

Arizona Pest Management Center: Implementing IPM in Diverse Environments of Arizona

(i)1. Program Staff

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Dr. Jim Christenson, Director of Cooperative Extension and administrative contact for all Extension programs, has designated Dr. Peter Ellsworth as our state IPM Coordinator and approved this proposal as our sole submission from the University of Arizona (*see Appendix 0*).

(i)2. *Our goal is to create a working environment in which the science and implementation of IPM can thrive in Arizona.* We do this to address critical stakeholder needs in support of economic, environmental, and human health goals by minimizing risks to pests and pest management practices. Extension objectives support this goal by (1) engaging stakeholders to identify IPM priorities; (2) promoting IPM adoption and implementation through support networks, resources, training, translational research and demonstration; and (3) assessing and documenting IPM adoption and impacts.

(i)3. Stakeholder engagement is central to the structure and function of IPM in AZ and is coordinated through the Arizona Pest Management Center (APMC), which also provides oversight for coordination of IPM programs and activities at UA, strategic planning, translational research and outreach, program assessment, and reporting (*see Appendix 1*). The multidisciplinary membership of the APMC is organized into “focal areas” (*see Appendix 1–2*) that reflect both our internal strengths and priority needs as determined through stakeholder engagement. The APMC maintains five program focal areas: Detection & Diagnostics (corresponds to IPM Support for Pest Diagnostic Facilities area of emphasis), Agricultural IPM (corresponds to High Value / High Input / Intensively Managed area of emphasis), Community IPM (includes IPM in Schools, IPM on Recreational Lands, and Consumer / Urban IPM areas of emphasis), IPM Assessment (spans all emphases), and Pesticide Education (spans all emphases). Within each focal area, program teams actively develop, manage, support and implement UA’s IPM programs. A 21-member multidisciplinary stakeholder group, the IPM Coordinating Committee, directs and oversees APMC activities. The IPM Coordinator has statewide responsibility for all IPM programs, manages resources, convenes the IPM Coordinating Committee, and submits federal reports. The organizational foundation of our statewide IPM efforts has been a dedicated faculty resource, our IPM Program Manager (Dr. Al Fournier, 100% Extension), who, in collaboration with the IPM Coordinator, manages the daily APMC activities, including communication and faculty support for needs assessment activities, proposal development and program evaluation. The APMC currently employs one part time web specialist (critical to IPM outreach), Theresa Smith, and one full-time database specialist and computer programmer (critical to IPM assessment), Richard Farmer.

The APMC has a continuing commitment to relevancy in all our IPM programs, validated through proactive stakeholder engagement at all levels of program planning, implementation and assessment. Stakeholders drive what we do in IPM by: (1) identifying IPM priorities; (2) providing input on regulatory issues and Federal IPM needs; (3) engaging in participatory research projects and demonstration workshops to promote adoption of IPM; (4) helping us design *workable*

IPM solutions to pressing problems through regular stakeholder discussions; and (5) helping us assess the adoption and impact of our IPM programs through surveys and other evaluations. This occurs at several levels. The IPM Coordinating Committee is the mechanism for stakeholder engagement on issues of overarching concern in our state and convenes at least 3 times/yr to examine needs, set priorities, and give direction to the APMC. Stakeholder interactions also provide direction to individual teams. The multi-disciplinary stakeholder working group, the Cross-commodity Research & Outreach Program (CROP), directs our efforts to optimize our inter-crop interactions (*see Emphasis C2*). This group worked with faculty to develop cross-commodity guidelines for whitefly management (Palumbo et al. 2003). Other teams regularly convene stakeholder advisory groups (e.g., for Vegetable IPM; Noxious Weeds). Locally, each County Agent responds to and engages local County Advisory or County Supervisor Boards. Regionally, we engage stakeholders through regional working groups (e.g., Western School IPM), pest management strategic plans (PMSPs; currently active in Desert Cotton, School IPM, Desert Turfgrass), and through our formal information network, the Arid Southwest IPM Network (*see "Collaboration" and Appendix 1*). Our "IPM Assessment" focal area is explicitly designed to regularly engage stakeholders. We have made heavy investment in a crop pest losses and impact assessment process that engages growers, pest control advisors (PCAs), agrochemical industry members, Extension faculty, and others in at least 7 workshops/yr (*see Emphasis C2*). In our "Pesticide Education" focal area, we also do extensive assessment and data-mining through a statewide pesticide use reporting database (*see "Collaboration"*). A multi-institutional stakeholder advisory board, representing Arizona Department of Agriculture, Arizona Farm Bureau, Western Growers Association, Arizona Cotton Growers Association, Arizona Crop Protection Association as well as individual PCAs, aerial applicators, growers, industry and University faculty, guide this research and assessment tool.

(i)4. The UA embraces the spirit of this competitive EIPM program and sees it as an important step toward strategic re-allocation of federal IPM resources to maximize their impact on IPM end-users while minimizing duplication of efforts. Historically, AZ has been under-served by federal formula funding, due in part to idiosyncrasies of the formula. Furthermore, AZ has never received federal cotton Extension IPM formula funds. Therefore, AZ has had to manage a very scarce resource to address the diverse IPM needs of an expansive agricultural industry and burgeoning urban populations. Our counties are very large, so we have few extension agents covering vast areas and needs. (The state of Massachusetts would fit within Maricopa County alone requiring more than 2.5 h drive from one end to the other.) This situation has forced us to hone the efficiency and relevancy of our IPM programs, garner significant extramural resources, and structure ourselves to maximize the impact of our relatively few "feet on the ground." *Our goal in responding to this RFA is to maintain our core function, and to invest new resources and expand our capacity to better demonstrate and stimulate implementation and adoption of IPM in an array of contexts and environments.*

Arizona is characterized by extremely productive irrigated agricultural lands, unique flora and fauna, extreme environments, large urban centers made-up of transplanted people and cultures, and a long tradition in IPM. The first federally supported Extension IPM demonstration was conducted in Pinal County, AZ, in cotton (as well as in tobacco in NC). The formula-funded 3(d) IPM program traces its roots to these highly visible events in our history (see Anonymous 2007 for a history). Entomologist, Dr. Leon Moore, UA's first state IPM Coordinator, managed this federal resource as a series of 3 IPM technicians strategically located in our 3 largest agricultural counties, to great effect. However, starting in the 1990s, administrators elevated these technical resources to full faculty status, hiring two IPM Specialists [based out of the Entomology Dept. with split appointments in Extension (70%) and Research (30%)] located at two research stations. Remaining

funds supported operations. No IPM agents exist in our system today, just more broadly trained agriculture and natural resources agents. In 2000, control of IPM federal funds was transferred to Extension Administration, and an IPM minigrants program was initiated. While this stimulated IPM extension projects, the overall program lacked coordination, team-building, stakeholder engagement, outcomes assessment, and, even more importantly, transparency. In 2003, AZ's IPM programs evolved with the formation of the APMC. This was in response to stakeholders' demands for more accountability, greater transparency, engagement and relevance, and more state-based investment. In 2004, we received important support from the Western IPM Center and began to get commitments from UA administration to invest state-based funds in salaries of the two IPM Specialists thus freeing more federal IPM funds for programmatic goals. With excellent input of the stakeholder IPM Coordinating Committee, we formulated a faculty level position description that was 100% Extension and dedicated to our IPM programmatic infrastructure. In 2005, we recruited Dr. Al Fournier to this position where he acts as IPM Program Manager and Associate Director of the APMC (*see Appendix 1*). He brings expertise in IPM assessment that is critical to identification of stakeholder needs and to our evaluation of impact.

With the formation of the APMC, we are now well positioned to strengthen and expand our capacity to support IPM implementation in agricultural, natural and urban environments and to systematically measure the economic and environmental impacts of our programs. The APMC provides proven support for stakeholder engagement, needs assessment, strategic planning, outreach and evaluation of IPM in all our systems. It is a structure that both our faculty and partner organizations have embraced.

