Part VI. Working with Customers to Identify IPM Research and Implementation Priorities

Introduction

Research and technology transfer are an important component of USDA's approach to achieving IPM adoption in agriculture, nurseries, and other pest-management settings. The importance of identifying and responding to the needs of customers, setting priorities, and building teams with diverse stakeholders are the session topics of this final part of the workshop.

In the first session, the advantages of teams for IPM research and implementation programs, which was the topic of a preconference workshop at the symposium, are outlined. Teams successful in integrating a broad array of interests and skills generate the potential for garnering additional support and expertise for IPM, finding new sources of funding, and making broader research accomplishments possible through collaboration. Participants in this preconference workshop identified more than 161 potential stakeholders (producers as well as consumers, taxpayers, legislators, consultants, and others) in IPM programs as sources of "good ideas, synergy, funding, political clout," and other program needs.

The second session contains reports on priority needs for IPM research and implementation that were made in nine commodity-based workshops held at the symposium, with seven focused on agricultural crops and two examining homes and landscapes. Numerous, specific needs were identified in some workshops (71 for nurseries and urban ornamentals, about 100 for tree fruits, and 339 for vegetables) while other points of discussion addressed generic or key priority needs.

The need for more fundamental, component, and systems research was identified in all of the workshops. Definitions for these three types of research were noted in the potato workshop. A wide range of specific biointensive and nonchemical pest-management research needs were also identified across most of the workshops. The workshops also identified numerous education- and information-delivery needs and goals, with demonstration farms and garden-center booths among the priorities that were mentioned in most of them.

Although an enormous amount of IPM research and implementation needs have been identified by customers in these workshops, at least one workshop reported significant progress in expanding the set of biointensive tools available to farmers since the early 1990s. Participants in the tree-fruit workshop reported that research had been expanded nationally for the use of predators, parasites and microbial biopesticides, host-plant resistance, cultural control, and semiochemicals.

Team Building for IPM Research, Implementation, and Outreach/Education

Ed Rajotte and Lynn Garling
The Pennsylvania State University
Moderators

A preconference team-building workshop was held during the National IPM Symposium/Workshop. The purpose of the workshop was to discuss the rationale and skills necessary to mount a participatory approach to IPM program development and implementation. Approximately 140 people attended. Written materials and an in-depth information packet were provided to each participant.

The workshop opened with five diverse testimonials citing challenges and real-world successes in IPM teamwork. The bulk of the session actively involved participants in practical exercises with specific techniques to identify barriers to team building and to discuss collaborative solutions.

Goals of Workshop

Specific goals of the workshop activities were to:

1. Stress the importance and scope of team building for IPM programming.
2. Use hands-on activities with specific small-group techniques.
3. Provide a format for participants to discuss their negative experiences with teams.
4. Illustrate how principles of teamwork arise from individuals' stated experiences.
5. Stress the importance of managing group dynamics for successful team building.
6. Identify stakeholders and their potential contributions to IPM programs.
7. Discuss the choice of appropriate group techniques for various situations.
8. Provide written materials in support of workshop activities and team building.

The following is a summary of the workshop content and results. Complete texts of speeches and results are available from Pennsylvania IPM Program, The Pennsylvania State University, Department of Entomology, 501 ASI, University Park, PA 16802; 814-863-8884; or lyn_garling@agcs. cas. psu. edu.

Why Teamwork?

Five speakers representing differing perspectives on the value of teamwork gave presentations at the outset of the session to provide an overall context for team building. The speakers were all intimately familiar with and/or actively involved in IPM research, implementation, and/or policy. Perspectives presented were private industry, independent crop consultant, private sustainable agriculture organization, land-grant-institution IPM coordinator, and government agricultural agency. Speakers were Steven S. Balling, Director, Environmental and Analytical Service, Del Monte Foods Research Center; Madeline Mellinger, President, Glades Crop Care, Inc.; Kathleen A. Merrigan, Senior Analyst, Henry A. Wallace Institute for Alternative Agriculture; Larry Olsen, IPM Coordinator, Michigan State University; and Larry Elworth, Special Assistant for Pesticide Policy, Natural Resources and the Environment, USDA. The following selected quotes highlight key points that were made.

Marketing and Politics

"Your customer is the grower. If he or she does not buy your product (your IPM program), it will languish on the shelf. In today's era of limited resources, if your product does not sell, your funding will disappear. After 40 years, IPM has finally gained some momentum, but is still missing one thing: funding. Without increased funding, IPM will simply not be able to meet the needs of its customers. Teamwork will (1) build a constituency of voters to support your programs at both the State and local levels and (2) build a constituency of funders to support your programs directly. For too long, we in agriculture have acted like ants without the genetic coding for socialization and colony building. We are industrious but have no organization. Even if a small percentage of that energy can be harnessed as an IPM constituency, your influence will grow immeasurably" (Balling).

Handling Complexity, Assuring Accuracy of Information, and Implementing

"The game that is being played by our team is agricultural production. Logic tells us right away the game is too big for a narrowly focused team. We need to bring together a strong, diverse group of players, including independent consultants. Consultants make careful observations on a site-specific basis over our entire service area. We synthesize this information into useful production-management recommendations. We are able to identify and prioritize the most important problems from our whole-crop-system approach because of our field-based, intimate familiarity with crops, populations, infrastructural issues, etc. We can communicate and advocate for our growers' specific needs for public research. We must understand and help our clients use a holistic systems approach when we introduce new technology to agricultural production" (Mellinger).

Political Divisiveness Does Not Serve the Needs of Agriculture; Invite Everyone to the Party and Work Together

"The foundation of a healthy agriculture is diversity: diversity of crops, production systems, geographic locations, and people. One of the most striking things that happens at every sustainable-agriculture meeting is that at some point, participants look around the room and ask "who's missing?" Do we have women, people of color, scientists as well as farm laborers, consumer and environmental activists, and geographic diversity? There is clear recognition of the need to broaden participation, that this is a necessary part of any solution we can devise. In contrast, I argue that the IPM community is not as inclusive, although great progress has been made. As you meet this week, look around the room and ask yourselves the question of who is missing? The bottom line is that team building and partnerships are not nice things to do, optional exercises that precede a conference. They must be at the very core of all activity and decision-making if IPM is to be sustainable" (Merrigan).

Teams at the Land Grant, Is it Possible?

"It is important that we articulate what our vision of IPM is in order to be able to find common ground and work together. Each person sees the need differently, but all know that we are in this together and that it is the land-grant university's mission to help growers solve their pest-management problems. In spite of the risks, there are many potential and real benefits associated with the formation of teams of commodity groups and others and with the networking required with the IPM effort. Funding, staff support, and legislative voice are all areas in which we have experienced increases as a result of our collaborative efforts. We were able to fund 10 IPM minigrants in 1995 by pooling and leveraging funds. We are able to make long-term financial commitments because of the diversity of contributors. [The Michigan IPM Alliance] was considered impossible just one year ago. The commodity groups have never been able to come together on any topic before. When Phil [Korson] approached Gerbers, Michigan Department of Agriculture, Michigan Potato Growers, the MSU Department Chairs, and the Dean of the College of Agriculture, they all thought it would not be possible, but thankfully, due to Phil's commitment it was!" (Olsen).

Group Activities

Participants were divided into 12 small groups, each with a facilitator. In structured exercises, they defined team dynamics and functional components from their own experiences. Following these observations, each small group was presented with a preestablished, well-documented IPM-implementation constraint and provided with a stepwise process to discuss constructive uses of collaboration to address the constraint. Lists and charts generated by these processes are available with the full report.

Summary and Results

Team Dynamics and Functional Components

Participants were asked a specific question aimed at revealing what works, what does not, and why in a team setting. Because negative experiences and misgivings are common when people are faced with teamwork, we took the approach of encouraging expression of these strong feelings. Besides allowing controlled "venting," the usefulness of this approach is that the ideas come quickly and easily and any articulated negative experience can be reversed to illustrate a positive element needed to create a better functioning team. Techniques for fostering positive team interaction exist and can be learned.

Question 1, "How did you *feel* in the worst team situation you were involved in?" produced 128 responses, including many repetitive expressions of frustration, anger, feelings of futility, powerlessness, anxiety, personal insult, and alienation.

The significance attached to these responses is:

- These types of feelings about teams (or even meetings) are widespread.

- Such emotional disincentives produce an invisible undercurrent of resistance to teamwork.

- If team leaders do not attend to resolving such feelings within a group, morale drops, team members' talents are not fully used, or they give up, and task goals suffer.

- Understanding the existence and source of such feelings can be used to help set up supportive, productive atmospheres for teamwork.

Question 2, "What was *not working* in that team?" produced 159 suggested dynamics that conspired to derail the team function. Specific remarks seemed to fall into roughly eight categories:

- lack of team atmosphere
- team makeup and involvement
- lack of clear vision or goal
- lack of effective team leadership
- poor facilitation
- lack of buy-in by key leadership
- lack of ability to see results
- poor communication

The contributing factors to these dynamics can be examined and reconstituted to create your own principles of successful teamwork. ("We have met the enemy and he is us!")

Location and Alleviation of Team Dynamics Problems

With the list of their group's team difficulties before them, participants were asked to locate the source of the team's problem. Specifically, they were asked, "Is the problem internal or external to the team itself? Further, is it a task or people process difficulty?" Once sources of problems were located, participants were asked to suggest ways to improve the situation. Results were tabulated by each group in a chart provided. For example, "Hidden agendas" was identified as an internal team problem with suggestions for improvement being "working in consensus mode and valuing all perspectives." As an external problem to team function, "Changing of rules by appointing authority" was cited. Possible amelioration included "written charge to group, mission statement, and written promise of support for team."

