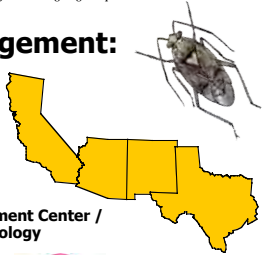



Open Forum - Management of the Sucking Bug Complex Across the Cotton Belt

Lygus Management: A Western Perspective



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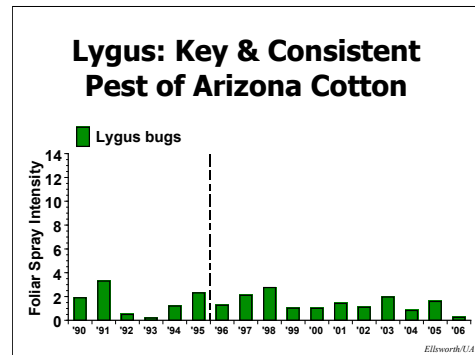


Ellsworth/UA

My comments are decidedly "Arizonan"; however, I will do my best to include comments and contributions from my Western colleagues, Drs. Pete Goodell (CA), Scott Bundy (NM), and Megha Parajulee (TX).

This presentation was invited by organizers of the Hemipteran Management Workshop as part of the 2008 Beltwide Cotton Conferences. The subject of this presentation is Lygus management in western cotton.

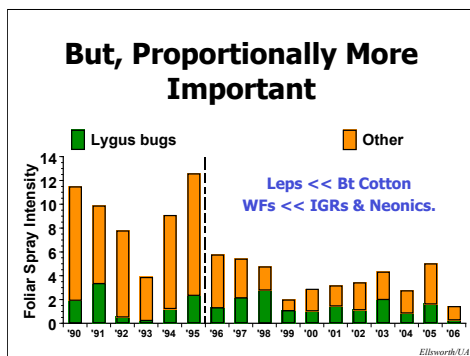
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There has been much talk about "the rise of the bugs" in cotton pest management across the cottonbelt. While that "talk" is justified, it is also clear that Lygus have been a fairly consistent target for Arizona cotton growers requiring, on average, about 1-2 sprays most years.

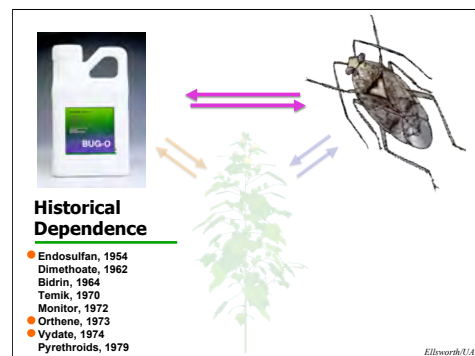
So Lygus are not new pests to Arizona cotton...

[Chart is of statewide average foliar spray intensity (no. of sprays) to control Lygus since 1990; derived from Ellsworth et al. 2007]



...But, they are now proportionally more important than they used to be. The reasons for this have been stated many times, and there are many. But principal among these for this pest shift has been the deployment of Bt cotton which essentially eliminates many concerns about Lepidopteran pests and the usage of Insect Growth Regulators and more selective neonicotinoids against whiteflies, both since 1996.

Importantly, we seem to have reached a new steady-state in foliar insecticide use, with 2006 representing the lowest foliar insecticide usage on record (since 1979). Interestingly, it looks like 2007 will shape up very similarly to the 2006 numbers where we sprayed less than 1.5 times for all arthropod pests.



For many years now, we have depended on a set of broad spectrum options. That is, compounds that are effective but are rather broad spectrum in their impact on the arthropods present in the system. These include acephate, methamidophos (which sees little use today), oxamyl, endosulfan, all in AZ, but also dimethoate, Temik, and Bidrin, throughout the South, and pyrethroids in other parts of the West. Until only very recently — nearly 30 years! — there have been no new chemistries developed with consistent control of the Lygus bug complex.

Opportunities: Great & Small

- No panacea, no silver bullet
- Regardless of technologies,
 - “The best thing you can put on your field is your shadow”
- Progress will be incremental, but progressive.



Ellsworth/UA

In thinking about what improvement that growers and consultants can make in Lygus management, it strikes me that there are significant opportunities, both “great” and “small”.

