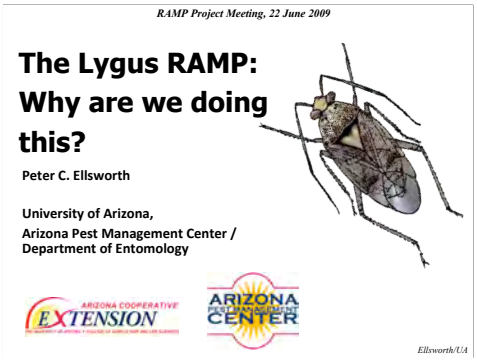
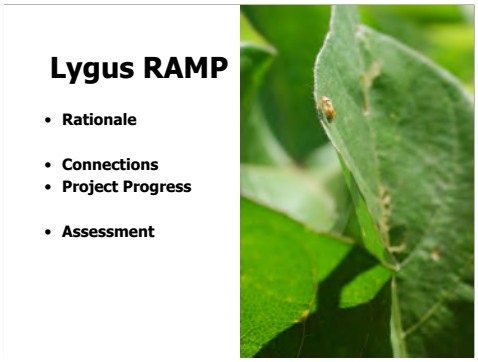



**The Lygus RAMP is a huge undertaking with many subprojects, goals and objectives. However, I think it is important for everyone to step back and re-orient to the basic rationale and reasons for doing what we are doing. This is review for many, but the first time for others to see how we are organized and our justification for our approach.**








**I will cover our rationale, which was a large component of our grant application. What is the justification for this RAMP?**

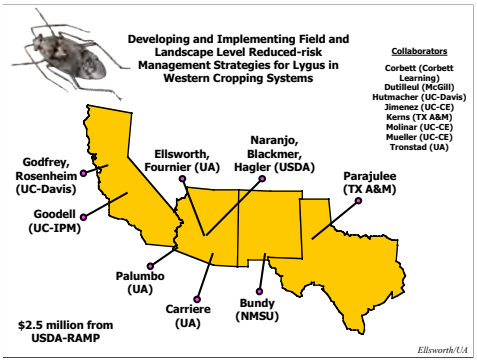
**We will review the connections of the pieces so that everyone sees and understands the interrelatedness of our individual projects.**

**I will do a broad overview of our RAMP make-up and the project progress we have made.**

**Lastly, I will touch upon assessment and outcomes as we set-up for Al's presentation.**





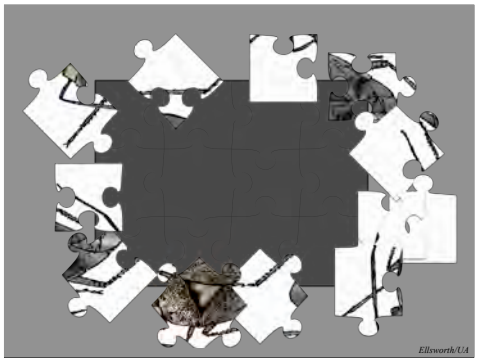



**This our group.**

**Ellsworth, P., P. Goodell, M. Parajulee, S. Bundy, S. Naranjo, J. Bancroft, J. Blackmer, Y. Carriere, A. Fournier, L. Godfrey, J. Hagler, J. Palumbo & J. Rosenheim. Developing and Implementing Field and Landscape Level Reduced-Risk Management Strategies for Lygus in Western Cropping Systems. $2,500,000. (Sept 2006 - Aug 2010).**








**We have never been fully assembled in one room together. We are a large and diverse effort. Some may only perceive the puzzle piece they are concentrated on and have a less developed view of the overall picture we are trying to assemble.**

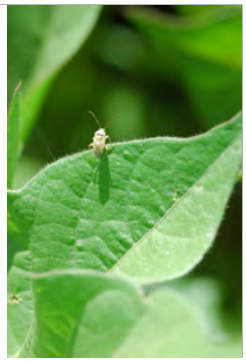

We have just 15 months left and hopefully through this and other discussions, we will all start to see the full picture emerging with just a few puzzle pieces remaining to be put into place.





