PLAN AHEAD
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
Basic Tips for No-Till Success

- Use certified seed of recommended varieties
  - Increase seeding rate by 10% unless conditions are ideal
- Add weights to drill as needed to make seed openers work properly
- Don’t plant faster than 3½ MPH in sod, moist soils or rough conditions
- Plant forage seeds no more than ¼” to ½” deep
  - Should see 1/3 of seed on top of ground when done
- Use press wheels that close the seed trench
  - May need to roll bare ground after seeding to get good soil-seed contact
- Be prepared to use post-emergence herbicides
  - Grasses must be well-tillered & established
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
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

$100

$750

Photo credit: www.farmtronics.com
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 hours</td>
<td>10 min.</td>
<td>2 min.</td>
<td></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>Chlorpyrifos (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></td>
<td>29 days</td>
<td></td>
</tr>
<tr>
<td>Dimethoate (insecticide)</td>
<td>12 hours</td>
<td></td>
<td>1 hour</td>
<td></td>
</tr>
<tr>
<td>Disulfoton (insecticide)</td>
<td>32 hours</td>
<td></td>
<td>7 hours</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

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
  - Weigh and calculate output
  - Adjust

- **Hand-Held Applicators**
  - Apply water or dry material over a given test site
  - Measure amount used
  - Calculate application rate
  - Adjust
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
  - 100 psi
Calibration Example – Boom Sprayer

a. \[ \text{GPM} = \frac{\text{GPA} \times \text{MPH} \times \text{W}}{5940} \]

b. \[ \text{GPM} = 15 \frac{\text{GPA}}{5940} \times 6 \frac{\text{MPH}}{5940} \times 20'' \]

\[ = 0.30 \text{ GPM per nozzle} \]

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><strong>80</strong></td>
<td>17-19</td>
</tr>
<tr>
<td>110</td>
<td>10-12</td>
</tr>
</tbody>
</table>
Proper Spray Coverage – Boom Sprayer

Flat-Fan Nozzles

Spray Overlap (50 Percent)

Flood Nozzles

Spray Overlap (100 Percent)
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

<table>
<thead>
<tr>
<th>Nozzle spacing (inches)</th>
<th>12</th>
<th>16</th>
<th>20</th>
<th>24</th>
<th>28</th>
<th>32</th>
<th>36</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course length (feet)</td>
<td>340</td>
<td>255</td>
<td>204</td>
<td>170</td>
<td>146</td>
<td>127</td>
<td>113</td>
<td>102</td>
</tr>
</tbody>
</table>
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)
Steps in Calibration – Boomless Sprayer

$W = \text{Maximum effective coverage with nozzle mounted at 36” height.}$

<table>
<thead>
<tr>
<th>Swath width (feet)</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (feet)</td>
<td>208</td>
<td>182</td>
<td>156</td>
<td>136</td>
<td>121</td>
<td>109</td>
</tr>
</tbody>
</table>
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
“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
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
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 LD50</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Extreme</td>
<td><strong>Nicotine</strong></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>DDT (insecticide)</td>
<td>113</td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td>Dursban (insecticide)</td>
<td>163</td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td><strong>Caffeine</strong></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-D (herbicide)</td>
<td>720</td>
</tr>
<tr>
<td>Slight</td>
<td>Very low</td>
<td><strong>Aspirin</strong></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><strong>Table salt</strong></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

- Ear canal: 5.4
- Forehead: 4.2
- Abdomen: 2.1
- Forearm: 1.0
- Palm: 1.3
- Scrotal area: 11.8
- Ball of foot: 1.6
- Scalp: 3.7
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
Laundering Pesticide-Contaminated Clothing

Fred Fischel, Department of Agronomy
Sharon Stevens, Missouri Textile and Apparel Center

Proper care of clothing and other protective items worn during the application of pesticides helps protect the user and prevents pesticide residues from spreading to areas where people live and work. The following guidelines apply to farmers and commercial pesticide applicators as well as to home gardeners who apply common, general-use products, such as Roundup® and Sevin®, to their lawns, flowers and vegetables.

