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O.03 - IPM implementation at field level: “What are the impediments to grower adoption of IPM? Why do they exist and what can be done to get around them?"

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Abstract

The agricultural economy in California is very large and has a farmgate value of more than $US24 billion. It is also one of the birth places of IPM, with several University of California scientists helping define the concept and implementing some of the first programmes. Nevertheless, many potential impediments to grower adoption of IPM in California orchards and vineyards still exist and they can be different for different growers. Some of them are: confusion over the definition of IPM, lack of guidance on how to implement IPM, lack of pest economic thresholds, insufficient effort expended for pest monitoring, lack of quantitative pest monitoring methods, lack of appreciation of the value of quantitatively-based pest monitoring, pest management being a low priority in farm management-decision making, the salaries of many pest management consultants being based on commissions from pesticide sales, and the fact that many pesticide-based pest management strategies are affordable and they work. I will start the presentation by discussing the definition of IPM used by the University of California state-wide IPM programme. Based on seven years' experience as an IPM consultant working in orchard crops and 12 years' experience working with 750 winegrape growers who manage 40,000 ha of vineyards, I will discuss the above impediments, why they exist and suggest ways of removing them so that the level of IPM implementation increases.

Introduction

The on-farm value of California agriculture is very large, worth $US31.4 billion in 2006[1]. The top 5 commodities in order are:

1.	Milk and cream	$4.5 billion
2.	Grapes (all)	$3.0 billion
3.	Nursery and greenhouse products	$2.8 billion
4.	Almonds	$2.0 billion
5.	Cattle and calves	$1.7 billion

This value is by far the largest of any other state in the US with Texas being second in agriculture production at $US16.0 on-farm value. Nine of the 10 top counties in terms of market value occur in California with Fresno being number one, producing $US4.8 billion. The year 2005 set a new record for exports, surpassing $US9 billion for the first time. The leading four destinations account for 56% of the total exports and are the European Union, Canada, Japan, and Mexico.

Agriculture production in California is very diverse, with 400 different crops being grown. One of the reasons for the high value of California agriculture relative to the rest of the US is because many of the crops are high value crops such as fruits and nuts. California accounts for 46% of the US fruit and nut production and 62% of the national value.

[1] USDA's National Agricultural Statistics Service. 2007. California Agricultural Statistics: 2006 Crop Year. Sacramento, CA. 96pp.

There were 76,000 farms operating in California in 2006, less than 4% of the national total. The average California farm income was $US413,000, three times higher that the US average. There were 10.5 million hectares of farmland in California in 2006 with the average farm size of 140 hectares.

California is one of the birthplaces of integrated pest management (IPM). Stern et al. (1959)[2] published the seminal paper introducing the integrated control concept which later became IPM. The University of California at Berkeley and Riverside was the home of many early IPM pioneers such as Drs. Stern, Hagen, van den Bosch, Debach, Huffaker, Dout, Messenger, Dahlsten, and Caltagrione. IPM depends on frequent crop monitoring, some call it scouting, and one of the early outcomes of the development of IPM in California was the creation of companies offering scouting services to growers. In fact Dr. Ken Hagen was one of the first people to offer such a service before he became a faculty member at UC Berkeley.

During the 1950s, 1960s and 1970s, the combination of the high value of California agriculture, the reliance of pest management systems on chemical pesticides, and the development of IPM at the University of California created major tensions within the agricultural community. Van den Bosch's 1978[3] book 'The Pesticide Conspiracy' brought many of them out into the open. One of the outcomes of the pest management debate was the passing of a law in the early 1970s requiring anyone giving pest management advice to growers in California to obtain a Pest Control Advisor's (PCA) licence. To qualify for a PCA licence one must have a series of University agriculture and pest management classes, a specified amount of experience in the field, or a combination of both. One then must pass an exam in eight areas of pest management: Insect, Mites and Other Invertebrates, Plant Pathogens, Nematodes, Weeds, Vertebrate Pests, Plant Defoliants, and Plant Growth Regulators, as well as knowledge of California pesticide laws and regulations. It is still the only law of its type in the US.

