A Rich and Rewarding Journey

Pursuing the Health of the Land and Its People Through Increased Scientific Knowledge

Richard L. Ridgway

Foreword by Edward A. Hiler

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Cover Photos

Top: Conservation practices combined to form a conservation system on a farm assure the continued productivity of cropland and protect water quality. Photo credit: Natural Resources Conservation Service, USDA.

Left, center: Corn was an important food for both people and livestock when the early settlers first came to the South Plains of Texas, and current-day improved varieties are an outstanding example of advances made possible through increased scientific knowledge. Photo credit: Pioneer Hi-Bred, a DuPont business.

Center: Cotton was an early cash crop on the author's family farm, and today, it is the major crop on the Southern Great Plains where 40 percent of the U.S. cotton is produced. Photo credit: Plains Cotton Growers Inc.

Right, center: Beef cattle can be a very important source of protein, and livestock provides a highly efficient method of harvesting forage from native and restored grasslands and from improved pastures. Photo credit: American Hereford Association.

Bottom: A major objective of pursuing increased scientific knowledge through agricultural, food, and natural resources research is to provide safe and nutritious food for people of all ages. Photo credit: Agricultural Research Service, USDA.

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DEDICATION

To my wife, Donna, who has traveled this rich and rewarding journey with me for more than five decades. And to our daughters, Susan and Sharon, who share our values in pursuit of education and service to others.

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Illustrations

Foreword

This wonderful book provides an inspired picture of the life and times of the author, Richard "Dick" L. Ridgway. It begins with the settlement in the Texas High Plains by his ancestors in the early 1900s and with a vivid description of the rugged setting (where earlier the buffalo roamed) that spawned Dick Ridgway. No doubt these early times shaped Dick's high level of commitment to excellence, his ability to focus on specific goals, and his determination to succeed that I have observed up close on more recent issues during our time working together as members of the Board of Directors of the Charles Valentine Riley Memorial Foundation (RMF).

With the widespread advent of irrigation from the Ogallala Aquifer in the late 1950s, a portion of the Great American Desert (characterized by vast open lands and limited water) was transformed into a region of highly productive agriculture. With this came greater prosperity for the Ridgway family and a greater opportunity to serve. And young Dick was prepared to take full advantage of the opportunity… and indeed did so.

Following his formal education at Texas Tech University and Cornell University, Dick became a leading entomologist with a primary focus on managing cotton insects, including eradication of the boll weevil.

His story provides an excellent picture of biological control and pest-management strategies. And Dick's actions with the battle against cotton insects ultimately made a major contribution to the highly effective Boll Weevil Eradication Program.

A common theme throughout the book, and indeed, throughout Dick Ridgway's life, is a strong commitment to the *sustainability* of food and fiber production systems in the United States and throughout the world. A fine firsthand example is focused on the South Plains of Texas that was the early setting of Dick's life and where he continues to have an active role in agricultural production. As our groundwater supplies diminish there, sustainable systems are imperative if the region's economic viability is to be maintained and enhanced.

Finally, and perhaps most importantly, Dick gives valuable insights into the legacy of Charles Valentine Riley. Riley's life and work were a major inspiration to Dick Ridgway, and he worked tirelessly for the past thirty years to carry Riley's vision forward for the benefit of humankind on our planet Earth. It was Nobel laureate Norman Borlaug who said, "Without a stable food supply, I assure you that there will be neither peace, nor human progress." A major objective of RMF is "to promote a broader and more complete understanding of agriculture as the most basic endeavor and to make secure the lever that is agriculture and its fulcrum, the natural environment, during this and succeeding generations."

Dick Ridgway's work with RMF has been the key to the success of its programs as described herein. In fact, it is not an overstatement to say that RMF would not exist today without Dick's tireless work on its behalf. RMF programs are described as only Dick could do it in latter chapters of the book.

A wonderful and valuable RMF partnership has been formed in recent years with the American Association for the Advancement of Science (AAAS) and the World Food Prize Foundation (WFPF). This partnership should ensure that the precepts of RMF will continue in perpetuity through a commitment to *collaboration/cooperation/partnering/coalitions* in research to secure a safe, healthy, and nutritious food supply for our ever-expanding population. What a wonderful and appropriate testimonial to the life and work of Richard L. Ridgway.

I commend this valuable book to your reading. May it be an inspiration to you as we all seek to make the world a better place.

Edward A. Hiler
Vice-chancellor and Dean Emeritus
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December 2011

Acknowledgments

A special thanks is extended to Edward A. Hiler, a valued member of the Charles Valentine Riley Memorial Foundation (RMF) Board of Directors, who reviewed the manuscript, provided useful comments, and wrote the foreword. A special thanks is also extended to Lloyd V. Knutson, a professional colleague since we were in graduate school together at Cornell University in the late 1950s. Dr. Knutson, an experienced scientific editor, carefully edited the manuscript and provided review comments for the book's back cover.

In addition, I am grateful to Michelle Davis, who assisted in organizing and editing the images and to the many individuals, institutions, and organizations that assisted by providing images. With one exception, where the source is unknown, credits are provided in the caption of each illustration.

Many of those that had a significant impact on my journey are recognized throughout the book, but I would particularly like to extend a special acknowledgment to many of the individuals who served through the years on the RMF Board of Directors. Included are the charter members of the board: John C. Gordon, John "Duke" S. Barr III, Emilie Wenban-Smith Brash, Durward F. Bateman, Gideon D. Hill, I. Garth Youngberg, Harry C. Mussman, Raymond J. Miller, Edward H. Smith, Dan M.

Martin, Bennie I. Osburn, Earl R. Swanson, and Robert H. Tweedy. A number of others played major roles within RMF through the years: A. S. Clausi, Richard Herrett, Gilbert Leveille, Larry Kusmenski, Ralph Grossi, Thomas Dille, Fred Shank, Catherine Woteki, Edward Hiler, and Marlyn Jorgensen. And of particular importance, as the future is considered, is a group of relatively new directors that have committed themselves to the future of RMF: Lowell Randel, William Fisher, Ellen Bergfeld, Barbara Glenn, James “Jim” Gulliford, Molly Jahn, and Katherine “Kitty” Smith, who rejoined the board after her retirement from USDA.

Important contributions to building on the legacy of Charles Valentine Riley has and is being made by Maria Pisa, Susan H. Fugate, Sara Lee, and others at USDA’s National Agricultural Library (NAL) for their role in maintaining the special collection for Charles Valentine Riley and archives for RMF and in providing exhibits during the Charles Valentine Riley Memorial Lectures. In addition, the assistance provided by Susan McCarthy on the RMF invasive-species program during the time I was housed at NAL and on publishing the proceedings of the Riley Lectures held in 2006 and 2008 is gratefully acknowledged.

1

The Journey Begins on the Llano Estacado

(1902–1953)

Introduction

Although I was born over three decades later, I feel that my journey really began when my grandfather, Joseph T. Hamilton, brought his wife and their first three children to the Plains of Texas. The family arrived by covered wagon in Terry County on February 16, 1902, where the population was 48 in 1900 compared to 12,651 in 2010. "Uncle Joe," as he became known by many, purchased a section of railroad land northeast of the present-day Brownfield. This beginning and many of the events that followed had a long-lasting impact not only during the twenty-one years that I was a resident of Terry County but also during all the years that have followed.

The desire for land and the promise of a better life for their family drew my grandparents to the Plains; and that land, with its flora, fauna, and water, provided most of the family's needs. That land and the experience of living off it that I experienced in my childhood years continued to have profound influences on me during my college years, my career as a research scientist, my relationships with institutions of higher learning, my continuing associations with the land and the people of the Southern Great Plains, and my service to a land-based nonprofit organization.

An overview of the land and its early peoples followed by my early personal experiences helps place in perspective the lasting impact that land-based experiences had on my life.

The Land and Early Settlers

The land that brought my grandparents to the Great Plains is part of the Llano Estacado, or "staked plains," which is that portion of the Great Plains that lies south of the Canadian River. The Llano can be characterized as a vast area without many visible natural landmarks and very limited surface water. The absence of landmarks led to some believing that the "staked plains" designation was associated with the early Spanish explorers placing stakes across the area so they would not become lost. The designation of the northern boundary of the Llano is somewhat arbitrary since the Great Plains extends well north of the Canadian River, but that boundary is probably associated with the very prominent features associated with the river. If the early explorers were near the river, they had a good reference point, and they also had ready access to surface water.

The vast open spaces, limited rainfall, and the scarce surface water were primarily responsible for the Llano being part of a larger area called the Great American Desert by early mapmakers.

Therefore, many early settlers avoided the region. However, after the Civil War and the surrender of a group of American Indians led by the last Comanche chief Quanah Parker in 1875, large ranches became established on vast expanses of school and railroad lands. The digging of water wells and the erection of windmills by ranchers, beginning in the early 1880s, to tap into the Ogallala Aquifer that underlies the Llano made water available throughout the Llano. Thus, windmills became a crucial factor in the settlement of the region by ranchers, who were followed by stock farmers.

Shortly after the beginning of the twentieth century, the State of Texas announced plans to begin selling school lands that were being leased for grazing. This attracted many new settlers. With plans to sell school lands, large parcels of land that had been granted to railroads many years before also began to attract buyers. Many of those buyers were farmers that wished to grow crops but also wanted to keep livestock and poultry primarily for their own use. The stock farmers brought the plow that initially was pulled by mules or horses to the Plains. Like early ranchers, farm families lived in covered wagons and dugouts until houses could be built. They collected dried cow chips (dung) for fuel and dug water wells. Wives and children worked together to do all the chores when the men were away. Women performed nurse and midwife duties. Boys as young as ten stayed with the herd at night to protect it from cattle rustlers and wolves.

In 1902, land transactions in Terry County were administered by Martin County in Stanton, Texas, nearly a hundred miles away. By 1904, the need for a county government became paramount. Brownfield was selected as the county seat, and Joe Hamilton was one of three men that contracted to build the first Terry County Court House.

The Joseph T. Hamilton Family

A dugout located about four miles from the center of Brownfield served as the initial home for my grandfather and his family. Uncle Joe, like other stock farmers that first came to Terry County, worked the land with mules and horses. In 1903, the dugout was replaced with a two-room box-and-strip house built with lumber freighted by wagon from Colorado City, Texas. Corn meal, dried beans, fresh and canned fruits and vegetables, beef, pork, milk, butter, chickens, turkeys, and eggs, all produced on the farm, kept the Hamilton family well fed. Corn was a particularly important source of feed for both family and farm animals. Neighbors gathered for harvest and for butchering livestock. Cotton was the most important cash crop, and Uncle Joe's carpentry and the family carrying mail provided additional cash income.

By 1907, the proceeds from all the Hamilton family's activities made it possible to purchase some seventy acres of land from M. V. Brownfield very near the city of Brownfield and to build a house located about one mile north of the Terry County Court House. The new house was more suitable for a family of seven and much closer to schools. The family continued as stock farmers on the newly acquired acres as well as on the original railroad section. A key factor in Uncle Joe's decision to purchase land in Brownfield was so his children would have better access to school.

The Weldon and Allie "Babe" Ridgway Family

My mother, Allie Mattie "Babe" Hamilton, born in 1907, was the youngest child of Joe and Laura Hamilton. She met Richard Weldon Ridgway, who had come to work as a carpenter for his uncle B. L. Thomson in the mid-1920s. Allie and Weldon were married in 1929. Their first son, Joseph Gene Ridgway, was born on January 13, 1932, and my father began farming on the original Hamilton railroad section. Soon after my birth in Brownfield on November 9, 1935, our family moved from town into the original box-and-strip house that had been built on the railroad section in 1903. However, it soon became increasingly evident that the living conditions were very primitive, and after a scare with a rattlesnake in the kitchen, we moved back to town. In 1941, with lumber salvaged from the original house, Dad completed construction of a two-bedroom stucco house. This farmhouse had many renovations over the years. As a skilled carpenter, Dad taught Gene and me to respect and use a number of tools.

My brother Gene and I gained a healthy respect for the land of our ancestors as we helped with farm animals, "chopped" cotton, and did other field work. Mother set aside a piece of land for a nature preserve that provided shelter for bobwhite quail, prairie chickens, horned toads, and an occasional coyote. The coyote caused many a disturbance in Mother's chicken coop. Through the years, when grandchildren came for a visit, Mother often surprised them with a baby horned toad or terrapin in a shoebox. Dad died in 1967, but Mother lived on the family farm until she was eighty-nine years old. During the years Mother lived alone, she cared for the farm. She was often seen riding her little red Massey Ferguson tractor as she sprayed herbicide on the dreaded weed, Johnson grass. She also became an expert bridge player. Mother died in 1996.

During my early years on the farm, particularly during periods of low rainfall when cash crops were in short supply, our family depended heavily on what could be raised on the land, and in many ways, our lifestyle resembled that of my original Terry County ancestors.

Farming with mules and horses by my grandfather and uncles and by my father continued through the 1930s. A very early attempt to mechanize cotton harvesting was a mule-drawn device that stripped cotton from the stalk with a metal rake attached to a wooden box on a sled. A similar device pulled by a Farmall H tractor purchased in 1940 was used on the Ridgway farm. Soon after World War II, a more powerful Farmall M tractor, a combine for harvesting grain sorghum, and a two-row, tractor-mounted cotton stripper were purchased; and our life on the farm continued to improve. The more powerful tractor made possible deep plowing to mix the sandy topsoil with clay to reduce wind erosion.

About the time that our new tractor was purchased, the Federal Rural

Electrical Administration assisted in the establishment of a cooperative that brought electricity to the farm, and soon indoor plumbing and hot water were added. In 1959, irrigation came to the Ridgway farm, greatly increasing productivity.

Brownfield Schools

My early school years provided an important foundation, but attending the Jesse G. Randal Elementary School and learning about Mrs. Randal's very early contribution to the Brownfield schools as the first teacher are particularly memorable. Also, education was a very important consideration in the lives of Hamilton descendants. The five children of Joe and Laura Hamilton graduated from Brownfield High School and most of their grandchildren attended college.

Upon entering high school in 1949, exceptional opportunities were provided through studies in vocational agriculture and the Future Farmers of America (FFA). The lead teacher, Lester Buford, was deeply dedicated to his students; he instilled discipline and displayed exemplary morals.

Participation in FFA judging contests provided exposure to higher education at both Texas Technological College (now Texas Tech University) and Texas A&M College (now Texas A&M University).

In the summer of 1952, I had the unique opportunity to work beside hardworking cowboys when I lived with Byron Fort's family on the Dickinson Ranch near Tatum, New Mexico. The Fort family's great love for the land, horses, cattle, sheep, their Christian faith, and their family provided me with a rich knowledge of ranch life and its people. As the foreman on this ranch, Byron was a good example of a hardworking, honorable friend. The treasured relationship with this family has continued for over sixty years. When I was a senior in high school, I had the good fortune of showing in the 1953 Terry County Livestock Show the grand champion steer that was purchased as a calf from the Dickinson Cattle Company.

Texas Technological College

Although Mr. Buford was the Brownfield teacher that influenced me the most, several other dedicated teachers provided the knowledge and incentive for me to advance my education. Thus, my presentation of the valedictory address at my high school graduation was a particularly significant milestone that led to my enrolling in Texas Tech in the summer of 1953.

The digging of water wells and the erection of windmills to tap into the Ogallala Aquifer that underlies the Llano Estacado was key to the development of the ranching and farming industries. Photo credit: US Geological Survey (USGS).

Tilling the soil with mule- or horse-drawn plows began crop production on the Llano Estacado. The author's grandfather, Joseph T. Hamilton, was one of the first to plow the soil in Terry County, Texas, in 1902. Photo credit: Southwest Collections, Texas Tech University (TTU).

The small box-and-strip house built in 1903 was the original Terry County home for the Joseph T. Hamilton family and an early home for the Ridgway family. Photo credit: author's collection.

A very early attempt to mechanize cotton harvesting was a mule-drawn device that stripped cotton from the stalk with a metal rake attached to a wooden box on a sled; a device similar to this one pulled by a tractor was used on the author's family farm in the early 1940s. Photo credit: Southwest Collections, TTU.

Shortly after World War II, a Farmall M tractor like this one pulling a combine and a tractor-mounted cotton stripper brought mechanization to the author's family farm. Photo credit: Winston Reeves and Southwest Collections, TTU.

The author's grand champion steer in the 1953 Terry County Livestock Show was purchased as a calf from the Dickenson Cattle Company. Photo credit: Brownfield News.

2

The Early Texas Tech Years

(1953–1957, 2011)

Introduction

I had a very positive experience on the campus of Texas Technological College (now Texas Tech University) in 1951 while first participating in the Future Farmers of America judging contests hosted by the School of Agriculture (now College of Agricultural Sciences and Natural Resources [CASNR]). Subsequently, after high school graduation, scholarships and opportunities for employment on campus opened the door of opportunity at Texas Tech. I was fortunate to have part-time jobs that helped finance my college education. I served meals in the Sneed Hall dormitory "chow hall," and I was employed in the Department of Biology as a botany laboratory assistant. A stipend for participating in advanced Reserve Officer Training Corps also helped. On the weekends, I often hitched a ride to Brownfield for a visit with family, and I would return to school with clean laundry and Mother's famous chocolate layered cake.

Student Affairs

To round out my college experience, I became involved in Wesley Foundation of the Methodist Church and several other campus organizations. The election to a leadership position in a freshmen honor society, Phi Eta Sigma, provided an early opportunity to become acquainted with Dean of Student Affairs, James G. Allen. Subsequently, as president of the honor society for upper classmen, Alpha Chi, and as chairman of the board of student organizations leadership retreat in 1956, I continued to benefit from the wise counsel of Dean Allen. My involvement in the leadership retreat also provided the opportunity to work with some sixty-five presidents or other elected representatives of student organizations, including Allen, Texas Tech president E. N. Jones, and past president D. M. Wiggins. These experiences and involvement in other campus organizations—including the Sigma Chi Fraternity, Men's Interdorm Council, Alpha Zeta, and Agronomy Club—contributed to my selection to Tech Salutes in 1956 and to Who's Who Among Students in American Colleges and Universities in 1957. Thus, the opportunity to benefit from the guidance of Allen and others in the broad college community was especially valuable for my Texas Tech experiences.

Dean Allen and Mrs. Louise C. Allen were an integral part of the proud traditions at Texas Tech that I had the good fortune to share. For many years, they served as "strong pillars behind the scenes, giving freely of their time, energy and ingenuities to help students." The "never-ending efforts to guide and counsel both individual students and campus organizations" by both Dean and Mrs. Allen were appropriately recognized by the students with the dedication of the 1957 La Ventana college yearbook to them.

School of Agriculture

One of the most enriching experiences for me while at Texas Tech was the opportunity to spend four days in 1954 with Dean of Agriculture W.

L. Stangel on a trip to Chicago to participate in a national competition for previous recipients of Sears and Roebuck scholarships. At the time, that seemed to be an unbelievable opportunity for a person that had not traveled outside Texas and eastern New Mexico. Dean Stangel was a true friend of students, an outstanding agricultural leader, and a gentleman's gentleman who inspired everyone that knew him. That trip provided a unique opportunity to learn from the dean and to interact with administrators and students from leading universities across the country.

Dean Stangel's influence on me, I now realize, was in many ways a reflection of his many years of his service to Texas Tech and West Texas agriculture. Stangel was one of the three faculty members in the Division of Agriculture when Texas Tech opened in 1925. A. H. Leidigh, the first head of the Division of Agriculture, who came to Tech from the position of assistant director of the Texas Agricultural Experiment Station, employed Stangel, who was a professor of animal husbandry at Texas A&M College (now Texas A&M University). He soon formed the Department of Animal Husbandry, which he headed until he replaced Dr. Leidigh as dean of the School of Agriculture in 1945.

During the years that Dean Stangel was at Tech, he made major contributions to the animal industry, to the School of Agriculture, and to Texas Tech as a whole. He was responsible for developing improved animal rations and setting the stage for the very extensive feedlot industry. These efforts included the use of cotton seed products and grain sorghum in those rations. Stangel, along with A. W. Young, were responsible for initiating the first master landscaping plan for the campus, and Stangel played a significant role in overseeing sports at Texas Tech as a member of the Athletic Council for many years. His many contributions, particularly to the field of agriculture, were recognized by Texas A&M University in 1956 when he was awarded an honorary doctoral degree. Stangel retired in 1958.

Department of Agronomy

Agricultural education and animal science were given serious consideration as majors, but exposure to Dr. Young, head of the Department of Agronomy (now the Department of Plant and Soil Science), brought to light a person that had a truly exceptional scientific understanding of how soil and water could be best managed in semiarid West Texas. That understanding and the associated intellect, together with an orientation toward crops, were major considerations in the selection of agronomy as a major.

Although my most specific memories of Dr. Young come from his teaching of soil and water conservation practices, his abilities were reflected in a range of activities for the over twenty years that he served Texas Tech. He played major leadership roles in developing a certified seed program, bringing landscape horticulture to the campus, initiating grain sorghum research, and helping design a program for cotton gin engineering that brought a federal ginning laboratory to Lubbock.

Entomology

A long-term impact of my experiences at Texas Tech came from association with Donald A. Ashdown, beginning with his courses in entomology and pest management. Dr. Ashdown was truly an inspirational teacher who had an unsurpassed ability to transfer his fascination with insects to his students. He had a phenomenal ability to remember the names of his students. Ashdown's passion for his discipline and his ability to instill that passion in his students were unsurpassed by any other faculty member that I had encountered.

As with some other members of the faculty in the School of Agriculture at Texas Tech, the nature of the person was not fully appreciated at the time. Dr. Ashdown was a key person in the initiation of cooperative research between Texas Tech and Texas A&M College; he was the first entomologist employed by Texas Tech, and he initiated research on the greenbug, an aphid that was a serious pest of wheat. The research project was an outgrowth of the transfer of the PanTech properties to Texas Tech and the associated legislation that provided funds for the project as part of an agreement with Texas A&M. Not long after Ashdown reported to PanTech, the need to address a wide range of insect pest problems in the region became more evident. In 1952, Ashdown joined the faculty of Texas Tech in Lubbock and, along with Russell Stroughtman in the School of Arts and Sciences, led the development of a major entomology teaching and research initiative. Ashdown was a highly effective communicator whether his audience was students, scientists, growers, or pest control operators. This contributed to the development of an undergraduate program in entomology that had more majors at one time than any other institution in the United States. Currently, an MS degree in plant protection is offered. Ashdown's contributions were appropriately recognized in 2006 when he was installed into Texas Tech's Department of Plant and Soil Science Hall of Fame for his contributions in the field of entomology.

Highlights

Although I had many rich and rewarding experiences while a student at Texas Tech, perhaps the Pig Roast, serving on the crops judging team, and the encouragement to pursue graduate studies were highlights.

Pig Roast. The annual Pig Roast started over eighty years ago as an informal gathering of students to recognize judging teams. The event has grown into a traditional event where students, faculty, and administrators honor teams and individuals who have further distinguished themselves and the college. Scholarship donors and recipients, as well as outstanding leaders in the field of agriculture, are also recognized and honored. The event also provides an opportunity to thank the individuals and companies who have assisted in the activities of CASNR.

The Pig Roast was a particularly significant event for me personally in that it was a focal point for recognizing the recipients of scholarships, including my receiving the freshman and sophomore Sears and Roebuck scholarships and the Borden and Fribourg scholarships, and for recognizing the crops and dairy product judging teams in which I participated. The ever-increasing importance of that event is evidenced by the fact that at the Twenty-Ninth Pig Roast in 1956, recipients of thirty-three awards valued at $8,000 were recognized, and at the Eighty-First Pig Roast in 2011, recipients of awards valued at $1.8 million were recognized.

Judging teams. The certified seed program initiated by Dr. Young, in addition to serving the seed industry well, led to the development of highly successful crops judging teams under Cecil Ayers. Teams coached by Professor Ayers placed either first or second in both the national and international judging teams from 1947 to 1953 and again in 1955. I had the good fortune of being a member of the 1955 team. The crop judging teams, together with the livestock judging teams that dated back to Dean Stangel's leadership soon after he came to Texas Tech, resulted in Tech holding the best national records in both areas of any college in the United States in the late 1950s. The experience of training and participating in the crops judging team not only was invaluable in the development of discipline and teamwork skills but also provided an opportunity to interact with leaders in the crop industry.

Graduate studies. Dr. Ashdown inspired many students who later became leaders in academia, government, and industry and who pursued graduate studies at other institutions. Numerous students from Texas Tech went on to study at Cornell University, Iowa State University, Kansas State University, Texas A&M University, and a number of other universities. Many of the early students went to Cornell, where Ashdown had attended graduate school.

After considering the possibility of graduate studies in genetics at a midwestern university, I decided to accept a graduate research assistantship with a salary of $2,500 per year in the Department of Entomology at Cornell University. In February 1957, I boarded an airplane in Lubbock, Texas, for Ithaca, New York.

James G. Allen, named the dean of student affairs at Texas Tech in 1950, and Mrs. Allen were strong pillars behind the scenes, giving freely of their time, energy, and ingenuities to help students. Photo credit: 1957 La Ventana.

W. L. Stangel, dean of the School of Agriculture at Texas Tech from 1945 until 1958 and an outstanding agricultural leader, was a mentor for the author and an inspiration to everyone that had the good fortune to know him. Photo credit: Southwest Collections, TTU.

A. W. Young, head of the Department of Agronomy at Texas Tech from 1937 until 1958, had an exceptional scientific understanding of how soil and water could be best managed in semiarid West Texas. Photo credit: 1957 La Ventana.

Members of the 1956 international championship crops judging team were, from left to right, the author, Ellis Huddleston, Cecil Ayers (coach), James Gaede, and Ray Joe Riley. Photo credit: College of Agriculture Sciences and Natural Resources, TTU.

US Congressman George Mahon (*center*) visits with Grady Tunnel (*right*), member of Texas Technological College Board of Directors, at the Pig Roast, circa 1950; the Pig Roast is held annually by Texas Tech's College of Agricultural Sciences and Natural Resources to honor those that have distinguished themselves during the past year. Photo credit: Southwest Collections, TTU.

Donald Ashdown (*left*), who served Texas Tech from 1952 until 1984 and in 2006, was inducted into the university's Department of Plant and Soil Science Hall of Fame for his contributions in the field of entomology. Photo credit: Southwest Collections, TTU.

