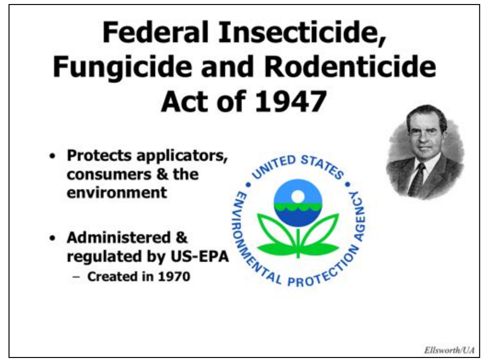
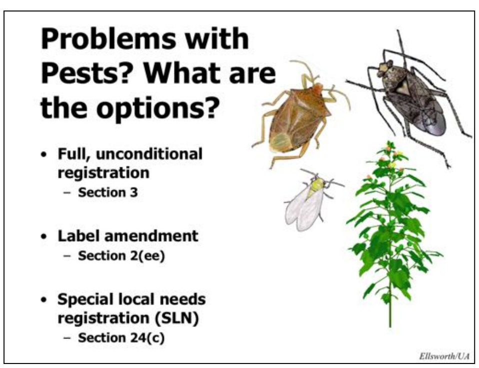
At the request of the organizers, I developed a presentation that addresses the recently submitted Section 18 request for exemption for Transform use in Arizona cotton. I have chosen to approach this topic by spending some time on the "laws and regs" of Section 18s and other registrations, as well as the specifics of the Transform submission. For some, this will be a review and a refresher for what Section 18s are and how they can be used to support growers' economic goals.

Invited presentation, AzCPA, Desert Ag Conference, Chandler, AZ; 50 min.; 1 CEU



The first question might be, "Why do we call these things Section 18s?" It's because it refers to a specific Section of federal law or code, in this case tracing its origins all the way back to FIFRA in 1947. This law was designed to protect people and the environment from pesticides. Nixon formed the US-EPA in 1970 which administers this law.

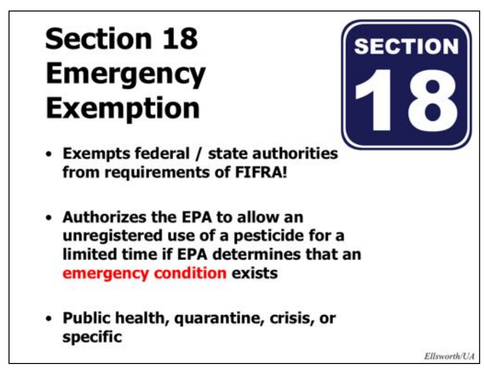


When a grower experiences a problem with a pest, they have these 3 options under FIFRA.

A Section 3 is a so-called "full" or regular label for use throughout the U.S..

A 2(ee) is generally an amendment that allows the registrant to add a new pest to the label.

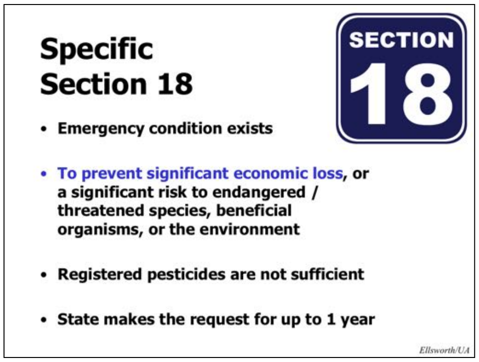
If neither is available for your pest situation, there are other options. A 24(c) is a special registration that permits the use of a pesticide for a crop or site to address some special local need that is not addressed by any other label. This is a powerful option that is governed and issued by State Lead Agencies responsible for pesticide regulation, in our case ADA. Anyone can request a 24(c), but there are specific standards and data required for their support.



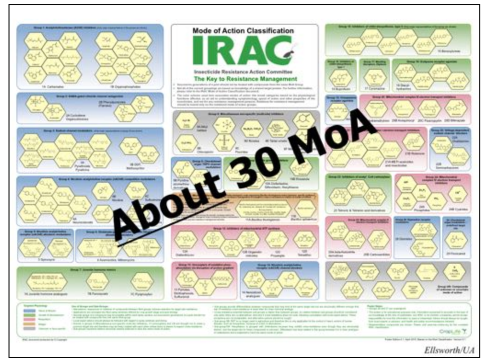
An SLN or 24(c) is possible only if there is an existing Section 3 for the pesticide of interest elsewhere (i.e., like on another crop), and only if there is an existing tolerance for the new, target site, assuming there is a food or feed use.

If this relief is not available, Section 18 Emergency Exemptions are possible. They come in different "flavors", too, the most common being "specific" Section 18s.

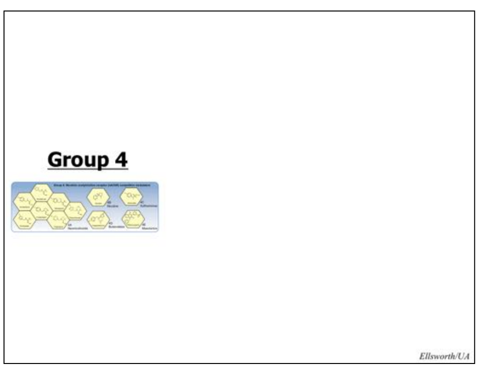
The beauty of this section of code is that it effectively releases the Feds and the State from the normal set of requirements of FIFRA! This is amazingly powerful and permits the agencies to exercise discretion in permitting the use of pesticides when they are absolutely needed. But there are rules.



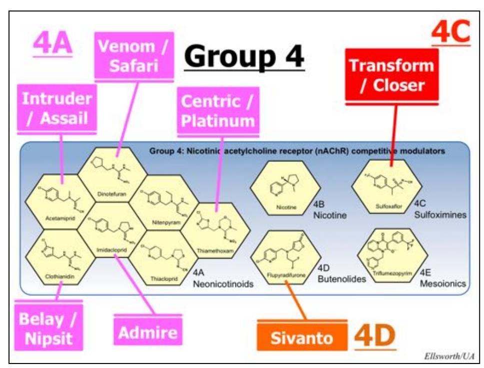
For a Specific Section 18, you must demonstrate these facts, the most important of which is showing that the emergency condition is likely to lead to significant economic loss (SEL) and that this pesticide is needed to avert that SEL. We will be saying a lot more about SEL later in this presentation.



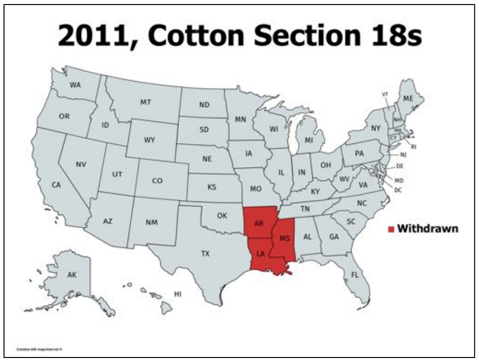
Before we go into SEL, let's spend some time identifying just where Transform (sulfoxaflor) fits among the 30 modes of action (MoA) that have been developed for use worldwide for the control of insects and other arthropods. The many thousands of products we use each day on this planet all trace their root activities to just these 30 MoA. This scheme of classification is maintained by an international organization called Insecticide Resistance Action Committee (IRAC) with scientific membership representing most of the world's registrant companies.



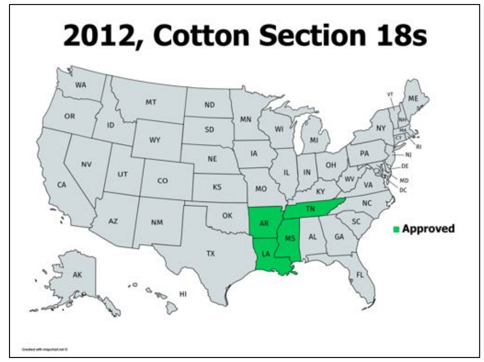
Sulfoxaflor is classified as Group 4, a group of chemistry of major importance in insect control.



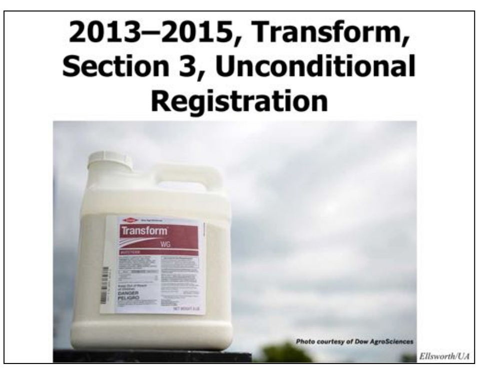
Within Group 4, there are the neonicotinoids (magenta), the butenolides (orange) and the sulfoxamines (red). Transform is in subgroup 4C and for the moment enables control of insects without cross-resistance to the other subgroups in Group 4. This is one reason why it sits in its own subgroup.