Most California growers receive pest management advice from PCAs and much of the field monitoring for pests is done by them as well. Many PCAs work for retail chemical companies and their salaries are primarily derived from a commission based on pesticide and fertilizer sales. A small portion of PCAs are called 'independents' and their income is not based on input sales. They charge growers a per acre fee for monitoring their fields and provide pest management advice based on this monitoring. These two systems date back to the early 1960s. Many PCAs also advise growers on other aspects of farming such as irrigation and crop nutrient management.

A great deal of research and outreach has been done on IPM systems for many of California's important agricultural crops. The University of California Statewide IPM Programme has not only written many outstanding IPM manuals for these crops but also created a website that hosts pest management guidelines for them and many other great resources like access to weather data around the state[4]. However, my experience in California agriculture working on orchard crops and winegrapes has taught me that there are two IPM worlds, one is an academic one where a great deal of IPM knowledge exists along with research-based programmes to be implemented in the field, the other is what really happens out on the farm in terms of pest management. My conclusion is that the level of IPM implementation on the farm is not as far along as one would expect given the approach was proposed almost 50 years ago.

My conclusions on what impediments exist in grower adoption of IPM and what can be done to get past them are based on my training and experience as a research scientist, working as an IPM consultant for orchard crop growers for seven years, and 12 years as IPM Director at the Lodi Winegrape Commission. It is not based on any formal surveys. Therefore let me briefly describe my background which has led me to these observations and opinions.

I have a Bachelor's Degree in forestry, specialising in forest pest management, from the State University of New York College of Environmental Science and Forestry, and a PhD in forest entomology from the

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[2] Stern, V. M., van den Bosch, R., and K. S. Hagen. 1959. The integrated control concept. *Hilgardia* 29:81-101.

[3] van den Bosch, R. 1978. The pesticide conspiracy. Doubleday & Conpany, Garden City, NY. 226 pp.

[4] http://www.ipm.ucdavis.edu/

University of California Berkeley. My professional goal was to become a research scientist in forest entomology. While at Berkeley I spent time talking with and taking classes from many of the IPM pioneers such as Drs. Hagen and van den Bosch, and Dr. Dahlsten was my major professor. Since I was focused on forest insect pest management I did not spend much time thinking about IPM in agriculture. However, I spent quite a bit of time with Dr. van den Bosch talking about the state of IPM implementation, or more accurately the lack thereof, in California agriculture. After graduating from UC Berkeley I took a research scientist's position with CSIRO Division of Forest Research in 1977 and moved to Australia in 1980 not realizing that in 10 years I would return to be a consultant in agricultural IPM in California.

My first field season as an IPM consultant was in 1990. I worked with almond and walnut growers in California in the northern part of Sacramento as well as with apple growers in eastern Washington State. During that season I underwent an epiphany. On getting out onto the farm observing what growers were doing and not doing in their pest management programs, as well as seeing the role pesticide companies were playing in grower pest management decision making, I realised that many of the problems van den Bosch recognized and pointed out in his book 'The Pesticide Conspiracy' published in 1978 still existed in 1990.

One of the biggest problems I saw was many growers and PCAs not doing quantitative pest monitoring and the lack of the use of quantitative data in making pest management decisions. I have spent the last 18 years trying to bring this to the attention of growers and PCAs, along with other important issues, to improve the implementation of IPM.

What is IPM?

If I am going to be discussing impediments to California growers implementing IPM it is only fair I discuss the definition I use. One of the challenges in encouraging growers to implement IPM is assessing their level of understanding of what it is. It is important for growers to understand the concept before they can be expected to implement it on an ongoing basis. My experience from working with growers is they are quick to say 'Tell me what to do and I will do it'. The problem with this attitude is that IPM is much more than a simple list of things to do. If it is approached in that manner and an unexpected problem arises in one's IPM programme, the grower does not know how to move forward. They then have a bad experience with IPM and conclude that it does not work. Unfortunately, many people have difficulty agreeing on a definition of IPM, including academics. That is because IPM is a concept or approach to dealing with pest problems rather than a simple problem solving recipe. I feel it is best viewed as a continuum from no IPM on one side to complete IPM on the other.

The definition of IPM I use in Lodi is the following: *IPM is a sustainable way of managing pests by combining biological, cultural and chemical tools to minimize economic, environmental and health risks.*

I like this definition because it is simple yet incorporates the concept of sustainability, implies long-term solutions, and puts it in terms of risk reduction on the important issues of economics, the environment and human health. Risk reduction is a sliding scale rather than a fixed outcome. Notice it does not say 'risk elimination'.