3

High Above Cayuga's Waters

(1957–1960, 2007–2008)

Introduction

I arrived at the Ithaca Municipal Airport in February of 1957 to begin a new adventure as a graduate student. I stepped off the plane wearing Dad's lightweight topcoat into deep and blowing snow with temperatures below twenty degrees. My major professor-to-be, Dr. George G. Gyrisco, welcomed me with "That coat will never do here!" He then took me to a department store where I was outfitted in a heavy wool coat with a warm hood and waterproof boots. This proved to be one of the best purchases I have ever made.

My next stop was the infamous insectary, a building with some modest research laboratories and insect-rearing facilities joined to greenhouses. On the second floor of the insectary, there was a small room with two bunk beds provided for students to use in exchange for their caring for the insect colonies and the plants in the greenhouse, particularly on the weekends. Since I did not have a car and was on a limited budget, George (Dr. Gyrisco insisted on being called George by his graduate students) had arranged for me to use one of the bunk beds. The next stop was Comstock Hall, where all of George's students had desks in a large room adjacent to his office. There I was introduced to my desk and my fellow graduate students. So with a new coat in tow, a place to sleep, and a desk, my New York venture as a graduate research assistant at Cornell University began high above Cayuga's waters.

The following June, I invited my hometown and college girlfriend, Donna Jane Newsom, to come for a visit. She drove from Texas with her parents, J. L. and Audine Newsom, and her sister, Barbara Sue. It was a perfect opportunity to show them the beautiful Finger Lakes region and take them to New York City. On this visit, I presented Donna with an engagement ring, and we were married September 15, 1957. Following our honeymoon trip from Brownfield, Texas, to Niagara Falls and on to Ithaca, New York, Donna and I began our first steps of this journey together.

The Setting

Cornell University is situated on high wooded hills above the center of the town of Ithaca. The town is at the south end of Cayuga Lake, one of the Finger Lakes in upstate New York. Rapidly flowing creeks are on the west side of the campus. What a contrast to where I spent the first twenty-one years of life on the high Plains of Texas!

Cornell is a unique Ivy League university in that it includes both privately endowed and state-supported schools and colleges. Cornell's rich heritage began when founders Ezra Cornell and Andrew White, who served in the New York State legislature together, wished to establish a great university. They had very different ideas about what should be emphasized. One had strong agricultural interests while the other favored the liberal arts. However, they came together to found a university, which was initially funded by Ezra Cornell's $500,000 endowment and by the sale of New York's 989,920 acres that were allotted under the Morrill Land Grant Act of 1862 to establish a land-grant university in every state. Thus, the foundation was laid for a unique private-controlled, state-supported statutory university that was established in 1865. Cornell University opened its doors in 1868. From the beginning, Cornell was a diverse institution that not only dealt with the practical issues associated with the original land-grant colleges but with liberal arts and the basic sciences as well. Fortunately, at the time I attended Cornell, graduate research assistants could attend classes in both the private- and state-supported parts of the university without paying tuition. This arrangement provided many rich and diverse opportunities that were particularly attractive to students with limited resources.

John Henry Comstock came to Cornell in 1869 as a student. In 1872, he offered lectures in entomology on a voluntary basis. These lectures attracted wide interest, including that of President Andrew White. As a result, Professor Comstock was employed as an instructor in 1873. Soon after his graduation in 1874, the first department of entomology in the United States was founded by Comstock. It included a rich mixture of applied and basic research that has prevailed for well over a century.

Forage and Cereal Insect Investigations

Dr. Gyrisco was the proud leader of a research effort that he fondly called the Forage and Cereal Insect Investigations (FCII). The research was conducted primarily by graduate research assistants. There were usually about five research assistants in FCII and sometimes a postdoctoral fellow. Everyone in the group was expected to work as part of a team on the insect problems associated with forage and cereal crops in New York. However, the vast majority of the work was with forage crops. The overall research program was composed mostly of specific problems with insect pests selected by George and the graduate students. The resulting research then became the bases for MS theses and PhD dissertations. Although my research assignment to study the effects of insects on bird's-foot trefoil was a rather specific New York State problem, my research involved the tarnished plant bug, a representative of a large group of sucking insects that are serious pests of numerous crops throughout the world.

The standard graduate advisory committee in the Department of Entomology and the course work required by George were integral parts of the graduate experience. However, George brought an extra dimension to the graduate experience by requiring that his students participate in various activities that, when combined, provided particularly outstanding training. For instance, each student was required to write a report each fall on all their experiments, which contributed to an annual FCII report. The reports from all the students were bound with black cover and labeled with gold lettering. That provided a valuable experience in technical writing and timely reporting of research results. That documentation later proved to be very useful in writing theses and dissertations.

As I was completing my master's degree, our daughter Susan Jane Ridgway was born on January 6, 1959, during a snowstorm. It seems her entrance into this world was greeted with snow much like my entrance to Ithaca. Donna and baby Susan stayed one week in the hospital (yes, in those days, new mothers did stay one week), and I spent much of that time typing the final copy of my master's thesis.

George strongly encouraged his students to participate in the branch and national meetings of the Entomological Society of America (ESA) whenever they were within driving distance. Thus, during most years, students presented papers at the meeting of the Eastern Branch of ESA. One year, a group of us drove to Detroit, Michigan, to participate in the national meeting. Both the branch and national meetings were valuable, but the national meetings provided a more in-depth exposure to a wide array of basic and applied entomological research. It was at that meeting that I heard reports of the comprehensive work on the integration of chemical and biological control of the spotted alfalfa aphid at the University of California. That exemplary research, which resulted in a combination of selective insecticides and parasites and predators in a management program, had a lasting impact on my professional career. Many of the principles involved were later applied to my research on cotton insects and were integrated into my broader writings on insect pest management.

Additional valuable training for George's students that was also beyond the norm for graduate assistants took place once each year when a regional farmers' cooperative sponsored a conference at their Ithaca facility. There, Cornell scientists and agribusiness representatives shared new developments. George insisted that his students report on their more significant experiments at this annual conference. The presentations were carefully rehearsed, with students offering critiques of one another's presentations. These annual extension-oriented conferences provided particularly good training for students that would pursue professional careers with applied orientations.

George was a very well-respected leader among forage insect scientists within the United States. For example, he was asked to author the first major review article on forage crop insects for the prestigious *Annual Review of Entomology*. George's relationship with scientists nationwide was a real asset in helping his students interact with other leaders in the field. Although most of his students conducted research on forage crops, George influenced many other students at Cornell through his service on their graduate advisory committees and in counseling those students. He encouraged his students to take full advantage of the expertise and diverse opportunities available at Cornell and beyond and he was particularly adept at opening doors of opportunity. Perhaps George's greatest assets were his abilities to identify and nurture academic talent and his deep commitment to his students. His greatest legacy is the training and the unlimited opportunities that he provided those having the good fortune to be associated with him.

As I reflect on George and his personal support of students, I am reminded of the annual Thanksgiving dinner that he and his wife, Val, hosted for his students. This event helped curb homesickness when we gathered around the dining table as one big family, watching George expertly carve the turkey, which was stuffed with sausage and bread dressing, anticipating Val's delicious meal. Through the years as Donna and I remembered those special Thanksgivings, we often named our turkeys George.

Fundamentals and Innovation

Courses in biochemistry, statistics, systematics (taxonomy), animal and insect ecology, insect physiology, and insect toxicology provided a firm scientific foundation, and the agricultural entomology training associated with the research assistantship provided much of what any student would expect from graduate studies. However, exceptional additional inspiration and innovation came from exposure to many distinguished scientists through formal courses and guest lectures. Among the most memorable are guest lecturer E. O. Wilson, a population ecologist from Harvard University's Museum of Comparative Zoology, and Cornell faculty members Thomas Eisner and Howard Evans from the Department of Entomology and Jerrold Meinwald from the Department of Chemistry. Drs. Wilson, Eisner, and Evans were all later elected to the National Academy of Sciences, and Eisner and Meinwald were awarded the Tyler Prize in Environmental Achievement for their collaborative research on chemical ecology. Of these individuals, perhaps my most in-depth contact was with Evans while taking his course on the taxonomy of wasps and bees. There was a time that taxonomists were often viewed as scientists that spent much of their time in museums studying dry specimens. Evans's pioneering research in the use of behavioral information from his studies of sand wasps helped place a different perspective on the role of systematics (taxonomy) in ecological research. Thus, his research and its presentation in his classes and his publications clearly demonstrated the importance of knowing the organism you are working with for the resulting research to be most meaningful.

A Broad Perspective

The Cornell experience included not only in-depth exposure to the science of entomology and other biological sciences and their application but also to science's broader role in agriculture and society. This broad background significantly influenced my activities for the over five decades that followed.

A focal point for that broad perspective was Charles E. Palm, head of the Department of Entomology when I arrived at Cornell. Dr. Palm had built the forage and field crops field laboratory near Oswego, New York, where I spent the summers, and he had a strong background in forage crop insects. He became a member of my graduate advisory committee, and although he was promoted to director of research in the College of Agriculture and then to dean of the college during my stay at Cornell, he continued to serve on my advisory committee. I was most fortunate to have the benefit of that association.

Dr. Palm, head of the Department of Entomology for twenty years, initiated specialized programs in insect toxicology, insect biochemistry, and insect physiology. Later, he helped inaugurate Cornell's Division of Biological Sciences, which formalized the linkages between the state-supported College of Agriculture and the private-supported College of Arts and Sciences. This involved such outstanding professors as Dr. Eisner and Dr. Meinwald, who taught in both colleges. Dr. Palm also played an integral role in national pest management policy. He chaired the National Research Council/National Academy of Sciences Committee on Plant and Animal Pests, which published six volumes, providing much of the basis for pest management practices for many years.

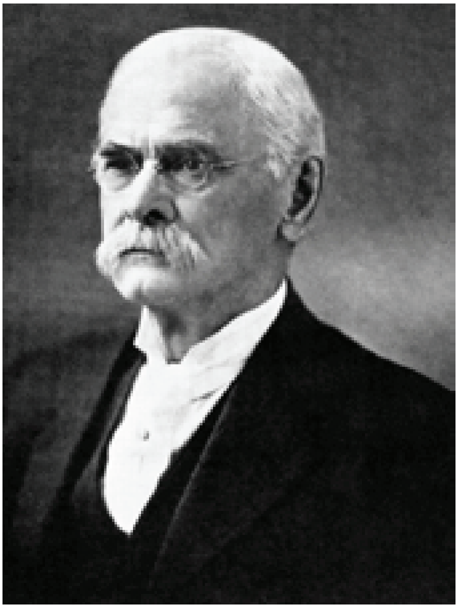
Perhaps the best way to summarize the Cornell experience is to quote Dr. Evans, who wrote that “insects as living organisms (are) such unique and fascinating organisms that those that study them are perhaps the most fortunate persons on earth.”

Search for Employment

As I was completing my studies at Cornell in 1960, my job search focused on discussions with the University of California and the Texas Agricultural Extension Service (now Texas AgriLife Extension Service). The Extension Service offered me the opportunity to return to Texas and begin work in June, with an arrangement for a six-month leave of absence beginning in September, allowing me to fulfill my commitment to the US Army at Fort Sam Houston in San Antonio, Texas. So with my PhD diploma in hand and Donna with her PhT diploma (for Putting Husband Through, which included typing my PhD dissertation, that was awarded by the Graduate Wives of Cornell University), we loaded our black Ford Fairlane and a rental trailer and left Ithaca with daughter Susan, to begin a new job in College Station, Texas. After three months in College Station, we moved on to San Antonio and Fort Sam Houston for six months before returning to College Station. The six months we were in San Antonio, perhaps the most beautiful city in Texas, was a most enjoyable experience. We lived in a nice apartment with swimming pool, and my rank as first lieutenant gave us enjoyable privileges in the officer’s club at Fort Sam Houston. After some basic Medical Service Corps training, I was assigned to the entomology laboratories, where I had the opportunity to conduct research on the control of scorpions. Thus, the graduate training at Cornell led not only to employment at Texas A&M but also to an enhanced military experience.

Cornell University Revisited

In early 2007, professor emeritus of entomology Arthur Muka at Cornell (one of George's former students) contacted me with a proposal to honor George, who died in 1989. I contacted the Entomological Foundation that had been established by the Entomological Society of America and drafted an agreement between Cornell University and the foundation to provide an endowment to support an annual George G. Gyrisco Graduate Student Award in Applied Entomology in perpetuity. Concurrently, Dr. Muka and I contacted George's former students and other friends to ask for contributions to the endowment. Some twenty-five entities contributed to ensure that funds will be available for an annual award. I was delighted to be able to join other former Gyrisco students at Cornell on September 15, 2008, for the presentation of the first annual George G. Gyrisco Graduate Student Award in Applied Entomology. The occasion also provided the opportunity to attend a concert on campus, to tour the campus and the Department of Entomology facilities, and to visit the university library. Many fond memories were rekindled and acquaintances made or renewed. The many advances that I observed then on the Cornell campus provided substantial evidence that Cornell continues to be one of America's finest universities.



John Henry Comstock became an instructor in entomology in 1871 and founded the Department of Entomology at Cornell University, where he served as chairman until 1914. Many outstanding scientists followed Professor Comstock, and in 1957, the department had as many entomology graduate students as any department in the United States. Photo credit: Department of Entomology, Cornell University.

George G. Gyrisco served his entire professional career in the Department of Entomology at Cornell University from 1947–1985, where he was well known as the graduate student's best friend. Photo credit: Department of Entomology, Cornell University.

Howard E. Evans, who conducted pioneering research on behavior of sand wasps, demonstrated the importance of knowing what organism you are working with in order for the resulting research to be most meaningful. Photo credit: Mary Jane West-Eberhard.

Charles E. Palm, who played an integral role in national pest management policy through the National Research Council of the National Academy of Sciences, served as the chairman of the Department of Entomology at Cornell University from 1938 to 1957 and as dean of the College of Agriculture (and Life Sciences) from 1959 to 1972. Photo credit: Department of Entomology, Cornell University.

The Forage and Cereal Crop Insect Investigations student research staff in the summer of 1958. *Left to right:* standing, Harry Shorey, George Poinar, Carl Koehler, Ellis Huddleston, Robert Little; kneeling, Donald Terrill, the author. Photo credit: George G. Gyrisco.

At the occasion of the presentation of the first George G. Gyrisco Graduate Student Award in Applied Entomology in 2008 were former students of Dr. Gyrisco: (*left to right*) the author, George Kennedy, and Arthur Muka. Photo credit: Marian Harthill.

4

Getting Started Along the Brazos

(1960–1964)

Introduction

I reported for work during the summer of 1960 as an associate extension entomologist in the Department of Entomology at Texas A&M University at College Station, Texas, not far from the Brazos River. This began an extended association with Texas A&M University, including serving on the graduate faculty while later employed on the campus by the US Department of Agriculture (USDA). After a leave of absence and the completion of my active military service, Donna and I, with daughter Susan, returned to College Station in March of 1961 and purchased our first home. On August 22 of that year, our second daughter, Sharon Kay Ridgway, was born.

Texas Agricultural Extension Service

A rewarding and memorable experience occurred very soon after reporting to duty at College Station. I was called to a farm in the blacklands of

Texas operated by Dan Pustejovski to advise on a problem with the cotton fleahopper. This was a problem that had a direct tie to my graduate research since both the tarnished plant bug and the cotton fleahopper have very similar feeding habits in that they both feed on very young flower buds, commonly called "squares" in cotton. This first field visit led to a long-term relationship with Mr. Pustejovski, who became an outstanding leader in the Texas cotton industry and an invaluable informal advisor during all the years I was at College Station.

During my tenure with the Texas Agricultural Extension Service (now Texas AgriLife Extension Service) from 1960 to 1963, I assisted with publications and other educational materials dealing with insect pests of cotton, livestock, vegetables, stored grain, and ornamentals and with bees and pesticide drift. However, I was most heavily involved with cotton and livestock.

As the lead Extension person for cotton insect control, I was responsible for an annual work session during which the Extension specialists met with Texas A&M University and USDA researchers to review insect control recommendations and provide inputs for recommendations that were included in insect control guides that were revised each year. Each spring, I joined a cotton production team led by agronomist Fred Elliot; we held production meetings throughout a major part of the state. During this process, I learned a great deal about cotton and benefited from interactions with a number of industry leaders. Knowledge gained proved quite valuable during later years while conducting research and interfacing with the cotton industry.

A major role with interests in livestock emerged as plans were made to launch the Southwestern Screwworm Eradication Program. The private Southwest Animal Health Foundation (SWAHF) was formed to provide a mechanism for the livestock industry to provide funds to match federal funds to eradicate the screwworm from Texas and the Southwest. I was asked to take the technical lead for the Extension Service. That involved extensive educational efforts during a fund-raising phase, followed by educational efforts as the eradication program was launched. I participated in regular meetings of SWAHF and communicated regularly with R. C. Bushland of the USDA's Agricultural Research Service (ARS), who had led the technical aspects of the successful eradication program in the southeastern United States. That program was originally conceived by Edward F. Knipling, also of ARS.

I developed a close working relationship with Dr. Bushland because I understood the science, and as with most operational programs, there are often difficult decisions to be made in regard not only to what is technically desirable but also to what is operationally feasible. As in many programs, ARS had responsibility for scientific and technical support, and the Animal and Plant Health Inspection Service had responsibility for implementation. The technical and operational personnel had numerous vigorous discussions as operational refinements were made. My experiences working in the screwworm program proved to be valuable in later years in dealing with cotton insect issues at the national level.

The time I spent with the Extension Service was enjoyable, and it proved to be very valuable in dealing with practical problems and the various users of insect management technologies. Also, I found the organizational and public relations skills and the visions of John Hutchinson, the state Extension director, to be outstanding. For example, he championed the concept of area-based specialists providing support to county staffs, public agencies, and commodity groups. I was actively involved in extending that concept to area specialists through the establishment of area entomologist positions.

When I joined the Extension Service, there were three professional entomologists on the headquarters staff and two county entomologists. During my tenure, a transition began toward establishing area entomologists to serve Extension districts. After two years, I was promoted to entomologist and named state coordinator for Extension entomology. Thus, after making substantial progress by more than doubling the staff in the Extension entomology program but with a personal desire to be closer to finding answers to problems, I began to explore a position closer to research.

Joining the Agricultural Research Service

As I began to explore a possible job change, I considered public and private employment. Of the private positions explored, I selected a research and development position with Shell Development Corporation as one of particular interest. I was offered a position with Shell in California, but after looking at that position in depth, I decided that I would prefer a position with more of a public service orientation. Because of my long-standing interest in both crops and livestock, positions in ARS related to both fields were explored. Subsequently, I was offered positions related to livestock at Kerrville, Texas, and to cotton at College Station, Texas. Both positions were of interest, but the position at College Station included the opportunity to continue to be a part of a university community and to serve on the graduate faculty at Texas A&M University. Also, the assignment at College Station was particularly attractive in that its objective was to develop more effective systemic insecticides under the assumption that if the insecticides were within the plant, beneficial insects would not be harmed by their use. The potential value of selective insecticides to preserve natural enemies was of considerable interest, dating back to 1959 when I was exposed to the work in California on developing an integrated program for control of the spotted alfalfa aphid. Therefore, I accepted the position in College Station and joined ARS in the spring of 1963. I was appointed to the graduate faculty in the Department of Entomology at Texas A&M shortly thereafter.

Natural Enemies

Even though my major research emphasis was initially placed on systemic insecticides as per the original research assignment, related studies on beneficial insects were welcomed as was research on other selective insecticides. Also, the value of natural enemies in regulating populations of bollworms and tobacco budworms was becoming better recognized. This was because of the increasing resistance in insects to insecticides and, in particular, because of the resistance in the tobacco budworm to organophosphate insecticides.

Since graduate students often provide an efficient means of conducting exploratory research, I began to seek their help. A qualified graduate student, Peter D. Lingren, was recruited, and that student obtained support through a fellowship awarded by the Cotton Foundation. Peter conducted studies on natural enemies of the bollworm and tobacco budworm. These studies included predatory behavior and insecticidal affects and led to the selection of the green lacewing as a promising candidate for use in mass releases for biological control of the bollworm and tobacco budworm.

Systemic Insecticides

The small group of USDA entomologists at College Station, Texas, with a long history of working on systemic insecticides was expanded, and the group moved into a new USDA building on the Texas A&M campus about the time I became a part of the group. Systemic insecticides continued as a major mission for the group, but a broader perspective came with the significant expansion of cotton insects research funding to build the Boll Weevil Research Laboratory at State College, Mississippi, and to increase research at a number of other locations, including College Station, Texas. The increased research had a major focus on the boll weevil.

When I joined ARS, I was fortunate that there were numerous experimental insecticides available from the industry for use in research. I immediately accelerated the research that was underway by initiating a wide range of fundamental and applied studies.

Previous studies on the effects of systemic insecticides on beneficial insects were very limited. The theory was that if the systemic insecticides were inside the plant, beneficial insects would not be harmed. The theory had not really been tested. So research was initiated to evaluate possible effects of systemic insecticides on beneficial insects.

The E. F. Knipling Influence

When I joined ARS, I was, as a result of my involvement in the Southwest Screwworm Eradication Program, fully aware of Dr. Knipling's innovative role in developing the highly successful sterile male technique for eradication of the screwworm. However, I was not fully aware of his immense influence on entomology. I soon became aware that Knipling had been primarily responsible for substantially increasing research on cotton insects. His approach can perhaps be introduced best by an excerpt from remarks he made at the Beltwide Cotton Conferences in 1956:

> We cannot now conclude that it was a mistake to put so much effort on continued search for new and better insecticides. The real mistake is that we have not been able to carry forward at the same time a broad program of basic research on many aspects of cotton insect problems.

Dr. Knipling outlined in that presentation the need to expand research broadly on cotton insects to include studies on (1) chemical control, (2) physiology and toxicology, (3) mechanisms and causes of resistance, (4) systemic insecticides, (5) attractants, (6) growth regulators, (7) cultural and biological controls, (8) estimation of and forecasting abundance, and (9) host plant resistance. This 1956 presentation was augmented by his concept for dealing with boll weevil eradication in a USDA task force report during late 1958. Subsequently, Knipling's leadership, with the assistance of the National Cotton Council, led to greatly increased appropriations for cotton insects research in 1959. That made possible initiation of the kinds of research proposed in 1956.

Dr. Knipling's efforts in developing more ecologically desirable methods of insect control went far beyond cotton insects. As director of USDA's Entomology Research Division, he led major changes in research direction throughout the division. Knipling had the foresight to make these changes well before the publication of Rachel Carson's 1962 *Silent Spring*, which condemned the use of conventional insecticides.

Although my research with ARS began with an emphasis on systemic insecticides, there arose opportunities to explore other avenues, especially biological methods of control.

Future Implications

The concept and principles, including those related to area-wide insect population management, put forth by Dr. Knipling and their impact on increasing federal appropriations provided both the framework and resources for expanding the research that I was conducting. That research included augmentation of natural enemies, systemic insecticides, microbial agents, boll weevil eradication, and other approaches to insect control.

The boll weevil entered the United States from Mexico in 1892 and became a highly destructive pest throughout the Cotton Belt; the availability of the systemic insecticide, aldicarb, provided a valuable tool for studying boll weevil eradication. Photo credit: Agricultural Research Service (ARS), US Department of Agriculture (USDA).

The immature stage of the green lacewing (*right*), which is a highly effective predator of the bollworm (*center*), tobacco budworm, and other plant pests, was used in the demonstration of augmentative releases for the control of a field crop pest in 1967. Photo credit: ARS, USDA.

5

Biological Control by Augmentation of Natural Enemies

(1965–1977)

Introduction

The selection of the green lacewing as a promising candidate for use in mass releases for biological control of the cotton bollworm and tobacco budworm and subsequent successful field-cage and field studies led to a major expansion of studies on mass rearing and augmentative releases of natural enemies at the US Department of Agriculture's (USDA) Agricultural Research Service's (ARS) cotton insects laboratory at College Station, Texas. That expansion was made possible primarily as a result of the support of Edward F. Knipling, director of the ARS's Entomology Research Division, and George Slater, vice president for agricultural research for Cotton Incorporated. The broad strategy behind the expansion was contained in the founder's memorial address presented by Dr. Knipling, "Some Basic Principles of Population Suppression," at the national meeting of the Entomological Society of America in 1965.

The multifaceted research with green lacewings and *Trichogramma* egg parasites detailed here provides a case study on the development of a program for use of two specific organisms for use in biological control of insect pests by augmentation of natural enemies.

Behavioral and Small-Scale Efficacy Studies with Green Lacewings

Because the green lacewing is a general predator that feeds on a wide range of insects, the high level of reduction on bollworms and tobacco budworms resulting from releases of the larvae was a bit puzzling. A fellowship from the Cotton Foundation made it possible to initiate detailed studies on the behavior of a green lacewing by a graduate research assistant Patrick Boyd. He found that green lacewing larvae position themselves within the bracts of cotton squares (flower buds) during the hot part of the day. Since small cotton bollworm and tobacco budworm larvae are also within the bracts of squares as they feed on the squares, the behavior of the three insects brings them together in rather close quarters. Thus, a general predator becomes a more specific predator because the predator and prey seek the same niche. This information provided additional justification for expanding research on the use of releases of green lacewings to control the bollworm and tobacco budworm.

The results of field tests of releases of green lacewings to control the bollworm and tobacco budworm on cotton conducted during 1967 clearly documented the successful use of releases of a natural enemy to control an insect pest on an annual field crop. These results led to a wide range of developments. First was Dr. Knipling's request that I present the results of this and other experiments on green lacewings at the International Congress of Entomology held in Moscow, USSR, in 1968. Early national attention was also given to the results through such events as the Tall Timbers Conference on Ecological Animal Control by

Habitat Management in Florida and the Summer Institute on Biological Control of Plant Insects and Diseases in Mississippi.

Program Expansion

The highly successful small-scale field experiment with green lacewings during 1967 raised the significant question, what should be done next? Although green lacewings were available commercially in limited quantities, they were not available for large-scale studies. Also, based on small-scale studies conducted at other locations and theoretical models, there was considerable interest in conducting large-scale studies with *Trichogramma* egg parasites. Since the Angoumois grain moth was believed to be a suitable host for both green lacewings and *Trichogramma,* the issue arose of building a pilot rearing facility that would support large-scale testing of both green lacewings and *Trichogramma* with large quantities of insects of known quality. The offer by Cotton Incorporated to build the pilot plant led to the decision to construct a rearing facility and expand the research program at College Station, and ARS transferred Richard Morrison, an insect-rearing specialist, from the ARS laboratory in Columbia, Missouri, to College Station in about 1970 to manage the facility. These actions, with additional funds, made possible expanded research on rearing and utilizing mass-reared natural enemies for control of insect pests. Ronald Stinner (a postdoctoral research associate through Texas A&M University who was to take the lead on the research on *Trichogramma*), B. G. Reeves (a senior engineer at Texas A&M who wished to complete a PhD dissertation on the engineering aspects of mass rearing and release of natural enemies), Richard Kinzer (an ARS entomologist), and Larry Jones (a senior ARS technician who had been involved in the research on green lacewings) formed a well-qualified team.