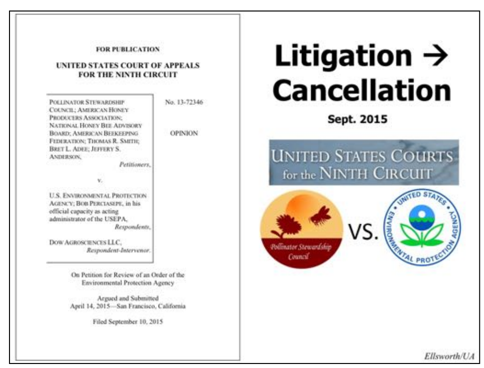
The first Section 18 was drafted for Transform in 2011. However, as sometimes happens, that draft never advanced to a decision at EPA and was instead withdrawn from review (probably at EPA's request or because the states recognized that they did not have enough data to support the request).



A year later, 4 states applied for and were granted Section 18s for Transform use in cotton. Mississippi was the lead in that year and the others referenced heavily the application by MS. EPA encourages this sort of regionalization and cooperation among states.



Then in 2013, Transform got a Section 3 label, making the Section 18s unnecessary. This continued through 2015.


FOR PUBLICATION

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

POLLINATOR STEWARDSHIP COUNCIL; AMERICAN HONEY PRODUCERS ASSOCIATION; NATIONAL HONEY BEE ADVISORY BOARD; AMERICAN BEEKEEPING FEDERATION; THOMAS R. SMITH; BRET L. ADEE; JEFFERY S. ANDERSON,
Petitioners,

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY; BOB PERCIASEPE, in his official capacity as acting administrator of the USEPA,
Respondents,

DOW AGROSCIENCES LLC,
Respondent-Intervenor.

No. 13-72346

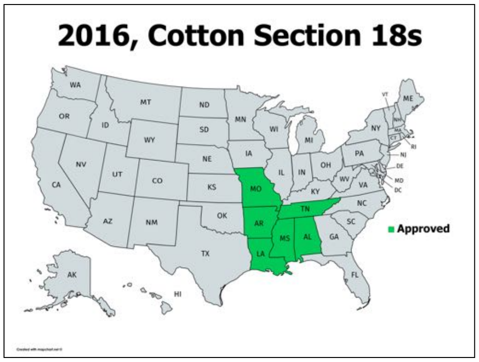
OPINION

On Petition for Review of an Order of the Environmental Protection Agency

Argued and Submitted
April 14, 2015—San Francisco, California

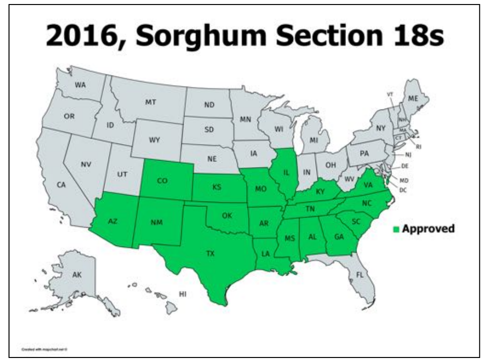
Filed September 10, 2015

Late in 2015, a lawsuit was litigated in the 9th Circuit that ultimately led to the court order to EPA to cancel all unconditional uses of sulfoxaflor, including Transform in cotton.



In 2016, MS dusted off their 2012 Section 18 and asked for a renewal, which was granted. Interestingly, two more states joined in this action by once again referencing heavily the MS package.

EPA does encourage this sort of regionalization where and when it makes sense to do so.



As an aside, and throughout this similar period, Section 18s were developed and granted for combating the invasive sugarcane aphid in sorghum, which first invaded Arizona's borders in 2016. In a remarkable turnaround time that year, EPA approved AZ's request in less than 2 weeks in large measure because we were able to reference NM's package and all the previous requests for this same use pattern.


Ninth Circuit Invalidates US EPA's Unconditional Registration of Sulfoxaflor Insecticide as the Agency Also Faces Other Challenges to Its Pollinator Protection Efforts

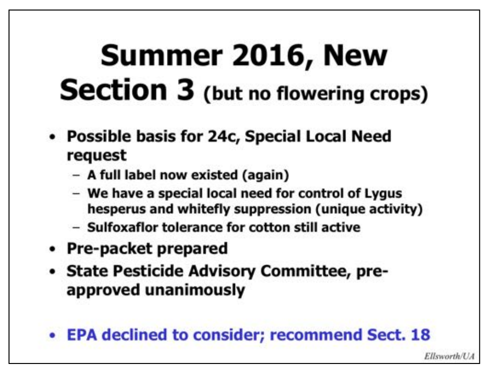
By Reed Sirak and Steve Owens on September 28, 2015

On September 10, 2015, in *Pollinator Stewardship Council et al. v. EPA*, the Ninth Circuit Court of Appeals invalidated US EPA's unconditional registration of the insecticide sulfoxaflor, concluding that the scientific data relied upon by the agency regarding the product's potential impact on honey bees did not support approval of the insecticide.

Ellsworth/UA

While the litigation cancelled all <u>unconditional</u> registrations for sulfoxaflor and carried with it some conditions on EPA for moving forward with new Section 3's for this compound, Section 18s are permitted because they are exemptions from registration allowed under FIFRA; i.e., they are not technically registrations of products but exemptions that permit their use, a fine but very important distinction. They also have stringent requirements for their use (when, where, and how much) and in development of the request.

Importantly, while a Section 3 is at the request (and expense) of the company, and a 24c can be requested by any potential user group, a Section 18 can only be requested by the State. Registrants are prohibited from requesting or inducing others to request a Section 18.



In 2016, Dow was successful in requesting a new Section 3 registration for many sulfoxaflor uses in agriculture. However, the label effectively excluded many flowering crops (like cotton) and had additional use requirements.

This change in status, a full federal Section 3 label for sulfoxaflor, now enabled discussions about and a basis for 24c requests. We certainly could demonstrate a special local need for Arizona cotton and fortunately the residue tolerances for cotton were still active and in force, having never been cancelled by EPA. While locally we developed a pre-packet with preliminary approvals by the State — remember 24c's are under the State's authority — EPA declined to consider the 24c from Arizona and recommended that we develop a Section 18. Why?

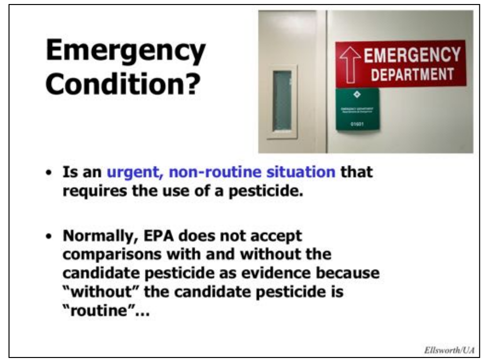

Ninth Circuit Invalidates US EPA's Unconditional Registration of Sulfoxaflor Insecticide as the Agency Also Faces Other Challenges to Its Pollinator Protection Efforts

By Reed Sirak and Steve Owens on September 28, 2015

On September 10, 2015, in *Pollinator Stewardship Council et al. v. EPA*, the Ninth Circuit Court of Appeals invalidated US EPA's unconditional registration of the insecticide sulfoxaflor, concluding that the scientific data relied upon by the agency regarding the product's potential impact on honey bees did not support approval of the insecticide.

Ellsworth/UA

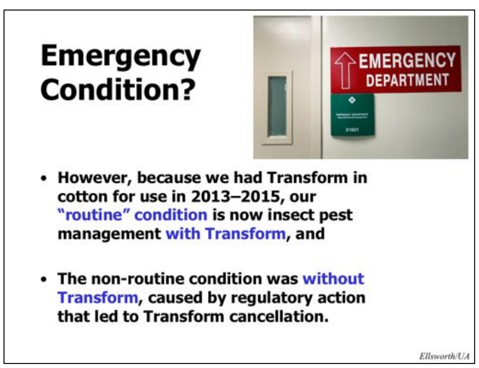
Sadly, fear of litigation is a very real and sometimes palpable element in our society and EPA is not immune from litigation. Their position was that a 24c is in fact a "registration" and they did not wish to challenge the court's authority over their cancellation decision. Instead, they advocate for the Section 18 remedies because these, in fact, are not registrations but exemptions from registration. Remember the genius of FIFRA is that Section 18 exempts the State and Feds from a wide array of requirements in FIFRA. And this is sensible, because there are emergency conditions that should be favored by actions taken by EPA to support controls needed to avert these emergencies.



So what is an emergency condition?

Defining what is "urgent and non-routine" is important here. Many applications for Section 18s for products never used in the marketplace before (i.e., in that local state) make the mistake of trying to compare their control system both with and without the candidate pesticide. However, in these situations, the use of the candidate pesticide has nothing to do with the emergency condition, the non-routine or routine condition!

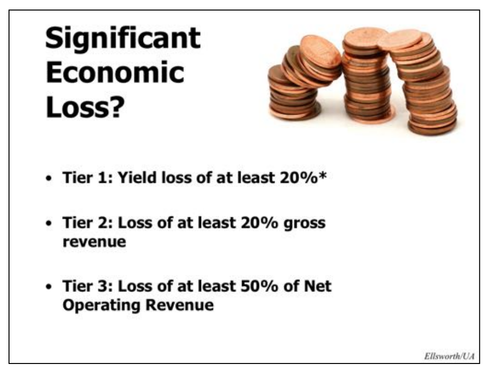
Presumably the urgent, non-routine conditions are the ones currently being experienced <u>without</u> the use of the candidate pesticide. Transform was different, however.



Transform had in fact been successfully integrated into our cotton IPM system and used in 2013–2015. Thus, in this particular case, our "routine" condition was a system of management that included Transform use.

