved?

- Case by case – industry body and or company e.g.:

Animal Industries:

- Feed lot beef
- Chicken meat
- Layers
- Dairy
- Pork

Grains industry

- AWB Ltd
- Graincorp
- Philp Brodie Grains

- Farmarco
- ABB

c. First Steps?
- Develop a plan for implementation

Group 3 Implementation of more relevant feed quality standards (Issue No. 4)

Participants: Neil Gannon, David Martin, Vince Edmondston, Brian Burns, Kym McIntyre

a. What needs to be done?
- Establish what is important by species (beef, pork, poultry, dairy) e.g. energy, protein, amino acids. (nutrient value, input value)
- Define what is measurable
- Determine how it can be incorporated into a standard
- Gain consensus across industry supply chain
- Develop Cost benefit ratio
- Identify impediments to introduction

b. Who needs to be involved?
- NACMA - National Agricultural Commodity Marketing Association
- SFMA – Stockfeed Manufacturers
- Agforce/Graingrowers and organisations
- FGUG – ALFA, APL, ADO, QMA, GRDC (PGLP), Poultry Industry

c. First step?
- Establish what is important through animal industry bodies

Group 4 - Fix Sorghum (Issue No. 2)

Participants: Roger Sneath, Dave Jordan, Des Rinehart, Gary Heidendreich, Danny Singh, Andy Inkerman, Bob Henzell, Ross Ingram

a. What needs to be done?
- Past thinking has been restricted by technology limitations of what is available and possible. Markers now provide more powerful selection tools.

- ***For Processing***
  - Enzymes – determine availability
  - Size of feedlot to make economical
  - Through put for pelleting

- ***For Ruminants***
  - Starch availability – can be fixed by steam flaking but $ 2x cost and not viable for small operators.
  - Waxy: Benefit/cost ratio needs to be determined – lines are only 90% of yield

- ***Research needed***
  - Intake - what effects it in poultry and pigs
  - Protein and starch types e.g. waxy and hetro-waxy sorghums

Climate change may require different crops, e.g. Sorghum silage better adapted than corn, but has lower digestibility than corn need to look at silage management issues such as moisture.

b. Who needs to be involved?
- Animal industries, researchers, stock feed manufacturers, nutritionists, chemists

c. First steps?

- Identify traits to pursue – liaise with animal industries to identify what various quality or processing limitations cost them in production.
- Economically assess R & D investment and the return to industry and growers or end users. (I.e. what does it cost end users or growers in production currently.)
- E.g. waxy would be a good start, hetro-waxy may be more economically viable than full waxy.
  - intake issues
  - water absorption
  - protein type
  - sorghum silage

VI. Conclusions

The grains and intensive livestock industries are developing closer trading relationships in an economically and environmentally tough climate. Grain growers view the intensive livestock industry as a growing market for their grain, while the intensive livestock industry seeks reliability in the supply of quality feed grains at competitive prices.

This workshop has provided an insight into some of the major issues relating to development of feed grains in northern Australia and in particular Queensland. The main focus was on quality and presentations and issues tended to follow this focus. As such it should not be considered to cover all the issues of concern for the combined feed grains and intensive livestock industries.

In trying to prioritise the important aspects of grain quality for the various livestock industries (e.g. beef feedlots, pork, poultry and dairy) it became obvious that each industry has differing requirements and in establishing "value" of grain to each of these industries this needs to be taken into consideration.

Presentations from industry as well as DPI&F staff have identified the potential for developments in technology which can allow the two industries to develop mutually beneficial measurements for quality. The measurements could provide an incentive to change the current thinking from feed grains as a downgraded product to a much more defined target market. As a result opportunities will be created to add value to the grain produced and improved livestock feeding efficiencies.

Whilst a large part of the focus of the workshop was on quality, supply and profitability of growing grain crops (particularly winter cereals) was also highlighted as major concern to both the grains and livestock industries.

The key issues identified as important for the growth of the two industries were workshopped further on the day. They include:

- Improve productivity of winter cereals (agronomy and breeding),
- Fix sorghum, (issues to do with energy availability, feed intake and pellating),
- Develop NIRS standards for feed grain quality measurement, and
- Develop standards for feed grain trading

These issues provide an opportunity for the grains and intensive livestock industries to work together with input from DPI & F to achieve reliability in the supply of quality feed grains at competitive prices.

Other issues identified on the day have rated highly on some of the feed back sheets received to date and should be considered further by DPI &F and industry. Many of them will be necessary for the "top 4" to be implemented effectively. Others such as pursuing GMO capabilities will require long term industry support and government policy input to ensure success.

The challenge for DPI & F and industry is to identify which of these issues will have the most impact on improving productivity and profitability of the industries for the resources invested. It was suggested that a method of economic analysis be investigated with MLA, GRDC and producer organisations with a view to progressing the issues further.

VII. Feedback Sheet to Participants

Sent to participants and to date 9 replies have been received. These replies will be collated and used to further assess areas of priority.