However, before we go further, I want to make sure I am clear. No matter what I or others present on this topic, there is no panacea or silver bullet in Lygus management, and regardless of the considerable technologies we bring forth, a truism still holds: “The best thing you can put on your field is your own shadow!”

In the end, progress will be incremental, slow at times, but very definitely progressive.

[Note: few are aware of St. Panacea, shown right.]

Abundance

- Movement
- Broad-Scale Features
 - Weather
 - Non-crop host availability
 - ✓ Host distributions
- Local management
 - ✓ Field specific

Great

Small



Ellsworth/UA

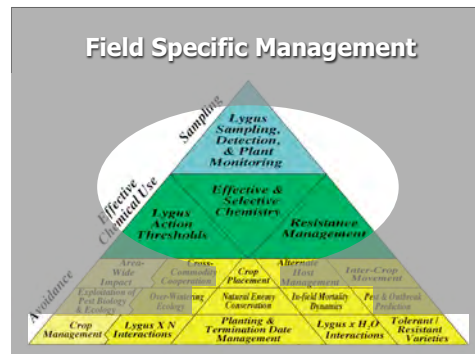
In thinking more about Lygus, indeed all insect pests, it becomes clear quite quickly that it is an issue of “Abundance”. And abundance is controlled by or a product of 3 major factors: Movement, Broad-Scale Features, and Local Management. Local management is field-specific, generally, but there are various broad-scale features of the system that are both within and beyond the control of pest managers. As I see it, however, there are at least two key areas, one Great and one Small (in scale), that represent major opportunities for improvement in our management system.

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.

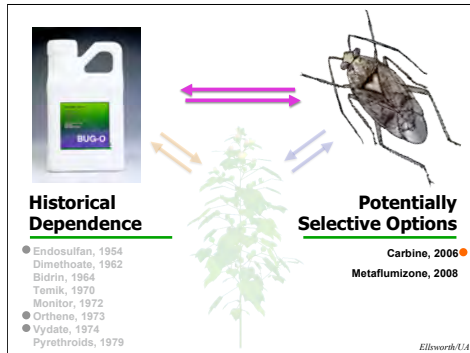
Field Specific Management



In examination of this IPM plan, we can readily identify many tactics that can be exploited in a field-specific manner, ranging from the well-known areas of sampling and effective chemical use, to various elements of “avoidance”.

With each grower practicing these things in a field-specific manner, we should see reductions in Lygus densities in target fields as well as population reductions locally and more broadly throughout an area.

For example, in AZ we have well-defined thresholds (15:4, or 15 total Lygus with 4 nymphs present per 100 sweeps) that, if followed, very effectively protects yields and maximizes profits to the grower.



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. These two compounds bring us new chemistry that so far have proven to be more selective than our traditional, broad spectrum options.

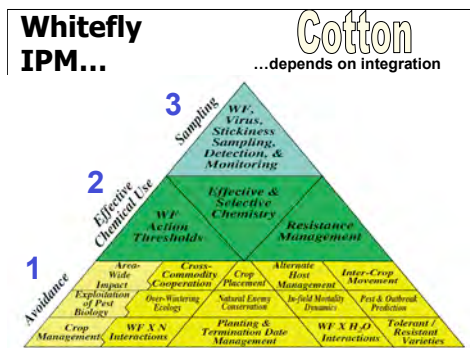
This not only gives us new "effective" options, but provides new opportunities to exploit the benefits of natural enemy conservation in our system.



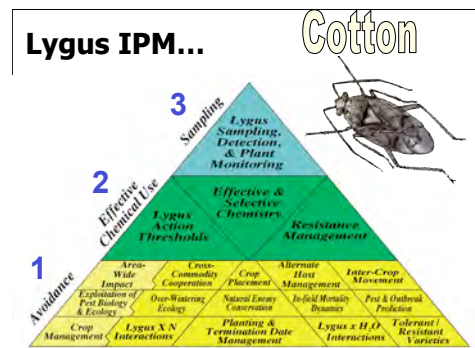
This leads us to some of the "Small" challenges we have now. That is, we need to identify what and how natural enemies are contributing to field-specific control of Lygus and other potential pests.

In addition, these new chemistries do not always behave like our older knock-down compounds. Many times they work more slowly or more subtly.

Powers of observation by our consultants will be tested and challenged to determine when or if bugs are dying in the field, and if they are feeding or causing damage.



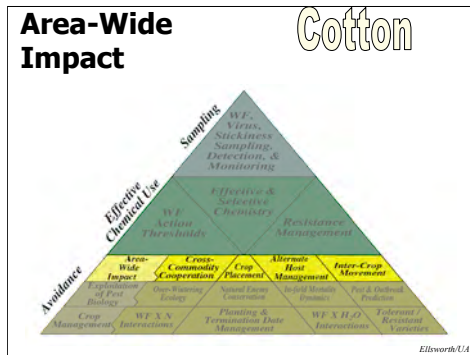
Any time we think about IPM in cotton in AZ, we have to remember the lessons learned during the severe whitefly episodes of the mid-1990's, where we learned that integration of the system was very important. We had to use and integrate ALL the tactics at our disposal; we had to also recognize that "IPM" is hardly integrated when solely focused on a single pest. One need only rotate this structure around...



...to see that a similarly constructed system of management is needed in support of Lygus control. This additional level of integration is required in developing sustainable IPM systems, but also in effectively communicating with growers, who, after all, must manage a whole suite of pest problems.

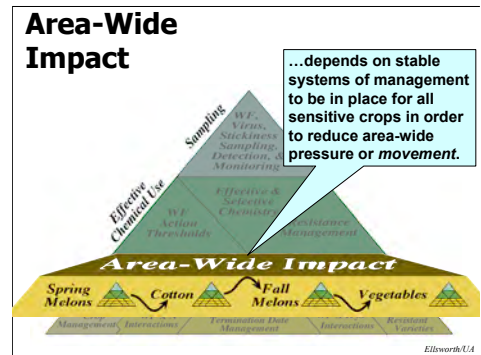
In this specific case, we learned that overly aggressive controls for Lygus often led to early onset of whitefly problems (largely through natural enemy destruction).

We learned something else in this multi-dimensional metaphor for IPM...



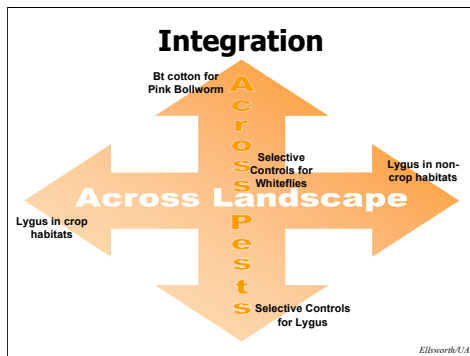
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...we learned just how important it is to consider this key layer of Avoidance that we call "Areawide Impact". Whiteflies, like Lygus, are polyphagous, mobile pests that can feed on literally hundreds of host plants. As such, this points to the critical need to sustain a cross-commodity dialog that considers intercrop pest movement and the tactical concerns of crop placement and alternate host management. Peering into this layer of management...



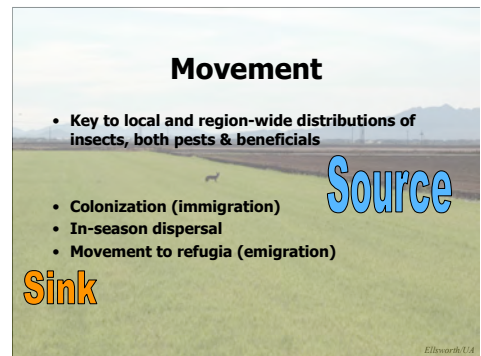
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...we can see that the "cotton" plan must consider the stable function and management of multiple crops within the system. "Integration" is explicitly part of our Arizona program, and whitefly management was utterly interdependent on stable functioning management systems in all sensitive crops. Cotton growers learned quickly that regardless of how good their "field specific" management program was, they could not stem the tide of these invaders that arrived from nearby fields of melons and other crops.



Ellsworth/UA

A few more comments about integration. Integration can be thought of in at least two dimensions. Consider that vertically, within a crop, we must integrate our management programs with advances in controlling all cotton pests; we strive to develop selective approaches like Bt cotton for pink bollworm control, selective IGRs for whitefly control, and ultimately selective controls for Lygus. At the same time, horizontally, Lygus in cotton are directly linked to Lygus across the entire landscape, in space and in time, from crop to non-crop habitats.