Several contexts govern most of what we hold as high priorities in IPM in AZ, and have informed the proposed program and areas of emphases indicated below.

a) *Access to a very professional and well-organized audience of pest managers.*

Specifically, nearly all our high input and high value agriculture is professionally scouted and managed by licensed Pest Control Advisors (PCAs) who must maintain their credentials through continuing education (15 CEUs/yr). Growers pay PCAs on an acreage basis depending on crop value and complexity (4–24\$/A) or through a full service agreement with an ag supplier. The professionalism and education of this group gives us a ready-made, concentrated target audience for our agricultural IPM programs. They in effect have become outstanding multipliers for our program as one PCA may check up to 20,000 A of agricultural land and have over 20 of his/her own grower-customers. Therefore, our “Agricultural IPM” focus area tends towards the development of PCA-specific training and educational materials. This also allows our scarce resource to have the greatest impact. In cotton alone since 1995, we estimate that over \$200 million has been saved in arthropod control costs and associated yield loss (see Anonymous 2007; Ellsworth et al. 2007).

b) *Arizona's populace is made up of a wide diversity and very high rate of transplanted peoples and cultures.* This has resulted in a population that is unfamiliar with the flora, fauna, and environment of the desert Southwest. This impacts our programmatic direction in two ways: we have many more inquiries for diagnoses than any single Specialist or Agent can handle, and people wish to beautify and landscape their environment. In both cases our statewide Master Gardener program offers us some potential for addressing these basic needs in diagnostics and in disseminating information about proper matching of plant material to climate and time of year. Progress on both fronts will help our IPM programs reduce pest incidence and severity, reduce ill-timed or unnecessary pesticide applications, and conserve and protect our sensitive environment and its natural resources. Thus, investment into our IPM “Detection & Diagnostics” focal area and our Consumer/Urban IPM programs are made to maximize Master Gardener preparation and education

as well as to reach out to other professionals that interface directly with consumers (e.g., landscape professionals, arborists, nursery suppliers).

c) *Arizona's urban centers are concentrated in two counties and have been subject of some of the largest growth in our nation, placing many children within relatively few school districts.* This has presented AZ with an excellent opportunity to develop and grow IPM programs for schools, which are particularly important because of our unique environment and pest management challenges (e.g., scorpions, endemic plague, large bat population with rabies potential). We have demonstrated huge successes in IPM-adoption in schools and other sensitive institutional environments, with 55–90% pesticide reductions and 78% fewer pest complaints (Anonymous 2007). Our goal is to re-establish and expand our IPM in schools program, which has diminished following departure of a research specialist / program coordinator and to create greater public awareness and visibility for IPM statewide.

d) *Arizona's unique and beautiful environment and mild winters have made tourism and outdoor sports a major industry for our state.* Golf alone is a \$3.5 billion industry in AZ. Our unique environment has led to a burgeoning need for locally relevant IPM information by our turfgrass industries. Therefore, our IPM on Recreational Lands program concentrates efforts on turfgrass IPM and targets professional turfgrass managers. Our initial efforts in this area have had impact. Turf managers adopting monitoring recommendations have eliminated 2–3 unnecessary insecticide sprays each year, saving up to \$5,500 annually per operation (Anonymous 2007).

e) *Arizona is large in landmass (6th in U.S.), people and agricultural value, but low in no. of counties and therefore County Agents and other local resources.* Arizona has just 15 counties, only one more than Massachusetts or Vermont. All states with fewer counties are much smaller Eastern states (VT, MA, NH, CT, RI, DE) except for Hawaii. All larger states except for NV have more than double the number of counties (NM-33, MT-56, CO-64, CA-58) and states like Michigan (11th largest) and Minnesota (12th largest) have 83 and 87 counties, respectively. This affects our capacity for IPM programming drastically and forces us to prioritize and allocate resources very carefully. No County Agent in AZ is dedicated to IPM, though most agricultural agents have some IPM training. This means that we need to position local technical resources if we are to successfully deploy, demonstrate and disseminate IPM information and technology.

(i)5–6. The recent restructuring of UA IPM programs under the APMC was envisioned as a way to maximize and focus the use of limited IPM resources on the most important needs of stakeholders, to better connect local IPM stakeholders to state, regional and national IPM resources, and to serve as a two-way conduit for IPM information. Through the APMC, we have improved communication and transparency of our programs, cultivated effective partnerships and new collaborations, documented and addressed stakeholder IPM needs, and developed the capacity to better measure IPM adoption and impacts statewide. Our IPM programs are staffed by an energetic, but limited number of faculty and staff from multiple departments, agricultural centers and counties across AZ. The activities of the APMC help keep our programs strategically focused, relevant, and well positioned to compete for IPM funding both regionally and nationally.

Because we are so small, *virtually no redundancy exists within our structure*, and because we are so strategically focused in such a unique environment we explicitly avoid any duplication of effort with neighboring states or regions. For example, we contribute to and promote local adoption of many IPM manuals developed by UC IPM, e.g., “IPM in Practice” (Flint & Gouveia 2001) is being incorporated with our ongoing revision of AZ PCA licensing education materials. In addition, we have developed a number of strategic partnerships (*see “Collaboration”*) with neighboring states to help synergize each other’s IPM activities.

The coordination function of the APMC has led to major increases in our leveraging ability, innovation and specialized intellectual capacity to advance the tenets of IPM, and large impacts and distinctions for many of our IPM programs. One such effort has allowed us to garner major resources to assist in the regional management of *Lygus spp.* across the Western agricultural landscape while marshalling the resources of 4 states (NM, TX, CA, & AZ) and increasing our extension IPM efficiency (Ellsworth et al. 2006). This \$2.5 million USDA-RAMP and related efforts capitalize on a new frontier in IPM and intellectual capacity we have developed in AZ, landscape ecology and spatial analyses in support of areawide management and habitat manipulation. Our research and Extension scientists are using new approaches to examine spatial distributions of pest management practices, pests and natural enemies in order to advise growers on how best to thwart resistance (Carrière et al. 2003, 2004, 2007; Ellsworth et al. 2005a, 2008; Palumbo et al. 2003, 2005) and to arrange crops so as to avoid pest problems (i.e., minimize intercrop antagonism) and maximize the potential for natural enemies (Carrière et al. 2006, 2007; Ellsworth et al. 2006). Furthermore, these same approaches are allowing us to measure grower behaviors and assess IPM adoption (Cattaneo et al. 2006; Ellsworth et al. 2005b, 2007, 2008; Fournier 2007; Fournier et al. 2007; Palumbo 2003, 2005, 2006a-d, 2007a-c). Our burgeoning capacity for retrieval and analysis of pesticide use data, part of our “IPM Assessment” focal area, has been seen as a major advance in our understanding and usage of IPM technologies (Marvier et al. 2008) (*also see “Collaboration” with ADA*). Furthermore, our deployed models for IPM and resistance management have been cited as some of the most effective examples at work today (Head & Savinelli 2007).

The APMC also serves as a hub for regional communication and collaborations related to both agricultural and urban IPM. The Arid Southwest IPM Network (*see “Collaboration”*) enhances IPM stakeholder communication and reduces duplication of effort among partner agencies in 4 states. This includes coordinated responses to federal information requests for the desert Southwest (cals.arizona.edu/apmc/Arid_SW_IPM.html). School IPM has been an area of distinction for UA. Our programs have demonstrated significant reductions in both pesticide use (71%) and pest complaints (78%) in AZ schools, impacting over 300,000 children statewide (Anonymous 2007, Gouge et al. 2006). Since 2006, Dr. Gouge has provided regional leadership for the Western School IPM Implementation and Assessment working group (cals.arizona.edu/apmc/westernschoolIPM.html), identifying priorities, creating an inventory of shared resources to reduce duplication of effort, and conducting state-by-state assessments of school IPM status throughout the West. The group includes >40 members representing 12 of 13 states in the Western region, as well as participants from working groups in the other 3 regions. As part of an EPA Pesticide Registration Improvement Renewal Act grant (Green 2008), Dr. Gouge will develop research-based performance measures to link school IPM adoption to the IPM Roadmap goal of reducing risks to human health. She also coordinates the Entomological Society of America School IPM Network, and the Western Coordinating Committee for Urban IPM, and participates in a National School IPM Steering Committee focused on achieving the goals of the School IPM PMSP (Green & Gouge 2008).

