Wheat inspection at first point of sale and downstream: A study of the major exporting countries

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World’s Major Wheat Exporting Countries
(69.7%, 2007-2008, USDA Ag Statistics)

Argentina (9.6%)
Australia (7.6%)
Canada (13.4%)
United Kingdom, France and other EU (8.6%)
United States (30.5%)
## Comparing the Countries
### Methods in Inspection

<table>
<thead>
<tr>
<th>Method</th>
<th>U.S.</th>
<th>Canada</th>
<th>Australia</th>
<th>France</th>
<th>U.K.</th>
<th>Argentina</th>
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Comparing the Countries
Wheat Classes and Grades

<table>
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<th>Attribute</th>
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<th>Australia</th>
<th>France</th>
<th>U.K.</th>
<th>Argentina</th>
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<td>Classes</td>
<td>6</td>
<td>8(W), 8 (E)</td>
<td>9</td>
<td>1?</td>
<td>1</td>
<td>3</td>
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<td>Grades per class</td>
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<td>3-5 (W), 2-3 (E)</td>
<td>2-3</td>
<td>4</td>
<td>2</td>
<td>3</td>
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</tbody>
</table>
United States
Quick Facts

• Six pure classes (HRS, HRW, SRW, HWW, SWW, Durum)
• Six grades (No. 1, 2, 3, 4, 5, sample)
United States
Wheat Official Inspection

Diagram:
- Work sample ~1,000 g
- Ergot (1000 g)
- 1st cut
- 2nd cut
- 3rd cut
- 4th cut
- 5th cut
- 6th cut
- Class
  - Wheat of other classes
  - Contrasting classes
  - Subclass (15 g)
- Smut (250 g)
- Foreign Material
  - Heat-Damage (60 g)
- Shrunken & Broken (250 g)
- Damaged kernels (15 g)
Kernel Visual Distinguishability was replaced in August 2008 with a Declaration system.
Canada

Variety Eligibility Declaration (VED) System

• Wheat varieties still registered by Canadian Food Inspection Agency (CFIA).
• New lines still undergo 3 years of crop performance trials.
• Resemblance within class criterion no longer required.
• Variety of grain lot is declared at country elevator.
Canada
Concerns Leading to Abandonment of KVD

• Varieties within the same class but having different functionalities.
• Difficulty for breeder to select for desirable trait (e.g., disease resistance) while maintaining same appearance.
• “Sneaking in” of unclassed varieties possessing visual characteristics that are common to a class (e.g., US Wheat)
Canada
VED Features

• Nine Western Wheat Classes

  – Canada Western Red Spring (CWRS)
  – Canada Western Amber Durum (CWAD)
  – Canada Western Red Winter (CWRW)
  – Canada Western Extra Strong (CWES)
  – Canada Prairie Spring Red (CPSR)
  – Canada Prairie Spring White (CPSW)
  – Canada Western Soft White Spring (CWSWS)
  – Canada Western Hard White Spring (CWHWS)
  – Non-milling class (for ethanol or feed)
Canada
VED System Compliance

1. Legislated fine system for false declarations.
2. Litigation through court system.
Canada
VED System Analytical Check Procedure

- Single kernel HPLC
- Single kernel PCA
- Composite sample PCA
Canada
Canada Grain Act (2005) – Responsibilities of CGC

- Establish and maintain standards of quality for Canadian Grain
- Regulate grain handling in Canada
- Ensure a dependable commodity for domestic and export markets
Canada
Wheat Inspection Procedure

1. For each load delivered, draw 1-2 kg by pneumatic probe in truck, manual scoop during unloading, or a diverter sampler.

2. Use Boerner divider to obtain a ≥ 900 g ‘official’ sample or ≥ 750 g ‘unofficial’ sample.

3. Clean sample for grade using Carter dockage tester and record dockage to nearest 0.1%.
4. User Boerner divider on cleaned sample to obtain a representative portion that is dependent on contaminant or damage condition under examination.

