Use of an Implementation Model and Diffusion Process for Establishing Integrated Pest Management in Arizona Schools

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ABSTRACT The Monroe IPM Model is designed to facilitate the transition from traditional pest control practices to a contemporary and verifiable IPM program in school districts. The model is an implementation plan providing the basic structure for organizing, maintaining, and evaluating a community-level program. The use of this model in 10 school districts in seven states (1–10 yr) resulted in an average 71% reduction in pesticide applications and 78% reduction in pest complaints to school administrations. Execution of the model resulted in the systematic diffusion of IPM in cohort school districts in Arizona. As of May 2005, 30.4% of K–12 children in Arizona schools are benefiting from verifiable IPM programs. Considering the percentage of Arizona students attending schools with IPM, the following diffusion rates are apparent: 1.8% in 2000–2001; 10.4% in 2002–2003, and 18.2% in 2004–May 2005.

Integrated Pest Management (IPM) is defined in many ways; but in this article, we define it as an ecologically based management strategy that provides long-term solutions to pest problems with minimum impact on human health and the environment. We use the term to refer to IPM as an innovation that can be adopted by school districts. IPM programs are educationally based and focus on our knowledge of pest biology. Management techniques used as part of an IPM program include improving hygiene standards, use of pest exclusion methods, habitat modification, and the selection of target-specific pesticides that have low associated risks to human health and low environmental impact.

There have been significant efforts to promote IPM in schools, primarily through programs organized and funded to increase good pest management practices through public-supported education and regulation. After more than a decade of continued community level education and legislative pressure (rather than implementation), slow progress is the prevailing paradigm for the adoption of IPM in schools. Few school districts have an adequate understanding of IPM philosophy and can effectively implement IPM practices in their schools (Lame 2005).

Increasing numbers of researchers are looking at combining technical IPM knowledge with social management strategies to improve community-level practice of IPM. The Monroe IPM Model was designed to facilitate the transition of school districts from traditional pest control practices (scheduled monthly spraying) to a verifiable IPM program. The model is based on Rogers's diffusion of innovations theory (1995).

Since inception of the model, a team of national implementers has exercised the process in seven states and four Native American reservations. In this article, we describe the model and the contemporary process as it has been used to establish areawide diffusion of IPM in schools. We offer a case history to document the effectiveness of the approach.

The Monroe IPM Model is a step-by-step implementation plan (Lame 2005) that provides the basic structure for organizing, maintaining, and evaluating an effective pest management program in a school system. Use of the model has resulted in the systematic diffusion of IPM in a coalition of school districts.

The model process is a sequence of exercises that forge communication links between and within school districts and a network of technical and political supporters. Management steps focus on activities that reduce pest-conducive conditions by using a communication process that is more people-oriented than pest-oriented; the steps exemplify a consistent theme in IPM programs that good pest management is essentially good people management (Metcalf and Luckmann 1994). The extended group of change agents for the coalition of school districts may consist of state-lead agencies, university researchers, pest management professionals, federal agencies, and children's environmental health advocates.

We apply concepts from diffusion theory, which explains the process by which new innovations (ideas or practices) are communicated to, and either adopted or rejected by, members of a social system over time (Rogers 1995). The Monroe IPM model is designed to take the school community through this process while demonstrating the positive attributes of the IPM innovation.

Pilot Demonstration

Supporting pilot demonstration sites is an early step in the process. They are planned for a year, but typically districts choose to expand districtwide after the first 6 months. The pilot begins with school staff interviews and an intensive site inspection or pest audit. The premises are inspected internally and externally by a team of implementers. A detailed audit report is generated from a standardized assessment protocol (Lame 2005); it includes information on active infestations, pest-conducive conditions, and perceived pests. Action items are classed as immediate, short-term, and long-term priorities, with suggested solutions for remediation. The implementation team then tailors a training program for the pilot school faculty and staff based on these priorities. Generally, trainings are given as part of faculty improvement or collegiate days two to three times a year.