Insect Production

Insect production, under the supervision of Mr. Morrison, was initiated after the design, construction, and equipping of a 4,000-square-foot building on the Texas A&M campus. Since the Angoumois grain moth eggs were used to rear both *Trichogramma* and green lacewing larvae, the grain moth rearing was critical support to the expanded research program. Procedures were established that provided for consistent production of about 450 grams of grain moth eggs each day during periods of peak demand. The availability of abundant grain moth eggs made possible the rearing of the insects needed to conduct the research necessary to make extensive improvements in procedures for rearing green lacewings and *Trichogramma* and to conduct field experiments.

As more was learned about the numbers of lacewings needed to obtain desired levels of insect control and about the cost of rearing grain moths, research was initiated on developing an artificial diet for lacewing larvae as a practical way of feeding the larvae. A successful diet was developed, and a joint project with the Southwest Research Institute resulted in the development of an encapsulated diet that was satisfactory for feeding second- and third-instar larvae. Since the capsule wall was too difficult for first-instar larvae to penetrate, a rearing protocol that involved feeding first-instar larvae grain moth eggs and feeding the later instars encapsulated diet was developed. This approach had considerable potential for greatly reducing the cost of rearing green lacewings.

Because of the high cost of rearing green lacewings, additional emphasis was placed on rearing *Trichogramma.* Subsequently, between thirteen and fourteen million *Trichogramma* were consistently produced each day during the growing season for several years.

Storage and Quality

Storage of different forms of viable biological materials is needed in order to utilize those materials more efficiently. Since storage and continuous rearing under confined conditions might affect the quality of the insects reared, continual monitoring of the number of insects produced and their quality is necessary to obtain predictable results.

Fortunately, grain moth eggs that are frozen for long periods are satisfactory for rearing lacewing larvae and other predators that feed on insect eggs. Research on storage of lacewing eggs demonstrated that they could be stored at reduced temperatures for ten days without adversely affecting hatch. Although this is a relatively short period of time, it is enough to be useful in managing when insects are available for field releases. Another important factor to consider in rearing lacewings is whether or not the viability of insects produced in culture under confined conditions at constant temperatures might deteriorate over time. Experiments with three strains of lacewings, reared for three periods of time, indicated that for best results, substantial numbers of field-collected insects should be added to cultures at least once each year.

Research on the storage of *Trichogramma* indicated that pupae could be stored for eight days without having any adverse affects on emergence. An additional benefit of cold storage is that if temperatures were carefully manipulated, the adult *Trichogramma* would emerge over a much shorter period of time, Thus, making it possible to reduce the mortality of *Trichogramma* adults and pupae prior to, during, and after release.

As part of the overall study of the quality of *Trichogramma,* the longevity, fecundity, and searching ability of *Trichogramma* reared on three different host eggs were determined. In general, larger host eggs were preferred. However, when costs of rearing the host were considered, the smaller grain moth eggs were preferred, although additional numbers of *Trichogramma* reared on the eggs of the smaller host were required to obtain the same results. The methodology used in this study and the data collected represent what is needed on a continual basis to ensure that insects of adequate quality are being produced.

Distribution

Historically, most mass-reared natural enemies have been released manually, which is very labor intensive. Therefore, automation of releases is important for this approach to be competitive with other methods of pest control. Since mechanized releases must be compatible with the stage of the insect involved, research on distribution methods included manipulating the insects so that the stage would be compatible with the mechanized release method and still result in the release of insects in a viable condition.

In the first field experiment on cotton with green lacewing, small larvae reared in individual paper cells (Hexcel) were released manually. Then efforts to automate release of green lacewing eggs showed that eggs could be suspended in solutions of water and starch and sprayed onto cotton with minimum damage to the eggs. However, when the eggs hatched, survival of the larvae was poor because they often did not find prey to feed upon. Therefore, Mr. Reeves studied automating the release of larvae. He developed a method whereby lacewing eggs could be mixed with sawdust and grain moth eggs so that when the lacewing eggs hatched, they would be able to feed on grain moth eggs. Also, the sawdust provided enough separation of the lacewing larvae to minimize cannibalism. This method proved to be quite satisfactory in preparing lacewing larvae for release in an automated fashion. Subsequently, backpack, tractor-mounted, and airplane-mounted distributors were designed, constructed, and tested. The backpack and tractor-mounted distributors performed as desired. However, the survival and recovery of lacewing larvae following aerial release was less than desired because considerably fewer larvae could be recovered on the cotton plants.

Traditionally, *Trichogramma* had been released manually on small squares of paper taken from a larger piece to which moth eggs had been glued before the eggs were parasitized by *Trichogramma* adults. The paper squares were placed on plants just as the *Trichogramma* adults began to emerge. Realizing that this method of distribution had been proven to be effective, the first effort to automate releases was to develop packaging for small paper squares and to design, construct, and evaluate equipment that could be mounted on a tractor or in an airplane to open and distribute the packages within which the *Trichogramma* had just emerged. By programming the *Trichogramma* pupae with cold temperatures, it was possible to compress the period of adult emergence within twenty-four hours, Thus, making it possible to release highly viable *Trichgramma* adults. This method was extensively tested on several hundred acres and proved to be operationally feasible. However, the packaging required more labor, and the packages cost more than was desired.

Subsequently, a method was developed by which the grain moth eggs were parasitized on glass plates and then removed so that *Trichogramma* pupae could be produced in bulk without using the paper substrate. This enabled the exploration of a wide range of options for automating releases.

Efficacy

The development of the lacewing/sawdust distribution method greatly facilitated field research in which emphasis was placed on evaluating different ages and numbers of lacewings. Larvae that were approximately one, two, and three days old released on cotton all reduced the numbers of bollworms and tobacco budworms on cotton, but the three-day-old larvae were the most effective. Releases of 10,000, 30,000, and 100,000 two- to three-day-old larvae per acre reduced the numbers of bollworms and tobacco budworms, with the 100,000 per acre level providing the desired level of control.

Field studies with *Trichogramma* were initiated during 1971. In these studies, 34 percent to 85 percent parasitism of bollworm and tobacco budworm eggs was obtained with releases of 20,000 to 388,000 *Trichogramma* per acre in replicated plots. The plots were two to four acres in size within a field located in the Brazos River bottom (under a contract so the farmer would be reimbursed for any damages). This arrangement made it feasible to have untreated controls and to continue treatments that were not providing desired levels of insect control.

Although desirable rates of parasitism were obtained during the initial releases, the rates of parasitism after subsequent releases dropped drastically. Insecticide drift from adjacent fields was suspected of killing the *Trichogramma*. Studies with caged *Trichogramma* at different distances downwind from where low volume aerial applications were being made to cotton indicated that insecticidal drift killed 99 percent of the *Trichogramma* caged 0.5 mile from the nearest treated field and that 74 percent were killed 1.0 mile from treated fields. Mortality of *Trichogramma* 2.0 miles from treated fields was only 4 percent. Because of the obvious need for experimentation in cotton fields some distance from those receiving aerial applications of insecticides, an experimental area in Frio County was selected. The fields were selected with the intent of managing the boll weevil with diapause control over a large area so as to be able to evaluate releases of *Trichogramma* on a number of cotton fields without the need to apply insecticides for control of the boll weevil during the regular growing season. Applications of insecticides for diapause boll weevil control were made in accord with the recommendations of federal and state agencies the fall before *Trichogramma* releases were made. Aerial releases of from 50,000 to 100,000 *Trichogramma* per acre were made on five fields in Frio County the following year. Those releases resulted in an average of 52 percent parasitism of bollworm and tobacco budworm. Unfortunately, the diapause boll weevil control program did not cover a large enough area to prevent boll weevils from beyond the diapause-treated area from infesting four of the five experimental fields. However, on one of the fields, the *Trichogramma* releases together with the natural occurring parasites and predators prevented the bollworms and tobacco budworms from reaching economically damaging levels. The efforts in Frio County demonstrated the operational feasibility of using aerial releases of *Trichogramma* to obtain over 50 percent parasitism of bollworm and tobacco budworm eggs. Likewise, the importance of removing the boll weevil and the related insecticide applications from cotton production in order to take full advantage of biologically based insect control technologies was vividly demonstrated.

International Significance and Future Implications

The successful field test with green lacewings, the expansion of research at College Station to include *Trichogramma*, the construction of the pilot rearing facility, and the results of the related research led to the request for me to participate in an exchange trip to the former Soviet Union in 1974.

That trip, along with the support of leading US biological control scientists P. S. Messenger and R. I. Sailor, resulted in the selection of augmentation of natural enemies as a topic for a major symposium by the organizing committee for the International Congress of Entomology to be held in Washington, DC.

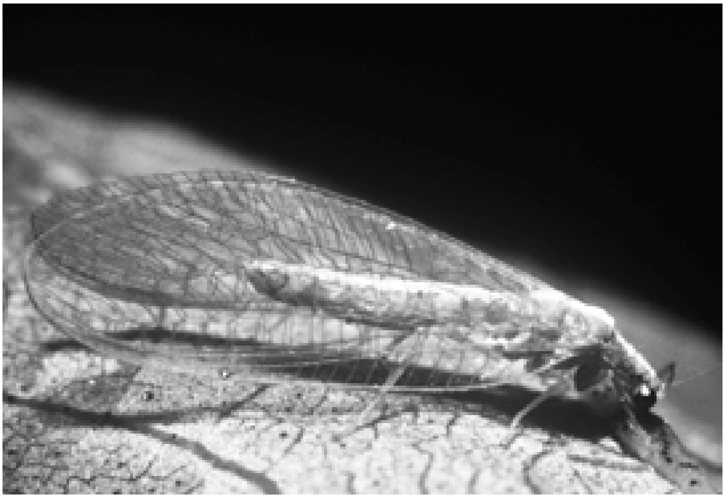
Scientists from the Canada, France, Great Britain, Soviet Union, Switzerland, and the United States participated in the symposium and prepared chapters that, together with some additional chapters, resulted in the book *Biological Control by Augmentation of Natural Enemies: Insect and Mite Control with Parasites and Predators*, published by Plenum Press in 1977. That book laid a firm foundation for continued international activities related to mass-reared natural enemies and other biologically based insect control technologies for insect control that took place over the next two decades.

Another experience associated with the early research on biological insect controls that had long-term impact was an invitation to make a presentation on biological insect control before a garden club in Dallas, Texas. I was given a subscription to *Organic Farming and Gardening* in appreciation for making the presentation. I continued to subscribe to that magazine for many years and developed a relationship with the Rodale Publishing Company that led to a long-term relationship with the Institute of Alternative Institute, including serving on the editorial board for the *American Journal of Alternative Agriculture*. Those relationships provided a perspective that has proved valuable over the years as I have strived to take a broad view of how agriculture serves society.

Edward F. Knipling, director of the Entomology Research Division, ARS, USDA, from 1953–1971, revolutionized insect research in USDA by greatly expanding research on ecologically desirable methods of insect control, including total population management of the boll weevil and the augmentation of natural enemies. Photo credit: ARS, USDA.

Richard K. Morrison, shown here with a *Trichogramma* parasite rearing cage, was transferred to College Station, Texas, from Columbia, Missouri, in about 1970 to manage a new pilot insect-rearing facility. Photo credit: ARS, USDA.

Trichogramma parasite adults place their eggs inside the host egg, where the parasite egg hatches and destroys the egg of such pests as the bollworm and tobacco budworm. Photo credit: ARS, USDA.



Green lacewing adults were reared in large quantities so their eggs and larvae could be released in the field to control the bollworm and tobacco budworm on cotton plants. Photo credit: ARS, USDA.

B. G. Reeves with equipment he designed and built for releasing green lacewing larvae that had been prepared for release in a carrier composed primarily of corn cob granules. Photo credit: ARS, USDA.

Scientists in front of the All-Union Scientific Research Institute of Phytopathology, Moscow, USSR, in 1974 during a scientific exchange on mass rearing and augmentation of natural enemies of insects: (*left to right*) G. A. Beglyarov, the author, and A. I. Smetnik. Photo credit: ARS, USDA.

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6

Selected Insect Control Technologies and a Boll Weevil Eradication Experiment

(1963–1975, 2010–2011)

Introduction

When I joined the US Department of Agriculture's Agricultural Research Service (ARS), initially a major emphasis was placed on research on systemic insecticides, including the evaluation of efficacy; fate in plants and soil; controlled release technology; methods of application, and large-scale field applications. This research led to efforts that included related studies on the effects of systemic and conventional insecticides on natural enemies, insecticide resistance, pheromones, microbial agents, and boll weevil eradication. ARS scientists at College Station, Texas, that were involved in the research included James R. Coppedge, Donald L. Bull, Richard E. Kinzer, Louis A. Bariola, and Donald A. Lindquist.

Systemic Insecticides

Basic and applied research was conducted over a period of about ten years that included (1) the efficacy of experimental compounds applied by different methods under laboratory, greenhouse, and field conditions, (2) the fate of insecticides after seed, stem, and soil applications using radioassay and bioassay procedures, (3) the design of a patented invention for equipment for the stem application treatment method in the field, (4) the development of methodology for evaluating controlled releases for systemic insecticides, (5) the discovery of many of the outstanding properties of the carbamate insecticide, aldicarb, and (6) the extensive field evaluations of aldicarb when applied in-furrow and as side-dress applications.

Variables affecting uptake. A wide range of studies involving soil type, moisture, and location of the placement in the soil on uptake, which in turn affected the level of insect control, proved to be very useful in planning field studies designed to determine efficacy. These studies led to research on controlled release of aldicarb from granular formulations to extend the length of time that insects would be controlled.

Controlled release technology. Formulations were designed, jointly with the manufacturer of aldicarb, that extended the period of effective insect control. Associated research on the fate of aldicarb applied in different formulations proved useful in designing those that were subsequently commercialized. The methodology used to study controlled release of systemic insecticides was later applied to the study of controlled release of the boll weevil pheromone.

Greenhouse and field-cage studies. The previously observed lack of effectiveness of systemic insecticides against sucking insects and the boll weevil stimulated numerous studies on the feeding behavior of the insects in relation to the distribution of aldicarb in the plant and on the effect of variables affecting uptake. Extensive studies of the boll weevil under greenhouse and field-cage conditions then were used to design field studies.

Small-scale field plot studies. In-furrow applications of systemic insecticides historically had been rather common. Therefore, in-furrow applications with aldicarb were conducted in small field plots, usually 0.2 of an acre. In those field studies, the unusual effectiveness of aldicarb against the cotton fleahopper was first discovered. With this lead, subsequent studies were conducted with lygus bugs, against which aldicarb also had proved to be effective. Included were side-dress applications of aldicarb for the control of lygus bugs and to extend the period of control of the cotton fleahopper beyond that obtained with in-furrow applications. Concurrently, studies in small field plots on the effect of systemic insecticides on beneficial insects indicated that significant reductions of beneficial insects occurred. This was a rather shocking discovery since it had been assumed that since the insecticide was inside the plant, the beneficial insects would not be harmed.

Large-scale field plot studies. The effects of a treatment method on boll weevils that move out of hibernation quarters into fields cannot be determined in small plots; multiacre-sized plots, if not whole fields, were necessary to evaluate aldicarb adequately. Thus, a proposal requesting additional funding for large-scale testing, based on the successful field-cage studies, was proposed in 1966. As a result, additional funds were made available to conduct relatively large-scale field plot studies with side-dress applications in 1967 and 1968. The large-scale studies were conducted in the Rolling Plains of Texas, where there were significant natural boll weevil populations and lighter soils; greenhouse and simulated field studies had shown that the side-dress applications were considerably more effective in lighter soils.

Insecticidal Effects on Natural Enemies

Since the cotton bollworm and the tobacco budworm have very similar habits and often are greatly reduced in numbers by naturally occurring predators and parasites, the reduction of beneficial insects by systemic insecticides was of considerable concern. Subsequently, studies were conducted on the effects of both systemic and conventional insecticides on natural enemies of the bollworm and budworm. Also, feeding behavior studies were conducted with the big-eyed bug, a sucking predator, once it was suspected that large reductions of sucking predators after application of systemic insecticides was due to those predators feeding on plants to obtain moisture. This type of feeding apparently did not cause any significant damage to plants.

Pheromones

The boll weevil pheromone was discovered by scientists at the ARS Boll Weevil Research Laboratory in State College, Mississippi, in 1969. Because of the pheromone's possible use in eradication and the promising results being obtained with aldicarb, we began to experiment with the pheromone. However, we were not able to reproduce results, apparently because the pheromone degraded. Subsequently, analytical methods were developed that were used for quality control studies to ensure that a known amount of pheromone was available. These methods were used to conduct the first carefully controlled experiments on controlled release formulations of the boll weevil pheromone. The first controlled release device that resulted was used in a large-scale pilot test in Mississippi. Those results were then used to support the use of pheromones in the studies of long-range movement of the boll weevil and were used in the design of a boll weevil eradication experiment.

Microbial Agents

Microbial agents were promoted in the early 1970s as possible effective ways to control insecticide-resistant insects. Because of the critical need for effective alternatives and a continuing debate about the efficacy of microbial agents, quality control and field studies were conducted in an effort to resolve that debate. Those studies showed that part of the difficulty with a nuclear polyhedrosis virus was that intended dosages were not being used (due to improper storage); also, the persistence of the virus after application was not adequate for practical application intervals to be effective. Concurrent studies with the toxin produced by the most potent strain of the bacterium available at the time, *Bacillus thuringiensis*, did not produce the desired results when applied at practical rates. Then careful studies to measure persistence and to establish rates necessary to obtain satisfactory control placed into proper perspective the microbial agents that were available at the time. Later, genes from a bacterium inserted into the genome of crop plants proved to be highly effective. The resulting varieties are now being widely used.

Boll Weevil Eradication

Because of the continuing promising results with aldicarb for control of boll weevil obtained in early 1968, an eradication experiment was conducted in 1988 and 1989 on a farm near Guthrie, Texas. The cotton field on this farm was isolated from other cotton fields by thirteen to fifteen air miles. A reproductive diapause control program was initiated in the fall, and pheromone traps were installed to monitor movement of boll weevils. Then aldicarb was applied in-furrow at planting, which could be expected to control boll weevils up until squares (flower buds) began to form, and additional pheromone traps were placed in the field to capture boll weevils. Side-dress applications of aldicarb were applied to the 273 acres of cotton on the farm when the cotton began to set squares. Five foliar applications of insecticides were also applied for control of the bollworm complex.

Extensive sampling with pheromone traps, a tractor-mounted insect-collecting machine, and hand inspections did not detect any living weevils until after September 1, when boll weevils (as indicated by pheromone-trap captures) began entering the farm from cotton thirteen to fifteen miles away. The previous extensive sampling that failed to detect a single living weevil and the evidence of an infertile female (some weevil eggs that did not hatch were detected) provided convincing evidence, at least in the minds of the researchers directly involved in the experiment, that the technical feasibility of boll weevil eradication had been demonstrated.

Insecticide Resistance

Resistance to chlorinated hydrocarbon insecticides in the boll weevil, first reported in the 1956, began to have a major influence on the direction of cotton insect research within ARS. The resistance problem intensified with the report of resistance in the tobacco budworm to chlorinated hydrocarbons in 1963 and to organophosphate insecticides in the Rio Grande Valley in 1968. Although I had assisted James R. Brazzel in collecting insects for his studies on resistance during my time with the Texas Agricultural Extension Service, research on insecticide resistance was not significantly involved in the ARS cotton insect research program at College Station until 1970.

Because of the critical nature of the problem, I followed the insecticide resistance issue and was familiar with the currently available insecticides, including some still in the later stages of development. Therefore, when the request for assistance came from a major cooperator, I was in a position to respond. Members of the College Station ARS research unit worked with the Department of Entomology at Texas A&M to survey a number of fields and to conduct a large-scale field test. Resistance to organophosphate insecticides in the tobacco budworm was confirmed. None of the available insecticides provided desirable levels of control of high populations of tobacco budworms. However, the experiences proved to be quite useful as I was asked to be the technical lead for USDA on related regulatory actions in 1975 and again in 1977 that had arisen because of the lack of commercially available insecticides that could control insecticide-resistant tobacco budworms.

Outcomes and Implications

The research with a variety of insect control technologies (including systemic and conventional insecticides, microbial agents, and pheromones with an emphasis on efficacy under practical field conditions) proved useful in later years in evaluating additional technologies and in developing strategies for integrating control technologies into pest management systems. Some more immediate outcomes included the extensive use of aldicarb on cotton, support of regulatory actions to obtain emergency exemptions for insecticides effective in controlling insecticide-resistant bollworms and tobacco budworms, and evaluating boll weevil eradication attempts.

More specifically, the research on aldicarb and other systemic insecticides contributed to the increased use of systemic insecticides from about 2 percent of the cotton acreage in the 1960s to over 25 percent of the acreage by the mid-1980s. At that time about 85 percent of that use was aldicarb. In 2010, the National Cotton Council reported that aldicarb was applied to 25 percent of the cotton grown in the United States.

Aldicarb was marketed for use on cotton and a number of other crops for over three decades under the trademark Temik. The most recent producer and marketer, Bayer CropSciences, has indicated that it will no longer produce and market aldicarb. However, AGLogic LLC, a subsidiary of MEY Corporation, filed for registration of aldicarb with the U. S. Environmental Protection Agency and was granted approval on

December 22, 2011 to market aldicarb under the proposed trade name Meymik.

As the use of systemic insecticides increased, the use of most other insecticides on cotton decreased drastically because of eradication of the boll weevil and the use of genetically modified plants that are resistant to lepidopterous pests.

The studies with systemic insecticides were the basis for my being awarded the Geigy Recognition Award for Outstanding Contributions to Agriculture through the Entomological Society of America in 1971. Included with this award was an agriculture tour of Switzerland and of CIBA-Geigy's (now Syngentia) principal research laboratories in Basel, Thus, providing a valuable perspective on the operations of a major international company.

The results of the 1970 field tests against the resistant tobacco budworms proved valuable in dealing with some of my future insecticide regulatory assignments. Field tests defining the limitations of microbial agents were valuable as continuing efforts were made to expand the use of biologically based insect control technologies.

The high rates of aldicarb, its particularly effective use only on lighter soils, and the adverse effect of aldicarb on beneficial insects were constraints that prevented aldicarb from becoming of practical use for boll weevil eradication. However, the methodology, particularly that used to demonstrate that boll weevil reproduction was prevented during the major portion of the growing season, proved to be invaluable in later years in interpreting the results of the boll weevil eradication trial in North Carolina.

Systemic insecticides are most commonly applied in granular formulations at planting time, but side-dress applications proved to be a valuable research tool to study boll weevil eradication, and they have had some selected practical uses. Photo credit: Unknown.

The big-eyed bug, feeding on the egg of an insect pest, also feeds on plants primarily as a source of water. Although this insect does not cause plant damage, it may be killed by systemic insecticides. Photo credit: University of California.

The cotton bollworm and its close relative, the tobacco budworm, which are often greatly reduced in numbers by naturally occurring predators and parasites, developed resistance to insecticides in the 1960s and 1970s. Photo credit: ARS, USDA.

Aerial applications of pyrethroid insecticides were possible in 1977 because of the emergency exemption from registration in eleven states; the exemptions were based on a critical assessment of the actual and potential losses due to insecticide-resistant tobacco budworms led by the author. Photo credit: Daniel Martin, ARS, USDA.

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Advancing Cooperative Regulatory Decision Making

(1970–1979)

Introduction

During September 1970, I received a phone call from US Department of Agriculture's (USDA) Entomology Research Division headquarters office within the Agricultural Research Service (ARS). I was directed to report to Beltsville, Maryland, for a special assignment as soon as possible. Thus, I became involved in the policy and political debate over the regulation of insecticide use. The experiences that followed involved four different cases. Those cases provided a unique perspective on the regulatory process involved at the federal level and illustrated how comprehensive scientific and technical documentation can, ultimately, result in positive outcomes. Those cases included the consolidated DDT hearings in 1970, a petition for an emergency use of DDT in 1975, an assessment designed to support petitions for emergency exemptions for use of new insecticides in 1977, and an assessment to support registration of an insect growth regulator in 1978.

Consolidated DDT Hearings

Upon arrival in Beltsville in the late summer of 1970, I reported to an entomology administrator, HC Cox, who had been asked to lead a team to prepare a report on review of the use of DDT and its alternatives. Dr. Cox briefed three of us (from Florence, South Carolina; Shafter, California; and College Station, Texas). We were told that USDA's secretary of agriculture and others had been petitioned by the Environmental Defense Fund and others in the United States Court of Appeals for the District of Columbia Circuit with the intent of banning all uses of DDT. Although we were not aware of the precise nature of the proceedings, we were aware of the controversy over the use of DDT, which had increased considerably in intensity after the publication of *Silent Spring* in 1962.

A previous report on DDT prepared by ARS staff entomologist J. E. Gilmore in Beltsville, Maryland, reviewed much of the scientific information available on DDT. This report was incorporated into a brief for the respondents and filed with the court on August 31, 1970. However, we were told that since much of the current DDT use was on cotton, the judgment was made that a special report focusing on cotton was desired and it should be prepared in a matter of days. Our team completed a seventy-six-page report on September 16, 1970.

Shortly after returning to College Station, I was informed that legal proceedings were being continued within the framework of the consolidated DDT hearings under the supervision of Administrative Law Judge Edmund Sweeney and that USDA officials wished for me to appear as an expert witness before Judge Sweeney in Alexandra, Virginia, on October 5, 1970. I was also informed that I should be prepared to answer questions not only related to cotton insect control but also on the contents of the documents on wildlife and human effects of DDT that had been prepared by other persons in USDA. After I testified for about an hour and based on my education and experience as a biologist, the judge ruled that I was qualified to testify not only on entomology but also on all the subjects covered in documents submitted by USDA.

Consequently, I returned the following week, at which time I was cross-examined for about three hours.

As the legal proceedings were ongoing, the US Congress passed the National Environmental Policy Act, and an executive order established the Environmental Protection Agency (EPA) effective December 2, 1970. Together those actions led to greatly increased public participation in pesticide regulation decisions. Although Judge Sweeney ruled in favor of USDA's position, after a number of additional legal actions and special studies, the administrator of EPA banned all uses of DDT to take effect in the fall of 1972. Clearly, there were a lot of differences in opinion on both sides, and it seemed to me that neither side was completely objective in interpreting the information that was available, but the time had come for change. The level of conflict was such that change was going to be disruptive and costly. Still, it should be remembered that the use of DDT did have many benefits, with perhaps its use in preventing an untold number of deaths during and after World War II by controlling vectors of disease, especially mosquitoes, being most noteworthy. During most previous wars, disease had caused more deaths than those resulting from battle. The extensive use of DDT for disease vector control came about not only because of its efficacy but also because of its relatively low acute toxicity to humans. Also, it should be noted that Edward F. Knipling, director of the Entomology Research Division in 1970 for USDA's ARS, who had led the team in the early 1940s that developed the DDT uses that protected soldiers and citizens, was well aware of the benefits of DDT. Still, Dr. Knipling was also aware of the development of resistance by the housefly to DDT by 1947, of residues of DDT in milk reported as early as 1948, and of DDT's undesirable presence in the environment. Although Knipling was not significantly involved in the consolidated DDT hearings, his leadership had, by the time of those hearings, impacted in many other ways on the future of insect control. His actions resulted in greatly increased research on more ecologically desirable methods of insect control.

From a personal point of view, I found the experience of serving as an expert witness at the formal DDT hearings quite enlightening. It set the stage for a number of other related experiences that eventually had more positive outcomes.

The Louisiana Emergency Exemption Petition

In early 1975, another call came from ARS Headquarters. This time I was advised to come prepared to stay for at least two weeks. Upon arrival in Beltsville, I was informed that Governor Edwin Edwards of Louisiana had filed a petition with EPA requesting an emergency exemption for the use of DDT in a mixture with toxaphene to control anticipated infestations of the tobacco budworm on cotton. I was also informed that EPA had, on February 6, 1975, requested that USDA assist EPA in evaluating the petition and that at a meeting with EPA on February 11, 1975, USDA agreed to prepare a review of the technical information related to the problem. I arrived in Beltsville shortly after that meeting, and I was asked to coordinate the preparation of a technical report that would (1) summarize relevant information on the nature of the *Heliothis* (cotton bollworm and tobacco budworm) problem and the efficacy, environmental safety, and human health hazards of DDT usage and (2) analyze the benefits and risks of the use pattern of DDT proposed in the Louisiana petition. I was given two weeks to complete the assignment with assurances from ARS administrator T. W. Edminster that I would have all the support needed from USDA to prepare a comprehensive, credible scientific report.

Following a quick review with USDA staff of the issues and needs, a nineteen-member task force was established, and work began. A 127-page report was completed on March 1, 1975. Subsequently, after briefing USDA administrators, I presented the report to a team of EPA specialists in a public hearing in Washington, DC. The nature of the discussions indicated that EPA was not likely to approve the exemption petition. I traveled to Louisiana to brief the Louisiana Department of Agriculture, the Louisiana Farm Bureau, and the Louisiana Cotton Producers Association. John S. "Duke" Barr, who had close ties to all three organizations as well as the National Cotton Council (NCC), was a key spokesman for the agricultural interests. Subsequently, a briefing was held in Louisiana for Governor Edwards and the state agricultural interests by an EPA representative. During that briefing, Governor Edwards commented that he knew that EPA would do the right thing, but in case they did not, they should be prepared to go to court. Back in Washington, DC, Mr. Barr and I briefed the deputy secretary of agriculture Phil Campbell, other USDA officials, and Congressional staffs.

The USDA report made a compelling case in support of the petition because of the estimated $15 million in benefits that would likely result and because of the relatively low acute toxicity of DDT to humans and wildlife when compared to the alternatives that were primarily mixtures containing organophosphate insecticides. However, there continued to be strong differences in opinion concerning efficacy and the risks of using DDT when compared to the available alternatives. In my professional opinion, EPA's position on the efficacy of the available alternatives could not be defended. The difference in positions was further heightened by the fact had EPA had approved an emergency exemption to registration for use of DDT to control disease vectors in 1972 and 1973. The great reluctance of EPA to approve the Louisiana petition was never clear, since two previous petitions had been approved. Perhaps there was concern that there would be an undesirable precedent set that would bring on additional petitions that would be politically unacceptable. EPA denied the petition, and the State of Louisiana filed suit against EPA in federal district court in the spring of 1975, which ruled in favor of EPA. The court of appeals upheld the district court's ruling. Although EPA had the legal authority to make the judgment that was made, there was broad resentment throughout the Louisiana agricultural community and the Louisiana congressional delegation in what was perceived to be a complete lack of understanding of the problem on EPA's part. A positive short-term result that spun out of the process was the appropriation of $500,000 to ARS in FY 1976 for additional research on the control of the tobacco budworm and bollworm.

The months while I worked on the Louisiana petition caused me to be away from home for long periods of time, and it was difficult for Donna and our daughters. Then I was offered a position on the ARS National Program Staff in Beltsville, Maryland. At the time, our daughters, Susan and Sharon, were both well-established in school activities, we had wonderful neighbors and church friends, we enjoyed Texas A&M University sports and the many other opportunities that a university community offered. The idea of leaving Texas to live on the East Coast was a difficult family decision. However, during August 1975, with two unhappy daughters, a caged cat, and our Chevrolet Vega in tow, we left the Lone Star State and made our new home in the Old Line State of Maryland. In time, the pain of moving subsided, we made friends, the girls excelled in school, and since we lived near Washington, DC, a steady stream of visitors arrived from Texas eager to visit the US capital.

The experiences in 1975 clearly demonstrated that the EPA specialists that were making or defending critical judgments had limited practical knowledge of cotton insect control. In the summer of 1976, I arranged a tour of a major portion of the Cottonbelt for an entomologist, a chemist, and a wildlife specialist from EPA. We made stops in Florence, South Carolina; Stoneville, Mississippi; Shreveport, Louisiana; and Waco, Texas. As a result, the EPA staff had an opportunity to learn firsthand about cotton insect control and to meet and visit with leaders in the cotton industry who served as hosts. In arranging for the tour, I had encouraged the cotton leaders to receive the EPA delegation graciously and to use this opportunity to educate the delegation rather than be critical of past actions by EPA. All went well except, as might be expected, in Louisiana discussions following an evening dinner became rather unpleasant. The nature of the discussions could perhaps best be described by quoting from the EPA chemist as he and I were returning to the hotel together, who said, “I just can’t believe that people could hate us that much.” Although a bit challenging, the tour of the Cottonbelt by a group from EPA laid some very important groundwork for what was to come next.

Emergency Exemptions for New Insecticides

As predicted, in 1975 serious losses occurred on cotton due to the tobacco budworm in Louisiana and throughout the mid-South and the Southeast. In 1976, pest population pressures were lighter than in 1975, but serious losses and difficulties in control were reported throughout the Cottonbelt, including the Imperial Valley of California. Because of increasing insecticide resistance and the withdrawal of some insecticides from the market, effective insecticides for controlling high-density populations of the tobacco budworm were no longer available. However, experiments conducted by ARS, the universities, and the industry showed that a number of experimental insecticides under development were effective. Representatives of NCC inquired as to when some of these insecticides might be available. Those insecticides included a new class of synthetic pyrethroid insecticides that were much more photostable than the natural pyrethrums, and for the most part, they were not undesirably persistent. Some new, more effective, organophosphate insecticides were also involved. Discussions with pesticide industry representatives indicated that although action on registration petitions could not be expected in time for any of the new insecticides to be available for the 1977 season, adequate data might be available for EPA to evaluate the risks of using some of the new insecticides under emergency exemptions from registration. A meeting was held within USDA in the fall of 1976 led by Assistant Secretary Robert Long with representatives of USDA’s science and education agencies and the Office of General Council. After a general discussion, Mr. Long charged me to lead a team to prepare a report that would be available to the states that might choose to use it in support of emergency exemption petitions. Long further expressed the desire for the NCC to take the lead in communicating with state agencies. A nine-member assessment team was formed, and a forty-seven-page report was completed on January 26, 1977.

The assessment report concluded that the new insecticides had been proven to be effective for the control of the tobacco budworm and that their being available for use would likely prevent annual losses of between $17 million and $29 million. In that report, USDA endorsed exemptions from registration to permit emergency use of the new insecticides if EPA determined that these would not create unreasonable risk to the environment or human health. Subsequently, eleven states filed petitions for emergency use of one or more new insecticides on cotton in 1977; all eleven petitions were approved by EPA. The emergency exemptions and the subsequent registrations provided technology that bridged an important gap in time during which the genetically engineered crops resistant to insect pests were developed. Also, many of the same insecticides or their relatives continue to be in use for control of cotton insects and are currently being used for a wide range of other purposes.

Registration of a New Insect Growth Regulator

Funds were appropriated for FY 1977 for a major boll weevil eradication trial to be initiated in North Carolina. However, Congressman Jamie Whitten, chairman of the House agricultural appropriations subcommittee, indicated that those funds would not be released until he was convinced that some new technology would be available. I had prepared a brief on a new insect growth regulator (diflubenzuron, Dimilin) as a new technology that could possibly be made available for use in the trial. Subsequently, I received a phone call in September 1977 from Francis “Frank” J. Mulhern, then administrator of USDA’s Animal and Plant Health Inspection Service (APHIS), indicating that he had an appointment with Congressman Whitten and he wanted to review the diflubenzuron situation with me to be sure he had his facts straight.

After reviewing the potential value of diflubenzuron in the trial, I noted that a registration petition was pending before EPA. I further noted that if APHIS wished to use diflubenzuron in the trial, it would not be needed until the 1979 season and that I was confident that ARS would do whatever it could to assist the registrant to obtain registration. Dr. Mulhern's discussions with Congressman Whitten were successful, and the funds to conduct the boll weevil eradication trial were released on September 27, 1977.

Later, based on my informal discussions with EPA officials, which were facilitated by Alfred Elder of the North Carolina Department of Agriculture and Consumer Services and the National Association of Departments of Agriculture, I informed Mr. Edminster that I had reason to believe that if he would make a personal request for EPA to expedite the diflubenzuron registration process, such a request would be honored. Mr. Edminster responded by calling on Edwin Johnson, who was the EPA administrator responsible for pesticide programs, and the two of them agreed to establish a joint USDA/state/EPA assessment team to consider key aspects of the diflubenzuron registration. Mr. Johnson and Mr. Edminster agreed that I should be asked to serve as team leader.

Three comprehensive reports were prepared on diflubenzuron: one on the biological and economic assessments, one on the potential exposure to nontarget organisms, and one on the effects on nontarget avian organisms. Potential uses for control of boll weevils, gypsy moths, and mosquitoes were emphasized. The reports were completed during July and September of 1978, and EPA issued a decision document on March 26, 1979, that resulted in the registration of diflubenzuron on cotton in time for it to be used in the boll weevil eradication trial in 1979.

Outcomes

The pesticide regulation process associated with cotton insect control during the 1970s was wrought with conflict and was very frustrating for many. However, a series of four cases focusing on relationships between USDA and EPA from 1970 to 1979 were part of a transition from very contentious legal proceedings to less formal administrative proceedings to truly joint actions by the two agencies. Continuing to focus on validating scientific and technical information in forums where a broad range of views could be heard was key to making progress, and the latter cases had very positive outcomes. Although the four cases reviewed here dealt with the more conventional insecticides, the lessons learned had considerable application to the regulation of biologically based pest controls. Thus, I developed a much better understanding of the societal context within which future insect controls as well as the adoption of other technologies would have to fit.

T. W. Edminster, administrator of ARS, USDA, provided exemplary leadership in working with the National Cotton Council (NCC) and involved federal agencies within and without USDA on a range of insect management issues. Photo credit: ARS, USDA.

John "Duke" S. Barr, an outstanding agricultural leader from Louisiana, who served in a number of NCC leadership positions, including president in 1984, led producer efforts in 1975–1977 to obtain regulatory relief for new insecticides needed to control insecticide-resistant insects. Photo credit: National Cotton Council.

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Pest Management Strategies and Boll Weevil Eradication

(1972–1984, 1999, 2009–2011)

Introduction

The recognition of a critical need for society to depend less on conventional insecticides and more on ecologically friendly methods of insect control was recognized by leaders in the profession of entomology in the mid-1950s. Edward F. Knipling of the US Department of Agriculture's (USDA) Agricultural Research Service (ARS) and Ray F. Smith of the University of California were leaders particularly of note. The publication of Rachel Carson's controversial *Silent Spring* in 1962 provided a great impetus for increasing funds for research by both the universities and USDA. However, the increased funding also led to the development of two different paradigms, one led by university scientists and another led by USDA scientists. The two paradigms, later described by John Perkins in 1982 as Integrated Pest Management (IPM) and Total Population Management (TPM), became very much a part of the national pest policy debate in the late 1960s. The differences between the two paradigms can perhaps best be described by a quote from Dr. Knipling in an interview with Dr. Perkins:

> Carl B. Huffaker and Ray F. Smith are not thinking [as]… I am. I'm thinking integrated control… [as] taking advantage of the characteristics of different systems and putting them together for total management of a population. They are looking at integrated control… [as being] based on assessment of economic threshold levels and not to use control measures until they reach that goal.

I was exposed to Dr. Smith's model integrated insect control program to manage aphids on alfalfa as a graduate student in 1959 and to Dr. Knipling's area-wide population management program for the screwworm in 1961. Both of these programs significantly influenced my thinking on pest management.

Pest Management and Cotton Insects

I began writing and speaking about pest management at the national and international levels in 1972 when I was asked to represent ARS before the International Cotton Advisory Committee in Managua, Nicaragua. That year, I was also invited to speak at the National Extension Insect Pest Management Workshop on Implementing Practical Pest Management Strategies at Purdue University. In 1974, I led a team that traveled to Pakistan to assist that country in designing a pest management research program. Then in 1975, I was thrust into the pest management debate at the national level soon after joining ARS's National Program Staff.

Involvement with pest management generally and cotton insects specifically at the national level widened my horizons considerably. Pest management activities not directly related to cotton insects included participating in a national Environmental Protection Agency conference and serving as a consultant for the US Department of State in designing and opening an IPM exhibit in China. I also prepared a comprehensive review of cotton insects for an American Society of Agronomy monograph on cotton that was published in 1984.

Cotton insect activities included devoting a majority of my time to planning and coordination of research on cotton insects, annual presentations at the Beltwide Cotton Conferences, and publication of articles in the conference proceedings. In addition, I participated in a cotton team that traveled to several locations in the former Soviet Union.

The discussion of cotton insect management and the boll weevil eradication conflict that follows will focus primarily on federal government activities. However, the National Cotton Council (NCC) played a major role over many years and was instrumental in obtaining additional public funds for both research and operational programs. Many different cotton producers were involved, but the role of Richie Smith, director of Technical Services for NCC, is worthy of particular note since he was the focal point for the NCC's activities for many years.

Comparative Management Trials

On a Wednesday in January 1976, I received a phone call while attending the Beltwide Cotton Conferences in Las Vegas, Nevada, and I was requested to be present at a meeting in Beltsville, Maryland, on the following Saturday with Waldemar Klassen, ARS national program leader for pest management. Arthur W. Cooper, ARS southern region deputy administrator, who played a key role in facilitating communications, was with me at the cotton meetings, and that week we had a conference call with T. W. Edminster, ARS administrator. We received useful guidance and learned that the Saturday morning meeting was for me to get prepared to represent ARS at a meeting with several USDA agency representatives on the following Monday. We were informed that the Office of Management and Budget had instructed USDA that a pest management trial was to be conducted concurrently with the Boll Weevil Eradication (BWE) trial for which USDA had requested be funded in the FY 1977 budget. Thus, to some extent, those two trials could be interpreted as a multimillion dollar test of the IPM and TPM paradigms. The purpose of the meeting on Monday was to work out plans for implementation of an expected budget increase in the FY 1977 federal budget that would include funds for a boll weevil eradication trial in North Carolina and a concurrent pest management trial against the boll weevil at another location. I met with Dr. Klassen on Saturday morning, and we reviewed what was ahead of us. He accompanied me to the meeting on Monday. Subsequently, Klassen and I worked closely together on a wide range of issues for nearly two decades, during which time he became a valued and highly respected colleague and friend.

Following that Monday meeting in 1976, as part of my National Program Staff responsibilities, I became the lead representative for ARS on boll weevil issues and served in that capacity until late 1983. As a result of that meeting, an Optimum Pest Management (OPM) trial with an extensive evaluation process became a part of the FY 1977 budget request, and an USDA interagency work group was established. Much has been written about the design and potential outcome of the trials, including several chapters in the 1983 technical monograph entitled *Cotton Insect Management with Special Reference to the Boll Weevil*. In the simplest terms, OPM could be described as a voluntary program with incentives that would include continuing practices for control of the boll weevil. BWE could be described as a mandatory program that would eliminate the boll weevil and the use of insecticides for control of that pest.

Professional Relations with IPM and TPM Interests

Although funds for the OPM and BWE trials were appropriated in the fall of 1976, funds were not released until the fall of 1977. The debate about the future of cotton insect management continued for several years after the trials were initiated. Within ARS, I was in a unique position because my research on systemic insecticides and other potentially selective insecticides designed to preserve natural enemies that held the bollworm complex in check was patterned after the integrated control model developed by Dr. Smith and others in California. Also, although the efficacy of releasing mass-reared natural enemies had not been demonstrated in field crops, efficacy had been demonstrated in strawberries and citrus crops in California by Carl B. Huffaker and others, and most of the commercial production of natural enemies was in California. Although there were differences between Dr. Knipling and Dr. Huffaker on strategies for using mass-reared natural enemies, both were very supportive of the general approach. I remember vividly the conversation with Huffaker when I invited him to write a lead chapter for the 1977 book on augmentation of natural enemies that would appear with a separate chapter to be written by Knipling. Huffaker indicated that he was reluctant to contribute because he did not want to imply that he supported Knipling's approach to total population management. I responded that if he had a different view of how natural enemies should be used, he had a responsibility to present it. Huffaker then agreed to write a chapter. Consequently, two rather different strategies on utilizing mass-reared natural enemies were presented in lead chapters for the book.

Although I was criticized by some for my relationships with Dr. Huffaker and other California entomologists, those relationships proved to be useful in communicating with the opponents of boll weevil eradication and in developing the options for the future of cotton insect management presented to USDA's secretary of agriculture in 1982.

Initiation of Economic Research

Immediately after the initiation of BWE and OPM trials in the fall of 1977, I arranged for some economic studies with Gerald Carlson of North Carolina State University. I believed that economic studies could very well be a key factor in resolving the conflict between those supporting the two different paradigms. I knew that Dr. Carlson was capable. He had previously assisted me by providing some very valuable assistance that had not been available from USDA on some of the insecticide regulatory issues. I considered Carlson to be one of the best practical pest management economists in the country, and I knew he would make a positive contribution to whatever evaluation processes that might be conducted.

The Cotton Insect Pest Management Policy Debate

My major involvement in the cotton insect pest management policy debate, which began in 1976 and culminated in 1983, has been reviewed previously in a book chapter prepared jointly with Harry Mussman, a former administrator of Animal and Plant Health Inspection Service (APHIS), and published in 2001 entitled "Integrating Science and Stakeholder Inputs: The Pivotal Years." Here are some highlights from that review, with the inclusion of some additional personal experiences.

In many ways the policy debate revolved around the evaluation of the trials and the implications that the results of the trials would have on other cotton insect management programs. An extensive USDA evaluation process was initiated. Earlier, Francis "Frank" Mulhern, when he was administrator of APHIS, recognized early on that an independent evaluation was likely to be of value in resolving existing disagreements. Thus, he authorized a contract between APHIS and the National Research Council (NRC) of the National Academy of Sciences (NAS) for an independent evaluation.

USDA Boll Weevil Policy Group. As the BWE and OPM trials got underway, the disagreements surrounding the IPM and TPM paradigms and the related OPM and BWE trials began to significantly and adversely affect the implementation of the trials and the evaluation process at all levels. I took my concerns about the disagreements and their adverse affects to Dr. Cooper. Together we designed the Boll Weevil Policy Group and the position of a new full-time executive coordinator to provide oversight for implementation and evaluation of the trials. Cooper took the plan to the administrator of the ARS, who recommended the plan to the director of USDA's science and education and to the administrators of APHIS and Economic Research Service (ERS). The plan was adopted and over time proved to be very useful in improving communications and in policy development. Harry Mussman, administrator of APHIS, chaired the policy group with Anson Bertrand representing USDA's science and education agencies.

USDA/state evaluation process. USDA developed a very elaborate evaluation process that included biological, environmental, and economic evaluation teams and an overall evaluation team. The biological evaluation team was led by ARS, the environmental evaluation team by APHIS, and the evaluation team by the ERS. The overall evaluation team was also led by ERS. A series of reports were produced in 1981, which are cited in the book chapter on the pivotal years.

Personal contributions to the debate. Fairly early in the process, evidence developed that the USDA evaluation processes had some significant limitations. A principal limitation was that the processes were led and heavily dominated by USDA personnel. The absence of any type of peer review process and the dominance of Washington, DC–based personnel with limited "real world" experience resulted in some lack of creditability and lack of adequate knowledge of practical cotton production within the evaluation teams. Perhaps the most objective approach to describing how I responded to these limitations is to quote from a nomination prepared, without my knowledge, for the Science and Education Director's Award for Special Achievement presented in 1982:

> In order to insure that all technical information was readily and uniformly available during the critical evaluation period, Dr. Ridgway proposed and co-edited a (20 chapter, peer reviewed) technical monograph entitled, *Cotton Insect Management with Special Reference to the Boll Weevil*. Drafts of this landmark manuscript were provided to key individuals involved in the evaluation process… realizing research yields little benefit until applied in the real world, Dr. Ridgway… worked diligently… to forge a policy on cotton insect management which would be acceptable to farmers, extension workers, the involved action agencies, USDA scientists, and policy makers… his technical communications and the respect he commands… directly influenced the recommendations adopted by the National Cotton Council (in early) 1982 (following Dr. Ridgway's introducing at) the Beltwide Cotton Conferences… the concept of Targeted Optimum Pest Management (TOPM)… aimed at… areas where insect control costs are high… and producer interest in an organized program is large.

The TOPM option evolved from a decision tree that was presented in the chapter 1 that I coauthored with E. P. Lloyd in the technical monograph on cotton insect management. However, the impact of that chapter was limited at least partially because of a lack of understanding within the evaluation teams of some of the issues involved.

National Research Council/National Academy of Sciences evaluation. The National Research Council (NRC) published a comprehensive report in 1981 that was critical of the BWE and OPM trials and their evaluation. The NRC report was analyzed in some detail in the book chapter on the pivotal years, but in terms of my personal involvement and what transpired, the issue of whether or not eradication was achieved in the BWE was perhaps the most important issue. I personally had extensive discussions in North Carolina in the summer of 1980 with the NRC's expert consultant on insect population modeling. During those discussions, I was unable to get the consultant to tell me what evidence he would need to agree that eradication was achieved. He implied that he would never agree that eradication was achieved regardless of the evidence. My reaction was to organize an expert team led by William Cross to address the issue using the best scientific methodology available. Subsequently, the team developed a probability statement on possible eradication that was included in the 1981 USDA biological evaluation team report:

> The overall probability of detection… for 1979 and 1980 combined was 0.9983… This high probability of detection, and the fact that no boll weevil reproduction was discovered between October, 1978 and September 11, 1980… points strongly to this infestation being a reintroduction.

With this evidence before them, the conclusion of the NRC committee on the issue of eradication was the following:

> The evidence does not demonstrate that migration was the reason for the discovery of an individual or the discovery of a reproducing weevil population in the BWE trial area. Therefore, the BWE trial did not conclusively demonstrate that eradication was achieved.

My criticism of the NRC report was that the committee reached their conclusions on the eradication issue apparently without considering the efficacy of the monitoring methods or the probability statement. The committee's consultant's position that no amount of evidence would be adequate for him to conclude that eradication was achieved—and the committee not commenting on the probability statement—in my mind showed a considerable bias within the committee. My view was supported by the one of the university scientists that had been critical of BWE. He stated that "it was highly probable that the native boll weevil population was eradicated from the core eradication area" (J. R. Bradley in Dickerson et al. 2001).

Varying definitions of eradication by the various participants complicated the debate. I thought that the key issue was whether or not reproduction by indigenous boll weevils had been prevented. If that was the case, then maintaining effective barriers to reinfestation and monitoring to detect migrants that could be eliminated was the key to the success of continuing eradication efforts. Based on the probability statement, my knowledge of the effectiveness of the monitoring, and my experience with the eradication experiment conducted near Guthrie, Texas, in 1969, I was convinced that reproduction from indigenous boll weevils had been prevented and, therefore, the BWE trial was a success.

Over the years, I have interacted with a number of NRC committees and National Academy members. There is no question that the National Academies and the associated NRC have had and will continue to be of great public service. But in my estimation, the report of the NRC boll weevil eradication committee was not the NRC's best work.

USDA task force on boll weevil/cotton insect management. After several reviews of the extensive evaluations conducted by the different USDA agencies by USDA's Boll Weevil Policy Group, the group did not feel that they had what was needed to prepare policy recommendations on what position USDA should take. The leader of the overall evaluation team had taken the position that since the TOPM option had not been evaluated, he did not think it should be considered in developing final recommendations. Still, there was a lot of evidence that the USDA evaluation teams had not produced viable options for making significant advances in cotton insect management based on what was learned in the trials. For instance, although the evaluations did not support a recommendation for a Beltwide eradication program, other options for proceeding with eradication were not considered.

The policy group dismissed the evaluation teams with thanks and appointed a special task force chaired by APHIS associate administrator James Lee. The task force met, and Mr. Lee requested that I work with APHIS budget analyst William Wallace to draft a policy paper incorporating some of the options previously presented in working papers, options that were not embraced by the chairman of the overall evaluation team. Mr. Wallace and I worked several days, including a weekend in the APHIS offices in Hyattsville, Maryland, and drafted a policy paper for consideration by the policy group. My inputs in the policy paper can be further characterized by quoting again from the nomination for the Science and Education Director's Award for Special Achievement:

> The… transmittal to the Secretary of Agriculture (May 24, 1982) of a set of recommendations for the future course (for cotton insect management programs)… has a high probability of acceptance by the widely divergent interest groups because of Dr. Ridgway's continuous critical analyses, unstinting commitment to open technical communications and an eagerness to see that… scientific (knowledge) is adopted in a manner which will benefit agriculture and the country as a whole.

The essence of the policy paper dated May 19, 1982, entitled "Cotton Insect Management Programs: A Report to the Secretary of Agriculture" outlined a range of options including TOPM. The paper provided four recommendations on how USDA should proceed. The recommendation most relevant to future actions was the following:

> Facilitate testing and expansion of areawide cotton insect management trials and programs throughout the Cottonbelt including possible future expansion of boll weevil eradication in the southeastern United States.

> Federal support should be determined on a case-by-case basis, through evaluation of state and producer proposals.

Secretary of Agriculture John Block concurred in the policy paper. Shortly thereafter, I was presented with a Science and Education Director's Award for Special Achievement with the following citation:

> For outstanding performance in providing sound technical information, analysis, and advice on the options available for the future boll weevil/cotton insect management programs. (Anson Bertrand, May 1982)

Outcomes

In early 1983, the cotton producers in southern North Carolina and South Carolina passed a referendum that committed them to pay 70 percent of the cost of the expanded eradication program and to abide by the associated regulatory requirements necessary. It is important to note that the economic benefits of BWE developed by Dr. Carlson played a key role in the producers' decision to vote for the referendum. In May 1983, the secretary of agriculture made the commitment to provide the federal share of the funds needed to expand the boll weevil eradication program to include the rest of North Carolina and South Carolina. The status of boll weevil eradication through 1999 was reviewed in a book entitled *Boll Weevil Eradication in the United States through 1999*, organized by W. A. "Bill" Dickerson and published by the Cotton Foundation in 2001. Since that time, boll weevil eradication efforts have been extended throughout all the boll weevil–infested areas of the Cottonbelt.

As eradication efforts were extended across the Cottonbelt, adjustments in program operations were made to accommodate local conditions. Those adjustments resulted in eradication programs being successfully implemented in the southeastern and southern states, and eradication is complete in much of Texas and eastern New Mexico, resulting in very substantial economic benefits.

In 2010, the Texas Boll Weevil Eradication Foundation conducted program activities in Texas and eastern New Mexico zones on 6.1 million acres of cotton. There was no evidence of reproduction in any of the over 5.3 million acres in the West Texas zones and the four zones in New Mexico. In spite of very adverse weather conditions and significant reproduction in three remaining zones, there was a 26 percent reduction in the number of weevils trapped in these zones when captures in 2010 are compared with captures in 2009. There were further reductions in numbers of weevils captured in 2011 compared to 2010, with some reproduction of weevils in only two zones.

The Plains Cotton Growers Inc. has reported that the progress of the program in West Texas made possible substantial reduction in the amount of the assessments in a number of zones. For example, the average assessment for the six zones in the High Plains region of West Texas, which are most advanced in the eradication program, was two dollars or less per acre in 2011, an appropriate amount to pay for post-eradication monitoring and for dealing with any reinfestations so that the outstanding benefits that have resulted from the eradication program will continue.

The boll weevil eradication program is being intensified where boll weevil reproduction continues in order to reduce migration and prevent reinfestation of cotton in weevil-free areas and to place additional emphasis on treatment and destruction of the volunteer and ornamental cotton that is unique to South Texas. Additional attention also is being given to the movement of boll weevils into the Lower Rio Grande Valley area from Mexico. The National Cotton Council's Boll Weevil Action Committee is appointing an International Boll Weevil Technical Advisory Committee that will focus on the southern Lower Rio Grande Valley in Texas and the northern Tamaulipas area of Mexico. Joint planning is expected to improve program effectiveness in both areas and reduce or perhaps prevent the movement of boll weevils from Mexico into Texas.

Finally, as the application of the components of current program are being intensified and fully implemented and the program's effectiveness in subtropical climates is better understood, the possible survival of boll weevils in subtropical areas that do not enter diapause and the resulting effect on the efficacy of the current program may need to be evaluated.

The experiences described above in resolving conflict surrounding cotton insect management strategies and boll weevil eradication proved to be valuable in pursuing other pest management and broader agriculture, food, and natural resource interests.

Waldemar Klassen, as the National Program Staff leader for Pest Management and director of the Beltsville Agricultural Research Center for USDA's ARS, provided innovative leadership and wise council. Photo credit: ARS, USDA.

Richie Smith, as director of Technical Services for NCC, played a key role in implementing council policy on pest management and boll weevil eradication. Photo credit: NCC.

Harry C. Mussman, as administrator of USDA's Animal and Plant Inspection Service (APHIS), served from 1980 to 1983 as chair of the USDA Boll Weevil Policy Group. The group guided the development and implementation of USDA policy on cotton insect management. Photo credit: Harry C. Mussman.

Anson R. Bertrand, director of Science and Education for USDA from 1979 to 1985, presented a special achievement award to the author for forging the pest management policy that led to Beltwide boll weevil eradication. Photo credit: USDA.

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Advancing Biological Controls and Pest Management

(1979–2001, 2010–2011)

Introduction

After I joined the National Program Staff of the US Department of Agriculture's (USDA) Agricultural Research Service (ARS) in Beltsville, Maryland, in 1975, most of my time was devoted to the boll weevil activities, insecticide regulatory matters, and other cotton insect issues, but I also had the opportunity to make presentations and/or prepare manuscripts for publication for the Joint American-Soviet Conference Use of Beneficial Organisms in the Control of Crop Pests in 1979, for the *1981 Yearbook of Science and the Future* published by the Encyclopædia Britannica, for an international monograph on green lacewings in 1982, and for a Beltsville Agricultural Research Center Symposium book on biological pest control. In addition, I led an interagency task force that developed a report that was published by USDA, entitled *Biological Pest Controls: Status and Prospects*. Thus, my involvement in a range of issues related to biological controls continued while serving primarily in a cotton insects staff position.

During the fall of 1982, Edward Kendrick, then deputy administrator for ARS's the Southern Region office, discussed the possibility of my serving a detail in their Southern Region office in New Orleans, Louisiana. At that time, our daughters, Susan and Sharon, had graduated from Paint Branch High School in Silver Spring, Maryland. Susan had graduated from University of Maryland with a BS degree in fashion merchandizing, and Sharon was in her final year at Texas A&M University in pursuit of a BS degree in education. Thus, the timing seemed to be right to engage in some new experiences.

During the time in New Orleans, beginning in January 1983, I was involved in a broad array of program and administrative activities for the Southern Region that gave me considerable insight into many of the diverse aspects of agriculture, food, and natural resources research. It also gave my wife, Donna, and me the opportunity to explore the unique history of the Crescent City. We rented a small apartment with an extra bed, which made it possible for a number of visitors to share these enriching experiences with us.

Upon my return to Maryland, I joined the Beltsville Agricultural Research Center (BARC), where I devoted most of my time pursuing biologically based technologies for insect control. Initially, I assumed the position of leader of what was to become the Insect Chemical Ecology Laboratory with a staff of highly competent senior chemists and entomologists. Discovery and use of insect pheromones and other behavioral modifying chemicals, such as attractants, repellents, and feeding deterrents, were the focus of this laboratory. Later I was associated with the Biological Control of Insects Laboratory, which enabled me to pursue further my earlier interests that I had pursued in College Station.

There was a lot of satisfaction associated with working with many of the scientists at BARC. However, the opportunity to work with May N. Inscoe, who served me as a support scientist for the remaining thirteen years that I was with ARS, was particularly rewarding. Dr. Inscoe and I became close working partners as we documented the science, technology, and application associated with a wide range of biologically based insect management technologies, including behavior-modifying chemicals, microbial agents, and multicellular organisms.

Pheromones and Other Behavior-Modifying Chemicals

Soon after joining BARC, I worked with Dr. Inscoe to review the status of behavior-modifying chemicals with emphasis on those discovered at BARC and the status of their practical use. That assessment indicated that there were many chemicals available that had potential practical uses and that a special effort was needed to explore that potential. About that same time, I was fortunate to have been invited by Jerrold Meinwald of Cornell University, who was serving as a senior fellow at the National Institutes of Health in Bethesda, Maryland, to serve on an organizing committee for the conference "Molecular Messengers in Nature." This provided an excellent opportunity for me to become acquainted with the top scientists working in the field, including Milton Silverstein of Syracuse University and Wendell Roloefs of Cornell University. Later, Dr. Silverstein and Dr. Roloefs became an integral part of organizing a major international conference designed to review all aspects of behavior-modifying chemicals.

Since research on pheromones was a major part of my responsibilities at BARC, my continuing involvement in the use of pheromones in boll weevil eradication efforts was appropriate. So I worked closely with Willard "Bill" Dickerson of ARS and later with the North Carolina Department of Agriculture and others to study how captures in boll weevil pheromone traps could best be used as a means to determine when insecticides should be applied in boll weevil eradication programs.

Between 1985 and 1987, a series of five publications in the *Proceedings of the Beltwide Cotton Production Research Conferences* reported the results that have served as the basis for making decisions on when to apply insecticides in boll weevil eradication programs.

The review of the status of behavior-modifying chemicals soon after I joined BARC stimulated a number of discussions at scientific meetings between 1984 and 1986 that led to broad consensus that there was a need for an international review to obtain a realistic evaluation of the status of the science and of the potential for application of behavior-modifying chemicals in insect management. A survey of twenty or so published or planned books dealing with insect pheromones indicated that although a number of excellent books were or would soon be available, few of them included a critical examination of barriers to practical application. Therefore, an international conference was held in Boston, Massachusetts, with speakers from Australia, Canada, England, France, Germany, Japan, Switzerland, Sweden, the Netherlands, and the United States, including ten contributors from the private sector. The conference proceedings were developed into a thirty-nine-chapter book, *Behavior-Modifying Chemicals for Insect Management*, that was published in 1990. The input on barriers to practical application indicated that pheromones were usually classified the same as conventional toxic insecticides in the regulatory process. Since many compounds were involved and the markets were relatively small, unreasonable regulatory requirements were a major barrier to practical application.

Subsequently, a less formal session was organized at an annual meeting of the Entomological Society of America to specifically review the regulatory issues. Those present concurred that there should be an effort to address formally the regulatory concerns at the international level. Subsequently, a special conference was held in association with the British Crop Protection Council in Brighton, United Kingdom, and a monograph, *Insect Pheromones and Other Behavior-Modifying Chemicals: Application and Regulation*, was published in 1992.

Thus, a series of events involving scientists and regulators that unfolded after our initial assessment of the status of practical applications for pheromones and other behavior modifying chemicals ultimately led to the US Environmental Protection Agency issuing exemptions to some of the regulatory data requirements for pheromones. Consequently, those collective efforts resulted in the removal of a significant barrier to the practical use of pheromones.

Microbial Agents

Research conducted at College Station, Texas, in the early 1970s demonstrated that it was possible to obtain adequate efficacy against the cotton bollworm and tobacco budworm on cotton with both the bacterium, *Bacillus thuringiensis (B. t.)* and an insect virus, but the rates and short intervals between applications required were not practical. When I joined the Insect Biocontrol Laboratory in 1990, studies were initiated to explore further how to improve the use of microbes through strain and species selection and the use of feeding stimulants and other enhancers. Studies were conducted with the gypsy moth, corn earworm, tobacco budworm, cabbage looper, and beet armyworm. Improved efficacy of *B. t.* and three different insect viruses was demonstrated in both laboratory and field experiments. The most significant practical uses indicated by the many studies, conducted jointly with Ralph Webb and/or Robert Farrar, was the use of *B. t.* for management of the gypsy moth.

Multicellular Organisms

Research on augmentation of natural enemies with insects reared in the pilot rearing facility designed and constructed at College Station, Texas, continued for some ten years after my relocation to Beltsville, Maryland. The research emphasizing the use of *Trichogramma* wasps for management of the cotton bollworm and tobacco budworm was summarized in a fourteen-chapter monograph organized by E. G. King,

D. L. Bull, L. F. Bouse, and J. R. Phillips that was published in 1985. The monograph covered all aspects of rearing, storage, transport, distribution, and efficacy; and I was asked to provide a worldwide perspective on the use of *Trichogramma* in the final chapter for the monograph. Subsequently, I was encouraged to present the status of *Trichogramma* in the United States at an international conference in China in 1986. Although the extensive research on the use of *Trichogramma* in cotton did not result in substantial practical use on that crop, the 1985 monograph and numerous other publications, including those on green lacewings that were linked with the College Station rearing facility, provided valuable information applicable for rearing and use of mass-reared natural enemies that was placed in the public domain. Thus, the information obtained was available to commercial concerns and other interested parties. In addition, when Richard K. Morrison, who managed the pilot rearing facility for over fifteen years, retired from ARS, he was employed by a commercial producer of natural enemies that facilitated the transfer of technology developed by ARS.

In 1990, with the employment of a postdoctoral associate, Moshe Coll, and the initiation of a cooperative agreement with Pennsylvania State University, research was initiated on the feeding behavior of a predatory bug, *Orius insidiosus* and the efficacy of *Trichogramma* for control of the European corn borer. As I became closer to original research on multicellular natural enemies and with my continuing interest in encouraging more practical use of biologically based technologies, the international conference "Technology Transfer in Biological Control from Research to Practice" held in France in 1996 provided an excellent venue within which to explore the relations between the public and private sectors. The symposium "Private-Public Sector Cooperation in the Development and Use of Mass-Produced Multicellular Natural Enemies" was organized, with presentations by public and private sector scientists and managers from France, United Kingdom, the Netherlands, Switzerland, Israel, Venezuela, and the United States. Nine presentations, authored by eight persons from the public sector and six persons from the private sector, were included in the symposium.

The success of the 1996 international symposium led to the development of a similar symposium that focused on the United States and Canada and involved many of the North American commercial producers. This symposium, held at the annual meeting of the Entomological Society of America, was entitled "Mass-Reared Natural Enemies: Application, Regulation, and Needs." The program for the symposium was planned closely with the American trade association, the Association of Natural Biocontrol Producers (ANBP). The presentations at the symposium were augmented and developed into a twelve-chapter monograph that was published in 1998. Emphasis was placed on documenting the scientific evidence supporting applications. Eight of the chapters were senior-authored by public sector scientists, four chapters were senior-authored by persons from the private sector, and one of the four editors was from the private sector. Also, the foreword was coauthored by the president and a past president of ANBP. But perhaps most importantly, Carol Glenister, who represented ANBP and coedited the monograph, made very significant contributions by helping communicate with the private sector authors and in making the members of ANBP aware of the monograph. Also, perhaps the monograph helped facilitate the process led by Ms. Glenister to develop standards for mass-reared natural enemies through the American Society for Testing Materials (ASTM), which Glenister is leading. This process, along with a comprehensive website, an annual conference, and an informative newsletter, is contributing significantly to the continued success of the industry represented by ANBP.

Genetically Modified Organisms

Waldemar Klassen, who in 1987 was director of BARC, and I were keenly aware of the potential use of biotechnology in the development of new pest control technologies. When Dr. Klassen was approached by the Crop Genetics International Corporation to assist in field evaluation of a genetically modified bacteria, he commented to me that we were at the beginning of a new era. That is, an era during which genetic engineering was going to become a routine procedure for making changes in use of microorganisms, with broad beneficial agricultural and medical applications. He further indicated that scientists at BARC were experimenting with numerous genetically modified bacteria to learn how to safely experiment with them in the field. I shared Klassen's view on the potential importance of genetic engineering. So when he asked me to coordinate one of the first field releases in the United States of a genetically modified organism intended to control an insect, I enthusiastically accepted the assignment.

Scientists at Crop Genetics International Corporation had earlier inserted a gene for producing a *B. t.* toxin into a nonpathogenic bacterium known to reproduce inside corn plants. By inoculating corn plants with the genetically modified bacterium, the corn plants had been shown, under carefully controlled conditions, to contain enough *B. t.* toxin to kill larvae of the European corn borer, a major insect pest of corn. Since this was to be one of the first field releases of a genetically modified organism to control an insect pest, the process for obtaining regulatory approval, which at that time was primarily a US Environmental Protection Agency (EPA) responsibility, was not well defined. Therefore, obtaining regulatory approval for the release was a real challenge. Also, though EPA was the agency with primary authority, a series of briefings were held with local, state, and federal officials; and a public information meeting was held to explain what was being planned. Those information-sharing efforts, together with detailed plans on what precautions were being taken to prevent any spread of the organism outside the experimental area, led to approval of the field release by EPA.

The purpose of the experimental release jointly by scientists from Crop Genetics International Corporation and BARC was to test the efficacy of the new modified microbe, to ensure that it did not spread outside the experimental area, and to learn enough about its fate in the environment so as to plan how it might be used under practical conditions. A security fence was erected around the experimental area, and a wide strip of fallow land was maintained around the area where corn seeds containing the genetically modified microbe were to be planted. Soil and plants in and near the experimental area were carefully monitored. There was no indication that the modified microbe spread beyond the experimental area. Therefore, the technology was deemed to be safe. Also, there was adequate toxin produced in the treated corn plants to provide some reduction in corn borers. However, in time, inserting genes for *B. t.* toxins directly into the corn genome proved to be more effective than using the endophyte as the carrier for the *B. t.* gene. This experience provided a very useful introduction into the world of genetic engineering and was useful in placing future efforts on biologically based technologies into proper perspective.

Adoption of Biologically Based Technologies

My efforts to encourage the adoption of insect control technologies that were biologically based led to my being invited to present my views on the status and prospects at several national and international conferences.

In 1988, I was asked to organize a symposium for the Institute on Alternative Agriculture on "Biologically Based Methods of Pest Control: Contributions to Sustainable Agriculture" and, in 1989, to make a presentation on "Implementation of Technologies for Management of Insects" at the symposium "Entomology Serving Society: Emerging Technologies and Challenges," held to commemorate the one hundredth anniversary of the Entomological Society of America. In 1992, I had the privilege of making the opening presentation on "Advances and Trends in Managing Insect Pests" at a three-day symposium organized by the International Atomic Energy Agency and the Food and Agricultural

Organization of the United Nations in Vienna, Austria. These three presentations were later included in published proceedings of the symposia.

Momentum was building to encourage increased commercialization of biologically based technologies. This included the United States Congress requesting their Office of Technology Assessment (OTA) to conduct a related study. After a briefing with OTA staff, I was asked to prepare a briefing paper on "Biologically Based Pest Controls: Markets, Industries, and Products" to provide inputs into that study. As interest continued to increase, commercially oriented conferences (with rather large registration fees), such as those organized by the International Business Communications Conferences Inc., became a part of the process. In 1996, I was invited to make a presentation on multicellular natural enemies at one of those conferences, "Biopesticides and Transgenic Plants." At a similar conference in 1997, I was asked to organize a section on biopesticides. At that conference, transgenic plants received increased interest, at least partially because the first commercial sales of transgenic plants occurred in 1996. The potential for widespread use of plants containing genes for production of *B. t.* toxins was becoming increasingly evident. Still, there was rather broad concern about the development of resistance to the *B. t.* toxins since the use of this technology would likely result in exposure of a very large portion of insect populations to the *B. t.* toxins.

Perspectives and Influences

My career of more than thirty-five years working as a civil servant associated with USDA seemed to go by very quickly. Our daughter Sharon graduated from Texas A&M University in December 1983, accepted her first teaching job in Houston, and moved on to her next job in Dallas. She remained in Texas and, on December 20, 1986, married Dwight Mankin in Dallas. They live in Coppell, Texas, and have three children: Blake Richard, Emily Jane, and Austin James. The following

June 27, 1987, Susan and Raymond Esposito were married in Silver Spring, Maryland. They live in Providence, Rhode Island, and have two children: Amy Catherine and Eric Raymond. One of my greatest rewards is knowing that our children and grandchildren are mutually loyal, generous, and strong in their faith and are committed to helping make this world a better place by volunteering for clean water projects, by supporting cancer research and soup kitchens, and by assisting in the rebuilding disaster areas.

After retirement from USDA in 1997, when I became executive director of the Charles Valentine Riley Memorial Foundation (RMF), my focus changed from biologically based insect management to the broad food, agriculture, and natural resources arena. However, I continued to maintain interest in entomology and insect control through membership in the Entomological Society of America and ANBP. Also, pest issues were a common thread through all parts of the broad agriculture and natural resource system, and invasive species were a major program activity for RMF from 1998 through 2001. In addition to RMF programming, personal farming operations on the South Plains of Texas and continued interest in university programs provided the incentive to maintain an interest in a wide range of technologies related to food, agriculture, and natural resources. However, I did continue to monitor the adoption of insect control technologies that I had been involved with over the years.

Biotechnology has probably had more impact on agriculture in a short period of time than any other technology in history. In a little over a decade from the first commercial availability worldwide, over a billion acres were being planted with transgenic crops throughout the world. The impact on insect control practices is illustrated by the fact that in the United States, at least 80 percent of the corn and 60 percent of the cotton acreage is planted with varieties containing genes for production of one or more *B. t.* toxins. The development of resistance continues to be a significant risk, and resistance to one *B. t.* toxin in the cotton bollworm has been reported. However, the use of refuges where insects are not exposed to the *B. t.* toxins and the availability of a number of different toxins greatly reduces the threat of unmanageable resistance developing.

Formulations containing various *B. t.* toxins designed for spray applications to control insect pests on vegetable, fruit, ornamental, and other crops as well as forestry continue to be the principal microbial pesticide used to control insects. Although biotechnology and transgenic plants have greatly changed the landscape and, in particular, insect management on large-acreage annual field crops, genetically modified plants are not likely to satisfy all needs for pest control. For instance, where there is a desire to maintain native forests, replacing those trees is not a viable option. Also, exclusively growing genetically modified fruit, vegetable, and some other crops may not be viable because of the lack of acceptance by a significant number of people and because limited acreages of some crops may not be enough to justify the investment required.

Over time, behavior-modifying chemicals, microbial agents, and multicellular organisms have found their place in the practical world. Behavior-modifying chemicals are now widely used to monitor insect populations. The most extensive single use is possibly the use of the boll weevil pheromone in traps, where these traps are used in millions of acres to detect possible reintroductions of the boll weevil into areas where the weevil has been eradicated. Also, such traps are used on hundreds of thousands of acres where eradication efforts are underway to determine where insecticide treatments are needed.

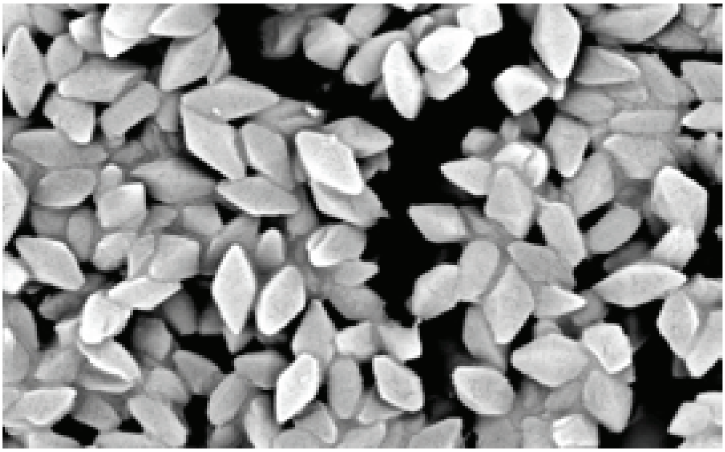
The use of multicellular organisms for pest control has evolved considerably over the past three decades. Most commercial producers, led by ANBP's board of directors, have entered the mainstream by placing increased emphasis on quality of their products and on evidence of efficacy. Perhaps the viability of the industry is best reflected by the nature of the conference "Blueprint for the Future of Arthropod Rearing and Quality

Assurance," which was held in Vienna, Austria, in October of 2010. The conference was a collaborative effort of the International Organizational of Biological Control's Global Working Group on Arthropod Mass Rearing and Quality Control, ANBP, American Society for Testing Materials Subcommittee E35.30 on Natural Multi-Cellular Biological Control Organisms, International Biocontrol Manufacturers' Association, Invertebrate Biocontrol Agents Group, and Joint Food and Agricultural Organization/International Atomic Energy Agency Division of Nuclear Techniques in Food and Agriculture. Representatives from twenty-nine countries attended the conference.

During the thirteen years in BARC that were devoted to continuing efforts to develop biologically based technologies and to encourage their adoption, I had many rewarding and satisfying experiences within the United States and throughout the world. Those experiences exposed me to much diversity. They provided me with a broad perspective that has continued to influence my thinking about how the public sector and nongovernmental organizations can work with the private sector to develop and implement improved practices and policies. Toward that end, I plan to continue to be involved with selected groups in improving the management of natural resources for the production of agricultural commodities and in improving the delivery of food and other products to those who need them to improve the quality of their lives.

May N. Inscoe provided invaluable scientific support and expert editorial assistance to the author from 1983 until 1998. Photo credit: ARS, USDA.

The boll weevil pheromone, which is used extensively in traps as a key component of the boll weevil eradication program, is representative of the many hundreds of pheromones used in traps for monitoring insect populations. Photo credit: APHIS, USDA.



The crystalline endotoxins produced by the bacterium, *Bacillus thuringiensis,* are useful as biological control agents; in addition, genes associated with numerous related toxins have been used to produce a wide range of genetically modified plants resistant to insects. Photo credit: Jim Buckman.

The Association of Natural Biological Producers (ANBP) represents a creditable private sector that provides biological agents for pest control. The 2011 board of directors are pictured (*back row from left to right*): Tom MacDonald, Carol Glenister, Angela Hale, Kim Horton, Rene Ruiter; (*front row from left to right*) Brian Spencer, Richard Ward, Eda Reinot, and Dan Cahn. Photo credit: ANBP.

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10

South Plains of Texas Revisited and Beyond: Seeking Economic Sustainability

(2000–2011)

Introduction

As my journey took me from the South Plains of Texas to New York State, then to central Texas, and on to the Washington, DC, area, my connections with the South Plains and beyond continued primarily through family, long-time friends, and farming interests. Those connections were strengthened and broadened considerably beginning in 2000 as I became involved in a range of activities in West Texas and eastern New Mexico. Included were the development of an educational park in the city of Brownfield, serving as managing partner for farms in Terry County, strengthened relationships with a New Mexico ranching family, research planning for the College of Agricultural Sciences and Natural Resources at Texas Tech University, and participation in the Chancellor's Council at Texas Tech. Relationships developed through these activities have continued. Concurrently, relationships with the

Texas A&M University System were renewed through the Charles Valentine Riley Memorial Foundation.

As I began to revisit the South Plains of Texas and consider the future of that extended region within the Southern Great Plains, the “Health of the Land and Its People” theme for the national agricultural forum conducted in 1986 in the name of Charles Valentine Riley came to mind. Clearly, the management of the land and other related natural resources directly or indirectly affects the well-being of everyone in the region. Also, Professor Riley’s emphasis on the importance of scientific knowledge and taking a whole-picture approach is highly relevant to the South Plains of Texas and the Southern Great Plains as well as to the nation and the world.

This part of my journey, in addition to describing my experiences in developing Hamilton Park and my involvement in planning a federally funded research initiative, includes a discussion of how a broadened national interest in sustainability with a special reference to food, agriculture, and natural resources might be applied to benefit the Southern Great Plains.

City of Brownfield, Hamilton Park and Terry County

In 2000, Nancy Wade, then mayor of the city of Brownfield, a rural community located on the South Plains of Texas and in the center of a region often referred to as the Llano Estacado, suggested that land at the intersection of two major highways belonging to three of us that are descendants of my grandparents be donated for a park. I worked with my brother, Joseph Gene Ridgway, and cousin, Charles Walter Isbell, to transfer the land to the city of Brownfield, at which time a multiyear effort to build a park began.

Coordinated efforts to build Hamilton Park, named for the Joseph T.

Hamilton family, began by structuring a citizen advisory committee and by the city of Brownfield contracting to plan drainage, traffic flow, parking, and curbing. The "Rich Heritage and Promising Future" theme for the park was derived from discussions with the mayor, city staff, and members of the Terry County Historical Commission. As efforts to design the park, raise funds, and begin construction were launched, I became the coordinator and chief fund-raiser for the project. Working with the citizen's advisory committee and a fund-raising committee provided me with the opportunity to become familiar with most of the institutions and many of the people in Terry County as well as those no longer living in the county but that continued to have interests there. Additional insights were obtained during the preparation of twelve interpretative panels and the selection of two bronze sculptures that involved working with local subject matter teams and doing a study of both the heritage and factors that are likely to impact on the future. The heritage elements in the park include the land; flora and fauna; law and order; ranching; farming; oil and gas; schools, churches, and medical services; and businesses. The *Book a Day* bronze sculpture, dramatically illustrating a child reading a book, is the centerpiece for the futures section of the park, which includes panels on natural resources, economy, communications, people, and education.

Business, agriculture, school, community, city and county leaders, and US Congressman Randy Neugebauer, along with Sheryl Santos, then dean of education at Texas Tech University, came together to dedicate an attractive educational park on May 6, 2006. Three related dedication events were attended by 350 people. Thus, Hamilton Park became a tribute to the people that first came to Terry County, passed the harsh test of survival, lived their dreams, and developed a sense of pride that has continued for generations, and to today's people that are making commitments to meet the challenges necessary to ensure a promising future for Terry County.

The story told in Hamilton Park is being formally communicated annually to the students at Oak Grove Elementary School as part of their Texas history curriculum. A field trip to the park is combined with the completion of a study aid and the presentation of awards at a dinner with their parents for those students that excel in completing the study aid. Funds for the awards and dinner are provided from the Hamilton Park Fund, which continues to be administered by the city of Brownfield.

West Texas Regional Economic Development: Natural Resource Management

In 2001, David Schmidly, then the president of Texas Tech University, invited me to visit the campus to discuss opportunities for Texas Tech to expand its services to the people of West Texas. Dr. Schmidly had a broad view of the ways research, technology, and information could be used to deal with some of the challenges facing rural communities in West Texas. Schmidly's invitation was preceded by a number of informal discussions involving the Plains Cotton Growers Inc., High Plains Underground Water Conservation District, the Lubbock Chamber of Commerce, and others. Subsequently, I spent two days on the Texas Tech campus, visiting representatives from several colleges and other offices on the campus that had interests in agriculture, engineering, biological sciences, economics, informational technology, intellectual property, rural development, small businesses, and economic development. The facilitated discussions were directed toward searching for ways wherein different interests on the campus might be brought together to address issues affecting rural communities.

After the two days on the Tech campus and follow-up discussions, the Lubbock Chamber of Commerce and John Abernathy, then dean of College of Agricultural Sciences and Natural Resources (CASNR), requested that I proceed with facilitating the planning of an initiative on natural resource management and economic development. Broad-based inputs were obtained over a period of several months, and a working paper entitled "West Texas Regional Economic Development: Natural Resource Management" was produced. The working paper provided the basis for presentations at a public meeting with stakeholders that was sponsored by the Lubbock Chamber. The information presented was converted into an initiative entitled "Natural Resource Management and Advancement of Agricultural Enterprises," which was included in the Texas Tech Federal Initiatives Program Prospectus for FY 2003. That initiative dealt with a wide range of natural resource and agriculture production issues. Included was management of water from the Ogallala Aquifer, which provides water for irrigation that greatly increases crop productivity. Improved management of grasslands, whether native or reestablished, to preserve the soil and to provide important wildlife habitat was also a part of the natural resource component. Development of advanced technologies for production and processing of cotton and beef were emphasized because of the economic importance of these commodities.

A compromise during the efforts to obtain funding resulted in US Department of Agriculture's (USDA) Agricultural Research Service (ARS) leading a multi-institutional Ogallala Aquifer initiative that first received federal funding beginning in FY 2003. The funding that was shared by ARS, CASNR, and Texas A&M University System.

Looking Forward

A move for Donna and me to Flower Mound, Texas occurred in November of 2003. Flower Mound is conveniently located near the Dallas/Fort Worth airport and provides reasonable access to the East Coast (Washington, DC, and Providence, Rhode Island), the South Plains of Texas, and family in Coppell, Texas. From Flower Mound, my continuing journey will, because of previous experiences, a love for the land and a deep interest in food, agriculture, and natural resources, involve at least a portion of the South Plains. Hopefully, that journey can include encouraging others to add to the scientific knowledge base that will be useful in meeting the challenges necessary to ensure a promising future for the region. Since sustainability is now receiving broad, increased attention, it should be a useful framework for exploring future opportunities.

Sustainability

The concept of sustainability apparently had its beginning in the organic agriculture and environmental movements. Organic agriculture in the United States was promoted beginning in 1942 by J. I. Rodale with the publication of *Organic Farming and Gardening* magazine and was identified with sustainable agriculture as early as 1977 by the International Federation of Organic Agriculture Movements. The concept of sustainable development received major international attention in 1992 at the Earth Summit in Rio de Janerio, Brazil.

My research on biological pest control received attention from the organic agriculture interests in the late 1960s, and I was invited to join the editorial board for the *American Journal of Alternative Agriculture* in the late 1970s. Thus, I have had the opportunity to follow the organic and sustainable agriculture movements over the years.

A definition of sustainable agriculture was codified in 1990 (US Code title 7, section 3103) as an agriculture that will (1) satisfy human needs, (2) enhance environmental quality and the natural resource base, (3) make the most efficient use of nonrenewable resources, (4) sustain the economic viability of farm operations, and (5) enhance the quality of life. Although this definition is much broader than organic agriculture as defined in current USDA standards, many of the organizations that promote organic agriculture still function under the sustainable agriculture umbrella.

Sustainability science was introduced at the World Congress "Challenges of a Changing Earth," held in Amsterdam in 2001, as its own discipline to provide for "stronger analytical and scientific underpinning" for sustainable development. However, that underpinning likely will come from other more traditional disciplines. Therefore, for the results of sustainability science to be most meaningful, the disciplines such as the agricultural sciences, natural resource sciences, geography, hydrology, engineering, and economics must be involved.

Sustainability seems to continue to have an environmental orientation, including the approach being taken by the National Research Council roundtable. However, the roundtable's emphasis on "scientific innovation, new knowledge and learning, and collaborative approaches to implementing technologies" and policies has broad application.

Additional activities related to sustainability of special note include the Keystone Alliance for Sustainable Agriculture and the American Association for the Advancement of Science forum on science and innovation for sustainable development. Since agriculture and natural resources provide the basis for all human activity, this would appear to be a good place to focus efforts on an expanded search for economic sustainability.

Based on my previous experiences with pesticide regulatory decisions and adoption of pest management practices, economics was, in the end, perhaps the single most critical element in the decision-making process although biology, ecology, chemistry, toxicology, and environmental considerations were involved. Also, because of the early influences of the organic and environmental movements on sustainability, an emphasis on economic sustainability is desired to provide balance. Thus, an understanding of the economic impact of agriculture is a critical underpinning in the pursuit of economic sustainability.

Regionalization: Heart of the Southern Great Plains

Agriculture is important throughout the State of Texas, but it is particularly important in northwest and west central Texas, where it is closely allied to agriculture in eastern New Mexico, western Oklahoma, southeastern Colorado, and southwestern Kansas. This region may be appropriately referred to as the Heart of the Southern Great Plains (HSGP). Although soils, climate, and the availability of underground water vary considerably throughout the region, there are many commonalities.

A review of the values of agricultural production and its economic impact should provide a useful basis for looking at opportunities to achieve economic sustainability and ensure a promising future for the region.

Value of Agricultural Production

Perhaps the most comprehensive database on values of agricultural production in Texas is compiled by the Texas AgriLife Extension Service, a unit of the Texas A&M University System. The data collected at the county level are then aggregated for each of the service's twelve districts. The agriculture census taken by USDA's National Agricultural Statistics Service (NASS) provides related data and may be the best available for values in nearby states.

The Texas AgriLife Extension Service database does not include government payments, and although the NASS database does, government payments are not included in the values from NASS presented here. Although government payments contribute significantly to the stability of some agriculture enterprises and to conservation of natural resources, much can be said about the economic importance of agriculture without including these payments.

South Plains of Texas. Texas AgriLife Extension's district 2, or South Plains District, includes twenty counties centered around the city of

Lubbock. In 2010, the value of crop production in this district was $2.9 billion, and the value of livestock production was $1.6 billion. Cotton was the leading crop with a value of $2.1 billion, followed by feed crops, primarily corn and sorghum. Fed beef was the leading livestock category valued at $0.6 billion. The total cash value associated with agriculture in the South Plains district was $4.5 billion.

Panhandle of Texas. Texas AgriLife Extension's district 1, or Panhandle District, includes twenty-two counties centered around the city of Amarillo. In 2010, the value of crop production was $1.4 billion, and the value of livestock production was $2.0 billion. Corn valued at $0.6 billion was the main crop, followed closely by wheat. Fed beef, again, was the leading livestock category, valued at $1.4 billion. The total cash value associated with agriculture in the Panhandle District was $3.4 billion.

The Heart of the Southern Great Plains. The South Plains and Panhandle of Texas, only 2 of the 12 Texas AgriLife Extension districts in Texas, representing 32 of the 254 counties in Texas, accounted for about 37 percent of the total value of agricultural production in the state in 2010. When the three adjoining Extension districts (3, 6, and 7) are included, that percentage increases to 52 percent. Thus, the total value of agricultural production in the five most western Texas AgriLife Extension districts in 2010 was $13.1 billion.

The value for agricultural production in the twenty-one counties in New Mexico, Oklahoma, Colorado, and Kansas nearest Texas as reported in the 2007 agricultural census was $2.6 billion. Therefore, the HSGP region, which has in common one or more of the major crops and/or livestock enterprises, produces crops and livestock that in most years are likely to be valued annually in excess of $15 billion.

Economic Impact

The value of agriculture production is only a part of the total economic impact of agriculture. Economic multipliers which vary by commodity are often used to estimate economic impact. The most common multipliers are those from the Minnesota IMPLAN input-output system that are based on values from the farm gate through the supply chain. Also, estimates of contributions to the Gross Domestic Product (GDP) by the food and fiber system in Texas are made periodically by the Texas AgriLife Research and Extension, Department of Agricultural Economics, Texas A&M University System, and the Office of the Comptroller, State of Texas.

The multipliers from the IMPLAN system for the five top commodities in Texas range from 2.0 to 2.7. Therefore, the economic impact of $15 billion of value at the farm gate could easily have an economic impact of $30 billion if projected through the supply chain. Further, although estimates of the GDP for Texas may not be transferable to the HSGP, they do provide some perspective on the total economic impact. Considering that the value of agricultural production in Texas was $21.6 billion in 2010 and that the GDP associated with agriculture in Texas in 2007 was about $99.1 billion, a multiplier of 4.6 can be derived from these values. Using this approach, with over $15 billion worth of agriculture production in the HSGP, the annual economic impact of agriculture in that region in 2010 could have been in excess of $60 billion.

However, it should be noted that in 2011, the most severe drought on record occurred within the HSGP, and the value of agriculture production will be much less than in previous years. Estimates of agricultural losses in Texas this year due to the drought are well in excess of $7 billion. Still, if the previous four years are considered, the long-term trends can be expected to be similar to that of 2010, particularly if advanced technologies can substitute for the likely decline in available water resources and other factors that could adversely affect production.

Finally, it is important to note that within the framework of seeking economic sustainability for the HSGP, there are economic impacts associated with the land that are probably not being adequately measured. For instance, there are indications that current estimates for the value of recreational uses, such as hunting and pleasure horses, are not fully reflected in current estimates. Also, such returns as those for leases for wind turbines, which are adding substantially to land-based income, are not included in generally available databases.

Institutions

There are numerous institutions that serve the various clienteles in the HSGP that can contribute to economic sustainability in the region. When public institutions dealing with food, agriculture, and natural resources are considered, the Texas Tech University System and the Texas A&M University System are perhaps on the forefront. Texas Tech's CASNR is organized into six major departments: plant and soil science, animal and food sciences, natural resources management (primarily range and wildlife), landscape architecture, agricultural and applied economics, and agricultural education and communications. In addition, significant research related to food, natural resources, and value-added processes are conducted in other parts of the university.

Texas A&M operates AgriLife Research and Extension Centers at Lubbock, Amarillo, San Angelo, Vernon, El Paso, and a research unit at West Texas A&M University at Canyon. In addition to the research personnel and subject management extension specialists at the centers, county-level staff provide services on agriculture and natural resources, family and consumer services, and youth and community development. Joint faculty appointments by Texas Tech and Texas A&M in both research and extension add an important dimension to the programs at these two institutions.

In addition to Texas Tech and Texas A&M, USDA's Agricultural Research Service operates major research centers at Lubbock and Bushland. Also, services related to agricultural and natural resources are provided by other USDA agencies, the Texas Department of Agriculture, and the underground water conservation districts.

The value of collaborations involving the three key agricultural research institutions serving the HSGP was demonstrated on March 15, 2011, when three cases of exemplary collaborations were selected from the sixty-one nominated to be presented at the Agriculture, Food, and Nutrition, and Natural Resources R&D Roundtable. One case involved the Ogallala Initiative, led by ARS in collaboration with Texas Tech and Texas A&M; another was a food safety case led by Texas Tech. A third case on the bovine genome included a major contribution from Texas A&M. Many nongovernment organizations that serve the HSGP region have interest in agriculture, but perhaps the Southwest Council for Agribusiness (SWCA) provides the single most unifying organization through its more than 120 members that represent nonprofit agricultural organizations, agribusinesses, and financial institutions. Currently, that unifying role is focused primarily on federal farm policy, but SWCA is well positioned to have broader influence.

Opportunities

There are opportunities for public institutions to increase their contribution to economic sustainability in the HSGP region through "scientific innovation, new knowledge and learning, and collaborative approaches to implementing technologies," starting with preserving the current agriculture and natural resource research and education base. Continuation and expansion of traditional agricultural research and information transfer activities at Texas Tech and Texas A&M are essential in this regard. However, as conditions change, including the availability of less water and increased energy costs, innovation, new knowledge, and taking a whole-picture approach will become increasingly important.

A special initiative on sustainability with increased interdisciplinary undertakings could be an important component of a broad strategy to increase funding for collaborative research and development involving the public institutions that serve the HSGP region. Such an initiative would include linkages between agricultural production, food, water, energy, climate, and environment. An expanded effort is particularly needed so that additional emphasis can be placed on economics as policies on sustainability evolve. Development and application of new technologies will be critical in sustaining the economy as conditions change. An initiative focusing on HSGP could lead to the development of a model that would have national and international significance.

The Challenge

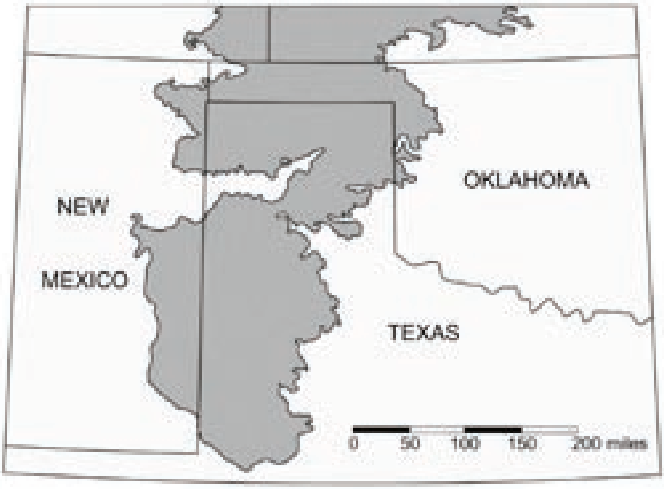
Economic sustainability in the HSGP and elsewhere can be greatly influenced by the public research and education organizations within the region working together to substantially expand the knowledge base associated with food, agriculture, and related natural resources. One of the important results of expanding the knowledge base would be providing private enterprises with additional options to consider as the private sector collaborates with the public sector to achieve economic sustainability in the HSGP.

As my continuing journey takes me to various parts of the HSGP, I will follow with interest how the different institutions and the associated people make adjustments at the local and regional levels that are necessary to achieve economic sustainability and ensure a promising future.

The city of Brownfield and Terry County lie near the middle of the Llano Estacado, a vast area without many visible natural landmarks and limited surface water; the Llano is an important defined region from both a historical and a present-day perspective. Map credit: Michelle Davis.

Hamilton Park, named for the Joseph T. Hamilton family, is an educational park that was developed to promote the rich heritage and promising future of rural communities on the South Plains of Texas and to honor the early settlers of Brownfield and Terry County. Photo credit: David Miller.

Today's people, whether they represent local businesses, underground water districts, local governments, or farmers, are committed to meeting the challenges necessary to ensure a promising future for the South Plains and beyond. *Left to right:* Sheri Simpson, Dennis Yowell, Willie Herrera, Scott Jackson, and Glenn Waters. Photo credit: David Miller.



The High Plains or Ogallala Aquifer lies below much of the Southern Great Plains; water taken from the aquifer by windmills made possible the original settlement of the region, and today it provides water for irrigating crops, greatly increasing productivity. Photo credit: USGS.

Grasslands, whether native or reestablished with the help of the federally funded Conservation Reserve Program, preserve the soil and provides important wildlife habitat. Photo credit: Natural Resources Conservation Service, USDA.

Cotton, produced with the aid of the most advanced technologies, is and will continue to be a vital part of the economy in much of Southern Great Plains. Photo credit: Deere and Company.

Beef cattle, whether feeding on native grassland, on reestablished grasslands, on intensely managed forage crops or being finished in feedlots, are an important part of the economy on much of the Southern Great Plains. Photo credit: ARS, USDA.

The bobwhite quail is a representative of the diverse wildlife that can be found on ranchland and other grasslands throughout the Southern Great Plains. Photo credit: Texas Department of Parks and Wildlife.

West Texas, eastern New Mexico, western Oklahoma, southeastern Colorado, and southwestern Kansas form the Heart of the Southern Great Plains and are linked by a range of mutual interests, including common crops, cattle on the range and in feedlots, water, energy, health care, and many other services. Map credit: University of Nebraska.

Wind turbines to generate electricity, utilizing an abundant and unending supply of a natural resource, offer an opportunity to provide extensive economic benefits to West Texas, including the export of energy outside the region. Photo credit: National Renewable Energy Laboratory, US Department of Energy.

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The Charles Valentine Riley Influence (1982–2008)

Introduction

Charles Valentine Riley rose to national prominence when he was named the first chief of the US Entomological Commission in 1876 and chief entomologist for the US Department of Agriculture (USDA) in 1878. The appointment to the latter position, which he held except for two years until 1890, occurred soon after John Henry Comstock graduated from Cornell University in 1874 and established the first academic department of entomology in the United States. Professor Riley soon recognized Professor Comstock's outstanding abilities and supported his conduct of a special study on cotton insects. Subsequently, Riley lectured at Cornell and Comstock took a leave of absence in 1879 and 1880 to serve in Riley's position as USDA's chief entomologist. Thus, there was a significant linkage between these two outstanding scientific leaders that developed in the latter part of the nineteenth century.

As a graduate student at Cornell from 1957 to 1960, I was exposed to much of the Comstock heritage, and I became generally acquainted with the work of both Professor Comstock and Professor Riley as outstanding national figures in entomology. I also became increasingly aware of Professor Riley's contributions to biological insect control in the mid 1960s as I began to direct more of my time to research on biological controls. However, in 1982, a much broader and intriguing perspective on Riley began to take shape when the US secretary of agriculture received a letter from Victor John Yannacone Jr., trustee of the Cathryn Vedalia Riley Trust (the Riley Trust). Mr. Yannacone requested assistance in establishing a suitable memorial for Riley as directed in the trust indenture executed by Riley's daughter, Cathryn Vedalia Riley. The letter was preceded by a number of communications with various USDA personnel, including Lloyd Knutson, then chairman of USDA's Insect Identification and Beneficial Insects Introduction Institute at Beltsville, Maryland.

Riley Memorials Program (1982–1985)

In August 1982, I received a phone call that led to Secretary of Agriculture John R. Block asking me to serve in a liaison capacity for USDA to work with Mr. Yannacone. Thus, the phone call and Secretary Block launched me off on a most challenging but satisfying segment of my extended journey.

I worked with Mr. Yannacone and various USDA administrators to develop a memorandum of understanding (MOU) that was signed by Yannacone and Secretary Block in January of 1983. That MOU provided the framework for a program to memorialize Professor Riley, including the assignment of administrative oversight for implementing that MOU to Assistant Secretary for Science and Education Orville G. Bentley. Subsequently, Dr. Bentley and I designed a USDA interagency work group that Bentley appointed. The work group was composed of Douglas E. Barnett, Animal and Plant Health Inspection Service; Klaus W.

Flach, Soil Conservation Service; Melvin E. McKnight, Forest Service; C. David McNeal, Extension Service; Robert C. Riley, Cooperative States Research Service; Richard L. Rissler, Animal and Plant Health Inspection Service; John R. Schaub, Economic Research Service; and me, representing the Agricultural Research Service, as chair. The work group soon learned to appreciate Riley's accomplishments. In 1888, Riley helped save the California citrus industry by introducing the Australian vedalia beetle to combat scale insects. He also was a key figure in the research that led to the rescue of the European wine industry from an invasive insect pest from America. France recognized this accomplishment by awarding Riley the Cross of the Legion of Honor. Recognizing that Riley was deserving of special recognition for his outstanding contributions in the field of entomology, the USDA work group proceeded to prepare a comprehensive plan for a Riley Memorials Program that was concurred in by the secretary of agriculture on February 24, 1984.

After the secretary of agriculture concurred in the program plan, I was successful in negotiating a $150,000 gift from the Riley Trust to USDA to initiate the Riley Memorials Program. Emilie Wenban-Smith Brash, granddaughter of Charles Valentine Riley, presented the first installment of the gift to Secretary Block on March 11, 1984, and the Charles Valentine Riley Memorials Program was established within USDA. An advisory group formed to assist in implementing the Riley Memorials Program came from a relatively wide array of disciplines, organizations, and backgrounds. The group was first chaired by Edward H. Smith of Cornell University and later by Ross S. Whaley of Syracuse University. Others involved were John C. Gordon of Yale University; Durward F. Bateman of North Carolina State University; Gideon D. Hill of E. I. DuPont Co.; I. Garth Youngberg of the Wallace Institute for Alternative Agriculture; Harry C. Mussman, then with the National Food Processors Association; Dan M. Martin of the MacArthur Foundation; and Raymond J. Miller of the University of Maryland.

Charles Valentine Riley Memorial Foundation (1985–1989)

As implementation of the Riley Memorials Program proceeded, I became aware that the Riley Trust indenture called for implementing the intended purpose of the trust through a public charity. Subsequently, Dr. Bentley and I met with interested members of the USDA advisory group and Mr. Yannacone in early 1985, and there was agreement that the formation of a public charity should be explored. The original advisory group was joined by several individuals to make up the first board of directors of the Charles Valentine Riley Memorial Foundation (RMF) with Dr. Gordon as its first president. Those additional individuals included John "Duke" S. Barr III, a farmer from Louisiana; Bennie I. Osburn of the University of California at Davis; Earl R. Swanson of the University of Illinois; Robert Tweedy, representing farm machinery manufacturers; and Ms. Brash, from Headley Down, Hampshire, England. RMF was established on August 27, 1985, with the following purpose:

> To promote a broader and more complete understanding of agriculture as the most basic human endeavor and to make secure the lever that is agriculture and its fulcrum, the natural environment, during this and succeeding generations.

RMF's board of directors first met on November 4, 1985, when the bylaws were adopted and a MOU between the USDA and RMF was signed by Secretary Block and Dr. Gordon. At the signing ceremony, an oil portrait of Professor Riley was presented to USDA by Ms. Brash. This portrait, painted in 1891 by the American portrait artist Henry Ulke, is now together with many other related documents and artifacts and is part of the *Special Collections* at the National Agricultural Library (NAL) in Beltsville, Maryland.

The MOU between USDA and RMF provided a mechanism for RMF, under Dr. Gordon's leadership, to assist USDA in carrying out the intent of the gift agreement between USDA and the trustee of the Riley Trust.

In that process, the broad vision of Professor Riley that extended far beyond the field of entomology began to influence the thinking of many of those involved. Subsequently, an understanding of agriculture in its broadest sense became the initial framework within which to memorialize Riley, and "Health of the Land and Its People" emerged as the theme for the national agricultural forum that was held on October 29–31, 1986.

At the first RMF board meeting, the decision was made to retain a New York–based firm to manage RMF. The firm assisted in planning and conducting the national agricultural forum in the fall of 1986. Norman E. Borlaug, a 1970 Nobel Prize recipient, made the keynote address "Food and Human Progress" at that forum on October 29, 1986. The following are quotes by Dr. Borlaug and others made during the forum laid a firm foundation for RMF:

> Without a stable food supply, I assure you that there will be neither peace, nor human progress. (Norman Borlaug, Nobel laureate, Texas A&M University)
>
> Agriculture touches all aspects of human activity and it provides the leverage to lift society to greater heights. (John Gordon, founding president, Riley Memorial Foundation)
>
> Agriculture [is] the biggest, most important industry in our nation… Correct decisions must be made about what to do to insure competitiveness in international trade, to help insure conservation of our natural resources, and to insure an aggressive commitment of resources to research. (Thad Cochran, United States senator)
>
> Now is the time for all of us to recall just how noble and important it is to care for the land and to broaden our horizons about the social benefits of farming. (William Reilly, Conservation Foundation)

A key early linkage with the World Food Prize was established at this first forum. RMF became aware through A. S. Clausi of the General Foods Corporation of the efforts by Dr. Borlaug to establish a Nobel-like prize in food and agriculture. RMF was pleased that during Borlaug's presentation at the national agriculture forum, he reviewed his efforts to establish the World Food Prize and announced that the first World Food Prize would be presented in 1987.

In August of 1987, essentially all the funds that had been made available by the trustee for the Riley Trust to support RMF had been expended. At that time, Dr. Gordon indicated that he thought it was very important to continue to pursue the purpose of RMF and Riley's vision as reflected in that first forum. In order to continue the work of the RMF, Gordon offered to host a second forum at Yale University. The Global Issues Forum "New Directions in Agriculture" was held on November 10, 1988, and a Riley prize was awarded to Toshio Murashige of the University of California, Riverside. Dr. Murashige was recognized for his contributions to agricultural biotechnology through pioneering plant tissue culture research. At that time, USDA's primary responsibilities under the original gift agreement, which also had included supporting the *Special Collections* at the National Agriculture Library (NAL), were fulfilled, and the original plan for the USDA Riley Memorials Program had been fully implemented. Immediately after the Global Issues Forum, Gordon invited me to join the RMF Board of Directors to assist in continuing the purposes of RMF. I resigned from my position as liaison between USDA and RMF, and approval by USDA for me to serve on the RMF Board of Directors in an official capacity was granted in the spring of 1989.

Continuing the Vision (1989–1996)

RMF functioned as an all-volunteer organization for the next seven years, during which time Dr. Bateman and Dr. Gordon continued to provide important leadership along with Richard A. Herriot, then director of research for ICI Americas, and Katherine "Kitty" Smith, then with the Institute of Alternative Agriculture, contributed significantly to program development. From 1989 to 1996, six activities and associated summary-type publications and reports were completed with modest funding, primarily from USDA and industry:

- National Initiatives on Investing in Research
- Enhancing the Safety of America's Food Supply
- Science Communications and Enhanced Agricultural Policy
- Science Policy and the Public Interest
- Input for Federal Food and Agricultural Research and Extension Programs
- Food and Agricultural Research in Changing Times

These activities demonstrated the ability of RMF to bring together persons with diverse interests to examine a wide range of interests, but opportunities remained to address issues from a truly whole-picture perspective.

World Food Prize

With Mr. Clausi serving on the RMF Board of Directors, RMF continued a linkage with the World Food Prize. In 1990, the World Food Prize was presented to John Niederhauser for his contributions to potato improvement in the Baird Auditorium at the Smithsonian Institution under the auspices of the World Food Prize Foundation (WFPF). RMF supported that occasion by hosting a lunch at the Cosmos Club for Dr. Neiderhauser. Professor Riley's serving as a charter member of the Cosmos Club in 1878 and founding the insect collection at the Smithsonian in 1892 provided fascinating linkages between the legacy of Riley, RMF, and the World Food Prize. In 1992, the World Food Prize was awarded to USDA entomologists E. F. Knipling and R. C. Bushland for their contributions to developing environmentally friendly methods of insect management that included the sterile male technique. Thus, Riley is still recognized today for his contributions to biological control of insect pests during the latter half of the nineteenth century. RMF hosted a luncheon for Dr. Knipling and Dr. Bushland at NAL, the home of many materials on Charles Valentine Riley that are held in the *Special Collections* there. Similarly, entomology and pest management were the basis for awarding the World Food Prize in 1997 to Perry L. Adkisson of the Texas A&M University System and Ray F. Smith of the University of California. Subsequently, the World Food Prize and related activities were greatly expanded under the leadership of Ambassador Kenneth M. Quinn, who became the president of the World Food Prize Foundation on January 1, 2000.

Riley's Influence beyond Entomology

Additional information about Riley provides an increased understanding of the importance of continuing to build on his legacy. Riley's contributions beyond entomology had been less obvious, but when they are carefully examined, it is clear that he left us a legacy that we should not refuse: a vision of integrated agriculture in its broadest sense, including its scientific, cultural, social, and political dimensions. As a part of Riley's view of agriculture, he understood far better than most men of his time the importance of scientific knowledge. This understanding was reflected in his third annual report as the state entomologist of Missouri, published in 1871:

> None but the well informed are successful; for success in agriculture… today, implies knowledge—scientific knowledge!"

N. J. Coleman reported in 1892 that Riley's passion for science was reflected by his membership in many scientific societies in the United States and abroad, including Belgium, France, Germany, Great Britain, New Zealand, and Switzerland. He was president of the Academy of Science of St. Louis, being the youngest member so honored. He was founder and president of the Entomological Society of Washington; one of the founders of the Biological Society of Washington; an honorary member of the horticultural societies of Illinois, Iowa, Kansas, and Missouri; and an honorary fellow of the Entomological Society of London and of the Royal Agricultural Society of Great Britain. The breadth of Riley's interests is evident in some of the other societies in which he was active, including the American Philosophical Society, the American Pomological Society, the American Agricultural Society, the Association of Scientific Agriculturists, and the Philosophical and Anthropological Societies of Washington. As a fellow of the American Association for the Advancement of Science, he held various offices, including presiding officer of its biological section.

Professor Riley's appreciation and understanding of natural systems was evidenced by his detailed illustrations and many observations. These qualities were especially evident in the nine annual reports he wrote as state entomologist of Missouri from 1868 until 1877. In 1995, Gene Kritsky cited a letter from Charles Darwin to Riley in which Darwin commented on the Missouri reports, "I must send you a line to thank you for sending me your ninth report, which like its eight predecessors has interested me much. You always manage to discuss points of general interest, besides those of practical importance." Riley's vice presidential paper "On the Causes of Variation in Organic Forms" presented before the section of biology of the American Association for the Advancement of Science in 1888 is regarded as one of his most important philosophic writings. In this paper, Riley discussed evolutionary theory, contrasted Darwinism and Lamarckism, and examined the relation between scientific and religious philosophy, concluding that

> the experience gained by those who have reached the highest ethical and intellectual growth must be formulated in precept and principle to be of benefit to society at large, and the higher ethical sentiment and religious

> belief—faith, love, hope, charity—are priceless beyond all that exact science can give it.

Riley's broad vision was also shown by his being the first, in a speech delivered before the National Agricultural Congress in 1879, to recommend the establishment of the Office of Experiment Stations. He also advocated establishment of the Branch of Economic Ornithology in USDA, which evolved into the Fish and Wildlife Service, now in the Department of the Interior. Also, in 1889, he was appointed by the president of the United States as expert commissioner to the Paris Exposition and representative of USDA. Riley's mastery of detail was evident throughout the US agricultural exhibit, which was said to be one of the finest in the great display.

Another facet of Riley, the man, is demonstrated by his involvement in the cultural aspects of his work through his charter membership in the Cosmos Club in Washington, DC. In 1878, Riley joined with Alexander Graham Bell, John Wesley Powell, and fifty-seven other men active in science, literature, and the arts to found this club as a social club for individuals of distinction, character, and sociability. This club elects as members individuals from professions having to do with scholarship, creative genius, or intellectual distinction; members have included American presidents and vice presidents, Supreme Court justices, and winners of the Nobel and Pulitzer Prizes. In 1885, L. O. Howard and others wrote about Riley's social qualities:

> Away from his work he was the most approachable and genial of men… Official cares were thrown aside and all the geniality of his nature came to the front. It is probable that the picture of Riley which will last longest in the minds of most of us will show him… discussing in his versatile way almost any subject from politics to ethics, his face beaming with animation and good humor."

Professor Riley was also reported to be a "judicious and tender" husband

and father, "finding in his family and in the culture of fruit and flowers on the spacious grounds that surrounded his residence" on Wyoming Avenue in Washington, DC, "much healthful relaxation from the cares of his office."

Finally, the singular characteristic of Riley's legacy, as reflected in the precepts and goals of the Charles Valentine Riley Memorial Foundation, was that he was a whole-picture person, an artist, a poet, a writer, a journalist, a linguist, a horticulturist, a botanist, a naturalist, and a philosopher, as well as an entomologist. Our greatest legacy from him may come through his vision and his ability to see agriculture, the productive use of the landscape, as an entity upon which all of society depends. In our age of academic and occupational specialization, and of shrinking numbers of people who live on and from the land, we need to make sure that all citizens see the wholeness of agriculture that Riley surely saw.

Thus, a group of us continued to be firmly committed to building upon Charles Valentine Riley's legacy as a whole-picture person with a vision for enhancing agriculture through scientific knowledge.

RMF Expansion Efforts (1997–2002)

In 1997, I retired from USDA, resigned from the RMF Board of Directors, and became executive director of the RMF. The RMF's long-standing cooperation with NAL was further strengthened shortly thereafter by an agreement that provided for RMF to be housed in NAL for a period of five years. During that period, the income from grants, contributions, and registration fees averaged about $100,000 per year. When preparing for meetings, I often worked in-house—meaning my home office—as well as at NAL. Many documents, particularly those associated with the administration of RMF, were produced in the home office and collated on our dining room table with my wife's assistance. Donna also graciously accompanied me to many different parts of the country and served as volunteer registrar and hostess for numerous events during the years that I served as executive director for RMF. The following assessments, workshops, and roundtables, with associated comprehensive publications and reports, were completed during that time:

- Agricultural Production and Natural Resource Conservation: Preliminary Assessment of Selected Projects
- Agricultural Productivity and Conservation: Working Toward Common Goals (four regional workshops and a national roundtable)
- Reducing Foodborne Illness
- Alien Invasive Species
- Invasive Species Databases
- Invasive Species Stakeholders: Collecting, Sharing, and Using Information
- Western Rangeland Noxious Weeds: Collecting, Sharing, and Using Information

Also, a commitment of funds was obtained on May 28, 2002, from the sale of property that was originally a part of the Riley Trust, and that, together with a personal contribution from Ms. Brash, made possible the establishment of an endowment of slightly over $200,000, resulting in a total income of over $700,000 during the period that I served as executive director. RMF directors that were particularly helpful during this period of expansion were Ralph Grossi, former president of American Farmland Trust; Thomas Dille, former chief executive officer of Rhone-Poulenc AG Company; Gilbert A. Leveille, past president of the Institute of Food Technologists; and Dr. Gordon.

An Emphasis on Information Delivery (2002–2005)

As part of my preparations for moving back to Texas, I expressed intent to resign as executive director of RMF at the annual board meeting in

December of 2001. At that time, I was elected to the RMF board. In February 2002, a contract was signed with a Washington, DC–based firm to manage RMF. During the following three years, two projects and associated publications were completed:

- *A Friends Group for the National Agricultural Library*
- *Delivery of Digital Information on Agriculture, Food, and Natural Resources: An Assessment of the Agriculture Network Information Center*

The Initial Riley Memorial Lectures (2006 and 2008)

Beginning in mid-2005, RMF again began operating primarily as a volunteer organization. At that time, I agreed to provide the administrative services for RMF until negotiations that were initiated by a letter from Ms. Brash to the New York Charities Bureau (NYCB) in 1995 concerning assets that were due RMF from the Riley Trust were completed.

In the interim, proceeds from the endowment established in 2003 were used to fund the Charles Valentine Riley Memorial Lecture Series in a partnership with the Borlaug Institute for International Agriculture within the Texas A&M University System. Two lectures were completed under this arrangement. The first lecture, held in 2006, involved collaboration between Texas A&M, NAL, and RMF. A fourth collaborator, the Association for International Agriculture and Rural Development, played a significant role in the second lecture, which was held in 2008. These lectures have been included in proceedings that were published by NAL:

- *The Impact of Technological Change in Agriculture on Poverty*
- *Agriculture for Sustainable Economic Development*

The expanding importance of the Riley legacy was independently highlighted by Joachim von Braun in the 2008 Riley Lecture when he stated:

> Charles (Valentine) Riley's vision for agricultural advancement through new scientific knowledge is today more relevant than ever.
>
> A new strategic policy portfolio of science, trade, and rural services is needed at the national and international levels to ensure sustainable growth and to reduce political risks.

Continuing the Riley Legacy

From 1986 through 2008, RMF was responsible for over twenty-five events and associated publications and reports. During that period, over forty persons have served on the board of directors. During 2006, 2007, and 2008, past president Dr. Leveille and the members of the executive committee; Edward A. Hiler, vice chancellor and dean emeritus for Agriculture and Life Sciences for the Texas A&M University System and member of the National Academies; and Marlyn L. Jorgensen, past president of the American Soybean Association, who served with me, were invaluable members of a team that assisted in planning the successful Riley lectures in 2006 and 2008. The team also completed in late 2008 the negotiations with the NYCB and the trustee for the Riley Trust that have made possible the establishment of an endowment that will continue to build on Professor Riley's legacy in perpetuity.

Perhaps the most important outcome from the events involving RMF from its beginning in 1985 through 2008 has been that a group of informed persons with diverse interests continue to be committed "to promoting a broader and more complete understanding of agriculture as the most basic human endeavor and to enhancing agriculture through increased scientific knowledge." That commitment evolved from extensive interactions among representatives from production agriculture and forestry, food and agricultural businesses, environmental interests, universities, and government that could see the big picture as did Riley. That commitment was also key to the events that were to follow involving the American Association for the Advancement of Science, the World Food Prize Foundation, several scientific societies, and others.

Charles Valentine Riley, shown here examining insects, was an outstanding scientist and administrator that was truly a whole-picture person—an artist, a poet, a writer, a journalist, a linguist, a naturalist, and a philosopher—who had an astonishing vision for the advancement of agriculture through scientific knowledge. Photo credit: National Agricultural Library, ARS, USDA.

Emilie Brash, granddaughter of Charles Valentine Riley, presented the gift from the Cathryn Vedalia Riley Trust to USDA's secretary of agriculture John R. Block that was used to establish the Charles Valentine Riley Memorials Program within USDA. Photo credit: USDA.

USDA's assistant secretary of agriculture Orville G. Bentley provided the policy leadership within USDA that made possible the development of the Riley Memorials Program and that set the stage for the founding of the Charles Valentine Riley Memorial Foundation. Photo credit: USDA.

The USDA work group that developed the plan for the Riley Memorials Program is shown with Emilie Brash (*left center*) and Victor John Yannacone Jr. (*right center*), trustee of the Cathryn Vedalia Riley Trust. Photo credit: USDA.

John C. Gordon, Pinchot professor emeritus and former dean of College of Forestry and Environmental Studies at Yale University, is the founding president of the Charles Valentine Riley Memorial Foundation. Photo credit: John Gordon.

Norman A. Borlaug (*left*), a 1970 Nobel Prize recipient, made the keynote address in 1986 at the National Agricultural Forum "Health of the Land and Its People" organized by the Charles Valentine Riley Memorial Foundation and announced the formation of the World Food Prize. Ambassador Kenneth M. Quinn (*right*) became president of the World Food Prize Foundation (WFPF) on January 1, 2000. Photo credits: WFPF.

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Coalition Building to Increase Scientific Knowledge

(2008–2011)

Introduction

In early 2008, considerable evidence became available that additional resources from the Cathryn Vedalia Riley Estate and Trust were likely to become available to further the goals of the Charles Valentine Riley Memorial Foundation (RMF). Therefore, RMF began to explore opportunities to continue to build on the legacy of Charles Valentine Riley, to establish a mechanism whereby there would be a perpetual program to honor Professor Riley, and to develop additional relationships that would raise RMF's efforts to greater heights. Thus, a process was initiated that involved briefings of five organizations that had previous experiences with RMF and/or with Professor Riley's work. The purpose for these briefings was to identify a partner that would be primarily responsible for a perpetual program and that could be part of an extensive network to further the general purposes of RMF. This process led to the tentative selection of the American Association for the Advancement of Science (AAAS) as the recipient of an endowment from RMF to establish a perpetual Charles Valentine Riley Memorial Lecture Series.

A formal commitment for RMF to receive additional funds in accord with the Cathryn Vedalia Riley Trust was made on August 7, 2008, through an agreement among representatives of Victor John Yannacone, Jr., trustee of the Cathryn Vedalia Riley Trust and executor of the estate of Cathryn Vedalia Riley; the New York Charities Bureau (NYCB); and RMF. This commitment made it possible for RMF to pursue formal negotiations to establish an endowment at AAAS and to pursue other activities with the overall goal "to promote a broader and more complete understanding of agriculture as the most basic endeavor and to make secure the lever that is agriculture and its fulcrum, the natural environment, during this and succeeding generations and to enhance agriculture through increased scientific knowledge" with an emphasis on increased scientific knowledge.

Honoring Professor Riley was a key objective behind utilizing additional resources, but RMF, consistent with Riley's whole-picture approach, wished to pursue coalition building beyond the involvement of AAAS. Thus, new initiatives in addition to the establishment of the AAAS Riley Memorial Lectures were undertaken, including facilitating the organization of research and development (R&D) writing team on the federal budget, sponsorship of seminars and symposia, and taking the lead in organizing a roundtable highlighting exemplary collaborations on agriculture, food, nutrition, and natural resources R&D. Thus, RMF has continued to be involved in a range of activities aimed at coalition building and promoting cooperation and collaboration to increase the productivity of the food, agriculture, and natural resources R&D system.

AAAS

Professor Riley's involvement with AAAS, beginning as a member in

1878 and later serving as the presiding officer of AAAS's section on biology in 1888, together with AAAS being the world's largest general scientific society—including 262 affiliated societies and academies of science and serving ten million individuals—provided the basis for AAAS being an appropriate home for a $500,000 Charles Valentine Riley Foundation endowment. Also, the excellent meeting facilities operated by AAAS in Washington, DC, provide a very attractive venue for events supported by the endowment. Therefore, an endowment memorandum of understanding (MOU) calling for a periodic AAAS Riley Lecture to be held in perpetuity was negotiated among AAAS and RMF representatives in December 2008.

World Food Prize

Subsequent to RMF's linkages with the World Food Prize in 1986, 1990, and 1992, RMF continued to follow the good works of the World Food Prize Foundation (WFPF) through the years as WFPF further developed the World Food Prize Announcement Ceremony in Washington, DC, and the World Food Prize Laureate Award Ceremony and the Norman E. Borlaug International Symposium in Des Moines, Iowa. Thus, the proposed AAAS Riley Lectures were thought to be a complement to WFPF's efforts to promote the food and agricultural sciences. Adding the WFPF as a collaborator on the Riley Lectures was deemed to be a positive move toward building a broader coalition supporting the increase of scientific knowledge.

Continuing the Riley Memorial Lectures

Subsequent discussions between representatives of AAAS, RMF, and WFPF led to the development of a collaboration MOU signed in December 2008 by Alan I. Leshner, CEO of AAAS and executive publisher of Science; Kenneth M. Quinn, president of WFPF; and me, as president of RMF, to conduct the Riley Lectures.

The inclusion of the WFPF in the collaboration brought an important practical dimension to the effort in that WFPF is involved in a range of activities intended to contribute to an adequate supply of nutritious food being available for people throughout the world.

The collaboration between AAAS, RMF, and WFPF was publicly launched on June 15, 2010, with the 2010 Riley Lecture "Agricultural Research: Changing the Guard, Guarding the Change." The lecture was presented by Roger N. Beachy, then director of USDA's National Institute for Food and Agriculture, before a standing-room-only audience at the AAAS headquarters in Washington, DC. Dr. Beachy's closing comments reaffirmed what RMF is all about:

> C. V. Riley lived and worked through one of the last great transformations in agriculture—the middle and late 1800s. Yet by all accounts this vibrant and exciting era of agricultural and entomological discovery did not turn Riley into a narrowly focused specialist bent on pursuing a single strand of this emerging scientific landscape. Rather, he is remembered today as a truly "whole-picture" person—an artist, a poet, a writer, a journalist, a linguist, a naturalist, and a philosopher as well as a scientist. We would do well to honor his memory this afternoon by finding the common ground we need to make sure our epoch of transformative change will be remembered a hundred years from now for its expansiveness, its vision, its willingness to take risks, and its commitment to solving the biggest problems we can.

The 2011 Riley Memorial Lecture was presented on June 21, 2011, by Pamela C. Ronald, professor of the Department of Plant Pathology of the University of California–Davis and coauthor of *Tomorrow's Table: Organic Farming, Genetics, and the Future of Food*, to further highlight the common purpose of the collaboration between AAAS, RMF, and WFPF. A distinguished discussion panel chaired by Nina Fedoroff, president of AAAS, was a part of that lecture program. In addition to references to Charles Valentine Riley's contributions mentioned by Dr. Beachy and Dr. Ronald, the National Agricultural Library (NAL) provided an exhibit at each of the two lectures that featured materials on Professor Riley from the *Special Collections* at NAL.

Thus, highly successful lectures were held in June of 2010 and 2011 at AAAS on the same day or the day after the World Food Prize Announcement Ceremonies that were held at the US Department of State. The Riley Lectures and the Announcement Ceremonies and other activities undertaken by AAAS, RMF, and WFPF are believed to be very synergistic and building on existing relationships among the three organizations has considerable potential for furthering the goals of each organization.

Facilitating Scientific Communication

As RMF surveyed the role of various institutions in increasing scientific knowledge, the role of over twenty scientific societies concerned with some aspect of agriculture, food, nutrition, and natural resources that are affiliated with AAAS came to our attention as did the annual AAAS report on the federal research and development (R&D) budget. Prior to 2010, there were twelve disciplinary chapters in that annual report written by representatives of scientific societies and two disciplinary chapters written by university associations. However, none of the AAAS-affiliated societies associated with agriculture were involved. Clearly, there appeared to be an opportunity for RMF to facilitate the organization of members of some scientific societies to contribute to the AAAS R&D report.

RMF organized a discussion session on December 9, 2009, led by then RMF director Catherine Woteki that included representatives from AAAS, USDA, RMF and six scientific societies to explore the possibility of increasing the involvement of societies in the annual AAAS R&D report. AAAS agreed to add a disciplinary chapter on agriculture, food, nutrition, and natural resources in the FY 2011 report, and RMF recruited representatives of scientific societies to form a writing team. Those represented on the team in 2010 were Institute for Food Technology; Agronomy, Crop, and Soil Science Societies; American Society of Nutrition; Federation of Animal Science Societies; National Association of University Forest Resource Programs; and Soil and Water Conservation Society. This disciplinary chapter, which was prepared again in 2011, is expected to be an increasingly important contribution to enhancing agriculture through increased scientific knowledge as more people develop a better understanding of the many interrelationships that have impact on food and the environment. As appropriate, RMF has continued to facilitate communications between the scientific societies and federal agencies so the writing team might have increased accessibility to information.

In addition to facilitating the disciplinary chapter on agriculture, food, nutrition, and natural resources for the AAAS R&D reports, RMF is also facilitating scientific communication through its sponsorship and active participation in selection of presenters of the US Hill staff seminars organized by the National Coalition for Food and Agriculture Research and its sponsorship of the annual Norman E. Borlaug International Symposium.

Collaborative Research and Development

USDA is the lead federal agency in the conduct of research on agriculture, food, nutrition, and natural resources. However, over the years other federal agencies have become more involved in conducting and sponsoring related research. As RMF continued to look at opportunities to broaden understanding of agriculture when viewed in its broadest contest and to enhance the acquisition of scientific knowledge, RMF saw an opportunity to showcase the good work done through the collaboration of USDA, other federal agencies, and their various partners. Therefore, RMF joined with the Farm Foundation NFP and five scientific societies to conduct a roundtable on March 15, 2011 on "Showcasing Exemplary R&D Collaborations: Agriculture, Food, Nutrition, and Natural Resources." The objectives of the roundtable were to (1) raise the profile of R&D related to agriculture, food, and natural resources throughout the federal government and beyond and (2) highlight the characteristics of highly productive collaborations in order to enhance future collaborations. Sixty-one cases, financially supported by over twenty different federal agencies, were nominated. From these, eight exemplary cases were selected for presentation, and six additional cases were selected for special recognition. These presentations were integrated with presentations of top-level science administrators in the presence of representatives from fourteen different federal agencies and eight scientific organizations. Catherine Woteki (undersecretary for Research, Education, and Economics of USDA) and Sherburne (Shere) Abbott (then associate director of the Office of Science and Technology Policy of the Executive Office of the President) were featured speakers.

Ms. Abbott commented that

> today, we face the growing challenge of how to feed the over 6 billion people living on this planet. Many regions remain vulnerable to limited food production and availability leading to chronic hunger, malnutrition, or the constant threat of famine… Today the issue of food production comes with many related challenges, including the need to balance factors such as access to reliable energy sources, water quality and availability, soil productivity, and the impacts of climate change on harvests. Scientific research and knowledge are central to these efforts.

Both Dr. Woteki and Ms. Abbott emphasized at the roundtable that robust agricultural and natural resources R&D enterprises are essential to address the world's most critical problems, and Woteki reported that USDA, the federal government's primary food and agriculture R&D agency, is taking advantage of expanded partnerships throughout the federal government, as well as with universities, state agencies, and the private sector. US Secretary of Agriculture Thomas Vilsack signed a "dear colleague" letter that is included in the roundtable proceedings in which he stated thus: "Collaboration and partnerships are essential to getting the most out of our public investments in research and development… (and) the round table epitomizes the kind of collaboration that brings together the best ideas to maximize our returns."

The breadth of involvement in food, agriculture, and natural resources R&D throughout the federal government clearly demonstrated a broad interest in agriculture, food, nutrition, and natural resources R&D and provided substantial evidence that there are opportunities to further enhance the productivity of R&D through additional collaborations.

