Basic Tips for No-Till Success

- Start with high soil fertility level
  - Soil test & correct nutrient deficiencies well in advance of seeding
- Choose well-drained fields, esp. if planting early
  - Start with non-compacted soils
- Remove plant competition
  - Control weeds; watch out for herbicide residual
  - Use a properly-calibrated sprayer
  - Don’t plant until soil crumbles in your hand
  - Prepare a smooth, firm seedbed
  - Let surface trash dry out before planting so coulters cut it

What is Sprayer Calibration?

- Applying the correct amount of material to the specified area
  - Read the label for application rate
  - Follow calibration instructions for equipment
**Calibration Studies**

- **Nebraska**
  - 1/3 overapply by average of 35%
  - 1/3 underapply by average of 30%

- **Ohio State**
  - 25% overapply

- **Univ. of Illinois**
  - 70% of all chemical problems are due to poor application

**Why Calibrate?**

- **Over-Application**
  - Extra chemical expense
  - Crop damage
  - Environmental risks

- **Under-Application**
  - Expense of second application
  - Weed competition - loss of yield
  - Loss of property use or stored crop

**What is a Pesticide?**

- A pesticide is a chemical that kills, prevents or controls a pest
  - herbicide
  - insecticide
  - fungicide
  - rodenticide
  - avicide
  - acaricide
  - germicide
  - etc.

**Diluting Pesticides Correctly**

- **Dilute Formulations**
  - Sold at application strength
  - "Ready-To-Use" (RTU)
  - Ex.: Granules & dusts

- **Concentrated Formulations**
  - Must be diluted before use
  - Ex.: Usually liquids or powders
  - Exception: Fumigants & ULVs are applied full-strength

**How Much to Apply**

**Amount may be listed several ways:**

- **As pesticide formulation**
  - 2 tablespoons per gallon
  - 10 gallons/acre
  - 1 lb. per 100 cu.ft. of space

- **As percentage of final dilution** -- can calculate for any dilution method
  - 1/2% by volume
  - 1% by weight

- **As active ingredient** -- can select different formulations, but figuring dilutions is complicated
  - 1 pt. A.I. per 1000 sq.ft.

**Mistakes Possible**

- **Choice of pesticide**
  - Ex: Sevin® dust on tomatoes for aphid control

- **Timing of pesticide application**
  - Ex: Roundup® for grass control during drought

- **Incorporation**
  - Ex: Failure to water in crabgrass preventer

- **Mixing**
  - Ex: “A little is good; more must be better”

- **Calibration**
  - Ex: Changing pressure to change application rate
Common Spraying Problems

- Nozzles mismatched, plugged, badly worn, or improperly cleaned
- Screens discarded
- Pressure gauges broken or inaccurate
- Tank volume unknown; inaccurate markings
- True travel speed unknown
- Poor timing of pesticide application to plants
- Wrong pH of spray mix water
- Outdoor temperature too low
- Herbicide drift

Nozzle Uniformity Comparison

- NEW SPRAY TIPS
  Produce a uniform distribution when properly overlapped
- WORN SPRAY TIPS
  Have a higher output with more spray concentrated under each tip
- DAMAGED SPRAY TIPS
  Have a very erratic output – overapplying and underapplying

Wear Rates of Flat-Fan Nozzle Materials

- Aluminum
- Brass
- Stainless Steel
- Nylon
- Hardened Stainless Steel

Travel Speed

- Has biggest effect on application rate
- Speed hard to measure with pickup-mounted sprayers and ATVs
  - Use GPS unit or low-speed add-on speedometer

Sprayer Application Variables

Depends on type of equipment:

- Multiple-Hopper or Nozzle Units
  - Set to recommended settings
  - Calculate application rate
  - Catch output for a given time
  - Adjust

- Dry Applicators
  - Adjust to label application rates
  - Catch output over a given area
  - Weight and calculate output
  - Adjust

- Hand-Held Applicators
  - Apply water or dry material over a given test site
  - Measure amount used
  - Calculate application rate
  - Adjust

Half-Life of Pesticides at Varying pH Values

- A half-life is the period of time it takes for one-half (50% hydrolysis) of the amount of pesticide in the water to degrade
- Add pH buffer or acidifier to high pH water for longer control