A continuing theme for all training participants is to "do what you're doing now, just think pests." No one is given an extra job. The entire school community is involved and encouraged to fulfill their own job responsibilities, armed with a better knowledge of how to conduct their day without generating pest-conducive conditions. District coordination through high-performance relationships (defined here as positive, respectful, and trusted associations) optimizes operations on all levels. Key personnel are often the custodians, kitchen staff, and maintenance crews, who have ample opportunity to avoid and mitigate pest-conducive conditions during routine duties. For example, kitchen staff who know that *Blattella germanica* (L.) can be transported into kitchen storage rooms in the corrugations of cardboard boxes are far more likely to remove cardboard from kitchen areas in a timely manner.

Pest audits, conducted at the initiation of the pilot, at midterm, and at the end of the 1-yr implementation period, generate any necessary remediation activities and ensure accountability.

IPM Specialists

The school district is asked to appoint an IPM specialist. The specialist should have districtwide responsibilities that at least include pest management duties. Irrespective of whether districts employ a private company or maintain in-house pest management staff, the IPM specialist becomes the point person who has easy access to a team of experts who provide timely technical information upon request.

The IPM specialist must effectively communicate with school district decision makers who can ensure any necessary cultural and mechanical remediation.

Together with pest management professionals, IPM specialists assume the role of diagnostician and educator for the district. Pest management becomes proactive more than reactive, and genuine pesticide use (and the risk associated with it) is reduced (Table 1). The specialists can demonstrate the ability to manage pests and should be empowered and professionalized by their success.

The implementation team usually provides an on-site IPM coordinator to give technical help. This team member is an experienced expert who assists with diagnostic and educational training and interacts monthly with the pilot site community, any contracted pest management service provider(s), and the district IPM specialist. The use of insect-monitoring traps and pest-sighting logs is required and reported upon by the pest management professional or the IPM specialist.

Community members are engaged as respected partners and encouraged to assume ownership of programmatic aspects. Often, individuals will associate with activities of personal interest. Principals often take it upon themselves to ensure that teachers unclutter their classrooms regularly, and lead custodians often agree to report on monitoring traps placed around their school.

The tools used in the pilot program enhance communication and involvement of all community members, from principals and teachers to custodians and kitchen staff. Monthly IPM newsletters are

Table 1. Impact of the Monroe IPM model

School district and year of inception	No. Schools	**Pest pressure[a] and the most common pests**	**Mean no. pesticide applications[b]/ school/ yr, pre-IPM (2 yr)**	Mean no. pesticide applications /school/yr	% Post-IPM (reduction)	% Reduction pest control requests	**IPM STAR certification and/or recognition**
Indiana Monroe County Community School Corporation 1995	21 (3 pilot schools)	**Moderate** Blattidae (3 spp.), Formicidae (3 spp.), Vespidae (2 spp.), Apidae, Muridae (2 spp.)	12 + (scheduled monthly treatments, plus callback treatments)	1	92	90	IPM STAR, news reports (5), awards (5)
Alabama: Auburn City Schools 2000	9 (3 pilot schools)	**Severe** Blattidae (2 spp.), Vespidae (2 spp.), Formicidae, Buthidae, Loxoscelidae, Muscidae, Psychodidae, Phoridae, Muridae	20 + (scheduled monthly treatments, plus callback treatments)	6	70	90	IPM STAR, News reports, (1)awards, (2)
Arizona: Kyrene Schools 2000	26 (3 pilot schools)	**Light** Blattidae (3 spp.), Formicidae (3 spp.), Apidae, Muridae (2 spp.), Gryllidae, Tephritidae, Psychodidae, Phoridae, Theridiidae, Buthidae, Columbidae (pigeons), Felidae (feral cats)	12 + (scheduled monthly treatments, callback treatments, and "clean out" every summer before school started)	1	83	85	IPM STAR, News reports, (4) Awards, (3)

(Table 1 continued on next page)

Table 1. (continued)

