Chapter 29

WORKING TOGETHER: ROLES OF PRIVATE CONSULTANTS, INDUSTRY, RESEARCHERS, EXTENSION, AND GROWERS

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INTRODUCTION

The transfer of technology in developing and using cotton insect and mite control methods encompasses a complex and challenging system that probably is as good an example as one can find of the interactions between private and public components in the American economic system. Development of control technology moves from the conceptual level through a vast array of bench scientists, field researchers, pilot programs, and extension demonstration and education programs before reaching the final advisor and user. It may originate and/or be developed by industry, the USDA Agricultural Research Service, various state agricultural experiment stations, and various other less structured "discoverers" of new technology.

Technology transfer usually involves numerous cooperative efforts between the various entities in the agricultural research and development business. When a control technology is proven effective, it is offered in the market, possibly as the only effective method of control, but usually as one of several methods competing for the cotton

grower's attention and dollars in his pest control budget. Information and advice on all the available technology reaches the final user through many routes provided by industry (basic manufacturers and dealer/distributors), the Cooperative Extension Service, and to an increasing extent, by professional crop consultants. Various federal and state regulatory agencies help insure proper use of products and quality of services. Other professionals may be involved in the application of a selected control technique, such as the aerial applicators who play an essential role in effective cotton insect and mite pest control. The final user is usually a fairly sophisticated cotton producer who, within the constraints of public health and safety considerations, will use a pest control method if it works effectively and is cost effective.

The complex interactions involved in this process of insect and mite control technology transfer are illustrated in Figure 1. This diagram may serve as a guide for the following discussions of how various public and private sectors work in the process of discovering, developing, marketing and using cotton insect and mite control technology.

HISTORICAL BACKGROUND

THE LAND GRANT SYSTEM

The land-grant system of higher education functioning in concert with mission oriented agricultural research and extension education and demonstration programs has been the foundation of America's unique success in agricultural production. The minds which conceived and fought for the system may not have realized its ultimate value, but it has proved to have been a grand scheme with which this nation has built the world's most productive agricultural industry. It was based on the idea that American productivity and quality of life can be directly influenced by the scholarship of the University and a dynamic linkage to its people by an Extension Service. It was designed to help solve society's problems, to respond to public needs, and to educate the nation's young people. The idea was unique in its time and continues to be highly successful in achieving its goals.

For the first 150 years of life as a free nation, the United States was almost exclusively agricultural. A century ago the nation's leaders were primarily concerned with the establishment of a reliable food supply. The country was truly an agrarian society; farming was a way of life. In 1920 about 6.4 million people were engaged in farming. In 1930, as we moved into an industrial society, still some 25-30 percent of the population was engaged in the production of food. During this period crop yields were almost equal worldwide. Differences among the United States, England, India, and Argentina were not readily perceptible. But over the next 50 years, United States productivity soared. Corn yields quadrupled, milk production per cow more than doubled and overall farm productivity increased about 2.5 times. This resulted from technology and public education — the Land-Grant concept.

This concept has been particularly well applied in cotton insect and mite control across the Cotton Belt. When technology has been developed by the research compo-

