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Bullet-Proof Boll Weevil: The History of Boll Weevil Eradication

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BULLET-PROOF BOLL WEEVIL: THE HISTORY OF BOLL WEEVIL ERADICATION

A Thesis

by

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ABSTRACT

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Farmers and entomologists have all experimented with various methods to find the best way to defeat the United States' boll weevil. The techniques themselves, while expansive, can be examined within the scope of the years that they were used. This provides an exciting insight into how cotton pest management became more complex as the decades moved on and revealed how the science of cotton pest management evolved to deal with the boll weevil and other future cotton threats.

DEDICATION

The completion of my doctoral studies would not have been possible without the love and support of my family. My mother, Jerry Lee, my father, Kenneth, my sister, Elyssa Ann, and dear friend April Wilson who have wholeheartedly inspired, motivated, and supported me to accomplish this degree. Thank you for your love and patience.

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CHAPTER I

INTRODUCTION

Farmers and entomologists have all experimented with various methods to find the best way to defeat the United States' boll weevil problem. From the 1900's to the 90's, boll weevil eradication changed and evolved as technology, research, and science became more integral to agriculture. The techniques themselves, while expansive, can be examined within the scope of the years that they were used. This provides an exciting insight into how cotton pest management became more complex as the decades moved on and revealed how the science of cotton pest management evolved to deal with the boll weevil and other future cotton threats.

This thesis looks to explore the significance that the boll weevil damages brought to U.S. cotton and how the weevils supposed "invincibility" created a drive to control and finally eradicate it from much of the U.S. It did not happen overnight, in fact, the eradication of the boll weevil took over 100 years, and it is during that 100 years where the boll weevil "may have done more damage to U.S. agriculture than any other single insect."[1] The boll weevil did not just destroy large swaths of U.S. cotton, it up-heaved the entire southern agriculture as well.

The boll weevil became a major player in the Southern economy as it pushed many farmers out of work and forced them to migrate and move throughout the United States. It

[1] Del Deterling. "The Boll Weevil: A Century of Pestilence." *Progressive Farmer (*October 1992). 26

created the weakening of cotton over-dependency, and even encouraged diversification of crops. It was also the catalyst for an entire pesticide industry that continues even to this day. The history of the boll weevil and cotton is a history that spans a hundred years of experimentation, cultural shifts, and environmental burdens. Effectively the cotton boll weevil "has redrawn the shape of the agricultural economy of the South."[2] The history of agriculture and farming life, no matter where it takes place, is, by its definition, the historical origins of culture and humanity. The blending of history, anthropology, and even entomology is needed to appreciate the significance of the boll weevil truly means to record.

Cotton is an incredibly important international crop and is especially important to the United States. Before the civil war, cotton was but one of four crops that were grown and harvested within the South, the other crops being tobacco, rice and sugar. The reason why cotton became a much more important crop to the Southern States had to do with their climate. Cotton is a very intensive crop that's most basic needs include "a long, hot growing season."[3] Which made the Southern states perfect for growing this particular crop.

This thesis will look primarily at Texas due to due to its significance as being an important cotton producing state, but also because it was the first state to feel the impact of the boll weevil as well. The boll weevil entered the U.S. through Brownsville Texas in 1892, and even now it continues to be a nuisance to Texas cotton culture. In 2011, U.S. Representative

[2] Ibid, p.26
[3] Lawrence A. Jones, David Durand. "The Cotton Belt". In *Mortgage Lending Experience in Agriculture. (*Princeton University Press, 1954), p.90. http://www.nber.org/chapters/c2946

Henry Cuellar was able to secure up to 11.52 million dollars in government funds reveals how deep the impact that the boll weevil brought to the U.S.[4]

What has been most peculiar is the apparent lack of books written about the weevil. The various articles were written about the boll weevil explore just how vital the insect was to Southern agriculture changed. However, there seem to be two sides that are apparent from the research investigated. Some researchers believe that the boll weevil had a tremendous impact on the cotton industry and influenced many of the changes that occurred for the farmers and people who lived on cotton and others who considered the boll weevil as just a small but still vital part of an ever-changing society that was the South.[5]

One of the important books written about the subject is James Giesen's book *Boll Weevil Blues*. Written in 2011, Giesen is an associate professor at Mississippi State university whose historical focus is on environmental and agricultural history of the South. His goal for the book was to look at the conceptions that southerners had of the boll weevil whose greatest accomplishment "was not the many strands of cotton it devoured, but rather the great explanatory power that people found in the weevil."[6] In that sense, while the boll weevil did cause lots of damage, it was that people saw this as a cultural end to the Southern way of life rather than as physical destruction. A review of the book takes this as its major topic, saying, "the massive changes by the insect's arrival were, in fact, largely a response to the image

[4]"$11.5 million secured to eradicate boll weevil".Staff Report. AP News. Published 1,2019. Accessed January 21, 2020. https://apnews.com/article/1c9a51c684b54bad9a243d38938bead9

[5] Fabian Lange, Alan L. Olmstead, and Paul W. Rhode. "The Impact of the Boll Weevil, 1892–1932." *The Journal of Economic History* 69, no. 3 (2009): p. 685. doi:10.1017/S0022050709001090.

[6] James Giesen. *Boll Weevil Blues:Cotton, Myth, and Power in the American South.(Chicago, University Press, 2011) Kindle Edition, location 65 of 5919.*

Southerners held of their agricultural enemy."[7] The image of the biblical infestation of the boll weevil was one of the myriad reasons that southern farmers began to rely less upon cotton and began to diversify their crops through State and Federal assistance.[8]

Giesen's book is one of the few books that looks at the boll weevil in a historical discussion. It is a vital source for the topic and provides plenty of educational opportunities for agricultural historians, especially those interested in Southern agriculture. However, because Giesen focuses more on the impact of the boll weevil as a social issue that was used as an excuse to alleviate the cotton industry's exploitative agrarian structure, he helps undermine the significance of the boll weevil by simply claiming the boll weevil was merely the symbol for the changing social structure of the South. Despite this, Giesens book is still an integral book for a topic that needs far more research.

Another book is *Growing Cotton* by V.R. Cardozier. Written in 1957 as part of the agricultural activity series, the book was used mostly by students who wanted to be farmers as an occupation. This series of books focused on many different rural and farming lifestyles and their importance to the United States, with cotton being the book's overall subject. V.R. Cardozier is a higher education professor at the University of Texas and has written books on agriculture and the subject of higher education during World War II. This work on *Growing Cotton* is incredibly crucial to the history of cotton as it provides a practical approach to the growing of cotton and even explores the various types of hardships and difficulties that come with cotton farming such as diseases and cotton pests, which, included the boll weevil. A review by Julian Miller states

[7] Saikku Mikko. *The American Historical Review* 117, no. 4 (2012): 1227-228. Accessed January 22, 2021. http://www.jstor.org/stable/23427936.
[8] Ibid, p.1227-1228

that “it is excellent for vocational students, for country agents, as the first approach to cotton-growing for college students, and growers and handlers of this crop.”[9] While the book is mostly about cotton, having context into the growing and maintenance of cotton is especially important for anyone who wants to understand why the boll weevil was such a devastating pest for that crop.

Another significant contribution is the book *Cotton*, by Harry Bates Brown and Jacob Ware. Written in 1938, this book is used to understand the importance of cotton, not just within the United States but throughout the world. While it is good that the book explores the global history of cotton through various ages and does explore the boll weevil, the main aspect of the book is that it does into a detailed historical evaluation into the cotton plant with the weevil getting a small piece of the book written about it. While it does not discuss much of the boll weevil, its research into the taxonomy of cotton, the varieties of cotton and even how commercial cotton became one of the most important products of the U.S. helps provide important agricultural history that is essential for historians look at cotton and its importance on a national and international scale.

While there has not been many books written about the boll weevil, much of the information written about the boll weevil comes from many primary documents, entomologist articles, and agricultural journals that examined the various ways that the boll weevil impacted the U.S. Reports such as Douglas Helm’s “Revision and Reversion: Changing Cultural Control Practices for the Cotton Boll Weevil” provide tremendous help in the topic as the journal goes through a timeline into how the various attempts at controlling the boll weevil shifted from

[9] Julian Miller.*The Quarterly Review of Biology* 34, no. 4(1959)

changing cultural norms to the usage of pesticides as an essential part of boll weevil management.[10]

Another important document is the A statistical study implemented in 2008 on the impact of the boll weevil from 1892 to 1932. Written by Fabian Lange of Yale University, Alan L. Olmstead of UC Davis, and Paul W. Rhode of Univ. of Arizona & NBER, the authors discuss the economic impact of the boll weevil during its initial invasion of the U.S. The study focused heavily on the local level of many different cotton-producing regions of the South, which helps to provide a more rounded view of the crucial the boll weevil was. Their research and discussion revolved around how the boll weevil was not just a symbol of change like James Giesens book, but, that it did cause physical upheaval as the weevil "traversed across the American South, it seriously disrupted local economies, significantly reduced the value of land (at this time still the most important asset in the American South) and triggered substantial intra-regional population movements."[11] Much like the Giesen book, this document is an integral part of the history of this subject of the boll weevil as a historical figure in the United States' changing. While Giesen looks at the boll weevil as part of a changing Southern culture, Fabian Lange and his associates' data instead look at the boll weevil from its first move into the United States up to the 1930s. While this study improved the historical evaluation of the boll weevil's impact, many researchers still underutilized how the weevil changed Southern culture through various methods. The weevil impacted pest management and cotton production in the areas it infested. Few books have

[10] Douglas Helms. "Revision and Reversion: Changing Cultural Control Practices for the Cotton Boll Weevil." *Agricultural History* 54, no. 1 (1980): 108. Accessed January 22, 2021. http://www.jstor.org/stable/3742598.

[11] Fabian Lange. Alan L. Olmstead, and Paul W. Rhode, "The Impact of the Boll Weevil, 1892–1932." p.686.

looked at the boll weevil as a topic, revealing just how much the weevil is underestimated as a historical entity.

The reason for this is that much of the researched material written is for entomologists. Entomologists study insects in a clinical matter, which can, for many readers, create a complex and often challenging to understand vernacular. While it is difficult to understand, the studies provide sufficient information into the insect and the methods in which the Department of Agriculture investigated to find means of control against the boll weevil.

The fact that many of the primary sources written were published when the boll weevil was beginning to enter the United States and into its full infestation of the Cotton Belt means that the research and information presented comes from scientists who were actively working to fight the weevil—making this information vital in the untapped history of the boll weevil upon the cotton industry. These various papers are all the foundations needed to appreciate the significance that this insect played in the entirely.

CHAPTER II

HISTORY OF COTTON IN TEXAS

Cotton has always been an essential plant within civilization. From the New World of the Americas to Egypt, Europe, and throughout much of the Old World, cotton has always found itself a part of the very fabric of society due to its importance as a textile in the creation of cloth and clothing[12]. During the 1800's, the British textile industry fueled cotton in the United States as the British need for large volumes of cotton resulted in the expansion of the Southern states.[13]

This is still true even to this day as much of our apparel is always made of this resilient plant. It can be no underestimated that cotton has cemented itself firmly within the United States as one of the most commercially essential cash crops within the country, with the present profits exceeded in according to the National Cotton Council of America, "$120 billion, making cotton America's number one value-added crop."[14]

To fully understand how Texas and cotton history became tangled together, we must look at the pre-Hispanic origins of Texas. The indigenous people of Texas who were also known as

[12] The History of Cotton", The Story of Cotton, National Cotton Council of America, Accessed January 16, 2019. https://www.cotton.org/pubs/cottoncounts/story/

[13] Andrew J. Torget, *Seeds of Empire: Cotton, Slavery, and the Transformation of the Texas Borderlands, 1800-1850*(Press Chapel Hill: North Carolina, 2015), p.3.

[14] "The Importance of Cotton", The Story of Cotton, National Cotton Council of America, Accessed January 16, 2019. https://www.cotton.org/pubs/cottoncounts/story/importance.cfm

Coahuiltecans were an incredibly diverse group, with the semi-nomadic tribes such as the Karankawa who lived along the Texas gulf coast, the Caddo of East Texas who were farmers and traders, and the Comanche and Apache who roamed the Texas plains who subsisted primarily upon wild game such as bison.[15] While many of the indigenous tribes were mostly hunter-gatherers, in some regions such as the Rio Grande, there was an opportunity to develop agriculture and utilize more wild plants such as mesquite beans, pecans and many other plants that were used for food.[16]

The agricultural systems that were used by the indigenous people were as varied as the tribes themselves. Simple farming techniques such as "slash and burn" where crops were slashed and then burned in the dry season so that the soil could be reinvigorated for the wetter season planting and harvesting was used in places where the soil was rather shallow.[17] In more dense populations, irrigation was a major part of the agriculture where water runoff from rains and flooding was used to flow into lines of dirt to soak and water crops, this technique was used in places such as San Antonio, Rio Grande and even in parts of Mexico.[18]

When the Spanish's arrived and began their colonization, the indigenous converts had to deal with a changing environment and culture. The Spanish brought with them new types of

[15] "American Indians: A Story Told For Thousands of Years", The Story of Texas, Bullock Texas State History Museum, Accessed May 4th, 2021. https://www.thestoryoftexas.com/discover/campfire-stories/native-americans.

[16] Anonymous, "Coahuiltecan Indians," Handbook of Texas Online, accessed May 04,2021, https://www.tshaonline.org/handbook/entries/coahuiltecan-indians. Allen Jones, *Texas Roots: Agriculture and Rural Life before the Civil War* 1st ed. (College Station: Texas A&M University Press, 2005). p. 9-10.

[17] Allen Jones, *Texas Roots*, (Texas A&M, University Press, 2005) p. 9-10.

[18] Ibid, p.10-11

animals such as horses and cattle, new technologies such as copper hoes and fruits and vegetables that would become integrated and overtake the way of life for the indigenous people.[19] Cotton became a more important crop as the Spanish desired a more active supply of the versatile plant that would be grown and harvested by their new subjects.[20] Even though cotton was used through the Indian trade within the Old World, the Spanish nevertheless found themselves fascinated by the unique way Mesoamerican natives used the cotton plant.

Cotton was another of these wild plants that was used by indigenous people, since it could be harvested without having to devote large amounts of time to grow, and it was incredibly useful for clothing and netting to catch animals and fish for eating and was a part of the cultural livelihood of the people that used it.[21] In reports of the missions in San Antonio in the year of 1745, they revealed "that several thousand pounds of cotton were produced annually, then spun and woven by mission craftsmen."[22]

As the Spanish expanded their empire through the Southwest, they found much stronger economic power with the cattle ranching industry than cotton. Cattle came to define much of the Spanish expansion within Texas as cattle had been vital to the Spanish since the Middle Ages. Soon, Mexico and Texas had thriving ranches that dominated the marketplace of cattle-based

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[19]. Ibid, p.11-12.
[20] Keith Voltano, *Texas, Cotton, and the New Deal* (Texas: A&M University Press, 2005), p. 4.

[21] Frances F. Berdan, "Cotton in Aztec Mexico: Production, Distribution, and Uses." *Mexican Studies/Estudios Mexicanos* 3, no. 2 (1987): p. 235. doi:10.2307/1051808.
[22] Karen Gerhardt Britton, Fred C. Elliott, and E. A. Miller, "Cotton Culture," *Handbook of Texas Online*, accessed October 08, 2020, https://www.tshaonline.org/handbook/entries/cotton-culture.

products. Sheep wool is used primarily for textile production began pushing cotton into a subdued product within Spanish life.[23]

This started to change as innovation in the cotton industry began to take root. Cotton originally had been difficult to carefully remove the seed from the profitable fiber of the cotton plant, with the creation of the cotton gin by Eli Whitney in the 1790's provided Americans with the ability to produce cotton quickly and in larger quantity. With that, cotton became one of the single most important plants within the U.S.[24] American migrants began pouring into places such as the newly acquired Louisiana, and began setting up shop near the borders of Spanish territory where they created both legal and illegal trading markets to supply the ever-growing cotton empire within the U.S.[25]

By 1810, The U.S. was gaining power as the Gulf Coast became a prime location for cotton agriculture. With new types of cottonseed that yielded bigger cotton bolls which could be picked more easily by hand, and a spike in the pricing of cotton made the ever-expanding cotton states into bastions of American wealth.[26] This versatile plant had fully integrated itself within the soil of Texas and provided Texans, Mexico, and the United States with a powerful economic product.[27]

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[23] Allen Jones, *Texas Root, p.14-15*.
[24] Andrew J. Torget, *Seeds of Empire: Cotton, Slavery, and the Transformation of the Texas Borderlands, 1800-1850* (North Carolina, Chapel Hill Press, 2015) p.35
[25]. Ibid, p.23

[26]. Ibid, p.35-36.

[27] James Giesen, *Boll Weevil Blues*, p.3.

With the growth of U.S. cotton, there would come conflict between them and Spanish controlled Mexico. The official treaty between the United States and Spain gave the U.S. control over Florida at the cost of Texas becoming off limits to the U.S. While this helped soften some of the rivalry between the two nations, many Americans believed that the rich and fertile Texan lands were far too important to the cotton market and control of Texas had to be wrested away from Spanish rule.[28] New Spain which is what Mexico was called at the time, had a dilemma that needed to be solved. They needed citizens to settle into the border areas to hold onto their control of Texas, they decided to allow American migrants to bring cotton into Texas and with that decision cotton would become a stable crop of Texas.[29]

Cotton agriculture would be expanded upon within the region as Anglo settlers began to move into Texas through men such as Moses Austin and his son Stephan F. These settlers sought to transform the land into a powerful extension of the Cotton Belt of the South. By the late 1820's, Texas landscape was shifting in part due to Anglo obsession with cotton, which almost seemed to reflect in many Mexican officials the fear of Anglo expansion and control within Texas itself.[30] Alongside the changing landscape of Texas, the culture within it was shifting as well. As more Anglos migrated and populated Texas, there came an issue with the topic of slavery being accepted within Texas.[31]

Slavery was in many ways, the lynchpin of cotton culture as slaves were used for much of the cotton agricultural process. With the sheer amounts of cotton being produced within Texas, the Anglo settlers who sought to build a cotton empire there fought heavily to gain the

[28] Andrew J. Torget, *Seeds of Empire*, p.45.
[29] Ibid, p.48.
[30]Ibid, p. 137.
[31] Ibid, p. 139.

most important tool.[32] Clashes between Mexican officials and the Anglo settlers became heated overtime, reaching a boiling point with the secession from Mexico and the battle for Texas independence.[33] With Texas free to pursue its own economic needs and desires, cotton would continue to rise in Texas and thus would forever change the culture and history of the Lone Star State.[34]

The American Civil War saw Texas take an important role within the conflict. Due to Texas's proximity to Mexico, and more importantly, the port of Matamoros, the Confederacy saw this to continue the war effort through the trading that Mexico and cotton could provide them, turning Matamoros and, by extension the exportation of cotton from Texas, into the backbone of the war effort.[35] While the Civil War caused a decline of output for cotton production in much of the other Southern States, Texas instead took up the effort of continued cotton production during the Civil War.[36]When the Civil War ended, Texas-based cotton continued to hold tremendous economic influence within the region. Texas had in a noticeably short time became "America's leading cotton-producing state, raising over one-third of the national crop on two-fifths of the total acreage."[37]

This increase in cotton production with the United States created a myriad of changes that revolutionized the industry. For many plantations, the usage of animals as tools in ginning was

[32] Ibid, p. 139.

[33] Ibid, p.139-141.
[34] Ibid, p.141.
[35] Robert W.Delaney, "Matamoros, Port for Texas during the Civil War." *The Southwestern Historical Quarterly* 58, no. 4 (1955), http://www.jstor.org/stable/30241907, p.473.

[36] Keith Voltano. *Texas, Cotton, and the New Deal, p.4.*

[37] Ibid, p.4.

important as these beasts of burden allowed for many cotton fibers to be pressed and ginned, but that changed with Robert S. Munger, who created the "system ginning" process, which allowed for a quicker and more efficient automaton that is still used even in the present.[38] Another factor that helped spread cotton throughout Texas was the railroads. It allowed more regions that could be traveled to and thus allowed for more cultivation and transportation of goods and people with cotton reaching over 3.5 million bales within large acres of Texas soil, all thanks to the railroad.[39] Alongside the railroads came the ability for inland cotton production to become more viable as a market. Moving the automatic ginning systems into these inland areas allowed for farmers to "to sell their crops directly to buyers, who represented textile mills on the East Coast, and the buyers to send the cotton directly to the mills by rail rather than by ship."[40]

Texas in a short amount of time became an especially important cotton state within the United States. To understand why cotton became such an important economic crop in Texas, we must look at the geographical location and climate of the Lone Star State. Inside the vast acres of land within Texas, there are roughly ten ecological regions; of that ten, there are seven that all contribute to cotton production in various ways, such as "distinct growing seasons, soils, rainfall, adapted varieties and production practices."[41]

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[38] Karen Gerhardt Britton, Fred C. Elliott, and E. A. Miller, "Cotton Culture," *Handbook of Texas Online*, accessed October 08, 2020, https://www.tshaonline.org/handbook/entries/cotton-culture.

[39] Ibid, https://www.tshaonline.org/handbook/entries/cotton-culture.

[40] Ibid, https://www.tshaonline.org/handbook/entries/cotton-culture.

[41] Douglas Stephenson, Mark Matocha. "A Pest Management Strategic Plan for Cotton Production in Texas." *Southern Integrated Pest Management Center*. Published 2004. Accessed September 23,2020. https://ipmdata.ipmcenters.org/source_report.cfm?sectionid=30&controltypeid=0&sourceid=1269. p.5.

East Texas is one of the most significant regions that produce cotton, with roughly fifteen million acres in just one of its massively large area known as the Pineywoods.[42] Within this region of East Texas, there are lots of well-watered forested locations due to the large amounts of precipitation that roll through the region's hills. Most of the cotton production is done while there are roughly 45 inches of rain throughout the year.[43] Combining this with the acidic and sandy loams of the soils in the upland and the acidic clay loams in the bottomlands make for cotton production that is reminiscent of the Midsouth, which often deal with muddy and rainy harvesting conditions.[44] The other region within East Texas that produces cotton is the Oak Woods. It is much smaller in size than the Pineywoods part, roughly 19,000 square miles, and is much drier.[45] The East Texas region produces only about four percent of short-season cotton, allowing farmers to avoid the last seasonal rains that would make cotton harvesting challenging to perform.[46]

The Blacklands region of Texas, much like East Texas, contains two different areas. One is a prairie that ranges from Dallas, Austin, and even a portion of San Antonio, which is approximately 25,000 square miles. The place itself often consists of rolling prairie lands which are known for their "rich, deep, fertile black soils that once supported the original tall grass prairie communities and, due to land-use change, today support crop production and cattle

[42] Ibid p.5.

[43] Ibid, p.5.

[44] Ibid, p.5.

[45] Ibid, p.5.

[46] Ibid, p.5.

ranching."[47] The other part of the Blacklands is a wooded prairie area that is often called the Crosstimbers. Within these two regions, there is only four percent of cotton production in Texas, much like East Texas, due to the rich black soils and the large amounts of rainfall which often lands into the 30 to 36 inches mean that cotton can only be harvested at certain times of the season.[48]

The area of South Texas is known for its varied range of geographical locations that range from "the Gulf Coast Prairies and Marshes and the inland, semi-arid South Texas Plains."[49] Within the 13 million acres of this varied region, only 1/3 of it is used as farmland. It is only within the coastal prairies that produce upward to 8 percent of Texas cotton, with a majority being grown with the dryland method, which means that there is little to no irrigation, the rest of the cotton areas using irrigation to help the harvest. With South Texas's temperate weather and decent accumulation of rainfall, this smaller area produces a more significant portion of cotton is substantial if compared to the amounts within East Texas and the Blacklands.[50]

Another important region of Texas is the Lower Rio Grande Valley. The Lower Rio Grande Valley or otherwise known as the Valley is a narrow area often prone to river flooding due to its proximity to the Rio Grande.[51] While it is part of the South Texas region, the subtropical climate in collaboration with more irrigation focused crop production that makes this

[47] Ibid, p.6.

[48] Ibid,p.6.

[49] Ibid, p.6.

[50] Ibid, p.6.

[51] Ibid, p.7.

region a very distinct place aside from the central part of South Texas.[52] Despite the area only producing three percent of the cotton in Texas, because of the subtropical climate, short-staple cotton crops are often the cotton type of choice due to their quick maturity that allows the region to plant and harvest quickly within a season of cotton production.[53] In comparison between East Texas, the Blacklands, and even South Texas, it can be seen that while the Valley produces a small amount of cotton, it is the climate that is perfect for short seasonal cotton crops that make it a critical region for Texas.

Texas's High Plains region is found around Lubbock and is approximately over 32,000 square miles, a relatively large Texas portion.[54] It is within the High Plains where most of the cotton is produced. It is said that over 65 percent of Texas cotton comes from the High Plains various twenty-seven counties, making it one of the essential cotton areas. It not only produces the bulk of Texas cotton but also a large majority of United States cotton. The reason that this region can produce so much cotton is due to its semi-arid condition. While it does get limited rainfall, it has many rivers, including the Canadian River, that give the counties of the High Plains the irrigation power needed to produce large quantities of short-season cotton crops.[55]

About twenty-eight million acres of land within the Rolling Plains encompasses much of North-Central Texas. With this large amount of land, the Rolling Plains is a part of the High Plains and the Great Plains of the United States, making it a massive section of Texas.[56] Much

[52] Ibid, p.7.

[53] Ibid,p.7.

[54] Ibid,p.7.

[55] Ibid, p.7.

[56] Ibid,p.7.

like the High Plains, this area produces a sizable amount of Texas cotton; roughly twenty percent is harvested in these twenty-eight million acres of land. Depending on the season, it only makes a small to moderate amount of the cotton harvested in the United States.[57]

Texas's Trans-Pecos region is considered aside from South Texas to be the most complex region of the state. It contains "the northern portion of the Chihuahua desert...It includes plateaus, desert valleys, and wooded mountains. The only true mountain ranges in Texas are in the Trans-Pecos."[58] While cattle ranching is the primary source of income for the region; cotton is also produced to a degree. However, due to the dry weather and lack of adequate rainfall, irrigation is a crucial part of cotton production.[59] What makes the Trans-Pecos area of Texas different from the many other regions is that due to the very intense heat and very little rainfall, this makes longer seasonal cotton a much more viable crop as it allows for cotton farmers to use irrigation through the rivers and various aquifers that will enable for these longer growing kinds of cotton to be produced and harvested.[60]

Texas cotton was a booming business, as shown with the large swathes of regions that could viably, to some degree, make profitable cotton production. And it only seemed that Texas cotton productivity would continue for the state as time passed. But there were already clouds of uncertainty on the horizon, bringing with them an insect that would change cotton history forever As cotton became more integral to Texas agriculture, the proximity of Mexico would bring the

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[57] Ibid,p.7.

[58] Ibid,p.8.

[59] Ibid,p.8.

[60] Ibid,p.8.

unforeseen side effect of introducing one of the most devastating ecological pests into the United States, the boll weevil.

The Mexican cotton boll weevil, otherwise known only as the boll weevil, is an insect that resides within Mexico, more commonly around the Veracruz region. Originally discovered by Dr. Eugene Schwarz, the species of stout beetle also known as Anthonomus grandis has existed in Mexico since ancient times. During an archaeological excavation in Oaxaca, it was discovered in a petrified cotton bud the remains of a boll weevil from at least 900 A.D.[61] Another interesting piece of information about the boll weevil is that it belongs to a group of weevils that have roughly over one hundred different species that reside throughout the North America.[62]

The boll weevil itself is barely 1/8 to almost ½ of an inch long with a grayish body and long snout. The boll weevil belongs to the Curculioninae which is the largest subfamily of beetles which includes many that are considered pests to various crops and other plant types.[63] While it is not an impressive form of insect biology, it is in fact, much more dangerous than many suspects. Boll weevils need cotton plants for most of their life cycle. Adults often emerge in early spring after the overwintering period and begin to move toward the nearest cotton field available. When they find a field, the adult will begin to eat the seedlings of the cotton plant and during this feast of cotton, adults will mate heavily during the spring and early summertime.

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[61] Rose Ella Warner, and C. Earle Smith. "Boll Weevil Found in Pre-Columbian Cotton from Mexico." Science 162, no. 3856 (1968): p.911. http://www.jstor.org.ezhost.utrgv.edu:2048/stable/1725537.)

[62] *W. H. Cross. "Ecology of Cotton Insects with Special Reference to the Boll Weevil" In Cotton Insect Management With Special Reference to the Boll Weevil.* edited by R.L Ridgway, E.P. Lloyd, and W. H. Cross. United States Department of Agriculture, Agricultural Research Service. Agriculture Handbook Number 589. Issued November 1983. p.54.

[63] Ibid, p.54.

Once the female boll weevils have finished mating, they will then start laying their eggs in the flower buds of the cotton plant which is often known as the squares.[64] The female boll weevils will pierce the squares and lay a single egg within them. And as the larva begins to hatch, it will begin to eat the squares from the inside out over the course of roughly 7-14 days, and within a short pupation period, the adult weevils will emerge from the squares or bolls and begin the process all over again.[65] Female boll weevils will burrow and lay their eggs into the bolls or fruits of the cotton plant, and the larva will consume it from the inside. Female boll weevils also produce upwards of 200 eggs over a 12-day period, which can allow for multiple generations of a single pairing to spread wildly through just one season of these remarkable insects.[66]

What makes boll weevils even more interesting is that studies have found that boll weevils are relatively blind at finding cotton crops except for when they are practically flying into the plant itself due to poor eyesight.[67] But while they don't rely on visual senses to find cotton, they instead use random olfactory senses that the cotton plant produces that gives the weevil the indication of feeding on the plant itself, though even then much of the early spawned boll weevils do so in a completely random manner.[68] Another interesting thing about boll weevils is that during the overwintered populations that come out of hibernation, they do not

[64] Ibid,p.54.

[65] Ibid,p.54-55.

[66] "Boll Weevil" Field Guide to Common Texas Insects. Texas A&M Agrilife Extension, Accessed February 12,2020. https://texasinsects.tamu.edu/coleoptera/boll-weevil/

[67] W. H. Cross. *"Ecology of Cotton Insects with Special Reference to the Boll Weevil",p.* 57.

[68] Ibid, p.57

begin mating until after there has been found a steady supply of cotton to consume and reproduce in. In fact, studies have shown that:

> an isolated overwintered male weevil that finds and feeds on cotton squares for several days begins to emit a strong aggregating pheromone that attracts both sexes from proved distances of 100 feet and perhaps farther when wind conditions are optimum.[69]

And even if female weevils follow the pheromones of the feeding male, they may not even mate at all, though in some experiments it was found that if the female was isolated yet comfortably fed on cotton, that once introduced to a male, she will usually urge him to mate with her through short-range pheromones or by stimulating him through physical contact.[70] But none of this research would have been possible without the investigative work of the first man who looked at these strange insects.

The first man to investigate this creature was not a scientist, but a Corpus Christi pharmacist by the name of Charles DeRyee. His importance to the boll weevil, despite being a pharmacist, has to do with the fact that "druggist commonly dispensed insecticides in those times."[71] So, it was no surprise that local farmers brought him some strange insect that they could not figure out, hoping that the druggist had a possible answer to their discovery. He sent a collection of the insects to the USDA and with that, the slow invasion of the United States by the boll weevil had begun.[72]

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[69] Ibid,p.57

[70] Ibid, p.57.

[71] "The Boll Weevil: A Century of Pestilence", p.26.

[72] Ibid, p.26.

Edward Palmer, who became the first State Entomologist for Texas, investigated the boll weevil in Monclova, Mexico and discovered a concerning issue about the insect. He said "Monclova...and the surrounding country a few years ago was famous for its large supply of cotton; at this time none can be grown, owing to the destructive insect."[73] When the insect migrated from Mexico into South Texas, there was already a great fear over the insect and the damage that it could do to cotton agriculture. The boll weevil then made its way into the United States through the city of Brownsville, Texas in the 1892. That invasion of the insect changed the Cotton Belt. What made the boll weevil a more infamous cotton pest than other native US pests was that while the native pests could eat other types of crops if available which helped to keep cotton losses at a more manageable number, the boll weevil subsisted entirely on cotton which meant that cotton was at a much higher threat of loss and infestation.[74]

By 1903, Texas Governor Samuel L.T. Lanham had created a bounty for the head of the boll weevil. Promising a reward of 50,000 dollars to anyone who could find a method to effectively kill the boll weevil showed how badly the boll weevil had become as a destructive entity to Texas well-being.[75] News traveled quickly throughout the United States about this devastating insect, so much so that in an inaugural address in 1904, President Theodore Roosevelt stated, "Our pathologists will find immune varieties that will resist the root disease, and the bollworm can be dealt with, but the boll weevil is a serious menace to the cotton crop. It

[73] Frank Wagner. *The Boll Weevil Comes to Texas,* Friends of the Corpus Christi Museum(Corpus Christi, 1980) p. 2.

[74] *W. H. Cross. Ecology of Cotton Insects with Special Reference to the Boll Weevil,*p. 54.

[75] "Pest Practices: A Legislative Battle with the Boll Weevil". Legislative Reference Library of Texas. Posted July 10, 2018. Accessed December 23, 2020. https://lrl.texas.gov/whatsNew/client/index.cfm/2018/7/10/Pest-Practices-A-Legislative-Battle-with-the-Boll-Weevil

is a Central American insect that has become acclimated in Texas and has done great damage."[76] The president was correct in his assumption about the severe threat the insect posed to cotton production within the United States. E Dwight Sanderson, the Texas State Entomologist from roughly 1902 to 1905, stated within a statistical study of the boll weevil that "accurate statistics of the cotton crop for each county of the infested area are of the utmost importance, for the loss due to this insect is now so great that it must exercise an increasingly important influence upon the market price of cotton."[77]

The boll weevil's reputation became so prevalent that even Europeans were cautious about purchasing American based cotton seeds for fear that the boll weevil could become a global scale economic threat to the entire cotton market. As quoted in an article written by the Scientific American in a 1903 publication, "The fact that several European governments are sending agents to this country to procure seed...calls attention to the probability that the weevil may be carried to remote portions of the globe."[78] Paranoia over the boll weevil becoming a global threat, causing the South to suffer from the insect in a more overwhelming sense. Boll weevils with their incredible breeding methods, and tenacity against rain and heat throughout the seasons that would have otherwise killed off a lot of other pests meant that even in small numbers the boll weevil had the potential to cause damage.[79]

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[76] "State of the Union Address: Theodore Roosevelt (December 6, 1904)", Infoplease.com, accessed April 23,2020.

[77] "A statistical study of the decrease in the Texas cotton crop due to the Mexican cotton boll weevil and the cotton acreage of Texas 1899-1904" inclusive by Sanderson, Dwight, 1878-1944; Texas. Dept. of Agriculture, Insurance, Statistics and History. Read from Library of Congress, https://archive.org/details/statisticalstudy00sand/page/n3. p. 3.

[78] "The Mexican Cotton-Boll Weevil and the Damage It Has Caused This Season" *Scientific American,* Vol. 89, no.23 (December 1903), p.47 https://www.jstor.org/stable/10.2307/24988176.

[79] Fabian Lange, Alan L. Olmstead, and Paul W. Rhode. "The Impact of the Boll Weevil, 1892–1932."p.688.

The Bureau of Entomology in its1904 report on the boll weevil discussed the possibility of the boll weevil invading Europe and causing issues with their cotton production. As many European countries were importing cottonseeds to experiment with their own possibilities of cotton agriculture, the BOE was cautious with the assumption of the boll weevil becoming an international threat, but they did not deny that if a:

> there is nothing whatever to prevent the weevils from being carried long distances on shipboard. When thus transported the indications are that they would be able to adapt themselves successfully to climatic conditions anywhere that cotton may be grown, unless possibly in a region of great elevation, like that of the Laguna district in Mexico.[80]

Adding into this paranoia of the boll weevil was the almost mythical abilities that farmers seemingly believed it to have. Folk tales and songs permeated the South regaling listeners to the magical invulnerability of the weevil against anything that man sought to use against him from fire, to cold, anything that could be used against the weevil simply annoyed him.[81] Some even proclaimed the weevil to be a biblical plague sent by God, calling it the "evil spirit that dwelleth among us."[82] This usage of religious language to depict nature attacking civilization as the personification of evil, pulled at the fears of deeply rural and thus very religious communities.

The Bureau of Entomology (BOE) had a great task ahead of themselves with the boll weevil. They had to find a way to exterminate the boll weevil from the infested lands of the cotton belt and see if those lands could even still be economically viable despite the boll weevil. In 1904, the BOE noted that the boll weevil "has been found outside of the State of Texas in only

[80] W.D. Hunter, "Information Concerning the Mexican Cotton Boll Weevil",U.S. Department of Agriculture. Farmers Bulletin No.189 (Washington: Government Printing Office-1904),p.24.

[81] Douglas Helms. Technological Methods For Boll Weevil Control. Agricultural History, Vol. 53, no.1 Southern Agriculture Since the Civil War: A Symposium (Jan. 1979) p. 286. https://www.jstor.org/stable/3742876

[82] Ian Manners. The Persistent Problem of the Boll Weevil: Pest Control in Principle and in Practice. Geographical review , vol. 69, no.1. (Jan, 1979), p.25

three instances."[83] These three locations all being in different parts Louisiana, while one was in the city of New Orleans. Because the farms themselves were mostly isolated, the BOE was relieved since those isolated farms could easily eradicate the boll weevil without a fear of them returning. However, the fact that the weevils entered these locations through cottonseed products and could be that far from Texas revealed that while the boll weevil moved slowly through Texas, it had the propensity to move far into the other cotton producing states in no time.[84]

As the possible threats the boll weevil brought to cotton, there was a need to find some method to kill it, but the diagnosis of finding a quick solution to exterminate the boll weevil was grim, stating "The work of the Division of Entomology for several years has demonstrated that there is not even a remote probability that the boll weevil will ever be exterminated."[85] However, despite the grim observation about the boll weevil, they were still optimistic that cotton could still be grown in a profitable manner within the United States. They just needed to find proper methods that farmers could easily follow that could combat the boll weevil and still allow them to pursue their economic needs of cotton production.

[83] W.D. Hunter, "Information Concerning the Mexican Cotton Boll Weevil",p.10

[84] Ibid,p.10.

[85] Ibid, p.1.

CHAPTER III

1900-1920: THE CULTURAL METHOD OF ERADICATION

The United States during the 1900's was changing. It was now becoming a contender on the world stage as a powerful nation, its lands were expanded heavily with homesteaders who sought to cultivate and settle the wild frontier of the U.S. Advancements in technology meant that farming could be done not only faster, but also large-scale which meant more economic opportunity on an international scale.[86]

Even the social consciousness of Americans was changing with the new era of American history, as there was a bigger desire to further "social and political reform, curbing political corruption caused by political machines, and limiting the political influence of large corporations."[87] Conservation also became an important piece of this new era. As the U.S. expanded throughout the once called "frontier" of its land, the land was heavily exploited in the

[86] "America at the Turn of the Century: A Look at the Historical Context", Library of Congress, Accessed May 5, 2021. https://www.loc.gov/collections/early-films-of-new-york-1898-to-1906/articles-and-essays/america-at-the-turn-of-the-century-a-look-at-the-historical-context/

[87] "The Progressive Movement and U.S. Foreign Policy, 1890-1920s" U.S. Department of State Archive, Accessed May 10, 2021. https://2001-2009.state.gov/r/pa/ho/time/ip/108646.htm#:~:text=Progressives%20were%20interested%20in%20establishing,for%20women%20and%20U.S.%20workers.

process. In response to this, there was a call to conserve some of the natural beauty of the American lands, something that appealing to naturalist such as President Theodore Roosevelt.[88]

In Texas, the once wild frontier was being replaced with major cities, telegraph lines and railroads that dotted the land. Texas was becoming a piece of the transforming U.S. with every new step into what would be called the "Progressive Era."[89] Cotton was also changing with this new era of American history and innovation, and the crux of this change was due to the boll weevils destruction on cotton production. From 1900 to 1920, this phase of boll weevil was to mark the United States first war against an insect.

As the boll weevil was starting to migrate from Texas and into the South, scientists were looking at what they could do to curtail the destructive insect's movement and prevent it from truly establishing itself within the United States. One of the first methods created in the hopes of thwarting the cotton boll weevil was the "cultural method" as coined by entomologists. However, many farmers referred to it as the "government method" due to their perceptions of governmental interference into their daily lives. Regardless of the name used, the plan was straightforward. If farmers manipulated and changed which cotton, they used, the boll weevils' devastation could be minimized and prevent large-scale crop loss for a lucrative market.[90] The

[88] "Conservation in the Progressive Era", Library of Congress, Accessed May 11, 2021. https://www.loc.gov/classroom-materials/united-states-history-primary-source-timeline/progressive-era-to-new-era-1900-1929/conservation-in-progressive-era/

[89] "Fear, Force, and Leather - The Texas Prison System's First Hundred Years, 1848-1948" Texas State Library and Archives Commission, modified August 22, 2019. Accessed May 10th, 2021. https://www.tsl.texas.gov/exhibits/prisons/scandal/page1.html

[90] Douglas Helms. "Revision and Reversion: Changing Cultural Control Practices for the Cotton Boll Weevil." *Agricultural History* 54, no. 1 (1980): p.108.. Accessed January 22, 2021. http://www.jstor.org/stable/3742598.

plan itself seemed simple enough that, if properly implemented, it could manage the boll weevil pest effectively and do so without much expense being placed on the farmer's shoulders.[91]

What made these cultural methods necessary initially was that many of these techniques worked in combination with other aspects of farming life. Insects that could be killed through simple plowing of the soil meant that farmers did not have to change many of their techniques to combat their insect pests.[92] But it took more than plowing to make more effective means to reduce the devastation that the weevil could cause for cotton farmers. As researchers learned about the boll weevil, they discovered that the insects were more active during the warm seasons. This allowed weevils the opportunity not only to deposit their eggs, but also for emerging eggs to begin consuming the cotton. It often took up to twenty days for large numbers of weevils to be born in that concise amount of time.[93] This meant that farmers had little time to ignore the weevils advancement and had to buckle down if they wanted to be able to harvest their crop and money from their hard work.

One of the earliest methods that farmers were instructed to use more frequently was the concept of crop rotation. Crop rotation meant that a completely new and different crop could be planted there to help keep the soil fertile after a specific type of produce was harvested. This had an added benefit to combat pests. If farmers grew a completely different within the soil, insects

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[91] F..A. Gunther and L.R. Jeppson, *Modern Insecticides and World Food Production(*John Wiley & Sons: New York, 1960), p.29.

[92] Ibid, p.29.

[93] W.E.Hinds and W.W. Yothers. *Hibernation of the Mexican Cotton Boll Weevil.*(Government Printing: Washington, 1909), p.13.

that consumed the earlier crop, like cotton weevils, would effectively starve their food supply when they became more prone to infestations.[94]

While these integral cultural techniques were essential, entomologists still tried to find other ways to combat the weevil. One of these methods was early crop maturation. Farmers needed to find ways to engineer techniques that "mature the crop early to avoid the weevil population explosion in mid and late summer, and to reduce the number during hibernation, thereby reducing infestation the following year."[95] Growing cotton that matured early was thought to be a way for farmers to maximize their profits quickly and more efficiently when it came to harvesting the plant as "An early crop means profit — a late crop goes to the weevil, not to the farmer."[96]

One of the methods that scientists explored was the idea of reducing the acreage of cotton. Scientists believed that reducing that acreage could not only help with the depletion of the boll weevils food supply but also allowed farmers to maximize the acreage that was being used for cotton production which kept it all cost effective.[97] One of the best way to mature cotton crops early was to use different cotton seeds that created more quickly developing cotton. Imports of these quick-growing cotton seeds, most often known as short-staple cotton seeds, were used in the hopes of maturing the cotton speedily and thus became more economically viable. Short staple cotton is quite different from most traditional cotton, commonly known as a

[94] F..A. Gunther and L.R. Jeppson, *Insecticides and World Food Production*, p. 29-30.

[95] Douglas Helms,"*Revision and Reversion."* p.108

[96] George Howard. Alford, *How to Prosper in Boll Weevil Territory*, (Agricultural Extension Department International: Chicago & Harvester Company of New Jersey), 1914. p. 7.

[97] Ibid, p. 8.

long staple. Short-staple has coarser fiber, and due to its natural heartiness, it allows farmers to plant the cotton in various soils and climates, making it more usable than long-staple, which only grew in certain types of soils. The downside of using short-staple cotton was that the seeds were much more difficult to remove for ginning purposes, and this reduced much of the fiber for textile production.[98] Not to mention that a farmer had to be careful with buying cotton seed as well, as they would need to buy from a reputable breeder of the seeds that they wanted, which if not careful could lead to fraudulent purchases by less than reputable sellers of cotton seeds.[99] But in the minds of scientists, this was a small price to pay for the overall health of the cotton market.

Many entomologists and agriculturalists looked at crop and stalk destruction as a regular means of boll weevil management and was considered at the time to be one of the best methods to help defeat the boll weevil.[100] There were three different methods that a farmer could use to destroy their left over cotton. One was pasturing, which was a method where a farmer who had access to cattle could have them go into the cotton field where they would trample and consume the left over cotton plants.[101]

Plowing was another method that a farmer could use to destroy not only cotton but also the immature boll weevils that possibly laid hidden in the bolls and squares. And finally burning was another method that could be utilized. Using flames to burn not only cotton stalk but boll

[98] "What is short-staple cotton? Answers.com, accessed July 3rd, 2019, https://www.answers.com/Q/What_is_short-staple_cotton.

[99] George Howard. Alford, *How to Prosper in Boll Weevil Territory, p*.10.

[100] Ibid, p.14.

[101] Ibid, p.15.

weevils was seen as a good alternative to farmers who either lacked cattle to pasture their crops or if plowing wasn't effective enough to completely destroy the cotton.[102] Farmers often did crop burning after harvesting their cotton, or in the case of a field already infested with boll weevils and thus dealing with heavy losses of cotton production, farmers destroyed and burned that leftover cotton and stalks to reduce both the food and sheltering places where boll weevils could hibernate during the winter months.[103]

This issue was a sore one for many farmers, as it meant they had to destroy plants and possibly suffer profit loss. Destruction of cotton represented just one issue with which farmers had to contend. Another problem with using different cotton seeds was that many of the various regions that produced cotton applied to specific breeds. Areas like the Gulf Coast of the South preferred the much longer staple cotton, as they had much more fertile lands than the northern frontiers of the South, which had more arid conditions and thus relied heavily upon the short-staple cotton.

By the 1910's, there was an influx of experimental technology that was thought to be useful in the fight against the boll weevil. Farmers often used netting and swatting tools to bring down the weevils, while others used electrical versions of the swatting tools, flooding, and more physically active methods to remove them from their cotton crops.[104] In fact, many small-town cotton farmers and merchants saw these tools as an excellent remedy against the cotton pest, as

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[102] Ibid, p.16.

[103] Douglas Stephenson, Mark Matocha. "A Pest Management Strategic Plan for Cotton Production in Texas". *Southern Integrated Pest Management Center*. Published 2004. Accessed September 23,2020.https://ipmdata.ipmcenters.org/source_report.cfm?sectionid=30&controltypeid=0&sourceid=1269. p.12.

[104] F..A. Gunther and L.R. Jeppson, *Modern Insecticides and World Food Production, p.*29.

many farmers used their children to move through the cotton boll lanes to swat and brush off the weevils.

Many other farmers employed school children during summer break with this task as well, often paying reasonably well to any child who worked to remove the cotton weevils from their plants and fields.[105] There were even conceptions of machines that could effectively collect cotton that was infested with the boll weevil, such as a "mule-drawn machine with revolving brooms which brushed weevils into attached pans."[106] Several other machines that could do the same thing cropped up. Quite a few were produced enough to become somewhat commercially viable, despite many of these machines being nothing more than entirely useless and expensive wastes of farmers' money.[107]

Despite these issues, farmers utilized these shorter staple cotton seeds to implement the easiest method.[108] With the short-staple cotton seeds now being used by cotton farmers, there was still an important issue that they had to overcome. As the U.S. started using these short-staple cotton crops, The international textile market found it difficult to accept the new cotton produced in the places where it gathered much of its raw material. Short-staple cotton usage affected Liverpool markets where Texas cotton was always in high demand, causing many Liverpool textile manufacturers to avoid using Texas cotton. This caused a severe dip in the reputation of the once enormously admired Texas cotton, and also the cotton throughout

[105] Douglas Helms,"Revision and Reversion." p.116.

[106] Douglas Helms, "Technological Methods for Boll Weevil Control."*Agricultural History 5*3, no. 1 (1979): p.288. Accessed January 28, 2020. www.jstor.org/stable/3742876.

[107] Ibid, p. 288.

[108] Douglas Helms,"*Revision and Reversion*."p. 109.

American South.[109] As the reputation of cotton was seemingly falling within the United States, there would still be much more experimentation into finding out what could keep the boll weevil in line.

As entomologists scrambled to understand how to deal with the boll weevil menace to the cotton market, their research created a unique and exciting look into agricultural environmentalism. Politicians, farmers, and entomologists alike single-mindedly imagined the destruction or, at the very least, control of the cotton boll weevil. Researchers looked into the various means to find some solution to the boll weevil problem, including investigating the insect's place in biological circles. In Texas, for example, the researchers discovered that the weevil could be attacked by three major parasites.[110] Knowing that natural enemies of the boll weevil existed gave researchers the incentive to investigate what else could be used to defeat the weevil's incursion into the United States. Many researchers looked into the natural habitats of the boll weevil. They found that many times "natural conditions annually reduce enormously the numbers of the cotton boll weevil."[111]

They realized that winter represented the most opportune time to kill boll weevils, as the weevils began their hibernation then and existed in much smaller amounts. Winter was "the most critical season in the whole life history of the weevil."[112] The reason behind this was that during the summer season, when boll weevils were more numerous, the wintering conditions made the

[109] Ibid, p.110.

[110] W. Dwight Pierce, *Insect Enemies of the Boll Weevil,* p.9.

[111] W.E.Hinds and W.W. Yothers, Hibernation *of the Mexican Cotton Boll Weevil*, p.7.

[112] Ibid,p. 7.

squares and bolls the weevils used less viable. Many weevils died off, and only a few became able to hibernate.[113] Even those that could hibernate, there was still the possibility that there would be weevils that would not survive the full hibernation period. Only those weevils born later who had the energy to survive emerged in the spring to begin the process all over again.[114] With that in mind, it became essential to reduce the squares and bolls during the winter to make it even more difficult for the struggling weevils.[115]

Such research hoped to find how naturally occurring enemies and predators of boll weevils could be used to provide natural pest control.[116] L.O. Howard, chief of the United States Bureau of Entomology, discovered that different species of parasites and predatory insects consumed the boll weevil as part of their life-cycles. Many lived within the United States, giving entomologists the hope that these natural enemies could be appropriately utilized for cotton farmers.[117] The investigation into these enemies was conducted in 1905, which allowed for a large expanse of the inquiry into the biological entities that could be a valuable source if the theory of natural pest control had any possibility of being effectively used for farmers. As researchers discovered how many different species of creatures hunted the boll weevil, they found over "49 species of insects which attack the immature stages of the boll weevil. Of these

[113] Ibid,p. 12.

[114] Ibid, 12.

[115] Ibid,12.

[116] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production,* 31.

[117] W. Dwight Pierce, The *Insect Enemies of the Cotton Boll Weevil*. p.9-10.

insects 29 species may be classed as parasitic, 5 as predatory larvae, and 15 as predatory adults."[118]

For the sake of brevity, as there are so many different species of cotton boll weevil enemies, this paper will look at only a few of them from each group to provide a brief but necessary acknowledgment of the research done on these insects and its impact on boll weevils. While there are various species of insects that prey on the boll weevil, the majority of the insects are parasitic in nature. The research into these natural enemies of the boll weevil revealed that many of them involved the immature stages of the boll weevil, parasites being the majority of the enemies that attack boll weevil larva. With a mortality rate of over 56.73 percent, the weevil's quick breeding process made these parasitical enemies' possible deterrents to the destructive weevils.[119]

One of these parasitic creatures that preyed on boll weevils were mites. Mites are small acarid or parasitic arachnids that often infest plants or animals.[120]Two types of mites were observed to prey on the boll weevil as parasitic enemies. One of them is the Pediculoides ventricosus, more commonly known as the straw or grain itch mite. These mites will latch onto the boll weevil and begin to inflate their abdomens over the course of two to five days until the abdomen is much larger than the mites thorax.[121] As this happens, the straw mite often releases its offspring while they are still attached to the weevil; in many cases, the straw mites will begin

[118] Ibid, p.10.