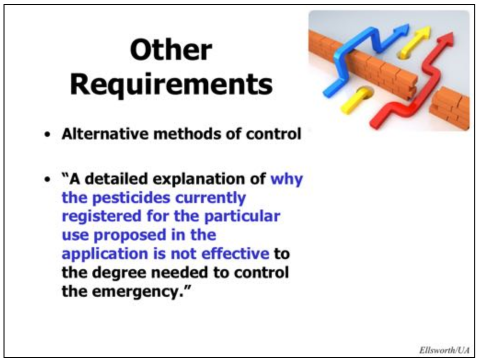
Our non-routine condition was without Transform availability in cotton.

This greatly simplifies our task; however, there is still the hurdle to identify what the significant economic losses are to our industry.



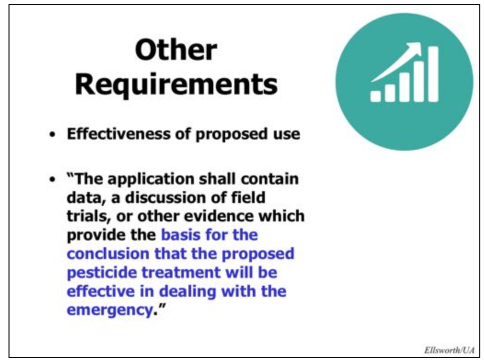
Turns out, SEL was not universally understood or defined in the Section 18 code. Years ago, the issue of demonstration of SELs was handled more qualitatively. "You know one when you see one" sort of solution. This actually worked fine many times. But there were times when stakeholders failed to be convincing and EPA wrote rules to better support the application process. In theory, they should still have some discretion, but now there are concrete metrics that need to be used to demonstrate SELs.

These break out as so called Tier 1, Tier 2 and Tier 3 thresholds for an economic analysis. Satisfy any one of these, and the State has demonstrated the potential for SEL.

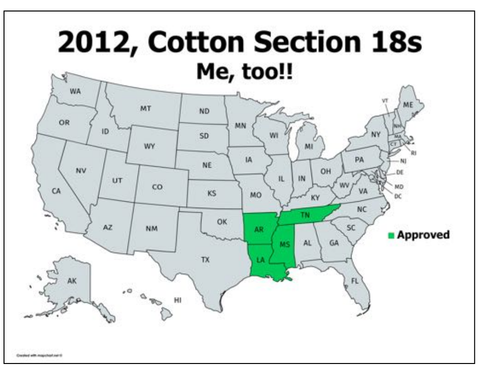


There are, of course, many other requirements in putting together a Section 18 request, some quite significant.

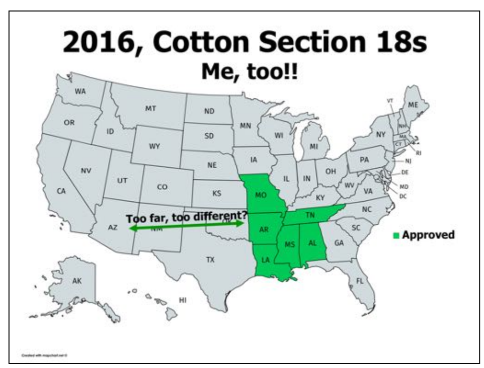
Why don't alternatives work just fine without the proposed use? Why can't other pesticides fill the gap identified?



And, can the missing pesticide actually do what it is purported to do? Can it deal with the emergency you have defined?



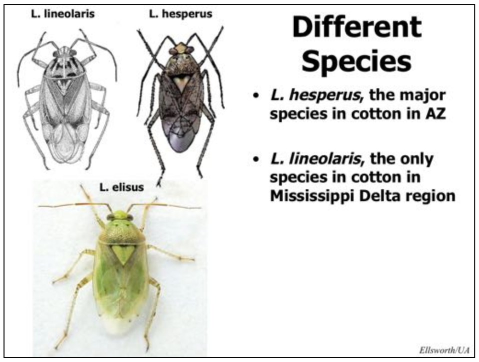
Let's look back again at the Section 18s for Transform in cotton. The 2012 state approvals looked like this.



The 2016 state approvals grew by 2 states, largely on the backs of the original request by MS. In essence MO & AL were "given" approval because they were experiencing the same set of conditions that the rest of that region was experiencing.

However, extending that rationale across a large region into a very different environment and context, one has to ask are we too far and too different from the Delta region of Mississippi to ask for a "me, too!"?

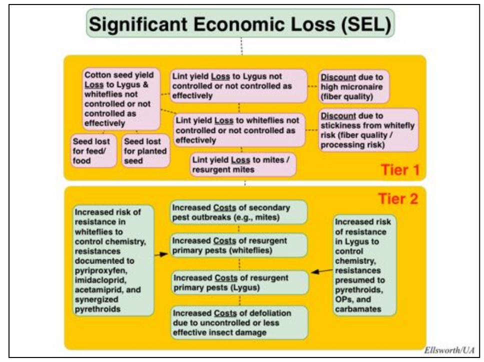
We do have elements in common. These are both cotton requests and they are both referencing a Lygus species.



However, we are actually targeting different species of Lygus between here in AZ and the Delta region of the South. Arizona has, in fact, 3 species of Lygus, pictured here. L. lineolaris can even be taken with some regularity in alfalfa. However, it is almost never found in cotton. L. hesperus dominates in our cotton system.

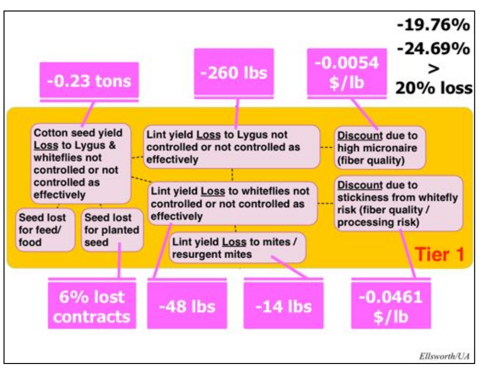
This difference could be important in the extension of any Section 18 rationale from MS to AZ. I.e., we believed that, and EPA confirmed, we were not eligible for a "streamlined" review, meaning we had to build our case from scratch. This was not only because of the differences between regions but also because we had never had a Section 18 for this use pattern. We were not seeking a renewal.

L. elisus photo, Copyright © 2006 Sean McCann



Moving to the specifics of our Section 18 request, I had to really think about EPAs requirements for demonstration of SEL. On the surface, one might think it's just what we lose to Lygus if we don't have Transform in our system. And, that certainly is central to the analysis. But there are many ways that Transform supports our management system, and therefore, there are many ways we experience economic loss without its availability.

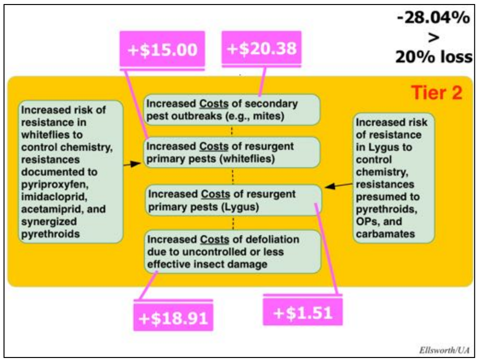
Largely for my own use in organizing my thoughts, I came up with this set of elements that contribute to the Tier 1 assessment and the Tier 2 assessment. The goal was to capture as many of the sources of economic loss as possible and create a "bullet-proof" rationale and application.



If numbers are not your thing, it is fine to gloss over this portion of my presentation. However, I put it here as an example of the many ways that a system can be impacted through changes in the availability of a control agent, in this case Transform. It also should give you a sense of all the data that needs to be amassed in order to be compelling. We'll cover more on <u>where</u> does all this data come from.

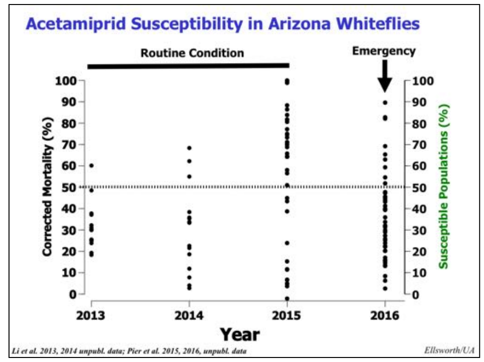
Looking at what we might lose just to Lygus as a result of not having Transform, we estimated a loss of 260 lbs or about 15%. However, we also lose small amounts to whitefly and to mites. The total value of these yield losses to these 3 pests is 19.76%, short of the Tier 1 standard of 20%. But looking deeper at not just our losses in lint yield but seedcotton yield and in seed contracts, we reach and exceed the Tier 1 standard.

For the younger members of our industry, they may not have ever experienced or even heard of "sticky" cotton, the phenomenon where honeydew excreta from whiteflies falls onto and contaminates exposed lint, which then disrupts the processing chain and causes major losses to mills. The last "stickiness" episode we experienced in AZ was more than 20 years ago! Kudos to everyone in our industry who makes sure our cotton is clean. So, why do we estimate losses associated with stickiness? Because the problem is not far from home. Recent reports in the ag press document a 2-yr period in California where stickness has become a real issue for them. Should we lose control of whiteflies because of a reduction in control measures (like Transform suppression of whiteflies), we are putting our industry at risk of a return of a stickiness episode.