Another definition we use is one developed by the University of California Statewide IPM Programme[5]: *Integrated Pest Management (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 minimises risks to human health, beneficial and non-target organisms, and the environment.*

I realise there are many IPM definitions in existence and I am not going to debate the positives and negatives of each. As mentioned above, I much prefer to look at IPM as a continuum. The perfect IPM

[5] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html

system would be one where pest populations are below the economic injury level and kept there through a combination of biological and cultural controls requiring no day to day input from the grower. In other words, the farm's ecological system is in balance. This is a rare situation, however. It may be a great goal to strive for but not very realistic for many growers to expect to attain. There are many reasons for this, the most important ones being that most of our crops are exotic as are the pests associated with them. In other words one is farming an ecologically unbalanced system. I suggest to growers they strive to move along the IPM continuum, improving over time, but realising a perfectly balanced ecological system is probably not attainable. It is viewing IPM as a continuum that I see as one of the challenges in communicating with growers about it. The dynamic nature of it makes it difficult visualise and to implement.

Definitions are great but giving them to a grower does not help them figure out how to implement IPM in their orchards or vineyards on a day to day basis. I therefore elaborate by saying that a good IPM system has the following five components and discuss their importance:

1. Understanding the ecology and dynamics of the crop. It is important to gather all of the available knowledge about the crop one is growing. Many grape pest problems can be directly related to the condition of the crop and its interaction with the surrounding environment. The more we know about the ecology of the crop, the better pest management decisions we can make. For example, it is well known that overly vigorous grapevine canopies can result in larger leafhopper populations than vines of less vigour. Therefore, maintaining a balanced vine is one way to keep leafhopper populations at acceptable levels (and to accomplish other goals, such as improved wine quality).

2. Understanding the ecology and dynamics of the pest(s) and their natural enemies. It is not only important to know what pests are present but also to know the details of their life cycles, what makes their populations change, whether any natural controls are present, and what effects these may have on the pests. We may find some weakness that can be exploited if we know as much about the pest as possible.

3. Instituting a monitoring programme to assess levels of pests and their natural enemies. It is vitally important to continually monitor the pest levels in the field. This is a crucial aspect of the IPM approach. By knowing how many pests are present we can make the best decision about how much damage they might cause to the crop. If natural enemies are present we need to know how many are present because they may take care of the pest problem for us.

4. Establishing an economic threshold for each pest. Effective monitoring and using economic thresholds make up the core of any IPM programme. What is an economic threshold? It is the level of a pest population above which, if a control action is not taken, the amount of damage caused by the pest will exceed the amount it costs to control that pest. In other words it is the level of the pest population at which the control measure used pays for itself.

5. Considering available control techniques and determining which are most appropriate. A wide range of control techniques is available for crop pests. They can be divided into five broad categories: chemical controls, such as pesticides; cultural controls, such as controlling vine vigour or leaf removal; biological controls, such as natural enemy releases or conserving natural enemies; behavioural control, such as the use of insect pheromones; and genetic control, such as the use of resistant rootstocks or loose-clustered clones.

It is very important to choose the right control method based on the economic nature of the pest problem, the cost of the particular control technique, and the effects of this method on the environment and people's health.

Impediments to Growers Implementing IPM

Confusion over the definition of IPM

I have already discussed this issue and suggested one way to remove the impediment is to discuss IPM as an approach to pest management in the form of a continuum rather than a static list of things to do. A

grower or PCA can then appreciate its dynamic nature and focus on improving over time by refining their IPM programme rather than approaching it simplistically.

Many pesticide-based pest management strategies are affordable and they work

This observation is one of the hardest impediments to overcome because it is a true statement. Put yourself in the position of a grower with a pest problem they perceive as a high risk situation and for which an efficacious spray programme exists. You approach them saying you have a great IPM programme for them to try that involves little or no spraying, will cost money, involves a series of cultural practices plus maybe parasite or predator releases, and has a certain level of risk associated with it. Why should they increase their risk and maybe farming costs rather than do something they know works and is simple to do, which is spray something? Moreover, many of the newer pesticides have a much lower environmental risk associated with their use than those in the past so the threat of environmental disruption is much less than it used to be.

