

# Roadmap for Integrated Pest Management

Systems Thinking to Build Better IPM for All Californians



Lori A. Berger  
James J. Farrar  
Peter B. Goodell  
Joseph McIntyre



University of California

Agriculture and Natural Resources ■ Integrated Pest Management Program

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**Lori A. Berger, Ph.D.**, *Academic Coordinator, UC Statewide IPM Program, Co-Principal Investigator*

**James J. Farrar, Ph.D.**, *Director, UC Statewide IPM Program, Co-Principal Investigator*

**Peter B. Goodell, Ph.D.**, *IPM Advisor (emeritus), UC Cooperative Extension*

**Joseph McIntyre**, *Senior Facilitation Analyst and Executive Director (emeritus), Ag Innovations Network*



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### **University of California Definition of Integrated Pest Management (IPM)**

IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.

### **Our Vision for Integrated Pest Management in California**

Our vision for IPM in California is a future where integrated pest management has successfully balanced effective pest management and risk reduction, and that IPM is practiced by both the public and professionals who understand, appreciate, and apply its principles.



Integrated Pest Management Program

# Executive Summary

Californians share the common experience of pests at home, at work, and in recreational areas. We also share multiple and often contradictory desires for outcomes from pest management: expectations of immediate results and long-term control, effective controls with lowest risk to people and the environment, and a wide choice of options including some choices that are inherently higher risk. It is not surprising then that while we share a deep apprehension of pests, we also have polarized attitudes about pesticides and other pest management practices.

We are at a pivotal point in the evolution of pest management in California. Changing pest pressures, increased urbanization, and the demand for healthy and reasonably priced food all drive the need to reexamine our relationship to, and management of, pests. We need to expand our understanding of the biology of pests and their management and agree on a common approach for cost-effective, reduced risk, long-term pest management in California.

The good news is that we already have this approach. Integrated pest management (IPM) is the pest management approach preferred by scientists, regulators, and practitioners alike. A wealth of empirical evidence demonstrates that IPM is a sustainable approach that uses multiple tactics to reduce or, in many cases, entirely eliminate the need for pesticides.

The Pests, Pesticides, and IPM Project was a two-year conversation to tackle the complex topic of pests and pest management, and to examine ways we could reach a common understanding of the issues surrounding pests, pesticides, and IPM. Equally, we examined barriers and drivers of IPM adoption and greater IPM use.

## Objectives of the Pests, Pesticides, and IPM (PPI) Project:

- To articulate the diversity of pest management needs and perceptions of risk at the field, research, regulatory, and policy levels
- To suggest policy, innovation, and communication approaches that support increased adoption of IPM
- To equip leaders with broadened knowledge and tools so that all stakeholders might consider and use more IPM-based approaches
- To establish ongoing dialogue between diverse stakeholders in IPM

Over the course of the project, small teams of community members, scientists, extension personnel, regulators, commodity group representatives, conservationists, worker advocacy representatives, health workers, growers, and pest control advisors from throughout California met for in-depth discussions. To ensure a powerful and robust conversation, we invited people from agricultural, landscape, and structural IPM communities in both urban and rural areas of California to engage in discussions of their particular concerns. Each participant came to creatively address the social, economic, and community concerns about pest management. We also listened to people with policy, innovation, and communication expertise to learn how to support improved IPM adoption.

We found that many of the underlying issues surrounding improved pest management systems, were societal, rather than scientific, in nature.

We learned of dozens of projects and efforts that were overcoming these social, attitudinal, and practical barriers. There is much that can be done right now to improve our approaches and extend the benefits of IPM throughout our beautifully diverse state. Moving forward, we can build upon and add to the many success stories in IPM.

We learned the importance of trusted messengers and how they can be foundational to new partnerships and collaborations within diverse communities. IPM provides a unique opportunity to engage the wisdom, values, and knowledge of all California communities, including indigenous communities and communities of color. This approach helps us to credibly connect on common issues and learn from diverse viewpoints and experiences.

It is these partnerships and trusted relationships that will be most productive moving forward. We must build connections now and not just when a crisis occurs. We must “begin with the end in mind” and equip the next generation of IPM leaders with new tools and communication skills. Overall, we must commit to ongoing dialogue about pest management in California.

Based on successful models of social change, we need to support the understanding that IPM is the best way to limit pest damage and to reduce risks to people, the environment, and the economy of California. Sufficient time must be allowed for broad acceptance of new concepts and widespread behavioral change to take root. Once established, this change actually becomes a type of societal “value,” such as nonsmoking areas and recycling efforts, which are accepted, embraced, and ultimately, expected, in a community.

The following recommendations support advancing and reinvigorating IPM in California:

- **Reinvest in IPM at Every Level**—to make sure the best science-based information is developed and available to all Californians.
- **Drive the Demand for IPM in the Value Chain**—to increase awareness of IPM and to create incentives for more IPM throughout the value chain.
- **Speed up the IPM Innovation Process**—to ensure a wide variety of tools are available.
- **Invest in Trusted Messengers**—to reach people in their own languages, customs, and styles about risk, health, and safety in order to more fully engage frontline workers in pest management.
- **Increase the Collaborative and Problem-Solving Capacity of Stakeholders, Practitioners, Policymakers, and the Public**—to maximize our collective resources, especially to problem solve when a crisis occurs.
- **Strengthen the Public’s Capacity to Understand Pests, Pesticides, and IPM**—so that scientific information and regulatory approaches are more readily understood, accepted, and supported.
- **Make IPM Practitioners More Effective Voices for IPM**—so that they, as front line professionals, can answer questions about pests and pesticide use that arise in their community.
- **Leverage Nontraditional Resources for IPM**—to increase collaborations and resources that support the power of partnerships in tackling complex issues related to pest management.
- **Strengthen Capacity of Practitioners to Use More IPM**—to more effectively reach out to the public who is concerned about health and safety.
- **Redesign the Retail IPM Process**—to educate consumers about the responsible use of pesticides and/or limit the availability of high risk products in the marketplace to trained and licensed professionals.

In the end, successful pest management is the shared responsibility of each and every Californian. We hope the information presented in this report contributes to a more informed California on pests, pesticides, and IPM, leading to the commitment and creativity required to continue this important dialogue and advance intelligent pest management.

Lori A. Berger, Ph.D., Academic Coordinator, UC Statewide IPM Program, Co-Principal Investigator  
James J. Farrar, Ph.D., Director, UC Statewide IPM Program, Co-Principal Investigator  
Peter B. Goodell, Ph.D., IPM Advisor (emeritus), UC Cooperative Extension  
Joseph McIntyre, Senior Facilitation Analyst and Executive Director (emeritus), Ag Innovations Network

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## Pests are a societal problem... and the reason for the Pests, Pesticides, and IPM Project

The Pests, Pesticides, and IPM Project (PPI) came about due to the increasing need to encourage productive discussions about pests and the use of pesticides in California and to advance greater adoption and implementation of IPM. While Californians have been leaders in IPM, the need to develop new tools and broaden our communication about the complex topic of pest management has never been greater. This has become more apparent with each new pest and pesticide issue encountered in our diverse state and concerns raised by the public, consumers, and workers. Scenarios of pest outbreaks and community concern about pest management have repeated themselves, leading to much polarization. This project allowed us to take a step back and evaluate how we could move forward in more collaborative ways to face the challenges.