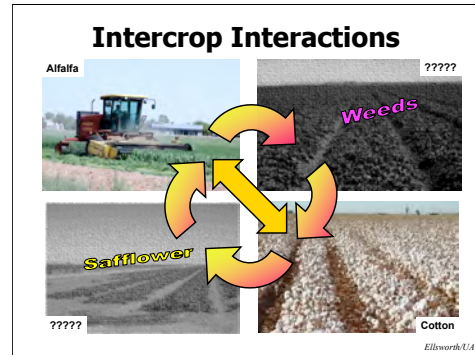
Ellsworth/UA

As I mentioned earlier, Movement is one of the 3 key elements of abundance. Most of our pest arthropods do not directly originate in our crop fields. They arrive from outside sources and colonize each year or season. And movement affects both local and region-wide distributions. Immigration from "sources" and "emigration" to habitat "sinks" represent another major area for us to consider improvements to our system.



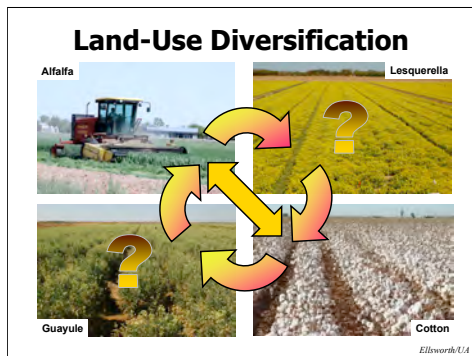
Distributions of sources and sink habitats throughout our system are the "Landscape Factors" that control distributions of pest insects very broadly from say the Farm-scale to Areawide.

So our "Great" opportunity for improvement of our management system transcends the individual field and asks us, "Can we learn enough about the distributions of hosts and capacity for movement of Lygus to exploit these landscape factors for our productive and economic benefit?"



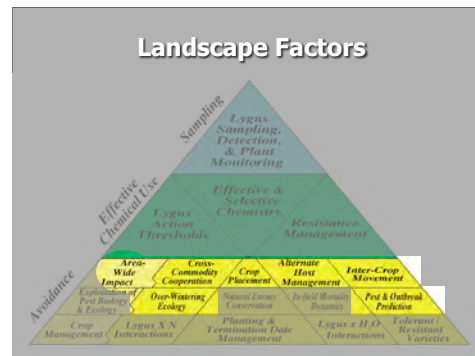
In fact, producers, practitioners, and scientists have been aware of and even, at times, exploited these intercrop interactions for decades. Some are very well-known. E.g., alfalfa grown for hay is alternately a source and a sink for Lygus depending on cutting status. Damage to or protection of cotton is completely dependent on the proximity of the source or sink. Other relationships have been noted in our desert ecosystem including winter weeds brought on by El Niño influenced winter moisture that host Lygus; or when contracts are strong, safflower is planted, and growers have long known that cotton immediately adjacent to this releasing source host is going to be damaged by Lygus.

These situations don't occur each year.



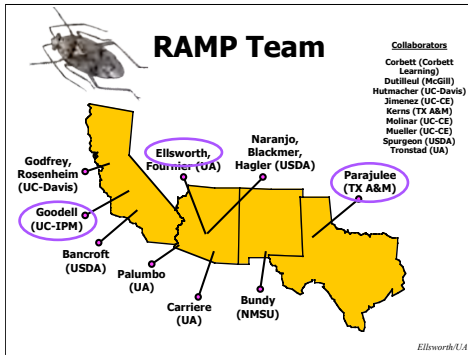
In fact, land-use diversification is leading to brand new relationships representing new risks as well as new opportunities. After all, we want producers growing money (and not necessarily just cotton) and as markets change, crop mix will change including at times the introduction of new crops like Lesquerella and Guayule, both of which host Lygus. However, the calculus that is used to determine what crops to grow in order to maximize farm profits rarely, if ever, consider how these structural and ecological changes create or mitigate risk of pest damage.

Guayule is commercialized and expanding; yet beyond knowing that they host Lygus, we have no prior understanding of when or even if guayule presents a risk as a source or an opportunity as a sink for Lygus. In essence, we need to get smarter!



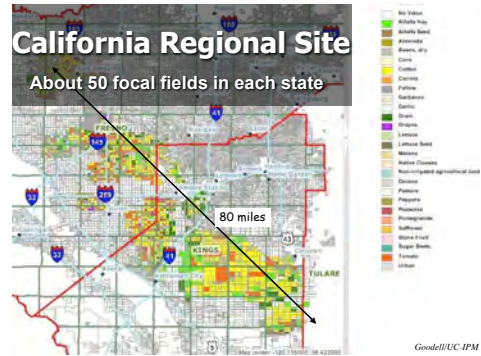
...and do our best to study and ultimately exploit these landscape factors that broadly control pest abundance in our system.

