A community of responsible and integrated pest management

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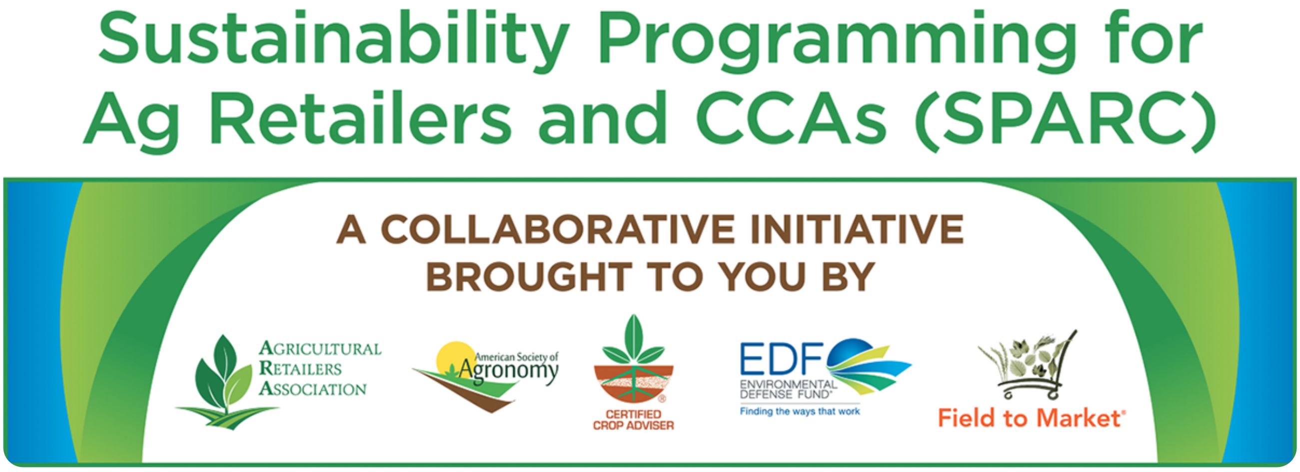

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The following was extracted the peer-reviewed report from Field to Market: The Alliance for Sustainable Agriculture, titled, “Trends in Pest Management in U.S. Agriculture: Identifying Barriers to Progress and Solutions Through Collective Action” (**Field to Market: The Alliance for Sustainable Agriculture, 2020**). The report, released in February 2020, was written in response to increased public interest in pesticide use within food supply chains and its potential impacts on biodiversity, water quality, and human health as well as agronomic challenges related to pesticide resistance.

Defining ‘Responsible’ and ‘Integrated’ Pest Management

Responsible pest management can be defined as systems that ensure successful pest control with no adverse effects on human health while optimizing crop yield, crop quality, and environmental protection and minimizing negative effects on biodiversity. Responsible pest management not only considers what methods are used in practice but also looks at how and when methods are used and why farmers make specific pest management decisions. In recent years, greater public concern about chemical pesticide use in agriculture has led to increased attention on the various implications of direct and indirect pesticide exposure, including potential human health impacts of pesticide residues in food and environmental implications of chemical pesticide use for water resources and biodiversity (Hartman Group, **2017**). Urgency to conserve biodiversity has increased with recent reports indicating a widespread loss of biodiversity globally, some of which can be attributed to increases in chemical pesticide use since the middle of the 20th century (IPBES, 2019; Dibartolomeis et al., 2019).

Integrated pest management (IPM) is an approach to managing pests in a way that minimizes economic, health, and environmental risks. The initial development of IPM occurred in part as a response to negative impacts attributable to excessive use of certain insecticides in the mid-20th century (Smith et all, 1976; Ehler, 2006; Gray et al., 2009). Early researchers found that pest resurgence, the rebounding of pest populations to equal or greater numbers after a pesticide treatment, was a consequence of indiscriminate insecticide applications. Following this discovery, California entomologists developed the notion of “supervised control.” This approach involves entomologists monitoring populations of both insect pests and natural enemies and recommending insecticide applications only when observed pest pressure warrants treatment, rather than basing applications on the calendar or as an “insurance” measure (Smith & Smith, 1949). Entomologists then went a step further to develop “integrated control,” an approach in which biological, chemical, and other methods are combined to manage insect pests (Stern et al., 1959; Smith & Allen, 1954; Smith & Reynolds, 1966).

Adjusting crop planting dates and planting crop varieties resistant to a specific pest can be an avoidance strategy to reduce pest impacts when they are already present. Source: United Soybean Board.

The USDA encouraged growers to use the “PAMS” framework: Prevention, Avoidance, Monitoring, and Suppression (USDA, 1993).