Throughout the two-year project, the Management Team convened IPM practitioners, scientists, and consumers to identify common themes and concerns about risks from pests and pest management and to make recommendations to chart the way forward. Our Advisory Board provided valuable insights throughout the process. A total of five professionally facilitated sessions (Interest Groups) allowed us to capture input on diverse pest issues impacting stakeholders in agricultural, landscape, and structural IPM. We also considered how best to direct future efforts in

policy, innovation, and communication to improve IPM outcomes and adoption. Risks to people, communities, workers, economics, and environmental quality in California's urban and rural communities were discussed. Our goal was to create a set of recommendations that would enhance overall understanding and exchange about pest-related issues for all Californians. Our findings were presented at the first IPM Summit held in Davis, California on April 17, 2018.

### PROJECT OBJECTIVES

- To articulate the diversity of pest management needs and perceptions of risk at the field, research, regulatory, and policy levels.
- To suggest policy, innovation, and communication approaches that support increased adoption of IPM.
- To equip leaders with broadened knowledge and tools so that all stakeholders might consider and use more IPM-based approaches.
- To establish ongoing dialogue between diverse stakeholders in IPM.

## What is the challenge we face?

**California is the land of opportunity for people—and pests. With our Mediterranean climate, diverse geography, warm winters, coastal location, movement of goods across borders, and increasing frequency of international travel, pests have been able to enter and establish themselves on a continuing basis. Pests of concern may vary by location and setting, but include insects, plant diseases, weeds, vertebrates, nematodes and other unwanted species. While entry is minimized as much as possible through border inspections and other regulatory actions, our risk from pest introductions in California presents an ongoing threat to our health, comfort, environment, working landscapes, and overall wellbeing.**

Before World War II, pesticides in use included lead arsenate, naphthalene, kerosene, and nicotine sulfate, all of which were highly effective, but also extremely toxic. We then moved into the era of broad-spectrum, persistent synthetic chemistries such as organochlorines, organophosphates, and carbamates. The 1960s marked the introduction of pyrethroids, which were less toxic than their predecessors and broke down quickly. By the 1970s, pheromones, growth regulators, and microbial pesticides were added to the chemical toolbox, soon joined by neonicotinoids and a number of narrow-spectrum, reduced-risk pesticides. Biological pesticides (or biopesticides) are derived from natural materials such as plants, bacteria, and minerals. Although biopesticides currently represent only 5 percent of the market, since 2010, their use has increased about three times faster than that of conventional pesticides.

During the 1970s, the movement toward more integrated approaches was driven by problems such as pesticide resistance and pest resurgence. While there is agreement that synthetic pesticides have played an important role in providing an abundant and inexpensive food supply to the world, scientists and society moved toward passionate expressions that the benefits of these tools must be balanced against potential adverse effects on human health and the environment.

In California, IPM has been fostered through the UC Statewide IPM Project created by the California legislature in 1979. This dedicated program came about because of scientific advances, a receptive political

climate, and support of the University of California. Today, the need for this program is even greater due to consumer and community concerns over pesticide risks, production practices, pesticide residues in water, pollinator protection, health, and other societal drivers. Unfortunately, the delivery of research and education has not kept pace with the pest issues due to reduced budgets, loss of personnel, and unfilled positions throughout the state and in county-based programs.

So, where are we with IPM today? In a highly diverse state such as California, the list of pests is long, quite variable, and, unfortunately, continually expanding (see table, next page). We are experiencing outbreaks of both established and new pest species as California undergoes climate change and urbanization—and as global trade and travel increase. Our challenge is to identify ways in which we can work together to balance the risks from pests and the pest management practices we use.

Polarization has arisen in California from not being able to agree on a common approach to pest management.

How can we, as Californians, balance the risks from pests and the risks from the pest management practices we use?"



## Diverse pests abound in agricultural, landscape, and structural settings

Pest Type	Agriculture	Landscape	Structures	
<b>INSECTS, MITES, AND OTHER INVERTEBRATES</b>	<ul style="list-style-type: none"> <li>Ants</li> <li>Aphids</li> <li>Asian citrus psyllid</li> <li>Bagrada bug</li> <li>Brown marmorated stink bug</li> <li>Leaffooted bugs</li> <li>Lepidopteran pests</li> <li>Light brown apple moth</li> <li>Lygus bug</li> </ul>	<ul style="list-style-type: none"> <li>Mealybugs</li> <li>Navel orangeworm</li> <li>Soil-borne insects</li> <li>Spotted wing drosophila</li> <li>Stink bugs</li> <li>Thrips as vectors</li> <li>Western flower thrips</li> <li>Treehoppers as vectors</li> <li>Varroa mites</li> </ul>	<ul style="list-style-type: none"> <li>Asian citrus psyllid</li> <li>Cockroaches</li> <li>Goldspotted oak borer</li> <li>Mealybugs</li> <li>Mosquitoes</li> <li>Pine bark beetles</li> <li>Shot hole borers</li> <li>Snails</li> <li>Palm weevil</li> </ul>	<ul style="list-style-type: none"> <li>Ants</li> <li>Bed bugs</li> <li>Bees</li> <li>Carpet Beetles</li> <li>Cockroaches</li> <li>Fleas</li> <li>Flies (various)</li> <li>Mosquitoes</li> <li>Pantry pests</li> <li>Spiders</li> <li>Springtails</li> <li>Termites</li> <li>Yellowjackets</li> </ul>
<b>WEEDS</b>	<ul style="list-style-type: none"> <li>Organic systems</li> <li>Herbicide-resistant weeds</li> <li>Invasive weeds</li> <li>Nutsedge</li> </ul>	<ul style="list-style-type: none"> <li>Annual bluegrass</li> <li>Sahara mustard</li> <li>Spotted spurge</li> <li>Water Primrose</li> </ul>	Not applicable	
<b>DISEASES</b>	<ul style="list-style-type: none"> <li>Cavity spot</li> <li>Curly top</li> <li>Laurel wilt</li> <li>Powdery mildew</li> <li>Red blotch in grapes</li> <li>Soil-borne diseases (emerging as fumigant use declines)</li> <li>Downy mildew</li> <li>Spotted wilt</li> </ul>	<ul style="list-style-type: none"> <li>Phytophthora</li> </ul>	Mold	
	<ul style="list-style-type: none"> <li>Root knot in tuber vegetables</li> <li>Species complex in fruit and nut trees</li> </ul>	Not applicable	Not applicable	
<b>VERTEBRATES</b>	<ul style="list-style-type: none"> <li>Gophers</li> <li>Ground squirrels</li> </ul>	<ul style="list-style-type: none"> <li>Birds</li> <li>Deer</li> <li>Foxes</li> <li>Ground squirrels</li> <li>House mice</li> <li>Rodents</li> <li>Roofrats</li> <li>Snakes</li> <li>Coyotes</li> </ul>	<ul style="list-style-type: none"> <li>Rodents</li> <li>Birds</li> </ul>	
<b>EMERGING PESTS AND ISSUES</b>	<ul style="list-style-type: none"> <li>Asian citrus psyllid</li> <li>Bagrada bug (organic crops)</li> <li>Red blotch in grapes</li> <li>Spotted wing drosophila</li> <li>Herbicide-resistant weeds</li> <li>Invasive weeds (e.g., water hyacinth)</li> </ul>	<ul style="list-style-type: none"> <li>Pine bark beetle</li> <li>Shot hole borers</li> <li>Coyotes (more incidents)</li> </ul>	<ul style="list-style-type: none"> <li>Bed bugs</li> <li>Biting mites (rodent &amp; bird mites)</li> <li>Chagas bug</li> <li>Climate change-related issues</li> <li>Encroachment</li> <li>Feral cats</li> <li>Mosquitoes</li> <li>Rodents</li> <li>Turkestan cockroaches</li> <li>Vector-borne diseases</li> </ul>	
<b>INTEREST GROUP MEETING(S)</b>	<ul style="list-style-type: none"> <li>June 13, 2017 in Paso Robles, California</li> <li>June 15, 2017 in Mendota, California</li> </ul>	<ul style="list-style-type: none"> <li>June 21, 2017 in Pasadena, California</li> </ul>	<ul style="list-style-type: none"> <li>June 7, 2017 in Lodi, California</li> </ul>	

## How did we get here? A very brief history of pest management in California

California has a long history of approaching pest issues holistically. In the 1940s and 1950s, the integrated pest management (IPM) groundwork was developed and refined in agriculture through field scouting, decision support tools, and the introduction of the Integrated Control Concept. During the 1960s, the environmental movement was born out of public concern about human, environmental, and pest management risks posed by dependence on and widespread use of pesticides.

