

Presidential Address

New Millennium Weed Management: Challenges and Opportunities for the California Weed Science Society

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In considering the future directions of weed science and management it seems that we are at a transition not unlike that which occurred in the early 1970's with the formation of the US Environmental Protection Agency (EPA) and the amendments to the Federal Fungicide, Insecticide and Rodenticide Act (FIFRA). It was at that time that new requirements for certification of applicators were imposed and new classifications of certain pesticides were defined as "restricted use". States struggled to meet compliance deadlines and programs for training and continued education were initiated. To be sure, these changes were not viewed favorably by all weed control practitioners since it meant a radical shift in operations and placed more demands on everyone's time. This period also led to improvements in product labeling aimed at increasing user-safety and reducing potential environmental impacts. Regardless of initial attitudes, the overall result has been a significantly heightened level of applicator knowledge, skill and environmental consciousness.

What is causing change now and how significant are recent shifts in approaches to weed management? In Table 1, I have listed some of what I believe are the most important drivers from both regulatory and socio-political arenas. Clearly, new technological innovations are moving weed management toward more precise and efficient methods; however from a broader societal view, the repercussions of trends and events represented in this table may have as much impact on how weed control will look in the decades ahead. Indeed, I will argue that without fundamental changes in science education-at the grade school level through adulthood- the gap between agriculture (and pest-management) and the lay-public will widen to the detriment of all.

Table 1. Regulatory and Social Challenges for California Weed Science and Management

- Demand for "organic commodities"
- Food Quality Protection Act
- Executive Order on InvasiveSpecies
- Plant Protection Act
- Genomics and Related Molecular Level Technologies
- NPDES Permits and Related Monitoring
- Public's Lack of "Weed Science Literacy" (Gap in K to 12 education)

Depending upon the commodity, organic market-demand is rising from 20 to 30% per year. Though it is still a minor component overall, this trend seems to demand more inclusion of both the science and the practitioner in CWSS. We will need to determine how best to achieve this.

Similarly, the newly defined requirements for a General National Discharge Elimination System permit (NPDES- Permit) for aquatic pesticide uses portends further environmental monitoring for all pesticide uses. The import (and impact!)of this is difficult to overstate. The US 9th District Court of Appeals in its ruling in Talent v. Headwaters last spring in essence made two fundamental changes to herbicide use, at least in western states under its jurisdiction: (1) compliance with current labeling is not sufficient to allow aquatic uses; and (2) herbicides, once entering water are to be considered a form of waste-discharge under the Federal Water Quality Act. The present scramble (amid confusion) to react to this regulatory tsunami in California, Washington and Oregon parallels the impact of above-mentioned 1970's EPA-mandated certification program- but with far less lead time. The Headwaters decision changed the compliance landscape virtually overnight. Monitoring protocols must be in place by July 2002 and the demand on analytical laboratories will be overwhelming.

Another perspective on future directions in weed management comes from comparing what I call "Pre-Millennium" and "Post-Millennium" approaches (Table 2). These are really changes more of a gradual, or evolutionary nature; no certain end-point or starting point is clear. However, over the past 5 years or so, there are clearly some shifts occurring due to both technologies and to improved understanding of weed ecology and biology. By standing back somewhat, the scale of change is more apparent and that is the intent of this table.

Table 2. Comparison of past and future weed science and management perspectives.

<u>Pre Millennium</u>	<u>Post-Millennium</u>
Single target focus	Ecological focus (population/community)
Specific crop/weed focus	Crop-weed complexes Beneficial insect habitat
Field-specific focus	Biogeographical scale ("Area Wide")
Single season economic thresholds	Long-term, modulated, ecologically-based thresholds Zero-tolerance seed banks
Major crop commodity-drive decisions	Commodity <i>and</i> Environment-driven
<u>Herbicide dependence:</u> Selectivity Timing Persistence Placement	<u>Mosaic of Inputs:</u> Synthetic and natural product herbicides Precision applications (GIS) Resistance management Cultural practices

Resistance
Carryover
Drift

Biological control
Optimized landscape features
Optimized crop geometry (canopy, spacing)

Regulatory Compliance:

Just follow the label.

Regulatory Compliance:

Fully integrated “environmental effects monitoring”

Some of the approaches in Table 2 are already well underway in some commodities. However, as in all changes, growers will continue to be quite conservative and carefully watch and evaluate new methods and systems. There are, I believe, some approaches that need to be examined in light of both new newly developed technologies and increased understanding of plant-plant interactions as well as plant-insect/pathogen interactions. Specifically, using GPS-guidance systems, it should be feasible to create cropping landscapes with any number or combination of elevations ranging for flats and shallow slopes to steep gradients of several feet and in any number of patterns. Such variable cropping landscapes or “VCLs” could make optimal use of differing irrigation requirements, shading benefits, canopy architecture, harvest times, nutritional demands, and beneficial insect habitat. Why do “refuges” have to be on borders? Is this optimal? The grower is really no longer limited to straight-line farming. With the use of “smart” equipment, field configurations and harvesting can be programmed to accommodate any number of variations. (Perhaps this notion comes from to having such little control of the natural aquatic and riparian environmental inputs!) I have listed a few potential opportunities and potential technologies with relevance to “New Millennium Weed Management”. I’m sure there are others.