Follow-up from Workshop:

Press release to Rural Media resulted in a number of press articles and one radio interview.
Reports made to the DPI&F Field Crops Portfolio and Beef Portfolio
Report distributed to participants, Grains Research Foundation, Industry groups (both grains and livestock).

APPENDIX A. - Feed Grains Workshop Project Team

General Managers

- David Hamilton, GM, Plant Science, DPI&F, Toowoomba
- Dr. Greg Robbins, GM, Animal Science, DPI&F, Brisbane

Project Leaders

- Kym McIntyre, Development Extension Officer (Barley), Plant Science, DPI&F, Warwick, Qld.
- Dr. Brian M. Burns, Principal Research Scientist, Animal Science, DPI&F, Rockhampton, Qld

Team Members

- John Daniels, Acting GM, Research & Development Coordination, DPI&F, Brisbane
- Jenny Shorter, Industry Development and Adjustment, DPI&F, Brisbane
- Vince Edmondston, Co-ordinator General's Department, Brisbane
- Warwick Lee, Senior Policy Officer, Industry Development and Adjustment, DPI&F, Brisbane
- Gerry Dixon, Senior Policy Officer, Industry Development and Adjustment, DPI&F, Brisbane
- Glen Fox, Cereal Chemist, Plant Science, DPI&F, Toowoomba.

APPENDIX B – List of Acronyms

Acronym	Full Name
ABB	Australian Barley Board
ADG	Average Daily Gain
ADF	Acid Digestible Fibre
ADF	Australian Dairy Farmers
ALFA	Australian Lot Feeders Association
APL	Australian Pork Limited
APSIM	Agricultural Production Systems integrated modelling
APSRU	Agricultural production systems research unit
AWB	Australian Wheat Board
CF	Crude Fibre
CP	Crude Protein
CRC	Cooperative Research Centre
DE	Digestible Energy
DM	Dry Matter
DMD	Dry Matter Digestibility
FGUG	Feed Grains Users Group
GRDC	Grains Research and Development Corporation
ISDMD	In sacco dry matter digestibility (nylon bag digestibility)
IPM	Integrated Pest Management
MLA	Meat and Livestock Australia
ME	Metabolisable Energy
MJ	Mega Joule
MJ/d	Mega Joule/day
N	Nitrogen
NACMA	National Agricultural Commodity Marketing Association
NDF	Neutral Digestible Fibre
NE	Net Energy
NIR	Near Infra-Red Reflectance
NIRS	Near Infra-Red Reflectance Spectroscopy
NSP	Non-starch polysaccharide
OM	Organic Matter
P	Phosphorus
PGLP	Premium Grains Livestock Project
QDO	Queensland Dairy Organisation
QMA	Queensland Merchants Association
SEC	Standard Error of Calibration
SEP	Standard Error of Prediction
SFMA	Stockfeed Manufacturers

APPENDIX C - Workshop Participants and Contact Details.

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APPENDIX D. – Presentations from Animal and Plant Science, DPI&F and Meat & Livestock Australia

(i) What is happening in the feed grains and intensive livestock industries?

i. Demand for feed grains from intensive livestock industries

Dr. Greg Robbins, General Manager, Animal Science

Key Issues
- There is a big and growing demand for feed grains
- Intensive livestock industry growth has been consistent and expected to continue

Introduction

- Historically, the supply of feed grain does not meet demand in 30% of years, due mainly to drought conditions.
- In Queensland, annual demand for feed grain is estimated to be in the order of 2.036 million tonnes.

It is estimated that	Cattle feedlots will account for	1,150,000 tonnes (56%)
	Piggeries	367,000 tonnes (18%)
	Poultry	335,000 tonnes (16%)
	Dairies	184,000 tonnes. (10%)

Supply of feed grains

- In 2003-04 Australian feed grain production was estimated to be around 21.518 million tonnes.
- In 2003-04 Queensland's feed grain production was estimated to be around 1.733 million tonnes, with 1.738 million tonnes produced in northern New South Wales.
- A significant proportion of grain production is exported each season, with carry-over stocks of feed grain usually small.
- High transport costs exist for importing grain to Queensland when supply does not meet demand.

Growth in intensive livestock industries

- Annual cattle feedlot turn-off increased by 7 % in Queensland in 2004 and by a further 14% in 2005.

	2003	2004	*% inc*	2005	*% inc*
Queensland	1,183,109	1,264,864	***7***	1,447,687	***14***
Australia	2,098,076	2,242,261		2,609,194	

Source: MLA/ALFA

- The Australian lot feeding capacity again reached record levels of 1.1 million head in the March 2006 quarter. Utilisation is approximately 80 %, following strong overseas demand with the ongoing exclusion of US beef from Japan.
- There is a steady growth in demand in Australia for lot fed beef with 33% of cattle on feed in the March 2006 quarter destined for the domestic market.