During the 1970s, IPM approaches in California gained momentum as single, chemical management approaches began to fail and secondary pest outbreaks arose. The creation of the California Environmental Quality Act (CEQA), further drove the demand for IPM when professionals making pest control recommendations were required to be licensed. As part of that process, recommendations for pest control had to be written and guarantee “that alternatives and mitigation measures that would substantially lessen any significant adverse impact on the environment have been considered and, if feasible, adopted.”

To meet the functional equivalency of CEQA, a formal program was needed to develop, demonstrate, and implement a host of alternative pest management practices.

Thus was born the University of California’s Statewide Integrated Pest Management Program (UC IPM) in the Division of Agriculture and Natural Resources. Since 1980, UC IPM has provided leadership in research, education, and extension to Californians in agricultural, urban, and landscape settings.

The term  
“integrated pest management”  
first appeared in public policy  
in 1972 in a message from  
President Nixon to Congress  
regarding a program for environmental  
protection, resulting in the organization  
of the U.S. Environmental Protection  
Agency (U.S. EPA).



## The state of IPM today: Potential not fully realized

Although IPM as an approach to pest management has been with us for over fifty years, the adoption of IPM practices has certainly not achieved its full potential; some would even say we have been stuck at very moderate levels of adoption. While many in the pest management industry say they use IPM as a tool, relatively fewer would say it is the core of their pest management approach.

There are numerous reasons for this, from the demand for near perfect fruits and vegetables and homes that are completely pest-free, to the difficulties of managing

invasive pests using IPM practices. What discourages (restrains) IPM was a central question in our discussions during the PPI Project. We also asked about what currently encourages (drives) IPM adoption.

Examples of some of these driving and restraining forces are in the following table. The challenge in a large and diverse state like California is to simultaneously reduce the barriers to IPM adoption, while increasing the social capital, i.e., the system of reciprocity, trust, and cooperation needed to move IPM forward.



## Forces acting upon IPM in California

### Drivers

Public concern about pest management practices, pesticide use, environmental quality, pollinators, and other issues

Climate change impacts on host biology and pest development

Increasing entry of invasive pests

Successful integration of biopesticides into organic and conventional production systems

Realization that planning and coordination around pests in public spaces is needed, and in some cases, should be required (schools, parks, care facilities)

Resistance due to overuse of certain active ingredients

Globalization of trade and a lack of international registrations (MRLs) for newer chemistries

Sustainability initiatives: People wanting to know more about how their food is produced and what safeguards are in place to protect workers, the environment, and consumers

Increasing regulations

### Drivers

Consumers have near-zero or zero tolerance of pests and damage in food

Lack of a trained workforce coming into IPM at all levels, public, private, and in government

Loss of institutional knowledge at UC, UCCE, and PCA levels—aging workforce

Lack of understanding of IPM by elected officials and government agencies (state, county, city)

Lack of development of lower-risk active ingredients and biopesticides

Real and perceived costs of using IPM

International registration process is lengthy and cumbersome

Lack of adequate funding to keep pace with pest introductions and outbreaks

Perception and reality of few incentives to use IPM

## Reinvigorating IPM in California

Moving forward requires robust approaches to deliver IPM solutions that are long lasting, sustainable, and embraced by the diversity of people, places, and perspectives that make up California. Systems thinking, partnerships, and dialogue, or a combination of these approaches, will be required to generate a renewed commitment to IPM.

We can explain why many past pest management programs have been weak, entirely failed, or were rejected by a community due to lack of connected thinking, inclusion, or dialogue. These factors will be described in more detail later in this report so that we can achieve more success in communicating pest issues to the public and in driving more adoption of IPM in the field.



Dialogue with the public must be ongoing, not just when a crisis occurs.



## A common approach for pest management in California

IPM is, at its core, is about working with biological systems to reduce the conditions that lead to pest problems and when problems do arise to take advantage of tools found in nature, such as predator species, to address issues. Pesticides become just one tool in the tool box, to be used only when appropriate.

For Californians to understand pest management and become genuine IPM partners, it will be necessary to share a common language. This will include education and active engagement with others to share skills, resources, and information to understand the biological systems around us, detect when those systems may be inviting to pests, and ready to be inviting to pests, and know how to work with nature to create a more pest-resistant environment. Included in this should be discussions about risk, risk management, the role of regulators, and the role of the regulatory processes in place to protect humans and the environment.

Fortunately, there are a number of resources made available through county extension offices, Master Gardener clubs, trade associations, and at some retail stores. The UC Statewide IPM Program hosts an extensive website ([www.ipm.ucanr.edu](http://www.ipm.ucanr.edu)) that includes pictures and information on habitat, damage, and pest management options for a wide range of pests.

UC IPM Statewide Integrated Pest Management Program

MAKE A GIFT Support UC IPM's mission to make integrated pest management the way to manage pests

Home, Garden, Turf & Landscape Pests

Agricultural Pests

Natural Environment Pests

Exotic & Invasive Pests

What's New

- **Pest Alert:** Huanglongbing found in Riverside
- **Highlights:** 2018 Annual Report
- **Strategic plan 2015-2019**
- **Ag Pest Management:** Dry Beans revised, Pecan and Avocado updated
- **Quick Tips:** 12 titles have been revised and updated with a brand-new design
- **Green Bulletin:** Spring 2018
- **Pest Notes:** Scaevola and Slugs, Dandelions, Redhumped Caterpillar updated, Dyer's Wood added
- **Retail Nursery & Garden Center IPM Newsletter:** Spring 2018
- **More...**

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- Newsletters
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- Online training
- Weather, models, & degree-days

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## Building trust: Engaging Californians as partners in pest management

During our extensive Interest Group discussions, the concept of trust continually emerged as essential to successful engagement around pest management activities. Building trust requires a commitment to talk and listen with the people who have concerns or needs and understand their fears and aspirations. There is no shortcut to creating these relationships and without them we are often condemned to being locked in perpetual conflict. Stronger relationships lead to deeper understanding of needs and interests and to creative solutions. When these new solutions work (like collaborations between workers, their employers, and pest control advisors to reduce pest habitat), it tends to strengthen the very relationships that lead to the creative ideas.

Building and maintaining trust isn't easy and it takes time to develop. And talking is not enough, our actions have to match our talk. That means everyone interested in building trust and flexibility has to accept some personal risk to accomplish the bigger goal. Yet, more often than not, people are willing to make changes if given respect, time, and support.