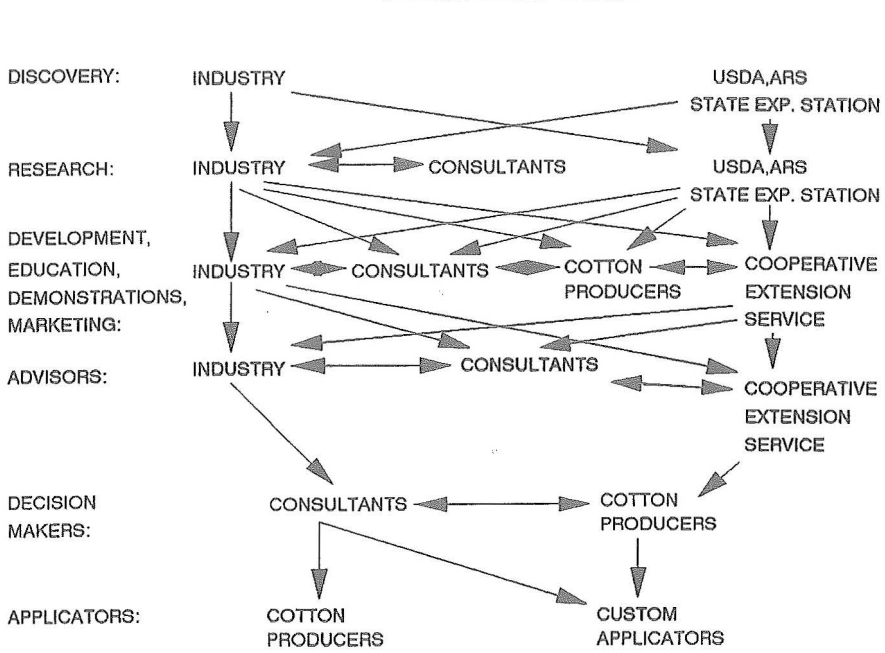

Figure 1. A schematic description of the interactions with regard to insect pest management among the various public and private groups within the cotton industry illustrating the complexities of these relationships.

nent of the system, the cooperative extension service has been diligent to develop education programs to take the new methods to the field.

PRIVATE INDUSTRY

Another key player in cotton insect and mite control is the pest management industry. Correctly referred to as the "pesticide industry" for many years, this industry is participating in innovative discovery and development of new concepts for products and services in insect and mite pest management for the twenty first century.

Devastation of cotton by the boll weevil, *Anthonomus grandis grandis* (Boheman), across most of the Cotton Belt during the first half of this century resulted in research of numerous methods of weevil control. Minimally effective cultural control methods and difficult to apply inorganic insecticides that gave only slightly better control were the cotton producers' only defense against the boll weevil during most of these years. During the 1940s the organic chemical industry began to produce organochlorine compounds such as DDT, BHC, chlordane, dieldrin, endrin and toxaphene, which were highly effective against boll weevil and other cotton pests. These chemicals appeared to have provided "the" solution to cotton insect pest problems, effectively

and permanently. However, insects and mites had survived many millennia in a hostile environment and they soon showed capability to adapt to these chemicals. Insecticide resistance has become a well known fact of life and private industry is responding by searching not only for new chemistry but also for new approaches to managing insect and mite pests of cotton. Since the 1970s, greater emphasis by industry has been given to development of biological insecticides such as the bacterium, *Bacillus thuringiensis,* and to development of chemicals that disrupt insect growth, development and behavior. These new chemicals include insect growth regulators, pheromones and semiochemicals. Private industry is also active in various stages of research, development and marketing of insect traps, attracticide devices, insect confusion products, parasites and predators for field release, and other new products and services.

Biotechnology is probably the area in which private industry has the greatest potential to change cotton insect control in the future. Cotton plants containing genes from *Bacillus thuringiensis* have been engineered to produce the endotoxin at sufficient levels to control lepidopterous pests including bollworm and tobacco budworm. Cotton varieties containing this trait are in advanced stages of development and some agronomically acceptable cultivars will be availabale for the 1996 planting season.

The goal of private industry is the development of products that meet the needs of the cotton grower. In addition to synthesizing and developing pesticides (chemical and biological agents), and other products, and manufacturing and distributing the products, the industry participates in training on proper use of products including integration of a product's use with other pest management tactics. These activities are done in cooperation with public organizations and the consulting profession.

PRIVATE CONSULTANTS

Private consultants have become important insect pest management advisors for cotton growers in recent years and their role continues to grow in importance. Private consulting in cotton pest control probably can be considered a new profession. Significant growth in numbers of individuals in the profession did not occur until the early 1950s. Earlier accounts of private consulting indicate a few individuals here and there contracted with the larger and more progressive cotton producers as early as the 1930s. In those days, the boll weevil was a major pest in most of the Cotton Belt and there were few effective control methods available for a consultant to recommend. Calcium arsenate dust was an inferior insecticide that was also difficult to apply. Application technology was in its infancy. A few cultural methods such as early planting and stalk destruction helped but had limited effectiveness against the boll weevil. Under such circumstances, private consulting in cotton insect control was not a very appealing career. This was the situation in cotton insect control until the late 1940s and early 1950s, when organochlorine insecticides were first produced.