At the moment, the only way I see to overcome this impediment is to develop an understanding in the grower community of the sustainable nature of IPM. If they truly understand this approach they will then be willing to move their pest management programmes along the IPM continuum. The concern over global climate change and its connection to fossil fuel consumption may open up people's minds to more holistic strategies like IPM.

Insufficient effort expended for pest monitoring

It is not possible to implement an IPM program without adequate pest monitoring. Lack of sufficient pest monitoring is the biggest problem I have observed in every crop on which I have worked in California. In talking with other pest management consultants in other parts of the US it is their biggest problem, too.

There are several reasons why this is the case. I will mention them here and elaborate on most of them below under their own heading. The most important one is that it appears that growers and PCAs do not value pest monitoring data. What I mean is they do not feel the numbers they get from the monitoring are important enough to spend the time and money to collect them. A second important problem is that research-based economic thresholds are lacking for most of the important pests. And finally, pest monitoring must be done by people. Labour is the most expensive part of farming in California. Therefore if costs must be cut, an obvious target is pest monitoring, particularly if the grower does not feel the data is valuable. Some people make the argument that remote sensing for determining pest problems may be a cost effective way of pest monitoring. However, from what I have seen so far these methods have not been that helpful in increasing IPM implementation. Moreover, many orchard and vineyard pests are relatively minor in importance and therefore have not had remote sensing monitoring systems developed for them. However, despite this minority status a significant amount of pesticide use it directed toward them.

My experience has convinced me that the way to overcome this impediment is through helping growers and PCAs appreciate the value of pest monitoring data. If a grower or PCA thinks something is valuable they will go to great lengths to obtain it. I will discuss this in more detail while discussing the next several impediments, which are all related.

Lack of economic thresholds for many pests

Despite the fact that the concept of economic threshold is the cornerstone of any IPM programme there is a lack of research-based, real world economic thresholds for the majority of the pests in California. I worked with almonds, walnuts, prunes, pistachios, apples and winegrapes and there were either no economic thresholds or the few that existed were very out of date and not useful. How can we expect to encourage growers to implement IPM if there are no economic thresholds for them to use in their pest management decision-making? Furthermore, this situation is not likely to change in California. There are no agencies, companies, or institutions willing to fund research to develop economic thresholds. I recommend that growers and PCAs develop their own based on experience over time.

Lack of appreciation by growers and PCAs of the value of quantitatively-based pest monitoring

I have spent almost 20 years trying to figure out why IPM implementation is not more advanced on California farms. The observations expressed in this presentation are most of the ones I have considered as important. Lately, I have been thinking that a core reason why IPM implementation is not what it should be is because growers and PCAs do not appreciate the value of quantitative pest monitoring data in terms of pest management decision-making. I know for a fact, based on grower surveys and experience, that at least until a few years ago not many growers or PCAs kept written or electronic pest monitoring records of any kind. Some of the arguments given are that they do not have time to collect pest monitoring data, it is too expensive to collect, and so forth. However, I have observed that if growers and PCAs think information is important they will go to great lengths and expense to collect it. One conclusion, therefore, is that they do not value this kind of data. If they did they would collect it.

If it is true that many growers and PCAs do not value quantitative pest monitoring data the challenge is to figure out how to change their minds. I will present a data set I use to try and accomplish this. From 1996 to 2006 staff of the Lodi Winegrape Commission monitored on a weekly basis important vineyard pests in 70 vineyards managed by 45 different growers and monitored by about 16 different PCAs. The monitoring was done on a quantitative basis and the data was input into a relational computer database. Moreover, pesticide use was recorded as were viticultural parameters such as harvest date and yield. This was part of a larger Biologically Integrated Farming Systems (BIFS) project being carried out by LWC with the goal of increasing the implementation of sustainable farming practices in Lodi vineyards including IPM[6].