During the course of multiple Pests, Pesticides, and IPM Project discussions, we identified several concrete trust-building opportunities that can be started immediately:

- Creation of **Regional IPM Councils** where diverse stakeholders can come together to learn what is working and what needs attention in regional pest management.
- Identifying and engaging **Trusted Messengers** who speak local languages and have a true understanding of local concerns, culture and history as key connectors between communities and pest managers.
- Holding events that act as **Bridges** such as an annual IPM Summit to convene stakeholders, share new tools, evolve the PPI initiative, highlight successes, and move more deeply towards systemic solutions.

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“ In the final analysis it doesn't really matter what the political system is... we don't need perfect political systems; We need perfect participation. ”

— Cesar Chavez

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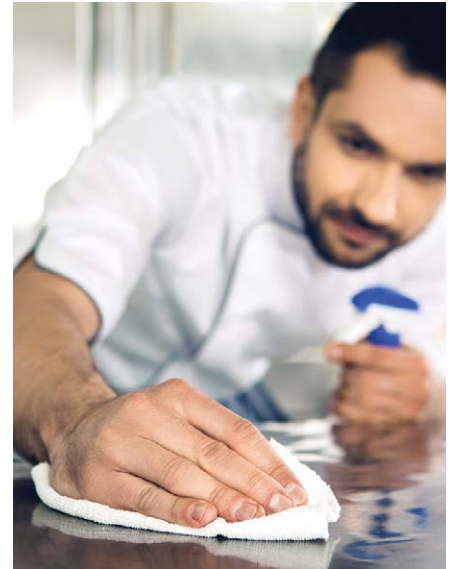
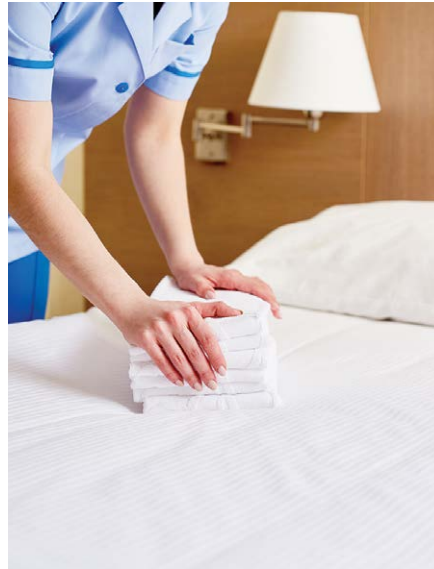
## California's diversity as a strength

California's colorful patchwork of urban and rural landscapes, climates, and people have bred distinctive economies and cultures that have been forced into contact with one another. Not only is our state the most populous, it is also the most diverse when ethnicities, cultures, religions, economic statuses, and educational backgrounds are considered. It is important to move forward looking at cultural diversity as a strength from which we can draw from for pest management.

The great number of cultures and languages that make up California create challenges and opportunities to understand and present IPM in unique ways.

- |                          |            |              |              |
|--------------------------|------------|--------------|--------------|
| ■ Afrikaans              | ■ French   | ■ Maidu      | ■ Tamil      |
| ■ Amharic                | ■ German   | ■ Miwok      | ■ Twi        |
| ■ Arabic                 | ■ Hindi    | ■ Mojave     | ■ Ukrainian  |
| ■ Armenian               | ■ Hmong    | ■ Pashto     | ■ Vietnamese |
| ■ Asian Pacific Islander | ■ Hupa     | ■ Pomo       | ■ Wappo      |
| ■ Assyrian               | ■ Ibo      | ■ Portuguese | ■ Wintu      |
| ■ Bantu                  | ■ Italian  | ■ Russian    | ■ Wintun     |
| ■ Chilula                | ■ Japanese | ■ Serrano    | ■ Wiyot      |
| ■ Chinese                | ■ Juaneno  | ■ Shasta     | ■ Yana       |
| ■ Chumash                | ■ Karok    | ■ Singhalese | ■ Yoruba     |
| ■ Cocopah                | ■ Kato     | ■ Somali     | ■ Yuma       |
| ■ Dutch                  | ■ Khmer    | ■ Spanish    | ■ Yurok      |
| ■ English                | ■ Korean   | ■ Swahili    |              |
| ■ Farsi                  | ■ Laotian  | ■ Swedish    |              |
|                          | ■ Latvian  | ■ Tagalog    |              |





**Spanish-dominant workers (meaning they also speak another language, but prefer Spanish) are often at the front line of pest problems on farms and in restaurants, schools, landscaping operations, and in many other settings. Creating respectful relationships with these valued allies can be foundational to building trust and developing outreach about pest management and IPM.**

To gather baseline data on the understanding of pests, pesticides, and IPM by Spanish-dominant workers, we organized focus groups in Fresno and Santa Maria. Our goal was to tap into the experiences of workers from a diverse array of industries: agriculture, nurseries, restaurants, and hotels.

Our findings confirmed that workers are deeply concerned about the harmful effects of pesticides on the health of their families and communities. The terms “pest management,” “integrated pest management,” and “IPM,” are unfamiliar and the concept of IPM is challenging to grasp. The word “management” is distancing, and workers do not connect it to something an individual would do. Connecting the practices of IPM to one’s home and family could improve understanding and relevance. The government and known local community-based organizations are the most likely places this sector would go to find information on a topic like IPM.

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The tech-savvy and mobile-first characteristics of the Spanish-speaking community create sufficient opportunities to increase IPM awareness about IPM.

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There are significant opportunities to work with the non-English speaking community. The Spanish-speaking community, in particular, is tech-savvy and mobile-first; we should explore ways to use technology to connect and share more efficiently.

#### **Recommendations to Increase IPM Awareness with English as a Second Language Workers:**

- Create and widely disseminate storytelling videos in Spanish and other languages that demonstrate the use and benefits of IPM
- Develop educational materials that draw clear connections of IPM to work, home, health, and family
- Create engaging and compelling stories with a clear roadmap for the use of IPM by the individual consumer
- Provide clear demonstrations to show the difference between IPM and non-IPM practices
- Format videos so they are easily found and shareable through social media
- Engage local community-based organizations (CBOs) to serve as trusted messengers to provide resources and education about IPM

## Shifting mindsets: Taking a systems approach

**When we see a pest in home or field, our first reaction is often to ask how can we immediately and inexpensively eliminate the unwanted bug, weed, or microbe. The logic is clear: We have a problem, we have a goal, and we need only to find an easy way to accomplish our goal. This simple chain of problem-solving is our traditional way of thinking about pest management.**

Yet managing pests while maintaining human, ecological, and economic health is not a simple chain. To help us manage this complexity, we turn to systems thinking to shift our approach from short to long-term, and from eradication to managing home, business, and farm environments in a way that reduces conditions that lead to pest problems.

This is a shift in thinking from problem-solving suitable for simple issues to problem-solving for complexity, and this shift is at the heart of IPM. Think of pest management as a giant iceberg, where most of what matters is below the waterline. What we see above the waterline are the periodic pest problems—the curl in the peach leaves, the worm in the orchard, or the ants in the kitchen.

Beneath the water line in the image is another story: there are the recurrent patterns of pest infestations and eradication efforts that seemingly ramp up every year. These patterns or trends are important measures of how pest and management approaches have changed over time. Underneath these patterns and trends are the systems and structures that create the patterns. For example, the desire for almost perfect fruits and vegetables creates enormous pressure on farmers to use any means possible to keep pests away from their products. This cycle drives both the need for and demand for control measures. This is just one of many systems structures that create the level and type of pest management we have today.