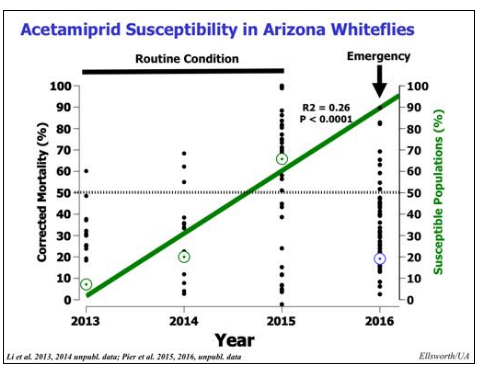


The goal is to have a successful application. These applications are data intensive and take much time to assemble. There is also a potentially lengthy review time by EPA. One wishes to minimize the chance that EPA will come back with questions that slow response time or worse with a denial. So even though a justification was developed for Tier 1 SEL, we continued our analyses into Tier 2, just in case any element was called into question.

And there are additional costs of management that growers face when their tools are constrained. These are accounted for in the Tier 2 analysis. Some are quite small, because our industry is very good at responding to many pest challenges. But cumulatively, this places our numbers well above the Tier 1 and Tier 2 thresholds of 20%.



Losses to resistance, per se, were not estimated, so much as captured by the additional costs of control that would be necessary if resistance were to erode the efficacy of our chemical arsenal. I.e., we might have to spray more if resistances were to worsen as a result of not having Transform in our system. How can we estimate this? What is the basis for believing that resistances are present and worsening without Transform? This chart shows whitefly populations (dots) collected from the field and tested/challenged by acetamiprid (Intruder/Assail) in the laboratory. High mortality means very good susceptibility. Low mortality equates to low susceptibility or resistance. Experience with this specific assay tells us that populations responding below 50% are almost definitely resistant to acetamiprid. Transform was used 2013–2015, but not in 2016.



Looking at the proportion of AZ whitefly populations that are resistant to acetamiprid over time, we notice a striking pattern. During the "routine" condition when we had access to and used Transform in cotton, populations became progressively more susceptible to acetamiprid. That's a good thing! Why precisely it happened this way, we don't know for sure. But Transform is a new MoA and even when deployed for the control of Lygus, it is supplying some amount of suppression of whiteflies. In contrast, however, in 2016, the emergency condition without access to Transform, we experience a major reduction in susceptibility to acetamiprid! This supports our hypothesis that Transform is contributing to our overall resistance management of whiteflies and helping us avoid outbreak conditions.

Data Sources:
Cotton Pest Losses

Year	Comment	Tier
1990–2015	Trend analysis showing our selective IPM plan; Number of sprays	1
2005	Last high insect pressure year (whiteflies) & last year without Carbine; % losses to whiteflies	1
2006–2015	Years with availability of Carbine for Lygus control	1
2006–2016	Average costs of secondary pest control	2
2011	Non-routine year; Upper estimate of % losses due to mites	1
2012–2013, 2016	Non-routine years; Increased usage of broad spectrum insecticides; Number of sprays against secondary pests	2
2014–2015	Routine years; Costs of secondary pest control, % loss to Lygus, to whiteflies, to mites; % infested acres	1–2
2016	Non-routine year; Average costs of applications, Lygus control, mite control; Yield without insects; % losses on infested acres (Lygus / WF)	1–2

Ellsworth/UA

There is not enough time here to review all the different pieces of information or the data presented to EPA in this packet. However, I want to summarize for you all the types of information that were used and briefly mention where that data comes from so that you can understand the wide array of tools and resources that are used on behalf of your industry.

We conduct Cotton Pest Losses & Impact Assessment surveys with participating PCAs around the state each year. These are difficult, complicated and time-consuming surveys to take and workshops to attend. But the data are incredibly valuable as you can see by all the years and places in the SEL analysis where they are used. Because of our systematized way of collecting and scrutinizing these data each year, we can form powerful arguments with EPA and others about your pest management system.

Data Sources: Field Studies

Year	Comment	Tier
1999–2001	Effects of Lygus damage on micronaire & cotton quality	1
2008–2014	Lygus efficacy of Transform, Carbine, Diamond, Belay, Orthene, Vydate, pyrethroids, and non-Transform rotations	1
2008–2010	Whitefly efficacy of Transform, Knack, Courier, Intruder, Oberon, Venom	1
2009, 2011	Non-target effects of Transform and other insecticides	1–2
2013–2016	Whitefly resistance to Intruder, Knack and Danitol+Orthene (X. Li et al. 2013–2014; Pier et al. 2015–2016)	1–2
2015	Cost of resurgent whitefly control (L. Brown, MS thesis)	2

Ellsworth/UA

Section 18s are typically not feasible without local research, the type of which is supported by your industry (Cotton Incorporated, Arizona Cotton Growers Association, and technology providers and interests). Most of these are field studies conducted by my laboratory and were integral to making the case to EPA on a variety of issues important to the SEL analysis.

Data Sources: Other Studies

Year	Comment	Tier
1992–1999	Potential discount due to "stickiness" (Ellsworth et al. 1999)	1
1996–2016	Estimates of use of Lygus chemical controls from APMC Pesticide Use Database, (Ellsworth, Fournier & Dixon, unpubl. data)	1
2010	Published APMC comment to US-EPA docket for Transform on its efficacy & safety in AZ (EPP-HQ-OPP-2010-0889; Ellsworth et al. 2010)	1
2015	Estimates of micronaire discounts for AZ upland cotton (AMS, 2016)	1
2016	Media report of current and 2017 upland cotton prices, Dr. O.A. Cleveland, Ag Economist	1

Ellsworth/UA

We also rely on published studies and published and unpublished data and reports to support information provided to EPA.

Notably, we made use of the Arizona Pest Management Center Pesticide Use Database, which itself is derived from 1080 reports made by your industry to the State.

We also refer to public comments developed by the APMC in association with the Western IPM Center and submitted to public dockets at EPA.

Data Sources: Expert Opinion / Your Industry!

- Market price for cotton seed in AZ ($/ton)
- Market price for planted seed contracts ($/ton)
  - % acres contracted for planted seed
  - Estimates of contract rejection rates due to insect damage
- Estimates of fiber quality discounts
- Defoliation & application costs

Special thanks to: Cheryl Goar (AzCPA)
Paco Ollerton (ACGA)
Dr. Randy Norton (UA)
Russell Noon (UA-MAC)

Ellsworth/UA

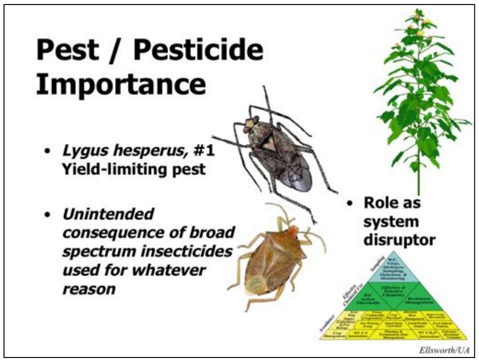
Some things are confidential business information or other proprietary knowledge that is not available from public sources. Other information can really only be supplied by experts. Your industry leaders are crucial to the development of this type of information and they deserve special thanks for their role.

Please Thank These People

- Jack Peterson (ADA)
- Your contacts at Dow AgroSciences
  - But especially Brian Bret (State Regulatory Manager) & Jamey Thomas (US Regulatory Manager)
- Andy Hancock & Cheryl Goar (and their staff), Arizona Crop Protection Association
- Ken Narramore, Verde Ag Service & grower
- Kevin Rogers, Arizona Farm Bureau (& Ana Kennedy)
- Paco Ollerton, Arizona Cotton Growers Assoc.
- ALL PCAs who contribute their time and data annually to the Cotton Pest Losses surveys!

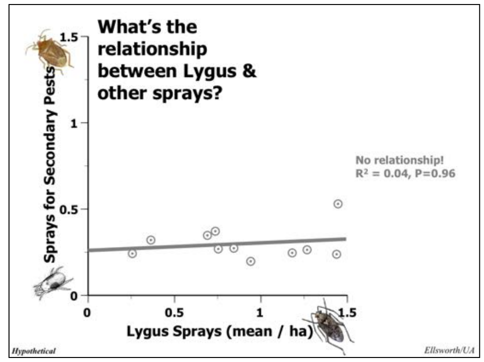
Ellsworth/UA

In addition, there are key people in your industry that directly support the Section 18 submission process including the many letters of support included. Do thank these folks if you encounter them. Their contributions are very important! And, thank all the PCAs that contribute time and their data to the Cotton Pest Losses survey process; and encourage others to participate in the future.



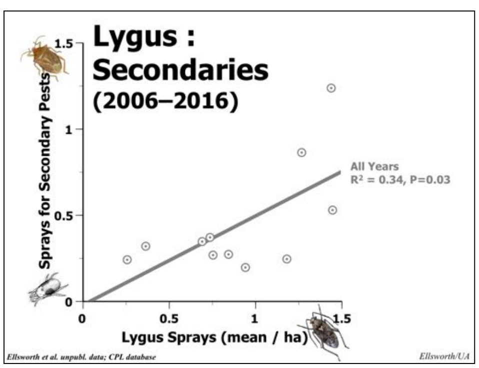
The balance of this presentation will be a broad survey of our cotton IPM system and the role that Transform plays in it along side other very important technologies and information.