The problem of "bad team dynamics" can seem amorphous and overwhelming. This activity demonstrated how such dynamics, which usually come from many sources, can be analyzed and broken down into bite-size units. Identifying components serves as a starting point for designing solutions that can be achieved.

IPM Constraints: Constructive Uses of Collaboration

Each of 11 small groups was provided with a different key IPM constraint. Participants were given a stepwise series of questions aimed at helping them think about positive collaborative approaches to the constraint. Question 4 first asked, "Who is a potential stakeholder in the outcome of this constraint?" Groups listed 151 potential stakeholders, averaging 14 for each IPM constraint. Stakeholders listed might be lumped into 29 distinct groups. Consumers, including "general public, taxpayers, neighbors, urbanites, and housewives" were mentioned as stakeholders 15 times in the 11 groups. Producers and environmentalists were both mentioned 10 times. The one constraint for which producers were not mentioned as stakeholders was "Society's concern over pesticide use." Other high-ranking stakeholders by frequency of mention were agribusinesses (10), researchers (9), legislators (9), consultants (8), and Extension agents (7). Participants then looked again at the IPM constraint before them. For each identified stakeholder in that constraint, they considered: (1) What are the specific potential benefits of collaboration for you and for the stakeholder in remedying this constraint? (2) How do you identify legitimate representatives of this stakeholder group? (3) What are potential ways to involve the stakeholder group in your program? Each group tabulated the results in a chart that was provided.

This exercise demonstrated that stakeholders in IPM implementation consist of people representing a wide variety of socioeconomic positions. It also sensitized the participants to the importance of diverse stakeholders as a source of good ideas, synergy, funding, political clout, priority setting, public relations, and outreach during program implementation. Productive stakeholder involvement in program design and imple-mentation requires forethought and attention to team dynamics to produce these desired results.

Supporting Materials

Take-home materials for participants included two books and folders of selected publications on collaboration and teamwork, group processes, and conflict management. A detailed annotated list of packet contents is in the full report.

IPM Programs for Cotton Producers

Allen Knutson
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Coordinator

The workshop opened with a review of the research and extension needs for cotton IPM as determined by more than 225 cotton producers, consultants, and Extension and research faculty participating in 17 assessment meetings held in 1995 and 1996 in North Carolina, Mississippi, Oklahoma, and Texas to identify the needs in research and extension education for cotton IPM as part of Phase 1 of the USDA IPM Initiative. The results of this assessment are summarized below and will provide part of the foundation to develop a proposal for implementation under Phase 2 of the IPM Initiative.

Because cotton losses from insects were at record levels during the 1995 growing season ($1.68 billion), it is not surprising that growers and consultants focused on insect and mite management. Identified research needs included a greater understanding of natural enemies and their use as biological control agents of cotton pests, better defined economic thresholds, and improved sampling and forecasting methods for cotton pests, an evaluation of the economics of transgenic cotton varieties containing the B.t. gene for bollworm/budworm resistance, and tactics for resistance management to preserve the effectiveness of this new technology. Other research needs focused on changes in the boll weevil eradication program to minimize disruption of natural enemies and secondary pest outbreaks, methods to manage insecticide resistance, improved management tactics for plant bugs, early season thrips and budworms, and understanding the impact of different tillage systems on pest infestations and crop productions. Participants also expressed the need for improved communication and interaction between researchers, growers, and consultants to better target research and implement research results.

In addition to entomological problems, growers voiced the need for developing management tactics for using transgenic varieties with herbicide resistance and determining the economic value of the technology. Developing economic thresholds and improved herbicide-application technology were also key needs in weed management. Regarding cotton diseases, identified needs in-cluded methods to forecast the need for fungicides to control seedling diseases and information on the effective use and economic return of fungicides to control seedling disease. The development of sampling methods, treatment threshold, and control tactics, including resistant varieties, for nematodes were also priority concerns.

In addition to research needs, growers and consultants were asked to address the extension and educational needs in cotton IPM. The identified needs included the expansion of current extension programs (such as in-depth workshops, in-field meetings, and field demonstrations) and the increased use of print publications, newsletters, and electronic methods (e.g., the World Wide Web and the direct satellite television network) to rapidly disseminate cotton IPM information. Extension was also encouraged to expand its unique role as an unbiased source of IPM information and to interact more with consultants and industry to facilitate technology transfer.

Other concerns were the need for more trained consultants and an increase in training and educational opportunities for consultants, a need to educate the public on the environmental stewardship practiced by agricultural producers, and the education of growers and practitioners about the goals and practice of IPM. And finally, growers and consultants said the long-term economic and biologic stability of IPM programs should be evaluated and demonstrated.

Following this presentation, workshop participants were divided into three discussion groups and asked to address one of the following issues. The assignment for each group and their responses are summarized below.

Issue 1. Develop an organizational structure for a community-based pest-management program. Describe how cotton IPM teams could be formed and function to meet the needs of research, education, implementation, and evaluation.

The program would be conducted by a steering committee composed of two to three growers; two to three consultants; a ginner; and one representative each from industry, Extension, and research for a total of about 10 individuals. It was felt that a committee of 10 to 12 would be optimum. Commitment by growers and consultants would be important to identify local needs and facilitate implementation and evaluation at the farm and community levels. A technical committee would consist of the research and extension specialists (agronomist, economist, weed scientist, etc.) and others involved in the IPM program. The steering committee and technical committee would meet three to five times each year to identify local research and extension needs, coordinate collection of field data with consultants to validate IPM practices, identify grower cooperators, plan and sponsor educational meetings to highlight program accomplishments and projects, identify and seek other funding sources, set annual goals, and measure program progress and impact.

Issue 2. Determine the communication needs that would improve delivery of IPM information and adoption.

Priorities are to provide current, real-time information that is well organized and synthesized, can be rapidly searched, is targeted to the user (client-based), and provides for feedback from the user. Workshops are needed to train those developing information-delivery systems and those using these systems. Important channels of communication are print on demand, cellular and mobile phones, electronic media (e-mail, CDs, fax, and the WWW), workshops, radio, and direct satellite television. Considerations concerning content are accountability, accessibility, commercial vs nonprofit institutions, timeliness, and mechanisms for feedback. Target audience can include consultants, producers, industry, retailers, colleagues, and bankers.

Issue 3. Describe how a community-based cotton IPM program can be organized and function to develop IPM programs, encourage their implementation, and assess the economic and environmental impact.

Success of a community-based program will depend upon producer buy-in. The size of a community will depend on biological, sociological, and economic factors (the target pest, what is manageable, the amount of funding available, and political boundaries). It is important to have baseline information on cropping practices, pest levels, pesticide use patterns, etc. to measure change.

Resource needs include a mission and goal (e.g., bollworm management in a two-county area); a steering committee composed of growers and consultants; a technical committee of research, Extension, consultants, growers, industry, and agribusiness personnel; an operational plan and budget; a project coordinator; interaction with an IPM team; an educational activities plan; and funding sources (State, Federal, and industry).

Research could be conducted first on experiment station plots, then moved to grower fields for validation and demonstration, then to whole farms and communities for adoption. Communication would be very important and could include stakeholder meetings, publication of white papers on program objectives and results, publicity of educational meetings, direct producer contacts, and frequent updates and progress reports.

Assessments of economic, environmental, and social impacts would be determined from data collected from grower cooperators' enterprise budgets. Environmental impact could be measured by comparing densities of beneficial insects, pesticide use (including shifts in use of pesticide classes), and movement of pesticides off-target. Social impact could be measured by surveying producers, consultants, the public at large, and field workers. Constraints include maintaining stakeholder support and enthusiasm; funding; and developing practices and technology that will actually be economical, practical, and implemented by the grower/consultant community.

IPM Programs for Wheat Growers

Greg Johnson
Montana State University
Coordinator

The focus of this commodity workshop was to discuss research and education needs that pertain to wheat production in the United States. Admittedly, this is a big challenge because of the complexity of the production system, the diverse farming practices used across the country, and variable abiotic factors that influence wheat production. In preparation for this workshop and to meet Phase I objectives of a National IPM Implementation project "Pest-Management Strategies for Dryland Wheat Systems in Northern Great Plains and Mountain Farm Production Regions," a Strategic Planning Workshop was held in February 1996 in Bozeman, Mont. This workshop, attended by 45 participants (including producers, consultants, Extension agents, researchers, and Extension specialists from Idaho, Montana, Nebraska, Wyoming, and South Dakota) focused on identifying strategic issues facing wheat producers in the northern Great Plains, developing solutions to these issues, and developing a plan of targeted activities to address these issues. The information collected at this workshop served as a starting point for initiating discussions at the wheat commodity workshop at the Third National IPM Symposium.

Pests and Factors of Production

An extensive list of disease, insect, and weed pests was developed for the northern Great Plains wheat-production region. Pests included on such a list change relative to the wheat-growing region of the United States. Perhaps more relevant to a large geographic region were nonpest problems. The nonpest problems encountered by wheat producers include grain-marketing strategies, crop-residue management, farm-program provisions, an increasing cost of inputs, water and soil manage-ment, viable crop rotations, risk management, limited variety selection, and transportation. While much attention is dedicated to research and education relative to solving pest problems, many producers consider nonpest problems of equal importance and worthy of attention.

Myriad factors influence disease, insect, and weed problems encountered in wheat production. These factors include: residue management and compliance, susceptible varieties, a monoculture system, cropping-system management, pest resistance, chemical fallow, lack of rotations, cultural practices, and pesticide reliance. Areas of research that were considered germane to addressing these factors include cropping-system management emphasizing the systems approach, developing resistant varieties, developing action thresholds, determining fertility responses, developing noncereal rotation crops, developing pest-management options for rotations, developing marketing strategies for rotation crops, and determining economic benefits of IPM.