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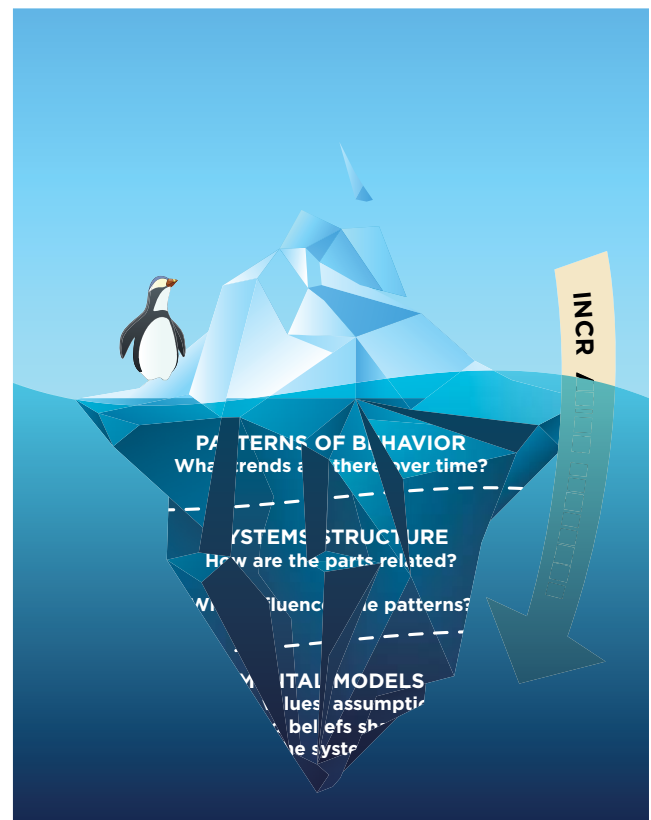
“ Systems thinking is a discipline for seeing wholes and a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots.”

— Peter Senge

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Finally, at the bottom of the iceberg, are our mental models of what is good and right. These models are formed over time by stories, experiences, and media messages. Not all of us have the same mental models, but when enough of us do, they create systems structures. Using the same example, our mental model of a grower trying to meet domestic and international quality standards for fresh produce creates the demand for a kind of food production that requires the use of pesticides.

We have used tools of systems thinking to help us understand and organize the information we collected throughout this project. The iceberg model encouraged us to look more deeply at what might be advocating for and holding back adoption of IPM. One of the tools we used was force field analysis that tells us that level of adoption of IPM may be held in the balance between forces that drive and restrain adoption.

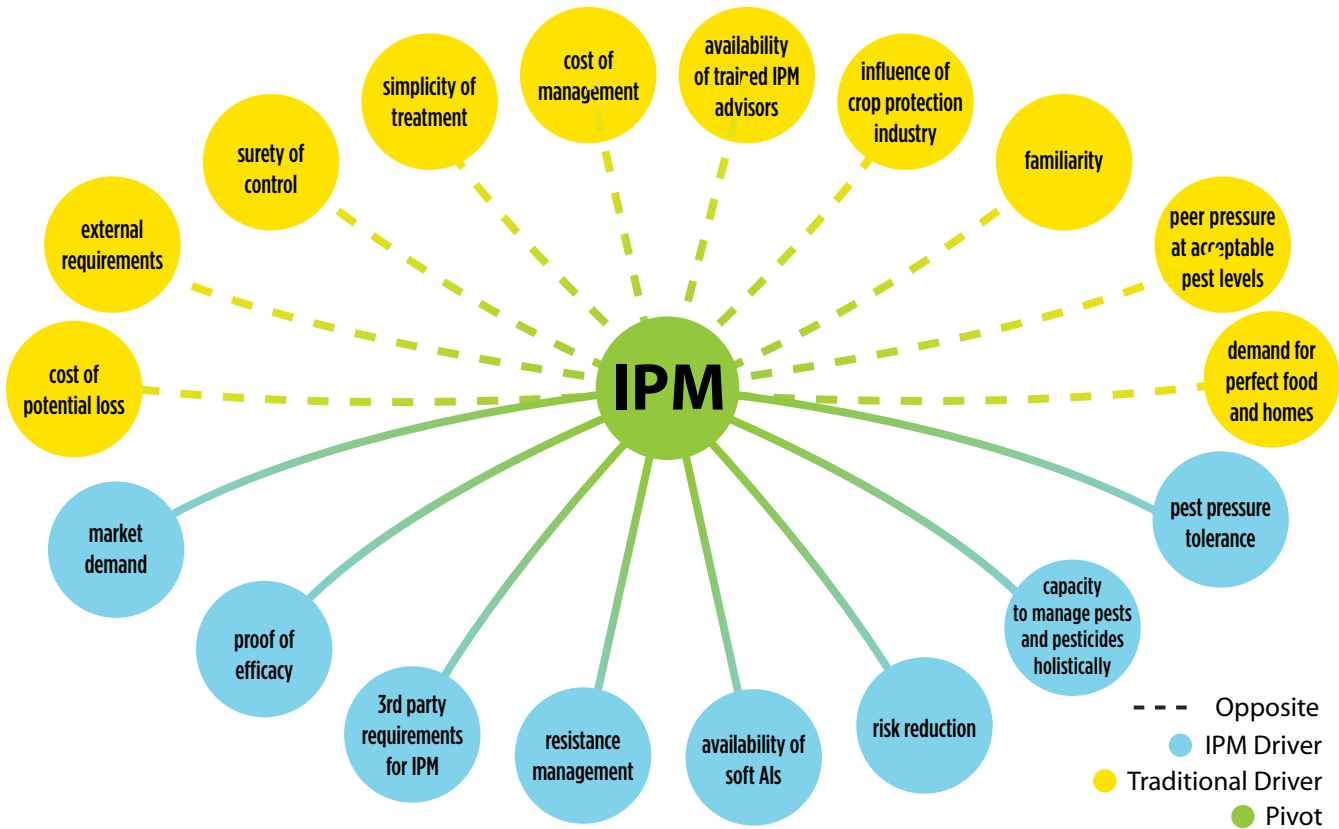


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<sup>1</sup>Kim, Daniel H. “Introduction to Systems Thinking.” Pegasus Communications, 1999.

<sup>2</sup>Lewin, Kurt. “Group decision and social change.” Readings in Social Psychology 3.1 (1947): 197–211.

## Driving and restraining forces



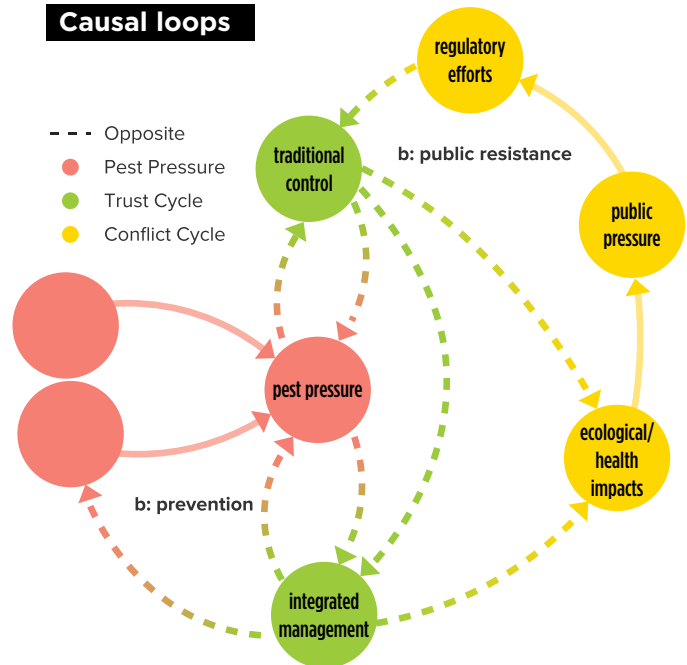
Based on the information provided by participants, several driving and restraining forces were identified that are influencing IPM adoption. Drivers (shown in blue in the diagram) include the market demand for high quality products, high level of efficacy for pest management, availability of alternative low-risk pesticides and non-pesticidal practices, economic demand for reducing risk to production, and tolerance for pest pressure. Forces that are restraining wider use of IPM (shown in yellow) include the cost of potential loss (including individual and community access to market) and cost of performing the new practice, confidence that new practices will perform at a high level, ease of use of alternate practices, availability of trained professionals in applying alternate practices, and community structures that seek to maintain status quo.