School district and year of inception	No. Schools	**Pest pressure[a] and the most common pests**	**Mean no. pesticide applications[b]/ school/ yr, pre-IPM (2 yr)**	Mean no. pesticide applications /school/yr	% Post-IPM (reduction)	% Reduction pest control requests	**IPM STAR certification and/or recognition**
Nevada: Clark County Schools (2002)	268 (3 pilot schools)	**Moderate** Blattidae (3spp.), Formicidae (3 spp.), Apidae, Dermestidae, Gryllidae (2 spp.), Lepismatidae (2 spp.), Theridiidae, Muridae, Columbidae, Felidae	11 (unscheduled treatments, and annual kitchen " clean out")	3	75	85	Districtwide expansion never occurred
Arizona: Navajo Indian Reservation 2002	68 BIA (3 pilot schools)	**Light** Apidae (2 spp.), Vespidae, Muscidae, Psychodidae, Formicidae, Chilopoda, Buthidae, Pediculidae, Cimicidae, Muridae, Viperidae (rattlesnake)	12 + (scheduled monthly treatments, plus callback treatments)	0	95	60	Districtwide adoption was discontinued after second year
Arizona: Gila River Indian Community 2003	8 (1 pilot school)	**Moderate** Culicidae, Formicidae, Rhinotermitidae, Theridiidae, Loxoscelidae, Buthidae, Muridae (2 spp.), Columbidae, Geomyidae (gopher), Canidae (feral dog)	12 + (scheduled monthly treatments, plus callback treatments)	2	84 NO liquid pesticide products used inside/outside of school	90	Awards, (1)
Ohio: Westerville City Schools 2003	23 (3 pilot schools)	**Light** Blattidae (2 spp.), Formicidae (2 spp.), Psychododidae, Phoridae, Lepismatidae, Muridae (2spp.), Columbidae	12 + (scheduled monthly treatments, plus callback treatments)	2	83	80	Awards (1)
Florida: Brevard County Public Schools 2004	82 (3 pilot schools)	**Severe** Blattidae (3 spp.), Formicidae (4 spp.), Gryllidae, Apidae, Rhinotermitidae, Culicidae, Lepismatidae, Loxoscelidae, Pediculidae, Muridae (2 spp.), Ardeidae (snowy egret), Icteridae (grackle), Sturnidae (European starling), Colubridae (2 spp. snake), Chiroptera (bats), Felidae	24 +	<20 (first year)	58	50	New program
Arizona: Mesa Public Schools (2004)	89 (1 pilot school)	**Light** Blattidae (3 spp.), Formicidae (4 spp.), Gryllidae, Forficulidae, Phoridae, Psychodidae, Culicidae, Apidae, Mycetophilidae, Theridiidae, Pholcidae, Carabidae, Lepismatidae (2 spp.), Columbidae	12 + (scheduled monthly treatments, plus callback treatments)	7	40	80	News reports, (6) awards, (3)
Arizona: Washington Elementary Schools 2004	32 (1 pilot school)	**Light** Blattidae (2 spp.), Formicidae (3 spp.), Gryllidae, Isopoda, Muscidae, Geomyidae	24 + (scheduled monthly treatments, plus callback treatments)	17	29 Least toxic options used	70	IPM STAR, news reports (3) awards, (20)
Washington DC: DC Public Schools 2003	148 (3 pilot schools)	**Severe** - Blattidae (3 spp.), Formicidae (2 spp.), Vespidae, Culicidae, Lepismatidae, Muridae (2 spp.)	Undetermined	Undetermined		General comments indicated reduced sightings of rodents and cockroaches	Discontinued

[a]Pest Pressure: **Light:** active infestations of forensic category II and/or III (insanitary and incidental pests); **Moderate:** active infestations of medically significant public health pests; **Severe:** active infestations of public health and/or forensic category I vectors in food preparation areas (FDA Sec. 555.600 - Filth from Insects, Rodents, and Other Pests in Foods CPG 7120.18)
[b]All internal and external insecticidal applications were counted (including bait applications). Herbicidal applications are not included.

produced on topical issues relevant to the season and are distributed to districts electronically. Widespread dissemination is promoted and includes faculty, staff, students, and parents. Newsletters are developed for easy reading by the school community and are applicable at home as well as in the school setting.

Conducting a pilot program allows early demonstration of effective IPM and provides adopters with an immediate benefit. The implementation team and the IPM innovation gain credibility and community attention.

The pilot demonstration shows a reliable, predictable approach to pest management that is highly efficient; and if all components of the model are incorporated, it shows significant risk reduction. Barriers to adopting the program are tangible and have included communication failures, poor maintenance remediation due to budgetary constraints, and a school board's insistence that kitchens are "sprayed" each month (a failure to understand IPM).

