Food grain for the world: USA & Aus

Export: 220 million ton
Feed: 790 million

Export: 40 million ton
Feed: 144 million

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Resistance: USA & Aus

Resistance a threat to global food supply (grain)
Until now, Aus has been #1 in herbicide resistance.

Why?
1850 onwards
140 million sheep
SHEEP belt
• Genetically-diverse
• Cross-pollinated (wind)

*Lolium* seeded & nurtured across half a continent when the sheep was king

• Short seedbank life
• Huge pop’s over vast areas
1970>

Sheep/wool prices dropped
Switch to wheat

No tillage, no crop rotation, no herbicide rotation, no diversity & low rates
ACCase & ALS multiple resistance

Legend
- Red: Resistant
- Orange: Developing
- Green: Susceptible

25 million acres

98% of pop’s resistant
Multiple resistance in *Lolium*

- Genetically diverse, huge pop’s treated at low herbicide rate = many survivors
- Obligate cross-pollination
  - Enrichment & accumulation of resistance genes among survivors

= rapid resistance evolution
Multiple herbicide resistant *Lolium* 2012

- Across Aus, susceptible *Lolium* is now RARE
- Multiple resistance across several herbicide chemistries/mode of action is common

*Multiple herbicide resistant Lolium* shattered any view of herbicide invincibility & forced diverse integrated control.
GLYPHOSATE BELT
Time is running out

Glyphosate: The world’s greatest herbicide.

So good.

So easy to over-use.
GLYPHOSATE
 driven to failure
 on big “driver”
 weeds
Still a window of opportunity to act in the mid-West & elsewhere to save glyphosate.
Resistance can be successfully managed
1. Recognising reality

- Recognition in ALL sectors: herbicides ALONE not sustainable

- USA history: resistance problems easily fixed!
  - Use alternative herbicides
  - All creativity is in herbicide technology

- USA: lamentably, widespread herbicide failure before illusion of invincibility shatters
2. Finding solutions

- DIVERSITY of weed control strategies needed for sustainability
- Creativity in development of strategies
- Identify weed biological weaknesses
  - Seed bank longevity?
  - Seed dispersal
3. Tailoring solutions

- Workable solutions will differ
  - Region to region
  - Enterprise to enterprise
  - Farm to farm
  - No single solution!!

- **But, common principles**
  - Smart crop & herbicide choices, sensible non-herbicide tools
What has worked in Aus

- Herbicide diversity & rotation
- Mandatory mode of action labelling
- Full dose herbicide mixtures
- Double knock
- Disruptive rotations
- Competitive crops through good agronomy
  - Seeding rate, row spacing, fertilizer placement etc.
- Late season weed seed control
Late season weed seed control

Multiple herbicide resistant annual weeds widespread & serious in Aus

- Annuals, persist from a viable seed bank
- Herbicides to minimise weed seed production
  - Pasture topping, crop topping, etc.
- Non-herbicide tools to kill weed seeds

Aus is **unique** in widespread use of tools to destroy weed seed
Harvest weed seed control

- Biological weakness: mature seed do not shatter before grain harvest
Weed seeds at harvest

Majority of weed seeds exit in the chaff fraction
# Target seed production at harvest

<table>
<thead>
<tr>
<th>Weed species</th>
<th>Retained seed* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Lolium</em></td>
<td>88</td>
</tr>
<tr>
<td><em>Raphanus raphanistrum</em></td>
<td>99</td>
</tr>
<tr>
<td><em>Bromus</em> spp.</td>
<td>73</td>
</tr>
<tr>
<td><em>Avena</em> spp.</td>
<td>85</td>
</tr>
</tbody>
</table>

* Seed above harvester cutting height (15cm)
Chaff collection

Up to 85% of Lolium seed collected and removed
Glenvar Bale Direct System

- Up to 95% of *Lolium* seed collected and removed in baled harvest residues
Narrow windrow burning

Concentrate harvest residues for autumn burning and destruction of up to 95% of *Lolium* seed
Harrington seed destructor

Process chaff to destroy up to 98% of *Lolium* seed

Walsh et al. 2012 Crop Science 52:1343–1347
Creative solutions

- Resistance will drive innovation
- New tools created
- Herbicides pivotal, but not used alone

- Great need & opportunities
  - Public & private sector R&D
  - Extension/communication
Recommendations

Northsworthy et al. 2012 Weed Science

1. Late season & harvest weed seed control
2. Mandatory MoA labelling
3. Publicise that new herbicides are rare
4. Show benefit & costs of IWM
5. Conserving current herbicides
6. Full label rate
7. Individual BMPs
8. Public & private working together
9. Research
USA & Aus must overcome resistance to help feed the world

- Universal acceptance that overuse of a powerful control tool = resistance
- Good science, good tools & real effort
- Excellent communication channels
- Public & private sector collaboration

Let’s do it!
Nothing wrong with US agriculture that cannot be fixed by what is right with US agriculture.
Ode to Diversity by Steve Powles

Americans all let us rejoice
For we are proud & free
We’ve golden soil & crops for toil
& now we’ve got Diversity

Resistant weeds will not be our fate
Crops, chemicals & tools we will rotate

Thus in joyful strains let us plea
Long live Diversity
You are invited!

INTERNATIONAL CONFERENCE
GLOBAL HERBICIDE RESISTANCE CHALLENGE
18-22 FEB. 2013
PERTH AUSTRALIA

www.herbicideresistanceconference.com.au