There were probably several interacting reasons for growth of the private agricultural consultant profession in cotton country. Numerous pests such as boll weevil, bollworm, tobacco budworm, thrips, aphid, spider mite, pink bollworm, *Lygus,* fleahopper,

cotton leafperforator and other pests cause significant problems requiring professional attention in cotton.

Lack of availability and quality of other sources of advice also contributed to the need for private consultants. Quality here is not used in reference to the general competence and importance of county and state extension personnel or pesticide salespeople, but refers to special skills and training in entomology and insect control. County agents were much more likely to be trained in animal science or dairy science than in entomology, and, even if they had a degree in entomology, their time for scouting and advising individual growers on cotton insect problems was limited. Some of the most competent entomologists in the business have worked in sales and technical service for chemical companies and pesticide dealers but their time for individual growers is limited and their primary job is to promote and sell product.

Circumstances in cotton production that developed in the late 1940s and during the 1950s were opening up a niche for the private entomology consultant. Remedies for cotton insect problems, principally chemical insecticides, became available and development of new ones mushroomed. Federal, state, and industry researchers developed better methods of how and when to use these products. Complications of insecticide resistance and secondary pest outbreaks, inherent in chemical insect control regimens, became apparent. Entrepreneurial entomologists began to move in to fill the niche.

Reduced federal and state funding for agricultural research and extension services, and changing societal needs have placed new demands on the state universities. Consequently, the land-grant system has been less able to respond to the needs of the cotton producer. These producers, if they can satisfy their needs through other (private) sources, seem willing to pay for services and information formerly provided through tax supported public agencies. By recognizing these entrepreneurs as complimentary and synergistic, rather than antagonistic and threatening, the land-grant system can remain relevant to society and to the individual producer.

In some states, the local research and extension personnel helped develop the private sector, the agricultural consultants, and continue their support through cooperative educational programs.

There has been a significant change to more use of private consultants in the final steps of technology transfer, but this has not diminished the role of the cooperative extension service. Consultants and other clients continue to heavily depend on the Cooperative Extension Service.

COOPERATIVE EFFORTS

The relationship between extension, state and federal research, consultants, pest control advisors (PCA's), private industry, and the cotton producer is important. This relationship has strengthened within the last few years and will continue to improve. Figure 1 is a schematic description of the interaction between the various public and private groups within the cotton industry. It illustrates the complexities of these relationships and the need for continued improvement in communication and cooperative

efforts among the sectors represented. With product usage becoming more complex and economic thresholds and other field monitoring technology changing rapidly, it is increasingly important for all segments to work together. The control of pests in cotton, whether insects, mites, weeds or diseases, is important for maximum yields and quality crops. There are public and private groups of people and companies working together to help the cotton producer manage his pests while protecting the environment.

There are numerous examples of cooperative programs where research, extension, industry, consultants and growers have cooperated to bring new technology to practical application. Two such programs will be discussed here to illustrate by specific example how the system of cooperation has worked. One such technology that has been applied across most of the Cotton Belt is a boll weevil control tactic called "reproduction-diapause control". The second widely applied technology is "pyrethroid resistance management".

BOLL WEEVIL REPRODUCTION-DIAPAUSE CONTROL PROGRAMS

Term "reproduction-diapause control" refers to a boll weevil control technique that is directed to a vulnerable period in late season when interruption of reproduction and prevention of diapause can be achieved with insecticide applications.

Research in boll weevil infested states across the Cotton Belt showed reproduction-diapause boll weevil control to be an effective method of suppressing boll weevils during the early and middle part of the cotton growing season by limiting the number of winter survivors. Consequently, many integrated pest management (IPM) systems were based on effective community-wide reproduction-diapause boll weevil control programs.