Awards in the form of plaques, certificates, and letters of appreciation are developed by the implementation team for coalition member school districts. The EPA, Office of Children's Health Protection's "Children's Environmental Health Award" is a prime example of a prestigious award opportunity. Popular media are involved when the school district receives recognition awards or simply surpasses expectations in a newsworthy manner. This affirmation is particularly valuable with regard to the political decision makers in the school community, most notably the elected members of the school board.

Independent evaluation confirms that districts are achieving practical success with validated positive impacts. The basic issue of which components are essential to earn the IPM designation continues to be debated (Ehler and Bottrell 2000). Use of IPM STAR[1] standards sets palpable and achievable goals for the school district. The IPM STAR criteria satisfy academic ideals and encourage district efficiency and compliance with legal mandates. In short, IPM STAR is awarded to districts with sustainable and effective pest management that is achieved using reduced-risk solutions.

Pesticide use records are compared pre- and post-IPM implementation, which allows districts to assess and track pesticide use patterns. An in-depth economic analysis of pre- and post-IPM implementation helps districts realize the relative costs involved and usually indicates a long-term saving. Comparative pesticide use data and relative economic cost analysis generates measurable impacts. Collating pest prevalence/occupant complaint data allows the team to show that IPM outperforms other strategies; and pesticide use data indicates reduced risk. Ideally, there should be no increase in cost, and an obvious indication of risk reduction (Fleigel and Kivlin 1966). Based on analysis conducted by our team, costs (excluding significant maintenance remediation) have not increased and have often been reduced long-term (Kubista-Hovis and Lame 2004). It should be emphasized that economic comparisons between traditional programs and IPM usually compare costs associated with drastically different levels of pest management success.

From an organizational perspective, implementing the Innovation-Decision process, as defined by Rogers (1995), dramatically increases the chances of measurable impact and improved resource efficiency. As a documented and systematic approach to implementation of IPM in schools, the Monroe IPM Model is an innovation in itself. Urban environments, such as schools, are intensely social, and the fundamentals of the Innovation-Decision process are enormously beneficial if understood and incorporated.

School districts are by nature hierarchical groups who are used to a systematic approach of fostering change within their own system. The education system in the United States is a dynamic institution, constantly under pressure to achieve more with less on many levels. Establishing strong relationships between community members with shared goals, shared knowledge, and mutual respect promotes timely, problem-solving interaction among the group. This, in turn, improves overall efficiency within the system. The "secret ingredient" delivered by the Monroe IPM Model approach is arguably the development of high-performance social relationships (Rogers and Kincaid 1981).

A Modified Monroe IPM Model

Using a modification of the Monroe IPM Model (Lame 2005) as a mechanism for diffusion of IPM, implementation within a geographical region occured in a series of stages. The following information is drawn essentially from experiences of the process in Arizona:

Stage 1. Developing a model school district. Early adopters of innovations are most likely to communicate with and have positive reactions from peers (Rogers and Kincaid 1981). Therefore, school districts that have a reputation of being well managed, are strategically located, and are willing to share or mentor are considered prime candidates as peer leaders. Rogers (1994) states that individuals who are predisposed to being inventive will adopt an innovation earlier than those who are less predisposed.

Peer leaders are referred to as "opinion leaders" by Rogers and Agarwala-Rogers (1976) and have been defined as individuals who frequently influence attitudes or behaviors (Rogers and Kincaid 1981). Opinion leaders are technically credible and represent the trusted norms of the group (Leonard-Barton and Kraus 1985). In any organization, a few of these individuals will regularly affect others' adoption decisions and, therefore, influence diffusion (Tornatzky and Fleisher 1990).

Traditional community awareness campaigns, education programs, and political pressure can increase the level of knowledge about new innovations. Nevertheless, for practitioners to gain confidence in using new tools, they need to be able to use and evaluate practices within their own frame of reference. Whereas pressure and incentives can come from outside a community, fundamental behavioral change comes from within (Rogers 1994). Regulatory or competitive pressures often yield little progress unless the necessary resources and attitude exist within the system.