Another systems thinking tool we used was causal loop mapping. This kind of mapping tries to describe the underlying systems structures that create the realities we see today in pest management. Specifically, we looked at the conflict between providing adequate protection of food, housing, health, and landscapes with reliable chemical control and the unintended consequences of pesticide exposure to humans, animals, and the environment.

Managing pests cannot be considered in a vacuum, either biologically or societally. Managing pests through the direct application of pesticides has resulted in substantial benefits, but has also come with an external price. If care is not taken by considering the larger

system, the result can be secondary pest outbreaks, reduced efficacy of the pesticide, human health impacts, and other unintended side effects, including environmental. The result when such situations occur is public resistance and calls for more oversight and regulation.

## Causal loops



<sup>3</sup>Tip, Team. "Guidelines for drawing causal loop diagrams." Systems Thinker 22.1 (2011).



An alternate approach to general use of pesticides is using integrated approaches that introduce more balance in management by developing and encouraging more long-term and sustainable practices. In the prevention loop, alternate approaches reduce ecological and health impacts, decreasing public resistance and encouraging policy that enhances use of integrated pest management.

Situations will occur that upset the balance in favor of the pests. Pesticides are usually required to initially manage, while multiple practices are developed to reestablish biological equilibrium (see Goodell, PB. 2013. From Invasion to IPM—Exotic pests and pest management challenges. CAPCA Adviser 16(6): 38–41).

IPM is one part of the larger system of sustainability and calls for continuous improvement.

However, experience predicts that any increase of pesticide or even large-scale nonpesticidal approaches causes a reaction from those who feel outside the decision process. This continual tension between protecting the interests of those impacted by pests and those affected by the pest management activities drives the polarization around pest management in California. Participants in the PPI project consistently stated that the best way to break down this polarization is to increase the communication and trust between stakeholders in the system.

## Transitioning from traditional thinking to systems thinking in pest management

Traditional Thinking	Systems Thinking
Pest control based on one tactic, usually a pesticide	Integrated pest management (IPM) combines many practices
Research projects focus on individual components of pest outbreaks	Research includes interrelationships of components (systems approach) that is multidisciplinary
Field or localized approach to IPM	Shift to area-wide IPM approaches that include other crops or areas plus social and community considerations
Pest management is curative and quick	Pest management focuses on long term pest prevention
In-field sampling used for decision making	Area-wide monitoring uses “Big Data” for decision making and crop management
Data is individual and kept private	Data is pooled for regional monitoring and stewardship efforts
Drift viewed as local issue to be managed at field level	Drift is viewed as a community issue; can include ambient air sampling programs, community considerations, and citizen science
Zero tolerance of pests or damage	Some pests or damage acceptable; preserves natural enemies
Bee protection is a secondary concern	Pollinator protection and best management practices (BMPs) widely adopted
Environmental factors are secondary concern	Environmental quality now a critical concern on both traditional and organic farms
Broad-spectrum products used	Trends toward narrow-spectrum products, pheromones, and biopesticides (traditional and organic farms)
Innovation meant a new active ingredient	Innovation includes all new technologies to reduce pests and maximize resources
Focus on efficiency	Shift to holistic management as demanded by supply chain and the public
Traceability tools limited	Big data allows large-scale monitoring and drives supply chain decisions
Retailers not Involved in pest management	Retailers influence pest management decisions through secondary certifications or approved products
Consumers not overly concerned about sourcing	Consumers want to know where their food comes from and how it is produced
Protection focuses on workers	Protection also considers the community and both short and long term safety
Workers trained by direct supervisors or employers	Community-based organizations and trusted messengers recognized as valued linkages in knowledge transfer for workers and their families
IPM is considered a system	IPM is considered a part of the larger sphere of sustainability

## IPM works! Success stories in California

**IPM is used in nearly every setting imaginable in California: Homes, gardens, farms, schools, buildings, roadways, parks, public lands, and more. Each opportunity has successfully leveraged the use of ecosystems-based thinking, partnerships, new tools, awareness campaigns, or, a combination of these approaches, for more effective and more broadly accepted pest management.**

IPM Opportunity	Approach	For More Information
Pests of trees in yards	Use of physical barrier reduces pests on backyard trees to eliminate pesticide use	<a href="http://www.backyardfoodgrowing.com/how-to-use-tanglefoot">www.backyardfoodgrowing.com/how-to-use-tanglefoot</a>
Lygus bugs in crops	Area-wide approach to reduce pests in safflower aids managing pests in neighboring cotton and tomato crops, reducing total inputs	<a href="http://ipmdata.ipmcenters.org/documents/pmsps/CASafflowerPMSP2016.pdf">ipmdata.ipmcenters.org/documents/pmsps/CASafflowerPMSP2016.pdf</a>
Indigenous stewardship program to manage weedy habitat to aid fire management on tribal lands	Integration of weed management into traditional ecological knowledge of Karuk Indians	<a href="http://www.californiaadaptationforum.org/2018/03/30/integrating-traditional-ecological-knowledge-and-world-renewal-ceremonies-into-fire-adaptation-an-indigenous-stewardship-model">www.californiaadaptationforum.org/2018/03/30/integrating-traditional-ecological-knowledge-and-world-renewal-ceremonies-into-fire-adaptation-an-indigenous-stewardship-model</a>
Home and garden pests	Broad educational program coordinated in partnership with small independent stores and major retail chains such as Home Depot	<a href="http://www.ourwaterourworld.org">www.ourwaterourworld.org</a>
Navel orangeworm in orchards	Sanitation and timely harvest along with pheromones and prescriptive insecticide use reduces damage and need for pesticides	<a href="http://www.almonds.com/pests/navel-orangeworm">www.almonds.com/pests/navel-orangeworm</a>
Gopher control in school athletic fields	Trapping program to reduce populations and reduces pesticide use in Madera School District	<a href="http://www.youtube.com/watch?v=1PTyLEbjOrI">www.youtube.com/watch?v=1PTyLEbjOrI</a>
Pollinator protection in orchards	Research-based strategies to protect bees while balancing the need for pest management options during the bloom period	<a href="http://www.amonds.com/BeeBMPs">www.amonds.com/BeeBMPs</a>
Vector control training for environmental health professionals (e.g., Zika virus)	Online program helps front-line workers address public health pests and vectors that spread human pathogens, including Zika virus	<a href="http://www.cdc.gov/nceh/ehs/elearn/vcehp.html#ipm">www.cdc.gov/nceh/ehs/elearn/vcehp.html#ipm</a>
Vegetation management for highways and rights of ways	Integrated vegetation management (IVM) helps reduce herbicide use on roadways throughout California	<a href="http://www.dot.ca.gov/dist05/maint/ivm/index.htm">www.dot.ca.gov/dist05/maint/ivm/index.htm</a>
Hepatitis A outbreak (public health emergency)	Reduced-risk sanitation options in public spaces such as sidewalks, gutters, and streets during a public health outbreak	<a href="http://www.sandiegocounty.gov/content/dam/sdc/deh/fhd/food/pdf/sanitation_right_of_way.pdf">www.sandiegocounty.gov/content/dam/sdc/deh/fhd/food/pdf/sanitation_right_of_way.pdf</a>
Pest prevention by design: guidelines for keeping pests out of structures	SF Department of the Environment guidelines focus on building design features to keep pests out of structures; used in over 3,500 buildings	<a href="http://cealameda.ucanr.edu/files/157953.pdf">http://cealameda.ucanr.edu/files/157953.pdf</a>
Mosquito control in municipalities	Use of vector control districts to prevent pests through monitoring and habitat management	<a href="http://www.mvcac.org">www.mvcac.org</a>
European grapevine moth in wine grapes	Successful eradication program for invasive pest in winegrapes	<a href="http://www2.ipm.ucanr.edu/Invasive-and-Exotic-Pests/European-grapevine-moth">www2.ipm.ucanr.edu/Invasive-and-Exotic-Pests/European-grapevine-moth</a>