Forecasts

- Increased demand through growth in the intensive livestock and ethanol industries could increase the one in three to four year shortfall of supply to a 6 to 7 year shortfall, if strategies are not put into place to increase production.
- MLA predicts that feedlot production will continue at current rates reaching a capacity of 1.5 million head in the next 5 years and 2 million head in 10-15 years.
- Ethanol plants proposed for Dalby and Millmerran estimate using a total of around 350,000 tonnes per year, or 25% of Queensland's feed grain production.

- By 2007-08, it is estimated that national feed grain production will increase by around 1% to 21.833 million tonnes, with production in Queensland increasing by 7% to 1.861 million tonnes and by 12% to 1.958 million tonnes in northern NSW.
- Growth within the intensive livestock industry is expected to increase consumption of feed grain from around 2 million tonnes in 2003-04 to an estimated 3 million tonnes in 2007-08, an increase of 50%.
- By 2007-08, ABARE predict that demand for feed grain in Australia will increase for cattle feedlots by 29%, piggeries 12%, chicken meat 15% and dairy 7%, compared to 2003-4 levels.

Challenges

- Development of feed grain varieties best suited to Queensland's range of environments and feed quality needs for the different intensive livestock industries.
- Access to imported grains from interstate and overseas when local supply does not meet demand.
- Impact of feed grain 'quality attributes' on animal performance is becoming increasingly important for all animal producers.

ii. Grain Industry perspectives

David Hamilton, General Manager, Plant Science, DPI&F

Key issues

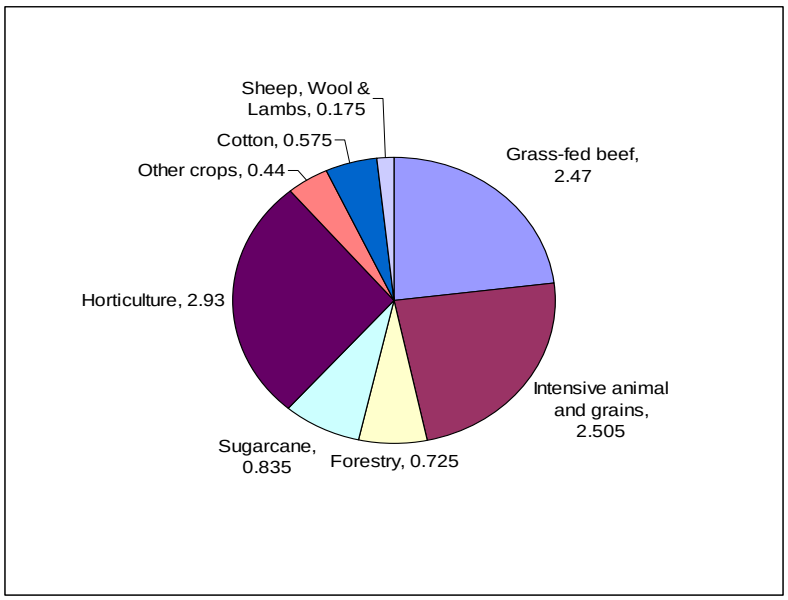
- The combined feed grains and intensive livestock industries should be looked at as a whole value chain. As a whole is a large contributor to the value created in the QLD rural economy around $2.5 billion at farm gate.
- Greater gains have been made in sorghum yield increases than wheat (winter cereal) yields due largely to a focus on milling quality traits, which restricts the available germplasm base.
- There are a range of ways to increase production (genetics, WUE, agronomy, diseases in insect management and we need to take an integrated approach to the process
- Water Use Efficiency (WUE) is important; both within crops and between crops, breeding and agronomic issues can contribute to improved WUE.
- DPI & F are putting a greater emphasis on feed grain breeding in their breeding programs, changed focus in barley, appointment of feed wheat breeder, continued support for sorghum and maize.

Issues for feed grains and intensive livestock industries

(i) Feed grains Demand Growing
(ii) Improving Productivity
(iii) Climate Change and Implications
(iv) Water Balance
(v) Feed grains and Fodder
(vi) Sorghum
(vii) Future Issues
- Industry view
- Feed grain quality
- GM grains
- Logistics

(i) Feed grains demand growing

Figure 1 Queensland Gross Value of Production 2003-04 -- $billion



Using DPI & F data on the farm gate value of Queensland agriculture the combined grains and intensive livestock value chain is close to one quarter of the total value at approximately 2.5 billion dollars.