<table>
<thead>
<tr>
<th>Chemical</th>
<th>pH=6</th>
<th>pH=7</th>
<th>pH=8</th>
<th>pH=9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captan (fungicide)</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Carbaryl (insecticide)</td>
<td>100-150 days</td>
<td>24-30 days</td>
<td>2-3 days</td>
<td>1-3 days</td>
</tr>
<tr>
<td>Chlorsulfuron (insecticide)</td>
<td>35 days</td>
<td>22 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diazinon (insecticide)</td>
<td>70 days</td>
<td>29 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimethoate (insecticide)</td>
<td>12 hours</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disulfoton (insecticide)</td>
<td>32 hours</td>
<td>7 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malathion (insecticide)</td>
<td>8 days</td>
<td>3 days</td>
<td>19 hours</td>
<td></td>
</tr>
<tr>
<td>Trichlorfon (insecticide)</td>
<td>4 days</td>
<td>6 hours</td>
<td>1 hour</td>
<td></td>
</tr>
</tbody>
</table>
Sprayer Application Variables

- Travel speed of sprayer
  - 10-20% wheel slippage = 10-20% overapplication
- Effective spray width of nozzle
- Nozzle flow rate
  - 10 gal./acre at 25 psi
  - 20 gal./acre at 100 psi

Calibration Example – Boom Sprayer

a. GPM = GPA x MPH x W
   5940
b. GPM = 15 GPA x 6 MPH x 20"
   5940
   = 0.30 GPM per nozzle
Select:
- TeeJet® XR8003VK (50 mesh), 40 psi

Regular Flat-Fan Nozzles

<table>
<thead>
<tr>
<th>Spray Angle (degrees)</th>
<th>Boom Height (inches) above Target for 20&quot; Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>21-23</td>
</tr>
<tr>
<td>73</td>
<td>20-22</td>
</tr>
<tr>
<td>80</td>
<td>17-19</td>
</tr>
<tr>
<td>110</td>
<td>10-12</td>
</tr>
</tbody>
</table>

Proper Spray Coverage – Boom Sprayer

Steps in Calibration – Boom Sprayer

- Set to recommended settings
- Calculate application rate
  - Use 15-20 GPA nozzles for good coverage
- Fill spray tank half-full of water
- Time measured distance both directions at field speed
  - Set field markers based on nozzle spacing
  - Average the times

Steps in Calibration – Boom Sprayer

Nozzle spacing (inches)  | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40
Course length (feet)    | 140| 194| 204| 214| 224| 234| 244| 254
Steps in Calibration – Boom Sprayer

- Park sprayer and run pump at same RPM as in field
- Catch output in ounces for measured time
  - Nozzle output in ounces = gallons/acre actually applied
- Adjust
  - Travel speed
  - Nozzles
  - Pressure (fine-tuning)

Steps in Calibration – Boomless Sprayer

- Set to recommended settings
- Calculate application rate
  - Use 15-20 GPA nozzles for good coverage
- Fill spray tank half-full of water
- Time measured distance both directions at field speed
- Park sprayer and run pump at same RPM as in field
- Catch output in pints for measured time
  - Nozzle output in pints = gallons/acre actually applied
- Adjust
  - Travel speed
  - Nozzles
  - Pressure (fine-tuning)

10 Tips for Reducing Spray Drift

1. Spray at low wind velocities (< 10 MPH)
2. Reduce spraying pressures
3. Increase carrier volumes (20 GPA vs. 10)
4. Select proper nozzles with coarse spray droplets
5. Use lower spray boom heights (110” vs. 80” or 73”)
6. Reduce ground speed (< 10 MPH = less boom bounce)
7. Spray when wind blows away from sensitive crops, homes
8. Use drift retardants (some nozzles not compatible)
9. Consider 250-300 foot buffer zones of distance or cover crops
10. Invest in “high-tech” sprayers with pulsing system

Calibration Summary

- Wear proper safety equipment
- Read the label for directions on dilution and use
- Check manufacturer’s catalogs for calibration tables
- Do a test application
- Aim for ± 5% application error
- Use measuring spoon, cup, jug, scale or flow meter for accuracy
- Re-check calibration often

Read the Label
Every pesticide label states...