Recently, we secured a large, USDA Risk Avoidance and Mitigation Program grant and assembled a large team of scientists to work through the continuum of field-specific to landscape factors that might be used to manage Lygus more effectively across an array of crop systems throughout the West. Our goal is to replace or minimize the impact of the broadly toxic insecticides that growers of certain crops currently depend.



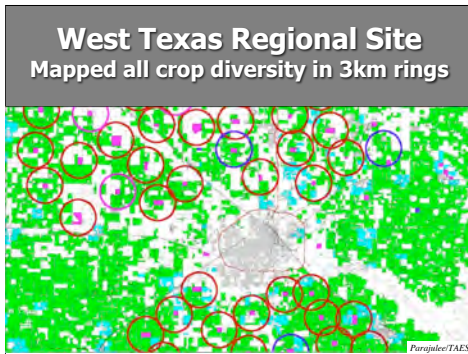
This is the project team for this large effort that spans four Western states. There are many individual projects that make-up our overall approach; however, for the balance of my talk, I wish to focus on one of the "Great" opportunities that I have alluded to several times.

I'll be covering study areas and information provided by Pete Goodell from CA, my group in AZ, and Megha Parajulee in TX. While we have only been at this one season and there are no conclusions to share at this point, I wanted to illustrate our approach and our rationale for an ecosystem approach that exploits the landscape factors that we have discussed so far.

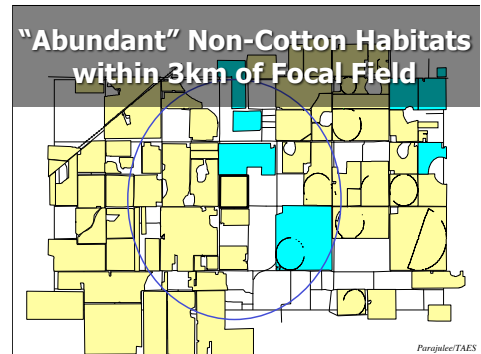


In each state, here the Central Valley of CA, we identified about 50 focal cotton fields. In each focal field, Lygus and other insect densities were measured weekly through much of the flowering period using a sweepnet. We collected 100 sweeps per field each week.

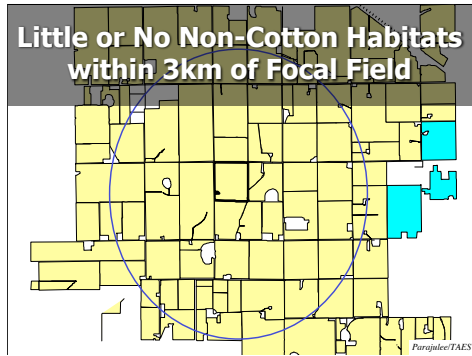
This part of California represents an area of great agricultural diversity but with low topographic diversity and very low diversity of natural habitats.



The 50 focal fields were selected in such a manner as to minimize the overlap of 3 km radiuses. This required the examination of a huge area in each state, over 1 million acres of land over the 3 state study areas. In each 3 km ring, all crop diversity was mapped with GIS tools, so that we know the specific arrangement of crops around each focal cotton field. In some cases, as in West TX, here around the Lubbock area, we (Megha's group) had to map marginal and roadside areas where there are large amounts of weedy habitats as well.



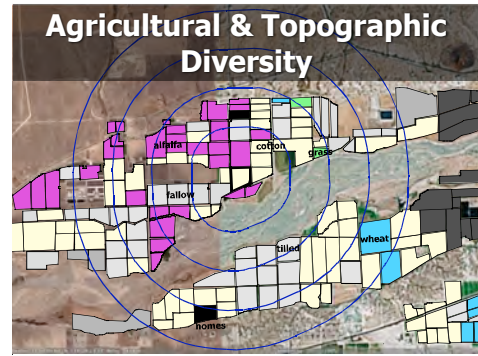
Megha provided an example one focal field of cotton in the center, where he noted "abundant" non-cotton habitat (in blue). I placed abundant in quotes because this is "abundant" only in a West Texas context of a sea of cotton (in light yellow). Nevertheless, this is a more "diverse" situation as opposed to the more common arrangement of W. TX crops...