Without question, because we collect these data, Lygus hesperus is our #1 yield-limiting pest in Arizona cotton. The pesticides used to control Lygus are therefore important to its control as well as to the array of effects they might have in our system. Anything that pushes us towards the use of more broad spectrum insecticides is likely to contribute to a destabilization that is costly to our growers.



If one follows the recommendations of the Cotton IPM program <u>and</u> believes that selectivity and safety of technology for beneficials is key to its sustainable success, then there should be no relationship between the spraying of Lygus and the spraying of secondary pests like mites and stink bugs, and others. I.e., selective spray practices for Lygus control, first enabled in 2006, should decouple Lygus control practices from any consequential sprays for secondary pests, because natural enemies are conserved.

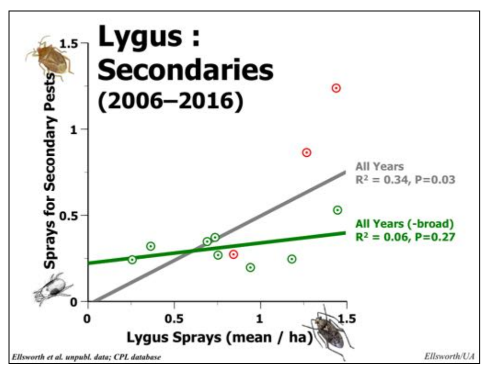
One would expect a lack of relationship as depicted here hypothetically. No matter how much you spray for Lygus, sprays for other things don't change… but



Here is a plot of Lygus sprays against secondary pest sprays for the years 2006–2016, a period when flonicamid (and sulfoxaflor, at times) were available for selective control of Lygus. What happened?!

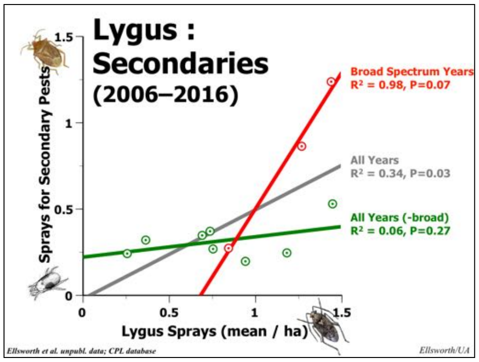
There is a significant, statistical relationship! How could that be? Does this invalidate our approach, our recommendation to use selective materials to control our target pests? Did we get this wrong?

This outcome bothered me enough that I began to look into these data more carefully. Note, these data are from the Cotton Pest Losses database, data that is sourced directly from pest manager reports of their own practices each year.



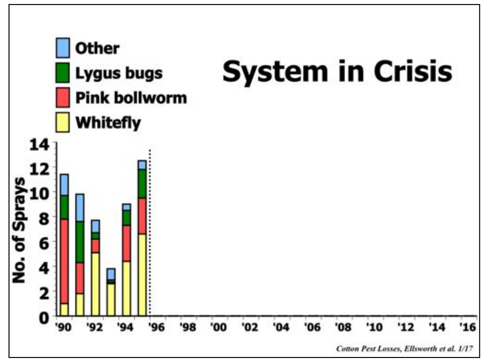
When we re-examine these data and exclude those years when significant broad spectrum insecticide use was occurring, the relationship changes! Excluding 3 years, the red points (2012, 2013 and 2016), the relationship between Lygus sprays and secondary pest sprays goes away. This means that in fact there is no relationship between Lygus sprays and other sprays, <u>when we are using selective chemistry for Lygus control</u>.

2012 and 2016 were both years when sulfoxaflor was not available and broad spectrum insecticide use increased. 2013, Transform was just introduced and not fully integrated into the plan, <u>and</u> acephate use spiked for Lygus and stink bug control. These usages and their impact on our occurrence of secondary pests is even more dramatic, when one considers…



…that the relationship between Lygus sprays and secondary pest sprays is exceptionally strong for the 3 "broad spectrum years". This tells us that broad spectrum chemistry in our system carries with it major consequences for secondary pest management. It re-enforces our guidelines to refrain from broad spectrum insecticide use whenever possible.

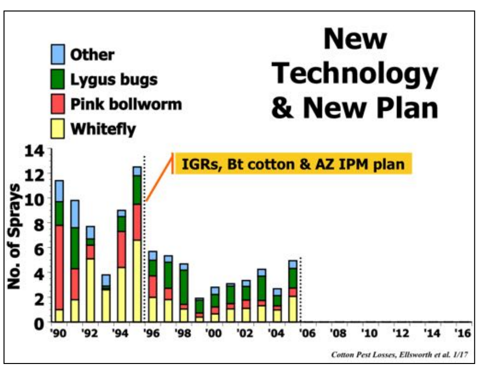
Transform usage in 2014–2015 likely prevented a statewide average reduction in the sprays of other pests by 0.61 sprays. Growers, who average 3.5 sprays to control Lygus without Transform would be spraying <u>an additional 4.4 times to control secondary pests</u>. An additional 0.61 sprays, on average, for other secondary pests would have been needed in 2014–2015, but for the availability and use of Transform at that time — a 57% increase in sprays avoided, equivalent to $50.34 / ha (20.38/a).



Our Cotton Pest Losses data on number of sprays used to control our key and other pests tells a powerful story that I share regularly with audiences.

The early 1990s was reeling after a historic PBW outbreak and the introduction of a new invasive whitefly species. This was a system in crisis and entirely dependent on broad-spectrum insecticides, because that was all that was available.

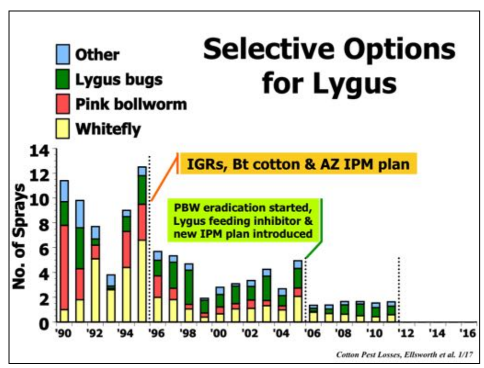
Adapted from Naranjo & Ellsworth 2009, & Ellsworth, unpubl.



New technologies and a new IPM plan began in 1996.

We gained insect growth regulators (IGRs) for whitefly management, Bt cotton for lepidopteran control, and developed a new Arizona IPM Plan. These advances in "selective" technologies and approaches to insect pest management were based on our need to better manage and conserve the natural controls in our system, such as predators of whiteflies and secondary pests.

Adapted from Naranjo & Ellsworth 2009, & Ellsworth, unpubl.

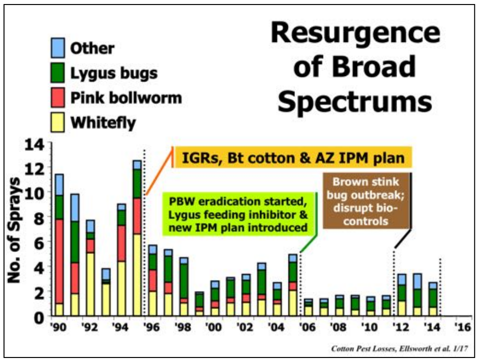


Progressive improvements to the system continued…

In 2006, we saw deployment of a selective Lygus feeding inhibitor [flonicamid (Carbine)] and the cotton industry banded together to develop a major pink bollworm eradication campaign.

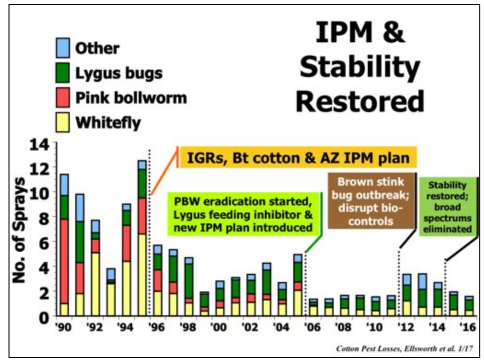
Under this new IPM plan, growers and pest managers throughout the state saw a continued lowering in the need for foliar insecticides for all insect pests, halving it once again relative to the previous period.

Adapted from Naranjo & Ellsworth 2009, & Ellsworth, unpubl.



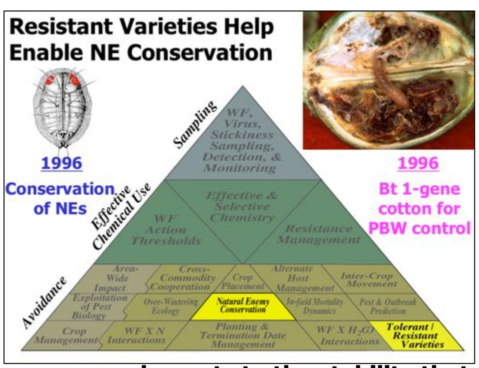
Set-backs occur, too! An outbreak of a native pest that hadn't been seen in damaging numbers since 1963. The brown stink bug brought with it efforts to control it with broad spectrum chemistry.

In 2012, we see an increase in the use of broad spectrum insecticides in response to elevated populations of BSB. In many areas, the use of broad spectrum insecticides disrupted biological control and led to resurgences of whiteflies and outbreaks of mites.



