Precision Weed Management

Dr. Heather Darby, UVM Extension Agronomist,
Precision Weed Management – Interest Grows

• Concern for possible impact of herbicides on farmers and environment

• Potential for financial savings
Crop protection

Crop Protection Approaches

Chemical control
- Insecticides
- Herbicides
- Fungicides
- Acaricides

Bio-pesticides
- Plant extracts
- Pathogenic bacteria and viruses
- Nematodes

Human factors
- Expertise
- Laws, regulations
- Quality standards
- Quarantine
- Food security
- Food safety
- Consumer perceptions
- Bio-diversity
- Land use

Physical control
- Shoot/root separation
- Uprooting/drying
- Burial
- Tissue rupture
  - Defoliation
  - Temperature, high
  - Temperature, low
  - Electrocution, etc.

Biological control
- Parasites, predators
- Resistant plants
- Transgenic plants (GMO)
2015 | Weeds Are Winning the Battle

# cases of weed resistance to glyphosate, dicamba or 2,4-D

1 2 3 4 5 6 7 8+

Source: www.weedscience.org, Stratus 2012 farmer survey, USDA NASS

60M+
Corn & soybean acres with herbicide resistant weeds
A new era in Agriculture

- Hand Tools
- Mechanical
- Chemical
- Biochemical
- Digital

10,000 years | 1900 | 1950 | 1990 | NOW
Crop management scale

- Conventional or traditional field management: Field
  One rate

- Optimised management: Sub-Field
  Variable rate

- Single plant management: Single plant
  Individual rate

- Leaf scale management: Leaf
  Leaf rate
Average US Corn Yields: No End in Sight

Average US Corn Yield, 1866-2009

Current Test Yield: 
~300 bu/acre
~500

Sources: USDA-NASS; Troyer, Crop Science 46.2 (2006): 528; Pioneer (Rupert and Butzen, Crop Sci, 19(2))
After teaching our system to identify cotton and weeds, it performed better than our agronomist.
Proof of concept in California lettuce
5,000 decisions per minute with ¼-inch spray accuracy
See & Spray uses artificial intelligence to identify and spray individual plants in milliseconds

**Sense & Decide:** Blue River’s artificial intelligence identifies subtle differences between crops (green) and weeds (red)

**Act:** Only weeds are sprayed, reducing chemicals by >90%

*Image of field, Detection, Selective spray*
• Weeds all day and night

• Tiny rods and sensors

• Video, lidar, and remote sensing

• Locates weeds

• Punches them!
  – 20 weeds per second
  – 3 acres an hour
  – 2mm accuracy
Robotic Weeders

- manipulator
- weed detection camera
- weeding tool
- visual servoing camera

[Diagram of a robotic weeder]

[Image of a field with weeds]
Jati - Light Saber Technology

- Name not a coincidence
- High resolution camera collects images in a 12” path
- Uses real-time by self-learning object recognition software
- Weeds zapped with laser beams
Laser Beam Weed Control

- Need optimum laser intensity
- Too weak makes the weeds grow more
- Too strong blow up machine
Commercialised machinery for precision physical weed control

Precision of machine vision based intra-row physical weed control

(source: Tillett and Hague Technology Ltd)

(source: CLAAS Agrosystems)

$max(a) = 30-40 \text{ mm (P 0.95)}$
On Farm Experiences with Camera-Guided Cultivation
Treatments
Weed biomass in organic barley

2007

2008

Weed biomass (g m⁻²)
Mustard density in organic spring wheat
Band Sowing with Cultivation
Band-sowing and inter-band hoeing for improved weed control in organic cereals

Funding: USDA NIFA OAREI

Rogers Farm, September 2015
Physical weed control (cultivation)

Why band sowing?

Row Cultivation

Band Cultivation
All treatments planted to Barley, var. Newdale

All treatments receive pre- and post-emergence tine harrowing

**STANDARD**

- 6.5"

**NARROW HD**

- Elevated Seeding Rate
- 4.5"

**WIDE +**

- 9"

**BAND +**

- 5”
- 6”

**BAND**

- 5”
- 6”
Weed Biomass in Barley Band Sowing Experiment

![Graphs showing weed biomass in Maine and Vermont for 2016 and 2017. The graphs compare Standard, Narrow HD, Wide +, Band, and Band + treatments, with different letters indicating statistical significance.](image-url)
Precision Hoeing

- Precision hoe operated by tractor that is guided by GPS.
- Utilizes RTK-GPS tracking technology.
- High resolution cameras to differentiate between crops & weeds.
- Plants must be planted in straight rows (no curves).
- Rows must be equally spaced.
Smith Farms
Westfield, Me.
CombCut Weeder
Combcut
University of Missouri

- ID Weed Application
- Dichotomous key
- Imagine library
Fusarium crown rot/root rot/head blight

Kernels-shriveled with white chalky appearance and pinkish
2010-2017 DON Means:

- Winter wheat variety trial
- Spring wheat variety trial
- Spring barley variety trial

Note: No 2010 spring barley trial & 2015 winter wheat trial
2017 SPRING BARLEY VARIETY TRIAL:
Figure 1. Stages of wheat at or near flowering.
Figure 2. Stages of barley at or near spike emergences.
### Spring Barley

#### News Feed
Economist expects slightly higher grain prices, input costs...

#### Most Effective Fungicides

<table>
<thead>
<tr>
<th>Brand</th>
<th>Rate</th>
<th>Timing</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosaro (Bayer)</td>
<td>6.5 to 8.2 fl oz per acre</td>
<td>Full Head Emergence (Feekes 10.5)</td>
<td>Good</td>
</tr>
<tr>
<td>Caramba (BASF)</td>
<td>13.5 to 17 fl oz per acre</td>
<td>Full Head Emergence (Feekes 10.5)</td>
<td>Good</td>
</tr>
<tr>
<td>Proline (Bayer)</td>
<td>5 to 5.7 fl oz per acre</td>
<td>Full Head Emergence (Feekes 10.5)</td>
<td>Good</td>
</tr>
<tr>
<td>Tebuconazole (Generics)</td>
<td>4.0 fl oz per acre</td>
<td>Full Head Emergence (Feekes 10.5)</td>
<td>Fair</td>
</tr>
</tbody>
</table>
2017 SPRING BARLEY FUNGICIDE:
2017 SPRING BARLEY FUNGICIDE: