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Re: 2018 NIFA Listens: Investing in Science to Transform Lives

NIFA Listens: In your field, what is the most-needed breakthrough in science/technology that would advance your agricultural enterprise?

1. **Development of precision technological packages combining 1) reliable and efficient real-time discrimination of weeds and crops under diverse field conditions with 2) precision application of chemical, mechanical and alternative weed control tools.**

   Rationale. Potential benefits are large, and include:
   - Reduced input costs including herbicide, labor, and fuel costs
   - Greater weed control efficacy and selectivity resulting in lower crop yield losses
   - Improved profitability
   - Reduced risks associated with excessive herbicide use (e.g. environmental, human health, herbicide resistance)
   - Reduced environmental costs associated with excessive mechanical cultivation (e.g. reduced soil disturbance and fuel use)

2. **Molecular biology and genomics tools to understand weed biology, ecology and evolution of herbicide resistance in weed species**

   Rationale:
   - The research in molecular biology and genomics in weed science is still in its infancy. Availability of such resources is vital to understand the biology and genetics of weedy and invasive species.
   - A better understanding of dioecy in certain weed species such as Palmer amaranth (*Amaranthus palmieri*) and waterhemp (*Amaranthus tuberculatus*) could lead to a NOVEL weed control approach, in which a gene drive is used to manipulate gender ratios.

- Genomics information will also help address fundamental mechanisms of evolution of herbicide resistance in weeds, as herbicide-resistant weeds pose a serious challenge for sustainable crop production

3. **Identification of cost effective alternatives for long-term weed management in conservation agricultural systems including preventative approaches.**

   Rationale:
   - Conservation agriculture is widely promoted as a means of maintaining soils and improving crop resilience to stress, but is often accompanied by weed management challenges and tradeoffs.
   - Weed management in conservation agricultural systems has generally been accomplished through greater use of herbicides.
   - Excessive herbicide applications create various problems (see #1 above)
   - Alternative approaches aimed at prevention have received much less research attention, and have potential to be win-win for soils and weeds.

4. **Development of effective physical devices to control weeds: lasers, precision flamers, abrasion, hot oils, high pressure water.**

   Rationale:
   - These are not herbicides and create diverse mechanisms to control weeds.
   - These devices could be paired with the weed/crop detection systems in #1 above.
   - The fundamental research on these tools needs to be done in the public sector because it is less likely that they will attract a great deal of commercial investment from the private sector.
   - These tools are not regulated as pesticides and can be used in a diverse set of crops without registrations. Example low acreage crops that could benefit: bok choy, gai lan (Chinese broccoli), radish and hundreds of others

5. **Develop molecular tools to regulate bud dormancy genes in perennial weeds**

   Rationale:
   - Despite decades of translocated herbicide use, perennial weeds like field bindweed (*Convovulus arvensis*), yellow and purple nutsedge (*Cyperus esculentus* and *C. rotundus*), Canada thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*) and others continue to cause crop loss and rangeland degradation. These weeds are challenging to control with current technologies and new strategies are needed.
   - Strategies to up or down regulate dormancy genes in these crops would provide a new set of tools to manage. This fundamental research needs to be conducted in the public sector as it is unlikely to garner sufficient commercial interest to invest in this research.

NIFA Listens: When considering all of agriculture, what is the greatest challenge that should be addressed through NIFA's research, education, and extension?

1. Conserving non-renewable resources (e.g. fuel and phosphorous) while maintaining crop productivity and resilience to weather extremes.

2. Herbicide resistance selection in weeds developed due to an oversimplification of the weed management system. Practical cost effective methods that reduce selection pressure, through use of integrated weed management systems, are needed. The public sector needs to demonstrate new weed management technologies with levels of redundancies that are long-term sustainable.

3. Evolution and management of herbicide resistance in weed species is one of the major challenges facing agriculture today. A deeper understanding of weed genomics and biology will lead to novel approaches in weed management and help us understand the fundamentals of herbicide resistance evolution.

NIFA Listens: What is your top priority in food and agricultural research, extension, or education that NIFA should address?

1. Optimize conservation agriculture systems (i.e. those emphasizing reduced-tillage and diversification strategies) through greater integration of economic and biological sciences. These disciplines are needed to characterize both private and social costs associated with alternative strategies, and to incentivize grower adoption.

2. Weed science students need to be trained in some aspects of engineering, program coding, genetics and molecular biology if they are to deal with future job markets where new technologies and ideas emerge daily.

3. Integrated pest management and sustainable crop production, including collaborations with economists and social scientists.

Scott Senseman

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cc: Dr. Chavonda Jacobs-Young, USDA-ARS, Administrator
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