## Creating our future: The next generation of IPM

**IPM today is at a crossroads. Never has the need for integrated approaches been greater. Yet, even as the need increases, the number of qualified IPM experts declines each year—and has done so since the 1980s. The attrition in the field, largely due to the retirement of the first generation of IPM leaders and innovators, is a critical restraining factor in meeting today's needs.**

It is time for a generational shift in the IPM field and workforce. The good news is that California is the perfect environment for encouraging students and others to look at IPM as a high-tech and high-value job and an opportunity to marry values like stewardship, community wellbeing, and commitment to agriculture. These are the good jobs that Californians crave.

Creating a pathway to developing a new IPM workforce begins at the earliest stages of education. There are many appealing ways to incorporate biology and pest management into everyday learning opportunities for children through interesting projects, hands-on training, art projects, and enticing field trips to observe science in action. Opportunities for high schoolers are expanded through job shadowing, part-time jobs, group projects, and science camps. Vocational programs provide excellent opportunities for students who want to enter the job market shortly after high school. College and graduate level programs offer numerous paid internships, assistantships, and training programs in agriculture, structural, and landscape IPM-related fields.

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“ The best way to predict your future is to create it. ”

— Abraham Lincoln

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### Engaging and developing future workers, entrepreneurs, and leaders in IPM

#### Youth

- Critical thinking skills
- Art and science projects
- 4-H youth development
- Science, technology, engineering, and math (STEM) programs
- Job shadowing and field trips

#### Vocational and technical training

- Pest scouting
- Pest control applicator
- Information technology
- Equipment maintenance and laboratory work

#### College graduates and young professionals

- Degree programs in pest management, biology, information technology, health sciences, organizational leadership
- Pathway to PCA Program through California Association of Pest Control Advisors (CAPCA)
- Internships and mentor programs in innovation, biopesticides, and new chemistry with corporate level research and development
- Employee development tracks within state and federal agencies
- Professional certifications (pest control advisor, certified crop advisor, qualified applicator, pest control operator)
- Research and technology graduate assistantship programs in biology, agriculture, engineering, sustainability
- Community development programs and endowments through nonprofit foundations
- International development programs—agriculture, health, environmental stewardship, sustainability initiatives
- Information technology opportunities in remote sensing, monitoring, global information systems, application technology
- Graduate fellowships at corporate level research and development facilities

# 10 bold recommendations to strengthen IPM for all Californians

1

## Reinvest in IPM At every level

### What This Could Look Like

- Fund UC and CSU to conduct IPM research, demonstrate effective IPM practices, and publish results and recommendations
- Update pest management guidelines for urban and rural areas, including newest results and technology (This is a free and online resource.)
- Fund cities and counties to hire IPM coordinators and implement IPM ordinances and plans

2

## Drive demand for IPM in the value chain

### What This Could Look Like

- Coordinate efforts with key organizations to link IPM and sustainability initiatives with retail brands
- Encourage IPM-friendly design in architectural and landscape training
- Raise IPM awareness within commodities and their allied groups such as packers and shippers, retailers, trade partners, and policy makers

3

## Speed up the IPM innovation process

### What This Could Look Like

- Create public-private partnerships to develop novel approaches, reduced-risk products, and mitigation strategies for pest management
- Hire more registration specialists at DPR to speed up review of new biological and reduced-risk synthetic pesticides
- Support innovation hubs to expedite development of new pest management technologies (e.g., drones, precision equipment, sampling devices, monitoring tools, and diagnostics)

4

## Invest in trusted messenger

### What This Could Look Like

- Collaborate with community-based organizations to facilitate field worker training on IPM and highlight ways they can be IPM leaders for their community as partners and storytellers
- Create opportunities through environmental justice to address pest and pesticide issues of impoverished communities
- Expand educational offerings in Spanish and other languages through the internet, videos, smart phones, and other high-tech devices

5

## Increase collaborative & problem solving capacity of stakeholders

### What This Could Look Like

- Convene diverse stakeholders at an annual IPM summit to continue dialogue about pests and IPM in California
- Establish regional IPM tours and IPM councils based on the successful food policy council model to extend IPM information to key stakeholder groups in production, economics, health, and policy
- Profit from the frontline knowledge of field workers and municipal applicators to improve early detection of pests, recommend lower risk approaches, and use safe practices in the workplace

**These independent, but interrelated recommendations rose to the top during our discussions. They are not listed in order of priority, but must all happen to some extent to move California IPM forward in meaningful and measurable ways.**

<b>6</b> <b>Strengthen the public's capacity to understand pests, pesticides, and IPM</b>	<b>What This Could Look Like</b> <ul style="list-style-type: none"><li>■ Feature IPM in training programs for all ages including STEM in schools, 4-H, Master Gardeners, tribal councils, senior citizens' groups, and others</li><li>■ Partner with local health agencies and organizations to teach consumers about pest prevention using IPM as an example</li><li>■ Develop simple, positive public safety announcements using pests and IPM in core messages</li><li>■ Include identification of pesticide poisoning in medical training</li></ul>
<b>7</b> <b>Make practitioners more effective voices for IPM</b>	<b>What This Could Look Like</b> <ul style="list-style-type: none"><li>■ Develop communication tools such as storytelling with simple messages to hand out while on the job (e.g., fact sheets, links to videos)</li><li>■ Provide speaker training at professional meetings (e.g., CAPCA, PCOC)</li><li>■ Collect stories about risks and benefits of IPM for frontline workers in agriculture, landscape, and structural IPM</li></ul>
<b>8</b> <b>Leverage nontraditional resources for IPM</b>	<b>What This Could Look Like</b> <ul style="list-style-type: none"><li>■ Work with tribal councils to understand and promote native wisdom that relates to IPM</li><li>■ Partner with community-based organizations to expand training materials in new languages with culturally appropriate materials</li><li>■ Coordinate with public health organizations to create awareness for IPM and its benefits at home, school, work, and play</li></ul>
<b>9</b> <b>Strengthen capacity of practitioners to use more IPM</b>	<b>What This Could Look Like</b> <ul style="list-style-type: none"><li>■ Expand digital access to IPM information and tools</li><li>■ Create incentives for on-farm demonstrations of new IPM tools</li><li>■ Fund farmer-to-farmer field days</li><li>■ Elevate critical importance of worker training in non-agricultural settings e.g., restaurant workers, assisted-living workers, landscapers, etc.</li></ul>
<b>10</b> <b>Redesign the retail IPM process</b>	<b>What This Could Look Like</b> <ul style="list-style-type: none"><li>■ Highlight ways retailers can educate consumers about the responsible use of pesticides</li><li>■ Limit the availability of high risk pesticides in the marketplace to trained and licensed professionals</li><li>■ Create partnerships with organizations such as Our Water Our World to provide on site education and resources for consumers</li></ul>