Opportunities for Applying New Technologies in Weed Management:

- Miniaturization and nanotechnology: e.g. soil, leaf sensors, microscale-transmitting cameras; root and rhizosphere microinstrumentation (assessment of allelopathy)
- Laser and GPS/GIS guided Variable Cropping Landscapes (VCLs)
- Ultrasonic systems for detecting and measuring seed banks
- 3D- digital scanning systems to develop plant/ weed competition models
- Collaborations with the biomedical and aerospace research/industry

One of the most exciting and significant new directions in weed management is the burgeoning support and recognition of exotic invasive weeds in natural/wildlands and aquatic resources. Problems in these sites are not new, but a combination of increased introductions, public awareness and political interest has led to slowly building interest in these weeds. As mentioned in Table 1, the Executive Order signed in 1999, and subsequent formation of the Invasive Species Task Force, newly adopted Plant Protection Act speak to this new awareness. Further evidence that these impacts have reached the political radar screen comes from very recent publication of two major federal level documents. A GAO Report on Invasive Species (GAO-01-724 was published in July, 2001. This 40+ page document, requested by, and

addressed to Congress, is in essence a “report card” on the progress of federal agencies in dealing with invasive species. Notable obstacles cited include:

- Lack of agreement on what “Rapid Response” means
- No nationally coordinated system to deal with invasive species
- No accountability of agencies when invasive species spread
- Lack of “authority” to act; reluctance to act without clear “mission”
- Lack of funding

These areas clearly need addressing. What can CWSS do to expedite improvements and to assist in overcoming the obstacles?

A second, even more recent publication was just released by the National Academy of Science this month entitled: Predicting Invasions of Nonindigenous Plant and Plant Pests. Several recommendations are stated including the need to pool information on non-native species, the need to develop predictive models to help identify potential problem species and the need to utilize the approved biological control agents as a means for studying introduced populations. This document is a virtual compendium of the problems we face in both stopping introductions and in coping with them.

I believe that the National Academy report, and the GAO report, as well as related reviews (e.g. see Sakai et al, 2001) point to very concrete and serious need for research, regulatory and educational reform on a scale that parallels the early 1970’s reforms in pesticide usage and environmental stewardship.

Where does the California Weed Science Society fit into this effort? There are no doubt several actions that would be useful. I have listed a few in Table 3.

Table 3. Opportunities for CWSS in Invasive Weed Problems

1. Training for “Rapid Response Weed Research and Action”
2. Outreach and Extension focusing on Prevention (e.g. Certification of “plant purveyors”)
3. Ecological Underpinning for Biological Control and Pest Exclusion
4. Facilitate development a curriculum for K-12th grade “Weed Literacy”
5. Facilitate teacher training
6. Educating public policy makers
7. Capitalize on emerging technologies- wherever they come from
8. Facilitate training to meet new compliance regulations
9. Respond to public perceptions by enhancing public understanding
10. Facilitate invasive species initiatives and coordinate with supportive groups

This brings me to my concluding remarks and a request that you become engaged in the newly initiated Strategic Planning your Executive Board is pursuing. I have identified some of the future trends in weed management as I see them. There are certainly others. And there are no doubt varying views on how CWSS should respond to these. However some changes are inevitable and it is important that CWSS anticipates and incorporates new demands and needs within California's weed research and management needs to sustain its vital service to the members and stakeholders, and newly emerging stakeholders as well. Where should we be headed? How do we get there? Strategic planning means developing a reasonable prediction of where we ought to be and then taking the steps to be there- at the right time! Some of the first steps will be to:

1. Define our mission and goals
2. Examine what we do- and determine what needs to change
3. Identify ways to implement the changes
4. Set time-tables, milestones... and then DO IT!

California has the most diverse cropping production system and is blessed with some of the most important natural, wildland, riparian and aquatic ecosystems in the US. It has consistently lead in innovative approaches to agricultural production and environmental protection. We are once again poised with the opportunity to lead weed science and management into this new millennium of challenges and great opportunities. I hope many of you will become involved with the California Weed Science Society and this strategic planning – it will be exciting for us all!

References:

1. General Accounting Office (GAO) Report on Invasive Species. 2001. GAO-01-724, 48p.
2. National Academy of Sciences Report: Predicting Invasions of Nonindigenous Plants and Plant Pests. 2002. National Academy Press, Washington, DC. 185 p.
3. Sakai, Ann, K. et al. 2001. The population biology of invasive species. *Annu. Rev. Ecol. Syst.* 32: 305-332.