Grape leafhopper was one of the insect pests monitored during this project. Both the adults and nymphs feed on grape leaves resulting in stippling where their mouth parts are inserted to feed, resulting in a loss of photosynthetic activity at these sites. It is not possible to monitor the adults accurately but the nymphs can easily and quickly be counted and the results converted to a useful number of nymphs per leaf. If leafhopper nymphs and adults occur in high enough numbers the feeding damage can be severe enough to delay fruit ripening and if numbers are really high the vines can defoliate. If the defoliation occurs early enough before harvest the crop may not ripen at all. Sunburn may also occur along with dehydration of the fruit.

Figure 1 contains a bar graph in which the highest level of leafhopper counts, expressed as nymphs per leaf, are plotted for 29 vineyards that were not sprayed for leafhoppers and 27 vineyards that were sprayed for leafhoppers during the growing season in 2000. The sprays were all done during June and July. For each sprayed vineyard the height of the bar was the highest nymph count in that vineyard before the spray was done. In other words it represents an economic threshold for the grower that managed that vineyard. The height of the bar for each unsprayed vineyard was the highest nymph count observed during the growing season. For ease of interpretation the leafhopper counts for both the sprayed and unsprayed vineyards were plotted from lowest on the left to highest on the right. Each point on the horizontal axis of the graph contains a pair of vineyards, one sprayed and one unsprayed. The pairing and vineyard number are not significant, the position of where a vineyard fell along the X axis is simply a result of the value of the leafhopper count for that vineyard.

One of the first things to notice when looking at Figure 1 is that the data set of leafhopper counts for sprayed vineyards is very similar to the data set for leafhopper counts of unsprayed vineyards. Leafhopper counts found in sprayed vineyards ranged from low to high as did the leafhopper counts in the unsprayed vineyards. This should not be the case if there was a consensus among growers and PCAs on an economic threshold. If there was such a consensus one would expect to see high counts, say about 10 nymphs per leaf, for all the sprayed vineyards and low counts for the unsprayed vineyards. Instead, Figure 1 shows that some growers sprayed for leafhoppers when they are present in very low numbers while other growers did not spray for leafhoppers when they are present in very high numbers.

[6] http://sarep.ucdavis.edu/BIFS/LWWCreport/

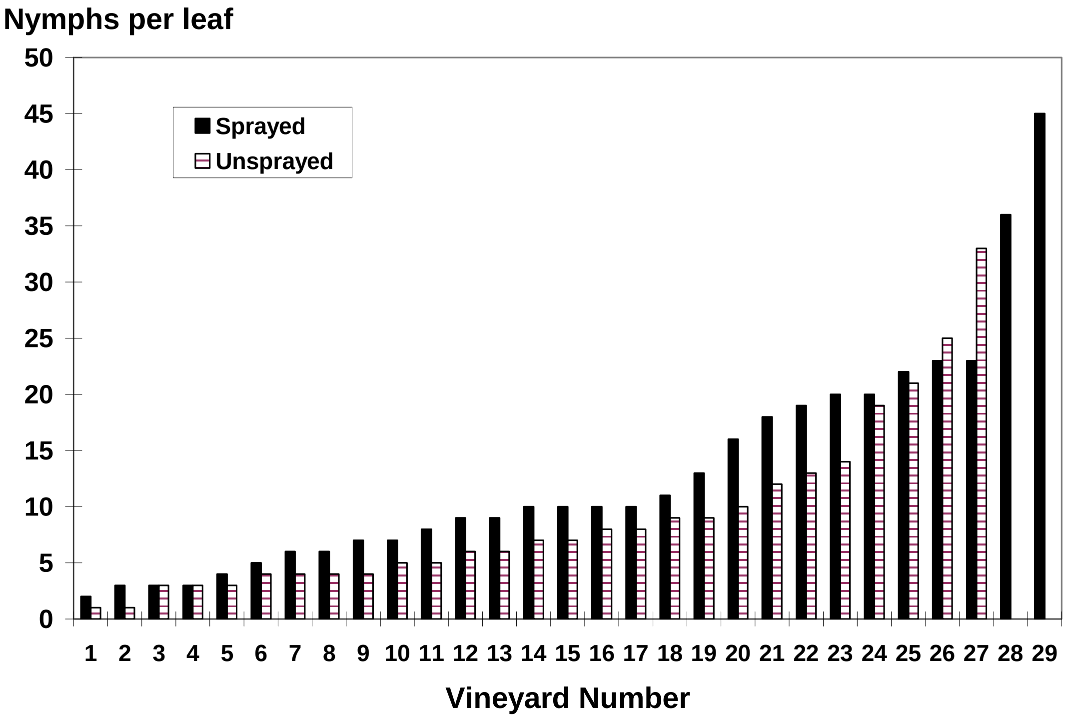

Figure 1. Leafhopper counts expressed as nymphs per leaf in vineyards that were sprayed and others that were not sprayed in 2000.