- **Prevention** is keeping pests from infesting a field; it emphasizes sanitation practices such as cleaning tillage and harvest equipment after completing work at each field and protecting habitats for pest predators.
- **Avoidance** is the use of sound cultural practices to reduce pest impacts when they are already present. Avoidance practices include planning crop rotations, adjusting crop planting or harvest dates, and choosing crop varieties resistant to a specific pest. Prevention and avoidance may overlap as they both keep potential pests away from susceptible crops.
- **Monitoring** refers to the use of scouting, soil or plant tissue testing, weather data, and record keeping; all these tactics become the basis of suppression efforts. Effective pest monitoring requires correct identification of pests and pest predators in all life stages.
- **Suppression** tactics are applied when prevention and avoidance strategies have failed, and monitoring indicates that action is needed to avoid economic losses. Chemical pesticide applications are one suppression tactic; other practices include tillage, trap crops, cover crops, residue management, and applying biopesticides, among others.

Common waterhemp. Source: University of Nebraska.

For a farmer, IPM is a complex system that requires managing multiple pests at the same time, frequent monitoring of pests and their natural enemies, establishing economic or pest population thresholds before applying pesticides, and integrating several suppressive tactics (Ehler, 2006). Monitoring or sampling pest populations to determine need and timing for pesticide applications is one of the most widely adopted tactics. However, IPM is often criticized for a lack of integration in practice despite its emphasis on integration practices in theory (Ehler, 2006; Pedigo, 1995; Ehler & Bottrell, 2000). Researchers have noted that IPM, as applied in practice, continues to emphasize pesticide-based programs (Pedigo, 1995; Ehler & Bottrell, 2000; Norsworthy et al., 2012; Mortensen et al., 2000; Anderson, 2005) in which scale and convenience have facilitated the adoption of prophylactic pest control as a form of insurance (Peterson et al., 2018).

Pesticide resistance has become increasingly widespread as cropping systems and the application of chemicals to control pests have become more uniform (Osteen & Fernandez-Cornejo, 2016). More than 250 weed species have evolved with resistance to at least one herbicide. Of the 26 different herbicidal modes of action known, weeds have successfully developed resistance to 23, resulting in resistance to more than 150 individual herbicides (Heap, 2019). Cases where individual weed species are resistant to as many as six different herbicide modes of action have also been discovered (Shergill et al., 2018).

Opportunities for Agribusinesses and CCAs to Advance Responsible Pest Management

Cleaning tillage and harvest equipment after completing work at each field is a prevention strategy that can help keep pests from infesting a field. Source: United Soybean Board.

Pest management is a community effort, and IPM adoption will be most effective when coordinated among neighboring farmers and their support networks. Certified Crop Advisers and the agribusinesses that employ them have a critical role to play in supplying farmers with effective approaches to manage pests.

A comprehensive analysis of USDA chemical use and pest management practices data from 1990–2018 across nine commodity crops (barley, corn, cotton, soybeans, rice, wheat, peanuts, potatoes, and sorghum) yielded five common themes that can be applied by CCAs in their work with farmers:

1. **Diversify crop rotations.** Understanding pest life cycles and disrupting them with timely rotation of a non-host crop and related strategies can reduce the incidence of damaging outbreaks that require chemical treatment on a farm or in a farming community. Diverse crop rotations also support other sustainable agriculture objectives, including improved soil health.
2. **Rotate chemical modes of action to reduce pesticide resistance.** This is a very important factor for the largest-acreage crops, which rely on very few pesticide modes of action, across the country. This problem is compounded in common rotations where both crops are frequently treated with the same chemical modes of action (e.g., corn–soybean and cotton–soybean).

3. **Use crop varieties bred or engineered to have specific pest resistance.** Crop varieties bred or engineered to resist pest pressures without significant yield loss have the potential to avoid, or reduce, the need for applied crop protectants. This solution is not a panacea as the biology of certain crops or pests can make development of resistant varieties technically challenging.
4. **Provide farmers with choice in seed traits.** For example, in regions where pests are developing resistance to seed treatment insecticides or to the Bt pesticidal effects, farmers need to have a choice of whether to plant seed with and without the pest control factor (e.g., untreated or untraited seed or Bt or non-Bt crop cultivars) or whether to use other IPM practices to manage pests while interrupting the pest's development of resistance to those modes of action.
5. **Partner with land grant universities for advanced pest detection networks and reporting tools.** Many have invested in development of digital tools and field tests to rapidly identify pest threats and target specific strategies for early mitigation.

Chemical pesticide applications are one pest suppression tactic that can be used when prevention and avoidance strategies have failed, and monitoring indicates that action is needed to avoid economic losses. Source: Flickr/Chafer Machinery.

Using a sweep net to monitor insect pest pressure. Source: Purdue University.

A critical element most commodity crop producers are missing is choice. While not every contingency can be planned for, the current reality for most crops is that treatments are disproportionately skewed toward worst-case scenarios of pest infestations, particularly regarding insect and fungal pests. Diversification of pest management practices has become essential for successful farming but can remain challenging to adopt for many farmers. By evolving and expanding their business models to sell differently, agribusiness companies can provide agronomic advice, tools, technologies, and services to support their customers in implementing responsible pest management.