...where there is little or no non-cotton habitat within 3 km of our focal field!

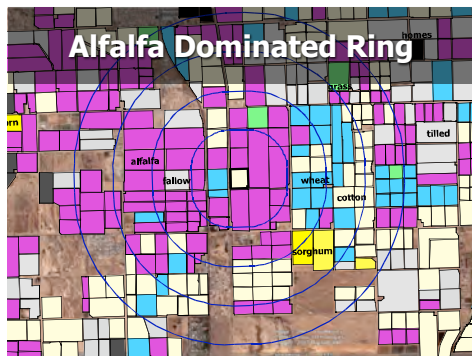
It is interesting to note here that historically W. TX cotton has not had large problems with Lygus in cotton.

In contrast, Arizona...



...is both agriculturally and topographically more diverse than W. Texas. First, we do actually have rivers, washes or arroyos even though they rarely have water in them! And, we have alfalfa (in purple) as a consistent element of our system. Here you can see cotton (light yellow), fallow and tilled ground (grays), wheat (light blue) and even homes and other buildings (black) all along a major wash area. Each ring or donut depicted here represents a 0.75km slice progressively out to 3km around the field.

By examining Lygus densities in the focal fields and relating this to densities of different habitats in each successive ring, we can geostatistically correlate the rise and fall of bug densities with specific arrangements of surrounding habitat. When the correlation is strong and significant, there is a relationship we might be able to exploit. 2007 FF#53

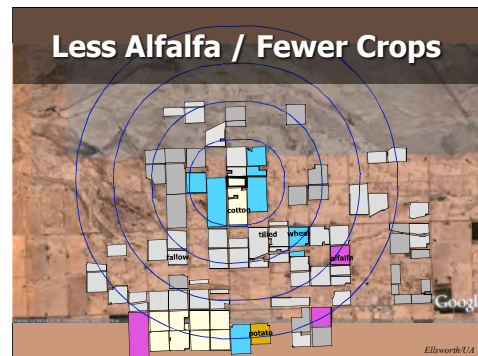


In this example, alfalfa dominates the landscape around the focal cotton field and throughout the 3km area.

Is this a situation that protects or harms cotton with respect to risk of Lygus colonization and damage there?

By examining the donut slices, we can estimate how far these relationships extend, whatever they are.

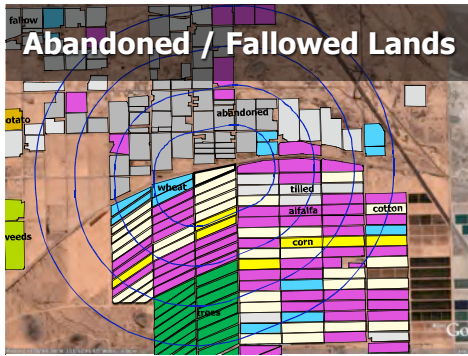
2007 FF#47



Here is an example with less alfalfa and just fewer crops overall. There is a lot of idle land here.

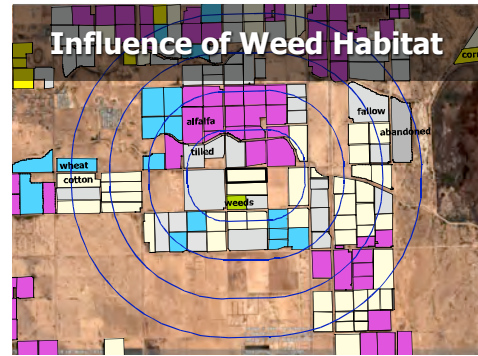
Is this a risky scenario?

2007 FF#06



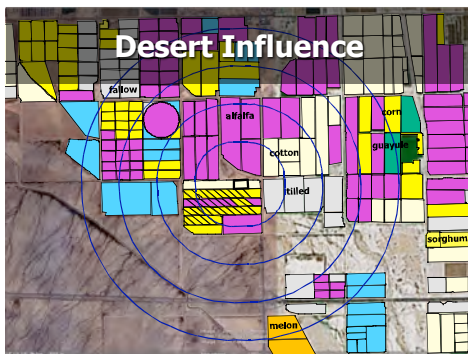
Here is another example where there is abandoned land that is slowly, very slowly reverting back to native desert, a process that takes decades.

