Valuing the Dissemination of Integrated Pest Management Information in California

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The challenge of controlling pests economically and protecting the environment led to the creation of Integrated Pest Management. This concept originated, to a large extent, from researchers at the UC system; and over the years, Extension activities brought it to the fields. We present three methods of estimating the benefits of the UC IPM program. From a few case studies, we find a benefit of $323-500.5 million annually; from the website use, $57 million dollars annually; and assessing the contribution of UC IPM to PCA industry approach, $34 million annually. This suggests that the overall benefits of the program exceed the total UCCE annual budget on extension, which includes many other programs.

Integrated Pest Management (IPM) is one of the University of California Cooperative Extension's most successful programs. It is a management approach to pest management that aims to profit agriculture while protecting the environment. IPM techniques emphasize monitoring of pest populations and weather to target chemical and other applications when they are most effective. The increased precision of IPM may result in increased yields, reduced costs, and improved environmental quality compared to traditional methods—such as spraying pesticides on a set schedule. IPM combines multiple approaches, including biological and cultural controls with chemical control of damaging pests and disease.

The UC IPM Extension program has several components. It provides training to pest control professionals; it provides free knowledge to professional farmers, pest control consultants, and garden hobbyists within and outside the state of California through a website and other means.

The fact that UC IPM provides freely available public good makes valuation of the program difficult. Valuation of government programs is critical to optimally allocate taxpayer funds. We use three methods to estimate the value of the program. The first method, the case study approach, relies on peer-reviewed articles that estimate the direct economic effect of IPM methods. Unfortunately, the literature only estimates the impact of particular IPM programs on profitability per acre and reduction of pesticide per crop, ignoring environmental improvement and other effects such as worker safety. This method, which involves aggregating the benefits across the studies, will therefore underestimate the true value.

Due to the limitations of the case study approach, we augment our analysis with two alternative indirect (revealed preference) approaches. These methods will also help distinguish the value of the research done in IPM and the value of the dissemination of the knowledge done by UC IPM. The first infers the value of Extension from the earnings of pest control advisors (PCAs). The second method estimates the value of UC IPM information conveyed to users of the IPM website. Each method provides a partial estimate of the value of UC IPM, but together they provide a rough estimate of the order of magnitude of the benefit to aid in assessment of the program. In the rest of the paper, we first provide a history of the IPM program and then present the results of our estimation technique.

History and Impact of IPM

While discussing the benefits of University of California Cooperative Extension (UCCE) with Extension specialists, we asked them what programs they thought constituted UCCE's greatest success stories. All of them placed IPM near the top of the list. The history of IPM is a story of how a fringe idea touted by environmentalists and scientists became mainstream practice. The timeline in Figure 1 displays the most important events in UC IPM history.

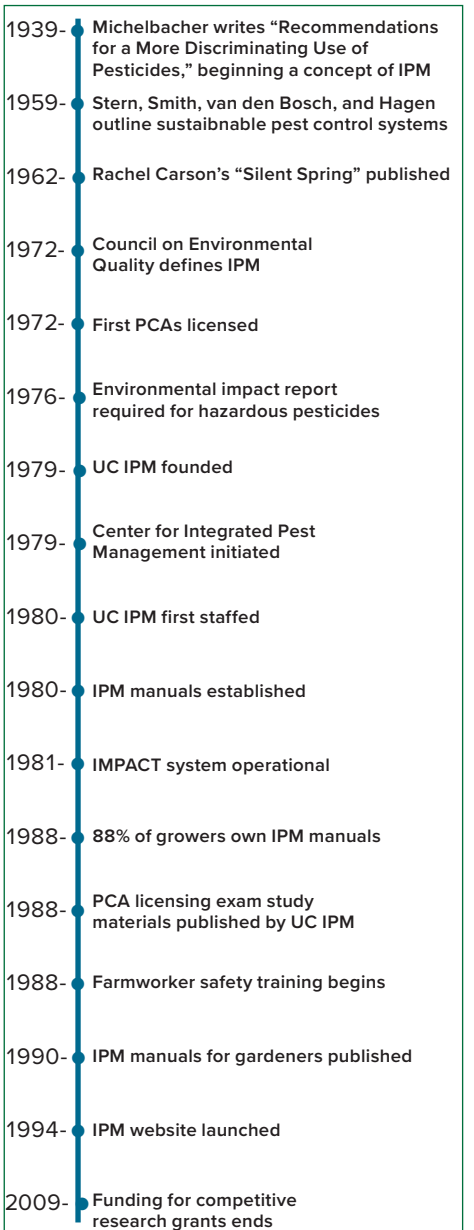

Figure 1. Timeline: UC IPM

Note: Center for Integrated Pest Management (CIPM)