Many of the practices recommended in IPM align with practices considered important for other environmental sustainability goals. For example, diversification of crops in a rotation and inclusion of cover crops are key strategies for improving soil health as well as for avoiding pest infestations. Similarly, balanced plant nutrition without deficiency or excess helps avoid increased susceptibility to several important diseases (Darnoff et al., 2007) while avoiding nutrient losses to the environment and depletion of soil nutrient stocks. The use of pesticides in a precise and judicious manner has a myriad of short- and long-term benefits for farmers and consumers alike. Advancing responsible pest management will take coordinated, collaborative action and commitment over time. Stakeholders must work together to develop systems for profitable and sustainable farms that can successfully manage pest problems while minimizing risk to environmental health, mitigating pest resistance development and improving human well-being.

References

Anderson, R.L. (2005). A multi-tactic approach to manage weed population dynamics in crop rotations. *Agronomy Journal*, **97**, 1579–1583.

Darnoff, L.E., Elmer, W.H., & Huber, D.M. (2007). *Mineral nutrition and plant disease*. American Phytopathological Society, St. Paul, MN.

Dibartolomeis, M., Kegley, S., Mineau, P., Radford, R., & Klein, K. (2019). An assessment of acute insecticide toxicity loading (AITL) of chemical pesticides used on agricultural land in the United. *PLoS One***14**(8), e0220029. https://doi.org/10.1371/journal.pone.0220029

Ehler, L.E. (2006). Integrated pest management (IPM): definition, historical development and implementation, and the other IPM. *Pest Management Science*, **62**, 787–789.

Ehler, L.E., & Bottrell, D.G. (2000). The illusion of integrated pest management. *Issues in Science and Technology*, **16**, 61–64.

Field to Market: The Alliance for Sustainable Agriculture. (2020). *Trends in Pest Management in U.S. Agriculture: Identifying barriers to progress and solutions through collective action*. **https://bit.ly/3ejCBo3**.

Gray, M., Ratcliffe, S., & Rice, M. (2009). The IPM paradigm: concepts, strategies and tactics. In E. Radcliffe, W. Hutchison, and R. Cancelado (Eds.) *Integrated pest management: concepts, tactics, strategies and case studies*. Cambridge, UK: Cambridge University Press.

Hartman Group. (2017). *Sustainability 2017: Connecting benefits with values through personal consumption*. Bellevue, WA: Hartman Group. **https://bit.ly/2VOPb48**

Heap, I. (2019). *International survey of herbicide resistant weeds*. Westminster, CO: Weed Science Society of America.

IPBES. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn, Germany: IPBES.

Mortensen, D.A., Bastiaans, L., & Sattin, M. (2000). The role of ecology in the development of weed management systems: An outlook. *Weed Research*, **40**, 49–62.

Norsworthy, J.K., Ward, S.M., Shaw, D.R., Llewellyn, R.S., Nichols, R.L., Webster, T.M., … Barrett, M. (2012). Reducing the risks of herbicide resistance: Best management practices and recommendations. *Weed Science*, **60**(sp1), 31–62.

https://doi.org/10.1614/WS-D-11-00155.1

Pedigo, L. (1995). Closing the gap between IPM theory and practice. *Journal of Agricultural Entomology*, **12**, 171–181.

Peterson, R.K.D., Higley, L.G., & Pedigo, L.P. (2018). Whatever happened to IPM? *American Entomologist*, **64**, 146–150.

Osteen, C.D., & Fernandez-Cornejo, J. (2016). Herbicide use trends: A backgrounder. *Choices*, **31**, 1–7.

Shergill, L., Barlow, B., Bish, M., & Bradley, K.W. (2018). Investigations of 2,4-D and multiple herbicide resistance in a Missouri waterhemp (*Amaranthus tuberculatus*) population. *Weed Science*, **66**, 386–394.

Smith, R.F., & Allen, W.W. (1954). Insect control and the balance of nature. *Scientific American*, **190**, 38–43.

Smith, R.F., Apple, J.L., & Bottrell, D.G. (1976). The origins of integrated pest management concepts for agricultural crops. In J.L. Apple and R. F. Smith (Eds.) *Integrated pest management* (pp. 1–16). Boston, MA: Springer. https://doi.org/10.1007/978-1-4615-7269-5_1

Smith, R.A., & Reynolds, H.T. (1966). Principles, definitions and scope of integrated pest control. In Proceedings of the FAO Symposium on Integrated Pest Control, Rome, Italy, 11-15 Oct. 1965. pp. 11–17.

Smith, R.F., & Smith, G.L. (1949). Supervised control of insects: Utilizes parasites and predators and makes chemical control more efficient. *California Agriculture*, **3**, 3–12.

Stern, V., Smith, R., Van den Bosch, R., & Hagen, K. (1959). The integration of chemical and biological control of the spotted alfalfa aphid: the integrated control concept. *Hilgardia*, **29**, 81–101.

USDA. (1993). *The practice of integrated pest management (IPM). The PAMS approach*. Washington, DC: USDA.

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