

National Alliance of Independent Crop Consultants
Annual Meeting

January 2000

"Alternative Agriculture and Best Management Practices"

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Introduction

Today, agriculture is undergoing catastrophic change driven by an array of economic, societal and biological pressures. Over the past 50 years, most of the economic growth in agriculture, as judged by per unit value, has been associated with processing and the retail/wholesale marketplace. In fact, per unit farmgate receipts have dropped an average of 8% since World War II. In the same period the input portion of agriculture has grown some 460% while the retail market sector has grown 627%. Profitability is a Gordian knot for most agriculture producers today. For those that can unravel the complex biological, ecological and sociological challenges of production agriculture, the future may be rosy, but for the vast majority of producers, the future is not an inviting place.

Other dramatic forces driving change in agriculture include the rise in environmentalism and consumerism and their joined effects on production agriculture. These grass root forces have been predicated on a growing awareness of the impact of mankind's activities on the biophysical and natural systems that all life is dependent upon. Since the early 1970's these two-driving factors have done more to change the face of agriculture than any other factor. They culminate in a proliferation of regulations that demand rapid and potentially catastrophic change in agriculture.

After the underlying societal forces, probably the most significant long-term changes in agriculture have resulted from the biological and ecological features of production systems. New pest species introductions into North American agriculture have increased as the U.S., Canada and Mexico have catered to a global marketplace that is essentially homogenizing pests globally. Agriculture will continue to experience the introduction of new pest species and biotypes of disease and insect pests in direct correlation with the degree of international commerce despite political efforts to curtail these introductions.

Pest resistance is also a rising global challenge to production agriculture. Resistance is the failure of a plant protection tool, tactic or strategy to control a pest where the failure is due to a genetic change in the pest. This micro-evolutionary adaptive processes that

leads to superpests is a global phenomenon. Archtype species like the Colorado Potato Beetle, Diamond Back Moth and German Cockroach demonstrate the genetic plasticity of the key pests in every food, fiber and structural system in the world. Without resistance management measures within an Integrated Pest Management (IPM) context, this alarming trend will increase with the increasing intensity of agriculture and trade globally.

The Food Quality Protection Act (FQPA) was passed by the U.S. Congress in August 1996. FQPA represents the latest product of society's desire to regulate pesticide use in agriculture, industry, public right-of-way management and human and animal health protection. This legislation will be implemented on a fabric of biological, ecological, economic and market driven forces that have many agriculture production systems on the brink of financial collapse.

Pesticide Use History in the US

One of the most significant reductions of agricultural production risk in this century has come about through the use of insecticides, fungicides and herbicides. These highly efficacious agrochemicals have essentially simplified the biological complexity of production, yet the use of agrochemicals is not a modern phenomena. Most of U.S. society is surprised to learn that pesticides have been continuously used in recorded history since at least 4000 BC. This use of agrochemicals has progressed from crude animal oils and diatimatiuous earth to chorinated hydrocarbons, organophosphates and carbonates to insect growth regulators, pheromone disruption and genetically engineered plants and animals. Yet public perception rules the day! Pesticides are not wonder drugs, they are poisons and detrimental to the environment. Any product termed "natural" by the public is safe. Meanwhile, pesticide residues are dangerous and cause cancer and the agrochemical industry is a bunch of crooks. These general perceptions often dictate modern media coverage of agrochemical use in agriculture and the ultimate result is the promulgation of more regulations and restrictions on pest management procedures. These regulations in turn forces small producers out of business while encouraging large industry-like corporate agricultural production structures.

However, modern maximized industrial agriculture has lead to high productivity with many real and perceived ecological, environmental and human health drawbacks. These highly tuned industrial production systems are probably the most sustainable systems. Sustainability, production systems with economic, environmental and ecological underpinning, may be the agriculture's best hope for the future.

The optimum pest management system under the sustainable rubric would exhibit the following features:

1. A closed pest management system that recycles inputs and outputs,
2. Economic returns to producers that assure equitable and sustainable production,
3. Minimal environmental impact,

4. Optimal Ecological diversity,
5. Biological intensive pest suppression, and
6. A sociological implementable strategies tactics and tools for pest management.