The University of California has spearheaded the concept of IPM since the 1930s. In 1939, UC Berkeley Professor and Entomologist, A.E. Michelbacher, laid the foundation of IPM concepts in his work "Recommendations for a More Discriminating Use of Pesticides," and he later coined the term "integrated control" for integration of biological and chemical controls.

In 1959, a group of UC Berkeley researchers—Vernon Stern, Ray Smith, Robert van den Bosh, and Kenneth Hagen—wrote the "Integrated Control Concept," as part of a study on control of the spotted alfalfa aphid. The basic goals and methods outlined in this paper are the backbone of modern IPM. Their system is based on three basic tenets: measure the pest before applying chemicals; consider the economic thresholds of damage; and avoid damaging natural predators with pesticide use. The term "Integrated Pest Management" was officially defined by the Council of Environmental Quality in 1972. This gave the fledgling field legitimacy as a tool for environmental protection.

The publication of Rachel Carson's "Silent Spring" in 1962, increased already existent public concern about overuse of chemical pesticides. The UC IPM program was first founded in 1979 at the end of a decade of growing environmental concern to encourage more environmentally safe methods of pest control. The public nature of the program was considered critical to offset the power the pesticide companies had over the information provided to growers. These fears had real basis in policy. Pest Control Advisors (PCAs) were licensed from the year 1972 to advise growers on choices they made about pest management.

In 1976, the California Attorney General ruled that an environmental impact report must be filed before most pesticide applications. Licensed PCAs provided these reports, making them necessary for most growers. Most of these licensed PCAs were affiliated with pesticide companies, creating a potential conflict of interest.

UC IPM began funding research early in its history with the creation of the Center for Integrated Pest Management (CIPM) in 1979. CIPM funded and organized research on IPM practices in alfalfa, apples, cotton, and soybeans by researchers across 17 universities. UC IPM was an early adopter of computers. In 1981 the "IMPACT" (Integrated Management of Production in Agriculture using Computer Technology) computer system went live. The IMPACT system allowed Extension employees and eventually growers to access data on weather, pest production, and crop information.

Dissemination of pest management information has consistently been a central aspect of the UC IPM program. The UC system's early attention to IPM and the diversity of the crops grown in California account for the UC system's place as an international powerhouse of IPM information. The program translates academic research ideas and introduces them to growers.

While short courses and grower meetings have been used, the publication of pest management manuals was historically the largest source of information from UC IPM. These manuals were sold throughout the country and the world, not merely in California. In 1994 the UC IPM website launched. This website contains much of the information published in the manuals, albeit in a shortened form for easy reference. Today it is considered an encyclopedia of pest management, where users from around the world can access IPM information for free.

The main goal of the modern UC IPM program is the dissemination of information. In earlier years, however, the program also funded researchers to implement new IPM management techniques. These projects fostered interdisciplinary growth and resulted in publications and new IPM methodology to be put to use in the field. To further aid in the dissemination of IPM methodologies, the program also works with the Department of Pesticide Regulation in training and credential upkeep courses for its PCAs.

Case Study Approach

After 80 years of the program, there are numerous IPM programs in existence. California grows roughly 200 crops, each vulnerable to multiple pests and pest problems, and solutions vary by region, crop, and season. Over time, new solutions replace old ones. Unfortunately, there are only a few empirical studies on the value of IPM programs, and even they provide limited impact measurements. Even so, the few case studies that we selected indicate that the value of IPM knowledge is substantial relative to its cost even though these studies often ignore benefits to the environment, farm worker safety, product quality, and price effects.

We summarize the findings of four studies in the following paragraphs. The studies we highlight were performed in the last several decades. Therefore, we will estimate the current value, both by converting the estimated benefit to 2016 dollars with a purchasing power conversion, and by determining the percent of the industry the benefit made up in the original year. We then apply this percentage to the value of the industry in 2016.