2007 Focal field #05.



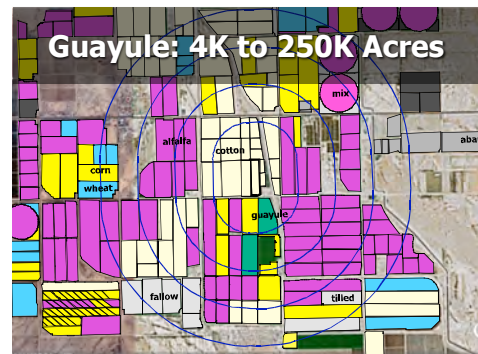
And while winter moisture was not abundant, we did have some areas where fallowed lands developed into significant summer weed habitat nearby our focal cotton field.

2007 FF#42



Of course the desert influence is of interest to us as well. In some years, winter rains can feed spring weeds and other blooming plants that paint the desert yellow, purple and gold. Lygus can thrive in years like this and depending on the period of dry down can funnel Lygus directly to cotton or more usually to some other bridging cultivated host like alfalfa.

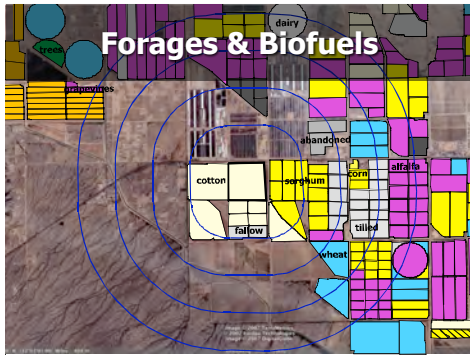
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I've not said anything about what guayule is or how it is grown; however, it is a commercial crop that is new to us and expanding with a projected western acreage of 250,000 A one day spanning W. TX to the SJV of CA. It is grown as a perennial and is a known reproductive host for Lygus, but currently grown on just 4,000 A in AZ.

Is it a source, a sink, or both depending on season? We just don't know at this point, but this example shows a focal cotton field adjacent to a 40A field of guayule.

2007FF#27



And one final example to underscore the watershed change to agriculture that even Arizona has not escaped. That is the impact of commodity prices and interest in biofuels. We have more demand by dairies and by biofuel refineries than at any other time in history. As a result we have more corn, sorghum and alfalfa than at any other time.

How will these land-use changes affect *Lygus* broad-scale dynamics?

We don't yet know. As an aside, I can say that we have not noticed the associations of *Lygus* with corn acreage as yet. Consultants have not observed *Lygus hesperus* in corn, though this association in the mid-South for *Lygus lineolaris* seems well-established.

Management for Areawide Impact

- Better field-scale management
 - Use of reduced-risk chemistry
 - Careful sampling & attention to detail
 - Better implementation of dynamic thresholds
 - Incorporation of benefits from Natural Enemies

- Farm- to Community-scale decisions
 - Better management of crop & non-crop sources
 - Crop Placement to lower community-wide risks of *Lygus* damage in all crops

Ellsworth/UA

To summarize, our challenge is to manage for areawide impact. By lowering the suitability of the ecosystem for sustaining economic populations of a pest, we can practice the ultimate in "avoidance". I come back to our basic formula where:

Pest Abundance is the product of local, field-scale management and broader scale factors. So there are opportunities to practice better field-scale management by deploying reduced-risk, more selective chemistries when needed and as determined by careful sampling and better implementation of dynamic thresholds and incorporation of NE benefits. These are our "Small" opportunities. Our farmscape decisions will some day be enhanced by new information that will enable better crop placement that lowers *Lygus* risks community-wide, our Great opportunity.



Thanks, too, to Yves Carriere and Christa Kirk (UA) who are instrumental to the mapping and analyses of the regional sampling data I covered and to the Arizona Cotton Research and Protection Council, Texas Boll Weevil Eradication Program that help supply maps for our analyses, and especially to the many growers, pest control advisors and others who have allowed us into their fields and provided pesticide records for this project.

The Arizona Pest Management Center (APMC) as part of its function maintains a website, the Arizona Crop Information Site (ACIS), which houses all crop production and protection information for our low desert crops, including a PDF version of this presentation for those interested in reviewing its content (<http://cals.arizona.edu/crops>).

Photo credit: J. Silvertooth