5. Perform visual analysis of portion.

6. Inspection for export has larger size and more stringent damage and contaminant criteria than inspection for inland use.
Canada
Wheat Grade Factors: Foreign Material

- Ergot
- Excreta
- Matter other than cereal grains
- Sclerotinia
- Stones
Canada
Wheat Grade Factors: Damage

• Artificial Stain
• Dark, immature
• Degermed
• Fireburnt
• Fusarium damaged
• Grass green
• Grasshopper, army worm

• Natural stain
• Pink
• Sawfly, midge
• Shrunken and broken
• Smudge and blackpoint
• Sprouted
• Heat
Canada

Wheat Inspection: Non-visual criteria

- Test Weight
- Protein content by NIR (for some western classes)
Canada
Wheat Inspection: Grades

- Western wheats = up to 5 classes + feed class
- Eastern wheats = 3 classes + feed.
Australia
Alphabet Soup

- **AWB** = Australian Wheat Board
- **WEA** = Wheat Exports Australia
- **GRDC** = Grain Research and Development Cooperation
- **IEG** = Industry Expert Group
- **NACMA** = National Agricultural Commodities Marketing Association
- **GTA** = Grain Trade Australia
Australia
1989 Wheat Marketing Act

- Australian Wheat Board given authority to purchase wheat from growers, with two stipulations:

  1. The Board was required to purchase grain when tendered.
  2. The grain had to meet the Board’s standards.
Australia
Wheat Export Marketing Bill 2008

AWB
(single desk marketer and inspector)

WEA
(regulate and accredit private exporters)

Effective July 1, 2008
Australia

Why the change in role of AWB, Ltd.

• Enhance competitiveness of Australian wheat in world marketplace.

• Improve profits for growers and downstream marketers.
Australia

AWB
(responsible for standards)

GTA
(formerly NACMA)

Effective July 1, 2008
Australia

Roles starting in 2008

- Research and Development – GRDC
- Wheat Breeding, later stages – non-GRDC
- Wheat Variety Classification – GRDC
- Wheat Receival Standards – GTA
- Production and Export Statistics – ABARE
- Technical Market Support – private industry
- Promotion and Branding – private industry
- Trade Advocacy – National government
Australia

Nine major marketing classes

- AGP – Australian General Purpose
- AH – Australian Hard
- ADR – Australian Durum
- APH – Australian Prime Hard
- APW – Australian Premium White
- ASW – Australian Standard White
- ASWN – Australian Noodle
- SOFT = Australian Soft
- FEED = Australian Feed
Australia
Wheat Grades

**AGP1** - Various Varieties except FEED (General Purpose Grade)
**ANW1** - Australian Standard White Noodle Varieties
**ANW2** - Australian Standard White Noodle Varieties
**APH2** - Australian Prime Hard Varieties
**APW1** - Australian Premium White Varieties
**APW2** - Australian Premium White Varieties
**ASW1** - Australian Standard White Varieties
**AUH2** - Australian Hard Varieties (Utility Grade)
**AUW1** - Various Varieties except FEED (Utility Grade)
**DR1** - Australian Durum Varieties

**DR2** - Australian Durum Varieties
**DR3** - Australian Durum Varieties
**FED1** - Various Varieties (Feed Grade)
**H1** - Australian Hard Varieties
**H2** - Australian Hard Varieties
**HPS1** - Australian Hard Varieties (High Screenings, High Protein Grade)
**PNC** - Cadoux variety
**PNE** - Eradu variety
**PWT** - Australian Korean Noodle Blend Varieties
**SFE1** - Australian Soft Varieties
**SFT1** - Australian Soft Varieties
**SFW1** - Various varieties (Stockfeed Wheat Grade)
Australia
Inspection Measurements

• Moisture content by oven or NIR
  – grade will specify maximum (e.g., 12.5%)
• Protein content by combustion or NIR
  – grade will specify range (e.g., 13.0% - higher)
• Test weight
  – grade will specify minimum (e.g., 74 kg/hL)
• Falling number
  – grade will specify minimum (e.g., 350 s)
Australia
14 Wheat Contaminants

• Pickling compounds
• Non-app. chemicals
• Foreign seeds
• ergot
• Objectionable matl.
• Non-obj. matl.
• earth

• Sand
• Stored grain insects
• Earcockle
• Field insects
• Snails
• Loose smut
• Bread wheat kernels in durum wheat
Australia
14 Wheat Defects

- Sprouted
- Stained
- Dry green, sappy
- Heat-damaged
- Black field fungi affected
- Grain drying influen.
- Staining, moist plant
- Takeall affected
- Non-vitreous kernels
- Rotted
- Ball smut affected
- Insect damaged
- Loose smut
- Pink stained
Australia
Sampling and Inspection

3 probe locations in bin for 3 L, plus 1 L for every 10 tonnes extra

3 liter

- screening and manual inspection
  - 0.5 liter

- moisture & protein analyses
  - 0.5 liter
Australia
Screening and manual inspection

• ‘Overs’ of screening (12.7 mm x 2.0 mm slots) visually examined
  – 30 to 60 seconds for typical lots.
  – Up to 5 minutes for cases in which category level requires quantification (using a 300-grain tray)
European Union
(France and United Kingdom)