Our probability of success is high and demonstrated in part by our capacity to leverage programs and funding. We estimate that the APMC has leveraged over \$4.8 million in IPM programmatic support—>10-fold our 3(d) allocation—none of which would have been possible without the foundation provided by IPM formula funds (*see Appendix 4*). ***The increased level of support (beyond prior formula funding level) sought through this proposal will allow us to develop local technical resources (Extension Assistants & Research Specialists) to increase our IPM capacity for diagnostics, IPM demonstrations and outreach to support implementation of IPM in all program areas.***

(ii) Rationale and Significance

Our organizational structure and function have been detailed in section ‘i’ above, and presented graphically in Appendix 1 & 2. Our focal areas and programmatic thrusts represent both organizational strengths and stakeholder-identified priorities, and align well with our selected EIPM emphasis areas (*see (i)4, a-e*). The purpose of this proposal is to sustain strategically focused resources of our institution and maintain our core function and capacity to put IPM into practice. More importantly, however, we wish to fuel latent capacity through infusion of resources, especially where local IPM resources are lacking (i.e., lack of County technical resources or Agents) in order to better demonstrate and stimulate implementation and adoption of IPM in an array of contexts and environments. Specific programmatic needs and rationales are presented with each emphasis area below. Our goal is to minimize adverse economic, environmental and human health risks from pests and related pest management practices.

(iii) IPM Coordination

Coordination of IPM translational research and outreach in AZ *is* the function of the APMC. Our administrative structure and coordination function, and their impact on all that we do in IPM has already been extensively developed in section ‘i’ and in Appendix 1 & 2, and will not be repeated here except in summary form (*see section i for details*). The APMC supports stakeholder engagement, priority-setting, strategic planning, resource development, Extension programming, communication and outreach, and IPM assessment activities in all areas of emphasis. Through our coordination function, the IPM Coordinator along with the IPM Program Manager and a multidisciplinary IPM Coordinating Committee plan and coordinate all IPM activities in AZ, respond to IPM-related inquiries from federal and stakeholder partners, develop and report on our state’s IPM efforts, support county-level capacity in IPM, develop and synergize collaborative efforts, build and help manage teams, and represent our state’s IPM program in state, regional, national and international venues. Our basic function is to sustain shared core assets and to remove as many other barriers to our faculty as possible towards achieving our mission of *creating a working environment in which the science and implementation of IPM can thrive in Arizona*. The expected outcomes of our coordination (many already apparent) are significant leveraged resources for IPM, improved communication and coordination of programs and partnerships, documentation of outcomes and impacts for all programs, transparency, increased implementation of IPM in all program areas, and the environmental, economic and human health benefits that flow from that. (Specific “outputs” are listed in each area of emphasis below.) Our organizational structure and the support it provides ensures that faculty develop quality programs that are relevant and responsive to stakeholder needs. Our potential for success is apparent in our ability to leverage limited formula IPM funds to great impact (*see Appendix 4*), our multi-disciplinary membership (*see Appendix 2 & 3*) our extensive collaborations and partnerships (*see Appendices 5, 6, 7, and “IPM Collaboration” below*), and the documented impacts of our IPM programs (Anonymous 2007).

(iii) IPM Collaboration (*see Appendix 6 for letters of collaboration and Appendix 7 for letters of support*).

The APMC provides a “face” to UA IPM and serves as a point-of-contact for stakeholders, collaborators, partner organizations and regional and federal IPM interests. We engage in several logical collaborations that help maximize the impact and reach of our IPM programs while minimizing duplication of effort among partner institutions. Here, we solidify and enhance certain collaborative relationships related to our organizational functions and to specific areas of emphasis.

The Arid Southwest IPM Network (ASIPMN) is a multi-state, multi-disciplinary IPM information network partially funded through a WIPMC grant. Partners include the UA (lead), the University of California, University of Nevada-Reno and New Mexico State University. This region is characterized by low rainfall, high solar radiation, intensive irrigated agriculture, large urban centers, and fragile and sensitive natural ecosystems. We serve a distinct clientele who deal with year-round pest pressures unique to our region. The ASIPMN coordinates stakeholder responses to state, regional and federal pesticide and IPM information requests, and brings together diverse interests in IPM to identify regional needs, minimize duplication of resources, and to fully participate in regional and national IPM objectives and priorities.

Our network is comprised of a small group of scientists and educators who serve as expert points-of-contact for collecting and communicating stakeholder input. A limitation has been the small and diminishing resources of our partner institutions, which can constrain the extent and quality of stakeholder input. We will enhance this engagement by providing small subcontracts to each partner institution to help defray the costs of their time invested. Each partner's role is to identify appropriate stakeholders, solicit feedback, and formulate a timely response back to Dr. Al Fournier, ASIPMN manager, who submits a single response representing all regional stakeholder input. We will also draw on this regional IPM "braintrust" in development and extension of IPM resources appropriate to the desert southwest. The infrastructure of the APMC, including the Arizona Crop Information Site (ACIS) (cals.arizona.edu/crops/crops.html) is available for delivery of IPM information from all partner organizations. Deliverables include improved responses to information requests posted on the ASIPMN website (cals.arizona.edu/apmc/Arid_SWPMC_Info_Requests.html), increased stakeholder representation on PMSPs and similar activities.

This collaboration addresses a primary goal of the National IPM Roadmap to increase nationwide communication and efficiency through information exchanges among federal and non-federal IPM practitioners and service providers. A natural outcome will be stakeholder-informed regulatory decision-making that will result in economic, human health and environmental benefits while taking into consideration real-world needs and concerns of pest managers in diverse environments.

This collaboration spans all areas of emphasis. Key personnel are Peter Ellsworth (UA), Scott Bundy (NMSU), Eric Natwick (UC), and Jay Davison and Earl Creech (UNR); Al Fournier (UA) coordinates all responses and communicates with WIPMC Director, Rick Melnicoe (UC-Davis). We will evaluate the impact of this collaboration after the 1st yr by comparing the level of stakeholder input from participating state partners to that achieved over the past 3 yr of the Network. We will also solicit feedback from partner states and the Western IPM Center to determine how outcomes may be improved.

The Arizona Department of Agriculture (ADA) is our state lead regulatory agency and key collaborator on many projects related to agricultural IPM areas of emphasis. Together we measure and document the adoption and impact of our IPM programs, a major goal of the IPM Roadmap, using a historical (1991–present) pesticide use-reporting (PUR) database. Users report most applications to ADA (e.g., custom applications, Sect. 18 exemptions, restricted use pesticides) on a form (L-1080) that includes target pest information, products, rates and location. We have jointly developed a comprehensive PUR database that will provide quantitative information useful in addressing goals of the IPM Roadmap: (1) to promote environmental stewardship and safety for our natural resources and biodiversity through documentation of changes in pest management practices; (2) to respond quantitatively to information needs related to pesticide registration; (3) to facilitate new production markets in response to increasing or changing consumer demands (e.g., organic production); (4) to conduct novel research and outreach especially with spatial data (e.g., GIS maps);

(5) to identify pest management needs and priorities; and (6) to quantify the adoption and impact of agricultural IPM practices. The APMC has hired a full-time database specialist, Richard Farmer, and formed a stakeholder steering committee to shape the development of this database. ADA provides access to PUR data, collaborates with us on technical aspects of database development, and maintains data entry within their budgetary constraints. Key personnel at ADA Environmental Services Division are Jack Peterson, Associate Director and Gary Christian, Program Manager (*see Appendix 6*). The **Arizona Cotton Research and Protection Council** (ACRPC, Larry Antilla, Director) will provide the APMC with detailed agricultural field map data that can be integrated with PUR data to enable substantial geographic analyses of pesticide use and related information through time (*see Appendix 6*). The APMC, under technical leadership of Richard Farmer, will be responsible for development of the database with input from the stakeholder advisory committee. The database itself and the information resource it will provide is the deliverable for this collaboration, but this end product will enable additional deliverables as listed above and critical to our “IPM Assessment” focal area.

The Arizona Crop Protection Association (AzCPA) is a state organization of agriculture industry representatives that interacts closely with the APMC to promote IPM for the professional improvement of their industry (*see Appendix 6 & 7*). We collaborate with AzCPA on several fronts; two are key to goals of the EIPM Program. First, we coordinate with AzCPA in delivery of IPM extension education at the annual Desert Agricultural Conference (DAC). This statewide venue reaches most PCAs, and many growers and other key audiences, and is used as a platform for engaging stakeholders in dialog relevant to development and improvement of our programs. Second, we have been working with AzCPA to develop a major revision of our state PCA Manual used in training and licensing of AZ PCAs. The manual, which has not had major revisions in over 18 yr, is being rewritten to emphasize modern IPM and integrated crop management approaches. The APMC is coordinating development with input from over a dozen UA faculty, ADA and AzCPA representatives. The role of AzCPA in this project has been project initiation (they presented the project as a key stakeholder need), providing stakeholder input and section reviews, and marketing the end product to their membership. The APMC is responsible for content development, editing, layout, and printing (through Western Growers Association) and is also coordinating with ADA on the development of new questions to support a revised PCA licensing exam. Deliverables include at least 5 IPM Extension presentations at the 2009 DAC, the completed AzCPA PCA Manual and a revised licensing exam by the end of this grant term. Key personnel are Al Fournier and Peter Ellsworth (UA), Jack Peterson and Gary Christian (ADA), and Lin Evans (AzCPA) as well as a long list of participating UA faculty authors.

(iii) C1. IPM in Agronomic Crops: Rationale and Significance

Crop production continues to represent a significant contribution to AZ’s economy with 26,000,000 A dedicated to farming and annual receipts of \$1,843,487,000 statewide. Key agronomic crops include alfalfa (250,000 A, leading the nation in yield at 8.3 tons/A and totaling 2.08M tons statewide), field corn (55,000 A, with grain yields of 10,360 lbs/A), Durum wheat (80,000 A, 3rd in the nation behind ND and MT & averaging 5000–6000 lbs/A), barley (35,000 A, 8th in the nation), and grain sorghum (45,000 A) (USDA-NASS 2008). Grain sorghum has drawn new interest because of its potential for and local production of ethanol. Changing societal needs and the current economic climate have driven recent rapid changes, including the emergence of new crops (e.g., guayule), new emphasis on biofuels production (e.g., grain sorghum), and expansion in high-quality alfalfa production to support demands by CA and AZ dairies. For many of these crops, little is

known about key pest issues and their impact on production, pesticide use, and profitability. Because of the changing face of this industry and its continuing economic importance, we must improve our understanding of the key pest issues facing producers. This need is confirmed by recent input from producers and other stakeholders, who have suggested we conduct a needs assessment in agronomic crops. While UA has expertise in both IPM and agronomic crops and works within an Integrated Crop Management (ICM) model, prior work in pest management in many of these crops has been slight. We are proposing through this grant to assemble a new Agronomic Crops IPM Team to conduct a pest management needs assessment of agronomic crop stakeholders to identify and prioritize research and education needs. This will provide us with a focus for the future in this critical area, and bolster our new investments that include a new hire, Dr. Sam Wang (Cropping Systems Specialist) and a new Area Agricultural Agent, Erin Taylor in central AZ.

Activities, Outputs and Their Use

Assemble Agronomic Crops IPM Team. We will assemble a team of UA specialists, researchers and extension personnel with multidisciplinary expertise in agronomic crops and IPM. The team will meet as needed (at least 3 times in the 1st yr) to address the goals of this project. The Y1 goal is to identify and begin to address stakeholder IPM priorities in agronomic crops in a systematic way.

Develop and Conduct Agronomic Crops IPM Needs Assessment. The team will develop a draft survey questionnaire and a plan for its implementation (mail, online, telephone survey or some combination). Extension personnel with survey expertise will review the survey, pilot test it with a sample of the target audience (growers, PCAs, ag. industry representatives), and finalize it based on their input. The survey will be implemented in fall 2009 and data summarized by the end of the grant period. In addition to the survey, we will plan and conduct one focus group session in 2009 to identify key IPM priorities.

Prioritize Needs. Based on analyses of stakeholder input from the survey and focus group session, we will develop a list of priority research and education needs for IPM in agronomic crops as part of a final needs assessment report. These priorities will be posted on the APMC website and will serve to guide future Extension activities in Agronomic Crop IPM/ICM.

Revise Existing Extension Publications to Incorporate IPM Concepts, Identify New Publication Priorities. The team will conduct a review of existing Extension publications and other education resources for agronomic crops. In the short term (Y1), we will revise at least 4 extension publications to incorporate the general principles of IPM. We will also identify the top priorities for development of new publications to address stakeholder IPM needs and assign team members to focus on their development.

Develop a Research Plan. We will identify major IPM applied research gaps through the needs assessment process. E.g., we know that pest status, let alone thresholds, are not known or understood in some of these crops. We will prioritize research needs with stakeholder input and develop a plan for funding and implementing the needed research to fill information gaps.

Deliverables

(1) A formalized Agronomic Crops IPM/ICM Team of experts will be formed within the APMC Agricultural IPM focal area; **(2)** an Agronomic Crops IPM Needs Assessment report based on survey and focus session data will be completed and posted to the APMC website (cals.arizona.edu/apmc); **(3)** lists of both research and education IPM priorities for agronomic crops, as determined with stakeholder input, will be developed as part of the report; **(4)** at least 4 existing

Extension publications focusing on specific agronomic crops will be revised to incorporate IPM principles and posted to the ACIS website (*cal.s.arizona.edu/crops*); (5) a strategic plan for future publications and future research and education efforts will be developed by the team and posted to the APMC website.

Expected Outcomes

Our modest goal for Y1 is to assemble the expertise and stakeholder input needed to identify future priorities and focus for addressing IPM needs in agronomic crops. Stakeholders and the Agronomic Crops IPM Team will become more knowledgeable about research and education gaps that affect our ability to address the goals of the IPM Roadmap in this area. We will emerge from this effort with a strategic plan for addressing critical needs in this area.

Roles

Rick Gibson (Pinal Co. CE Director), **Erin Taylor** and **Dr. Sam Wang** provide team leadership, and **Dr. Al Fournier** (0.12 FTE) will work with the team to develop the needs assessment. **The Agronomic Crops IPM Team** (*see Appendix 3*) is largely made up of Specialists and Agents with agricultural responsibilities and will play a major role in developing the assessment tools and process. Specific assignments to activities are covered in the attached “*Budget Justification*”.

Evaluation

The success of our efforts will be measured based on survey and focus group participation levels and response rates, quality of the needs assessment report with respect to guiding future extension efforts in agronomic crop IPM, and the number of publications revised.

Potential Pitfalls

It will be critical to design the survey and the focus group activities to maximize response rates and participation. The value of our Extension strategic planning for IPM in agronomic crops will be directly linked to the breadth, depth and quality of responses and how well they represent stakeholder needs.

(iii) C2. High Value, High Input or Intensively Managed Crops: Rationale and Significance

The intensity of agriculture in AZ is unlikely matched by any other state except for CA or FL. Our year-round production systems and extensive irrigation have led to AZ’s leading yields, qualities, and market positions for many fresh vegetables, melons, tree nuts and fruit, and cotton. AZ produces fresh market vegetables and melons on 134,000 A at an estimated value of over \$900,000,000. AZ ranks 3rd in production of fresh market vegetables and 2nd only to CA in production of head lettuce, leaf and romaine lettuce, broccoli, cauliflower, spinach, cantaloupes, and honeydews. Chile pepper, dry onion and watermelon production rank 3rd, 4th and 5th in the U.S. During the winter, Yuma, AZ, is the primary producer of fresh leafy vegetable products, accounting for more than 95% of the consumption in the U.S. During other market windows, AZ is the primary producer of cantaloupes and honeydews in the U.S. AZ ranks 4th in pecans (ca. 22,000 A valued at \$36.8M); 2nd in lemon production (nearly 1/4th of U.S. production; 13,000 A worth \$50M); and hosts smaller acreages of gourmet-quality pistachios (2,000 A), apples, olives, dates and other fruits. AZ generally leads the nation in upland cotton yields at over 1430 lbs/A (on ca. 150,000 A valued at > \$150M), which is

more than double the yields of most other states (AL, FL, KS, NC, SC, TN, TX, VA) and >50% more than all other (AR, GA, LA, MS, MO, OK), except for CA and NM.

This intensity creates large demands and need for our IPM programs: our weather and year-round production lead to high pest potentials; our system of inputs (e.g., irrigation and related tillage) lead to greater need for control tactics and IPM strategies especially for weeds; consumer demands, market expectations, and aesthetic concerns place greater pressures on pest managers especially for insect control; and food safety and security issues create reticence in growers for sharing information and adopting new or changed control systems.

Investment in pest management tactics can be very high (as much as \$350/A for insect control alone in lettuce) and demands a highly skilled and professional pest manager (PCAs). Some are young and lack training necessary to become proficient in IPM; others are more experienced but perhaps less conversant in new technologies. Our programs have successfully targeted this audience with *dramatic examples of adoption and progressive change in the industry*. E.g., Cotton, once sprayed for arthropods as much as 12.4 times (1995), is now managed with less than 2 sprays/season and with extremely selective and reduced-risk insecticides—2006 and 2007 saw the lowest foliar insecticide use in 29 yr (1.3 sprays). Comparing 1995 to 2006, insecticide active ingredients were reduced by 1.7 million lbs statewide (Anonymous 2007). In complex multi-crop systems, we have measured adoption of our guidelines representing a 4-fold change in behavior with only up to 10% non-adoption. We have measured IPM guidelines adoption rates as high as 83.1% in fall lettuce growers. We have also documented areawide lowering of key pest densities over broad agricultural landscapes with 2 orders of magnitude lowering of whiteflies in complex communities of broccoli, lettuce, melon and cotton production (Ellsworth et al. 2008), and major areawide reductions of pink bollworm in cotton statewide (Carriere et al. 2003). The documentation of these successes are based in two factors: highly organized and functional translational research and outreach IPM teams in “Vegetable IPM”, “Cotton IPM” and “CROP” (cross-commodity); and our commitment to “IPM Assessment” (see *Appendix 1 and section i*). These teams are very successful in garnering competitive awards and commodity support for IPM “projects”, but limited in what they can accomplish in IPM outreach and implementation by a lack of resources. Our proposal hopes to synergize our efforts by strategically investing in extension educators (Assistants in Extension) and other IPM human resources necessary for delivering and demonstrating IPM in high value production systems.

Activities, Outputs & Their Use

Translational Research & On-Farm Demonstration. This priority activity will energize our IPM programs and stimulate adoption and learning in our clientele. Teams will work with our Assistants in Extension to develop weed, insect, and pathogen management demonstrations and grower-participatory research in commercial settings (e.g., Kerb chemigation and fusarium wilt management in lettuce; CYSDV epidemiology in fall melons; reduced-risk whitefly management in cotton, lettuce, melons and broccoli; conservation of natural enemies and selective management of Lygus, pink bollworm, and whiteflies in cotton; Lygus control termination timing in cotton; spatial ecology of whiteflies and natural enemies in agricultural communities; and orchard floor management without glyphosate). A small minigrant program, through this grant and administered by the APMC, will help support these kinds of activities, which will be showcased in field days & workshops (*described below*). Partnerships will be established with many commodity groups and industry interests (see *Appendix 7*) to identify needs and plan and implement research.

Educational Meetings & Events. Over 100 IPM hrs (i.e., CEUs) will be conveyed via trainings, meetings, seminars, field days, and workshops, highlighting new IPM information on pest biology,

ecology, and management. We will also offer new monthly “*Tailgate Lunch Meetings*” and field tours centered on successful demonstrations noted above; plan and develop local county and topical meetings (e.g., CYSDV melon meetings), state-wide venues (e.g., Desert Ag Conference), regional expo’s (Southwest AG Summit, Desert Vegetable Workshop), and a week-long (5*4 hr) Vegetable IPM in Desert Cropping Systems Short Course with ADA, AzCPA, and CAPCA.

Development & Dissemination of IPM Technical Resources. Our Assistants in Extension will work with IPM teams to revise and develop new publications for desert crops IPM for printing and posting on ACIS (*see Deliverables for details*). We will expand existing and establish new stakeholder listservs for regular communication.

Troubleshooting Site-Visits & Other Interactions. Our teams will engage in regular diagnosis, sample collections, individual and small group consultations, and phone communications as needed.

Stakeholder Engagement, Needs Assessment & Program Measurement. We have invested many resources into our focal area, “IPM Assessment”, which is discussed elsewhere (*see Evaluation and ‘i’*).

Deliverables

(1) On farm demonstration workshops / meetings for high value crops in Yuma, Pinal and Maricopa Counties; **(2)** Over 100 IPM hrs (i.e., CEUs) conveyed via various trainings statewide; **(3)** New and revised education materials including at least 1 *IPM Series* publication; updated *IPM Guidelines*; 2 new series, *IPM Reference Guides* (2–3 pp. each) and *Pesticide & IPM Fact Sheets*; re-established biweekly *Desert Vegetable Advisory* web-based newsletter, and weekly *Cotton IPM Advisory* in FAX, mail and e-form.

Expected Outcomes

Our goal in the 1st year is to install our new Extension educators, who will assist our teams in the production of educational materials, workshops, meetings, and grower demonstrations. Specific expected outcomes are increased awareness and technical knowledge of IPM among target audiences (short-term), increased use of IPM tactics (medium-term), and reduced pest levels and reliance on routine pesticide use among adopting growers, resulting in human health and environmental benefits (long-term).

Roles

Dr. John Palumbo, Vegetable IPM Specialist (no support sought here) will provide leadership for the “Vegetable IPM” team; **Dr. Bill McCloskey**, Extension Weed Specialist (no support sought here) will lead the Tree Crops team; **Dr. Peter Ellsworth** (PD, no support sought here) will lead the “Cotton IPM” team; and **Drs. Palumbo, Ellsworth, and Fournier** (co-PD, 0.04 FTE sought here), and **Erin Taylor**, Area Ag Agent, will co-lead the “CROP” team (*see Appendix 3 for team complements*). Specific assignments to activities are covered in the attached “*Budget Justification*”.

Evaluation

Evaluation of broad programmatic impacts is at the core of what we do; IPM assessment is a major activity and focus of the APMC (*see section i(3)*). The tools and approaches we have developed for measuring the adoption and impact of IPM in high-value crops have set the standard for what we hope to achieve in other program areas. These include a Crop Pest Losses and Impact Assessment process that engages PCAs and other clients in face-to-face workshops (~7/yr) to document “real world” pest impacts (insects, weeds, diseases) on yields, profits and pest management behaviors in

key crops (cotton, melons, lettuce). The data provide insights on changing pest dynamics, economic impacts, research needs and adoption of IPM (Fournier et al. 2007). We are also developing, in partnership with ADA and a diverse agricultural stakeholder advisory board [*details in i(3)*], a statewide pesticide use reporting database that can be mined to evaluate adoption of IPM practices, changes in pests and pest management behaviors over time and space, and for responding quantitatively to stakeholder and federal pesticide use inquiries. We have proven the potential of this approach with a 5-yr database used to measure spatial adoption of cross-commodity guidelines for whitefly control (Ellsworth et al. 2005b, 2008), and have hired a database specialist, Richard Farmer, who is providing technical leadership on developing a historical database (1991-present). In addition, our agricultural IPM teams regularly engage stakeholders in a variety of advisory groups aimed at identifying program priorities and emerging industry needs and providing input and feedback to all of our programmatic efforts (e.g., “Vegetable IPM”, “CROP” and PCA advisory groups).

Potential Pitfalls

Our efforts are already well-organized, so no major pitfalls are expected; however, recruitment of the human resources within the constraints of the grant cycle will be a challenge (2.2 FTEs).

(iii) C4. IPM Support for Pest Diagnostics Facilities: Rationale and Significance

Accurate and timely pest diagnostics, including arthropod, plant pathogen, weed and nematode identifications, are critical to IPM decision-making in urban, agricultural and natural settings. Stakeholders who benefit from timely and accurate diagnostics statewide include growers, PCAs, county Extension Agents, Master Gardeners, landscape professionals, park managers, turf managers and homeowners. Responsibility for pest diagnostics in support of IPM at UA is divided among a small number of decentralized specialists operating with varied resources. Two critical areas of diagnostics to our IPM stakeholders, arthropod identifications and plant disease / abiotic problem diagnostics, are currently under-funded and under-staffed. In 2008, over 5,000 arthropod samples or electronic queries and over 400 physical and 520 electronic plant samples or queries were submitted. Under current conditions, we have been unable in most cases to provide timely responses needed to support IPM decision-making. Through this grant we are seeking support to bolster our diagnostics capacity to support IPM decision-making and the goals of the IPM Roadmap.

Activities, Outputs & Their Use

Increase Capacity for Arthropod and Plant Disease Diagnostics. Activities include processing of samples and queries, database entries, and responding to the public. This will be accomplished as described in the attached “*Budget Justification*”. Data will be used to improve IPM decision-making of stakeholders.

Diagnostics and IPM Education. Results from diagnostic data and its influence on implementation of IPM practices will be presented at commodity meetings and field days for row crops and vegetables, landscape workshops (statewide Master Gardener training, Smartscape, Landscape Professional Training, statewide landscape conferences, gardening conferences sponsored by county Master Gardeners and docent training at botanical gardens, county and state parks), and school IPM and turf workshops and trainings.

Website Updates. Based on diagnostic information and stakeholder needs, we will provide updates for the Extension Plant Pathology Website for diseases of field crops, vegetables, turf, landscape and native plants (cals.arizona.edu/PLP/plpext) and the Urban IPM website (cals.arizona.edu/urbanipm).

Coordination with Other Diagnostic Functions. Diagnostics capacity exists at the UA and in the state to support other goals: pest survey, detection and mitigation of invasive species, and other regulatory objectives. By formalization of our virtual center in IPM Diagnostics, we will have a role in USDA-APHIS, ADA, CAPS, and AzPDN of communicating our renewed capacity and support to IPM as well as provide input to these regulatory processes on strategic targets, on-going and unusual sample submissions, and where possible, coordination of resources and diagnostic services.

Deliverables

Deliverables are quicker turn-around on diagnostic services provided to clientele, technical presentations at trainings and workshops, informed through diagnostic activities and stakeholder interactions, and updated web-based information made available to the public.

Expected Outcomes

(1) Faster sample turnaround time will allow us to provide real-time diagnostics to clientele to support their IPM decision-making; (2) improve relationships between Extension and clientele groups; (3) increased awareness of pest incidence and severity will help inform IPM priority-setting; (4) increased diagnostic capacity will activate our existing Extension network, supporting county personnel and increasing their ability to actively respond to pest management needs of the public; (5) Better coordination (communication & resources) with other diagnostic functions present in AZ.

Roles

Dr. Mary Olsen, Extension Plant Pathologist, **Carl Olson**, Assistant in Extension and Curator, and **Dr. Dawn Gouge** (Urban IPM Team leader) will provide leadership and organizational support for our IPM diagnostics capacity. Gouge will supervise a **Research Specialist** (0.2 FTE, to be hired) who will provide diagnostic support in the metro Phoenix area. **Dr. Claudia Nischwitz**, research associate with experience in diagnosis of plant problems and diseases, **Dr. Mike Matheron**, Extension Plant Pathologist, and **The Diagnostics Team** (*see Appendix 3*) form the functional core of this emphasis area. Specific assignments to activities are covered in the attached “*Budget Justification*”.

Evaluation

Increased diagnostic capacity will be evaluated by tracking the number of weed, plant, arthropod and nematode samples processed and the turn-around time for responding to clientele.

Potential Pitfalls

Our diagnostics capacity is modest and even with this support may become overwhelmed by the renewed and stimulated interest in this type of service. The metropolitan area of Phoenix alone generates thousands of inquiries, many of which we try to handle through the voluntary Master Gardener clinic in Maricopa County. AZ's high rates of peoples transplanted from other parts of the country lead to greater than normal demands for diagnostics services. This coupled with our very unusual fauna lead to high rates of concern about putative dangers posed to people, property and plants by various organisms. Our hot, dry climate leads to dermatitis at higher than normal rates and the concomitant cases of delusory parasitosis. The time required to counsel these people is intensive and takes time and resources away from our Specialists and Agents who are confronted by these individuals.

(iii) C5. IPM in Schools: Rationale and Significance

Over 1.1 million children spend most of their waking hours in one of AZ's 2,078 public schools, 71% of them in the metropolitan areas of Phoenix (58%) and Tucson (13%). Pest problems and unsafe pesticide use practices in schools pose risks to children's health. AZ's unique pest fauna includes several toxic or dangerous arthropods (e.g., black widow and recluse spiders, Africanized bees, bark scorpions) and animals (e.g., rattlesnakes, rabid bats), some of which pose year-round risks to residents. Children in particular are often more sensitive and more vulnerable to these pests and to pesticide exposure, due to their developing physiology and exploratory behaviors (National Research Council 1993). IPM programs have shown significant reductions in both pesticide use and pest complaints in schools and other public buildings with no long-term increase in costs (Gouge et al. 2006). The UA has been a leader in school IPM since 2000, when we initiated a coordinated statewide education and implementation effort. *Ultimately 30.4% of children in AZ K-12 schools benefited from verifiable IPM programs by May 2005.* However, budget cuts, a reduction in extramural funds and the recent departure of a dedicated state school IPM program coordinator (Research Specialist, 1.0 FTE) have resulted in a near-discontinuation of in-state education and implementation efforts. Experience has shown that without ongoing education and technical support, school IPM programs are threatened by turnover in personnel, shifting administrative priorities and other factors (Schuler 2001, Fournier & Johnson 2002). We wish to restore an active in-state school IPM program: provide hands-on education and demonstrations to school personnel and pest management professionals; support IPM implementation efforts; connect IPM end-users to each other and to technical resources through a communication network; create awareness and demand for school IPM through popular press articles; and activate a network of AZ state agency personnel to serve as school IPM "change agents" and multiply our impacts statewide. Program elements are designed to help diffusion of IPM from core practicing school districts to urban and rural schools statewide.

Activities, Outputs & Their Use

Expand IPM Communication Network. We will expand our database and listserv of in-state school IPM contacts including school district employees, pest management professionals, state agency and non-profit organization partners. These are the primary target audiences for Extension education efforts. The listserv will be used to send notice of trainings, new online IPM resources, articles, etc., and to connect new IPM implementers to a network of more experienced peers.

Provide Access to IPM Technical Resources. Many effective technical resources for school IPM exist. The UA Urban IPM Website (cals.arizona.edu/urbanipm) will be used to connect local school IPM implementers to existing technical resources (model policies, IPM plans, pest fact sheets, training modules, pesticide helpline, etc.), including the national school IPM website (schoolipm.ifas.ufl.edu). We will promote the website to local audiences, identify information gaps based on stakeholder input, and begin to address these gaps by creating or linking to other needed resources. We will publish and distribute a school IPM newsletter about key pests and IPM tactics, "The Pest Press", 4 times/yr both online and at trainings and through the listserv.

Support IPM Implementation through Demonstrations and Coalitions. We will conduct 3 workshops for school personnel and pest management professionals in AZ (Phoenix, Tucson and Cochise County) including IPM demonstrations and hands-on training to support implementation in local school districts. We will coordinate these workshops with the National Pesticide Information Center (NPIC). The workshops will "sell" the concept of IPM and provide technical know-how and support resources to implementers. We will start a new local school IPM coalition in Cochise Co.

connecting IPM-experienced and non-experienced districts in a peer-support network. Existing coalitions in the Phoenix and Tucson metro areas have been quite effective in helping to sustain existing school IPM programs while using them as peer resources to support new programs. We will facilitate regular meetings between partner school districts and provide technical support.

Build IPM Awareness. We will publish at least 2 popular press articles in the 1st yr, which will promote broad awareness of school IPM among parents statewide, providing steps for them to engage their local school districts.

Activate Partner Organizations. We will continue a productive 6-yr collaboration with the AZ Department of Environmental Quality (ADEQ) to broaden statewide school and childcare IPM education efforts. ADEQ will translate IPM education products into Spanish, disseminate UA-developed outreach materials and presentations, integrate IPM education into indoor air quality training, and connect AZ asthma action agencies and concerned parents to school districts that have implemented IPM. We will also conduct one “change agent” demonstration workshop specifically targeting AZ partner agencies involved in school environmental health (e.g., ADEQ, and other state departments of Environmental Health, Agriculture, and Education). This workshop will increase awareness and technical knowledge of IPM and engage other state agency personnel (beyond ADEQ) to integrate IPM education into their programs and professional interactions with school districts and childcare audiences, thus multiplying the impact of our efforts.

Deliverables

(1) Expanded in-state communication network of school IPM implementers and partners; (2) expanded local access to existing school IPM resources through UA Urban / School IPM website; (3) 3 face-to-face demonstration workshops in Phoenix, Tucson and Cochise County; (4) 1 “change agent” workshop; (5) new state agency partners to expand capacity for IPM education; (6) at least 2 popular press articles to increase awareness of and demand for school IPM; (7) at least 4 face-to-face meetings with Cochise Co. school personnel and pest management professionals to activate local school IPM peer network coalition.

Expected Outcomes

Our goal in the Y1 of this program is to re-activate our in-state school IPM education and outreach program, emphasizing face-to-face and electronic contact with target audiences to provide technical and infrastructural support for IPM implementation. Specific expected outcomes are increased awareness and technical knowledge of IPM among target audiences (short-term), increased use of IPM tactics (medium-term), and reduced pest levels and reliance on routine pesticide use among adopting school districts, resulting in human health and environmental benefits (long-term).

Roles

Dr. Dawn Gouge, Urban IPM Specialist (no support sought here) will provide leadership for this emphasis area with major support from a **Research Specialist** (to be hired, 0.8 FTE sought here & supervised by Dr. Gouge), **Dr. Al Fournier**, UA IPM Program Manager (0.07 FTE sought here), and **The School IPM Team** (*see Appendix 3*). Specific assignments to activities are covered in the attached “*Budget Justification*”.

Evaluation

We will conduct an annual assessment of AZ’s school IPM program based on a modified version of the EPA “School IPM Report Card” developed as part of the National School IPM PMSP (Green

and Gouge 2008). The assessment will include an inventory of available resources, no. of participants in education programs and communication networks, and a mail/telephone survey of all 148 AZ school districts to document pest management policies and practices, and awareness of education resources. We will develop and maintain a list of key contacts in each school district to respond on annual progress and to serve as points-of-contact for our education efforts. In addition, Dr. Gouge and colleagues will receive funding through an EPA PRIA II grant to develop research-based performance measures to link school IPM adoption to the IPM Roadmap goal of reducing risks to human health (Green 2008). This involves comparison of cockroach allergen levels and absenteeism rates in IPM and non-IPM schools in AZ, and in schools pre- and post-implementation of an IPM program. While separate from the specific activities of this grant, the data generated by 2011 is expected to provide us with verifiable health measures we can link to school IPM program implementation.

Potential Pitfalls

The biggest challenge to meeting our Y1 goals will be recruitment of a Research Specialist to support and coordinate many of these efforts. We also face the challenges of engaging under-funded AZ school systems to actively participate in IPM education programs and peer networks.

(iii) C7. IPM on Recreation Lands: Rationale and Significance

Over 775,000 residents and thousands of tourists play nearly 12 million rounds of golf annually on one of AZ's 300 golf courses, supporting a \$3.5 billion industry (Schmitz, 2006). Arizona has 12 professional baseball stadiums and/or training complexes, 3 university and professional football stadiums and 148 public school districts with sports field complexes and playgrounds with turfgrass. Active children and athletes play on turf in parks and on professionally managed sports fields. Management of weeds, insect pests, nematodes and plant diseases on recreational turf represents a significant amount of urban pesticide use with potentially negative impacts on human health and our fragile desert environment. IPM techniques, where developed for desert turf pests, can significantly reduce these impacts. Through our previous education programs during the past 5 yr, some turf managers have eliminated up to 2–3 unnecessary sprays each year, and golf course managers that adopted easy-to-use trapping and monitoring techniques for beetles saved up to \$5,500 on pesticide expenses. Additional unneeded pesticide use can be eliminated through accurate, timely diagnostics; abiotic factors caused 22% of turf problems in samples submitted in 2007. The UA Turf Team has engaged turfgrass industry stakeholders to identify IPM research and education needs, and will work with stakeholder organizations and research collaborators to address these issues. Major needs include **(1)** improved understanding of underlying biology and management of rapid blight on golf courses; **(2)** identification, pest status determination, and monitoring and management of white grub and billbug spp. in desert turf; **(3)** surveys for nematodes in golf course greens and nematicide screening trials to replace cancelled registrations; and **(4)** development of improved weed management practices and public education focused on invasive weeds in turf and urban landscapes. However, the loss of a critical position (Research Specialist, 2007) has presented a serious setback to achieving these goals. This technical resource assisted with research, diagnostic and extension efforts related to insect, weed, disease and nematode management (working on a regular basis with key faculty), coordinated contacts with stakeholders, and designed and maintained the UA Turf Team website. Through this grant, we seek 0.75 FTE to restore this position to support our goals of continued stakeholder engagement, promotion of IPM through hands-on training and demonstrations, real-time diagnostics and problem solving for clientele, and educational outputs.

Activities, Outputs & Their Use

Engage Stakeholders to Identify Research & Education Priorities. In 2008, we conducted a stakeholder meeting to develop a Desert Turf PMSP focusing on golf and recreational turf in AZ, NV and southern CA. We are finalizing the draft, which will be published in 2009. Priorities identified through this process will direct future focus of the Turf Team.

Promote Adoption of IPM Tactics at Workshops, Seminars, and Field Days. We will conduct at least 4 specific training events targeting golf course, sports and municipal recreational turf managers and the commercial landscape industry (see “*Deliverables*”). In all venues, we strongly emphasize hands-on training and research demonstrations to convey the concepts of IPM, including weed, insect, disease and nematode management in turf. Members of the Turf Team have worked with the Golf Course Superintendents Association of America to help develop an IPM Workbook for superintendents that promotes record-keeping that is basic to effective IPM. This project is nearing completion, and in 2009, we will promote adoption of the workbook in AZ to heighten IPM awareness and improve its practice.

Provide Diagnostics and Problem Solving to Clientele. The Turf Team will provide IPM problem solving and situational assessment to clientele on-demand, done in collaboration with the UA Diagnostics Team, and sometimes in consultation with out-of-state turf research colleagues. Often these problem-solving situations provide opportunities to set-up participatory research studies that can be used to promote IPM solutions (e.g., trapping & monitoring to enhance decision-making) to a broader stakeholder base at mini-field days.

Develop and Provide Research-based Information to Clientele. We will publish a series of research articles, some on pest management topics, in the “*Turfgrass, Landscape and Urban IPM Research Summary*,” made available on the UA Turf Team website (turf.arizona.edu/index.htm). This site is also used as a communication tool along with a listserv to alert clientele of training events, new publications, and other relevant, timely information.

Deliverables

(1) Publication of the Desert Turfgrass PMSP; **(2)** at least 4 training events promoting IPM adoption through hands-on training and demonstrations: the 5-day “*Desert Turf School*” short course, Annual Spring Turf Seminar, Karsten Turf Field Day and an annual summer Short Course focusing on the basic science underlying IPM and ICM concepts; **(3)** continued processing of diagnostic problems in collaboration with the UA Diagnostics Team; **(4)** research information delivered to clientele via the “*Turfgrass, Landscape and Urban IPM Research Summary*” and UA Turf Team website.

Expected Outcomes

With budget cuts and loss of a key IPM support position, our goal is to re-energize our highly collaborative IPM program by hiring a Research Specialist. With this resource in place, we can again emphasize hands-on trainings and demonstrations to promote adoption of IPM, timely situational diagnostics, and stakeholder coordination and engagement. Specific expected outcomes are increased awareness and technical knowledge of IPM among target audiences (short-term), including better management of rapid blight, nematodes, grub and billbug spp., and weeds in turf (medium-term), and reduced pest problems and reliance on routine pesticide use among adopting turf managers, resulting in human health and environmental benefits (long-term).

Roles

Kai Umeda, Area Extension Agent based in Phoenix, and **Dr. David Kopec**, Turf Extension Specialist based at the Karsten Turf Research Facility in Tucson will provide leadership for this emphasis area with major coordination by a **Research Specialist** (to be hired, 0.75 FTE sought through grant) and contributions from the rest of **The Turf IPM Team** (*see Appendix 3*). Specific assignments to activities are covered in the attached “*Budget Justification*”.

Evaluation

We will evaluate changes in knowledge and intention to adopt IPM practices using pre-and-post or exit surveys at each face-to-face training opportunity, and will attempt to confirm adoption in follow-up surveys at later meetings—94% of respondents to the 2008 IPM Spring Turf Seminar evaluation indicated they would immediately use or adopt techniques presented. We will document participation in meetings and no. page views and downloads from the Turf IPM website—following full implementation of the UA Turf Team website, ca 50,000 page views were counted in 2006.

Potential Pitfalls

The biggest challenge to meeting the 1 yr goals in this emphasis area will be recruitment of a Research Specialist that will be dedicated to support and coordination of many of these efforts.

(iii) C8. Consumer/Urban IPM: Rationale and Significance

Arizona is among the fastest growing states, increasing 20% in population from 2000 to 2006 with most residents (90%) living in urban areas. New residents in the arid Southwest need education on the unique requirements of desert landscape plants and pest management practices that are much different from the Midwest and other regions. From plant selection to weed and insect management practices, lack of understanding of plants in desert environments often leads to pest problems and unnecessary use of pesticides. Hundreds of Master Gardeners in nearly every county statewide serve as front-line contacts for homeowners with questions related to horticulture and pest management. These dedicated volunteers field thousands of home and garden questions each year, diagnose pest problems and serve as “first detectors” for potential invasive pest issues such as citrus greening. Volunteers must maintain consumer confidence by providing dependable and accurate pest control information. Therefore, effective education of this volunteer force is critical. Through this grant, the Consumer/Urban IPM Team will develop a coordinated education program based on stakeholder input targeting homeowners, residential and commercial landscape managers and Master Gardeners.

Activities, Outputs & Their Use

Conduct Consumer/Urban IPM Program Planning. The UA Urban Horticulture IPM Team members will meet to plan integrated extension education in the area of Consumer/Urban IPM. Our educational focus for Y1, based on stakeholder needs, will be in the areas of weed management (non-turf) and education to distinguish abiotic plant disorders from pest damage.

Provide Training for Horticultural Professionals. At least 5 educational presentations and hands-on trainings for landscape professionals and homeowners will be presented at industry conferences and other educational venues throughout the year to educate clientele on priority IPM topics.

Educate and Activate AZ Master Gardeners to Address Urban IPM. The Urban Horticulture IPM Team will activate the Master Gardener volunteer workforce to support IPM extension through education and technical support. The Team will develop a standardized Master Gardener

IPM section in the training curriculum to help volunteers teach the science behind management strategies to support clientele IPM decision-making. Team members will present at least 16 presentations to Master Gardeners and will provide them with ongoing technical support as needed.

Expand Urban IPM Website and Develop Extension Bulletins. We will provide information on plant and landscape management on our website (cals.arizona.edu/extension/ornamentalhort), which will be expanded to include a section on urban weed management and a section on abiotic disorders that are often mistaken for a pest problem and treated unnecessarily with pesticides. We will also develop, post and distribute 2 Extension bulletins on the topics of weed management and abiotic disorders of desert plants and contribute, as a team, several articles to the UA's annual "*Turfgrass, Landscape and Urban IPM Research Summary*" or trade journals geared to landscape professionals.

Deliverables

(1) 5 or more educational presentations to landscape and horticulture industry professionals throughout the state; (2) 16 presentations to help train master gardeners; (3) expanded website to include 2 new sections; (4) 2 Extension bulletins and several other research-based articles.

Expected Outcomes

Our goal in the 1st yr is to establish the Urban Horticulture IPM Team and initiate program planning and extension programming as described. Short-term expected outcomes are increased awareness and technical knowledge of weed management principles to reduce herbicide use in urban settings; increased awareness of abiotic issues that can affect desert plants and the ability to distinguish these from pest symptoms; and increased knowledge of basic IPM principles among Master Gardeners statewide. Medium-term, we expect increased use of IPM tactics by homeowners and commercial landscapers. Long-term, IPM will result in reduced pest levels and reduced reliance on routine pesticide use, resulting in human health, environmental, economic, and aesthetic benefits.

Roles

Dr. Ursula Schuch, Extension Specialist in Arid Ornamentals (Tucson), and **Rick Gibson** will provide leadership for this emphasis area with major support from **Dr. Bill McCloskey**, Associate Weed Science Specialist, **Mr. Tilak Mahato** (Research Specialist 0.33 FTE from this grant), and **The Horticulture IPM Team** (*see Appendix 3*). Specific assignments to activities are covered in the attached "*Budget Justification*".

Evaluation

We will evaluate changes in knowledge and intention to adopt IPM practices using pre-and-post or exit surveys at face-to-face training opportunities for both Master Gardeners and landscape professionals. We will document participation in meetings and no. page views and downloads from the Urban Horticulture website.

Potential Pitfalls

The biggest challenge to meeting the Y1 goals in this area of emphasis will be to bring about uniformity in the IPM curricula offered to Master Gardeners. Currently, our large state hosts individual county-based Master Gardener programs that draw upon different manuals and training materials. We are losing a major Agent resource due to retirement (after >30 yr) in Maricopa Co. (serving metro Phoenix), and another urban horticulture position is vacant with no plans for replacement due to serious state shortfalls.