[119] Ibid, p.10.

[120] *Merriam-Webster.com Dictionary*, s.v. "mite," accessed June 4, 2020, https://www.merriam-webster.com/dictionary/mite

[121] W. Dwight Pierce, The *Insect Enemies of the Cotton Boll Weevil,p. 46.*

mating again during this expulsion from the parent. One record showed that "an average of 100 female offspring to an individual was recorded."[122] What makes these mites so damaging to boll weevils is the fact that the mites "reproduce viviparously and their offspring are mature and fertile at birth."[123] Observations into how potent the straw mites are against the boll weevil found that over the course of four days, "50 out of 153 weevil stages in squares were attacked, or 32.6 percent."[124]

Flies, otherwise known as Diptera, do not primarily use the boll weevil in a parasitic fashion; however, researchers found family of flies known as the Tachinidae, and the Phoridae are otherwise known as parasitic flies, which means they often lay their eggs around other insects or animals.[125] For example, in the Phoridae family, or the hump-backed or scuttle fly, the larva is part of a category known as the endoparasitic, which means "a parasite that lives in the internal organs or tissues of its host."[126] Once they enter into the boll weevil, they slowly eat it from the inside out, and once it is empty, they then use the shell as a pupa for the next cycle of their growth.[127] Myiophasia aenea, or the Tachninde flies, are the second family of parasitic flies, with over 1,300 different species in North America alone.[128] These types of flies are

[122] Ibid,p.46.

[123] Ibid, p.46

[124] Ibid,p.46.

[125] Ibid,p.47.

[126] *Merriam-Webster.com Dictionary*, s.v. "endoparasite," accessed June 4, 2020, https://www.merriam-webster.com/dictionary/endoparasite.

[127] W. Dwight Pierce, *The Insect Enemies of the Cotton Boll Weevil,* p.47.

[128] Susan Mahr. "Tachinid Flies". Master Gardener Program, published October 15, 2007. Accessed June 4th, 2020. https://wimastergardener.org/article/tachinid-flies/

effective against weevils because several species of weevils are attacked by this group of flies, especially in environments that are moist and shady, as that was the prime breeding environment for these flies.[129]

Wasps, or Hymenopterans, are considered to bethe most important of the boll weevil's insect enemies because there are so many species of wasp that prey on the weevil insect.[130] The family known as Torymidae wasps are a particular type of wasp found specifically to go after weevils as they were ectoparasites, meaning that they leave their larvae on the outside of their prey and allow the larvae to eat the prey from the outside in. They are found worldwide, much like the many different parasitic flies, making them another contender in natural control methods against weevils.[131] Within this family, there are multitudes of wasps found to be quite potent in their preying on the boll weevil. The Microdontomerus anthonomi, for example, was ranked the seventh most crucial wasp enemy of the boll weevil. However, it was later promoted to fourth place after it was imperative in Texas's regions known as the black-prairies.[132] Another wasp from the Eurytomidae family, more commonly known as the "copper" wasps, has a species known as Eurycoma tylodermatis, which is considered to be the most crucial wasp that preys on the boll weevil because of it "having a range of distribution practically coextensive with that of its host, the boll weevil."[133] But, the single most important species of wasp that hunts the boll

[129] W. Dwight Pierce.*The Insect Enemies of the Cotton Boll Weevil,* p. 48.

[130] Ibid, p.48.

[131] "Torymidae", Torymid wasps of the Afrotropical Region. Waspweb. Accessed June 7, 2020. http://www.waspweb.org/Chalcidoidea/Torymidae/index.htm

[132] Ibid, p.49.

[133] Ibid,p. 49-50.

weevil are the Braconinae family of wasps. The Braconid, as it is also called, is a worldwide species of wasp and is essential to both garden and commercial crops as they often attack and feed on numerous pests that affect both, making them a generally good biological insect for pest control.[134] Looking at the complete viability of parasitic insects for a more natural control method against the boll weevil, there was continued research into how the parasites could be used to combat the annoying pest. Firstly, while the parasitic insects were not known to fly in large numbers, they could be seen swarming the cotton plants to find their host.[135]

Many researchers observed these parasitic insects around various flowers, which gave them the opportunity to use them in experiments to see how much viability they had and, if possible, forcibly make these parasites attack boll weevils more frequently.[136] Another benefit added to the utilization of parasitic insects was that many of these insects lived within the same areas that were being invaded by the boll weevil, making them a sort of natural defense against it.[137] While much of the research conducted only looked at the predators of the boll weevil larvae, researchers did find that there were roughly six different insects that hunted adult boll weevils that could be found in many other parts of the cotton belt, which included "one praying mantis, one predaceous bug, two beetles, and two ants—six species in all."[138]

[134] "Braconid Wasps on Hornworms". Beneficials in the Garden. Texas A&M University. Accessed June 7, 2020. https://aggie-horticulture.tamu.edu/galveston/beneficials/beneficial-04_braconid_wasp_on_hornworm.htm

[135] W. Dwight Pierce, *The Insect Enemies of the Cotton Boll Weevil, p.54.*

[136] Ibid, p.54.

[137] Ibid, 61.

[138] Ibid, 10.

Many beetles that hunt the boll weevil do so merely because they are often found "either breeding in the square upon the boll-weevil stages or of entering the square and consuming the weevil."[139] Four distinct beetle species hunt the boll weevil, and they are often found among the cotton plants where weevils tend to be. The first is the Hydnocera pallipennis, otherwise known as the "checkered beetles." What makes this species so important is that both the larval and adult stages hunt the boll weevil, making them a prominent insect ally for cotton farmers.[140] Another beetle that belongs to the Hydnocera family is the Hydnocera pubescens, known to be a "common breeder in weevil cells. Its larvae have been found...feeding upon the various weevil stages."[141]

The Cathartes gemellatus is a member of insects' cucujid family though they are known more as part of the "flat bark" family of beetles.[142] These types of beetles are opportunistic, and will either hunt or scavenge on other insects. As scientists looked into this type of "flat bark" beetle, they found that "its larva being frequently found, however, feeding upon boll-weevil stages which they must have killed."[143] Even the "fire-fly" family of beetles are known hunters of boll weevils. The Chauliognathus is commonly found around cotton squares and bolls, especially in Louisiana and Mississippi.[144] Continued research revealed that many of the

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[139] Ibid, p.68.

[140] "Checkered Beetle (Enoclerus rosmarus)". Insectidentification.org. Accessed June 8th 2020. https://www.insectidentification.org/insect-description.asp?identification=Checkered-Beetle

[141] W. Dwight Pierce,*The Insect Enemies of the Cotton Boll Weevil, p.68.*

[142] Family Cucujidae - Flat Bark Beetles". Bugguide.net. Accessed June 8th, 2020. https://bugguide.net/node/view/7529

[143] W. Dwight Pierce, *The Insect Enemies of the Cotton Boll Weevil,* p.68.

[144] Ibid, p.68.

predators and parasites that could attack the boll weevil already consumed weevils within their regions; these enemies then naturally attacked the boll weevil as it migrated and began infesting in other parts of the South.[145] Also, scientists discovered that the cotton crops that had been planted much earlier in the season developed the beneficial parasites first, allowing for them to clear much of the cotton crops of the larval boll weevils. This discovery lent itself to the push of planting earlier that the USDA wished to implement for cotton agriculture.[146]

Birds researchers also looked at birds' viability as a form of biological control over the boll weevil. One experiment looked at the use of chickens to help the farmer control the weevil and other types of insect pests as well. The plan was for farmers to use chickens, which could be used all year round and were a more viable tool for combating the weevil.[147] How could poultry be used to combat the boll weevil? Simply put, the trap patch would attract the boll weevils or other pest insects that could trap them but allow the poultry to move through them. In this way, the poultry could eat the insects at their leisure.[148] Another important aspect of utilizing poultry in the documentation was that since poultry ate insects and seeds thrown to them by the farmers who raise them, economically, they paid for themselves instead of using more expensive non-natural means of control against the weevil and many other pest insects.[149]

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[145] Ibid, p.35.

[146] *Ibid, p.31.*

[147] Fred Heinlein, *The Use of Poison in the Control of the Boll Weevil,p.* 2.

[148] Ibid, p.3.

[149] Ibid,p.3.

As the search for more natural control continued, wild birds became a topic of research to understand how viable they could be as a means of defense against the weevil menace. Arthur Howell, an assistant biologist for the United States Department of Agriculture (USDA), researched avian predators of the boll weevil from 1905 to 1907. As the boll weevil continued to move through Texas and encroached upon other southern states, Howell believed that "a study of the relations of our native birds to the pest is of increasing importance."[150] Howell found that since there are quite a few bird species that actively consume weevils as part of their food sources, "the weevil-eating kinds are a few whose numbers it is believed can be greatly augmented through careful protection and by providing them with safe nesting places."[151] However, this was only part of the "solution," according to Howell, as while legislation was important, it also educated the public about the importance of these insectivorous birds and seeking to keep them protected properly.[152]

With that in mind, questions arose about wild birds' viability as biological control. While it was confirmed that many wild birds consumed insects, including the boll weevil, many of these birds also consumed grain and fruits, which in turn made them just as bad a pest as the insects that farmers were hoping to implement as part of pest control, as "the more agriculture is developed, the less benefit can be derived from wild birds and the more damage to be expected."[153] Ultimately, research and investigation into using weevil-eating birds revealed that

[150] Arthur Howell, The *Relation of Birds to the Cotton Boll Weevil*. U.S. Department of Agriculture. Biological Survey-bulletin no.29. (Washington, 1907), p.5.

[151] Ibid,p.5.

[152] Ibid,p.7

[153] Fred Heinlein, The *Use of Poison in the Control of the Boll Weevil*, p.5.

"while birds can not be depended upon to stay its progress, much less to exterminate it, yet the service they render in controlling it is of great importance."[154]

The economic viability of the boll weevil's biological control through natural predators and elements was also researched. The advocates of natural pest control believed that the "utilization of parasites and other insects inimical to the boll weevil as intimately connected with good agriculture."[155] The benefits of parasitic insects seemed rather apparent, as these parasites were easily checked by other natural agents such as other insects and birds. And even if some of these insects themselves became pests in different regions of the Cotton Belt, they would still be held to the natural checks of other animals, making a natural balance for control.[156]

While it can be seen as admirable that scientists were looking into using natural deterrents to the boll weevil, some issues had to be addressed since "every factor which checks these enemies without also checking the weevil benefits the weevil."[157]

Researchers also conducted experiments on how natural weather conditions could be used to combat the weevil. Climate played an essential part in the study as the Cotton Belt had a tremendous difference in temperatures ranging from arid plains to semitropical to swampland. Knowing what environments affected the boll weevil more easily meant that farmers and scientists could understand what seasons they could plant and harvest that prevented the boll

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[154] Arthur Howell, The *Relation of Birds to the Cotton Boll Weevil, p.*5.

[155] W. Dwight Pierce,*The Insect Enemies of the Cotton Boll Weevil,* p.83.

[156] Ibid,p.83-84.

[157] Ibid,p.9.

weevil from infesting cotton's central seasonal time.[158] Scientists found that many of the predators and species which fed on the boll weevil could not easily be moved to other parts of the Cotton Belt to effectively combat the pest. The introduction of new predators from other places just to fight against one insect caused fears that there was a danger of the introduced species affecting the local animals fed on the boll weevil.[159]

All in all, while crucial to the conceptualization of control against the boll weevil pest, factors such as predators, parasites, or even weather could easily be controlled to make them truly useful against the weevil. The fact that there were too many variables to implementing biological control methods against the weevil pushed many farmers and researchers into looking for more tangible forms of control.[160]

The Progressive Era of the United States was an important turning point in cotton agriculture, where gaining more information on the boll weevil in collaboration with understanding how natural defenses and changing cultural standards could work with keeping the cotton industry afloat. While the more natural methods were not the smoking gun that entomologists were hoping for they still provided foundation for the next step in boll weevil eradication.

[158] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production* , p.36.

[159] Ibid, p.33.

[160] Ibid, p.9.

CHAPTER IV

1920-1940:THE PESTICIDE METHOD OF ERADICATION

Despite the changes that U.S. cotton was using to combat the boll weevil, the global market of cotton was still viable enough to provide marketable prices. But, with the onset of World War I in 1914 this would cause a difficult wrench in the global cotton market as certain nations were now considered off limits due to their position as enemy combatants.[161] The United States maintained a neutral position in the Great War as World War I was called which allowed it to trade with both sides of the conflict.[162] However, the neutrality of the United States did not prevent it from suffering from the blocking of certain nations from trade causing decline in the price of cotton which could not have come at a worst time as the 1914 cotton production was considerably larger than previous years.[163]But, what was remarkable was that while cotton as a textile was declining during the war effort, cottonseed and products made of cottonseed were still in very high demand, which meant that farmers and cotton ginners could still make a profit though not as much as cotton itself.[164] Despite the loss in cotton, farmers were still desperate to

[161] Maurice Cooper, *Some Effects of the World War on Cotton*, (Washington: DC, 1937), p.1.

[162] Katherine Kuehler Walters, "World War I,"Handbook of Texas Online, accessed May 13, 2021, https://www.tshaonline.org/handbook/entries/world-war-i.

[163] Ibid, p.3.

[164] Ibid, p.2-3.

make profit through not only the war, but through the continued nuisance of the boll weevil. This desperation would create one of the largest and longest eradication control methods used, chemical control.

When natural control methods did not work out as desired, farmers tried chemical processes to defeat the boll weevil menace. While the government tried to change cotton farmers' practices and did succeed in some cases, many farmers were not interested in changing their methods and were simply desiring something like a poison that could effectively kill the boll weevil and not do extra work they saw as unnecessary.[165] This method is known as applied control, or the application of materials or chemicals that can be used to control insects' population. Chemical use against pests has been around for centuries, though chemical methods were much more easily experimented with and researched beginning in the 1850s.[166] In fact, chemical control as an eradication method was experimented with much like the natural methods that were explored in the 1900's. By 1901, chemical control became more critical as winds that dominated the fall and winter seasons allowed the weevils to spread themselves not just into the larger cotton-producing parts of Texas but got the insect close to the Louisiana border, signaling to many farmers the slow but encroaching threat to their vital crops.[167]

Many entomologist were critical of chemical usage, claiming that the application of chemicals were not only expensive but that if the cotton was already infested with boll weevils then it was completely worthless and a waste of money.[168] However, farmers were desperate to

[165] Douglas Helms, "Technological Methods for Boll Weevil Control",p. 288.

[166] F..A. Gunther and L.R. Jeppson, *Modern Insecticides and World Food Production*, p.23.

[167] Samuel Lee Evans, "Texas Agriculture, 1880-1930" (Ph.D. diss., University of Texas, 1960), p.61.

[168] George Howard Alford, *How to Prosper in Boll Weevil Territory*, p.19

protect the cash crop and were in need of something that was practical. The desperation to find something that could kill the boll weevil revealed how exploitative people could be, as there were attempts by some to encourage the use of both animal and human waste as possible deterrents against the weevil. Rumors and hoodwinking were quite common, and many entomologists had to contend with competition to their experiments and research which often undermined their own attempts.[169]

Chemical controls can be split into several types. These are stomach poisons, contact pesticides, systemic insecticides, and finally, fumigants. With the various types of chemical control that could be implemented upon insects, it can be no surprise that these controls became the most effective tool in managing this insect and many other types of pests. The reasoning behind this was that "attacks by insects could be suppressed below the level of economic importance, by chemical means."[170]

One of these pesticides was known as Paris Green. Known by its other name as Schweinfurt, Paris Green is "an extremely poisonous, bright green powder that was formerly used extensively as a pigment (e.g., in wallpaper), and that is sometimes used as an insecticide or to kill plant fungi."[171] Because of its extremely poisonous capabilities, once pigment turned pesticide, it was "estimated that more than two thousand tons of Paris green are annually used as an insecticide in the United States since it is the most rapid and effective of the arsenical

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[169] Douglas Helms. "Technological Methods for Boll Weevil Control",p.290.

[170] F..A. Gunther and L.R. Jeppson, *Modern Insecticides and World Food Production*, p.23.

[171] "Paris Green".*The Columbia Electronic Encyclopedia,*6th ed. Copyright 2012, Columbia University Press. All rights reserved. Accessed October 18, 2019.

preparations used for this purpose."[172] But while Paris Green was being used as an effective form of pesticide against the cotton boll weevil and other cotton pests, the problem arose that it was not economically viable, making the cost of using it outweigh any benefits that the pesticide had for farmers suffering from the weevil's damage to their crops.[173]

Calcium Arsenate was another form of pesticide was used to kill off the boll weevil. Calcium arsenates are part of a type of poisons known as the inorganic metallic salts, often called "stomach poisons." These types of toxins attack the insect's digestive tract. Experiments were underway by 1919 to see how to use the calcium arsenate. One investigation relied upon the mixing of calcium arsenate dust with molasses or syrup that was lightly placed upon the cotton crops that would kill the boll weevils who ate the toxic molasses mixture.[174] The experiment took into account that many farmers did not understand just how quickly the boll weevil populated within a short amount of time; according to the published material, the farmer could have "five hundred weevils to the acre giving June 20 as the starting point, that by November 1 there would be many hundred millions per acre."[175] This meant that in just a few short months, weevils could overrun cotton crops and devastate them before they could be handled with pesticides. The material then exclaims that farmers who choose to procrastinate on any amount of boll weevils within their fields are to be blamed when the weevils destroy the

[172] "Paris Green." *Scientific American* 73, no. 15(1895),http://www.jstor.org.ezhost.utrgv.edu:2048/stable/26116575 p.230.

[173] Douglas Helms,"Technological Methods for Boll Weevil Control." p.289.