Figure 2. Cotton industry has made significant increases in production

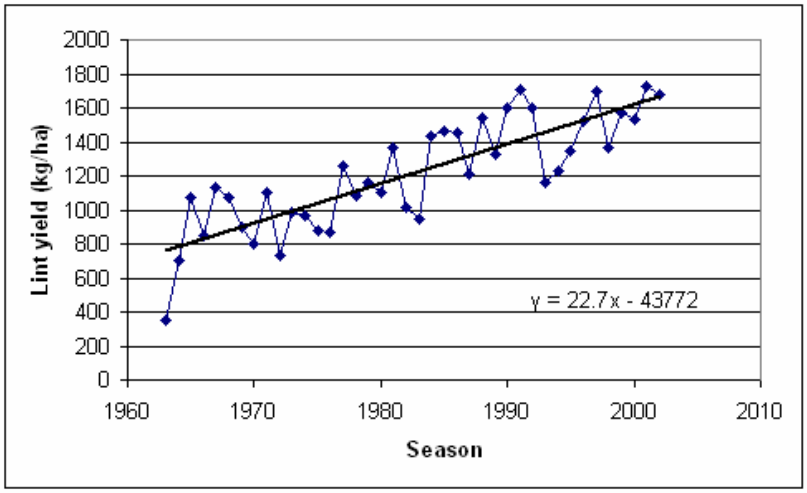
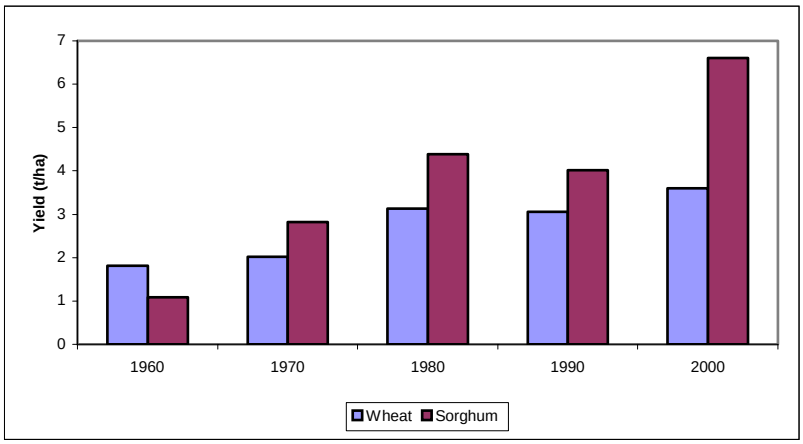


Figure 3. Grain Crop yields have increased (sorghum but not wheat)



(ii) Improving productivity

Information presented at the 2004 Crop Science congress indicated that a combination of factors would contribute to future yield improvements of crops.

Table 1 Relative contribution to yield improvements to 2015

Breeding	45%
Soil and Water Management	25%
Insect management	20%
Disease Management	10%

Source: (Constable, Crop Science Congress 2004)

(iii) Climate change and implications

- **Climate change scenarios**
  Predict 1.24 degrees warmer by 2030
- One of our great challenges will be making more efficient use of water and coping with temperature increases.
- In Queensland we are seeing

  - Water resources further stressed
  - Decline in annual rainfall
  - Less runoff
  - More frequent and severe droughts
- Decline in annual rainfall
- Less runoff
- More frequent and severe droughts

(iv) Water balance

What does this mean about the types of crops we grow?

Water balance components – Data taken from long term data on a property near Dalby SE Qld looking at various annual cropping options.

Rotation	Annual Rainfall (mm)	Runoff (mm)	Evaporation (mm)	Transpiration (mm)	Drainage (mm)
Annual Wheat	620	73	370	134	13
Annual Sorghum	620	64	340	210	8
Opportunity Cropping (Sorghum/wheat)	620	69	347	206	1
Irrigated Cotton (Estimates)	*620+600*	*70+*	*400+*	*600+*	*100-200*

(v) Feed grains and Fodder –
What is DPI & F Plant Science doing currently to address feed grains deficit?

- New wheat breeder, Rex Williams, focusing on yield and disease resistance
- Focus on feed barley as part of Barley Breeding Australia (new breeder commencing in July 2006)
- Sorghum: 50 male and female lines licensed to seed companies so far this year. Includes new ergot-resistant segregating lines for breeding. DPI&F germplasm in all grain sorghum varieties (midge resistance, staygreen, yield, ergot resistance)
- Forage cultivars: Oat lines QA2 and QA3 released to Heritage Seeds. Commercial seed available 2007.
- Tropically adapted maize and sweet corn NQ

(vi) Sorghum – a multi faceted approach involving research, modelling and farming systems

- **Core Breeding** -- Implementing molecular marker technologies for ergot and genetically diverse sources of midge resistance, yield (and other traits) together with commercial seed companies
- **Crop Physiology** – genes for drought resistance
- **Crop Protection** – ergot resistance, midge resistance, rutherglen bugs, IPM adoption, weed science
- **Crop Modeling** -- Use APSIM (Systems Modeling Technology) to breed varieties specifically for production systems and management practices -- gene to phenotype, rapid genetic advance, integrated genomics, plant structure and function
- **Sustainable Farming Systems**
- **Soil Health**
- **Water Use Efficiency**
- **Grain storage**