A symposium during the 1983 Cotton Insect Research and Control Conference, Beltwide Cotton Production Research conferences, was entitled "A Decade of Extension Cotton Integrated Pest Management 1972-1982" (Young, 1983). The objectives of the federally funded cotton pest management program were to assist growers in developing effective, economical, and environmentally-sound pest management practices that involve combinations of chemical, cultural, and biological control methods; with emphasis on early planting trap crops, delayed in-season insect control, early post-harvest crop destruction, chemical diapause control (of boll weevil), pheromones, and other technologies as appropriate (Blair, 1983). One of the greatest changes in cotton insect pest management observed during this ten-year period was the increase in acreage scouted by private consultants, up from 401,500 acres in 1972 to over 2.2 million acres in 1982 (Lambert, 1983). The number of private consultants involved in cotton insect management increased during this period from 66 in 1972 to 571 in 1982, and many chemical companies started promoting integrated pest management concepts in their advertising and other product promotion activities (Head, 1983). Benefits of IPM during the ten-year period included improved quantity and quality of scouting (monitoring pest populations), greater use of beneficial insects, greater reliance on thresholds for timing insecticide applications as needed, reduced number and rates of insecticide applications, and millions of dollars in economic benefits across the Cotton Belt (Smith, 1983).

The effective transfer of reproduction-diapause boll weevil control technology from research to cotton growers by the cooperative extension service was particularly important during the early 1970s because of resistance in bollworm/tobacco budworm to both organochlorine and organophosphate insecticides. Reduced in-season insecticide applications against boll weevil was essential for certain bollworm/tobacco budworm management tactics such as utilizing natural enemies to control early generations in cotton. Consultants who practiced integrated pest management adopted the practice for their clients in boll weevil infested areas. The pesticide industry participated in the demonstration efforts and positioned certain products to fit the integrated insect pest management concept of which reproduction-diapause boll weevil control was the basic tactic. The ovicide, chlordimeform, (Fundal®, Galecron®) was introduced into the cotton insecticide market during the early 1970s and was particularly suited for use in the insect management programs upon which cotton producers were dependent at the time.

During this period when growers recognized the acute need for careful management of their insect control resources and turned increasingly to private consultants for expert advice, a cooperative relationship between extension service specialists and private consultants became important. Their roles were intrinsically linked and synergistic. The private agricultural consultant professionals, in fact, became important clients of the cooperative extension service.

INSECTICIDE RESISTANCE MANAGEMENT

Highly effective pyrethroid insecticides became available toward the end of the 1970s decade and by 1980 cotton growers across the Cotton Belt had begun to rely heavily on these products to control their most serious insect pests. A few problems occasionally occurred following pyrethroid applications, i.e. cotton aphid, spider mites, and whitefly infestations might be flared. However, these problems seemed minor compared to earlier difficulties with resistant tobacco budworms. Several pyrethroid products were soon developed, registered, and introduced into the cotton insecticide market. Competition was keen and price was lowered. Vigilance regarding integrated pest management strategies was relaxed. Dependence on natural enemies for bollworm, *Helicoverpa zea* (Boddie)/tobacco budworm, *Heliothis virescens* (F.), control became less important to growers. Entomologists who knew the history of resistance in cotton insect pests and the mode of action of the pyrethroids began early in the 1980s to issue warnings about the probability of pyrethroid resistance with continued prevalent use of the products in cotton insect control.

The reality of pyrethroid resistance in tobacco budworm occurred with field control failures in Texas in 1985 and in the Mid-South states of Arkansas, Louisiana, and Mississippi in 1986 (Graves *et al.*, 1991). The significance of these events was immediately recognized by consultants, researchers, and extension entomologists in Texas and the Mid-South.

A group of consultants operating in the Brazos River Valley and the Winter Garden areas of Texas developed and implemented an insecticide resistance management plan which was widely used with great success.