## Goal

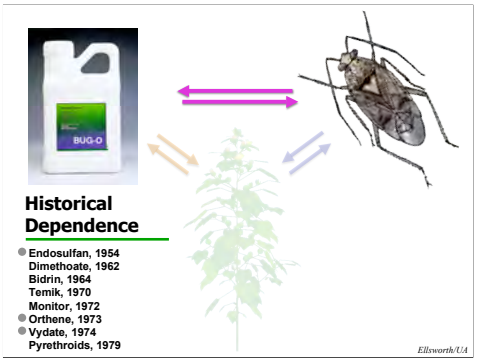
- Reduce impact of Lygus and Lygus control chemistry on the Western agro-ecosystem



While stated somewhat differently in our grant application, our goal boils down to this.





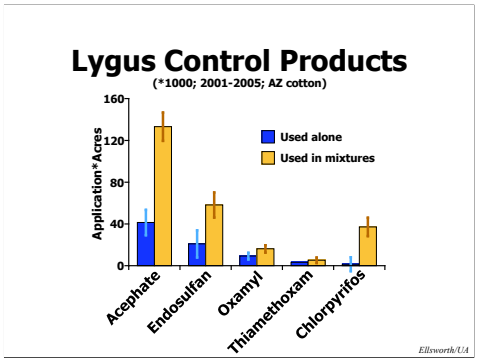



Most Lygus control taking place in the U.S. depends on one or more of these rather old pieces of chemistry. Endosulfan is banned in more than two dozen countries and may be greatly reduced in the U.S. very soon. It is still used widely in AZ for Lygus and other pest control. Acephate (Orthene) was our number one active ingredient in Arizona cotton for about 15 years! Even the pyrethroids are 30 years old and will be subject to greater regulatory and environmental scrutiny.

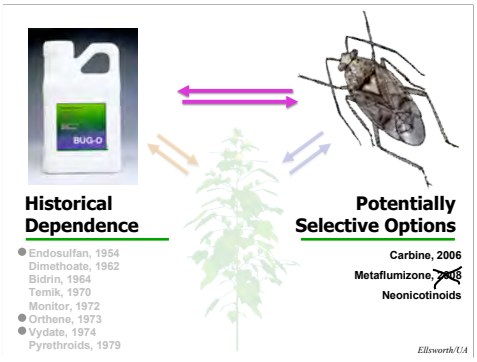
It is this old set of chemistry that forms the basis of the rationale for our RAMP.








These data are from AZ cotton. Whether mixed with other chemicals or used alone, acephate, endosulfan, and oxamyl have been our mainstay products for Lygus control.



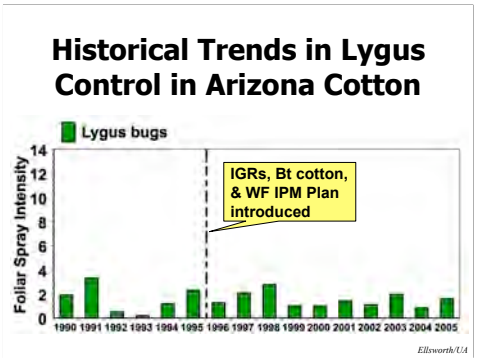

More recently, we have had exciting new advances with potentially selective options: flonicamid was recently registered as Carbine and is very effective against Lygus, and metaflumizone is on track for registration very soon, though delayed several times. These two compounds bring us new chemistry that so far have proven to be more selective than our traditional, broad spectrum options.

This not only gives us new "effective" options, but provides new opportunities to exploit the benefits of natural enemy conservation in our system.

Registered and unregistered neonicotinoids may also play a role in some systems.



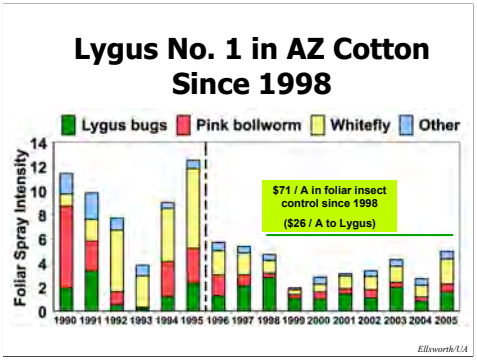





Lygus is not a new pest to Arizona cotton growers. It is one that has been present and at play for a long time. This chart shows the statewide foliar spray intensity for Lygus bugs since 1990. In general, you can see that we have been spraying Lygus ca. 1-3 times per season. This trend appears consistent even after dramatic and major changes to our system. The introduction of Bt cotton and selective whitefly IGRs has not changed the basic need to control Lygus in our system.