Although the pesticide label should be used as a guideline for laundering contaminated clothing, most labels do not contain specific instructions. This publication should be regarded as a supplement to the information provided on pesticide labels or the Material Safety Data Sheets (MSDS) available from chemical dealers.

Saturated clothing
Do not attempt to launder clothing that has become saturated with undiluted pesticides. Saturated, contaminated clothing should be removed immediately and the wearer should shower as soon as possible. The contaminated clothing must be secured and held for a household hazardous waste collection or be discarded in accordance with local laws and regulations. Place the clothing in an air tight, metal container and label the container with contents and date. Do not store the container inside the house; place it in a pesticide storage facility or where it is away from sources of heat, spark, flame or ignition. Contact your local University Outreach and Extension Center to find out about collection programs in your area.

Protecting others from contaminated clothing
Pesticide-contaminated clothing may pose a risk to family members in addition to the person applying the pesticide. Pesticide-contaminated clothing to be laundered should be kept separate from family laundry in a disposable plastic bag. It is important that the person doing the laundry understand that the clothing is contaminated with pesticide and requires special handling.

Minimizing the risk
The majority of pesticide exposures occur through contact with the skin. Keep in mind the following precautions to protect yourself, your clothing and others in your household who may be exposed to pesticide residues:

1. Wear clean clothes when working around pesticides. It is more difficult to remove pesticide from clothes that are already dirty than from clean clothes.
2. Wear protective aprons and other protective equipment listed on the label during mixing and loading of pesticides to protect against accidental spills and contamination from undiluted materials. The pesticide label will provide information regarding the proper personal protective equipment to wear while making applications. Use disposable protective clothing when possible. See MU publication G1917, Personal Protective Equipment for Working With Pesticides.
3. At the completion of the job, wash the outside of your gloves with detergent and water before removing them.
4. Wash clothing as soon as possible after use. Delay will reduce the likelihood that all the residue will be removed.
5. Wear unlined chemical-resistant gloves to handle pesticide-soiled clothes. Wash the gloves thoroughly, as if washing your hands, before removing them. Do not use the gloves for other household tasks.
6. Pre-rinse other garments in a pull of hot water, hose them off outdoors, or agitate them in an automatic washer. Empty the pre-rinse water where it won’t endanger people, animals, water sources or the environment.
7. Pockets and cuffs on garments worn during application of granular pesticides should be emptied outdoors to remove trapped granules before the clothing is stored to be washed. Note that even small quantities of pesticides should be emptied only onto sites that are listed on the pesticide label as approved.
8. Keep clothes worn for pesticide application separate from other laundry — before and during washing.

For more detailed information on laundering pesticide-contaminated clothing, ask for MU Guide G1914
Preventing Harm to Non-Target Organisms

ENVIRONMENTAL HAZARDS: This product is toxic to aquatic invertebrates. Drift or runoff may adversely affect aquatic invertebrates and nontarget plants. 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 phenoxy herbicides such as 2,4-D and MCPP-p have been associated with mixing/loading and disposal sites. Caution should be exercised when handling 2,4-D and MCPP-p pesticides at such sites to prevent contamination of groundwater supplies. Use of closed systems for mixing and transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent groundwater contamination.

- Most labeling will contain warnings that are fairly general
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
The best storage practice for pesticides is to purchase only the amount needed to do the job.
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/LabelsMsds/LMDefault.aspx](http://www.cdms.net/LabelsMsds/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: npic.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/](http://www.dnr.mo.gov/env/swmp/)  
[ww.dnr.mo.gov/env/hwp/pesticide/](http://ww.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. Marshall St.
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 Heinkel Bldg, Columbia, MO 65211

USDA
- Office of Civil Rights, Director
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-9410

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