By 2014–2015, most growers were abandoning efforts to chemically control brown stink bugs. Our research was showing that most chemistries did nothing at all and even the best ones were not efficiently killing brown stink bugs in a large degree. It also showed that these broad spectrum chemistries were creating conditions for primary pest resurgences (Lygus and whiteflies) and secondary pest outbreaks (mites and others).

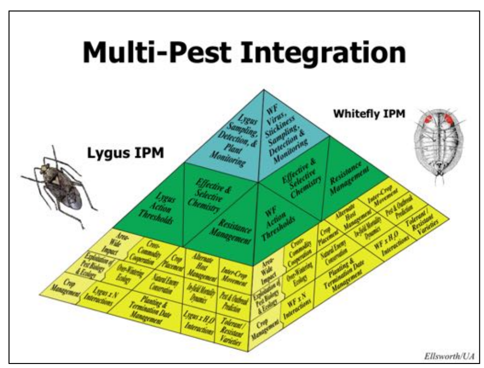
With the return to little to no use of broad spectrum insecticides, stability returned to our system.



There are many elements to the stability that we now enjoy in the Cotton IPM system.

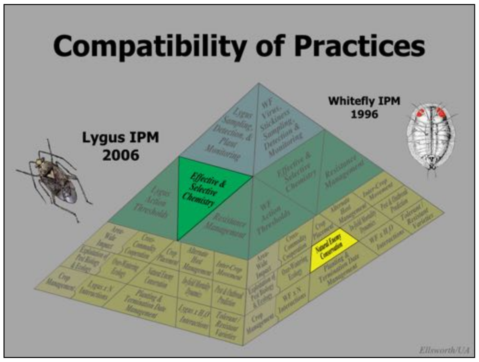
It starts with the cornerstone tactic of IPM, pest-resistant plants.

This shapes the foundation for all else that we do in the production of cotton. Bt cotton first deployed in 1996 for us in Arizona has been an all-important selective control tactic for pink bollworm. However, as that cornerstone, it also serves us in whitefly (and other pest) management by enabling even greater opportunity for conservation of natural enemies and biological control.



Continued durability and stability of our system depends on the full integration of practices over the range of pests that growers face in cotton.

So innovation had to continue, and after discovery, testing, and optimization, we found solutions to each pest that is compatible with practices used for the remaining pests.



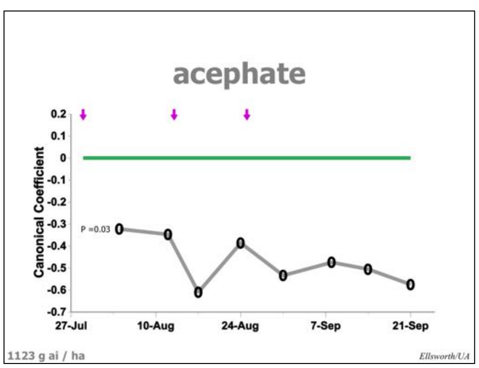
In 2006, we found and integrated a key piece to the IPM puzzle, a more sustainable practice for Lygus control.

Chemical controls for Lygus prior to 2006 were all very broad spectrum and potentially damaging to the natural enemies we were seeking to conserve for whitefly management. But in 2006 after years of development, flonicamid, a fully selective feeding inhibitor, was introduced to control Lygus such that natural enemies were conserved for whitefly (and secondary) pest control.

Product selectivity is of paramount importance in our system.

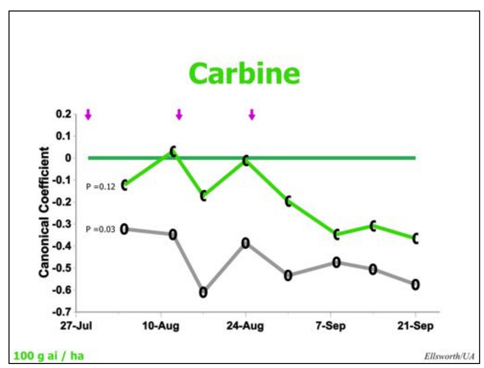
How do you determine product selectivity or safety to beneficials?

You could do evaluations in the lab; you would have to take a guess at which species were important and spray them in isolation. But that's not how it works in the real world. So what follows will be direct assessments in the field system where these beneficials make a living every day. And, we'll examine all species simultaneously. This requires some specific math and statistics that thankfully we can depict fairly easily & graphically through Principal Response Curves.



These charts show the response of an entire community of predators and other beneficials after spraying with insecticides and in comparison to an unsprayed check (green line). The unsprayed line is kept constant and what we see is the relative change in the aggregate density of predators compared to that check (represented as canonical coefficients).

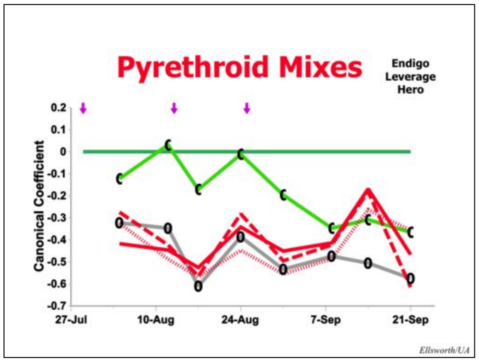
This chart shows us what many already know. Acephate or Orthene sprayed on cotton will significantly reduce the number of natural enemies present relative to unsprayed areas.



Carbine at the maximum labeled rate turned up not significantly different from the UTC, i.e., fully selective or fully safe to beneficials in our system.

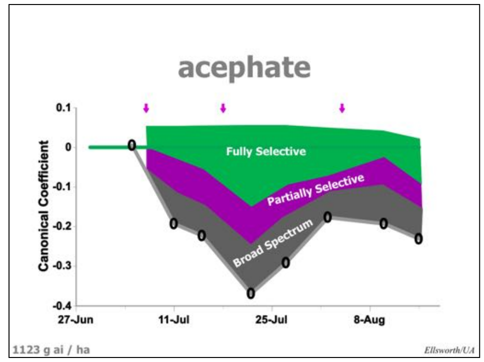
[The late season decline in numbers could reflect the declining amount of prey items, in this case Lygus, for predators to feed on in the Carbine plots. In other words, Carbine has effectively controlled Lygus there.]

09F3L 2.8 oz of Carbine



If there is any doubt, pyrethroid mixtures are very potent and damaging to natural enemy populations, just as damaging as Orthene.

09F3L Hero, Endigo, Leverage360Hi



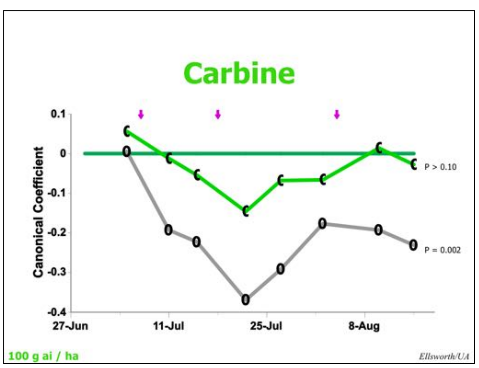
Our system of evaluation allows us to categorize insecticides as either fully or partially selective, or broad spectrum.

Responses at or near the response of Orthene would signal a compound with broad spectrum impacts on this natural enemy community (ca. 20 species).

Responses at or near the y=0 or untreated check line would signal a compound with great safety for the natural enemy community, which we term fully selective.

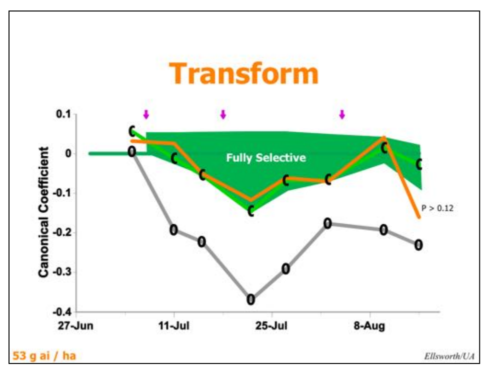
Responses falling between these two zones would be classified as "partially selective".

11F32NTO



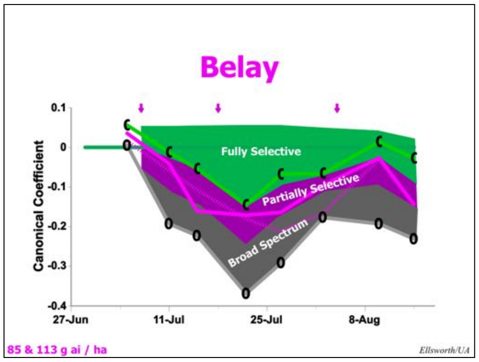
Again, Carbine at the maximum labeled rate was once again not significantly different from the UTC, i.e., fully selective.

11F32NTO 2.8 oz of Carbine sprayed 3 times



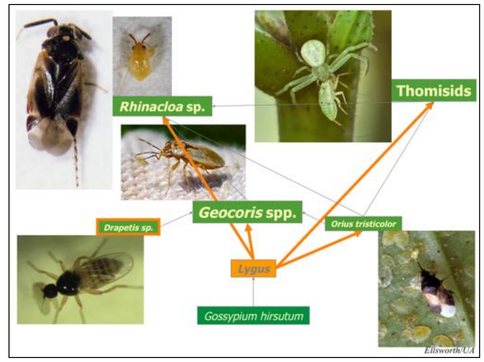
Transform at the Lygus rate (at 1.5 oz/A) was not significantly different from the UTC and fell at or above the Carbine line in most cases, i.e., fully selective.