The first study is based on surveys collected in the 1980s on the impact of an IPM program in almonds. This program improved cultural practices, including pruning, weed control and monitoring pests, and contributed to increase yields and reduced pesticide costs. The net annual gain was estimated at $12.8 million (in 1990 dollars), or $23.2 million in 2016 dollars. The $12.8 million is 2.3% of the $550

Table 1. Summary of the Estimated Benefits from IPM from Four Selected Studies

Crop	Year of Study	Original Estimated Value	Benefit in 2016 Dollars	Income in Industry in Year of Study	Benefit as a Share of Income of Industry	Income of Industry Now	Estimated Value[1]
Almond	1990	$12.8 M	$23.2 M	$550 M	2.3%	$6.4 B[2]	$147 M
Cotton	1977	$9.8 M	$38.3 M	$844 M	1.2%	$120 M[3]	$1.4 M
Cotton	1989	$175 M	$334 M	$792 M	42%	$120 M	$50 M
Citrus	1977	$1.9 M	$7.4 M	$276 M	2.7%	$1 B	$27 M
Grapes	2016	$80 M	$80 M	$5.2 B[4]	1.5%	NA	$80 M
Pears	2016	$17.6 M	$17.6 M	$88.6 M[5]	20%	NA	$17.6 M
Total		**$297.1 M**	**$500.5M**				**$323 M**

[1] We multiply the benefit as a share of industry with the current income of the industry.
[2] Most recent number from 2013; [3] Most recent number from 2011;
[4] Most recent number from 2014; [5] Most recent number from 2014

million in almond revenue at the time. In 2013 the almond revenue in California was $6.4 billion. If IPM still creates a net annual gain of 2.3%, the current value would be about $147 million. Some of the practices continue today and other IPM programs have been added.

Another early study on the economic impact of IPM written in the 1970s concludes that IPM practices reduce pesticide use, pest management costs, and risk compared to conventional methods, but require fixed monitoring costs. The net gain was estimated to be $7 per acre for both cotton and citrus. In cotton, this corresponds to $9.8 million (1977 dollars), or $38.3 million in 2016 dollars. In 1977 this corresponded to 1.2% of the $334 million industry. The cotton industry has shrunk; 1.2% of today's $120 million industry is $1.4 million. For citrus, the estimates are $1.9 million (1977 dollars) or $7.4 million in 2016 dollars. In 1977 this corresponded to 2.7% of the $276 million industry. Today, California citrus is valued over $1 billion, so 2.7% is $27 million.

One of the major successes of IPM was the program to fight Pink Bollworm in cotton by reducing the growing season and improving timing of application through enhanced monitoring. A 1989 study on the economic impact of this program shows that farmers gain $168 per acre taking into account secondary benefits, and primary and secondary pests, which is $175 million annually in 1989 dollars, or $334 million in 2016. In 1989 this made up 42% of revenue, which would correspond to $50 million of today's industry.

Finally, a 2016 study on the impact of UC IPM in grapes and pears estimates that (i) the prevention of Pierce's Disease and damage by the glassy winged sharp shooter saved the grape industry $80 million annually, and (ii) disrupting the mating of the codling moth saved the pear industry between $11.7 and 23.4 million annually, on average $17.6 million. Given that pear industry revenue was $88.6 million in 2014, this savings corresponds to 20% of their total revenue.

Given just the results for these five crops summarized in Table 1, IPM has an annual benefit of $500.5 annually when the results from the studies are translated into 2016 dollars using a simple purchasing power calculator. When using a share of the industry calculation, an annual benefit of $323 million is realized. These numbers are massive and can be attributed to research faculty, Extension specialists, and farm advisors. However, we can not disentangle the value of extension—disseminating knowledge done by researchers—and the value of the original research. Therefore, we will turn to revealed preference approaches to value the work of extension.

Website and Opportunity Cost

As mentioned in the history section, one of the main tools UC Extension uses to distribute information about IPM is the IPM webpage. We will attempt to value the webpage to pinpoint the value of the Extension work. We use data for the traffic on the IPM webpage, combined with estimates on hourly wage and average hit time, to estimate the value of the IPM website. This is based on opportunity cost theory.

In a given hour, individuals can choose to sell their labor to the market or participate in another activity. Therefore, any activity they participate in must have an equal or higher value to them than their hourly wage. That is, the value of an hourly wage gives us a lower bound on the agent's valuation of the activity. To estimate the value of the IPM website, we apply different assumptions about hourly wage to the data, given that each hit to the website takes 10 minutes.