- “It is a violation of federal law to use this product in a manner inconsistent with its labeling”
- ‘Use’ includes more than only applying
  - handling
  - mixing
  - loading
  - storage
  - transportation
  - disposal
  - environmental exposure

A summary to help understand the pesticide label is MU Guide G1911

Product Labels

KEEP OUT OF REACH OF CHILDREN

- Child hazard warning stated on every pesticide label
- Statement of practical treatment/first aid
  - Used by medical personnel in event of exposure
- Specific exposure routes

Missouri Regional Poison Control Center
Phone: 800-366-8888 or 800-392-9111

Pesticide Poisonings

- In 1996, 7,279 of 15,015 reported pesticide poisonings in the U.S. involved children less than 6 years of age
  -- Source: American Association of Poison Control Centers

Product Removal

- “Special Review” by EPA, used when
  - acute human or animal toxicity
  - chronic human health effects
  - hazard to nontarget organisms
  - risk to threatened or endangered species or their habitat
  - risk may outweigh the benefits

Relative Toxicity

LD_50 is the number of mg of substance per kg of body weight of test animal that is required to kill 50% of the test animals.

<table>
<thead>
<tr>
<th>Toxicity</th>
<th>Hazard</th>
<th>Product</th>
<th>Acute Oral LD_50</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Extreme</td>
<td>nicotine</td>
<td>10</td>
</tr>
<tr>
<td>High</td>
<td>Very high</td>
<td>strychnine (rodenticide)</td>
<td>30</td>
</tr>
<tr>
<td>High</td>
<td>Moderate</td>
<td>diazinon (insecticide)</td>
<td>87</td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td>OP (insecticide)</td>
<td>223</td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td>durban (insecticide)</td>
<td>363</td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td>caffeine</td>
<td>200</td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td>Sevin (insecticide)</td>
<td>500</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td>2,4,5 (herbicide)</td>
<td>720</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td>aspirin</td>
<td>750</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td>cyfluthrin (insecticide)</td>
<td>1070</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td>malathion (insecticide)</td>
<td>1375</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td>table salt</td>
<td>3320</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td>glyphosate (herbicide)</td>
<td>5600</td>
</tr>
</tbody>
</table>
Pesticide Exposure Routes

- Dermal (skin)
- Oral (ingestion)
- Respiratory (breathing)
- Ocular (eyes)

Are All Dermal Entry Routes Equal?

Parathion absorption rates through the skin on various regions:

<table>
<thead>
<tr>
<th>Region</th>
<th>Absorption Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalp</td>
<td>0.7</td>
</tr>
<tr>
<td>Forehead</td>
<td>0.5</td>
</tr>
<tr>
<td>Abdomen</td>
<td>2.1</td>
</tr>
<tr>
<td>Forearm</td>
<td>1.4</td>
</tr>
<tr>
<td>Palm</td>
<td>1.3</td>
</tr>
<tr>
<td>Ball of foot</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Personal Protective Equipment (PPE)

- The label lists the PPE needed when mixing and applying product

- This man is properly using protective clothing:
  - No leather shoes
  - No cloth or leather gloves
  - Launder caps often

Preventing Harm to Non-Target Organisms

For more detailed information on laundering pesticide-contaminated clothing, ask for MU Guide G1914

- Most labeling will contain warnings that are fairly general

Environmental Hazards: This product is toxic to aquatic invertebrates. Do not apply directly to water. Do not contaminate water when disposing of equipment washwater. When cleaning equipment, do not pour the washwater on the ground; spray or drain over a large area away from wells and other water sources. Do not apply when weather conditions favor drift from target area. Most cases of groundwater contamination involving fenuron herbicides such as 2.4-D and MCPA are associated with misapplication and disposal sites. Caution should be exercised when handling 2,4-D and MCPA at such sites to prevent contamination of groundwater supplies. Use of closed systems for mixing and transporting this pesticide will reduce the probability of spills. Placement of the misapplication equipment on an impervious pad to contain spills will help prevent groundwater contamination.
Physical or Chemical Hazards

- Provides information regarding any special fire, explosion, or chemical hazards
- Name and address of manufacturer
- Toll-free help line