So what is going on here? When growers and PCAs decide to spray they do so because they feel that the leafhopper populations are at a problem level or soon will be and the winegrape crop would be adversely affected. Growers and PCAs who decide not to spray feel that the leafhopper population present will not cause a problem. Figure 1 indicates that for 27 vineyards growers thought the leafhoppers were at a problem level. The leafhopper counts in those vineyards varied from 1 per leaf to 29 per leaf. That is a huge range.

Research has shown that grape canopies can suffer up to 20% defoliation without affecting yield. Leafhopper counts of 5 nymphs per leaf or less indicate the population is not going to damage the crop. Therefore spraying when leafhopper counts are below 5 is not necessary. Likewise, growers and PCAs who are not treating when leafhopper counts are above 20 are likely suffering economic damage and should be spraying. Are growers and PCAs deliberately spraying when they do not need to and not spraying when they should? Of course they are not. Each one feels they are making the correct decision. If we had not collected the quantitative monitoring data shown in Figure 1 we would not know a huge range in treatment thresholds exist among growers and PCAs. Without this data one can only say 'I thought there was a problem so I sprayed' or 'I did not think there was a problem so I did not spray'. This does not move one along the IPM continuum.

The dataset presented in Figure 1 highlights the importance of quantitative pest monitoring, the lack of established economic thresholds, and points out a possible way to develop them. I often tell growers and PCAs that they do not learn anything by spraying a pest population. That is because if one calibrates the sprayer correctly, drives at the correct speed to get good coverage, and selects the proper material, the pest population will be controlled. This is a given. However, it is when one does not spray they learn something and it is one of two things. Either it was a good decision not to spray because the pest did not cause any damage or it was a bad decision because damage occurred. If quantitative measures are made

of the pest population when a spray is not made then if no damage occurs then one knows the economic threshold has not been exceeded. If damage does occur if a spray is not made one then knows the economic threshold was exceeded. In this trial and error manner growers can zero in on an economic threshold.

Pest management being a low priority in farm management-decision making

For crops in California such as orchards and vineyards, the budget allocated for pest management on many of the mid to large-sized farms is small, maybe 10% of the total. It is likely that companies will not spend a large amount of their time focusing on a programme that is only about 10% of their monetary costs. They are more likely to set up something that will minimise risk, which up until this point in time is a pesticide-based pest management programme, and spend more of their time trying to fine tune other parts of their farm management program that is taking up much more of their budget.

Lack of guidance on how to implement IPM

IPM is a systems approach to pest management and therefore a complex message to deliver to growers. As I have already mentioned, one of the challenges is to develop a way to translate this message into day to day crop management operations. The approach of many University extension programmes is to develop what some would label as the 'best management practice' approach to a particular problem. This is often a list of practices a grower should use to address a particular pest problem. One down side to this approach is a grower may not be able to do all of the practices on the list. If so, does this mean the grower is not doing IPM? Moreover, it does not help growers figure out how to get from where they are at on the IPM continuum to the next level for a particular pest problem.

The Lodi Winegrape Commission designed the *Lodi Winegrower's Workbook*[7] to meet the challenge described above. It is a workbook growers use to assess their level of sustainable winegrowing for 160 winegrape growing issues. It helps them identify where they are along the sustainable farming continuum for each issue. Since the foundation of the pest management chapter is IPM, the workbook format helps a grower see each pest issue from the perspective of the IPM continuum.

Figure 2 provides an example of a worksheet from the Pest Management Chapter to illustrate this approach. A grower or PCA reads each category and stops at the one that best describes how they manage omnivorous leafroller. Category 4 represents the best management (IPM) set of practices and Category 1 represents the opposite end of the IPM continuum, which is no IPM is used. Categories 2 and 3 are in between. In this way a grower or PCA sees where they are at on the IPM continuum for managing this pest and where they should be moving to, i.e. Category 4.