Programs in which the Monroe IPM Model has been implemented effectively are in well-managed school districts, led by socially connected opinion leaders, and where the infrastructure of efficient communication and cooperation are apparent from the onset. Participants in successful programs often work closely with other coalition members beyond their own boundaries.

Whereas the inclination of funding agencies is to implement IPM in a politically or economically disenfranchised location, change agents must choose carefully when initiating an areawide program. Funding for environmental programs is often biased toward environmental justice, or simply crisis-driven opportunities. Unfortunately, this is rarely where innovations flourish. In fact, two of the three failures of this model occurred in school districts chosen to satisfy the social goals of the funding agency. The Navajo Reservation Bureau of Indian Affairs (BIA) schools discontinued a highly successful program soon after the implementation team completed their portion of the implementation, due to lack of BIA commitment and support (Lame 2005); and the Washington, DC, Public Schools could not adhere to the Memorandum of Understanding (see Stage 3) because of a cumbersome and ineffective bureaucracy. Considerable investment of the entire community may be required before all community groups are incorporated.

The IPM Institute of North America is an independent nonprofit organization formed in 1998 to foster recognition and rewards in the marketplace for goods and service providers who practice IPM. The institute's mission is to accelerate adoption of IPM in agriculture and communities through consumer education and development of IPM standards for self-evaluation and IPM certification (http://www.ipminstitute.org/ipmstar.htm).

Stage 2. Forming a state or regional coalition (engaging the social network) supporting the innovation. Discovering and gathering personnel from the diffuse decision-making environment that forms school districts are ongoing efforts. This step has typically been undertaken by the national implementation team (IPM experts), which is an eclectic group of university experts and experienced school district personnel.

Leadership is needed to support and allow members of the school community to work together to achieve common goals. Ideally, enthusiastic leadership is provided nationally as well as within state; and multistate partners support one another as an implementation team. Close relationships are fostered between in-state school districts and local leaders, and out-of-state expertise is drafted in for specific training and evaluation tasks. Establishing credible leadership allows long-lasting partnerships to synergize.

In accordance with the principle of communication network analysis, adopting an innovation is an individual's prerogative, whereas diffusion or large-scale adoption takes place within social networks. The initial decision to embrace a concept may be an administrative one, but the practical operation of technology clusters requires a network of supporters able to communicate and coordinate (Rogers and Kincaid 1981).

Stage 3. Creating and enforcing a memorandum of understanding (MOU). The MOU is a useful tool to ensure that everyone is appraised of the responsibilities they have. For change agents, it might require scheduled and convenient training programs with monthly inspections. For the adopting school district, it normally requires access to records about historical pesticide use, pest management contracts, access to staff for training and the cessation of pesticide application without consultation with the implementation team. The MOU helps to establish the partnership critical to program implementation. Furthermore, it protects both sides from misinterpreting the intent and accountability of their commitment.

As a result of clearly shared goals and definitive responsibilities, engaged school districts usually become enthusiastic, compliant partners. In our experience, continuing to invest resources in noncompliant coalition members has been a waste of time, effort, and resources. Further attempts to engage uninterested parties are contrary to how the diffusion process becomes self-sustaining (Rogers 1995). Resources are dedicated to adopters who demonstrate their commitment. Partners that fall short of MOU specifications are dropped from the program, allowing resources to be refocused.

Stage 4. Establishing the pilot school demonstration. The school district is asked to give the implementation team one school site with a progressive principal and significant pest problems. Working with just one site, the district takes a relatively small risk in a situation where current pest management practices are clearly failing. The opportunity here is to demonstrate a dramatic solution to a significant pest problem. Thus, IPM is viewed as having the positive attributes of triability and relative advantage compared with traditional practices (Lame 1997).

Stage 5. Professional recognition. Recognition achieves professionalism among individuals, strengthens leadership and commitment, and encourages diffusion beyond school district boundaries. Not only are individuals and institutions empowered by their own success, but resource partnerships are formed and widescale efficiency improves. Key individuals (or "peer leaders") are used in other locations to initiate new programs, and district members engage in peer-to-peer communication and cooperation. Recognition and reward come in many forms, and related mass-media attention generates confirmation to the public and increases awareness of the innovation.