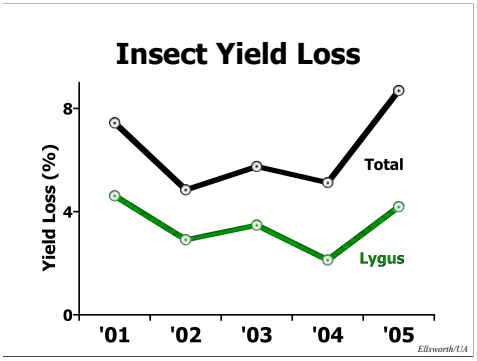



Lygus has been our number one insect pest of cotton since 1998. Lygus has gained in importance simply because it occupies a greater proportion of our spray requirements and budgets since the introduction of selective technologies for other pests in 1996 (Bt cotton for PBW and IGRs for whitefly control). In fact, it is the largest yield threat to AZ cotton.

About 150,000 A are grown in AZ. Over half of the U.S. production of Upland cotton and ALL Pima cotton production is made in the 4 RAMP states.








Lygus bugs are major agricultural pests of many western crops. In cotton, growers on average routinely lose about 5–10% of their yield to all insect pests. About half of this loss is directly related to Lygus bugs. They can dramatically reduce yields on individual fields and result in almost a total loss if not controlled.

## Potential Impact

- Other affected crops (not in RAMP)
  - Clover seed, sugarbeets, celery, strawberry, peach, nectarine, pulses, plum, pear, lettuce
- AZ no. 1 producers of broccoli & cauliflower seed
  - 1-2 sprays each year; 10% loss in seed quality
- Eggplant losses 3-10% in CA & ca. 1.5 sprays
- 1M A of alfalfa grown in CA/AZ
- Guayule could increase to as much as 200,000 A
- Cotton = $1 billion crop in RAMP states, half of all U.S. production

Ellsworth/UA

**Lygus is an indigenous, polyphagous mirid with seed or floral-feeding habits that make it particularly damaging to a wide array of fruit, vegetable, and field crops in the West and beyond.**

**These crops are ones that our RAMP results could impact or ones that we are examining directly. These risks are core to our rationale for the RAMP.**

**Losses to and control costs for Lygus are extremely large. Huge advances have been made in IPM overall in the last decade; however, Lygus and other mirids remain or have become key pests that tend to only have very broadly toxic insecticides as their primary control options.**





## Stakeholder Engagement

**These numbers come from a dialog directly with stakeholders. Furthermore, through Pest Management Strategic Plans (PMSPs) and other documented sources, stakeholders tell us directly that Lygus are important to them, and that improvements in our pest management system are needed.**





## Approach

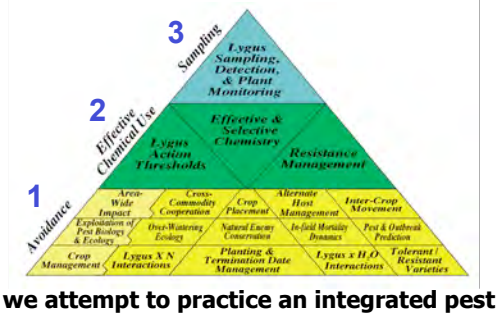
- Identify & deploy reduced-risk alternatives
  - Improve decision-making
- Reduce densities
  - Locally, in-field
  - Systematically, throughout landscape via crop placement & better ecosystem services


**While very complex and very diverse, our basic approach is two-fold. There is an expectation that we will be successful in both areas and therefore reduce the impact of Lygus and Lygus control chemistry in the Western agro-ecosystem.**