11F32NTO 1.5 oz of Transform sprayed 3 times



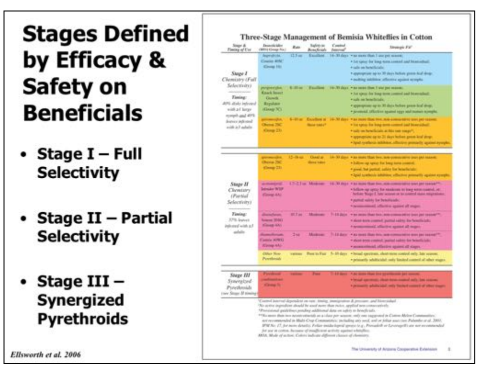
Belay was tested at two rates, 4.5 and 6 oz / A (solid & dashed line, respectively). In general, the response falls between the broad spectrum and fully selective zones; i.e., partially selective, regardless of rate used.

11F32NTO 4.5 & 6 oz rates of Belay, each sprayed 3 times



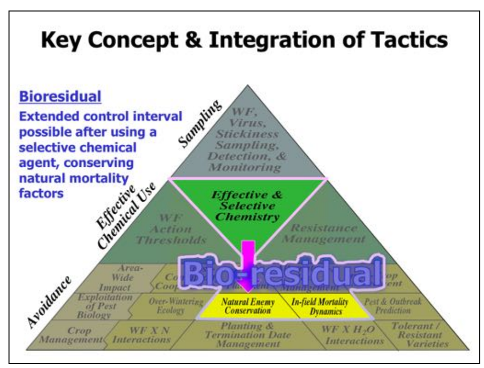
Here are photos of some of the influential species that turned up as most important in the 2009 analyses.

But the point is there is a complex food web that is supported through the use of selective chemistries and this food web is dynamic and resilient as long as we minimize the usage of broadly toxic insecticides.



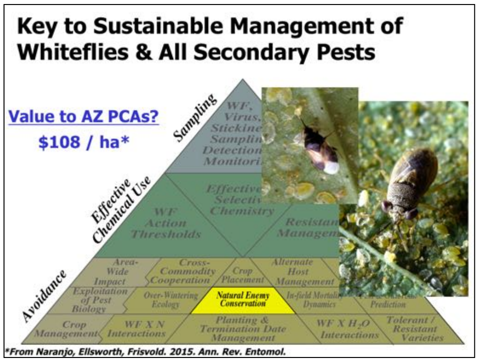
Our whitefly management system was based on threshold-based use of chemistries according to their efficacy and selectivity in our system, with the ultimate goal of exploiting selectivity as much as is possible. It does not mandate a sequence but teaches growers that more selective approaches will create more effective ecosystem services that provide regulation of all pest species.

Not surprisingly, we have constructed parallel recommendations for Lygus.



Key to all of this is understanding advanced concepts of IPM that not only address the current pest challenge but also prepare to sustainably confront the next challenge.

The role and function of predators and natural mortalities in whiteflies in cotton and the integration of these mortality factors with fully selective insecticides is key to our plan's success. The two combined give us access to an extended suppressive interval known as bio-residual.

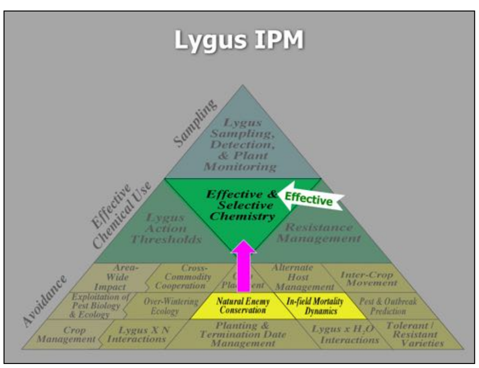


This harnessing of natural enemies is valuable in whitefly key pest control as it is in the continued suppression of all secondary pests. It is now widely recognized and valued by our stakeholders. In a survey conducted 2015, we asked Arizona pest managers (PCAs) how much do they value biological controls in cotton. While the range was large, the average response was $108/ha or about $44/A. This recognition by practitioners is the economic incentive to implement the plan developed.

We have a large complement of potential generalist predators. Just a few pictured here.

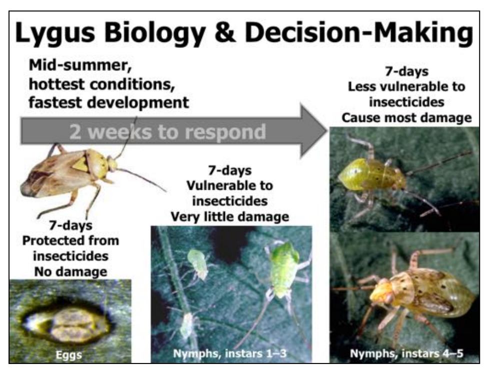
[We also have 2 parasitoids; however, Anaphes, an egg parasitoid, will not readily colonize cotton; and I've seen Peristenus (nymphal parasitoid) just once in 25 years.]

These predators play a role in primary pest control (whiteflies and Lygus), while suppressing/controlling all secondary pests (mites, leps, etc.).



So natural enemy conservation becomes an important objective of our overall management program including Lygus. But in the end, natural enemies alone are often not sufficient to control economic levels of Lygus (or whiteflies) and effective and selective chemistry is still needed.

No matter how selective a chemistry is, efficacy against the target pest is still very important.



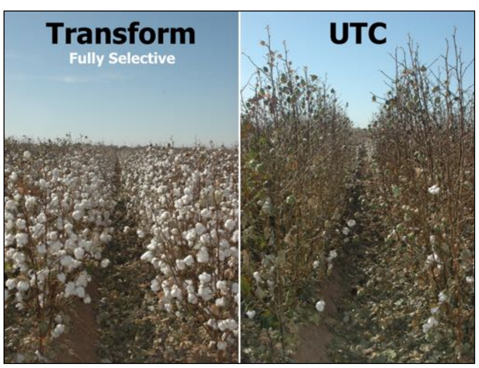
Efficacy starts with understanding these biological facts which are based in close monitoring and knowing how much time a grower has to respond to Lygus infestations.

Bear in mind that the response time one has to react is entirely based on how well a pest manager scouts a field and detects the activities first of adults arriving (and staying) in a field and then later in detecting the hatching of 1st instars.

We do have excellent Lygus control chemistry. Pretty easy to pick out the untreated check where Lygus bugs reduced yields over 5-fold. And right next to the foreground plot where we used three products in rotation, including Carbine.

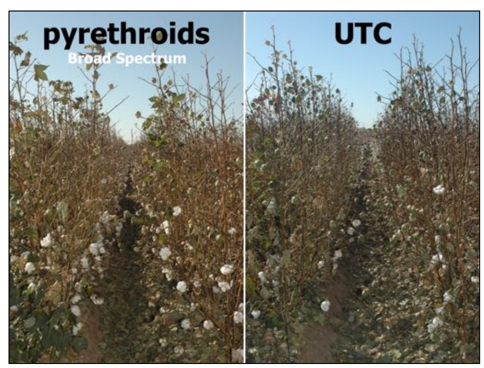
Carbine has continued to perform outstanding in control of Lygus and protection of yield. Note the height differences.

It is our Lygus control standard and was adopted in over 80% of all Lygus applications made in Arizona cotton and in over 90% of the first applications made for Lygus (2006-2012).

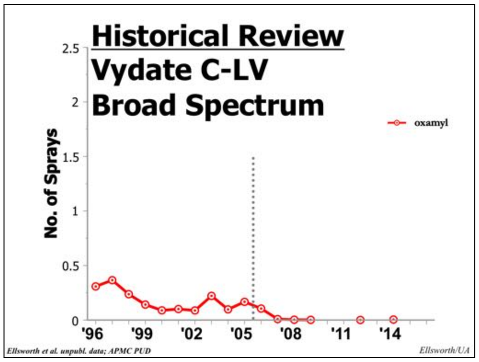


However, sulfoxaflor (Transform) has given us new opportunities and flexibility in Lygus control while enjoying some whitefly suppression. Note the huge difference in plant heights. When Lygus are not controlled, fruiting positions (and fruit) are lost. Then all the energy the plant produces goes into unproductive vertical growth. Tall cotton is a telltale sign of Lygus injury many times.

Transform was registered for use in Arizona for the first time in 2013. Since then, almost all Lygus applications are either with Transform or Carbine, or a rotation of these two effective and selective products.

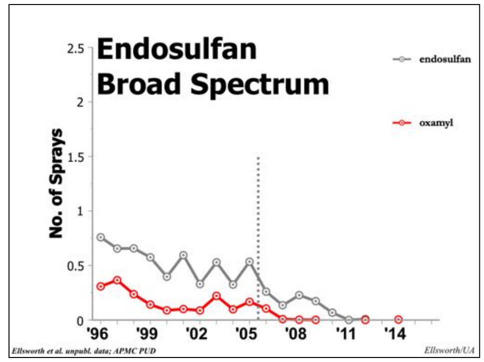


Pyrethroids still don't work in our system against Lygus in cotton. Every so often, people argue this point with me. So periodically, we re-examine this in trials. This time we chose to use Hero, a new very active mixture of two pyrethroids (bifenthrin + cypermethrin). As you can see there was no significant control of Lygus. Note the height of the crop. (Sprayed 5 times instead of just 3 of the standard).