Objectives Identified

Targeted objectives to expedite achieving IPM research and education needs include: (1) a cropping-system approach to pest management, (2) diversified crop-rotation systems, (3) residue-management programs, (4) IPM training and education, (5) farm-policy programs, and (6) measuring IPM profitability.

Objective 1. Cropping-system approach to pest management. This objective should focus on investigating system-level reactions to pest-management practices and optimize long-term economical and ecological pest-management practices. Targeted activities to achieve this objective include forming interdisciplinary research and extension teams; investigating system-level reactions to specific pest-management practices; developing practices from a water-conservation standpoint; emphasizing development and evaluation of resistant varieties; developing action thresholds; and exploring flex cropping; develop on-farm post-harvest management practices.

Objective 2. Diversified crop-rotation systems. Systems developed by integrated teams of researchers, Extension personnel, and producers must agronomically complement each other, be regionally adaptable, and be marketable. Activities identified by workshop participants include: identify and evaluate viable, noncereal rotation crops; conduct long-term rotational studies; investigate the impact of companion crops on fertility rotational benefits; determine the impact of rotational systems on pest populations, investigate rotational influences on disease, insects, and weeds; and identify uses, storage, transportation, and market opportunities for rotational crops.

Objective 3. Residue management. A point of clarification was made that residue-management activities can be beneficial or detrimental to wheat-production systems. The targeted activities for this objective include: develop on-farm demonstration plots to determine the impact of plant residue on selected pest populations; determine varietal responses in high-residue systems; investigate alternative methods to conserve soil and water; compare effects of no till, minimum till, and conventional till to selected agronomic parameters (moisture and erosion), pests, and economics.

Objective 4. IPM training and education. The primary goal of a wheat-production IPM program is to increase the understanding and implementation of IPM through enhanced education of producers, advisors, and consumers. Targeted activities for this objective include: improving multiple methods of educational delivery (on-farm demonstrations, and multidisciplinary teaching at workshops); form "wheat clubs" with progressive growers; use producers as trainers; increase electronic media use; and develop an effective marketing strategy for IPM.

Objective 5. Farm-policy provisions. This objective was identified because farm programs (rules, regulations, and policies) can prevent and/or inhibit adopting farm-specific IPM practices. Targeted activities include: explore local or regional control in implementing farm policy; educate consumers relative to farm policies; and develop rewards and incentives for producers adopting IPM practices.

Objective 6. Measure IPM profitability. To be adopted, IPM must be economically profitable with recognizable risks and uncertainties. Targeted activities include: conduct economic-profitability studies; focus activities on economic efficiency; and identify and examine risks and uncertainties through research and education.

Implementation and Assessment

To facilitate adoption and implementation of IPM practices in wheat production, the following methods were identified: on-farm demonstration plots, producer participation in planning activities, development of IPM producer groups, and increased electronic-media use. Workshop discussion focused on the method of assessment to determine the degree of adoption of IPM in wheat production. It was understood that the degree of adoption would be based on field scouting. It is important that criteria be developed for wheat on a regional basis; field monitoring is not a good measurement of IPM use in this commodity. The following constraints toward adopting IPM were identified: age of producers that may influence adapting to change, USDA farm programs, lack of incentives, lack of research on the cropping-system approach, misperception of IPM, risk of changing practices, marketing factors, and economics.

IPM Programs for Corn and Soybean Producers

Ken Ostlie
University of Minnesota
Coordinator

Corn and soybeans are planted on more than 124 million acres in the United States. Pesticides are an important management component of corn- and soybean-production systems. More than 93 percent of the acreage is treated with one or more herbicides, and more than 25 percent of the corn acreage is treated with insecticides. Intensity of pesticide use, concern over environmental and health issues, and emerging pest problems necess-itate a closer look at IPM implementation. IPM adoption has been estimated at from 17 to 65 per-cent for corn and from 13 to 59 percent for soy-beans (Vandeman et al. 1994; Cate and Hinkle 1994). The objectives of this workshop were to review, discuss, and suggest improvements to three IPM efforts:

- Defining the key components of IPM in corn and soybeans for use in measuring IPM progress
- Measuring IPM adoption through survey activities of the Agricultural Resource Management Study (ARMS)
- Establishing clientele-based priorities for IPM research and extension.

Defining IPM for Corn and Soybeans

Dr. Wendy Wintersteen summarized the Government Performance and Reporting Act and its implications for federally funded IPM programs. Defining IPM for corn and soybean production systems is critical to establishing baseline data on IPM usage in these crops and to measuring the future performance of IPM programs. Beginning with results of an earlier workshop, participants produced the following list of key IPM components.

General IPM Practices

1. Regularly receive pest- and crop-management information during the growing season.
2. Attend meetings on pests, their identification, and management.
3. Keep field records (including weed and disease maps).
4. Conduct off-season crop-management planning.
5. Scout crops for key pests and general problems.
6. Use cultural practices (tillage, row spacing, seeding rates, planting dates, and cultivars) that reduce and/or control pests.
7. Use prevent measures that reduce the spread of pests.

Weed Management

1. Tailor weed management in individual fields based on in-season and fall scouting.
2. Reduce herbicide use by one or more of the following methods appropriate to your situation: mechanical control (tillage, rotary hoe, or cultivation), cultural measures, herbi-cide banding and cultivation, spot treatments, below-label herbicide rates timed by field scouting, and herbicide applications based on in-season scouting and weed thresholds.
3. Practice strategies that reduce herbicide resistance.

Insect Management

1. Routinely scout for key insects (e.g., in corn for the European corn borer, corn rootworms, black cutworms, and others appropriate to local conditions and in soybean for stand reducers, defoliators, and pod feeders as appropriate to the local situation).
2. Base insecticide decisions on economic thresholds.
3. Minimize adverse insecticide impacts through judicious selection of insecticides, rates, areas to be treated , and timing.
4. Use cultural and weed-control practices that minimize risks from key insects.

Disease Management

1. Use crop rotations that reduce disease incidence and severity.
2. Plant resistant varieties.
3. Perform soil sampling for nematodes.
4. Submit diseased plants to diagnostic clinics for identification.

IPM adoption is viewed as a continuum so discussion ensued on the degree of adoption necessary for a farmer to call himself an IPM practitioner. The geographic variation in key pests and appropriate pest-management practices were other key discussion points, with one resolution to define IPM for various corn- and soybean-production systems on a State or area basis.

Measuring IPM Practices

Ms. Cathy Greene, Economic Research Service (ERS), reviewed progress on ARMS, the Agricultural Resource Management Study. ARMS developed from combining the old Cropping Practices Service and the Farm Costs and Returns Survey conducted by the National Agricultural Statistics Survey (NASS). She discussed several proposed questions for the new ARMS survey to be conducted among corn and soybean producers in 1996. To gather feedback on the proposed survey, several smaller workgroups discussed the survey questions with ERS and NASS representatives.

Extension and Research Priorities for IPM Implementation

Dr. Ken Ostlie presented the outcome of a regional workshop held to determine Extension and research priorities for IPM in corn and soybean. A broad cross-section of farmers, crop consultants, agronomists, agricultural-chemical-industry representatives, environmental activists, Extension educators, government staff, and university professors met in February 1996 to tackle this task. The following priorities from this workshop were presented for review and discussion:

Research

- Develop weed thresholds and optimal management systems.
- Explore the economic and risk-management implications of IPM.
- Plant cropping systems that minimize pest problems and maximize profits.
- Adopt alternative management strategies to pesticides.
- Improve scouting techniques and tools.
- Investigate the implications of new technologies (geopositioning, geographical information systems, statistics, and variable-rate application) for IPM.
- Examine the factors influencing adoption of IPM.
- Conduct a survey of IPM adoption.

Extension

- Provide real-world information to producers.
- Conduct more on-farm applied research and demonstrations.
- Form strategic alliances with industry and growers to promote IPM messages and practices.
- Emphasize the holistic context for IPM programs.
- Use electronic media for IPM-information delivery.
- Use community-based educational efforts.
- Educate “nonfarm” audiences about IPM.
- Market IPM more effectively.
- Evaluate IPM programs to identify what works and what does not, and then share the results.
- Develop an IPM recognition program for farmers.

Small groups discussed these priorities with the general consensus that these priorities truly captured their own personal priorities for IPM research and education in corn and soybeans. No substantive additions were offered.

IPM Programs for Forage-Crop Producers

Bill Lamp
University of Maryland
Coordinator

The workshop was organized to address the research and extension needs for forage crops. Forage crops differ from most of the cropping systems discussed at the IPM Symposium for several reasons:

1. The crops are of relatively low value, and therefore the economics of IPM on forage crops differs from other crops.
2. A number of plant species (legumes, grasses, and crucifers) are used as forages, and concomitantly a wide range of pest species reduce the growth, development, and persistence of forage crops.
3. Forages can be used singly or in mixtures and range from closely managed hay systems to relatively little-managed prairie systems.
4. Forages are an integral part of a wide variety of sustainable farm systems, although they rarely serve as the major economic resource of a system.
5. Forages are usually perennial and persist in stands for several years; thus, they provide a consistent habitat for many pest species, although cutting may cause frequent disruption of habitat suitability of other species.

These qualities make forage-crop protection from pests unique among crop systems and result in special challenges to IPM implementation.

The workshop was conducted as a discussion of questions, led by four panelists, and included audience participation. The four panelists were: John Dantine, Consultant, Lancaster, Pennsylvania; Alan Gotlieb, Plant Pathologist, University of Vermont; Phillip Mulder, Extension Entomologist, Oklahoma State University; and David Liewehr, Ph.D. Student Entomologist, University of Maryland.