## Lygus IPM



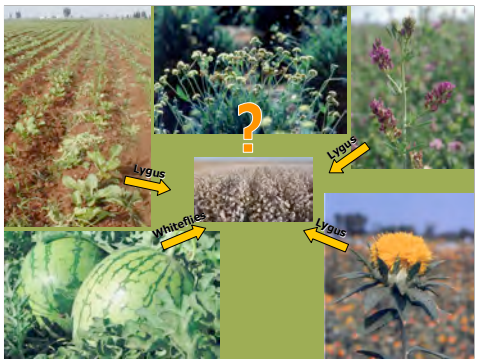

**In AZ, we attempt to practice an integrated pest management plan for Lygus that depends on the 3 basic keys in common with any IPM plan: sampling, effective chemical use, and "avoidance". Avoidance is a set of practices and tactics that can be further subdivided into "Crop Management" or practices that affect crop health and reduce the crop's sensitivity or attractiveness to Lygus; "Exploitation of Pest Biology & Ecology" which capitalizes on our knowledge of how Lygus live and die within the system; and Area-wide Impact" or those set of approaches that influence larger-scale distributions of Lygus in our system.**

**Our focus is on lowering the areawide impact of pests in our system, in this case Lygus bugs through more efficient field-specific and new region-wide approaches.**


Growers, practitioners and scientists have noted anecdotally for decades the role that some crops play as sources of pests in cotton. These relationships are poorly defined, especially beyond adjacent fields. Bollworms and mites from corn, thrips and brown stink bug from wheat, stink bugs from soybeans and peanuts, tobacco budworms from peanuts and bollworms and Lygus from sorghum.





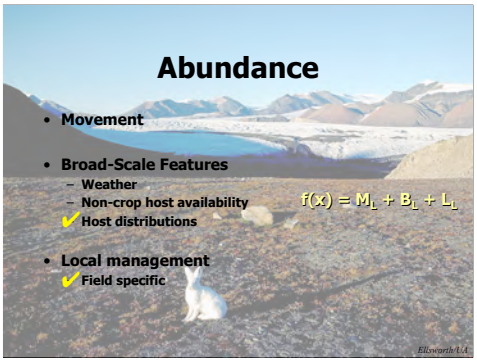



In more western scenarios, we've seen Lygus from seed alfalfa, safflower, and sugar beets, as well as whiteflies sourced from melons to cotton. The role that guayule, as a new, introduced crop to the southwest is completely unknown with respect to pest or beneficial insect movement.

The strength of our approach is in our commitment to better understand and quantitatively define the spatial dynamics of a key pest in our western agro-ecosystem.



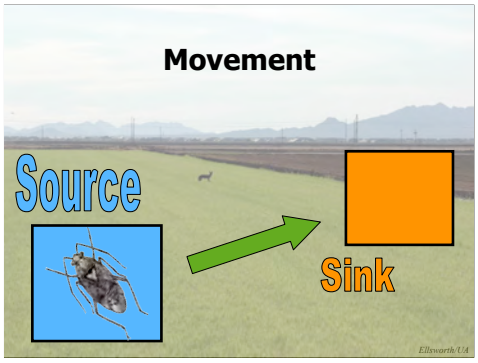





In thinking more about Lygus, indeed all insect pests, it becomes clear quite quickly that it is an issue of "Abundance". Abundance is affected by Movement, a set of Broad-Scale Features, and Local Management. While there is not much we can do about the weather, a grower does control Local Management decisions on his/her own field or farm and we wish to continue to develop research to support this decision-making. However, insect abundance is controlled also by one Broad-Scale Feature that we can control, host or crop and non-crop distributions in an area. It is this opportunity, "great" in scale, that we would like to focus our research to benefit growers. Growers who make land use decisions over larger areas stand to gain the most.

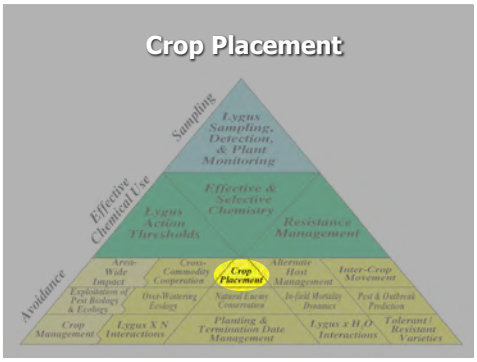







One cannot rationally control host or crop distributions without more information about how an insect moves and travels between different habitats. So Movement is very important. Insect pests and beneficials arrive to and depart from grower fields each year. Where they come from are "Sources". Where they go are "Sinks".

We are trying to precisely define what the source and sink habitats are and how we can manipulate them for the benefit of the entire community.

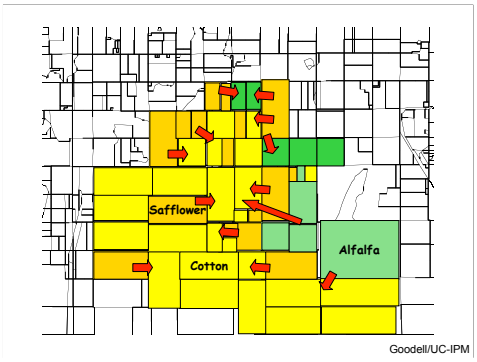



**Right at the heart of our IPM strategy is "Crop Placement". Crop placement is central to its availability to other pests. By strategically considering how we arrange and place our crops both in space and time, we can help to deny our crops as a resource for pest insects.**

**The problem until now is that we have only very limited information on how to strategically arrange our crops to prevent or minimize damage from insect pests.**





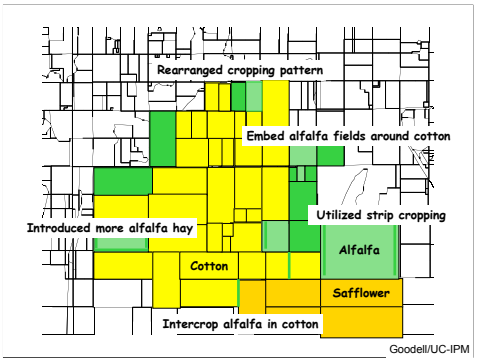



**This graphic is borrowed from Pete Goodell at UC-IPM and was developed several years ago, well before it rather presciently represented the difficult Lygus problem in the central valley of CA in 2008.**

**In short, a cropping plan that does not consider the spatial dynamics of crop-pest interactions can result in a scattering of sources throughout the landscape causing multiple sites of entry into sensitive crops like cotton.**



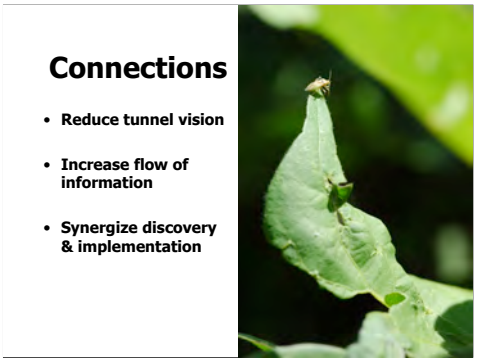




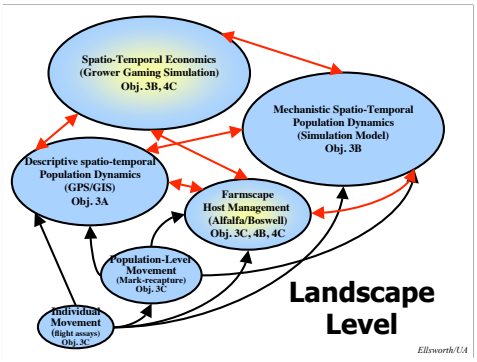

**However, by making some sensible decisions about crop densities and locations, a grower could potentially minimize the risk of Lygus movement and invasion into sensitive crops: grouping sources, including more sinks, making use of other creative cropping / cultural practices.**







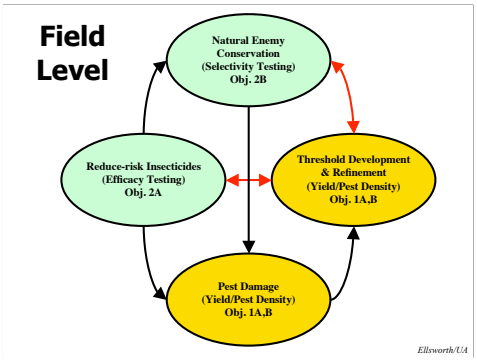

**The connections we have among RAMP subprojects are many. We'll review these as a way to help guard against tunnel vision, to increase flow of information and to synergize discovery and implementation.**




**A conceptual flow-diagram of the proposed project delineating components of the three major elements (field-level research, landscape-level research and outreach) and their interrelationships. Arrows depict the flow of information; black arrows indicate a one-way flow and red arrows depict flows with feedback. Within the Landscape-Level domain the size of the ovals indicate the spatial context of that element from very localized (e.g., individual movement) to regional and multi-state (e.g. spatio-temporal economics).**



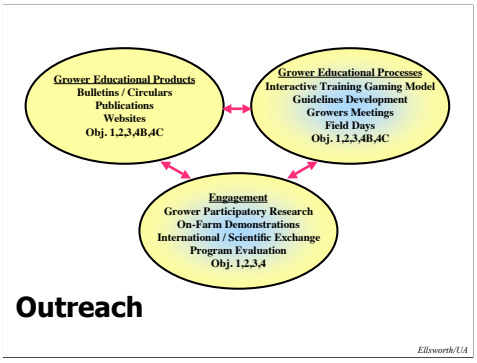





**Field-level components feed into the landscape-level by governing localized population dynamics and management practices that ultimately determine population processes and management strategies within larger landscape contexts. Feedback occurs when landscape-level processes result in lowering of Lygus risks such that field-level practices become more functional (e.g., natural enemy conservation & biological control).**



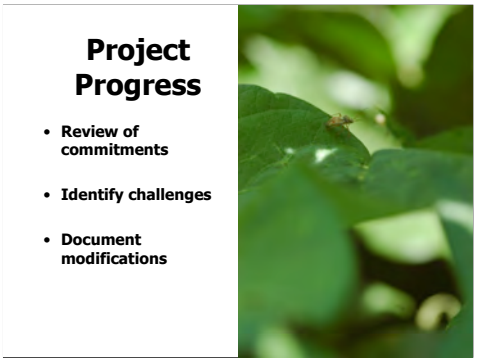





**Outreach activities bridge field- and landscape-level components and provide critical feedback to ensure that research is relevant and provides practical solutions to risk mitigation while also fostering an improved fundamental understanding of pest impact, behavior, biology, and ecology at multiple spatial scales. See Appendix 8a for objective numbers/letters and associated colors.**








**The balance of this day will be dedicated to reviewing project progress. However, I wish to do a broad overview of where we are by reviewing commitments, identifying challenges, and documenting modifications.**

## Themes

- Plant/Pest/Pesticide Interactions
- Individual Behavior & Local Movement
- Regional Ecology, Movement, & Modeling
- Grower Education

Ellsworth/UA

**Our work can be organized in so many ways. However, for this exercise we will follow these four themes**





## Reduced-risk Approaches

| Plant/Pest/Pesticide Interactions | | | |
|---|---|---|---|
| | Efficacy | Damage/Density | NT effects |
| Bundy | | cotton, chiles | |
| Ellsworth | cotton | cotton | |
| Godfrey | dry beans | | dry beans |
| Goodell, Godfrey et al. | | Pima, eggplant | |
| McGuire | fungus | | |
| Naranjo & Ellsworth | | lesquerella, guayule | cotton |
| Parajulee & Kerns | cotton | cotton | cotton |
| Rosenheim | | Geocoris in cotton | |

Spurgeon

Ellsworth/UA

**These are the projects that fall within the Plant/Pest/Pesticide Interactions theme. As an affiliate outside the RAMP, Dale Spurgeon has done research on sweeps sampling that will be helpful in designing decision-making tools.**





## Lygus Behavior

| Individual Behavior & Local Movement | | | |
|---|---|---|---|
| | Individual | Local Factors | Management |
| Blackmer & Naranjo | flight assays | | |
| Goodell | | | alfalfa management |
| Hagler, Blackmer, Naranjo | | intercrop movement | |
| Parajulee | | non-cotton hosts | |