[174] B.R. Coad "The Efficacy of Poisoned Molasses Mixture for the Control of the Cotton Boll Weevil", compiled by Willam. J.Mims. *Boll Weevil Control with Syrup (or molasses) and Calcium Arsenate*. (Birmingham, Ala.,Alsop printing co.,1921),Accessed March 29,2020. p.5

[175] Ibid,p. 4.

lion's share of his crop, placing the responsibility of his crop solely upon his shoulders.[176] The reasoning behind the desire to eliminate the boll weevils early considered that since boll weevils hibernate, those who come out during the spring would often "concentrate near the hibernation quarters in which they spent the preceding winter. They remain rather closely at these points until they have multiplied sufficiently to threaten a shortage of food supply."[177] The tests conducted on this experiment consisted of "cage studies comparing the weevil mortality on plants treated with the molasses mixture, plain dusted calcium arsenate and also unpoisoned check plants."[178]

There were approximately 86 different cage tests, and the results created an exciting conclusion to said experiment as, "The average of the entire series showed the mortality in all cages treated with the dusted calcium arsenate to be exactly the same as that in the cages treated with the molasses mixture."[179] The tests were conducted with varying degrees of molasses and normal dusted arsenate. They were found to have the same amount of lethality to the weevil whether the weevils were given a small amount or a much larger dosage of both forms of the arsenate.[180]

While these experiments showed an exciting conclusion, these were caged tests, and thus, there would need to be tests done on fields to see if there was a difference in how these mixtures worked against the boll weevils. Fifteen rows of cotton were tested again with the molasses

[176] Ibid,p.4.

[177] Ibid,p.4.

[178] B.R. Coad "The Efficacy of Poisoned Molasses Mixture for the Control of the Cotton Boll Weevil", p.5.

[179] Ibid,p.5-6.

[180] Ibid,p. 6.

mixture on five fields, the dusted calcium arsenate on another five fields, and an untested five fields as the base to see how potent the other two could be against boll weevil infestations[181] These forms of tests were repeated up to four times, and then the weevils were captured and examined. The results showed that, like with the caged tests, there wasn't much difference in the total mortality of the weevils in consumption of either the molasses mixture or the dusted calcium arsenate.[182] Further testing revealed an even more interesting result. In the examination of the molasses mixture, it was discovered that "a much better degree of control was secured from the molasses mixture…..noted only in the case of very small cotton plants averaging a few inches in height, and also during exceedingly dry weather."[183]

This testing created the conclusion that dusted calcium arsenate was more effective against the weevil except in the driest of conditions where a weevil's thirst drove them to drink the molasses mixture of arsenate. Not only that, but it was discovered that the cost of labor in the application of the molasses mixture was greater than the standard application of the dusted arsenate. These tests helped determine how arsenate in its dusted form could be a potential problem-solver for cotton farmers' boll weevil.[184]While the arsenates could be effective against the boll weevil and other insects, the dangers of the possible contamination of both the plant and human or animal consumption of the toxic plant made the use of these types of pesticides incredibly dangerous.[185] Another issue with the inorganic metallic salts is that certain types had

[181] Ibid,p.6.

[182] Ibid,p. 6.

[183] Ibid,p. 6.

[184] Ibid,p.7.

[185] F..A. Gunther and L.R. Jeppson, Modern *Insecticides and World Food Production*, p.25.

to be diluted to prevent physical and toxic damage to the crops that they were used upon, not to mention that if the poison used was not quick-acting, the insect could either regurgitate the toxins or even continue to consume and damage the crops before it died. These were but a few of the difficult tasks that farmers had to get around to use these pesticides against their insect foes.[186]

Another critique of the dust style arsenates was that while it was effective with the killing of boll weevils, it needed to be used in cooperation with earlier cultural methods properly to grow and harvest cotton crops, not to mention that in a season when the weevils were not as heavy it made the usage of the arsenates much more expensive and not worth the effort to use on the crops themselves.[187] Even weather could become detrimental to the dusting of arsenates, as rain diluted the dust and made it less effective, but with the proper judgment of appropriate schedules to weather, even the rain could be less problematic for farmers who utilized the dust properly.[188] These pesticides were initially sprayed with various mechanical methods such as spray guns and even machines that needed to be pulled by mules, either in a singular plow style or as a two mule pull cart. These methods had to be used with strict guidelines to provide farmers with the proper help with dusting and do so in a safe manner.[189] This proved to be

[186] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production,* p.25-26.

[187] Franklin Sherman and Bruce Mabee, *Dust-Poison Method for Control of the Boll Weevil,* N. C.Agricultural Extension Servive of the State College and State Department of Agriculture and U.S. Department of Agriculture Cooperating. July 1923, p. 4.

[188] Ibid, p.9.

[189] B.R.Coad and T.P. Cassidy. *Dusting for the Cotton Boll Weevil, United State Department of Agriculture,* Circular 274, Washington DC May, 1923. p.2-3.

completely impractical for proper control, as using sprays or dust only affected one type of cotton pest at a time.[190]

As dust, the calcium arsenate was often mixed with sulfur, nicotine, and other carcinogenic materials. The arsenate could be used against other types of insects, further enhancing the toxicity of the pesticide.[191] Calcium Arsenate is an acute hazard for humans and has been found, "Based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic."[192] Despite the risks involved with calcium arsenates, it was quickly adopted by many southern cotton farmers, and with it, an industry grew. Even with the expenses of machinery designed to spray the arsenate dust, it was still more profitable due to its effective results in controlling the boll weevil and other cotton pests.[193] From 1910 to the 1920's not only did farmers purchase three million to almost ten million pounds of the pesticide, but several companies also grew to supply the demand that farmers wanted for this chemical over the weevil. However, innovation continued to find better and better chemical solutions to the weevil menace.[194] Contact insecticides were another form of pesticide that was used to combat

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[190] Brown,*Cotton*, p.219.

[191] Ibid,p.220.

[192] National Center for Biotechnology Information. PubChem Database. Calcium arsenate, CID=24501, https://pubchem.ncbi.nlm.nih.gov/compound/Calcium-arsenate (accessed on Nov. 19, 2019)

[193] Franklin Sherman and Bruce Mabee.*Dust-Poison Method for Control of Boll Weevil*, N.C. Agricultural Extension Service of the State College and State Department of Agriculture and U.S. Department of Agriculture Cooperating. July 1923, p.4.

[194] Douglas Helms. "Technological Methods for Boll Weevil Control." p.291.

insects such as the boll weevil. These pesticides were called contact because they "kill by intimate and direct contact with the body of the pest."[195]

World War I saw insecticides become not only a tool for the eradication of insects, but a primary tool in researching chemical warfare. In fact, there was a shortage of chemical insecticides due to the military's need of this potent and dangerous weapon, it cannot be understated that World War I was also known as the "Chemists War" due to this research and dependency to chemical weaponry.[196]

With the expansion of the pesticide market after the war, there was an imperative to educate farmers on the proper use of the dust pesticides and to understand how proper dusting could help, or in the matter of improper use, hinder the cotton crops that the farmer dusted.[197] By 1945, synthetic organic pesticides such as DDT or dichloro-diphenyl-trichloroethane became much more effective or a more popular form of insect control. DDT is known as a chlorinated hydrocarbon and belongs to a group of chemicals that include chlorine, hydrogen, and even carbon. Synthetic organics were first created in 1874, but would not become more popular until 1939, when they were used as an effective insecticide with its "advantages of these synthetic chemicals over previously used botanical or natural insecticides were improved efficacy, lower use rates, lower costs, and greater persistence."[198] DDT itself was used in World War II as an

[195] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production*, p.26.

[196] Matthew Wills, "War and Pest Control", JSTORdaily, Accessed May 13th 2021. https://daily.jstor.org/war-and-pest-control/

[197] B.R.Coad and T.P. Cassidy. *Dusting for the Cotton Boll Weevil,p.*1.

[198] Frederick M. Fishel, "Pesticide Toxicity Profile: Chlorinated Hydrocarbon Pesticides", TPI-53, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date July 2005. Revised April 2011, February 2014, and March 2017. Accessed November 19, 2019. https://edis.ifas.ufl.edu/pi090

effective weapon against the disease carrying mosquitoes and lice, thus creating a new age of chemical eradication.[199]

The contact poisons as pesticides became effective due to how they fought the pests. The contact poisons that entered through the skin of the insect pests targeted the enzymes that were part of the nervous system. This inhibition of the enzymes meant that the insect pests' nervous or respiratory system made them very effective as a means of pest control.[200] However, even with the effective methods of this form of pesticide, there were issues such as the loss of potency after application onto the crops. This made it more likely that these pesticides would have to be applied with more frequency making it more likely that the crops would be more toxic for animal and human consumption.[201] But, much like with calcium arsenate, there was heavy toxicity to DDT that caused innumerable symptoms in mammals. DDT affects the nervous system, and prolonged exposure was found to cause involuntary movements and further deterioration.[202]

Systemic pesticides are pesticides that move throughout the entire plant through various methods such as "spraying, painting, injection, or feeding via the root system."[203] Many of these systems are derived from phosphoric organics or even thiophosphoric acids, which is why these

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[199] Matthew Wills, “War and Pest Control”. https://daily.jstor.org/war-and-pest-control/

[200] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production*, p.26.

[201] Ibid,p.27.

[202] Frederick M. Fishel, "Pesticide Toxicity Profile: Chlorinated Hydrocarbon Pesticides," accessed November 19, 2019.https://edis.ifas.ufl.edu/pi090.

[203] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production*, p.27.

are often called "Organic phosphates." or as Organophosphates. This type of chemical control is the most prevalent form of insecticide used in recent times due to how it attacks the pests themselves. It "works by damaging an enzyme in the body called acetylcholinesterase. This enzyme is critical for controlling nerve signals in the body. The damage to this enzyme kills pest."[204] The most commonly used Organophosphate to combat boll weevils is called malathion. Registered for use in 1956, malathion has been used not only against boll weevil, but against other pests such as fruit flies, mosquitoes, and in some cases even lice.[205]

Like many other organophosphates, malathion targets the nervous system of the pests sprayed by this pesticide. While making it effective against the insects that are sprayed by it, there is still concern over the toxicity of the chemical and the effects of prolonged exposure, which can cause toxicity by various means such as "taken into the body whether you breathe it in or you swallow it. Malathion is also readily taken into the body through skin, though the amount absorbed will depend on where the exposure occurs on the body."[206] Adding to this danger is that malathion can become more potent and toxic through exposure to heat for long periods, making for a potent recipe for disaster for negligent farmers.[207]In addition to the dangers of chemical control, some insects built up resistance against the pesticides being used. Whether by overuse of a pesticide against certain insects, or perhaps due to the insect breeding into itself a more resistant gene, the ability to withstand the chemical control against them created a harsh

[204] "What are organophosphates?". Centers for Disease Control and Prevention. Accessed January 23, 2020. https://www.cdc.gov/nceh/clusters/fallon/organophosfaq.htm#what

[205] "Malathion". National Pesticide Information Center. Accessed May 26,2020. http://npic.orst.edu/factsheets/malagen.html

[206] Ibid, http://npic.orst.edu/factsheets/malagen.html

[207] Ibid, http://npic.orst.edu/factsheets/malagen.html

burden upon the farmers. This meant that while the pesticide used will kill off the majority of the pests, the resistant ones would have the opportunity to breed and thus spread their genes to their offspring to continue making themselves able to withstand pesticides.[208] Despite the issues of possible pesticide resistance, the benefits that pesticides brought to the cotton industry balanced the precariousness as pesticides "encouraged the adoption of other highly productive practices such as fertilization, irrigation and drainage, and planting of long-growing indeterminate varieties of cotton."[209]

As time went on, the usage of strictly pesticide as a means of weevil control began to lessen. A report from the United States Department of Agriculture (USDA) that researched pesticide use for 21 different crops from 1960 to 2008 revealed some interesting statistics. From 1960 to 1981, pesticide usage had increased from "196 million pounds of active ingredient….to 632 million pounds in 1981."[210] The reason behind this increase of pesticide usage overall had to do with the growing acreage of crops such as soybeans, corn, and more that needed more dosages of their appropriate pesticide.[211] The years after WWII were often called the “war on insects”, as if reflecting the mental scope of how farmers saw the boll weevil. It was no longer just a pest that they had to deal it, it was an enemy that had to be truly eradicated from the face of the earth.

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[208] F..A. Gunther and L.R. Jeppson,*Modern Insecticides and World Food Production,* p.105-106.

[209] *Pest Control: An Assessment of Present and Alternative Technologies. Volume III: Cotton Pest Control.*National Academy of Sciences (Washington D.C.: 1975), p.1.

[210] Jorge Fernandez-Cornejo, Richard Nehring, Craig Osteen, Seth Wechsler, Andrew Martin, and Alex Vialou. *Pesticide in U.S. Agriculture:21 Selected Crops , 1960-2008* EIB-124, U.S. Department of Agriculture, Economic Research, May 2014. p.1

[211]Ibid,p.1.

CHAPTER V

1950-1970: INTEGRATED PEST MANAGEMENT

By the 1950's, the chemical method of eradication had been the most used and popular form of boll weevil eradication. However, it seemed as if the times were once again changing for boll weevil eradication. It seemed that pesticides were already beginning to lost favor with many farmers, as research found that the percentage of pesticides used primarily on cotton:

> accounted for just over 7 percent of the pesticides, mostly insecticides, in 2008, a major reduction from its 40-percent share in the early 1960s. The quantity applied to cotton trended downwards since 1972 due to the replacement of DDT and other older insecticides with more effective products, eradication of the boll weevil, and adoption of Bt cotton.[212]

The reason pesticide had endured for so long as one of the main tools to combat the boll weevil came from the fact that it seemed the most effective be-all, end-all for the cotton consuming pest, and that a failure by many farmers to explore other methods of control in tangent with pesticides created a huge demand for chemical control that lessened as time went on. As people looked to find alternatives to pesticides, proper research into eradicating the weevil became more tangible.[213]

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[212] Jorge Fernandez-Cornejo, Richard Nehring, Craig Osteen, Seth Wechsler, Andrew Martin, and Alex Vialou. *Pesticide in U.S. Agriculture:21 Selected Crops, 1960-2008, p.*2.

[213] Ian Manners, *The Persistent Problem of the Boll Weevil: Pest Control in Principle and Practice*. Geographical Review , vol. 69, no.1. (Jan, 1979), p.25-26.

However, many were concerned. rightfully so, with the overuse of pesticides, not just on cotton boll weevils, but in general against all pests. Their fears came from the 1961 book S*ilent Spring*. Written by Rachel Carson, the book looks into the dangers of the over-dependence on pesticides as they become more and more potent and dangerous not only for insects but also for humans. This proactive book instigated DDT banning and created a need to find fewer chemical needs to manage pests.[214] With that in mind, by the 1970s, the concept of Integrated Pest Management (IPM) became a focal point of understanding pest management in opposition to strictly just pesticide use. IPM looked at using alternative methods of management, focusing on the combination of natural and cultural controls. Much like the earlier tests done as the boll weevil had slowly entered into the U.S., the hope was that it would be more environmentally safe by using fewer chemical controls.[215]

Economically, those who believed in the IPM as a more effective management system looked at how many pesticides had to be used on cotton. Because of the number of cotton pests and the relatively inexpensive pesticides available for farmers to purchase, World War II allowed "cotton producers to adhere to a "sterile field" philosophy, where each pest was dealt with individually. This resulted in up to twenty insecticide applications per season, compared to only one or two applications for soybean pest control."[216] With such a high amount of insecticide used on just cotton crops, this created a problem. Even though insecticide had been more cost-effective, the sheer volume of the applications made it more expensive. In the minds of IPM

[214] "Summary of Silent Spring" Online Ethics Center for Engineering 7/6/2006 OEC Accessed: Monday, April 27, 2020 www.onlineethics.org/Topics/ProfPractice/Exemplars/BehavingWell/carsonindex/SSsummary.aspx

[215] "History of IPM", Museum Pests, Accessed April 27,2020. https://museumpests.net/history-of-ipm/

[216] Fred C. White and Michael E. Wetzstein." Effects of Cotton Integrated Pest Management". American Journal of Agricultural Economics, Vol. 77, No. 3 (Aug., 1995), pp. 602. https://www.jstor.org/stable/1243228

supporters, the overuse of insecticide or pesticides caused "serious environmental degradation, and ultimately are responsible for increased pest resistance."[217]

While pesticides and the various methods of control implemented to combat the weevil had varying degrees of successes and failures, several other factors contributed to the control and later on the complete eradication of the boll weevil from much of the Cotton Belt. By the 1960s, the boll weevil's economic devastation became a priority of the USDA, and a research lab was created to look into proper methods of eradication rather than simple control over the insect that had pestered the cotton industry for over one hundred years.[218] What that in mind, several challenges had to be addressed to put the idea of eradication into effect. First, could such a task be possible? Secondly, would there be enough money for proper research? And finally, getting farmers to go along with and support this endeavor made this a task monumental.[219] Much like earlier experiments done against the weevil since its introduction into the United States, the hope was that there would be a much easier solution to the problem. One of the ideas experimented with now that science and genetic technology became more advanced was using sterilized weevils.

Edward Knipling, who was part of the USDA Agricultural Research Service, came up with this concept. His idea was that they should flood the "environment with lots of sterile males. Those males then mate with females, but don't produce any offspring."[220] As the

[217] Ibid, p.602

[218] "History of the Eradication Program", National Cotton Council of America, accessed February 13, 2020. https://www.cotton.org/tech/pest/bollweevil/eradication2.cfm

[219] Dominic Reisig , "The Boll Weevil War.", https://news.ncsu.edu/2017/05/boll-weevil-war-2017/.