## Continuing the dialogue: The true measure of success of the Pests, Pesticides, and IPM Project

A major objective of the PPI Project was to establish dialogue about pests, pesticides, and IPM among diverse stakeholders in IPM and to suggest ways in which this could be continued. The inaugural IPM Summit was held on April 17, 2018 in Davis, California. Included on the agenda were the recommendations from the 2017 Interest Group discussions and a very wide range of IPM topics, including new tools and collaborative approaches. Approximately 125 people attended, representing just under 100 organizations.

The World Cafe format was used by our professional facilitation team to optimize dialogue in the large group setting of the Summit ([www.theworldcafe.com](http://www.theworldcafe.com)). Seating at small tables and rotating tables throughout the day created a friendly and informal atmosphere in which to share perspectives in a safe setting. People and groups that might never have intersected before were immersed in conversations about their own concerns and working together to create solutions.

While very simple, the positive connections created a shift in dynamics. The realization of shared concerns, interests, values, and opportunities created a sense of optimism and possibility moving forward. The energy of new connections, networking, and potential partnerships was apparent. It was exciting, and, at the end of the day, when asked about interest in continuing with similar conferences on an annual basis, the resounding response was “Yes!”



### Organizations at the inaugural IPM Summit in Davis, California on April 17, 2018

Ag Innovations Network  
Alameda County Ag Comm. Office  
Alden Lane Nursery  
Almond Board of California  
Annie's Foods  
Bayer CropScience  
Blue River Technology  
California Assoc. of Pest Control Advisors (CAPCA)  
California Department of Food and Agriculture  
California Dept. of Public Health  
California Growers Association  
California Institute for Water Resources  
California Poison Control System  
California Rice Commission  
California Rural Legal Assistance Foundation  
California Safety Training  
California Safflower Growers Association  
California Strawberry Commission  
California Walnut Board & Commission  
Caltrans  
CeJa-Reyes Inc.  
Central Calif. Environmental Justice Network  
Cen. Coast Alliance United for a Sust. Economy  
CERCH, Public Health, UC Berkeley  
City & County of San Francisco  
City of Sacramento  
City of Santa Monica  
Clark Pest Control  
County of Contra Costa  
County of Napa  
County of Sonoma

Del Monte Foods  
Department of Defense  
Department of Pesticide Regulation  
El Dorado County Dept. of Agriculture  
FMC Corporation  
Fresno Westside Mosquito Abatement  
Greater Los Angeles Co. Vector Control District  
Harris Woolf CA Almonds  
Innovative Genomics Institute, UC Berkeley  
Irvine Ranch Conservancy  
JG Boswell Farming Company  
Kashia Band of Pomo Indians  
Living Resources Company  
Marrone Bio Innovations  
McDonnell Nursery  
National Park Service  
Naturipe Berry Growers  
Neighborly Pest Management Inc.  
Nutrition Policy Institute  
OFR INC  
Orange Co., Mosquito & Vector Control District  
Organic Landscape Maintenance  
Org. en California de Lideres Campesinas, Inc.  
Our Water Our World  
Pacific Biocontrol  
Pest Options, Inc  
Pestec, Inc.  
Pioneer Hi-Bred International  
Pesticide Action Network (PANNA)  
Public Health Institute  
Randlett Nelson Madden  
Regional Asthma Management and Prevention

Rincon Fresh, LLC  
Riverside County Ag Commissioner  
San Francisco Dept. of the Environment  
Santa Clara County Division of Agriculture  
SIMI Marketing Inc.  
The Gualco Group, Inc.  
The Nature Conservancy  
The Sustainability Consortium  
Trees, Bugs, Dirt  
UC Agriculture and Natural Resources  
UC Davis College of Ag and Env. Sci.  
UC Cooperative Extension  
UC Statewide IPM Program  
UC Davis  
UC Riverside  
UC SAREP  
UC 4-H Youth Development Program  
U.S. Environmental Protection Agency (EPA)  
USDA  
USDA APHIS PPG  
USDA NRCS  
USDA-ARS  
W. Neudorff GmbH KG  
Western Ctr. for Agricultural Health & Safety  
Western Growers Association  
Western Plant Health Association  
Western Region IR-4 Program

## Next steps

To continue the momentum, the Management Team will encourage the pest management community to move forward on the recommendations included in this report.

### Beginning immediately, we will focus on the following:

- Re-engage the Advisory Board for reflection and recommitment to the spirit and goals of the project; Set near term goals
- Agree to establish the IPM Summit as an annual event; Develop a path forward, including suggestions for funding
- Meet with UC ANR leadership to align PPI recommendations with strategic directions at ANR and within Statewide Programs
- Seek partnership opportunities to establish an IPM awareness campaign and to develop key performance indicators for communicating responsible pest management with retailers and brands
- Develop a concept proposal for regional IPM tours for legislative staff and agency personnel in Northern, Central, and Southern California to educate them about IPM, local pest issues, resources, and opportunities impacting their constituents
- Determine the complement of UC and CSU staff required to deliver more and better IPM throughout California, including basic and applied research and outreach; Organize a path forward
- Identify key community-based organizations (CBOs) capable of and interested in becoming partners in IPM in Spanish-dominant communities
- Elevate the visibility of a mandate for IPM-friendly design in state offices and buildings
- Develop a concept proposal for regional IPM councils (similar to food policy councils) to integrate and extend IPM information with key stakeholder groups in the arenas of production, economics, health, and policy

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“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.”

— Margaret Mead

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## In closing

Our sincere hope is that stakeholders in IPM will act on the recommendations developed during this process. Only through commitment and follow through will the goals of the Pests, Pesticides, and IPM Project be achieved.

The true measure of the success of this challenge will be the dialogue and energy we as individuals and as a collective generate moving forward.

## The Pests, Pesticides, and IPM Project Management Team

**Lori A. Berger**, Academic Coordinator, University of California Statewide IPM Program (Co-Principal Investigator)

**James J. Farrar**, Director, University of California Statewide IPM Program (Co-Principal Investigator)

**Peter B. Goodell**, IPM Advisor, emeritus, University of California Statewide Cooperative Extension

**Nan Gorder**, Special Assistant to the Director, Department of Pesticide Regulation (retired)

**Doug Downie**, Senior Environmental Scientist, Department of Pesticide Regulation

**Nita Davidson**, Senior Environmental Scientist, Department of Pesticide Regulation

**Joseph McIntyre**, Senior Facilitation Analyst and Executive Director, emeritus, Ag Innovations Network

For more information on the Pests, Pesticides, and IPM Project, go to: [ipm.ucanr.edu/PPI](http://ipm.ucanr.edu/PPI)



Integrated Pest Management Program

(530) 750-1370  
ipm.ucanr.edu

2801 Second Street  
Davis, CA 95618-7774