Brent
Spurgeon

Ellsworth/UA

**These fall in the individual behavior and local movement theme. Naranjo will continue/complete the work and objectives that Jackie was a part of. As affiliates to the RAMP, Colin Brent has done much work on reproductive physiology and he with Dale Spurgeon have been investigating the role that diapause plays in this insect.**





## Regional Ecology

| Regional Ecology, Movement & Modeling | | |
|---|---|---|
| | Statistical | Mechanistic |
| Carriere, Dutilleul, Ellsworth, Goodell, Parajulee | AZ, CA, TX sampling | |
| Corbett & Rosenheim | | Simulation Model |
| Rosenheim & Hagler | Mark-Capture | |

Corbett
Dutilleul (out of funding)

Ellsworth/UA

**These projects are part of the regional ecology theme. Andrew Corbett is withdrawing from the RAMP as a funded collaborator. We will need to discuss his objectives and how they will be completed. Pierre Dutilleul, our funded collaborator at McGill University, has unexpectedly run out of money. We will need to discuss this in our sessions. He is key to the analyses of our data from the large sampling project.**

## Education & Outreach

| | Outreach | |
|---|---|---|
| | Communication | Teaching |
| Ellsworth | | Grower demonstrations |
| Ellsworth & Goodell | International Meeting | Sampling video |
| Ellsworth, Corbett, Goodell, Rosenheim, Carriere, Tronstad | | Game training simulation & workshops |
| Fournier | ACIS / APMC / Listserv | |
| Fournier, Goodell, Parajulee, Kerns, Bundy, Godfrey | Evaluation & Assessment | |

Corbett

*Ellsworth/UA*

**The final theme falls in education and outreach. Again, Andrew was to have played a key role here in the development of a game training simulation.**





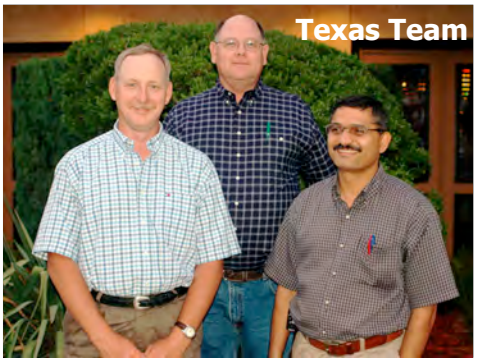

**We are so large that we've never had everyone in one spot at one time, but this is about half of the overall team (including collaborators). As part of our project, we organized the 2nd international Lygus symposium.**

**The project team. Missing PIs: Larry Godfrey (UC-Davis); David Kerns (Texas A&M); Jay Rosenheim (UC-Davis); Scott Bundy (NMSU).**

**This picture is from the 2nd International Lygus Symposium held at Asilomar Conference Center, Pacific Grove, CA, 15-19 April 2007, and sponsored in part by the APMC and the USDA-RAMP grant.**



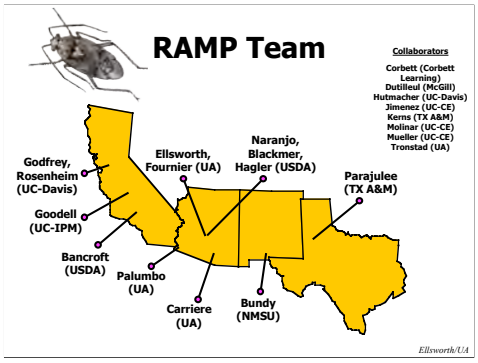




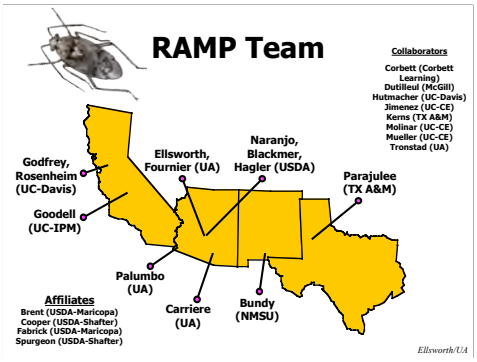

**Here are the project leaders of the TX team. Kerns, Carroll, and Parajulee.**








**As already noted, we have had a number of project modifications since inception of the RAMP. Mickey McClure dropped off the project shortly after its submission. Thus his unfunded objective, which was minor, has been dropped. Jay Bancroft, also of USDA-Shafter, left the USDA system. He was a co-PI on some objectives, which continued without his input.**