The following is a summary of the questions posed and some of the key points made during the discussion.

1. Producers need specific answers to questions with regard to their pest problems. From the perspective of the producers, what research is needed to answer these questions?

- A need exists to integrate forages from the perspectives of crop growth and animal requirements. The current focus is IPM; we need to move toward integrated crop management (ICM) and integrated farm management (IFM).

- An often-suggested need is voiced as "stand decline," yet stand persistence is a result of complex interactions of crop genetics, management practices, abiotic factors, as well as biotic factors (especially pests).

- Generally, producers need clearly defined thresholds and easily implemented control alternatives, including the use of crop-management practices for managing pests.

- Producers desire economic data to support their decision making.

2. Various barriers currently impede the transfer of information across disciplines and research/extension/industry sectors. How can we enhance the communication of forage-crop IPM?

- Because of the low crop value and shifting paradigms at universities, no one State has all the expertise necessary to implement forage-crop programs. Yet, all States need to transfer information because of the integral nature of forages within many farm systems. Thus, more emphasis should be placed on regional or national approaches to forage-crop IPM.

- Conversely, there remains the need for local expertise in forages who understand local problems and needs.

- A more holistic approach to planning is needed (i.e., a team approach involving multiple disciplines and/or industry/university partnerships). These teams force a shift from parochial to more holistic perspectives.

- Not all producers are willing to listen to new information; perhaps we should accept that we cannot reach all producers.

3. New technologies are being developed to control pests in forage crops. What are the major problems (and their solutions) for the adoption of new pest-control measures?

- Most new technologies are too expensive for use on forages. The major exception is the development of new crops and new varieties.

- For new crops, growers need to know the pests and how they can be managed. Regional differences are critical because problems will vary locally and regionally.

- Intensive grazing has become a new technology because of fencing; research is needed to assess its use for forage-crop IPM.

4. IPM is a knowledge-based strategy for managing pests, and therefore education is critical for IPM implementation. How is education of forage-crop IPM programs best achieved?

- Communication is needed among all participants in understanding the forage system.

- Education should focus on specific issues and provide recommendations with regard to economic costs and benefits.

- Simply stated, farmers want answers, not statistics.

- Educators need to understand the audience to market their information successfully.

5. We have a stated goal of 75-percent implementation over the next 5 to 6 years. How can we measure the level of implementation of forage-crop IPM on the basis of economic, environmental,, and social impacts?

- Although we are making progress in increasing awareness of scouting, the awareness of more complex, multiple-pest issues, such as forage-stand persistence, is difficult to assess and even more difficult to quantify.

- We need to assess change over all forage species. For example, a switch from legume to grass will reduce the economic losses to pests, the use of pesticides, and the preservation of nutrients for animal production.

- Measures include pesticide-use reduction and pesticide-use efficiency; economic measures include yield, quality, and stand persistence.

- In the short term, IPM has increased pesticide use because of the awareness of the losses associated with certain pests. In the long term, these pests have become targeted for nonchemical controls, such as the use of natural enemies, host-plant resistance, and cultural controls.

- Progress needs to occur along multiple lines by providing options to growers.

- Again, a more holistic view is needed to consider nontraditional components of IPM and how they fit into crop and farm management as a whole.

IPM Programs for Potato Growers

Mary Powelson and Carol Mallory-Smith
Oregon State University
Coordinators

The purpose of the commodity workshop was to identify the key research, technology transfer, and extension-education needs for implementation of IPM for potatoes on 75 percent of the crop acres. Our charge was to look 5 to 6 years ahead when making our recommendations. Our approach was to organize the workshop into two primary topical areas: research needs and technology and extension needs. Each topic was the subject of a separate work session that lasted about 45 minutes with each participant having the opportunity to contribute to both sessions. This report identifies the key research and extension needs.

Key Research Needs

To analyze the full range of research needs in IPM, we agreed that the three categories frequently used to describe agricultural research were fundamental, component, and systems research. **Fundamental** research produces new knowledge, leading to understanding of basic principles, processes, and mechanisms. **Component** research is the study of one or more factors that affect the performance of an agricultural system. The process by which the nature of interactions among the components of a system are discovered is systems research. **Systems** research results in knowledge that is distinctly different than the sum of results for component research. More importantly, systems research is not distinct from fundamental or component research. Because systems involve different kinds of components, systems research requires an interdisciplinary approach. These definitions, taken from a report of an AIBS-sponsored workshop on Research in Support of Sustainable Agriculture, are also applicable to research on IPM.

Listed below are the key research areas that emerged during the course of the discussion as having potential to contribute significantly to the future success of IPM on potatoes. These themes were common to the three pest disciplines (i.e., diseases, insects, and weeds).

Fundamental Research

- host resistance to pests
- biological control
- pest/potato interactions
- microbe/potato interactions
- pest biology

Component Research

- traditional breeding
- genetic engineering for pest resistance
- management of transgenic plants
- pesticide resistance management
- alternative methods to soil fumigation
- environmentally benign compounds for pest control
- economic thresholds
- pesticide application technology

Systems Research

- interrelationships of cultivars, pests, and agronomic practices
- long-term rotational studies
- pest threshold x cultivar x fertility interactions

Technology-Transfer and Education Needs

Several broad areas were identified that can serve as a starting point for discussion of strategies to enhance IPM on potatoes.

- Development of computer databases, knowledge-based systems, and networks that provide state-of-the-art information about pests, pest-control recommendations, and weather. Examples include bulletin boards, 1-800 networks, and expert systems. With the 800 numbers, pest alerts and timely information on control measures must be updated frequently.

- Production and distribution of up-to-date educational materials. Examples include videos on specific IPM practices growers can adopt, field books with picture keys for identification of seedling and mature weeds, insect pests, and diseases. This same information should also be available on CD- ROM. The picture key books should be of the quality that if they get wet, the ink does not wash away. For paper-based newsletters to be effective, they should be easily recognizable by a farmer.

- Stakeholder education of IPM strategies. Examples include on-farm demonstration plots, field days when farm activity is low, training sessions during the field season (pest ID and IPM), and educational meetings during off season. The importance of one-on-one interactions for problem solving was stressed.

There is a perception that the gap between the research community and its stakeholders (potato grower and processor) is large. For IPM to be successful, the need for better communication and meaningful participation by a larger group of stakeholders was stressed.

One major concern was how to define adoption. Acres under production with IPM and pesticide use are often mentioned as measures of adoption, but defining what are IPM practices and the amount of use of those practices have been problematic at times, leading to questionable results. A rating system was discussed as a potential approach, similar to what is already being done in Massachusetts for IPM certification. It was suggested that we should start with what is agreed to be IPM, recognizing it is a series of "things" not just a single thing. The percentage of growers practicing defined IPM activities is possible to measure. It was also recognized that the level of adoption will change as the cropping system changes and as new pests occur or practices become available.

Because IPM is knowledge, it might be possible to test growers at meetings for understanding of IPM concepts. An example of this was given from cranberries. Testing understanding might also permit analysis of why practices are not used. If a concept is understood by growers yet is not being practiced, what would it take to adapt the practice for use? Further research or overcoming some other constraint might be suggested.

IPM certification was discussed, but the discussion led to the issue of whether the market would drive the need. Does a market exist? If a sufficient market does not exist, could one be created?

Summary

In the end, it was concluded that if 75-percent adoption of IPM becomes reality, it will occur only because growers actually do it. Research is needed to provide the knowledge of what is possible in IPM. Extension adapts this basic IPM knowledge for growers and their consultants to use. It is up to growers to actually put IPM knowledge to use in a practical and economical way.

IPM Programs for Fresh-Market and Processing Vegetables

Larry G. Olsen
Michigan State University
Coordinator

The purposes of this workshop were to identify the key research, technology transfer, and extension education needs for implementation of IPM on 75 percent of the crop acres; determine how to assess the economic, environmental, public-health, and social impacts of IPM implementation; and determine how we can achieve greater IPM implementation in the next 5 years.

To set the stage, the Workshop started with panel presentations discussing IPM needs from different viewpoints, including a major food processor and a diversified family farmer. The speakers presented an overview of their operation and their short- and long-term extension and research needs from the land-grant-university system.

Todd DeKryger represented Gerber Products, Inc., a major processor of vegetables with special very-low-pesticide residue and no-pest-contamination requirements in the end product. They have developed a very strong IPM program working with growers to assist them in raising high-quality vegetables and fruits with minimal pesticides.

Kurt Alstede is from New Jersey and was Rutgers Vegetable Grower of the Year in 1995. Kurt markets almost solely to the roadside fresh market. He has real IPM needs because of the large diversity of crops he grows and the quality demanded by his customers. He needs more scouts in more crops to keep him informed about pest development and is convinced growers will pay for scouting if the service is good. Kurt stresses that research and demonstrations must be done on the farm to match real situations. Lastly, the university must educate citizens in IPM and what growers are doing to reduce chemical use for their own environmental and food-safety reasons.

Discussions

After the presentations, the audience of processors, consultants, growers, academics, and agency people was divided into three groups based on commodity groupings. An interactive workshop format was used with small groups reviewing, discussing, and prioritizing needs. The groups used flip charts, markers, and dots for voting to ease the process. Three facilitators and the MSU IPM staff helped organize the handouts and visuals for the discussions. The groups worked for 3 hours to respond to the following three items.

I. Identify Key Research, Technology Transfer, and Extension Education Needs for Implementation of IPM in Both the Short (1 to 3 Years) and Long (4 to 5 Years) Terms

IPM needs identified through the needs assessment process by 18 State IPM coordinators on 34 vegetable crops were summarized and presented to the appropriate group. The work groups then added other priorities and ranked the needs; 339 needs were identified. The highest-ranking needs follow in descending order. (Each person had three votes to rank their priority needs.)