In short, this idealized pest management system would be a “best practice” system because it would optimally adopt new sustainable practices as they became available.

Although there have been many different definitions of Integrated Pest Management (IPM), I prefer the definition that emphasizes integration, monitoring, management of pest populations with minimal impacts. In my view, IPM is the integration of strategies, tactics and tools to manage pest populations below economic injury levels with minimal adverse sociological, environmental and ecological impacts. Concurrent with this definition, is an understanding that IPM is a continuum of integration and management to reduce external inputs into agriculture.

Production Agriculture Sustainability Challenges

Since the late 1960’s US society has haltingly undertaken a process of the societal valuation of different technological paths to more highly sustained agricultural productivity with lower inputs and negative outcomes. This search for an optimum agricultural production system can be illustrated ecologically in Figure 1.

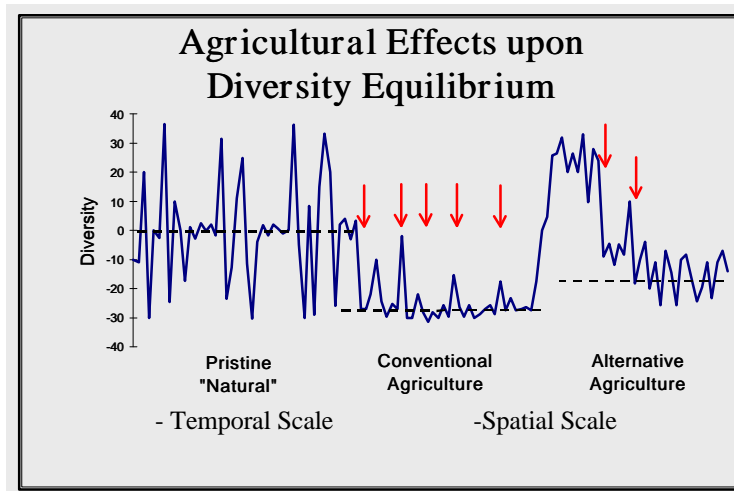


Figure 1: Agricultural pesticide management effects on theoretical species diversity equilibrium for a pristine, conventional and alternative pest management systems.

Essentially in pristine “natural” ecosystems, species diversity, density and richness vary across time, often with large fluctuations. In modern agriculture, species has been dramatically dampened by pesticide inputs. As society has mandated alternative, lower pesticide input production systems, greater diversity with increased variation have resulted. Increased variability within the system results when a disproportionate portion of the increased diversity is made up of new, rebound or facilitated pests. As agriculture

moves from pesticide intensive production systems to these alternative systems, there are numerous challenges and management questions that producers face (Table 1).

Challenges of Alternative Pest Management	
Conventional	Alternative
Delivery established (1X)	↔ Delivery Requirements increase (6x)
Simple, straight forward	↔ Complex, Dyanamic (?)
Very effective (too effective)	↔ Less effective (?)
Quality requirements predicated on efficacy	↔ Initially reduced quality quantity
Known food safety hazards	↔ Wholesomeness (?)
Production system design established	↔ Change of focus (production) to biology
Equipment developed	↔ Equipment unknown – adoption (?)
Economics simple (too simple)	↔ Economics unknown
Consumers conditioned	↔ Consumers willing to pay (?)
Diversity greatly reduced	↔ Diversity Increased
Ecosystem simplified	↔ Ecosystem complex
Varieties Optimized	↔ Variety development (?)
Proximate ecosystems neutralized	↔ Scale change in management (3X)
Complexity Index = 1	↔ Complexity index = 10X – 20X

Table 1

Unfortunately, in these more diverse biologically intensive IPM systems, the operational and biological complexity of the production system may be dramatically increased. In some minor crop production systems (e.g. perennial tree fruit culture) the transition from conventional pesticide managed systems to biologically intensive IPM systems results in increased management complexity ranging from 10-20x.

Along with the increased complexity issue, the public sector cost to develop, demonstrate and implement IPM systems has increased dramatically over the 1960's and 70's pesticide efficacy testing and "spray guide" approach to pest management. For example (Table 2), an economic entomologist employed at a Land Grant University could carryout efficacy testing in an outlying experiment station or on farms for approximately \$1,500-3,000.

The Cost of Pest Management Research at Michigan State University					
Apple Example					
	Cost	Support	Delivery	Risk	Recommendations
Pesticide Efficacy Testing	\$1,000-6,000/year	Heavily subsidized by public and private sector	Fruit Spray Calendar	Current system	Simple
Alternative Management Systems at Clarksville	\$50,000-100,000/year	Public sector support only	Educational intensive	High Risk/Best Guess Approach	Complex

Table 2

These efficacy trials were directly supported by the agrochemical industry, USDA and Land Grant Universities. Today, alternative biologically intensive IPM management systems are much more complex and difficult to carry forward in on-farm research programs. In addition, the agrochemical industry is less inclined to support these programs since these systems reduce the use of external inputs like pesticides. Therefore, there is a greater burden on the public sector to fund these multi-disciplinary, systems integration trials. Fewer and fewer Land Grant Universities have the resources to invest and there is a paucity of public sector dollars from consumers, environmentalists and alternative agriculture advocates. This situation has become the modern dilemma of societies valuation of different technological paths to more sustainable agricultural production systems. In short, society says they want these systems, but higher food prices and increase support for IPM have not materialized.

In general, our current Land Grant system is inadequate to address the scope of the economic ecological, environmental and sociological demands for alternative pest management systems in agriculture. Unless society will help in the funding of the development, dissemination and implementation of these programs they are certain to fail in the incubation stage.

The Food Quality Protection Act

In August of 1996 the Food Quality Protection Act (FQPA) was passed unanimously by congress. This legislation had broad support from industry, agriculture, consumers and environmental activities alike. Although the legislation has many nuances, there are three principle features that will fundamentally change pesticide based agricultural production systems. These three features include the reregistration of all pesticides uses with new consideration for common mode of action, aggregate exposure in the diet, environment, air, water and cumulative exposure over a seventy year lifetime. Finally, the hormonal effects of pesticides must be considered as well. The net effect of these new registration conditions together with the focus on children safety will result in dramatic decreases in the use of many current pesticides.

Several recent documents have addressed the general effects of FQPA on agriculture and even on IPM programs. Janet Anderson, Director of Biopesticides and Pollution Prevention Division, USEPA, said that "FQPA will push us to biopesticides, we no doubt will lose many pesticide uses".¹ Another significant general effect of FQPA is the new responsibility for developing extensive new data for tolerances establishment in EPA. Much of these new data requirements will fall on agricultural producers, commodity organizations, processors, state departments of agriculture and Land Grant Universities.

Political Unification of Agriculture

Probably the most dramatic immediate effect of the FQPA on agriculture is the political unification of minor crop agriculture. In the past, animal and row crop agriculture have been well represented by the American Farm Bureau (AFB) while minor and specialty crop producers have been less vigorously represented. Minor or specialty crops on the other hand, have been largely fragmented and often congressionally uninformed,

¹ February 25, 1998. Ottawa, Canada. Biopesticides Workshop.

politically naive and underfunded. FQPA galvanized these divergent minor crop industries into a major thrust on Washington contributing to the Vice President's invoking of the Federal Advisory Committee Act to form the Tolerance Reassessment Advisory Committee (TRAC).

FQPA impact on IPM

Certainly economic factors will drive the development of alternative pest management practices in major crops. Minor crops, however, are at great risk because the infrastructure and the economics in the private sector are not sufficient to facilitate the development of pesticide alternatives before FQPA results in losses of these pesticide tools. Therefore, many production scientists and economic entomologist are acknowledging that insecticide costs will likely grow 15-40% in minor crop agriculture² as a result of FQPA. This will occur because product substations for older and more broad spectrum insecticides, will cost 10-80% more per treatment. Many of these alternative tools are less effective and narrow in this pest control spectrum. In addition, more information is necessary to make adequate decisions in the deployment of these newer chemistries. Concurrent with the reduction or elimination of the broad spectrums, agriculture will lose their suppressing effects on secondary and occasion pests. Post FQPA minor crop production systems will be a least 1-2 orders of magnitude more complex biologically due to the greater number of species which will establish or reestablished in these production systems. A good example of these complexities associated with the introduction of more benign and narrower spectrum pest management tools is the use of pheromone disruption products. These chemicals are released by wild-type females to call the male to her for mating purposes. Scientists have isolated these compounds and industry has synthesized and produced them for the commercial market. These pheromones are released in minute quantities over the crop and result in "male confusion" and failure of females to mate. Reduced pest damage results. In apple production, the cost of pheromones currently ranges \$80-160 per acre compared with a conventional insecticide spray program that may cost \$40 per acre. These cost increases come along at a very bad time for agriculture apple producers, and they have not brought with them any "value added" price increase.

A number of agriculture workers may have initially exaggerated the enhanced environmental and ecological benefits of FQPA on agriculture. However, production systems are dynamic and the long-term effects of FQPA may yet yield measurable environmental gains. Will public-sector agriculture research, extension and other supports have sufficient resources to meet the challenges of pesticide alternatives under FQPA? The answer will depend on a very complex, dynamic private-public sector interaction. FQPA has supported the agrochemical industry's discovery science strategy very effectively since most companies were investing on safer, more environmentally benign tools. Today, no agrochemical multinational or startup company has a broad spectrum, nerve toxin discovery program underway. Rather "biorational" strategies are in place at all levels. However, the regulatory environment has significantly disrupted the agrochemical market stability and sustained new product development is very questionable from the private sector if these regulatory-based

² WSU Newsletter - Jay Brunner article

uncertainties are not stabilized quickly. Indeed, FQPA has introduced a new dynamic and increased risk into private sector discovery, registration and marketing situation.

In many instances, unless society steps forward and reevaluates fruit and vegetable grading and quality standards many producers will not be able to transition the FQPA challenge. In the face of reduced efficacy of alternative products, increased complexity of the information necessary to control pest, a decreased control-spectrum of pest management products, disrupted IPM programs and changing market demand have resulted in a very unstable picture for minor crop agriculture.

FQPA may have very dramatic effects on pesticide resistance development. If FQPA reduces the availability of different modes of mortality (classes of chemistry) in the marketplace, while increasing the reliance on a narrow array of remaining tools, tactics and strategies, accelerated pest adaptation will result. In the long term, FQPA will probably lead to a broad array of new tools in agriculture. Many of these tools will help to diversify modes of mortality in population suppression. Thus, the short-term consequences may be increased resistance with the long term reduction of pesticide resistance may well result from FQPA.

One of the most significant developments of FQPA may be its impact on agricultural processors. With the increased awareness of the importance of pesticide residues on agronomic and minor crops, processors are moving rapidly to develop their own residue monitoring system. Many are contracting work with the developing residue monitoring service industry while others are developing their own in-house labs. In addition, there is a push to develop residue management/mitigation systems that reduce pesticide residues on agronomic products. These measures may justify processor mediated product increases that will be passed on to consumers, but are unlikely to generate additional revenues for agricultural producers.

Conclusion

Analysis suggests that the passage of FQPA was the result of a societal valuation of different technological pathways in production agriculture. The forces culminating in FQPA resulted primarily in perceived flaws in the Federal Insecticide Fungicide Rodenticide Act involving the Delaney Clause and more importantly, environmental and consumer fear of pesticide residues in food. The promulgation of this legislation will have profound impacts on the agriculture-input sector and will result in dramatic structural changes within agriculture production, processing and marketing. The specific impacts of FQPA on Integrated Pest Management are likely to result in production cost increases, and increased complexity of management strategies, tactics and tools. The increased production system biological dynamics will be brought on by increased arthropod and microbial diversity in production agriculture. Changes in quality standards produce labeling and processor driven restrictions will also result in the adoption of more complex and biointensive IPM systems. Whether enhanced environmental and ecological benefits actually accrue to the passage of FQPA remains for future measurement. The evolutionary adaptation of pest to reduced pesticide availability in the short-term will likely result in increased pesticide resistance. However,

as IPM systems become more biologically intense and more "biorational" tools become available resistance should decrease.