The website receives an average of 40,000 to 50,000 hits per day, with 85% of the hits from California. Given our assumption that each hit takes ten minutes, this is 6,667 to 8,333 hours of use per day. Preliminary website use data shows that not only are there many hits for pages aimed at commercial growers, but also for pages aimed at homeowners and home gardeners—such as hits about rats, squirrels, insects and spiders.

We use different measures of average wage in America from the Bureau of Labor Statistics (BLS) to estimate a range of values for the website. We include an estimated yearly wage of $80 thousand annually for agribusiness professionals, including PCAs. We use three average hourly wage estimates:

the average U.S. wage ($25), the average Californian wage ($26), and the average wage of an agricultural professional ($33). We then multiply the number of hours we estimate are spent on the website in total each day, to give a range of daily values for 40 to 50 thousand daily hits. We then take a daily average. Lastly, we create an annual average by multiplying the daily average by 300, which assumes 300 working days. The results of these calculations are shown in Table 2.

These estimates give us an idea of the lower bound on the value that the users have for the UC IPM website. We believe that the first calculation of an annual value of $57 million is the most reasonable. We do not know the careers of the website users, but search evidence suggests they are not all working farmers. Zilberman et al. 1991 suggest that the value of pesticides is around twice the value of the direct costs of purchasing them. If we apply this theory to the value of pesticide information, the information is worth twice the amount spent on obtaining it, we conclude that there is a net value of the IPM webpage of around $56 million dollars.

PCA Approach

While the UC IPM program does not trade its products directly in the market, it does aid in the training of PCAs who do trade their services in the market. PCAs are people licensed by the state to approve the use of chemical pesticides and to advise growers in IPM and other alternative pest control activities. UC IPM has been creating training materials for the PCA since 1988. According to the California Assocation of Pest Control Advisers, there are 4,000 PCAs in California making an approximate average of $75 thousand a year. This amounts to a $300 million industry. This is not the value of the pesticide industry as a whole, of course, but simply the value of the work done by the PCAs.

Table 2. Valuation of the IPM Website Using Different Hourly Wages

Average Hourly Wage	40K-50K Hits	Daily Average	Average Annual
$25 (US)	$167-208K	$188K	$56M
$26 (CA)	$173-217K	$195K	$59M
$33 (AG PRO)	$220-275K	$248K	$74M

Research on information consumption by agribusiness intermediaries suggests that PCAs would receive 30-60% of their information from the public. Since UC IPM participates in the licensing of PCAs, we expect the percentage of their information from public sources to be at the higher end of that range. If we assume 25% of the value of the service of the PCA comes from their information, then 7.5-15% of the value of the PCA industry comes from UC IPM. That is, $22.5-45 million annually, which we average at $34 million.

Conclusion

We have presented three different methods of estimating the benefits of the UC IPM program. From the partial case studies approach, we find a benefit of $323-500 million annually; from the website use approach, we find a benefit of around $56 million dollars annually; from the PCA industry approach we find a benefit of $34 million annually. Each of these approaches has limitations, and ways in which our numbers undervalue the true benefit of UC IPM.

We described how the case studies number does not include all crops or microclimates. The $56 million number we estimated from the website will not include some beneficiaries of the program that do not access their information through the website, but use traditional published manuals or Extension courses. The value of UC IPM to the PCA industry does not include the use of IPM by home gardeners. However, the shortcomings of the estimates of the benefits of UC IPM are due to an inability to control for all the ways that UC IPM benefits California agriculture, environment, and people. Our estimates suggest that the value of the program is certainly in the tens of millions annually, and probably valued above $100 million.

As we mentioned before, even a partial assessment of the impact of the UC IPM program suggests that it provides value in the hundreds of millions of dollars. But the revealed preference provides two measures of the value of the Extension program that together generate an annual benefit of about $80 million (even assuming some overlap, it is above likely to be $50 million). Since the annual budget of Extension is $67 million, and IPM is a modest part of Extension, we can conclude that investments made into UCCE generate enormously disproportional benefits.

AUTHOR'S BIO

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Suggested Citation:

Schatzberg, M., and D. Zilberman. "Valuing the Dissemination of Integrated Pest Management Information in California." *ARE Update* 20(2) (2016): 5-8. University of California Giannini Foundation of Agricultural Economics.