II. Define How to Measure Impact of IPM Implementation

The second charge to the groups was to define ways to measure the impact of IPM implementation.

Group 1, instead of identifying the impacts of IPM implementation, defined how to measure IPM implementation. All their comments are summarized below in a prioritized listing with the total votes received for that method. Each participant voted twice. Several of the items listed received no votes.

Votes	Crop	Comments
10	Cucurbits	Develop better foliar-disease-management programs, including action thresholds, weather-based monitoring systems, and application technology.
6	Sweet corn	More systems research to solve all problems
4	Cucurbits	Conduct multidimensional on-farm demonstrations of IPM practices
4	Tomato	Interaction of soil, water, and cultural practices with diseases and weeds
4	Tomato	Better control of aphid-transmitted viruses
3	Cucurbits	Develop better management for gummy stem blight
3	Snap Beans	Improve insect control by better monitoring systems, thresholds, transgenic Bt plants, and cultural and chemical controls
3	Snap Beans	Improve weed control with thresholds and effective alternatives
3	Sweet corn	Develop better information on pest biology, crop phenology, and their interaction
3	Sweet corn	Develop better understanding of beneficials and their augmentation and preservation
3	Sweet corn	Develop alternative (nonchemical) controls for corn earworm
2	Cucumber	Develop threshold for striped cucumber beetle
2	Cucurbits	Investigate aphid-vector population dynamics, virus epidemiology, and cultural-control tactics
2	Cucurbits	Develop better management for powdery mildew
2	Pepper	Provide better bacterial-leaf-spot control recommendations
2	Pepper	Improve scouting techniques and decision guidelines for management of European corn borer
2	Pepper	Improve monitoring system for pepper maggot
2	Sweet corn	More IPM field implementation personnel
2	Sweet corn	Develop resistance-management programs

1. Number of acres under IPM and degree of implementation; must define IPM/levels of adoption first (11 votes)
2. Use the Environmental Impact Quotient to measure risk (3 votes)
3. Record the increase in scouts and consultants (2 votes)
4. Cost per acre and cost benefit of IPM (2 votes)
5. Number of growers using IPM
6. Environmental risk reduction
7. Worker safety measured as man hours at risk
8. Increase of natural enemies
9. Biodiversity increase
10. Pesticide use:
    active ingredient per acre (poor measure)
    cost per acre
    toxicity ratio
11. Acres scouted
12. Quantify pesticide residue in end product

Groups 2 and 3 listed ways to measure the impact of IPM implementation. Again, each participant had two votes, with the total votes for each measure indicated. Several methods received no votes. Similar comments from the groups were merged into one list.

1. Number of growers and acres using a defined IPM system (10 votes)
2. Positive enterprise budget, which measures “return of investment for IPM system” (9 votes)
3. Reduce use of a “risky” pesticide (4 votes)
4. Use of Environmental Impact Quotient (EIQ) (2 votes)
5. Lower active ingredient of chemical per acre (2 votes)
6. Lower pesticide residue in packing house and waste water (2 votes)
7. Grower willingness to pay for IPM practices; do they raise risk (2 votes)
8. Consumer satisfaction (1 vote)

9. Pesticide residue on raw and processed products (1 vote)
10. Dietary risk (1 vote)
11. Maintain pesticide onsite
12. Using resistance-management program
13. Grower satisfaction with IPM program
14. Will they work on-farm when privatized
15. Improved or equal quality as market demands
16. Reducing number of sprays per season
17. Enhanced soil structure
18. Adopting reduced-cost practices
19. Number or percent of workers trained in pesticide safety
20. Preservation of open space
21. Better relation to nonfarm neighbors
22. Establish baselines for environmental quality, worker exposure, etc. and measure changes over time
23. Measure worker exposure
24. Marketplace willingness to pay for IPM practices
25. Cost of food to consumers
26. Groundwater contamination
27. Maintain health of pesticide handlers

III. How Can We Achieve Greater IPM Implementation in Five Years?

The last discussion topic was to list ways we can achieve greater IPM implementation in vegetables in the next 5 years. This list is not prioritized but provides numerous excellent techniques the IPM coordinators and programs can use to enhance implementation. Many of these techniques assist in measuring the impact of IPM programs and will be required for reporting for the Government Performance and Results Act.

1. Local demonstrations are a must. They can be twilight tours and must be on-farm with key-farmer involvement. Demonstrations might include things such as TOMCAST or reflective mulch for aphid repellent.
2. Measure and promote "dollars saved" by producers by implementing IPM.
3. Train more scouts and private consultants, who are necessary to increase greater adoption of IPM.
4. Obtain grower/commodity group seed money for crop management associations and grower IPM associations.
5. Conduct research that helps farmers solve problems.
6. Public demand for IPM-grown produce may increase IPM adoption.
7. Develop more useful IPM publications (bulletins, notebooks, and fact sheets) and share knowledge of pest conditions and management options by multiple means (radio programs, code-a-phones, FAX, and the Internet).
8. Explain economics of time allocation for own scouting versus buying scouting services.
9. Deliver information differently (new packaging and marketing); use groups like the Natural Resources Defense Council, World Wildlife Fund, sustainable agriculture groups, and environmental groups; the key message for us to get across to these groups is softer and fewer pesticides with IPM and biointensive IPM (as it becomes available).
10. One-on-one visits on farm will increase IPM adoption slowly.
11. Develop IPM programs for the whole farm with tools like expert systems that are grower friendly.
12. Intensive training for agents in all aspects of IPM, including technology, economics, and marketing for IPM.
13. Commodity-based IPM teams need to be established with a spectrum of participants from basic scientists to growers.
14. University infrastructure needs to include an IPM coordinator, commodity-focused program leaders, and a diagnostician that provides quick and accurate information.
15. Regional sharing of information is essential because each State does not and will not have all the IPM expertise necessary to implement effective IPM programs on all commodities. This sharing begins with Regional Planning Grants (Phase 1) and may continue with IPM Regional Centers.
16. Seek additional support. State support is mandatory!

What Is an IPM Program?

Kurt Alstede mentioned during his panel presentation that Rutgers has a very good sweet corn IPM program but does not have one for pumpkins. This partial coverage is likely true for every State and territory of the United States. We all have commodity programs that are strong because of strengths of the university and grower demand, but it is not possible to have IPM programs for every commodity. It is likely we have components of IPM programs. Specific components include:

- Training materials, such as notebooks, fact sheets, and videos
- Training programs
- Scouting services, public or private
- Monitoring schemes, techniques, and time lines
- Economic thresholds
- Alternative pest-management techniques
- Evaluation tools that measure level and impact of adoption of IPM
- Demonstrations
- IPM team of specialists and agents
- IPM commodity steering and advisory committees
- Data-management systems

Each IPM coordinator must decide which of these IPM program components to have for each commodity and how many are needed before deciding if an IPM program is available for that commodity.

IPM Programs for Tree-Fruit Growers

Frank G. Zalom
University of California
Coordinator

The primary charges to the Tree Fruit Workshop participants were to identify key research, technology transfer, and Extension education needs for implementation of IPM on 75 percent of crop acreage and to address how impacts of IPM implementation could be measured.

Resources used for reviewing the status of IPM in tree fruits included the status of apple IPM research and implementation, which had been determined for the National IPM Forum in 1991, and a summary of responses to the recent USDA survey "Farmer-Identified Priority Research and Extension Needs," which was facilitated by State IPM coordinators.

Dr. James Tette presented the summary compiled for the National IPM Forum, which indicated that considerable research was under way nationally on biological controls with predators, parasites, and microbial biopesticides; on host-plant resistance with both traditional and transgenic breeding approaches; on cultural control methods; and on semiochemicals for insect control. Several workshop participants noted that research activity related to these approaches had expanded nationally in the five years since the study was completed. Methods in use by apple growers at that time included biological control of mites (13 States), biological control of insects (6 States), use of insect virus (1 State), mating disruption (2 States), and mass trapping (1 State) with pheromones, biological control of pathogens (2 States), cultural control methods (16 States), and
sterile-male releases (1 State).

Responses to the USDA survey of "Farmer-Identified Priority Research and Extension Needs" were summarized for all fruit crops, and indicated general areas of research (r) and Extension (e) needs that were identified across States and commodities. Table 1 presents that information.

Drs. Harvey Reissig and Joe Kovach of Cornell University, Dr. William Coli of Massachusetts, and Dr. James Walgenbach of North Carolina discussed their experiences in developing IPM teams through "Phase 1" IPM planning grants they had received. Participants in that process helped to identify lists of priority pests and of research, Extension, and infrastructure needs, but the emphasis was different in each case.

James Cranney of the International Apple Institute and David Benner, an apple grower from Pennsylvania, discussed the importance of the apple-industry research committee, which helps link growers, Congress, the USDA, and the land-grant universities. Such diverse teams, which function to identify grower needs, can also help to identify how to deal with the lack of research, education, and funding needs.

Many innovative ideas were mentioned by workshop participants as currently being studied, including disease forecasting for several pathogens; manipulating plant defense chemicals through cultural management; the use of bees to distribute a biological control agent to control *Botrytis* of strawberries; development of interactive websites on the Internet, such as the virtual orchard in New Hampshire; research on host-plant resistance and resistant rootstocks; pheromone-based mating disruption; canopy management for disease control; a trap-out strategy for apple maggot that uses toxicant-baited spheres; use of various orchard-floor-management approaches, including cover crops for weed and insect control; and implementation of arthropod biological controls through the release of beneficial organisms and in-field insectaries.