**We have, on the plus side, gained many valuable affiliates from new scientiests at USDA-Shafter and USDA-Maricopa. Glad to have them involved!**





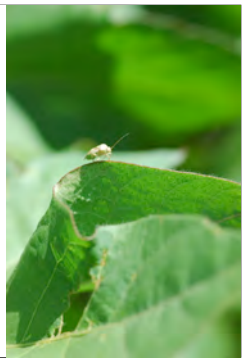

**We of course have also experienced a tragic loss in the passing of Jackie Blackmer. She was a wonderful colleague, excellent scientist and tireless worker even to the very end. Thankfully, she carefully addressed most of her objectives prior to her passing, and Steve Naranjo will continue some of the flight behavior work. We will miss Jackie.**





## Assessment

- Grant requirement
- Extension mandate
- Measures & documents success
- Guides future efforts



**Assessment is a foreign concept to many in the scientific community. But for reasons that are many, we must assess not only how and what our RAMP activities have accomplished and influenced, but how Lygus management has changed over the course of this grant period. Al will dedicate some time to discuss this area.**



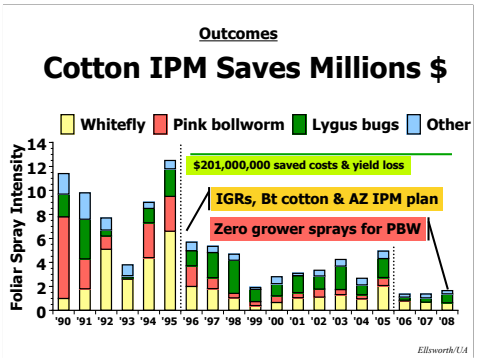


## Cooperative Extension Model

- Identify problem through stakeholder feedback
  - Impact of Lygus and Lygus control chemistry cause de-stabilizing risks for the Western agro-ecosystem
- Develop solutions through applied research & education
  - Reduced-risk approaches are discovered and developed; guidelines are generated, published & workshops conducted
- Assess & measure impacts and changes in client behavior
  - Growers make better decisions & insecticide use choices based ostensibly on guidelines
- Develop feedback & make adjustments in research & education
  - Economic forces change crop patterns; new data needed

Ellsworth/UA

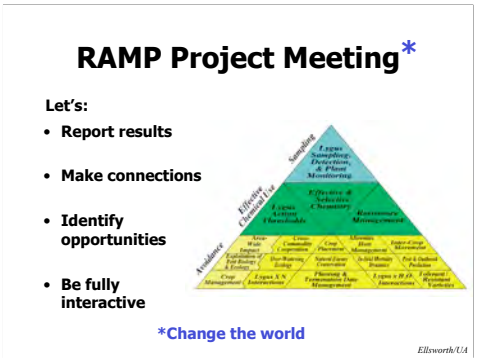
**The modern Cooperative Extension Model is firmly in place here in Arizona, and includes important stakeholder linkages as well as assessment. We can only guess how and what our assessment tells us, but it might look something like this as an example.**




**Assesments can lead you to outcomes and impacts. These are critical to documenting success and attracting future funding. For cotton, we have been measuring insecticide use behaviors for years. The results have been striking. A watershed of change occurred in 1996 with the introduction of very safe and selective Insect Growth Regulators for whitefly control, and transgenic Bt cotton, along with an IPM plan for whitefly management. More recently, state agencies began a PBW eradication in 2006. For the first time since the mid-1960's, AZ growers statewide did not spray at all for PBW! Bt cotton is grown on 98.25% of the acreage. And whiteflies have faded from memory as a severe and unmanageable pest. The credit we take for any part of this is shared with many, many others, but the result has been over $200M saved cumulatively since 1996.**








**So this is OUR meeting. Let's make the most of it!**