Salaries of many pest management consultants being based on commissions from pesticide sales

This issue still generates very heated discussions in the grower and PCA community in not only California but in many other regions in the US. Most do not talk about it and feel it is not important but there is a certain level of denial about it because when the topic comes up some get very agitated.

For many years I have tried to come up with an analogy to describe why this is a problem and not have PCAs get angry. My latest attempt was two years ago at the annual meeting of the Washington Horticulture Association. I asked the audience to consider someone who sells vacuum cleaners for a living and their salary is based on sales commissions. I then asked them what the reaction of this person's boss would be if at the end of the week the salesperson reported "This was a good week for me, I did not sell any vacuum cleaners to my clients because I told them they did not need any". The boss clearly would not be happy. The take home message is that a system based on sales is not conducive to reducing the

[7] Ohmart, C. P., Storm C. P., Matthiasson S. K.. 2008. *Lodi Winegrower's Workbook 2nd Edition.* Lodi Winegrape Commission, Lodi California. 350pp.

sale/use of something. However, the audience's reaction to my parable was that I was accusing PCAs of being vacuum cleaner sales people.

Any business based on sales must sell product to be successful. Since pesticide companies make money by selling product then any PCA connected to that company must sell product to be considered a successful employee. This system is not conducive to increasing the implementation of IPM systems that are not pesticide based.

It is not known how many PCAs in California work for pesticide companies. However, my experience is that the average grower in California is getting their pest management advice from a PCA associated with a pesticide/fertiliser company. PCAs get angry when this topic is discussed because they feel their professionalism is being questioned. The skill level of PCAs who work for chemical companies is no different than that of PCAs who are 'independents'. There are some very good PCAs working in both systems and there are also some not so good ones in each, too. The people are not the problem, it is the system. If we are to increase the implementation of IPM systems that are not pesticide based then pest management advice should not be connected to pesticide sales.

6.9 Managing omnivorous leafroller (OLR)			
Category 4	**Category 3**	**Category 2**	**Category 1**
I do not have to treat for OLR because parasites keep the population below the economic threshold ***Or*** If control is necessary due to problems in the previous season, I use pheromone confusion for control.	I check 10 flower clusters on 20 vines at bloom time for treatment decision-making ***And*** I obtain a biofix for OLR using a pheromone trap, and degree-days are tracked using weather station data ***And*** Treatment is timed for 700-900 degree-days from biofix (the most susceptible stage) ***And*** I use LWWC's PEAS model in selecting the pesticide to use for OLR taking into account the environmental impact units (EIUs) and efficacy.	My treatment for OLR is based on the time of year or stage of grapevine development (e.g. bloom) ***And*** I use LWWC's PEAS model in selecting the pesticide to use for OLR taking into account the environmental impact units (EIUs) and efficacy.	My treatment for OLR is based on the time of year or stage of grapevine development (e.g. bloom) ***And*** Environmental impact is not considered when I choose a pesticide to use for OLR.

Figure 2. Workbook worksheet for Issue No. 6.9 from the Pest Management Chapter in the *Lodi Winegrower's Workbook 2nd Edition* (Ohmart et al. 2008).

Conclusions

Over the past 5 years I have noticed a much greater awareness and discussion among growers and PCAs of IPM, the importance of monitoring, and use of reduced risk pesticides. My conclusion is that the rate of IPM implementation has increased over this period when compared to the previous 20 years.

IPM is an ecological approach to managing pests and therefore is complex in concept as well as in implementation. Because of this complexity there are continuing arguments of what it is and at what point a pest management programme can be considered IPM. These arguments are a distraction to increasing its implementation on the farm. Many things affect pest management decision making, including science, economics, risk, government regulations, marketing, and human psychology. It is no wonder then that the level of IPM implementation is not as far along as one would expect given the concept was introduced in 1959 (Stern et al. 1959). Based on my academic and practical experience I have discussed some of the factors that, in my opinion, act as impediments to IPM implementation. For each one I also presented suggestions as to how they might be overcome.

The beauty of using IPM in managing pests is that it is a continuum along which one moves, providing the opportunity for continual improvement over time. Ironically, it is this continuum attribute that makes IPM a challenge for growers and PCAs to understand and implement.