Measuring IPM adoption was a focus of considerable discussion in the workshop. The need to involve social scientists or evaluation specialists in IPM evaluation was recognized.

Table 1. Farmer-identified priority research (r) and education (e) needs.

Grower-Identified Needs by State	Need		Fruit Crop
Alternative management strategies for arthropod pests:			
Low-toxicity, selective, and biological pesticides (W.Va., Penn., Ore., N.Y., Wash., Conn., Calif., Ala., N.C., Mich.)	r	e	Apple, peach, tree fruit, pear, citrus, raspberry, nectarine, almond, fig, pecan, blueberry, grape, strawberry, sweet and tart cherry
Biological control (W.Va., Ky., Penn., Ore., N.Y., Conn., Calif., Ala., N.C., N.H., Mich.)	r	e	Apple, peach, tree fruit, plum, pear, almond, pistachio, cling peach, citrus, prune, plum, grape, blueberry, tart cherry
Effect of cover crops on beneficials (N.Y., Mich.)	r		Apple, grape
Action thresholds (N.Y., Calif., N.C., Mich.)	r	e	Apple, pistachio, blueberry, tart cherry, grape, plum, prune
Resistance management and resistance assays (W.Va., Calif., Mich.)	r	e	Apple, peach, citrus
Efficient sampling, monitoring methods, and traps (W.Va., Ky., Penn., Ore., N.Y., Wash., Calif., Ala., N.C., N.H., Mich.)	r	e	Apple, peach, tree fruit, pear, pecan, pistachio, cling peach, raspberry, blueberry, tart cherry, grape
Degree-day forecasts and phenological modeling (Penn., Ore., N.H., Ky., Mich.)	r		Tree fruit, pear, peach, apple, blueberry
Host-plant resistance, phytochemical studies, and biotechnology (N.Y., Conn., Ala., Mich.)	r	e	Apple, pecan, strawberry, blueberry, raspberry
Evaluate bagging fruit as control (Ky.)	r		Apple
Mating disruption:			
Codling moth (Ky., Ore., N.Y., Wash., Calif., N.C., Mich.)	r	e	Apple, pear, walnut
OBLR (N.Y., Wash., Mich.)	r	e	Apple
Spotted tentiform leafminer (N.Y.)	r	e	Apple
Omnivorous leafroller (Calif.)	r	e	Nectarines
San Jose scale (Calif.)	r		Stone fruit
Oriental fruit moth (Calif.)	r	e	Cling peach, nectarines
Peach twig borer (Wash., Calif.)	r	e	Tree fruit, cling peach, almond
Borer complex (Mich.)	r		Tart cherry
Physical barriers and spatial isolation (N.Y., Conn.)	r		Apple
Disrupt overwintering habitat (Calif., N.H.)	r	e	Almond, apple, pistachio
Effect of spray adjuvants (Penn.)	r		Tree fruit
Incidence of quarantine pests (Penn., Calif.)	r	e	Tree fruit, citrus
Alternative to carbaryl for thinning (Mich.)	r		Apple
Trap crops (Mich.)	r		Grape
Cultural-control information (Mich.)	r		Raspberry
Improved management of diseases:			
Alternative control strategies (Ky., Penn., Conn., Wash., Calif., N.H., Mich.)	r	e	Apple, tree fruit, cling peach, blueberry, prune, strawberry
New-product R&D (W.Va., Mich.)	r	e	Apple, peach, grape, blueberry

Environmentally friendly application methods (W.Va.)	r	e	Apple, peach
Resistance management (N.H., Mich.)	r	e	Apple
Improved sampling, monitoring, and detection techniques (N.Y., Mich., N.H.)	r		Apple, blueberry
Strong nursery management (W.Va.)	r	e	Apple, peach
New bioagents and biocontrols (W.Va., Ore., N.Y., Calif., Ala., Mich.)	r	e	Apple, peach, pear, almond, pistachio, grape
Disease resistance and biotechnology (W.Va., Ky., Penn., N.Y., Calif., Ala., Mich., N.H.)	r	e	Apple, peach, cling peach, almond, pecan, tree fruit, blueberry, tart cherry, plum, grape, strawberry, prune, raspberry
Methods for identifying and controlling viruses (W.Va., Wash.)	r		Apple, peach, cherry, tree fruit
Disease epidemiology and forecasting (W.Va., Penn., Ore., N.Y., Calif., Ala., Mich., N.C., N.H.)	r	e	Apple, peach, pear, almond, cling peach, blueberry, grape, sweet, and tart cherry, strawberry
Natural products for inhibition (N.Y.)	r		Apple
Disease-severity ratings (N.H.)		e	Apple
Exploit detritovores to destroy leaf litter (N.Y.)	r		Apple
Effect of spray adjuvants (Penn.)	r		Apple, tree fruit
Alternatives to methyl bromide for postharvest control (Wash., Calif.)	r		Stone fruit, cherry, prune
Postharvest controls (biocontrols and modified atmospheres) (Penn., Mich., Ore., N.Y., Wash., Calif.)	r		Tree fruit, pear, apple
Revise application schedules (Mich.)	r		Blueberry, strawberry
Cultural-control information (Mich.)	r		Raspberry
Improved management of nematodes:			
Nonchemical management techniques (W.Va., Calif.)	r		Apple, almond, tree fruit
Alternatives to methyl bromide (Calif.)	r	e	Cling peach, apple
Green manures (Penn.)	r		Tree fruit
Resistant rootstocks (Calif.)	r	e	Apple
Suppressive cover crops (N.Y.)	r		Apple
Damage thresholds (W.Va.)	r		Apple, peach
Alternate weed control strategies:			
Noncultivation alternatives to herbicides on slopes (Mich.)	r		Grape
Cover crops for weed suppression (Ore., N.Y., Mich.)	r		Apple, pear, blueberry, grape
Low rates of herbicides and growth regulators to suppress ground-cover growth (N.Y.)	r		Apple
Synthetic and natural mulches (N.Y.)	r		Apple
Assess flaming as a control (N.Y.)	r		Apple
Selective herbicides to manipulate ground cover (N.Y.)	r		Apple
Develop weed thresholds (N.Y.)	r		Apple
Hot water (steam) (N.H.)	r		Apple
Alternatives to preemergence herbicides (Conn., Calif., N.H., Mich.)	r	e	Apple, prune, strawberry, sweet, and tart cherry
Less damaging methods of in-row cultivation (N.Y.)	r		Apple
Barriers (Penn.)	r		Tree fruit
Herbicide-resistant plants (Mich.)	r		Blueberry

Register new herbicides for resistance management and less residue (Mich.)	r		Blueberry
Alternative vertebrate control strategies:			
Nonchemical alternatives (N.H.)	r	e	Apple
Assess effect of raptor perches (N.Y.)	r		Apple
Assess effect of predator odors (N.Y.)	r		Apple
Mechanical and chemical bird repellents (N.Y., Mich.)	r	e	Apple, blueberry, grape
Damage thresholds (N.Y.)	r		Apple
Vole-resistant rootstocks (N.Y.)	r		Apple
Diversionary crops (distant to target crop) for deer control (N.Y.)	r		Apple
Economical deer control	r		Grape
Alternatives for vole control (Mich.)	r		Grape
Improved IPM systems:			
Arthropod and disease pests in high-density orchards (W.Va., Ky.)	r	e	Apple
Single/double pest economic thresholds (W.Va., N.Y.)	r	e	Apple, peach
Effect of trap crops and cover crops (multidisciplinary) (N.Y.)	r		Apple
Understand changes in pest complex with IPM (W.Va.)	r	e	Apple, peach
Nutrient management (Penn., Calif., N.C.)	r	e	Cling peach, tree fruit, prune
Tree architecture (Penn., N.C.)	r	e	Tree fruit
Prevent practices for management (Conn.)	r	e	Apple
Orchard management at urban/rural interface (Penn.)		e	Tree fruit
Costs/benefits of IPM implementation (W.Va., N.Y., Wash.)		e	Apple, peach, raspberry
Effect of earthworms on scab and leafminers (N.H.)	r		Apple
Integrated, multidisciplinary, and ICM studies (Mich.)	r		Blueberry, tart cherry, grape
Improved pesticide application techniques:			
Evaluation of electrostatic sprayers (N.Y.)	r		Apple
Better spray coverage (Calif.)	r	e	Apple
Adjust volume (N.C.)		e	Apple
Alternate rows (N.C.)		e	Apple
Reduced rates (Mich.)	r		Blueberry
Better application technology (Mich.)	r		Apple, blueberry, grape, tart cherry
Minimize off-target contamination (N.Y.)	r		Apple
IPM information dissemination or infrastructure:			
Regional coordinator (clearinghouse) (W.Va., N.H.)	r	e	Apple, peach
Expert systems (W.Va., Ky., Penn., N.Y.)	r	e	Apple, peach, tree fruit
Fax on demand (N.Y.)		e	Apple
Hands-on workshops (Wash.)		e	Apple, raspberry
IPM manuals (Wash., Mich.)		e	Apple, sweet and tart cherry, raspberry
Role and needs of IPM consultants and training of consultants (Penn., N.Y., Mich.)	r	e	Tree fruit, apple, and sweet and tart cherry

Promote on-farm research and demonstration (N.Y., Wash., Mich.)	r	e	Apple, raspberry, blueberry
Weather data for pest management (W.Va., N.C., Mich.)	r	e	Apple, peach, and sweet and tart cherry
Information on beneficial insects (Mich.)		e	Apple
Grower and public-information classes (Mich.)		e	Apple, blueberry, raspberry
IPM tactics for sustainable orchard production (W.Va.)	r	e	Apple, peach

IPM Programs for Nurseries and Urban Ornamentals

Michael J. Raupp
University of Maryland
Harry Hoitink
Ohio State University
Moderators

Workshop Organization and Goals

Individuals from all geographic regions of the country and representing the varying perspectives of nursery producers; landscape maintenance companies; public landscape managers; homeowners; industries serving homeowner pest-management needs (e.g., garden centers); environmental interests; and professional horticulturalists, plant pathologists, entomologists, and weed scientists participated in this effort to identify nursery and landscape IPM priorities. The focus of the structured workshop discussions was on the production and maintenance of woody plants (trees, shrubs, and ornamentals). Some minor issues on turf- and lawn-pest management and floricultural pest-management also were discussed.

