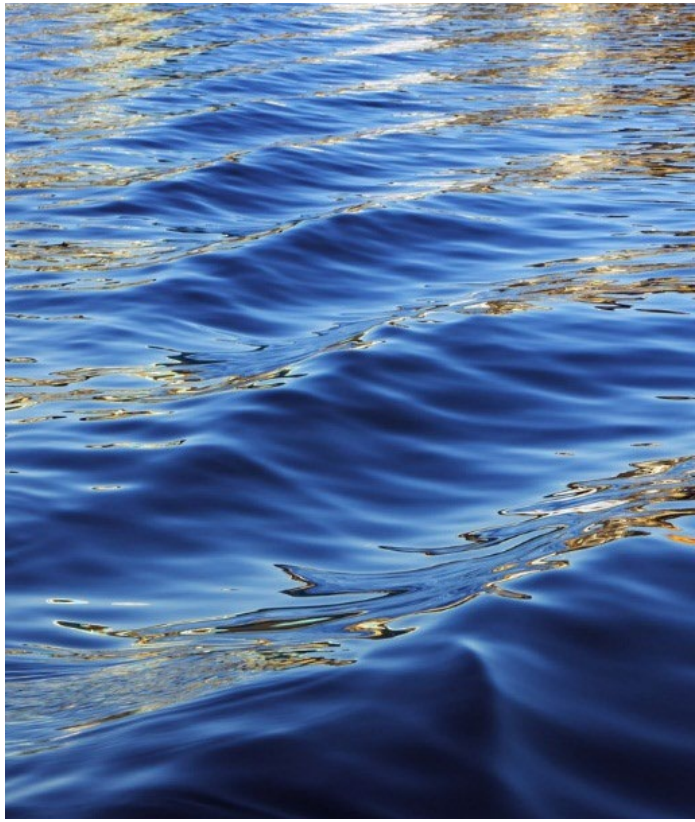
Toward a framework to quantify risks & benefits of pesticide resistance & resistance management



What to measure?

- Costs & risks from resistance
  - Losses to producers & consumers from reduced efficacy
  - Shifts to substitute compounds with greater environmental or human health risks
- Costs & risks of resistance management practices
- Critical timing questions: when does resistance occur
  - Without resistance management?
  - With resistance management?

How to measure? Costs of resistance

- Benefits of resistance management are avoided costs & risks from resistance
- Cost of resistance are similar to (and can be estimated in similar ways) as the costs of pesticide cancellation
- Long-established methods for estimating costs of pesticide cancellation
  - Producers must shift to different compounds or control methods
    - With higher costs
    - That provide less yield protection (affecting output)
    - That provide less quality protection (affecting price)
    - That have potentially greater environmental or human health risks

Steps in quantifying resistance costs

1. Identify substitute compounds or control methods & quantify their production performance / attributes via
   - Expert opinion surveys
   - Historical market shares
   - Single, best substitute
   - Analytical models
   - Field trial and demonstration farm data
2. Obtain Environmental & human health risk profile from pre-existing risk assessments
3. Use changes in production attributes as inputs in regional or national commodity supply and demand models
   - Yield and cost changes shift supply curve
   - Quality shifts shift demand curve
   - Past research suggests significant variation across crops and regions

Steps in quantifying resistance management costs

1. Identify alternative treatment regimes, their costs, yield & quality performance via
   - Field trial / demonstration farm data
   - Extension recommendations / expert opinion
   - Biological models
   - Examples
     - Rotating herbicides
     - Diversifying modes of action
     - PIPs: costs of refuges are foregone gains on refuge acres

2. Obtain Environmental & human health risk profile from pre-existing risk assessments

3. Use changes in production attributes as inputs in regional or national commodity supply and demand models

Possible (in principle) to conduct benefit-cost analysis of resistance management

- With resistance management practices
  - Short-run returns lower
  - Long-run returns greater
  - Small negative short-run supply shifts to avoid larger long-run negative supply shifts
- Could do standard multi-year BC analysis
  - Estimate the Net Present Value of resistance management
  - Following EPA principles & guidelines

Now the hard part:
Everything hinges on 2 questions

- When would resistance occur absent resistance management?
- How long does resistance management delay onset of resistance?
- Options for measurement
  - Biological / genetic modeling
  - (arbitrarily) choosing years & conducting sensitivity analysis
- Priorities for measurement
  - Breadth – widely use compounds
  - Depth
    - Some compounds not widely used, but critical for specialty crops / specific contexts
    - Resistance costs could be large **in percentage terms** for systems without good substitutes

Considerations

- How do registration / cancellation decisions affect availability of effective MOAs?
  - How might cancellation of compound X affect resistance management for compound Y?
  - At minimum, this could be described and characterized
- Results above could be used in representative farm models & decision support tools (for extension & education)
  - Palmer Amaranth Management (PAM)
  - Ryegrass Integrated weed Management model RIM (Australia)
- Results could inform cost-share programs
  - Private rebate programs
  - USDA programs (EQIP, CSP)
  - Challenges in achieving "additionality"