Stage 6. Scheduling quarterly meetings. The coalition members meet quarterly. Typically, district administrators, IPM specialists, pest management professionals and group leaders (lead purchasing agents, head nurses, etc.) attend these meetings. Members of the extended support group (state agencies, advocacy agencies, etc.) are encouraged to attend. Peers connect, share experiences, and devise solutions to common problems in need of resolution. Meeting regularly offers educational opportunities and fosters resource partnerships. The coalition group in Arizona has expanded to form a team of the most progressive school districts, which have now taken it upon themselves to invite and aid diffusion of the innovation to potential adopters. Establishing a record of implementation success despite statewide budget cuts, chronic school understaffing, and low inner-city morale is compelling even to the most risk-adverse audience.

Coalition meetings promote relationships, encourage partnerships, and facilitate diagnosis of their own systems. Participants play a central role in information flow and problem-solving. Interaction at meetings and during practical pest audits promotes boundary spanning (incidences in which individuals step out of their usual professional role and engage within a different echelon or perspective). Increasing the understanding of operational practicalities fosters cooperation and efficiency at all levels. The most profound realizations have been experienced by government representatives and district facilities managers who accompany the IPM implementation team on school assessments and actually get to crawl and climb around one of their own school sites. The importance of boundary spanning cannot be overstated. Using the power of relationship-based performance is not new to business models (Hoffer Gittell 2002), but it is relatively new to the science application process.

Stage 7. Hub transfer and mentoring of the innovation to achieve areawide diffusion of IPM. School district administrators who have adopted districtwide IPM practice are encouraged to connect with a peer in an adjacent or overlapping school district. Experienced managers and IPM specialists mentor new adopters, and the coalition expands. The coalition approach incorporates a "hub-and-spoke" system of expansion. Model implementation and resources are concentrated in high-density urban and suburban areas.

Stage 8. "Stacking" new layers. The infrastructure for adopting school environmental health programs is now in place. Additional components can be layered into the existing system without diluting IPM efforts. Districts with risk management teams should already be involved with the program. The introduction of indoor air quality (IAQ) and asbestos or lead remediation programs strengthens the overall environmental health program, community involvement, and investment.

Diffusion of the IPM Innovation

By diffusing innovations within geographically clustered communities, school districts can use their time, effort, and resources effectively. Controlled expansion and peer mentoring sustains the expansion effort, and program stacking improves professional efficacy. Any of the established environmental health programs can be introduced and successfully implemented once the community network is formed. IPM specialists become broader-based environmental health experts and are a professional asset to the school district.

Data for each school district implementation (normally one to three pilot schools) were obtained using standardized assessment tools, which were developed and used by a team of entomologists. It was understood at the inception of this model that perceptions and scientifically backed research about risks from pests and pesticides would change. Therefore, the average number of annual pesticide applications was used, rather than active ingredient concentrations or amount of pesticide, as an indicator of need or perceived need for pest control. Furthermore, this strategy eliminated the variable of toxicity levels. Though monitoring stations were used and documented during implementation, preprogram pest complaints were measured and compared with postprogram complaints by surveying school occupants (administrators, faculty, and staff). Similarly to Green and Breisch (2002), we relied on pest complaint records instead of monitoring data; pest management is services-oriented, and pesticide applications are often determined by pest perceptions as opposed to real infestations warranting treatment.

Pesticide use data were determined from preprogram (minimum, 2 yr) and postprogram (1–3 yr depending on the maturity of the program) invoices and pesticide application work orders (Table 1).

Diffusion rates were developed for school districts in Arizona 2000–2005. Each school district was required to document implementation of IPM tools inherent to the Monroe IPM Model: use of monitoring traps, training for identifying and remediating pest-conducive conditions for faculty, staff, administrators, and pest management professionals; remediating pest-conducive conditions; distributing the newsletters; and properly using reduced-risk chemical pesticides when documented as necessary.

Use of the Monroe model in 10 school districts in seven states (1–10 yr) indicated an average 71% reduction in pesticide applications and 78% reduction in pest complaints to school administrations. Clearly, the premise that the use of pesticides prevents pests is false.