(vii) Future Issues

- Beef Industry view *versus* Grains industry view
- Feed grains quality
- GM grains
- Logistics

iii. Feedlot sector perspectives

Mr. Des Rinehart, Project Manager Feedlots, Meat & Livestock Australia

Priority Issues for MLA Feedlot Program:

- Feed stuff security is a serious issue – especially grain
- Alternative feedstuffs (Distillers grain)
- Superior feedstuffs
- Rapid tests of grain quality

Areas to address

(i) Breeding specialist feed grains varieties
- address agronomic requirements – disease resistance etc
- Yield, Yield and more Yield

(ii) Starch not readily available in sorghum unless processed

(iii) Development of rapid NIR tests for grain quality
- Concerns about cost and maintenance of calibrations across diverse range of individual operations
- Energy value of grains and mixed diets – Net Energy more use than Metabolisable Energy

- Workshop held August 2005 – Brisbane
  - R&D Committee
  - Other operators
  - Industry consultants – vets, nutritionists, environmental

- Additional consultation
  - R&D provider organisations
  - All accredited feedlots

- No significant changes as a result of feedback from accredited feedlots

- Final approval – May 2006
  - ALFA Council
  - MLA Board

Future for Feedlots

- Capacity increasing at 7 – 8% per annum
  - Current capacity >1 M head
  - Likely to be maintained going forward

- Future extent of industry limited by
  - Availability and access to water
  - Grain and cattle supply constraints
  - Labour supply constraints
  - Environmental considerations
  - Impact of fuel prices

Priority Issues

- Feedstuff security – especially grain
- Alternative feedstuffs
  - Distillers grain
- Superior feedstuffs
- Rapid tests of grain quality

Feedstuff Security

- Remains number 1 concern (particularly in Qld)
- Current situation – 1 in 3-4 years deficit in SQ & NNSW
- Exacerbated in future
  - Climatic variability
  - Environmental pressures
  - Cost pressures
  - Increased competition
- Need to work closely with grains sector to address structural issues
  - Transport
  - Import protocols

Superior feedstuffs (grain)

- Recognition of feed grain users as a legitimate customer
  - Currently seen as a market of last resort for grains that have been bred and grown for the premium human consumption markets
  - Development of specialist feed grain varieties
  - More targeted perspective to breeding programs

Areas to address

- Breeding specialist feed grain varieties
  - Address agronomic requirements – disease resistance, etc.
  - Basic minimum requirements for energy and protein
  - Yield, Yield and More Yield

- Specific problems associated with sorghum
  - Starch not readily available unless processed

- Development of rapid NIR tests of grain quality
  - Concerns about cost and maintenance of calibrations across diverse range of individual operations
  - Energy value of grains and mixed diets – NE rather than ME

APPENDIX E – Presentations from Animal and Plant Science, DPI&F and Research Groups and Stockfeed Manufacturers

(i) How do we describe and measure quality?

i. Dr Mike Tavener, GRDC, Pork CRC and Premium Grains for Livestock Project

Key Issues

- A number of key NIR calibrations have been determined to measure feed quality
- Measures are different for different livestock species
- Yield is still the driving force but scanning of a wide range of samples indicates there is no negative correlation between yield and the "energy" traits measured.
- Both digestible energy and intake impact on livestock production and they do not seem to be closely correlated
- Intake is particularly important for pork and poultry industry.
- Current trading parameters for feed grains bear little relationship to available energy content of the grain but do impact on the processability of the grain
- Screening for breeding or selection is one thing but we need a trading standard if it is to be fully adopted – it is up to industry to validate robustness for commercial use.

Broad Program Objectives

- Improve marketing opportunities for grain growers & the reliability of feed grain quality for the animal industries
- Rational basis for trading livestock grains based on rapid measurement of quality and assessment of economic benefits
- "A fair system for growers and end-users"

Research Goals

- Understand the factors determining nutritional value of cereal grains for different animal types
- Improve Nutritional Value through breeding, processing, & storage
- Develop rapid methods for measuring determinants of grain quality
- Computer programs to predict animal performance and the economic value of grains
- NIR and other rapid methods for measuring energy availability content and intake
- Rapid methods for predicting the response of grains to processing
- Determine the nutritional value of sprouted grain (other weather damaged grain)
- Selection criteria and breeding objectives for plant breeders
- A ruminant model for feedlot cattle industry

Premium Grains for Livestock Program 2 - Deliverables 2

- A process for improving the pelletability of sorghum based feeds
- Comprehensive database of grain characteristics
- Recommendations for grains to plant
- Potential increase in marketing opportunities
- Information on nutritional value of grains for humans
- A process for the rational trading of grains

Premium Grains for Livestock Program

Procedures

- Collected > 3300 cereal grains varying widely in nutritional value – wheat, barley, oats, triticale, sorghum
- NIR, chemical, physical & microscopic evaluation
- *In vitro* evaluation - rumen fermentation, enzyme 'intestinal' digestion
- > 190 grains fed to animals - Sheep, cattle, pigs, broilers, layers