Transport of Pesticides

- **Never** carry in passenger section of vehicle
- **Never** allow passenger or pets to ride with pesticides
- **Never** transport with food, clothing, or other things that contact people or animals
- **Never** leave unlocked or open-bed vehicle unattended
- Transport highly-volatile pesticides in separate trips from other chemicals
- Secure firmly to prevent spills

Storage and Disposal

- The best storage practice for pesticides is to purchase only the amount needed to do the job

Storage and Disposal

- **STORAGE AND DISPOSAL**
  - STORAGE: Keep from freezing. Store in original container in a locked storage area inaccessible to children and pets. Avoid contamination of food or feedstuffs.
  - CONTAINER DISPOSAL: If empty: Do not reuse this container. Place in trash or offer for recycling if available. If partially filled: Call your local solid waste agency or call this number (1-800-CLEANUP) for disposal instructions. Never place unused product down any indoor or outdoor drain.

- May include temperature requirements
- Generally recommends “triple-rinsing”
  1. Empty contents and drain for 30 seconds
  2. Refill container one-fourth full with rinse water
  3. Rinse thoroughly & drain; repeat Step 2 & 3 three times

Disposing of rinsate
Conditions for Product Disposal

- Farmers are exempt for pesticide disposal as hazardous waste if they triple-rinse the container and dispose of the residues according to label instructions
- No “free liquids” can go to a landfill
- Open dumping or burning is prohibited in MO
- Store product in a safe place until disposal or collection
  - Cool, dry, non-freezing (NOT the well-house!)  
  - Labeled and in good condition

What to Do With Outdated Products

- Pesticides can usually still be used until supplies are exhausted
  - CMDS Pesticide Label Database  
    Web: http://www.cdms.net/LabelsMds/LMDefault.aspx
  - Out-dated labels
  - Labeled uses have changed
  - Pesticide has been taken off of the market
    - Dursban® and diazinon
- Exceptions:
  - EPA allows old label uses for only a short time after product cancellation or label change
  - EPA may put a stop use on a product at the time of cancellation
    - 2,4,5-T and chlordane

What to Do With Outdated Products:

- Contact the manufacturer to find out whether you can still use the product
- See if pesticide manufacturer will take it back
- Contact:
  - MO Department of Agriculture Bureau of Pesticide Control  
    Phone: 573-751-5504  
    Web: agriculture.mo.gov/plants/pesticides/
  - Web: https://apps.mda.mo.gov/moplants/index.aspx
  - EPA Region 7 – Kansas City
    Phone: 1-800-223-0425
    Web: www2.epa.gov/aboutepa/epa-region-7-midwest
  - National Pesticide Information Center  
    Phone: 1-800-858-7378
    Web: epic.orst.edu/

Option #1 – Use It Up

- Use up according to label directions for the approved target
  - May apply a pesticide to a labeled site even if the pest is absent
  - Give to other pesticide users if they can use it
    - Not legal to sell it to them unless a licensed dealer
    - Make sure product has original label

Option #2 - Collection Day

- Available sporadically and involves:
  - a sponsoring state agency
  - a source of grant or other funds
  - an industry or other group that will take responsibility for assisting the program's development
- Work through the Solid Waste District that covers your county  
  Web: www.dnr.mo.gov/env/swmp/
  www.dnr.mo.gov/env/hwp/pesticide/

Pesticide Safety

“The dose makes the poison”

- Read and follow the label
- Store in marked, locked building away from food, feed, kids and pets
- Store in original containers
  - Wear proper protective clothing and respirators
  - Immediately remove contaminated clothing. Wash with water
- Use clean clothes daily. Wash separately
- Keep Poison Control Center phone number handy
  - Phone: 800-366-8888 or 800-392-9111
Questions?

Robert A. (Bob) Schultheis
Natural Resource Engineering Specialist
Webster County Extension Center
800 S. Marsh Rd
Marshfield, MO 65706
Voice: 417-859-2044
Fax: 417-468-2086
E-mail: schultheisr@missouri.edu
Web: extension.missouri.edu/webster

Program Complaint Information
To file a program complaint you may contact any of the following:

University of Missouri
• MU Extension AA/EEO Office
  109 F. Whitten Hall, Columbia, MO 65211
• MU Human Resources Office
  130 Heindel Bldg, Columbia, MO 65211
USDA
• Office of Civil Rights, Director
  Room 326, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-0013

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