This workshop built on the foundation provided by earlier meetings that sought to identify major research and extension needs in the nursery and urban-landscape arenas. These meetings were conducted as part of a Phase I planning exercise conducted by representatives of the Northeast and North Central regions. The workshop sought to incorporate ideas from regions and groups that did not participate in the Phase I exercise. The contributions of these groups have been incorporated into the summary report presented below.

The specific goals of the workshop were to:

1. identify and rank major pest-plant complexes in the nursery and landscape settings,
2. identify critical nursery and landscape IPM research needs, and
3. identify critical nursery and landscape IPM information-transfer needs.

Key Pest Problems

The Phase I activity identified 71 plant-pest complexes and pest-related problems of key importance in nursery production as a result of quarantine regulations and/or in landscape maintenance. Some key pests were identified as being problematic across all three settings (production, quarantine, and maintenance), while others were problems only in one or two of the different settings.

A pest-problem prioritization process revealed general agreement among participants about the most critically important of the identified pest problems. Table 1 lists the top "dirty dozen" pests receiving highest rankings of importance from participants and indicates the settings in which the pests are judged to be of particular importance.

Other pests ranked by the group at this workshop group as "very important" in either the nursery production or landscape-maintenance setting for additional regions were (for the southeast) roots and wilts, problems associated with sandy soils, nematodes, and fire ants and (for the southwest) cultural problems, including installation, mulching, fertilizing, and watering.

Nursery and Landscape IPM Research and Information-Transfer Needs Assessment

Participants added research and information-transfer needs to the initial list identified by the Phase I activity; 36 generic and 52 pest-specific research needs were specified by both activities. These have been restructured into five categories entitled basic and applied research; development

Table 1: The Twelve Most Important Pests for Nursery and Landscape IPM in the Northeastern and North Central United States.

	Setting(s) within which the pest problem is most important		
	Production	Maintenance	Quarantine
Root rots and wilts	*		
Cankers/dieback		*	
Weeds	*	*	*
Japanese beetles	*	*	*
Black vine weevil	*		*
Borers	*	*	
Gypsy moth	*	*	*
Spruce spider mite		*	
Winter injury		*	
Conspicuous leaf spots	*	*	
Lace bugs		*	
Armored scales	*	*	

of pest-management tactics; monitoring and decision-making tools; pesticide efficacy, safety, and off-site effects; and economic and social studies. In addition to the five areas of critical research needs, twelve major information-transfer needs were identified. The organizers of the planning session have added to the document a list of approaches to address the information-transfer needs.

1. Basic and Applied Research

A. Ecology

1. Urban ecology studies to understand the setting in which much landscape-maintenance IPM must take place
2. Comparisons of pest-host dynamics in natural versus managed ecosystems
3. Basic weed-ecology studies
4. Determination of the relationships between weed populations/weed management and insect and disease problems in production and maintenance settings

B. Biology

1. Basic biological studies and systematics of cankers
2. Life-cycle studies of bitter cress and other emerging nursery-production weed pests
3. Better determine Japanese beetle adult host preference (especially in relation to naturally occurring nonvalued plants)
4. Studies of host-plant attractiveness, susceptibility, and resistance to borers, including work on the role of semiochemicals
5. Replication/validation of gypsy moth migration rates by wind and land
6. Understand the basic biology of the Asian gypsy moth
7. Study the biology of imported pests in their countries of origin

C. Plant Stress

1. Assess the relationship between moisture stress and canker development
2. Assess the relationship between plant stress and borer attack

2. Development of Pest-Management Tactics

A. Biological Control

1. Development of systems for the conservation of natural enemies in nursery and landscape settings
2. Development of predator-enhancement techniques for gypsy moth natural control
3. Development of borer biological-control alternatives
4. Research on weed pathogens as nursery bio-control alternatives
5. Development of more and better microbial-control alternatives for Japanese beetle grubs
6. Development of biological-control strategies for adult Japanese beetles
7. Development of biological-control strategies for spruce spider mite in the landscape setting
8. Development of biological-control alternatives for lace bugs
9. Development of biological-control alternatives for scales
10. Study mechanisms of biocontrol of phytopthera root rots, verticillium wilts, black root rot, and other important root rots and wilts

B. Alternative Controls

1. Development of mating-disruption techniques for borers
2. *Any*effective method for black vine weevil grub control
3. Effective pheromone trapping lures/techniques for dogwood, Zimmerman, flat-headed apple tree, bronze birch, and two-line borers
4. More and better gypsy moth management tools, including more effective chemicals, chemicals more suitable for use in urban environments, cultural strategies, and better microbials

C. Host-Plant Resistance

1. Need continuous characterization of resistance/susceptibility by species
2. Expand hybridization programs for pest resistance
3. Study Japanese beetle grub feeding preferences to determine susceptible species
4. Study systemic acquired resistance (of host plants) to leaf spots, particularly as affected by cultural practices
5. Develop specific cultivar resistance to leaf spot
6. Study plant susceptibility/resistance to lace bug infestation and damage
7. Study host-plant resistance/susceptibility to scale infestation and damage

D. Cultural Control

1. Determine the relationship between landscape design and mite outbreaks
2. Evaluate container media and soil augmentation/formulation with respect to plant health and suppression of pest problems
3. Assess the relationships among irrigation practices and pest and nutrient management
4. Determine the effectiveness of fertilization strategies for borer control
5. Assess the relationship between fertilization (and other cultural practices) and spruce spider mite infestation/damage
6. Develop cultural practices for dealing with winter injury
7. Cultural control/allelopathy (cover crops) for weed management in the production setting

3. Development of Monitoring and Decision-Making Tools

A. Detection and Monitoring

1. Develop detection methods for root rots and wilts and a framework for assessment of root health
2. Develop techniques for black vine weevil population detection and monitoring
3. Develop effective borer-infestation predictive indicators

B. Modeling and Expert System Development

1. Need forecasting and predictive models specific to both the nursery and the landscape settings
2. Development of computer software for analysis of landscape conditions and trends
3. Predictive population modeling for mites

C. Development of Effective Treatment Thresholds for Key Pests

1. Studies to determine the relationship between pest population levels and losses (economic losses and/or aesthetic-quality losses) in both the production and the landscape settings
2. Development of black vine weevil treatment thresholds
3. Improved gypsy moth threshold development in the homeowner setting
4. Development of spruce spider mite threshold levels
5. Need treatment (aesthetics-related) thresholds for leaf spots
6. Development of threshold levels for armored

scales

7. Studies of public perceptions and preferences regarding woody-plant aesthetic quality, how these relate to the psychological basis for pest management, and what that implies for perceived tradeoffs between pest management and landscape quality.

4. Pesticide Use, Efficacy, Safety, and Off-Site Effects

A. There is a need for baseline data on pesticide use in the nursery and landscape maintenance settings.
B. IR-4 Program-related research for expansion of pesticide labels to "minor uses" critical to nursery and landscape pest management
C. Studies of pesticide fate and transport in the landscape setting
D. Development of equipment for assessing pesticide fate and transport in landscape settings
E. Assessing the nontarget and off-site effects of homeowners' pesticide use and disposal practices
F. Development of improved and/or adaptation of existing pesticide-delivery systems and equipment for the nursery and landscape settings
G. Better pesticide-efficacy studies under a wider variety of environmental conditions faced in nursery and landscape IPM
H. Research on pesticide resistance in nursery weed species
I. Studies of the phytotoxicity of herbicides in nursery and landscape settings
J. Investigation of bark-feeding scales' tolerance to systemic insecticides
K. Gauge the effect of pesticide material/timing on scale predator and parasite conservation
L. Efficacy studies of biorational products including neem and diatomaceous earth

5. Economic and Sociological Studies

A. Studies of public perceptions and preferences regarding woody-plant aesthetic quality, how these relate to the psychological basis for pest management, and what that implies for perceived tradeoffs between pest management and landscape quality.
B. Research on sociological factors influencing IPM acceptance/adoption
C. Determine degrees of homeowner awareness and comprehension of pesticide labeling and elements of proper use and disposal of pesticides
D. Studies of the landscape-maintenance labor market (because labor availability is a limiting factor to expanded pest-management programs in the landscape setting)
E. Applied economic/interdisciplinary research to determine the cost-effectiveness of alternative IPM strategies in the nursery-production setting
F. Studies of nursery and landscape business profitability with respect to IPM use and services
G. A "full-cost accounting" (private costs plus environmental and other societal costs) of nursery and landscape pest-management alternatives
H. Economic assessments of weed-management alternatives in both the nursery and landscape settings
I. Assess the commercial feasibility of Gypcheck production for use on public landscapes

Information-Transfer Needs and Approaches

Workshop participants catalogued 12 major information-transfer goals and identified several specific needs and possible actions that could be taken to further each goal. The planning group recognized that the nursery and landscape-maintenance professionals' needs would be largely addressed by extension delivery systems currently in place. The group recognized that market demands of consumers would drive the patterns of goods and services provided by the nursery and landscape-maintenance industries. Therefore, the demand for IPM goods and services depends on consumers informed of the relative costs and benefits of IPM. As consumer demand increases, the nursery and landscape-maintenance industries will respond.