- Investigated several processing and storage techniques to improve nutritional value
- Ruminant model for feedlot cattle
- Definition of the energy value of grains for animals

Cereal grains are fed to livestock as a source of energy

- Available (digestible energy) content (MJ/kg)
- Intake (kg/d) influenced by rate of passage
- Available energy intake (MJ/d) – total energy available for metabolism

Total available energy expressed as:
DE in pigs; AME in poultry; ME in ruminants

Variation in the available energy content of cereal grains for different animal species *(MJ/kg DM)*

	Wheat	Barley	Oats	Triticale	Sorghum
Sheep	12.7-13.7	11.5-13.9	11.2-15.7	12.3-13.4	13.6-14.3
Cattle	12.2-13.1	12.2-13.2	10.8-13.4	12.9-13.2	10.2-13.1
Pigs	12.4-15.0	10.6-14.7	12.3-16.5	-	15.5-16.6
Broilers	12.4-15.6	11.2-13.7	12.6-14.6	11.0-14.6	15.2-16.5
Layers	13.1-17.1	11.0-14.8	12.7-16.4	11.6-14.4	15.5-16.3

The amount of energy in the grain is only part of the story. Need to know how much energy the animal takes in.

Total Available Energy Intake from Barley – Productive energy
Total available energy intake (MJ/d) = Available energy content of grain (MJ/kg) x Grain intake (kg/d)

- There was little relationship between available energy content and grain intake for any animal type studied

These poor correlations indicate that characteristics of a grain that influence digestion are either not the same as those that affect voluntary feed intake or they have a different magnitude of effect on feed intake.

- If voluntary intake was reduced by 4% due to source of grain in diet, this would increase period by 1 day and cost 4c/bird ($2m/yr for an operation of 1 m birds/wk)
- Estimates of over 20% differences in voluntary feed intake have been reported between different sources of wheat and sorghum

Desired characteristics for breeding wheat, barley & triticale for pigs & poultry

- Thin, fragile endosperm cell walls
- Low arabinoxylan and ß-glucan content
- Low whole grain viscosity – for poultry
- Soft grains, high water holding capacity
- Low hull content

Desired characteristics for breeding wheat, barley & triticale for ruminants

- Thick, intact endosperm cell walls
- High arabinoxylan content
- High whole grain viscosity
- Low acidosis index
- Hard grains *(to reduce rate of water uptake)*
- Low fibre & hull content
-

Desired characteristics for oat grain for ruminants are:

- High *in sacco* digestibility
- Low hull content

Desired characteristics for sorghum for cattle:

- Increased digestibility of kafirin proteins through selection for low S:N ratio
- Protein matrix with non-continuous encapsulation of starch granules
- Waxy endosperm

Desirable characteristics for sorghum for pigs and poultry:

- Increased digestibility of kafirin proteins through selection for low S:N ratio
- Protein matrix with non-continuous encapsulation of starch granules

What can be measured by NIR?

Calibration type	**Calibration accuracy**
Ruminants	
Sheep DM Digty (%)	Excellent
Cattle ME *ad libitum* (MJ/kg)	Good
Starch in faeces	Excellent
Acidosis index	Quantitative
Herbivores	
Whole oats 48 hr in sacco DMD (%)	Good
Hull lignin (%)	Quantitative
Hull % whole grain	Good
Pigs	
Faecal DE (MJ/kg)	Good
Ileal/Faecal DE ratio	High-Low
DE intake index (0-100)	High-Low
Broilers	
AME (MJ/kg)	Good
AME intake index (0-100)	Quantitative
Layers	
AME (MJ/kg)	High-Low
AME intake index (0-100) Poor	

Calibration type	**Calibration accuracy**
Chemical component	
Crude protein (%)	Excellent
Crude fat (%)	Excellent
ADF (%)	Excellent
NDF (%) Quantitative Starch (%)	Excellent
ß-glucans (%)	Excellent
Total insoluble NSP(%)	Excellent
Xylose (%)	Excellent

Can this be done using current technology?

Portability of NIR calibrations

- A comparison across 9 NIR instruments for in vivo DMD sheep, starch, CP, Lysine, Total insol NSP, CF, NDF & ADF
- Instruments varied in accuracy depending on measurement made
- Highest accuracy – Foss 6500 & Bruker
- Lowest accuracy – Bran & Luebbe & crop scan:
- Foss Infratec - intermediate
- Loss in accuracy significant, but relatively small

Premium Grains for Livestock Program - CASE studies

1. ABB
2. Ridley
3. Ingham
4. QAF
5. GrainSearch

ii. What is feed quality? Can we select/breed for feed quality?