Funded projects did not include provisions for collecting data from nonparticipating control schools; thus, we view the data collected as case histories.

The use of the Monroe model to diffuse IPM in school districts has resulted in a consistent and significant reduction of pesticide applications. There has also been a concurrent, consistent, and significant reduction of pest complaints by the occupants of adopting school districts. Results have been most dramatic in school districts that previously used scheduled application of pesticides and had light-to-moderate levels of pest pressure. In all cases where the model has been fully implemented, districts eliminated the routine spraying of school areas and summer pesticide applications.

As IPM has become established as a desirable management strategy and insecticide formulations have improved, we have observed some increase in effective pest management. Therefore, it is not surprising that the more recent adopters of the Monroe IPM Model demonstrate a less dramatic reduction in pesticide use and incidences of pest complaint. However, the reduction of pests and pesticides in these school districts also has been consistent and significant.

It is the experience of most pest managers (professional and academic) that the diffusion of IPM is based on the behavior of the human community rather than on the pest complex. It is also our experience that although the geographic location of the schools did present some differences with regard to pest type and pressure, the only factor that determined positive behavior change by the human community was the quality of management exhibited by school decision makers.

The execution of the model has resulted in the systematic diffusion of IPM in cohort school districts in Arizona. Based on the percentage of Arizona students attending IPM schools, the following diffusion rates were apparent (Figure 1): 1.8% over the first two years (2000–2001); 10.4% in the following two years (2002–2003) and 18.2% over the last year and a half (2004–May 2005). Figure 1 shows the beginning of a typical diffusion curve as described by Rogers (1995). During May 2005, 30.4% of K–12 children in Arizona schools were benefiting from verifiable IPM programs.

Use of an Innovation–Diffusion model aids community adoption of IPM practices in schools. It has been our experience that there is an established demand for improved pest management and reduced pesticide dependence in our schools. As documentation and evaluation are built into the implementation plan, the results can be experienced by participants and demonstrated at the aggregate level.

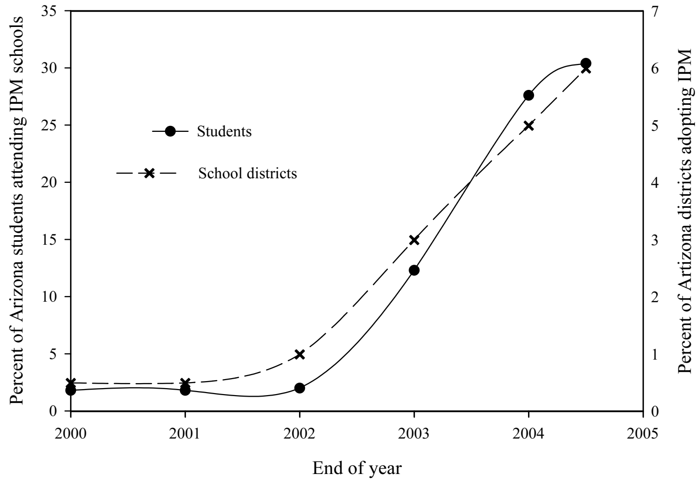

Fig. 1. The beginning of a diffusion curve showing the percentage of students attending schools, and the percentage of school districts practicing IPM in Arizona, 2000 to May 2005

There is the obvious need for a comprehensive compilation of all effective IPM for schools innovations into a "toolbox" to conserve resources, a greater effort by federal funding agencies for national coordination, and an economic model for the verifiable implementation of IPM. Finally, industry partnerships with school districts must be encouraged, and business models established that ensure mutually successful relationships.

Well before broad-based federal campaigns to integrate pesticide reform into government planning (Clinton 2000), IPM was considered the technological paradigm for reducing risks due to pesticides (USEPA 1993, Benbrook et al. 1996, Goldman 1996). Greene and Breisch 2002 concluded that IPM in government buildings resulted in significant decreases in quantities of insecticide applied and requests for pest management services by building occupants. The data were collected over a decade from a large-scale program and indicate good success. However, our children, the most sensitive portion of the population (National Research Council 1993), spend their "working day" in daycare facilities and schools. This is where significant efforts should now be focused.

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