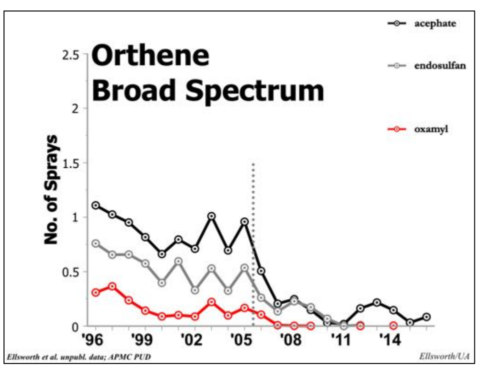


We also have access to pesticide use reports (1080s) through the APMC Pesticide Use Database. This gives us a nice historical review of how and when chemistry was used, mainly to control Lygus.

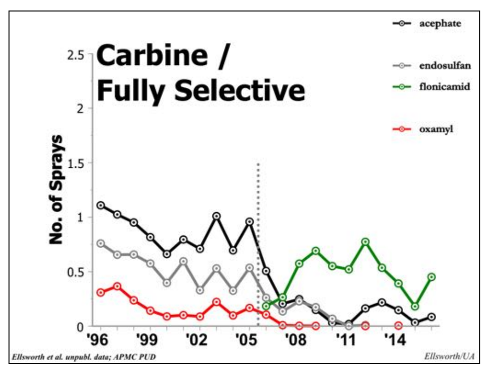
Vydate is a carbamate with Lygus efficacy. Almost none is used today.



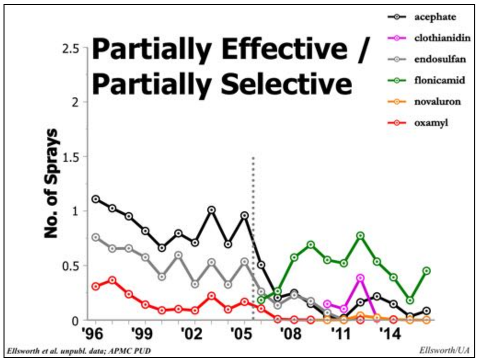
Endosulfan was the last organochlorine permitted for use in cotton and is largely banned from all agricultural uses worldwide today. However, it was the last truly cross-spectrum material we had for Lygus and whiteflies, though very high rates were needed.



Acephate or Orthene was our number one active ingredient used in cotton for many years. After 2006, its usage fell way off because of the selective alternative available (Carbine), but see the increase in usage in 2012–2014.

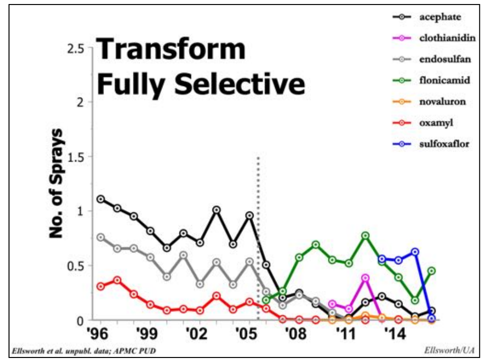


Starting in 2006, Carbine has been a mainstay of Lygus control, doing so selectively and safely.

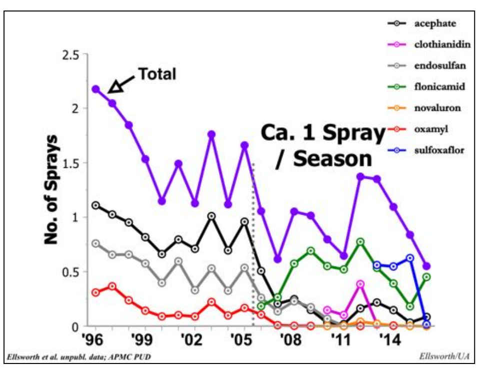


Belay has Lygus efficacy. Unfortunately it is not quite as effective as Carbine (or Transform). So it does not see much use because it is only partially effective and unfortunately only partially selective (instead of being fully selective).

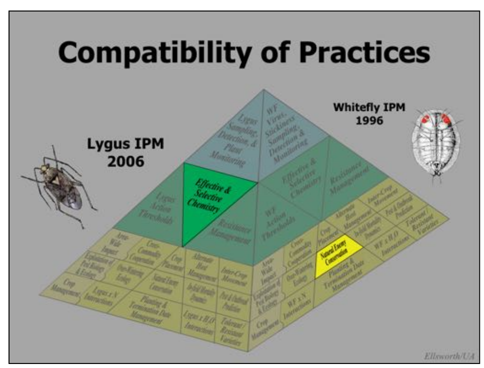
Novaluron (Diamond, Mayhem, Rimon) is an IGR with some activity against Lygus and whiteflies. As an IGR, its principal action is against the immature stages. However, unlike other IGRs we have, it is quite damaging to the natural enemies in the system. In fact, it is similar in non-target profile (i.e., safety to beneficials) as pyrethroids or acephate. So it is only partially effective against Lygus and broad spectrum when it comes to natural enemies. Whitefly resurgence, and secondary outbreaks of mites and aphids are possible with novaluron. Very little is used in Arizona.



Transform (sulfoxaflor), registered in 2013 is fully effective against Lygus and fully selective or safe to natural enemies.



The impact of having and using selective options in Lygus control cannot be overstated. When we use these compounds, we spray for Lygus less and we spray for everything else less.



We come back to this picture, because it is so important. Our strategy for managing Lygus is related to the management of whiteflies as well as other secondary pests. Having Transform as another selective control tool for Lygus helps growers out. Obtaining some collateral suppression of whiteflies at the same time is icing on the cake that, as it turns out, may be important to the management of resistance in this pest.

Selectivity & Efficacy of Cotton Chemistry

Selectivity	Compound	Lygus	Whitefly	Brown stink bug
Full safety	Courier		•••• (N)	
	Carbine	••••		
	Knack		•••• (E,N)	
	Oberon[1]		•••• (N)	
	Transform	••••	•	
Partial Safety	Assail / Intruder		••••	
	Belay	••	••	
	Venom		•••	
	Centric		••	
Not selective	Pyrethroid			•?
	Acephate	•••		•?
	Dibrom	•		•?
	Diamond / Rimon	•	•	•?
	Vydate C-LV	•••		

[1] At 140–175 g ai / ha only; ••••, Excellent control; •••, Good control; ••, Fair control; •, Suppression only

Ellsworth/UA

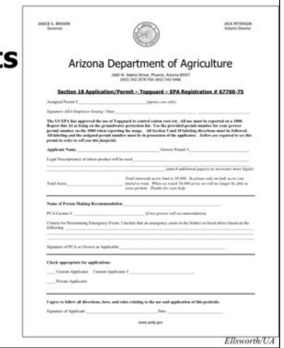
This table summarizes what we know about cotton chemistry and its efficacy and selectivity against our two key pests and the brown stink bug.

We have excellent options in whitefly control, even in the face of developing resistances. And, we have fewer, but excellent options in Lygus control. Transform is particularly well suited to our system as the only compound with at least some efficacy against both Lygus and whiteflies while being fully selective and safe to beneficials.

[At present, we do not have effective or selective options in the control of the brown stink bug.]

Requirements

- Fill out ADA's application
- Grower permit #
- Total acres*
- PCA license #
- 1080 reporting



Ellsworth/UA

ADA has requirements specific to Section 18s. This includes the need for the user to fill out an application providing information about the grower and the intended, potential acreage where Transform will be used. And, any usage of Transform under the Section 18 must be reported to ADA on form 1080.

Transform Section 18

- Section 18s are data-intensive requests
- As an exemption, they have specific requirements that must be met (e.g., SEL)
- Signs look very good for approval soon by EPA
- Cotton IPM in AZ is a system dependent on selective technologies

Ellsworth/UA

Post-Script!

Signs not only looked good at the time of this presentation, ostensibly EPA had already approved this Section 18 for use on Arizona cotton on 21 April 2017. Because of some technical changes to the language of EPA's April letter of authorization, it was further amended and approved on 4 May 2017. Please contact ADA to initiate the application process for use of Transform under this exemption.

Funding & Support

Grants from:
Arizona Cotton Growers Association
Cotton Incorporated
USDA-NIFA, Extension Implementation Program
Western IPM Center, Project Initiation Grant
Western IPM Center, Crop Pest Losses & Impact Assessment Signature Program
Monsanto Insect Knowledge Management Program
And support from agrochemical industry

The University of Arizona — College of Agriculture and Life Sciences, Cooperative Extension, Arizona Pest Management Center

Collaborators:
Arizona Department of Agriculture
Jack Peterson
Robert Tolton
David Hall
APMC Pesticide Use Database Advisory Committee
PCAs & growers statewide

USDA — United States Department of Agriculture, National Institute of Food and Agriculture

Western IPM Center

Ellsworth/UA

While there is no funding specific to the development of this Section 18, we thank all the agencies, grants and other stakeholders who have supported the research and other data used in this application.