[220]Ibid, https://news.ncsu.edu/2017/05/boll-weevil-war-2017/

understanding of genetics evolved over the decades, the idea was a fairly solid experiment of genetic manipulation as a pest control method that was becoming more viable.[221] In Knipling's mind, the weevil was the perfect pest to experiment with as "it had two chinks in its armor. First, it was an exotic species, which meant that it could be present without some of the parasites and predators that weakened populations in its native Mexico. Second, it was reliant on a single host plant, cotton, which was also not native to the U.S."[222] This, in combination with other population suppression measures such as chemical control, pheromone trapping, and many other techniques that had been worked on throughout the weevil's lifetime in the United States would be the complete cure-all to the weevil problem.[223] However, the experiment did not yield the results that Knipling wanted. The sterilized males that were released could not compete with the more virile male weevils; thus, barely suppressing the weevil in any substantial manner would benefit cotton farmers.[224]

Further experiments into this form of genetic manipulation revealed what exactly was needed to provide any real significant impact with just this form of pest control. For the technique to impact the pest, the pest population had to be relatively low, making the genetic sterilization of the pests more effective overall. But the problem was that boll weevils breed quickly, which made genetic manipulation difficult to implement.[225] This problem did not deter researchers, who continued looking into methods to defeat the weevil. They looked at some of

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[221] *Pest Control, An Assessment of Present and Alternative Technologies. Volume III: Cotton Pest Control*.p.76.

[222] Dominic Reisig , "The Boll Weevil War". https://news.ncsu.edu/2017/05/boll-weevil-war-2017/

[223] *Pest Control: An Assessment of Present and Alternative Technologies. Volume III: Cotton Pest Control,*p.76-77.

[224] Dominic Reisig , "The Boll Weevil War". https://news.ncsu.edu/2017/05/boll-weevil-war-2017/

[225] *Pest Control: An Assessment of Present and Alternative Technologies, Volume III: Cotton Pest Control.* p.76.

the earlier methods used, and by the 1960s, combined mechanical and chemical control in a unique way with the creation of artificial female weevil pheromone trappers. Pheromones are a special blend of chemicals used by animals and insects to attract males of their species to mate and create children. The creation of artificial pheromones for boll weevils created an important tool as male boll weevils "could be attracted, trapped, and monitored."[226] Adding to this was the use of the reproduction-diapause control method, where scientists "discovered that, by making multiple insecticide applications at short intervals during the autumn, they could both reduce the last reproductive generation of the weevils and significantly limit the survival of potentially overwintering adults."[227]

Finding out what could be used to kill off the boll weevil effectively was incredibly important not just as an economic need, but also environmental as the constant usage of pesticides could have profound effects on the land that would cause many more issues.[228] One issue that arose with the Eradication program came from how much it would actively cost to put the program into implementation. Initially, the idea was to have the "government lead a 6-to 10-year campaign...to rid the cotton belt of this pest once and for all."[229] With a project that immense and with that long of a time-frame, the expense for such an endeavor became one of intense approximation as "$655 million is the industry estimate, and some skeptical entomologists believe $1.5 billion is more like it."[230] Edward Kipling himself was not shy in

[226] Dominic Reisig , "The Boll Weevil War". https://news.ncsu.edu/2017/05/boll-weevil-war-2017/

[227] Ibid, https://news.ncsu.edu/2017/05/boll-weevil-war-2017/

[228] *Pest Control: An Assessment of Present and Alternative Technologies. Volume III: Cotton Pest Control,p.* 77.

[229] Luther Carter. "Eradicating the Boll Weevil: Would it Be a No-Win War?" Science, New Series Vol.183, No. 4124(Feb. 8, 1974). http://www.jstor.og/stable/1737144. p.494.

[230] Ibid, p.495.

admitting that the program for weevil eradication would be, in his opinion, "the most costly and difficult pest eradication program ever attempted….100 percent cooperation of growers and 100 percent [operational]precision and efficiency would be required for success."[231]

This uncertainty created a critical response to this experimental program as many entomologists believed that the sheer amount of money needed plus the amount of time estimated would create in their minds an "entomological Vietnam."[232] This perception weighted as the weevil had a hideaway in Mexico, which meant that once weevils were removed from the Cotton Belt, they could easily enter back in from South Texas and start the process all over again. Only through continual protection of South Texas did this idea of eradication seem like a feasible experiment to embark on for farmers and scientists.[233] Also, there was a fear that pursuing a heavy attack of pesticides on the boll weevil would lead to an increase of resistance against the program's techniques to combat the weevil, making things even more difficult for farmers.[234]

Nevertheless, this was a chance that many entomologists believed was the best response to finally defeat the weevil and push the long-standing invader from its essential cotton industries. By the 1970s, the pilot program was being implemented in Alabama, Mississippi, andLouisiana. The results from this research found that while it was inconclusive if the techniques used could effectively eradicate the weevil, they significantly reduced the weevil

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[231] Ibid, p.495.

[232] Ibid, p.495.

[233] Ibid, p.496,498.

[234] Ibid, p.499.

population to be seen as a positive success.[235] As experiments continued, there came an epiphany that spelled victory for the Cotton Belt against one of its most deadly foes. Suppose they used the diapause to coordinate with cultural practices and even use pesticides at an opportune time. In that case, farmers would produce the perfect effect to truly get rid of the boll weevil throughout most states that made up the Cotton Belt.[236]

Further research from the Agricultural Research Service looked at how the cotton plant could be a deterrent against the weevil foes. At Mississippi State University, they developed "a stock of cotton germplasm armed is built-in-boll weevil defence: flowerbuds that deter female weevils from laying eggs."[237] A germplasm is a type of tissue such as seeds or other genetic material used for breeding purposes, often with the intent to build stronger plants for agricultural purposes. This is incredibly important for farming because while farmers may desire a more uniform crop for profit, the diverse creation of their crops allows for "plant breeders the sustained ability to develop new high yielding, high quality varieties that can resist constantly evolving pests, diseases and environmental stresses."[238] To create these more resilient forms of cotton plants, the researchers looked at: first evaluating wild cotton strains acquired from Mexico and Central America, cotton's place of origin. Over thousands of years of evolution, these strains survived the weevil by using built-in genetic resistance. From their evaluations, the

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[235] Dominic Reisig , "The Boll Weevil War, or How Farmers and Scientists Saved Cotton in the South" N.C. State. https://news.ncsu.edu/2017/05/boll-weevil-war-201

[236] *Pest Control: An Assessment of Present and Alternative Technologies. Volume III: Cotton Pest Control,p.*79.

[237] Jan Suszkiw. "Resistant Cotton Stymies Pests."*Agricultural Research.* 43 (11) 1995. p.20. http://search.ebscohost.com.ezhost.utrgv.edu:2048/login.aspx?

[238] "Germplasm", UC Davis, Seed Biotechnology Center, accessed May 13, 2020. http://sbc.ucdavis.edu/About_US/Seed_Biotechnologies/Germplasm/

researchers selected 69 weevil-resistant strains. They crossed these with commercial cotton cultivars, selecting germplasm lines whose flowering would allow for further testing.[239]

This cross-breeding of various cotton crop types is extremely important to cotton production as it makes things more difficult for the boll weevil. The boll weevil often attacks where the sugars and other nutrients are most plentiful inside the cotton plant; usually, this is among the anther or close to the cotton buds. This has an additional benefit for the boll weevil as it keeps their eggs protected from predators.[240] As the eggs develop inside the cotton plant, the buds will fall off the plant, thus depriving farmers of the prize that they had worked so hard to harvest. However, with the more resistant cotton produced, it would make it much more difficult for the weevils to lay their eggs inside that vulnerable area of the plant, reducing the numbers of weevils that could reproduce up to an estimation of almost 50 percent.[241] This also benefited cotton farmers, as further research into pesticide usage with these more resilient cotton crops revealed that crops could be sprayed far less than usual. This meant that farmers could reduce the expense of the pesticides and help reduce the environmental issues that could arise from too many pesticides within the soil.[242] However, there was a caveat to these new resistant cotton plants. They were not yet viable enough to be sold commercially as the process to breed these new types of cotton plants took up to almost a decade of research and experimentation.[243]

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[239] Jan Suszkiw. "Resistant Cotton Stymies Pests.",p. 20.

[240] Ibid, p.20.

[241] Ibid, p.20.

[242] Ibid, p.20.

[243] Ibid, p.20.

While these experiments into creating new resistant cotton crops and research into the boll weevil were difficult, they were the stepping stones to creating what would become the penultimate eradication method that would be used even to this present day.

CHAPTER VI

1970-1990: BOLL WEEVIL ERADICATION PROGRAM

By 1958, there was a desire to truly be rid of the boll weevil within the United States. This insect had plagued cotton production for almost one hundred years and finally there was a way to effectively combat the boll weevil that. But, how could this be accomplished? The chemical resistance had begun to form in some boll weevil specimens which meant that the once thought to be effective weapon against the boll weevil became useless. But, there was still hope as the USDA looked at Kniplings work with Integrated Pest Management that gave them the spark needed to believe that the boll weevil could be fully eradicated from the U.S.[244] In 1961, the USDA set up a Boll Weevil Research Laboratory (BWRL) in Mississippi which would allow them to create one of the most important tools for modern boll weevil eradication, the pheromone trap.[245]

The pheromone trap was the mixing of earlier experiments done by Knipling. By utilizing the pheromone of boll weevils, the hope was that they could be lured into the trap and thus could be properly identified and eradicated in an effective manner. This was a major breakthrough for

[244] "We Don't Cotton to Boll Weevil 'Round Here Anymore", United States Department of Agriculture, *AgResearch Magazine*, Accessed May 13th, 2021. https://agresearchmag.ars.usda.gov/2003/feb/boll/

[245] Ibid, https://agresearchmag.ars.usda.gov/2003/feb/boll/

eradication as it not only provided tangible data but also was easy to install and practical for farmers to use as well.[246] While testing in the lab seemed to prove it's potential, field tests could make or break this new experimental eradication technique. There were several factors that researchers had to uncover if they were to succeed in finally eradicating the boll weevil, such as how far could a boll weevil travel, and how the boll weevils dormancy during winter could possibly be used to help in getting rid of it.[247] By 1968, field tests were underway, while in Mississippi the BWRL set up a small-scale demonstration of how utilizing the diapause of boll weevil reproduction and controlled spraying to kill the boll weevils and prevent them from continued reproduction.[248] With these experiments conducted, the Boll Weevil Eradication Program was now born.

The Eradication program was a unique entity, as a quasi-governmental agency that was to be funded in part by growers of cotton alongside the federal funds. This created an interesting dynamic as growers had a major stake and voice in what they could do to eradicate the boll weevil. Not only that, but they also had allocated funds to help them fully push the weevil out of their crops, and more importantly their states.[249] In Addition, farmers' ability to choose whether or not to participate in the program created an opportunity for farmer autonomy.[250] The impact of the Eradication program on Texas was far rougher than a person could expect. Because the

[246] Ibid, https://agresearchmag.ars.usda.gov/2003/feb/boll/

[247] Ibid, https://agresearchmag.ars.usda.gov/2003/feb/boll/

[248] Ibid, https://agresearchmag.ars.usda.gov/2003/feb/boll/

[249] Texas Boll Weevil Eradication Foundation", Sunset Advisory Committee. Accessed March 20th, 2020. https://www.sunset.texas.gov/public/uploads/files/reports/Boll%20Weevil%20RTL%202009%2081st%20Leg.pdf p.33.

[250] Ibid, p.33.

boll weevil began its steps into the Cotton Belt in Texas, it took much longer for an eradication program to become viable for the state. While many of the Cotton Belt states were creating their eradication programs in the 1970s, Texas did create one until the 1990s, a full two decades later. And even when it got its program, there was an issue that almost pushed the program out of Texas.

When the Texas Boll Weevil Eradication Program (TBWEP) was established, many farmers and members of the TBWEP believed that using the pesticide known as malathion applied multiple times would effectively destroy the weevil within the Rio Grande Valley, one of the major cotton-producing areas of Texas. While the pesticide had been applied properly, it left cotton crops vulnerable to a different pest that rose to the surface. This new cotton pest was the beet armyworm. The beet armyworm, also known as Spodoptera exigua, is the caterpillar form of a moth that consumes any kind of leaves or foliage. These caterpillars are devastating in large numbers, especially to cotton, as they consume the plant's bolls and squares.[251] This insect was a cotton eater, like the boll weevil. While the malathion had killed the boll weevil, it also killed off the helpful insects that preyed on the beet armyworm, allowing it to run rampant and devastate Texas crops.[252] This blunder cost cotton farmers within the RGV millions of dollars in lost crops and led to many of them suing the Texas Eradication Program for the damages to their crops, which the farmers believed fell squarely on the program for failing in its goal. In the wake of this disastrous economic loss, many Texas farmers were rightfully upset about the loss of

[251] "Beet Armyworm",Field Guide to Common Texas Insects, Texas A&M Agrilife, accessed march 21,2020.https://texasinsects.tamu.edu/lepidoptera/beet-armyworm/

[252] "Farmers Sue, Saying Weevil Spray Killed Profits, Too" New York Times, Published August 4th 1996, accessed March 21, 2020. https://www.nytimes.com/1996/08/04/us/farmers-sue-saying-weevil-spray-killed-profits-too.html

their crops and their livelihoods. Some even considered voting to stop the Eradication Program within the state and looked to sue it for damages. In contrast, the Eradication Program sued farmers for nonpayment as many chose to stop paying into the Eradication Program, and thus it came under heavy debt.[253] By 1996, the Eradication Program ended in the Rio Grande Valley, and with it came an unknown future for cotton within the region.[254]

In 2004, a discussion emerged on whether the Eradication Program would be implemented within the Rio Grande Valley. Several different informational gatherings were conducted with different promises that many who supported the Eradication Program would "address how the new program differs from the past and its benefits to the Valley, said Sam Simmons, president of the Cotton and Grain Producers of the Lower Rio Grande Valley. The proposed program will begin in the fall, rather than spring to alleviate the weevil population before planting, he said."[255]

Adding to the more favorable promises that were being implemented now, there was much discussion into the actual success rate of the Eradication Program in the many other parts of Texas, claiming that: "We've seen anywhere from 70- to a 99-percent reduction in pesticide use in areas that we've been able to eliminate the weevil," said Lindy Patton, executive director of the Abilene-based boll weevil eradication foundation. "Farmers have experienced lower costs and higher yields," he said of areas with successful eradication programs."[256] Despite the issues

[253] Ibid, https://www.nytimes.com/1996/08/04/us/farmers-sue-saying-weevil-spray-killed-profits-too.html

[254] Victoria Hirschberg, "Texas Cotton Producers Consider Restoring Boll Weevil Eradication Program." *Monitor, The (McAllen, TX)*.2020. Accessed May 8. http://search.ebscohost.com/login.aspx?

[255] Ibid, http://search.ebscohost.com/login.aspx?

[256] Ibid, http://search.ebscohost.com/login.aspx?

that cropped up with the Eradication Program in Texas, by the 2000's the Eradication Program regained more confidence in South Texas farmers' minds. When ballots were shipped out by the Texas Department of Agriculture, otherwise known as the TDA, to vote the Eradication Program back into the Rio Grande Valley, they found that "Out of 1,458 ballots that TDA mailed to cotton producers in 10 counties, 633 ballots were received before the deadline. From that, 457 ballots were in favor of the zone and 166 against."[257]

While the number of ballots was small, it cannot be underestimated that South Texas cotton farmers were now more than willing to participate and implement the Eradication Program in their region, so in 2005 the program was voted to be used once again.[258] Some believed the program was far more accepted now than before, some believed that "because of the foundation's new administration and approach to eradication. In 1995,…the eradication foundation did not listen to input from local producers and because the program began in the spring, weevils were never controlled."[259] Without a moment to spare, the program got to work on making a new eradication zone for the Rio Grande Valley. The Eradication Program looked to combat the weevil in Texas to create buffer zones to properly contain and continue to eradicate the boll weevil. These buffer zones were "divided into 16 zones, with Cameron County and surrounding counties part of the Lower Rio Grande Valley Zone. Texas is the last U.S. state -- and the Lower Valley the last zone in Texas -- to lick the boll weevil scourge."[260]

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[257] Ibid, http://search.ebscohost.com/login.aspx?

[258] Steve Clark,"Eradication Program Wins out against Destructive Boll Weevil."*The Brownsville Herald, (TX),* January 16.2012. http://search.ebscohost.com/login.aspx?

[259] Victoria Hirschberg. 2020. "Cotton Producers in Southern Texas Vote for New Boll Weevil Eradication Zone." http://search.ebscohost.com/login.aspx?

[260] Steve Clark,"Eradication Program Wins out against Destructive Boll Weevil. http://search.ebscohost.com/login.aspx?

Looking at how the Texas Boll Weevil Eradication Foundation (TBWEF) created the zones and all the methods needed to properly research, manage, and eradicate the weevil is nothing short of a full-blown military strategy. One of the first tasks that the TBWEF did was to map the area in the eradication zones. This task within the eradication zones provided researchers areas such as brush, grass, shrubs, weeds, etc. In the latter stages of a program, trap density is reduced."[261]

The vigilance of these type of eradication programs were essential to keeping cotton safe from another disaster of boll weevils; for a while, as they were slowly being pushed out of the United States, there were still issues that concerned many of the members of the TBWEF that without assistance from Latin America that the weevil could return, stating "We're not going to quit monitoring because you still have "weevils in Mexico, Central America, and South America,".... "There's always a chance they could be reintroduced, and we don't want to go back to where we were."[262] Because of these strict controls that the TBWEF placed upon the trappers and the appropriate data from boll weevil trappers regarding a significant rise in boll weevil population inn the area, any research and data collected must be completely accurate, as it will be used to defend against any more invasion techniques that the weevil may attempt to employ during the overwintering seasons and the seasons where they attempt to overpopulate.[263]

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[261] "Trapping" Texas Boll Weevil Eradication Program, Inc, Accessed April 4th, 2020. https://www.txbollweevil.org/trapping.html

[262] Elliot Minor,"Dreaded Cotton Pest Virtually Wiped Out." *A.P. Online*. The Associated Press, 2004. http://search.ebscohost.com/login.aspx?