Information-Transfer Goals

1. Enhance the General Public's Awareness and Knowledge of IPM

A. Develop or coordinate available home and garden IPM modules for K through 12 science curricula (emphasizing positive aspects of IPM; biological relationships rather than threat)
B. Market plant materials to emphasize pest-related

sustainability/long-run maintenance costs in the landscape (label plants according to their pest-related sustainability in the landscape setting)
C. Use public-interest announcements and popular videos to get the message across
D. Inform and coordinate with public-interest groups (e.g., environmental groups)
E. Develop and use Internet home pages, websites, other computer- based information resources for the general public (take better advantage of existing channels; link/integrate with horticultural-information sources)
F. Capture media personalities to assist in delivering the IPM message
G. Interface closely with the Cooperative Extension System's Master Gardener Program

2. Increase the Level of Confidence of Landscape and Horticultural Professionals in IPM's Effectiveness

A. To the degree possible, increase Extension specialists' face-to-face contact with landscape and horticultural professionals
B. Involve professionals who do practice IPM in extension forums and demonstrations as principal spokespersons.
C. Create more practical, comprehensive, and up-to-date sources of information on IPM options (this relies on additional research and increased availability of research results)

3. Demonstrate IPM Profitability to Landscape and Horticultural Businesses

A. New funds must be committed to demonstration projects (especially in landscape-maintenance and garden-center settings)
B. Use trade associations as a principal conduit for landscape IPM information

4. Improve the Flow of Information among Researchers, Extension Professionals, and Industry and Public-Interest Groups

A. Provide scout-training programs and networking opportunities for industry and public-interest groups
B. Use Extension IPM (3d) enhancement funds to develop and implement working groups among researchers, extension personnel, and IPM users
C. Establish an e-mail network for nursery and landscape IPM

5. Create Better Incentives for the Adoption of IPM

Create an ad hoc IPM certification process, form, or check-off list for consumers' information.

6. Increase Public Awareness

Make homeowners aware of the potential environmental/health impacts of their own or their contractors' landscape pest-management actions.

7. Provide Marketing Tools

To improve the ability of landscape and horticultural businesses to market IPM to their end users/customers, materials that help landscape professionals "sell" IPM to their customers need to be produced.

8. Educate Landscape Architects and Landscape Designers and/or Their Clients about the Pest-Management Implications of Design and Design Aspects of IPM

A. Insert IPM in undergraduate curricula for landscape architecture and horticulture
B. Develop extension IPM materials targeted to the landscape-design industry (and call it an element of "environmental stewardship" in landscape design)

9. Increase Information Flow among Landscape Professionals, Homeowners, Health-Care Professionals, and Veterinary Professionals

Develop information for display in veterinary offices about the pet-health implications of home and garden pesticide use.

10. Improve the Efficiency of Extension IPM Information-Transfer Technology, Methods, and Approaches

A. Develop and install automated (unmanned) booths at garden centers, public parks, other sites where visitors can easily access useful information on pest management
B. Develop cheap, attractive IPM educational products for display on garden-center and hardware-store shelves (this might include videos or CD-ROMS and require substantial developmental funds)

C. Create an attractive, user-friendly source of pest-control information for use at garden centers
D. Develop Extension materials that "give answers" to pest-management questions.
E. The Extension Service should recommend "plants of the year" (by region) as a way of emphasizing the IPM advantages of various landscape plant species.

11. Provide Information That Encourages the Development of Public Policies That Are Sympathetic to IPM

A. Create a Friends of Extension (and Friends of IPM Research and Friends of IPM Teaching) to relay information and messages to politicians
B. Disseminate regulatory-impact-assessment information specific to landscape-pest management

12. Provide Professional Development

Individuals' and companies' abilities to anticipate, plan for, and respond to trends in policy, economics, and technology with relevance to IPM need to be enhanced.

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IPM Programs for Urban Arthropods

Faith M. Oi
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Coordinator

The other workshops were titled "Developing and Delivering IPM for ... ." Our section was simply titled "Developing IPM Approaches for Urban Arthropods" because there is no cohesive IPM strategy for the urban environment. We are still at the development stage. Urban pest management is important because urban pests are not merely a nuisance; they can pose health risks by biting, stinging, being the source of potent allergens as well as causing severe structural damage to our homes and other structures. Urban pest management affects everyone, not only those who live in urban environments.

Seven invited presenters were asked to address various topics that would be used to stimulate discussion on key urban-pest-management issues. Each of the speakers comments are briefly summarized below.

Progress Report on IPM Initiative, Phase I, Faith Oi, Auburn University.

Industry representative Jim Stephens indicated that IPM fails in urban environments because consumers do not understand it and do not demand it. We have also failed to focus efforts at educating the building construction industry, mortgage companies, and realtors to the pest risks associated with certain construction types. Discussion focused on how to define IPM for the purposes of this project and to devise sampling and monitoring methods that could realistically be used by consumers and pest-control operators. Urban IPM is different from agricultural IPM because we deal with zero tolerances and the preservation of biodiversity under a sink is not an issue.

The Status of Urban Pest Management: Research Opportunities Dan Suiter, Purdue University

Purdue's current funding initiative has focused efforts toward obtaining Federal support with the objective of "legitimize(ing) 'urban' as a funding category" within the existing USDA programs, such as (1) Regional IPM, (2) Alternatives to Pesticides, (3) IPM Implementation, and (4) the Natural Resource Inventory. The Purdue funding initiative suggests that it is the responsibility of researchers to target their department heads, experiment station directors, and the USDA to create an "urban" funding category in the programs that already exist. In the long term, the goal is to create new USDA money; in the near term, the objectives are (1) lobbying to set up new funding programs in USDA/CSREES and/or (2) lobby(ing) to include "urban" in Sen. Lugar's new Agricultural Competitiveness Initiative. Mike Linker also commented that the cotton producers show up at the legislature but the average voter (who is most likely to be affected by "urban" research) does not show up. He also asked why EPA and HUD were not included in the plan to secure funding sources.

A Vision for Urban IPM, Arthur Appel, Auburn University.

Urban-pest-management problems are broad with multiple layers. Context specific goals and definitions for urban IPM are needed. In most IPM systems, we talk about managing pests; with urban-pest management, we talk about eradication. Some people may disagree with the goal of eradication, but in urban situations, where the goal is pest management of inside structures, we are faced with questions such as "should we make people tolerate allergens or should we tolerate our houses being eaten? However, can we manage cockroaches, etc., outside so they do not come into the house? Yes. Context-specific goals should consider the area of control and the pest being controlled.

Comparative Risk Assessment and Precision Targeting, Richard Brenner, USDA-ARS, Gainesville

The Strategic Environmental Research and

Development Program (SERDP) funded a grant to do comparative risk assessment of pest-control practices and precision targeting of pests in the urban environment. The USDA, DOD, universities, and consumer groups are involved. It focuses on reduced-risk pest management, including better use of existing toxicants and developing better alternatives through contour maps (monitoring and GPS technology) of pests and human activity. Regardless of the target pest, greater knowledge of the pest is needed to standardize and decrease the skill level needed to do urban IPM.

IPM in Schools, George Bird, Michigan State University

The group was led through a case-study exercise to demonstrate the difficulty of establishing an IPM program in schools. The case-study facts included the dilemma of a school superintendent whose schools had received public-health citations because of a serious cockroach problem. The public health authority had declared that IPM was not suitable. The superintendent had 30 days to solve the problem. Various solutions were discussed. The questions "Is IPM suitable for use in human living environments, and is biological control suitable for use in human living environments?" were posed.

Building Construction Problems and Urban IPM, Julian Yates, University of Hawaii

The Formosan subterranean termite is a major urban pest in Hawaii. Alternative, reduced-chemical methods of control are slow to receive acceptance because of the liability involved. The Basaltic Termite Barrier, basaltic rock crushed to a specific range of sizes small enough so that the termite bodies cannot squeeze through the spaces between the rocks and large enough so that the termite mandibles cannot grasp the rocks to pull them away, has been commercially available since 1987. There has been minimal acceptance of this method because pest-control operators view it as competing with chemical control, and homeowners are wary of the up-front costs of installation. Studies on termite control with Termi-mesh, a patented physical barrier of steel were also discussed. Advantages, disadvantages, product development, and technology transfer to the building construction industry were discussed.

Technology Transfer in Urban IPM, Nan-Yao Su, University of Florida

One reason technology transfer is difficult is because research institutions, such as universities and private companies, have conflicting goals. Taxpayer-funded research is not in the interest of private companies because companies want exclusive rights to the information and technology. But if the product is developed with public funds, everyone will have access to that information, and it is no longer exclusive. Questions that developed during this section included: how to define the public demand for urban IPM and related technologies, and who was going to decide who got what money to do development research and technology transfer in urban-pest management.

The discussion group concluded that an urban IPM definition should include the following characteristics:

- Concern about pest management in human living environments
- Use of a context-specific systems approach to pest management
- Use of the most selective management technique/strategy against a properly identified pest
- Include risk reduction
- Include reduced reliance on pesticides

The primary stakeholders are the members of the general public. The key priorities that were identified were:

1. Consumer education on urban IPM should be carried out through the National Pest Control Association, Cooperative Extension Service, public forums, and schools.
2. Risks to humans and the environment associated with urban-pest control should be decreased.
3. A national certification program in urban IPM should be developed for applicators.

Among the identified incentives to change were increased reports of multiple-chemical-sensitivity cases and liability.