Following the 1986 tobacco budworm control failures with pyrethroids in the Mid-South, J. R. Phillips of the University of Arkansas named a Pyrethroid Task Force for the Tri-State area of Arkansas, Louisiana, and Mississippi. This group of 16 entomologists met in Greenville, Mississippi on November 6, 1986 to initiate development of a Pyrethroid Resistance Management Plan for the Mid-South. J. B. Graves of Louisiana State University was asked to act as facilitator for the group and he drafted a tentative Pyrethroid Resistance Management Plan for the group's consideration. During this meeting the Pyrethroid Task Force made slight revisions to the draft and recommended the plan for adoption by the three Mid-South states represented. The plan was adopted by the entomologists representing the three states for promotion and use starting with the 1987 cotton growing season. The plan has been modified several times since 1987 and has become an Insecticide Resistance Management Plan rather than a Pyrethroid Resistance Management Plan. The original plan consisted of the following three basic components: (a) avoid late planting and establish a healthy, vigorous stand of cotton; (b) control insects during the period from planting to June 30 in order to allow production of a crop in 120-140 days, but avoid use of pyrethroids during this period; and (c) use pyrethroids as needed during the period of July 1 through the end of the season. As levels of pyrethroid resistance in tobacco budworm increased the pyrethroid use window was narrowed to mid-season and growers were advised to use organophosphate insecticides in late season. Full rates, short intervals and mixtures with other insecticides were advised when tobacco budworms were present in the infestation (Personal communication, J. B. Graves, Louisiana State University, Baton Rouge).

The insecticide resistance management plan developed by the Tri-State Pyrethroid Task Force, and subsequent modifications, has been widely promoted, advocated, accepted and used by researchers, extension entomologists, consultants and cotton producers across the Cotton Belt where pyrethroid resistance has occurred in tobacco budworm.

Insecticide resistance management has strong support in industry. An Insecticide Resistance Action Committee (IRAC) represents manufacturers of all insecticides and exists to extend the useful life of insecticides. An international organization of pyrethroid insecticide manufacturers known as the Pyrethroid Efficacy Group (PEG) is a major supporter of pyrethroid resistance management efforts worldwide. A subcommittee known as PEG/US has supported the pyrethroid resistance management efforts in the United States with members (pyrethroid manufacturing and marketing companies) making major contributions in personnel and funds (Graves *et al.*, 1991).

The efforts of a broadly based and often administratively unstructured consortium of industry and people interested in avoiding or delaying development of pyrethroid resistance in cotton insects, especially tobacco budworm, appears to have been successful. The evidence is circumstantial but intensive monitoring activity across the region shows a decline in pyrethroid resistance in tobacco budworm during the time when use of pyrethroids is discouraged. The level of success notwithstanding, the insecticide resistance management activities across the Cotton Belt of the United

States, as well as around the world, are excellent examples of working together between all segments of the cotton insect management profession.

SUMMARY

The various entities which develop and transfer cotton insect technology are synergistic in their interrelationships, both through cooperative efforts and through an inherent system of checks and balances. Through it all is a continually evolving array of information, services, and products available to the system's clients and customers — the world's cotton farmers. The system has done an excellent job of screening this flow of information and technology and discarding that which proved to be inferior and promoting that which proved to be effective. The result is a top quality delivery system — the best information, the best service, the best line of products.

The future will bring greater demands for "working together" by all segments of the cotton insect and mite pest management delivery system. Public opinion and legal requirements will continue to increase demands for assured environmental safety and human health protection. Highly adaptable insect and mite pests will continue to evolve defenses against control tactics. Pest management will become more complex and implementation of effective and safe pest management tactics will require more knowledge and superior judgement.

Working together involves interaction of federal, state, industry and self-employed professionals on farms, at grower meetings, in special training workshops and a myriad of other training opportunities, including the mecca of cotton information exchange and technology transfer, the Beltwide Cotton Production and Research Conferences. These annual Beltwide conferences epitomize the concept of diverse segments of the industry working together to support and promote the interests of the entire cotton industry, including improved insect and mite pest management.