- Price support (‘intervention’) system for major grain species, including bread wheat, durum wheat, barley, maize, and sorghum.
- Grain taken in by intervention must meet standards ratified by the Commission of the European Communities (EC).
European Union
Standards for Intervention - Damage

- Broken
- Shriveled
- Discolored
- Overheated
- Sprouted
- Decayed
- Insect-damaged
European Union
Standards for Intervention- Contaminants

- Extraneous seeds
- Husks
- Ergot
- Dead insects & fragments
- Other cereals
- Extraneous matter
European Union
Standards for Intervention- Analytical

- Moisture content minimum
- Protein content minimum
- Falling number minimum
- Zeleny sedimentation volume (durum only)
United Kingdom
Home-Grown Cereals Authority (HGCA)

• Branding system for exported wheat (estab. 2004)
  – **UKP** = Blend of semi-hard varieties for breadmaking.
  – **UKS** = Blend of soft extensible varieties for biscuit making.

Analytical Measurements for Brand

• Protein content range
• Alveograph W
• Alveograph P/L
France
Four wheat classes

E = corrective (5% in 2008)
1 = superior breadmaking (47%)
2 = standard breadmaking (39%)
3 = other uses (9%)

Analytical Measurements for Class

• Protein content range (all classes)
• Alveograph W (E, 1)
• Falling number (E, 1, 2)
Argentina
Programa Nacional de Calidad del Trigo (PRONACATRI)

• Begun in 2004, new wheat varieties pass through a coordinated trial program. Classified into 3 groups, depending on (in order of importance) –

  – Alveograph W
  – Loaf volume
  – Flour yield / ash content ratio
  – Farinograph dough stability
  – Wet gluten content
  – Protein content
  – Test weight

**Group 1** – extra strong for blending and baking (29% in 2007)

**Group 2** – traditional methods of baking, > 8 hr fermentation time (47%)

**Group 3** – direct methods of baking, < 8 hr (16%)
Argentina
El Servicio Nacional de Sanidad y Calidad Agroalimentaria (SENASA)

• Export wheat divided into 3 grades, 1 (best) to 3.

  Analytical Methods for Grade
  - Test weight

  Analytical Methods for Price
  - Protein content (Grade 2 is basis,
The Common Denominator
(Argentina, Australia, Canada, EU, USA)

Manual Inspection
Newer Technologies
Digital Imaging Research

- Kernel morphology for wheat class and impurities in 1980s
- Kernel color
- Kernel texture
- Kernel vitreosity
Newer Technologies
Commercial Imaging Instruments

- **Acurum® - DuPont Canada**
  - Approx. 100 kernels/second, successful application in determining percentage of hard vitreous durum kernels.

- **Cervitec® - Foss**
  - Approx. 700 kernels/minute, train using neural network algorithms for condition of interest
Newer Technologies

Hyperspectral Imaging (= imaging + spectroscopy)

• Reported
  – Fusarium-damaged wheat kernels
  – Differentiation of mold species (Penicillium, Aspergillus, Fusarium)
  – Black point, field fungi, pink stain
  – Hard vitreous kernels

• Planned
  – Milling yield
Hyperspectral Imaging System

Field of View (FOV)

Spectrum of the corner point

Intensity distribution of each spectral channel

Line-scan CCD

Spectral Dimension
Black Tip Fungus: Official Grade Criterion

“Kernels affected by black tip fungus to the extent that the resulting discoloration extends beyond the germ and continues around at least one cheek and into the crease, thus forming a continuous band that extends around the cheek.”

Source: USDA-GIPSA – Visual Reference Images, Interpretive Lines
Reflectance Spectra of the Wheat Kernels

![Graph showing reflectance spectra of wheat kernels.](image)
High-Speed Optical Sorting

Routine Optical Sorting (White vs. Red)

Currently Investigated Scab vs. Normal
One-pass Sorting: Regular Samples

Sample, ordered from lowest (top) to highest (bottom) incoming DON concentration.

- DON (mg/kg)
- Sample concentration
- Accepts
- Rejects
- Before sort
Idealized Regression Analyses for Bichromatic Sorting

Parameters for Discrimination

- **Slope:** encapsulates relationship between green and red light reflectance.

- **r^2:** relates to texture of kernel surface (0 = roughest, 1 = smoothest).
Alternate Technologies

- Electronic Noses
  - Alpha MOS (France)
  - Electronic Sensor Technology (USA)
- X-ray Imaging for internal insects
  - Operator-assisted
  - Unattended
- ELISA for mycotoxins or insect activity
- PCR
Future Trends

Declaration

Electronic Records

Wheat Quality

Objective Methodologies
(to keep the system honest)
Thank You