[263] "Trapping" Texas Boll Weevil Eradication Foundation Inc, https://www.txbollweevil.org/trapping.html

DNA marker technology also became an important part of boll weevil research and eradication. As the pheromone trackers help understand the population density of cotton fields, using DNA markers enabled scientists to know if there have been any new boll weevil movements either into the area or into newer locations.[264] The technique to mark the boll weevils was a fairly simple but ingenious one. As boll weevils were caught in areas, they "were marked with enamel paint or fluorescent powder."[265] Then the data was placed into microsatellites, which are defined as "repetitive, short sequences of DNA. Also called "short tandem repeats," they provide scientists with a way of locating genes."[266] This is important to entomological study because the microsatellites locate genes which makes them important tools in insect movement, especially for a destructive pest such as the boll weevil.[267]

In 2010, research was conducted to understand how malathion with wide-spread application in correlation with the Eradication Program impacted the various insects and creatures that preyed on cotton pests such as the boll weevil. Experiments were conducted in the Southern Blacklands area of central Texas in 2002, 2003, and 2006 to observe the short and long-term effects of malathion spraying. The location of central Texas also provided a unique location to test the wide-spread usage of malathion on an area that had at the time an "active

[264] T.G. Around. "Where'd That Boll Weevil Come From?,*www.nps.ars.usda.gov*. *Accessed September 22, 2020. https://agresearchmag.ars.usda.gov/ar/archive/2007/aug/weevil0807.pdf*

[265] Ibid, *https://agresearchmag.ars.usda.gov/ar/archive/2007/aug/weevil0807.pdf*

[266] Ibid,*https://agresearchmag.ars.usda.gov/ar/archive/2007/aug/weevil0807.*pdf

[267] Ibid, *https://agresearchmag.ars.usda.gov/ar/archive/2007/aug/weevil0807.p*df

eradication zone adjacent to an inactive pre-eradication zone, both with similar climate and crop production practices."[268]

As there were two sections of the cotton field that could observe malathion's effects, the treatment method had to be done in a very specific manner. The treatment was: applied by the Texas Boll Weevil Program using fixed-wing aircraft, though some field margins and areas difficult to reach by the aerial application were treated using mist-blowers. A threshold of twoweevils captured in pheromone traps per 16.2 ha field (40 ac) per week was used to trigger an application of malathion ULV in the corresponding field.[269]

While the experiments were looking at the effectiveness of malathion, the researchers knew that they had to observe boll weevils and other pests and predatory insects as they too would be affected by the malathion sprays. The researchers sampled many different parts of Central Texas, revealing how vital the research and experimentation was for overall evaluation of the malathion's effects. These observations were also done with the fields where no malathion spray would occur to compare the results.[270] The results of these experiments revealed some interesting statistical data. In the fields where there was the consistent application of the malathion spray during the years of 2002 and 2003, there was a decrease in the density of "total insect predators, total spiders and total predators...was significantly lower in the active eradication zone than in the inactive zone during 2002 and 2003."[271] Within the non-sprayed

[268] Allen E. Knutson , James Butler , Julio Bernal , Carlos Bográn , and Manuel Campos. "Impact of area-wide malathion on predatory arthropods and secondary pests in cotton during boll weevil eradication in Texas" Crop Protection 30 (2011), www.elsevier.com/locate/cropro. p. 457.

[269] Ibid,p.457.

[270] Ibid,p.458

[271] Ibid, p.459.

fields, the opposite was observed with the insects' density increasing in the inactive zone throughout the 2002 and 2003 field experiments in the Southern Blacklands. While that was the overall data, the individual data was a bit more complex. For some insect pests, their numbers increased in the active spraying zones despite the application of malathion. Meaning that while malathion was effective, there was still growth by certain types of insects that could survive the initial spraying in the short-term.[272]

Considering the densities of the insect pests and predators in the zones that were researched, there was even more interesting data found. During the 2002-2005 observations, before using the malathion sprays as part of the active eradication of these experiments, farmers often sprayed other broad insecticides throughout the season of cotton growing, which meant that cotton farmers were spraying upward to six times a season just to combat a few of the various cotton pests. With the application of malathion in 2006, the amount of spraying increased until some of the fields being used in the experiments were sprayed up to eight times during the cotton growing season.[273] Another interesting observation during this long-term experiment is that while there was significant density loss of many insects and spiders during the active eradication to the years prior, much like the other field, there was just as much significant growth during the active eradication some of the insects had active density growth despite the eradication going on in that region of the Northern Blacklands.[274]

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[272] Ibid,p.459-61.

[273] Ibid, p.461.

[274] Ibid, p.461-62.

The experiment revealed many pros and cons to the utilization of malathion spraying. While malathion was effective in killing off many boll weevil and other cotton pests, several fears pressed heavily on many who supported the eradication program, such as "The potential risk of secondary pest outbreaks, associated crop damage and cost of control are of great concern to growers and eradication program managers."[275] For Texas, the threat that secondary pest outbreaks have on cotton production is indeed concerning as the term "describes the increase in secondary (non-target) pest densities following their release from biological control, which typically results from the destruction of natural enemies by insecticides"[276]

Inside of an eradication zone, malathion is often "repeatedly applied to each cotton field within an eradication zone beginning with the first appearance of fruiting buds and continuing until harvest."[277] This creates a difficult conundrum for both the managers of the Eradication Program and farmers as the most successful way to keep the boll weevil at bay is the malathion must constantly be applied to the cotton crops, thus reducing the weevil but also creating a fear of killing off potentially helpful insects that can kill off the boll weevil population as well.[278]

Understanding how pest outbreaks became an important part of the eradication program, as that research was needed to approximate how effective the spraying and eradication would be in the areas that were having it be implemented. Certain insect pests and their populations grew quickly since with the loss of predatory insects and spiders, this left cotton vulnerable to the

[275] Ibid,p.456.

[276] Ibid, p.456.

[277] Ibid, p.456.

[278] Ibid, p.457.

pests that we're able to survive the malathion spraying to damage the cotton fields.[279] For Texas, this means that the TBWEF has to monitor the situation very closely. By using data based on the population of cotton pests such as the boll weevil, alongside field reports from cotton growers and field agents, the foundation can observe the condition of the cotton fields in an eradication zone and can update any information that can help reduce or increase the amount of malathion spraying needed.[280] However, this may prove ineffective if the subsequent changes are implemented too late, and the secondary pest populations become impossible to effectively combat with the usage of malathion spraying.[281] Despite the issues that malathion sprays brought, they still were the best usage of chemical control in collaboration with proper biological control with natural predators and pests to be effective against the boll weevil. And with that, the boll weevil's reign as potent cotton destroying pest came to its conclusion.

For over one hundred years, the boll weevil had been a slow but impacting game-changer of the South. Once seen as a biblical insect that destroyed Southern livelihood, it had become a myth of when cotton was at the very brink of being annihilated from the United States and especially in Texas. Now, it is only a matter of time before the weevil is effectively wiped out of Texas and becomes a faded memory of a small brown weevil that changed Texas cotton culture.

[279] Ibid, p.462.

[280] Ibid, p.457.

[281] Ibid, p.457.

CHAPTER VII

THE IMPACT OF THE BOLL WEEVIL

Understanding how the damage to cotton by the boll weevil concerning the economic loss of cotton farmers is imperative to fully comprehend how significant its role was in the complete overhaul of cotton agriculture within the South, and especially so for Texas. The boll weevil's attacks on cotton within the state had become, in the words of E. Dwight Sanderson, one of Texas's state entomologists, that the "loss due to this insect is now so great that it must exercise an increasingly important influence upon the market price of cotton."[282]

However, there has been much debate between historians into how devastating the boll weevil was to the Cotton Belt's local economies. In 1909, the Bureau of Agricultural Economics, otherwise known as B.A.E. investigated and found that in much of the Cotton Belt, the averages were wildly different, with some places having low percentages to average and even high percentages of losses due to the boll weevil.[283] The damages that the boll weevil presented was multi-pronged as it affected cotton in different ways. One of these was with farmers adopting the early maturing versions of cotton. Once bigger cotton bolls were sought after, farmers instead

[282] E. Dwight Sanderson, "A Statisical Study of the Decrease in the Texas Cotton Crop due to the Mexican Cotton Boll Weevil and the Cotton Acreage of Texas: 1899 to 1904 Inclusive", compiled by W.J. Clay in *The Boll Weevil and Cotton Crop of Texas*,(Austin: State Printing Press, 1905). p.3.

[283] Fabian Lange, Alan L. Olmstead, and Paul W. Rhode. "The Impact of the Boll Weevil, 1892–1932." p.694

had to use cotton plants to become harvest-able at a much earlier rate. This damaged the pricing and caused many of the longer stalk cotton varieties to go extinct due to the damage the boll weevil could inflict.[284] Another factor contributing to the damages of the boll weevil was that it took a very long time for the boll weevil to become a staple insect within the places it invaded. Looking at the production of cotton crops before and after the boll weevil, there was a significant increase in damages as the year went back because weevils "typically required about six years to cross a state, points of the periods under periods under comparison roughly a decade apart."[285]

Economic loss is an extremely high and dangerous part of farming, especially with such high-value crops. Diseases. More importantly, insects are so damaging to crops because they "reduce yields, lower quality, increase costs of production and harvesting, and equipment to apply any type of control measure."[286] Research done in various countries that measured the total area and arable land from places such as Australia, Brazil, and more found that the United States came in second to the U.S.S.R. when it came to annual losses due to insect infestations. The United States was losing roughly 4,095,000,000 from insects destroying crops.[287]

During the initial infestation of the boll weevil into Texas, the state was working to make sure it could accurately determine the statistical damage the weevil had upon Texas cotton crops and forecast the impact of the boll weevil in prime cotton regions so that, a farmer could "sell his

[284] Ibid,p.687.

[285] Ibid,p.694.

[286] Gunther, F.A. and L.R. Jeppson, *Modern Insecticides and World Food Production* p.42.

[287] Ibid,p.43.

crop intelligently and to realize the most that the market will warrant."[288] This created a difficult experience for farmers due to the boll weevil as the damages towards their crops often meant that they had to sell them at much lower prices despite the shorter crop or rather smaller bulks of cotton due to supply and demand. With that in mind, it meant that there could have been much higher profits than the farmer could have gotten for their crops, not knowing until their cotton was already sold and thus too late to increase the price range.[289]

Accuracy was important to calculate the economic loss that the boll weevil brought to Texas. During assessment in the field, there were exaggerations to the actual percentage of infested cotton crops within Texas, especially for places that only made up a small percent of the state's overall cotton production.[290] This created a difficult task for state entomologists and members of the United States Department of Agricultural (U.S.D.A.) as they needed to know the total acreage and the productivity of said cotton acreages in Texas's various counties. They also had to consider events such as storms, other cotton eating insects, floods, and diseases to understand just how badly the damage the boll weevil was doing to Texas cotton.[291]

Using reports from cotton ginners from the census bureau in conjunction with volunteer entomologists who did on field observation, state officials could more accurately discover how

[288] E. Dwight Sanderson, "A Statisical Study of the Decrease in the Texas Cotton Crop due to the Mexican Cotton Boll Weevil and the Cotton Acreage of Texas: 1899 to 1904 Inclusive", compiled by W.J. Clayin, *The Boll Weevil and Cotton Crop of Texas* ,(Austin: State Printing Press, 1905). p.3

[289] Ibid,p.3

[290] Ibid,p. 3.

[291] Ibid,p.4.

bad the boll weevils damage was by looking through the time frame of 1898 to 1904.[292] Hence in roughly six years, the damages by the boll weevil were:

> a total of 1,725,000 bales loss during the past six years. Since it arrived in Texas, 2,000,000 bales worth nearly $100,000,000 have undoubtedly been lost due to its devastation's.[293]

This trend of cotton's decline continued into the 1930s, despite it being one of the peak decades in which cotton produced over 42 million acres with one statistic saying that over a million farmers were producing cotton throughout the entire Southern United States.[294]

As time went on and the various methods of control became more readily available for cotton farmers to utilize in their prevention of the boll weevil, it was determined that "in a favorable or average season a fair crop can be grown despite the weevil by the use of better methods."[295] However, in contrast, cotton could still be profitable for many farmers; the damage that the boll weevil had brought made many farmers decide to drop out of cotton agriculture in favor of other crops. By the 1980s, cotton production throughout the South had declined tremendously to where roughly 27 million farmers were producing a small 7 million acres of cotton, a major shrinkage of the amount produced in the 1930s.[296] Even into the modern era, the boll weevil still creates economic damages that, while dependent on cotton prices, were always expensive regardless of the weevil's involvement due to the volatile nature of cotton economics.

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[292] Ibid,p.4.

[293] Ibid,p.27.

[294] John Fraser Hart, "THE METEMPSYCHOSIS OF KING COTTON" Southeastern Geographer, Vol. 40, No. 1, Special Issue: Geographies of Religion in a Changing South (MAY 2000), pp. 95. University of North Carolina Press, https://www.jstor.org/stable/44371073

[295] E. Dwight Sanderson,"A Statisical Study of the Decrease in the Texas Cotton Crop due to the Mexican Cotton Boll Weevil and the Cotton Acreage of Texas: 1899 to 1904 Inclusive",p.27

[296] John Fraser Hart,"The Metempsychosis of King Cotton"*Southeastern Geographer*40, no. 1 (2000): p.95. https://www.jstor.org/stable/44371073

An example of this volatile economics being "the damage of insects reduces the cotton crop of the Cotton Belt by 10 percent, a potential 14-million-bale crop is reduced by 1,400,000 bales. At 32 cents a pound for lint, this is a loss of $224 million."[297]

However, this has changed with the Eradication Program and has begun to improve for many cotton farmers. Texas, as it is the United States' largest producer of cotton crops, makes it very important. Texas is still a leading state in cotton production due to the large amounts of land that can be converted into crops for cotton agriculture, which in comparison to other states means:

> This exceeds 9,300 square miles and is a land area larger than combined total land areas of Connecticut, Delaware, and Rhode Island. It is also larger than the total land area of Hawaii, New Jersey, Massachusetts, New Hampshire, or Vermont.[298]

In terms of money and economic marketable value in Texas, cotton is still considered to be the:

> leading cash crop of Texas and ranks only behind the beef and nursery industries in total cash receipts. In any one year, Texas cotton growers produce between 4 and 6 million bales. This represents more than $1 billion to the Texas economy and is between 25 and 30 percent of the entire U.S. crop.[299]

Understanding how Texas is one of the leading states in cotton production even after King Cotton's height had passed has to deal with the geographical production regions of the state. Because of the large acres of land with different production viability, that means different regions can produce cotton all year round, while others do it on a purely seasonal basis.[300] Which

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[297] Harry Bates Brown,*Cotton*, p.220.

[298] Douglas Stephenson, Mark Matocha. "A Pest Management Strategic Plan for Cotton Production in Texas". Southern Integrated Pest Management Center. Published 2004. Accessed September 23,2020. https://ipmdata.ipmcenters.org/source_report.cfm?sectionid=30&controltypeid=0&sourceid=1269. p.4.

[299] Ibid, p.4.

[300] Ibid, p.4.

makes even a region as the Rio Grande Valley an important one, even though it only produces about 3% of cotton within Texas itself.[301] Even though the Rio Grande Valley only makes up a small amount of cotton production, it is the fact that cotton can be harvested all year round which makes it still an important area.[302] It was reported in 2012, the areas of "Cameron, Hidalgo, and Willacy counties produced 200,000 acres of cotton."[303]

While it is true that cotton has lost much of its significance due to the boll weevil, the fact that cotton is still produced not only in Texas but is still being grown in other states of the Cotton Belt reveals that while the damages to economics and the livelihood of farmers did cause strife, it also revealed how farmers could adapt to the situation as they did with all types of other hardships that befell them.[304] As the boll-weevil moved from a biblical pest that sought to devastate the cotton belt and into a small but still dangerous entity that has largely been forgotten with the decline of cotton's importance; nonetheless, this insect has impacted the United States in many different ways.

Firstly, we must look at the physical labor that came with cotton agriculture. In the 1930s, manual labor was still the main source of work for cotton production, and these experiences were repeated with the next generation as "Everyone was familiar with the tiresome task of chopping weeds from the rows of the growing crops with hand hoes. Everyone was familiar with

[301] Ibid,p.7.

[302] Ibid,p.10.

[303] Steve Clark."Weevil War: Eradication Program Beats Cotton Scourge." *Valley Morning Star (Harlingen, TX)*, January 16,2012. http://search.ebscohost.com/login.aspx?

[304] Fabian Lange, Alan L. Olmstead, and Paul W. Rhode. "The Impact of the Boll Weevil, 1892–1932.",p.695.

the stoop labor of pulling the soft, seed-filled lint from bolls that were so hard they tore your fingers."[305]

Among the farmers that suffered under the threat the boll weevil brought to their regions, it was the tenant farmers who bore much of the brunt of its wrath. Tenancy farming, where the people who work the land do not own it but instead are paid or allowed to live on the land, they farm by the landowner who rents it to the tenant farmers. It was a form of labor whose deep roots came from the Antebellum period in the South which often disavowed the laborers from much of the control of the land.[306] By the 1900's, tenant farming was becoming less of a desired occupation for many workers due to many different factors such as "the sharp rise in land values, the high cost of credit, and the low price of cotton."[307] With the increase of land value, this changed how cotton could be farmed. Cotton was no longer just isolated farms that grew cotton on their own and benefited or suffered alone, instead singular and larger farms began to dominate much of the cotton acres within places such as Corpus Christi.[308]

As the United States expanded and the vast frontier was settled, the ability for farmers to find land for their own farms were being swallowed up quickly. By the 1900's tenant farmers were working much of the cotton regions within Texas and continued to do so as cotton became more and more integral to the Texan economy.[309] However, despite cottons growing market

[305] John Fraser Hart, "The Metempsychosis of King Cotton", p. 96.