Glen Fox, Plant Science, DPI&F, Toowoomba, Qld

Key Points

- In barley up to 13% difference in calculated ADG (Average Daily Gain) has been measured between commercial varieties – for ruminants.
- NIR provides a robust tool for selecting feed quality, still have a lot to learn

Results to date

- Selection for feed quality
- Assessing for feed quality (NIR)

The following table outlines the difference between a number of commercial barley lines for a range of "feed quality" parameters and a predicted average daily gain using a formula developed by Montana State University in their feed lot program.

		Measured					Predicted	
Genotype	Type	DM	ADF	Starch	DMD	PS	NE	ADG
Best Line	?	91.2	3.9	58.5	31.6	1,391.0	2.54	1.66
Lindwall	Malt	91.5	3.9	56.7	33.0	1,225.9	2.51	1.66
Tallon	Malt	91.4	3.6	57.7	33.3	1,252.9	2.51	1.66
Mackay	Feed	90.2	4.1	61.3	40.4	1,221.8	2.44	1.56
Valier	?	91.1	3.8	59.1	40.4	1,221.8	2.44	1.56
Binalong	Feed	91.8	3.9	57.0	39.1	1,293.6	2.44	1.58
Grimmett	Malt	91.6	3.7	59.3	41.8	1,253.5	2.42	1.54
Gairdner	Malt	91.0	4.0	57.6	45.5	1,287.4	2.36	1.49
Worst Line	?	91.7	3.4	59.2	50.5	1,244.2	2.32	1.44
Range (%)		5	27	10	37	13	9	13

NIR Feed Calibrations (PGLP# & DPI&F*)

- Starch#*, Fibre#*, NSP#, hardness*, ISDMD*
- ME#*, DE#, AME#
- Predicted on barley and wheat ME (> 3000 samples / 250 genotypes) (PGLP wheat only)

Results to date

- Environmental effects
- Genetic variation
- Heritable traits

Summary

- Difference in feed quality for barley measured using in-sacco methods with differences in predicted average daily gain up to 13%.
- NIRS provides robust tool for selecting feed quality

iii. Possible roles for NIRS to evaluate and /or investigate feeding value of grains

Dr. Rob Dixon, Animal Science, DPI&F, Rockhampton, Qld

Key Points

- NIRS analysis of faeces of ruminants (faecal NIRS) has been developed to measure the diet selected by grazing ruminants.
- There appears to be little reason to develop faecal NIRS to measure characteristics of grain-based diets.
- Faecal NIRS could have roles to measure starch in faeces, for monitoring nutrients in waste from intensive animal operations, and for understanding variation in the nutritive value of various grains

1) Using NIRS spectra of grains to measure chemical or functional or nutritional characteristics.
This is the most common application of NIRS for grains - and likely to continue so.
Premium Grains Project, etc.

2) Using NIRS spectra of faeces to measure characteristics of that faeces e.g. content of starch, N, P, Some other minerals in faeces.
   - Straight-forward application of NIRS technology.
   - Equipment and calibrations have been developed for effluent management, compost quality.
   - Possible to use economical & portable diode array instruments.
   - May have application to investigate / monitor effectiveness of grain processing on starch digestion (particularly sorghum).

3) Using NIRS spectra of faeces to measure characteristics of the diet fed to the animal.
   - This technology has been developed for grazing cattle.
   - Current calibrations are primarily for forage diets.
   - Limited calibrations have been developed for mixed forage – grain diets.
   - In the situation where animals are in pens and the diet can be reliably sampled -- Is there any advantage to NIRS analysis of faeces rather than feed?

4) Using differences between the NIRS spectra of feed and faeces to predict DM and OM digestibility of The diet.
   - One study where forage and forage / concentrate diets were fed to cattle.
   - Showed that a calibration could be developed between the (Feed – Faeces) NIRS difference spectra and the DM and OM digestibility of the diet.
   - R2cal = 0.83, SEC = 2.9 % units, SEP = 1.9 – 3.3 % units.
   - This may provide a rapid method to rank samples of grain for DM digestibility.

5) Using differences between the NIRS spectra of feed and faeces to understand digestion of the forages by the ruminant.
   - Objective -- to add to quantitative understanding of the processes of digestion of forage.
   - NIRS is measuring relative proportions of C-H, N-H and O-H bonds.
   - Possible to identify regions of the spectrum which are associated with known groups of constituents. Since regions may be associated with low or high apparent digestion can therefore associate digestion with constituents.
   - Application to understanding digestion of grains?

iv. How do we describe/measure feed grain 'quality' attributes?
Current grain standards - what are they, what do they mean, how applicable are they?

Dr. Neil Gannon, Ridley Agri Products, Toowoomba, Qld

Key Issues from presentation:
- Livestock industries need relevant and rapidly measurable quality parameters (current grain trading standards do not reflect ration formulation needs).
- Requires a change in breeding, agronomic and trading parameters.
- In some cases, premiums may be paid, in other cases having a market for the grain may be the reward.
- Providing segregation for quality may be one of the big challenges.
- Pipe dream may be to buy on MJ/ha.