Expansion of the RMF Board

With the success of the Riley Lectures at AAAS, the facilitation of the writing team that prepared the disciplinary chapter in the last two annual AAAS R&D budget reports, and other activities, the RMF Board of Directors was expanded to increase the ability of RMF to support these activities in the future. In addition to Edward A. Hiler, Marlyn L. Jorgensen, Gilbert A. Leveille, John C. Gordon, and me, the board was expanded to include William Fisher, vice president of Science and Policy Initiatives for the Institute of Food Technologists; James "Jim" Gulliford, executive director of the Soil and Water Conservation Society; Molly Jahn, former dean of the College of Agriculture and Life Sciences, University of Wisconsin–Madison; and Lowell W. Randel, Science Policy director for the Federation of Animal Science Societies. Then, because the completion of a highly successful agriculture, food, nutrition, and natural resources roundtable that has continued to demonstrate that RMF has the unique ability to bring together diverse interests with a common goal and because continuation of these efforts are envisioned, the RMF Board of Directors was further expanded to include Katherine “Kitty” Smith, vice president of Programs and Chief Economist, American Farmland Trust; Barbara P. Glenn, vice president of Science and Regularity Affairs, CropLife America; and Ellen Bergfeld, CEO of the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, and the Alliance of Crop, Soil and Environmental Societies.

The Future

As existing programs are continued and future opportunities explored, the support of many different organizations of both the goals of RMF and of the financial needs of RMF will continue to be important. During the over three decades that RMF has been in existence, RMF has received financial support from public charities and other non-government organizations, universities, government agencies in several Federal departments and private industry. The supporting sponsors for the 2011 Riley Lecture are examples of the many organizations that have provided financial support over the years that RMF has been in existence: CaseIH, E.I. DuPont Co., Mars Inc., Agricultural Research Service, National Institute of Food and Agriculture, Economic Research Service, and Borlaug Institute at Texas A&M University.

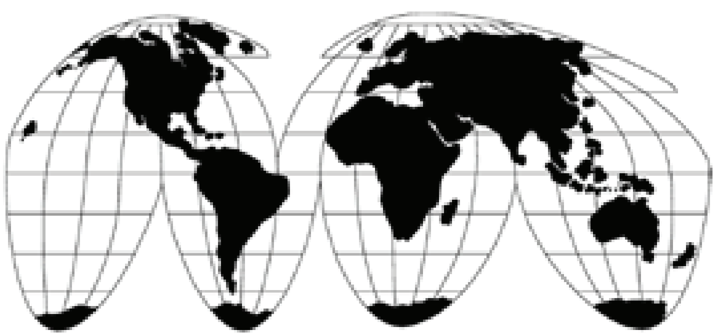
In terms of future programming, the endowment established at AAAS will ensure that Professor Riley’s legacy and the precepts of RMF will be brought forward periodically in a public forum in perpetuity. Raising the profile of food, agriculture, and natural resources R&D at AAAS and providing for a means to honor Riley is a significant and lasting accomplishment. However, other activities also contribute to ensuring that there will be a viable and robust food, agriculture, and natural resources system to provide a secure food supply and a sustainable economy not only in the United States but throughout the world. Thus, the need is great for broader coalitions to be formed so that maximum benefit can result from R&D and related education efforts.

The precise role that food, agriculture, and natural resources will play within a particular country or region within a country will vary whether it be in North America, South America, Europe, Africa, Asia, or Oceania. However, in every situation scientific knowledge will be fundamental to success. Consequently, Professor Riley's whole-picture view and his recognition of the importance of increasing scientific knowledge will be essential to ensure the health of the land and its people throughout the nation and world.


Alan I. Leshner (*left*), chief executive officer of American Association for the Advancement of Science (AAAS) and executive publisher of *Science*, and the author (*right*), president of the Charles Valentine Riley Memorial Foundation, signed a memorandum of understanding in 2008 to cosponsor the Charles Valentine Riley Memorial Lectures in collaboration with the World Food Prize Foundation. Photo credit: AAAS and the author.


Roger N. Beachy (*left*), former director of the National Institute for Food and Agriculture, USDA, presented the 2010 Riley Memorial Lecture "Agricultural Research: Changing of the Guard, Guarding the Change." Pamela C. Ronald (*left*), professor of University of California–Davis and coauthor of *Tomorrow's Table: Organic Farming, Genetics, and the Future of Food*, presented the 2011 Riley Lecture. Photo credits: USDA and University of California–Davis.

Catherine Woteki (*left*), undersecretary for Research, Education, and Economics, USDA, and Sherburne "Shere" Abbott (*right*), former associate director of the Office of Science and Technology Policy of the Executive Office of the President, were feature speakers at the 2011 Agriculture, Food, Nutrition, and Natural Resources R&D RoundTable. Photo credits: USDA and Caron Gala Bijl.



The role that agriculture plays within a country or in a region within a country will vary, but in every situation, a strong scientific knowledge base is essential to ensure the health of the land and its people in the United States and throughout the world. Map credit: WFPF.

Selected References

Authors note: Unpublished reports and other unpublished documents included in these selected references are in the personal files of the author, and unpublished reports should be in the files of the organization for which the documents were prepared. All the selected references for chapters 11 and 12 associated with the Charles Valentine Riley Memorial Foundation are archived in the Special Collections *at the National Agricultural Library in Beltsville, Maryland.*

Chapter 1

Morris, J. M. 1997. El Llano Estacada. Texas State Historical Society. 414 pp.

Early Settlers of Terry County. 1968. Terry County Historical Survey Committee. Terry County, TX. 118 pp.

Terry County, Texas. 2002. Terry County Historical Commission. Terry County, TX. 713 pp.

Chapter 2

Green, D. E. 1977. Fifty Years Service to West Texas Agriculture: A History of Texas Tech University's College of Agricultural Sciences, 1925–1975. Texas Tech University Press. Lubbock, TX. 182 pp.

Landmarks. 2011. The College of Agricultural Sciences and Natural Resources. Texas Tech University. Lubbock, TX. 23:1–12.

Texas Tech. 1957. La Ventana. Lubbock, TX. 527 pp.

Chapter 3

Engst, E. D. 2007. Cornell University. http://hdl.handle.net/1813/5418

Evans, H. E. 1975. The Comstock Heritage. pp. xvii–xxv. In Insects, Science and Society. David Pimentel (Ed.) Academic Press, NY. 284 pp.

Gyrisco, G. G. 1958. Forage Insects and Their Control. Annual Review of Entomology. 3: 421–448.

Meinwald, J. 2011. Thomas Eisner (1929–2011). Science 332:549.

Ridgway, R. L. 1960. Studies of the biology and economic importance of the tarnished plant bug, *Lygus lineolaris* (P. de B.), in relation to birdsfoot trefoil seed production. PhD Dissertation. Cornell University, Ithaca, NY. 131 pp.

Stern, V. M., R. F. Smith, R. van den Bosch, and K. S. Hagen. 1959. The integration of chemical and biological control of the spotted alfalfa aphid; the integrated control concept. Hilgardia 29:81–101.

Chapter 4

Knipling, E. F. 1979. The Basic Principles of Insect Population Suppression and Management. Agricultural Handbook Number 512. USDA. Washington, DC. 659 pp.

Lingren, P. D., R. L. Ridgway, and S. L. Jones. 1968. Consumption by several common arthropod predators of eggs and larvae of two *Heliothis* species that attack cotton. Ann. Entomol. Soc. Am. 61:613–618.

Ridgway, R. L. 1962. The latest on the Southwest Screwworm Eradication Program. Sheep and Goat Raiser. 42(1):18–19.

Ridgway, R. L., and L. J. Gorzycki. 1965. Evaluation of some experimental phosphorus and carbamate compounds as systemic insecticides. ARS 33–106. USDA. 6 pp.

Chapter 5

Boyd, J. P. 1970. Feeding and searching behavior of *Chrysopa carnea* Stephens. PhD Dissertation. Texas A&M University. 107 pp.

Kinzer, R. E. 1976. Development and evaluation of techniques for using *Chrysopa carnea* Stephens to control *Heliothis* spp. in cotton. PhD Dissertation. Texas A&M University. 60 pp.

Morrison, R. K., and E. G. King. 1977. Mass production of natural enemies. pp. 183–217. In R. L. Ridgway and S. B. Vinson (Eds.). Biological Control by Augmentation of Natural Enemies. Plenum Press, New York and London. 480 pp.

Reeves, B. G. 1975. Design and evaluation of facilities and equipment for mass production of facilities and equipment for mass production and field releases of an insect parasite and an insect predator. PhD Dissertation. Texas A&M University. 180 pp.

Ridgway, R. L., and S. B. Vinson (Eds.). 1977. Biological Control by Augmentation of Natural Enemies. Plenum Press, New York and London. 480 pp.

Stinner, R. E., R. L. Ridgway, J. R. Coppedge, R. K. Morrison, and W. A. Dickerson, Jr. 1974. Parasitism of *Heliothis* eggs after field releases of *Trichogramma pretiosum* in cotton. Environ. Entomol. 3:497–500.

Vanderzandt, E. S. 1973. An artificial diet and rearing method for *Chrysopa carnea* larvae and adults. J. Econ. Entomol. 62:256–7.

Chapter 6

Bariola, L. A., R. L. Ridgway, and J. R. Coppedge. 1971. Large-scale field tests of soil applications of aldicarb for suppression of populations of boll weevils. J. Econ. Entomol. 64:1280–1284.

Bull, D. L., J. R. Coppedge, R. L. Ridgway, D. D. Hardee, and T. M. Graves. 1973. Formulations for controlling the release of the synthetic pheromone (grandlure) of the boll weevil. 1. Analytical studies. Environ. Entomol. 2:829–835.

Coppedge, J. R., W. L. Sterling, R. L. Ridgway, R. E. Kinzer, and C. J. Whitten. 1972. Foliar applications of selected insecticides for control of methyl parathion-resistant *Heliothis* on cotton. Texas Agric. Exp. Rep. PR-3887. 6 pp.

Coppedge, J. R., R. E. Kinzer, and R. L. Ridgway. 1972. Field evaluations of *Bacillus thuringiensis* and the *Heliothis* nuclear polyhedrosis virus for control of *Heliothis* on cotton. Texas Agric. Exp. Rep. PR-3086. 6 pp.

Coppedge, J. R., and R. L. Ridgway. 1973. The integration of selected boll weevil suppression techniques in an eradication experiment. USDA Prod. Res. Rep. 152. 26 pp.

Cowan, C. B., Jr. R. L. Ridgway, J. W. Davis, J. K. Walker, W. C. Walkins, Jr. and R. F. Dudley. 1966. Systemic insecticides for control of cotton insects. J. Econ. Entomol. 59:958–961.

Ridgway, R. L., P. D. Lingren, C. B. Cowan, Jr. and J. W. Davis. 1967. Populations of arthropod predators and *Heliothis* spp. After applications of systemic insecticides to cotton. J. Econ. Entomol. 60: 1012–1016.

Ridgway, R. L., S. L. Jones, J. R. Coppedge and D. A. Lindquist. 1968. Systemic activity of UC-21149 (Temik). J. Econ. Entomol. 61:1705–1712.

Chapter 7

Ridgway, R. L., J. C. Tinney, J. T. MacGregor, and N. H. Starler. 1978. Pesticide use in agriculture. Environ. Health Perspectives. 27:103–112.

U. S. Department of Agriculture, Agricultural Research Service. Cox, HC, R. L. Ridgway, T. F. Leigh and H. M. Taft. 1970. Review of DDT and alternatives. 72 pp. Unpublished report.

U. S. Department of Agriculture. R. L. Ridgway, Coordinator. 1975. Status of the Bollworm complex on cotton and an assessment of potential benefits and risks of the use of DDT as proposed in the petition from Louisiana. 127 pp. Unpublished report.

U. S. Department of Agriculture. R. L. Ridgway, Task Force Chairman. 1977. The bollworm and tobacco budworm on cotton, status of insecticides and other methods of control for 1977. 46 pp. Unpublished report.

U. S. Department of Agriculture, Land-Grant Universities, and Environmental Protection Agency. R. L. Ridgway, Team Leader. 1978.

Preliminary biological and economic assessments of some proposed uses of difflubenzuron (Dimilin). 146 pp. Unpublished report.

Chapter 8

Dickerson, W. A., A. L. Breashear, J. T. Brumley, F. L. Carter, W. J. Grefenstette and F. A. Harris. (Eds.). 2001. Boll Weevil Eradication in the United States through 1999. Cotton Foundation. Memphis, TN. 617 pp.

Perkins, J. H. 1982. Insects, Experts, and the Insecticide Crisis. Plenum Press. New York and London. 304 pp.

Ridgway, R. L. 1972. Integrated Control of Cotton Insects in the United States. 31st Plenary Meeting of the International Cotton Advisory Committee, Managua, Nicaragua. Doc. 8. pp.190–195.

Ridgway, R. L. 1978. USDA Perspectives on pest management. In Pest Management in Transition. Proc. Pest Control Strategies Conf. Wright-Ingraham Institute. Colorado Springs, CO, and Environmental Protection Agency, Denver, CO. pp.117–120.

Ridgway, R. L. 1984. Cotton Protection Practices in the USA and World: Insects. pp. 266–283. In R. J. Kohl and C. F. Lewis (Eds.) Cotton. American Society of Agronomy, Inc. Madison, WI. 605 pp.

Ridgway, R. L., E. P. Lloyd, and W. H. Cross. (Eds.) 1983. Cotton Insect Management with Special Reference to the Boll weevil. A Technical Monograph. USDA Agricultural Handbook No. 589. Washington, DC. 591 pp.

Ridgway, R. L. and H. C. Mussman. 2001. Integrating Science and Stakeholder Inputs: The Pivotal Years. pp. 55–76. In W. A. Dickerson, A. L. Brashear, J. T. Brumley, F. L. Carter, W. J. Grefenstette and F. A. Harris (Eds.) Boll Weevil Eradication. Cotton Foundation. Memphis, TN. 627 pp.

Texas Boll Weevil Eradication Foundation. 2011. http://www.txbollweevil.org

U. S. Department of Agriculture. 1982. Cotton Insect Management Programs: A Report to the Secretary of Agriculture. Washington, DC. 20 pp.

Chapter 9

Benjamins, C. R. 1987. Biotech test possible at Beltsville field next spring. Princes Georges J. November 6. pp. A1 and A17.

Farrar, R. R., Jr., R. L. Ridgway, and J. P. Dively, 1999. Activity and persistence of the nuclear polyhedrosis virus of the celery looper (Lepidoptera: Noctuidae) with a feeding stimulant J. Entomol. Science 34:369–380.

King, E. G., D. L. Bull, L. F. Bouse, and J. R. Phillips. (Eds.) 1985. Biological Control of Bollworm and Tobacco Budworm in Cotton by Augmentative Releases of *Trichogramma*. The Southwestern Entomol. Suppl. 8. 195 pp.

Ridgway, R. L., W. A. Dickerson, J. R. Brazzel, J. R. Leggett, E. P. Lloyd, and F. R. Planer. 1985. Boll weevil trap captures for treatment thresholds and population assessments. Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council, Memphis, TN. pp. 138–141.

Ridgway, R. L., R. M. Silverstein, and M. N. Inscoe. (Eds.) 1990. Behavior-Modifying Chemicals for Insect Management. Marcel Decker, Inc. New York and Basel. 761 pp.

Ridgway, R. L., M. N. Inscoe, and K. W. Thorpe. 1991. Implementation of Emerging Technologies for Management of Insect Pests. pp. 392–424. In Vinson, S. B., and R. L. Metcalf (Eds.). Entomology Serving Society; Emerging Technologies and Challenges. Entomol. Soc. Am. Lanham, MD. 515 pp.

Ridgway, R. L., M. N. Inscoe, and H. Arn. (Eds.) 1992. Insect Pheromones and Other Behavior-Modifying Chemicals. British Crop Protection Council. Farnham, Surrey, UK. 135 pp.

Ridgway, R. L., M. N. Inscoe, K. W. Thorpe. 1993. Advances and trends in managing insect pests. pp. 3–16. In Management of Insect Pests: Nuclear and Related Molecular and Genetic Techniques. Intern. Atomic Energy Agency. Vienna, Austria. 669 pp.

Ridgway, R. L., and J. Rabasse (Organizers). 1996. Symposium, Private-Public Sector Cooperation in the Development and Use of Mass-Produced Multicellular Natural Enemies. International Conference on Technology

Transfer in Biological Control: From Research to Practice. Montpelier, France. Intern. Organ. Biol. Control Bull. 19(8):141–150.

Ridgway, R. L., and M. N. Inscoe. 1997. Applied biologically based pest-control products: status and opportunities. In Proc. Conf. on Biopesticides and Transgenic Plants. Washington, DC. Intern. Bus. Communications Confs., Inc. Southborough, MA. Unnumbered pages.

Ridgway, R. L., M. P. Hoffman, M. N. Inscoe, and C. S. Glenister (Eds.). 1998. Mass-Reared Natural Enemies. Thomas Say Publications in Entomol. Entomol. Soc. Am. Lanham, MD. 332 pp.

Youngberg, G., and R. L. Ridgway. (Eds.) 1988. Biologically based methods of pest control: contributions to sustainable agriculture. Am. J. of Alt. Agric. Vol. 3 (2&3):49–122.

Chapter 10

Brooks, E. and J. Emel. 2000. The Llano Estacado of the Southern High Plains. United Nations Press. Tokyo. New York. Paris. 176 pp.

Cochran, M. and J. Lumpkin. Foreword by J. T. Montford. 1999. West Texas: A Portrait of Its People and Their Raw and Wondrous Land. Texas Tech University Press. Lubbock, TX. 176 pp.

Gold, M. V. 2007. Sustainable agriculture: definitions and terms. (Special reference briefs; 99-02). National Agricultural Library, Beltsville, MD.

Hamilton Park: Celebrating the Past and Future. 2006. Special Supplement to the Brownfield News. Brownfield, TX. May 6. 8 pp.

Natural Resources Conservation Service. 2010. Resource Data and Concerns, Zone 1 (Texas), USDA, Lubbock, TX. 127 pp.

Burke, D. M. and J. Robinson. 2011. Texas. Estimated Values of Agricultural Production and Related Items, 2007–2010, 2011 Projected, State and Extension Districts. Texas AgriLife Extension. Texas A&M University System, College Station, TX. 119 pp.

Ridgway, R. L. 2001. West Texas Economic Development: Natural Resources Management. A Preliminary Assessment of Natural Resources, Agriculture and Opportunities. Prepared for the Lubbock Chamber of

Commerce by BioManage Services. Silver Spring, MD. 16 pp. Unpublished report.

Smith, S. L. (Ed.) 2003. The Future of the South Plains. University of Oklahoma Press, Norman. OK. 275 pp.

Texas Tech University System. 2002. Federal Initiatives Program Prospectus, Fiscal Year 2003, Lubbock, TX.

Texas AgriLife Research and Extension. 2011. The Food and Fiber System and Production Agriculture's Contribution to the Texas Economy. Texas A&M University System, College Station, TX. 4 pp.

Texas Almanac: 2010–2011. Texas State Historical Association. Distributed by the Texas A&M Univeristy Press, College Station, TX. 736 pp.

Web sites: National Academies of Sciences, http://sustainability. nationalacademies. org/Roundtable; American Association for the Advancement of Sciences, www.aaas.org/programs/centers/sd; The Keystone Center, http://keystone.org/spp/env-sustain_ag.html; National Agricultural Statistics Service, USDA, www.agcensus.usda.gov; Economic Research Service, USDA, www.ers.usda.gov/publications/TB1909, Texas Tech University, www.texastech.edu/; Texas A&M University, www.tamu.edu; University of Nebraska, www.unl.edu/plains/; https://implan.com.

Chapter 11

Borlaug, N. 1986. Food and Human Progress. Transcript of a presentation at the forum on The Health of the Land and Its People. Charles Valentine Riley Memorial Foundation. October 29, 1986. Washington, DC. 5 pp.

Busta, F. F., M. P. Doyle, G. A. Leveille, R. L. Ridgway, C. Sizer, and K. R. Swartzel. (Eds.) 2000. Reducing Foodborne Illness: Advancing the Adoption of Technologies. Charles Valentine Riley Memorial Foundation, Silver Spring, MD. 46 pp. NTIS Accession No. PB2000-108252.

Colman, N. J. 1892. Professor C. V. Riley, US entomologist. Colman's Rural World, 12 May. pp. 1–8.

Howard, L. O., E. A. Schwarz and H. G. Hubbard. 1895. Charles V. Riley, PhD Proc. Entomol. Soc. Wash. 3: 293–298.

Knutson, L. 1991. A tribute to Charles Valentine Riley: American entomologist. In Proceedings of an Entomological Society of America Centennial Symposium, Washington, DC. pp. 97–103

Kritsky, G. 1995. Darwin, Walsh, and Riley: The Entomological Link. Am. Entomol. 41: 89–95.

Pinstrup-Anderson, P. 2006. The Impact of Technological Change in Agriculture on Poverty and Armed Conflict. Charles Valentine Riley Memorial Lecture Series. Charles Valentine Riley Memorial Foundation, Texas A&M University System, and USDA, Agricultural Research Service, National Agricultural Library. 2006. 37 pp.

National Agricultural Library. 2011. The Charles Valentine Riley Collection at the National Agricultural Library. *www.nal.usda.gov.*

Ridgway, R. L. (Ed.) 1988. Health of the Land and Its People. Summary proceedings of a forum held October 29–31, 1986, in Washington, DC. Charles Valentine Riley Memorial Foundation. 1988. 28 pp. NTIS Accession No. PB88-101574)

Ridgway, R. L. (Ed.) 1992. Enhancing the Safety of America's Food Supply. Summary of Food Safety Round Table held on November 21, 1991, in Washington, DC. Charles Valentine Riley Memorial Foundation. 11 pp. NTIS Accession No. PB93-101582.

Ridgway, R. L. and R. Reeder. (Eds.) 1995. Food and Agricultural Research in Changing Times: Highlights of a National Round Table. Summary of a round table held on June 16, 1995, in Washington, DC. Charles Valentine Riley Memorial Foundation. 18 pp. NTIS Accession No. PB95-2656476

Ridgway, R. L., and J. C. Gordon. 1997. The Legacy and Vision of Charles Valentine Riley: Entomology and Beyond. Adapted from a presentation at a Symposium on Achievements and Future of the Science of Entomology held on April 18–19, 1995, in Columbia, MO. Agricultural Research Service, USDA, and Charles Valentine Riley Memorial Foundation, Beltsville, MD. Unpublished manuscript. 24 pp.

Ridgway, R. L. Agricultural Production and Natural Resource Conservation: Preliminary Assessments of Selected Projects. Assessment of selected cooperative projects for exploring opportunities to strengthen linkages between economically viable agricultural-production and natural-resource conservation activities. Charles Valentine Riley Memorial

Foundation, Silver Spring, MD. 1997. 10 pp. NTIS Accession No. PB98-100266.

Ridgway, R. L., et al. (Eds.) 2001. Invasive Species Stakeholders: Collecting, Sharing and Using Information. Proceedings of a round table held on April 26, 2000, in Washington, DC. Charles Valentine Riley Memorial Foundation. 57 pp. NTIS Accession No. PB2001-102898.

Smith, E. H., and Janet R. Smith. 1996. Charles Valentine Riley: The Making of the Man and His Achievements. Am. Entomol. 42(4):228–238.

von Braun, J. 2009. Agriculture for Sustainable Economic Development. Charles Valentine Riley Memorial Lecture Series. Association for International Agriculture and Rural Development (AIARD), Texas A&M University System, Charles Valentine Riley Memorial Foundation, and the National Agricultural Library. In: Proceedings of the 2008 AIARD Capitol Hill Forum. pp. 3–14.

Chapter 12

Beachy, R. N. 2010. Agriculture Research: Changing the Guard, Guarding the Change. In: Proceedings of the 2010 Charles Valentine Riley Memorial Lecture. American Association for the Advancement of Science. Washington, DC. pp. 7–11. *http://www.aaas.org/aboutaaas/giving/highlights/riley/media/riley_lecture_proceedings_2010.pdf*

Charles Valentine Riley Memorial Foundation. 2011. Lifting Society to Greater Heights. *www.rileymemorial.org*

Intersociety Working Group. 2011. AAAS Report XXXVI: Research & Development for 2012. American Association for the Advancement of Science. Washington, DC. 288 pp. *http://www.aaas.org/spp/rd/rdreport2012/*

Ridgway, R. L. (Ed.) 2011. Agriculture, Food, Nutrition, and Natural Resources R&D Round Table: Partnerships Yield Greater Societal Returns. Proceedings of the round table. Charles Valentine Riley Memorial Foundation. Flower Mound, TX. 28 pp. NTS Accession No. PB2011-109690. *http://www.farmfoundation.org/news/articlefiles/1733-Proceedings_web.pdf*

Ronald, P. C. 2011. Tomorrow's Table: Organic Farming, Genetics, and the Future of Food. In: Proceedings of the 2011 Charles Valentine Riley

Memorial Lecture. American Association for the Advancement of Science. Washington, DC. pp. 9–13. *http://www.aaas.org/aboutaaas/giving/highlights/riley/media/riley_lecture_proceedings_2011.pdf*

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ADVANCED PRAISE

A Rich and Rewarding Journey is an admirable autobiographical account of the extraordinary career of Richard L. Ridgway. With humble beginnings in Texas and years of service in the Washington, DC area, he continues to promote a broad understanding of agriculture as the most basic human endeavor.

Ridgway's experience in bringing conflicting parties together is particularly noteworthy. His innate qualities were used to forge a policy, in the midst of conflict, that led to Beltwide boll weevil eradication. Efforts related to pesticide regulation resulted in true cooperation between USDA and USEPA. Ridgway's perception of how science can serve society was instrumental in founding the Charles Valentine Riley Memorial Foundation (RMF) and a unique partnership between RMF, the American Association for the Advancement of Science and the World Food Prize Foundation.

Anyone interested in commitment, inspiration, scientific knowledge, consensus-building and agriculture, when broadly defined, should join Ridgway on his extended journey.

Lloyd V. Knutson
Agricultural Research Service
U.S. Department of Agriculture (retired)

About the Author

Richard L. Ridgway was raised on a farm in Texas. He received a BS degree from Texas Tech University and MS and PhD degrees from Cornell University. He served on the faculty of Texas A&M University and in positions for USDA in Texas and Maryland. He has made significant scientific contributions to biological insect controls, regulation of pesticides, and pest management. Currently, he is President of the Charles Valentine Riley Memorial Foundation, a non-profit corporation, and a managing partner for farms in Texas

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