[306] James Giesen, *Boll Weevil Blues. p.*27,p.30.

[307] Neil Foley, *White Scourge: Mexicans, Blacks, and Poor White in Texas Cotton Culture*,(University Press: California, 1997), Kindle edition, location 931.

[308] Ibid, Kindle edition, location 1736-1742.

[309] James Giesen, *Boll Weevil Blues,* p.30.

value, the ability to move oneself upward on the “agricultural ladder” was instead stagnated by the oppressive and often exploitative nature of tenancy farming itself.[310] Tenant labor in the South was often a mixed culture where poor laborers had to endure with the back-breaking labors of cotton farming while dealing with rich landowners who considered them “inferior” to themselves and only truly suited to farm their cotton acres.[311]

As the boll weevil began moving through Texas and into the South, it caused an upheaval in labor that helped to exacerbate the already difficult conditions that many laborers especially African-Americans suffered from.[312] With an industrial revolution occurring for southern agriculture; this left many experts to contemplate how African-American farmers and laborers could deal with this change not only in location but of the labor itself as 'The measure of the negro's ability to grow cotton under the conditions likely to confront him in the territory east of the Mississippi, will be his adaptability to these changes and his capacity to become part of this industrial revolution."[313]

In Texas for example, poor whites dominated much of the tenant labor in Texas, despite the often association of black labor with cotton. These percentages of poor white labor increased overtime and by the 1940’s, white tenant farming still outpaced black labor in Texas.[314] Subrenting also was an issue, as some poor whites would rent out some of their farming to

[310] Neil Foley, *White Scourge*, Kindle edition, location 940.

[311] Ibid, kindle edition, location 940.

[312] Alfred H Stone,"Negro Labor and the Boll Weevil." *The Annals of the American Academy of Political and Social Science*33, no. 2 (1909): p.167. Accessed September 15, 2020. http://www.jstor.org/stable/1011574.

[313] Ibid,p.169.

[314] Neil Foley, *White Scourge*, Kindle edition, location 967,987.

minorities which gave the subrenters more advantage as they "did not have to farm the land, could exercise authority as supervisors" which allowed them to mitigate some of the stresses that tenant farming produced.[315] Hispanic labor also became an important piece of tenant farming, as seasonal labor meant that these large cotton farms not only had additional hands to harvest cotton and they could then hire these Hispanic laborers at much lower wages than they could Anglo or African-American tenant laborers.[316] In places such as Corpus Christi, Hispanic labor was the predominate form of labor within these large company farms that were becoming more and more popular and lucrative as the 1900's went on.[317]

The boll weevil moved through the Cotton Belt along with the fears that landowners and tenant farmers experienced with the insect created a unique opportunity for minority farmers and Anglo farmers. The boll weevil created a revolution of cotton labor, one that understood that the old guard of plantation-style cotton agriculture had to be uprooted despite its heritage that was so tied to the production and farming of cotton.[318] In many parts of the Cotton Belt where labor and wages were often exploitative in their methods. The uniqueness of Texas allowed for laborers to try and find the best work available and allowed landowners to find workers that could work for less pay or were more skilled in cotton farming.[319]

[315] Ibid, Kindle Edition, location 987.

[316] Ibid, Kindle Edition, location 1817.

[317] Ibid, Kindle Edition, location 1808.

[318] Alfred H Stone,"Negro Labor and the Boll Weevil."p.168-69.

[319] James Giesen, *Boll Weevil Blues, p.*31

But as the weevil moved through Texas, laborers who were caught by the insect and the devastation that it brought only had a few options available to them. This often involved the enduring laborer hardships that might include quitting, moving to a different place, or simply just continuing despite the dangers the boll weevil brought.[320] For many minority farmers, the prospect of migration and moving to find other forms of work and labor was something of an "emancipation," allowing them to forge their own lives and not be tied down to one form or another of labor that was decided for them. In this case, the weevil could be seen as a rather positive silver lining in the stormy clouds of its economic destruction of cotton.[321]

The concept of "economic entomology" and "plant pathology" became a more well-developed idea during the invasion by the boll weevil. The term "economic entomology" refers to the usage of insects to be beneficial for economic endeavors such as using predatory insects and spiders to attack pests that could attack certain crops, while "plant pathology" refers to the understanding of how plants function and how to improve the plant in the hopes of making it a much stronger variety. This growing importance on entomology and plants came from the initial lack of interest in insect control during the early times of the United States. Oftentimes if there was any information distributed, it was only "from time to time the scarce newspapers that paid attention to agriculture would record unusual abundance of some pest; but on the whole no attention was paid to the subject that would warrant mention."[322]

[320] Ibid,p.33.

[321] Ibid,p.34-35.

[322] L. O.Howard, "The Rise of Applied Entomology in the United States." *Agricultural History* 3, no. 3 (1929): p.133. Accessed September 16, 2020. http://www.jstor.org/stable/3739753.

That changed in the 1900s, as more research was done on the actual economic impact that insect pests had on crops within the United States. As the "fear of insects is increasing; that people realize that they are causing increasing damage to humanity in an increasing number of number of ways."[323] In fact, it was said that there were four events that pushed economic entomology into being an incredibly important part of an agricultural study with the boll weevil being one of those important insect pests that revealed the threats insect pests possessed.[324]

The boll weevil, in the minds of entomologists who researched its threat potential, impacted not just the economics of cotton production and agriculture, but it also had the power to upend the one-crop that was the staple of the Southern United States, ultimately being beneficial to agricultural diversity.[325] Economic entomology proved the need and effectiveness of its potential during these tumultuous times, with funding from the House of Representatives secured under Congressman Henry Cuellar , but with the creation of programs in education to create schooling in those particular subjects. That is one of the benefits that the boll weevil and other insect pests brought to agricultural history and economic history as well.[326]

A significant factor that the weevil brought to the Cotton Belt was the folk tales, songs, and legends of its devastation that created a unique look at cotton farming at the turn of the twentieth century. With the stresses of cotton labor and the weevil affecting their livelihoods, many laborers created larger than life stories, and songs to both make light and deal with the

[323] Ibid,p.132.

[324] Ibid,p.137.

[325] Ibid,p.137-38.

[326] Ibid,p.132-33,136-37.

conditions that they were under. As laborers moved out of Texas, the songs and stories about the dangers of the weevil were brought with them, which in turn created more stories and songs until it became part of the piece that would create Blues music in places such as the Delta of Mississippi and into Missouri.[327] While no one knows for sure who created the song "Boll Weevil Blues" or the "Boll Weevil Song" as it is sometimes called, it was made popular by blues and country artists such as Huddie "Leadbelly" Ledbetter, Woodie Guthry, and many more.[328]

The lyrics of the song, much like many folk songs that were used to tell the mythical tales of peoples and events anthropomorphize, the boll weevil is given a personality and almost herculean resistance against everything that the farmers threw at him, all for himself and his family to find a place in which to call their own.[329] This is a common trope of folk stories and songs as to anthropomorphize the character that you are singing about, then gives that creature a personality and makes it a far more important entity to the story itself, as seen by the lyrics of the song:

The farmer said to the boll weevil "I see you're on the square"
Boll weevil said to the farmer "Say yep! My whole darn family's here"
(We gotta have a home, gotta have a home)[330]

In Enterprise, Coffee County Alabama, there is a monument to the insect for its impact upon the region and the positives that it brought. The insect moved into Alabama in 1910

[327] James Giesen, *Boll Weevil Blues*, p.38-39.

[328] Stephanie Hall, "The Life and Times of Boll Weevil", Library of Congress, accessed March 22,2020. https://blogs.loc.gov/folklife/2013/12/the-life-and-times-of-boll-weevil/

[329] Boll Weevil Song" Collected by Merlin Mitchell Transcribed by Mary C. Parler Pete Martin Lincoln, Ark. November 12, 1950 Reel 75, Item 2. University of Arkansas, Digital collection, Accessed March 23,2020. https://digitalcollections.uark.edu/digital/collection/OzarkFolkSong/id/544/

[330] Brook Benton, "The Boll Weevil Song" Accessed May 19, 2020. https://www.lyrics.com/lyric/5186175/Brook+Benton/The+Boll+Weevil+Song

through Texas, bringing with it the economic devastation for which it is known for. Because of this, many farmers within the region had to diversify their crops to those such as peanuts. This was a boon to the region, as, South Alabama had a large harvest of peanuts, which was so profitable that the citizens of Enterprise had a monument constructed to the boll weevil.[331]

But it is within Texas that the greatest impact is still felt even to this day of how important the boll weevil was to cotton history. Particularly for the region known as the Rio Grande Valley, or the RGV, as there is still a small cotton farming community within this area. The Rio Grande Valley of South Texas is the last bastion of the boll weevil within the United States. It cannot be understated that the farmers of the Rio Grande Valley are "on the front line of the war against boll weevils."[332] This is due to the proximity of the Rio Grande Valley is to Mexico. Because of its location next to Mexico, it is close to constant infestations of the boll weevil, which makes the Valley "the last and only cotton-growing area of the country that has not eradicated the boll weevil."[333] This causes the Rio Grande Valley a myriad of issues as it must constantly be vigilant in keeping the weevil population at bay, but also places it under the scrutiny of not just upper Texas but the entirety of the South as there is a "potential re-infestation from weevils in this area."[334]

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[331] Ben Berntson , "Boll Weevil Monument", Encyclopedia of Alabama, accessed March 17th, 2020. http://www.encyclopediaofalabama.org/article/h-2384

[332] Allen Essex. “COTTON PESTS: Experts: Valley Has Worst Boll Weevil Infestation.” *Valley Morning Star (Harlingen, TX)*, January 17, 2013.http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,shib&db=n5h&AN=2W62488114077&site=ehost-live.

[333] Ibid.http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,shib&db=n5h&AN=2W62488114077&site=ehost-live.

[334]Ibid.http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,shib&db=n5h&AN=2W62488114077&site=ehost-live.

Due to this significance in maintaining control of the boll weevil to prevent any re-infestation, in 2019, the U.S. Representative Henry Cuellar secured roughly 11.5 million dollars to be used for the eradication of the boll weevil within the Rio Grande Valley.[335] Even though Texas does not produce as much cotton as it used to, the fact that cotton is still seen as a precious commodity and crop for the state reveals the sheer significance that the boll weevil brought.[336]

Maintaining the decline and eradication of the weevil became the topmost priority of the program, and so there was discussion to make cooperation between the United States and Mexico to combat the weevil. As the weevil itself originated in Mexico and then traveled into the United States, Mexico had its difficulties with the boll weevil. Much like within Texas, Mexico's problems with the boll weevil rivals it with the number of weevils caught, as an estimated amount of 56,000 boll weevils were captured within Mexico in 2017, revealing that even in their native location, the boll weevil continues to provide headaches for cotton production.[337] With this knowledge that Mexico was dealing with their weevil issues. There was a desire to see how both Mexico and Texas could combine their efforts to combat this mutual threat to their industry as "the future success of our eradication efforts here in the U.S. lies in the hands of the eradication program in Mexico."[338]

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[335] Staff Report, "$11.5 Million Secured to Eradicate Boll Weevil", AP News, March 31, 2019.Accessed April19th 2020. https://apnews.com/article/1c9a51c684b54bad9a243d38938bead9

[336] Steve Clark. "Weevil War: Eradication Program Beats Cotton Scourge." *Valley Morning Star (Harlingen, TX)*, January 16.2012 http://search.ebscohost.com/login.aspx?

[337] Brad Robb, "Lower Rio Grande Valley: a national weevil buffer zone" *Farm Progress.* February 22,2019. p.2. p.2. Accessed April 23rd, 2020. https://www.farmprogress.com/cotton/lower-rio-grande-valley-national-boll-weevil-buffer-zone

[338] Ibid, p.2.

This effort can be attributed to the many cotton fields of Mexico that are just across the Rio Grande, which means that as the boll weevils move from Mexican cotton crops, they then have access to Texas cotton and in the minds of many farmers "continue causing headaches for...growers in Texas."[339] This seemed a perfect moment for the two nations to combat a singular foe, and do so by being as close as possible to each other. But due to difficulties with figuring out how to mesh the two programs together has made it slow with varying degrees of success.[340]

Many of these difficulties stems from the fact that in Mexico, there are over 22,000 acres of cotton and that there is wild cotton that grows on creeks banks and other places on both sides of the border that give boll weevils the food needed to continue making trouble for the two nations cotton production.[341] With this desire to push back at the boll weevil at the front door of Texas, the Rio Grande Valley, much like border security, has strict policies to keep any hitch-hiking boll weevils from going anywhere else. One of the policies is that any harvesters must have a permit before leaving the Rio Grande Valley.[342] With this cooperation between two different countries, there has been a very significant drop in the weevil population within the Rio Grande Valley. In 2010, except in minor cases, the state declared that the boll weevil had been virtually eliminated from Texas, including the Rio Grande Valley. This is a historical and

[339] Ibid,p.2.

[340] Dominic Reisig , "The Boll Weevil War, or How Farmers and Scientists Saved Cotton in the South" https://news.ncsu.edu/2017/05/boll-weevil-war-2017/

[341] Brad Robb, "Lower Rio Grande Valley: a national weevil buffer zone", p.3.

[342] Ibid,p.3

important event as this marks the last vestiges of the boll weevil and its invasion of the United States.[343]

The Boll Weevil has contributed much to the agricultural history of Texas and the United States,so much so that its history has virtually become a legend as farming becomes less of an important feature of the modern era. While the weevil is not the once mythical foe against cotton as it was once proclaimed to be, its presence continues to be felt, and it is only a matter of time for a slip up to happen that will allow the weevil to begin its biblical infestation of Texas anew. But, because of the decades of experimentation and experiences, the weevil will not have the same impact as it did all those decades ago and will continue to be nothing more than an inconvenient nuisance for the remaining cotton farmers that still dot the farmlands of Texas.

[343] Steve Clark. "Eradication Program Wins out against Destructive Boll Weevil." http://search.ebscohost.com/login.aspx?

CHAPTER VIII

THE FUTURE OF BOLL WEEVIL ERADICATION?

For over one hundred years, the boll weevil had been a slow but impacting game-changer of the South. Once seen as a biblical insect that destroyed Southern livelihood, it had become a myth of when cotton was at the very brink of being annihilated from the United States and especially in Texas. Now, it is only a matter of time before the weevil is effectively wiped out of Texas and becomes a faded memory of a small brown weevil that changed Texas cotton culture. As discussed in this thesis, the various control methods have evolved into the balancing act of the Eradication Program. But, while that has shown to be a good method in keeping the weevil checked in many places, there have been many experiments into finding another method of control against the boll weevil.

For example, in Brazil, many scientists are looking at how genetic manipulation may be the key component to finally eliminating the cotton boll weevil from their crops and, by extension, the crops of the United States. One of these research projects has to do with understanding the boll weevil's digestive features so that much more potent insecticide can be created to combat the weevil. One of these important features is chitin.[344]

[344] Macedo,L.L.P. J.D. Antonino de Souza Junior, R.R. Coelho, F.C.A. Fonseca, A.A.P. Firmino, M.C.M. Silva, R.R. Fragoso, et al. "Knocking down Chitin Synthase 2 by RNAi Is Lethal to the Cotton Boll Weevil." *Biotechnology Research & Innovation* 1, no. 1 (January 1, 2017), https://doaj.org/article/6b7a8b5ed102430a980c88ff87d704bd. p.73.

Chitin is an important strand of the gene for insects as that is what is created as part of their exoskeleton. There are two types of chitin used by insects. The first one is used for the external exoskeleton of the insect, otherwise known as (Chitin Synthase 1), and the second is what is produced in the midgut of insects that helps create the material needed to digest food and protect their organs, otherwise known as Chitin Synthase 2.[345] Because this form of chitin synthase is connected to the creation of important digestive measures in insects, researchers believe that if modifications made to this gene could create a unique way to control the insect population by removing the insect's ability to properly digest certain plants, such as the boll weevil and its hunger for cotton crops.[346]

Another reason that many scientists investigated this genetic manipulation had to do with that many types of cotton have been genetically modified to combat pests and that if they could do the same to the insects, then they could reduce not only the cost of crop management but also prevent the accidental poisoning of people that could happen with the standard spraying of pesticides.[347]

Alongside the genetics of the boll weevil and other cotton pests, Bt Transgenic cotton's creation also provides a glimpse into the future of boll weevil control. Bt transgenic cotton is cotton that has been bred with a specific toxin that kills cotton consuming insects, making them an important addition to the future of control against not just the boll weevil but also other

[345] Ibid, p.73.

[346] Ibid, p.73.

[347] Ibid, p.73.

insects.[348] As shown, the control of the boll weevil has evolved with each new technique and technological advancement that scientists and farmers have experimented with to effectively combat their age-old nemesis. With this advent of technology, it has shown that the boll weevil has become nothing more than a stubborn and ingrained foe that the cotton industry will continue to fight.

But as technology advances, the boll weevil will continue to be a reminder of how far cotton agriculture has evolved over the century.

[348] Douglas Stephenson, Mark Matocha. "A Pest Management Strategic Plan for Cotton Production in Texas". Southern Integrated Pest Management Center. Published 2004. Accessed September 23,2020. https://ipmdata.ipmcenters.org/source_report.cfm?sectionid=30&controltypeid=0&sourceid=1269. p.11.

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