What are feed manufacturers looking for?
- Available all year round
- Sole use for animal feed
- Consistent in quality
- Safe to feed
- Chemically, Microbiologically and Metabolically
- Easily processed
- Value for money

Is a wide range of ingredients available but the ingredients are only a means to an end.
The current grain trading standards are not aligned with what the diets are formulated on.
Quality parameters as measured on farm have no bearing on feeding quality.

What nutritionists formulate on:	**What grain is traded on:**
• Energy – MJ (DE or ME for each species) • Available amino acids eg. lysine, methionine, threonine • Fat • Fibre • Available minerals • Phytate level • Pelletability indices • Palatability factors	• Being a sorghum/ wheat etc • Moisture (+ protein?) • Test weight • Total Admixture • Foreign material • Screenings • Trash • Defective grains • Seed contaminants • Other contaminants

- Are largely looking for energy which can vary between grains (eg wheat, barley, sorghum) and between loads of the same variety.
- Some grains have more available energy than other grains for different animal types.
- Processing also an issue. Ability of grain to form a durable pellet impacts on production, also the time and energy taken to form the pellet. I.e. can make good durable pellets with sorghum but throughput very slow and lot of time and energy required which means it is costly. (Graph presented)
- The variation means that it is something that could be improved?
- Protein can also be highly variable both within and across months and seasons and between seasons (as much a 6% protein variation in sorghum).
- Moisture content also varies and despite a limit of 2.5% often higher which results in potential mould and storage issues.

Value is determined by least cost formulating which considers all aspects of:
- Raw material availability
- Inclusion levels

- Ability to supply nutrients.

The feed industry does not set grain prices. We are predominantly price takers.

The crucial costing is the $/MJ of energy available to animal.
Although the price of sorghum per units of energy may be good due to the cost to make it available for the ruminant animal the cost is $10-15 higher than wheat. (Graph presented).
A lot of talk in the past about breeding for traits such as lysine but the cost of synthetic lysine is so much cheaper not worthwhile.

Summary of what they want.

- Livestock industries need relevant and rapidly measurable quality parameters
- Requires a change in breeding, agronomic and trading parameters
- In some cases premiums may be paid, in others the fact that there is a market for the grain may be the reward
- Segregation on these new quality parameters may be the biggest challenge
- Pipe dream may be to buy on MJ/ha !

APPENDIX F. Feedback Sheet

Department of Primary Industries & Fisheries' Feed Grains Workshop Feedback Form

Please fax form to Kym McIntyre at (07) 4660 3600
or
E-mail to kym.mcintyre@dpi.qld.gov.au

1. Please indicate (by circling) the organisation you represent.

Organisation	Grains Industry	Livestock Industry	DPI&F	Other/ Nominate

2. The following issues were identified by participants at the Feed Grains Quality Workshop, 16 June, 2006. Please indicate the level of importance which you believe addressing the issue would have in order to improve the profitability of your business or industry?

Issue	**Low Priority**					**High Priority**
Winter feed grain crop (eg wheat, barley) Higher yielding varieties with improved $ returns	**1**	**2**	**3**	**4**	**5**	**6**
Fix sorghum Eg. Increase and stabilise yield, improve digestibility of starch, improve ability of grain to absorb water during processing, decrease variability in grain size	**1**	**2**	**3**	**4**	**5**	**6**
Develop NIR Standards to determine nutritive value Must be accessible and reportable, quick and reasonably priced, simple and robust	**1**	**2**	**3**	**4**	**5**	**6**
Improve agronomy of current crops (especially winter cereals) Develop packages to support varietal work, water use efficiency	**1**	**2**	**3**	**4**	**5**	**6**
Develop standards for feed grain trading	**1**	**2**	**3**	**4**	**5**	**6**
Improve signals for market value • What determines profitability? • Address any stigma about producing feed grain as opposed to food grain	**1**	**2**	**3**	**4**	**5**	**6**
Produce viable alternative crops • Peas, millet etc.	**1**	**2**	**3**	**4**	**5**	**6**
Encourage contracts • Supply chain arrangements and marketing signals	**1**	**2**	**3**	**4**	**5**	**6**
Logistics of moving grain • Within Australia and from overseas.	**1**	**2**	**3**	**4**	**5**	**6**
Segregation of feed grains	**1**	**2**	**3**	**4**	**5**	**6**
Genetic Modification	**1**	**2**	**3**	**4**	**5**	**6**
Silage • More information and variety development	**1**	**2**	**3**	**4**	**5**	**6**
Storage • Short and long term • Insect control, mycotoxins	**1**	**2**	**3**	**4**	**5**	**6**
How to prioritise options for improvement	**1**	**2**	**3**	**4**	**5**	**6**

Communication and Education • Through GRDC, CRC	**1**	**2**	**3**	**4**	**5**	**6**

3. Are there any other issues that you believe should be included?

4. What was the most important 'take home message' for you from the workshop?