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The Economic Impact of Boll Weevil Eradication in Texas

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Abstract

Substantial progress has been made in eradicating the boll weevil from the majority of the cotton producing regions in Texas. While the full economic benefits will not be realized until eradication is achieved statewide, economic benefits approaching \$1 billion have already been realized.

Issue

Without a doubt, the boll weevil has been the most destructive insect pest of cotton in Texas and the U.S. Recent efforts to eradicate this insect from the U.S. Cotton Belt began in 1978 with a small, 30,000 acre pilot program conducted in North Carolina. Eradication of the boll weevil rapidly progressed across other southeastern states, as well as western cotton producing states in the 1980's. Texas joined the national boll weevil eradication program in the mid-1990's, along with several states in the mid-south. Due to the large cotton acreages involved, the state was divided into eradication zones. Presently all zones and respective cotton acreages are included in the eradication program. While not complete at this time, substantial progress has been made in eradicating the boll weevil from the majority of the state's cotton producing regions. Additionally and of equal importance, is the reduction of insecticide use following eradication-leading to less insecticide exposure to humans and a cleaner environment.

Background

The boll weevil entered Texas from Mexico in 1892 (Howard). Evolving on wild cotton in Mexico, the weevil's biology was uniquely adapted to cotton as its primary host. Upon reaching commercial cotton plantings in south Texas, the weevil quickly expanded its range. Without effective natural control agents, the weevil freely fed on developing cotton squares (buds) and small bolls, resulting in near exponential increases in its population. By 1921, the boll weevil had traversed the heart of the U.S. cotton belt and made its way eastward to the Atlantic seaboard (Coad, Tucker, Williams, Bondy and Gaines). No other insect pest of cotton has caused such devastating yield losses and so negatively impacted the economy of U.S. cotton production. The economy of Texas has suffered greatly from this destructive pest. Indeed, the boll weevil largely determined where cotton could be profitably grown in Texas and caused the majority of cotton production to shift from east to west Texas. Direct yield losses and the economic impact of these losses have run into the billions of dollars since the weevil entered Texas. Prior to the boll weevils entry into the High Plains production regions in the early 1990s, recent Texas losses and control costs for the boll weevil in Texas were estimated to range between \$25 million and \$50 million per year as reported in the Beltwide Cotton Insect Losses of the Proceedings of the Beltwide Cotton Research Conferences (1989-1996). Following this report, estimated losses for the High Plains region of Texas (1995-1998) were estimated at an additional \$200 million per year (Leser, Bodden, and Haldenby).

Plans were underway in the late 1980's and early 1990's for Texas to join the national boll weevil eradication effort. Enabling legislation was passed in March of 1993, allowing cotton producers to organize themselves and vote for the creation and funding of the Texas boll weevil eradication program. By 1990, boll weevil eradication programs were progressing, or

successfully completed, in multiple southeastern and southwestern cotton producing states. The Texas Cotton Producers, Inc. requested that the Department of Entomology at Texas A&M University develop an eradication plan for Texas. In 1992, Extension entomologists joined with colleagues at the Texas Agricultural Experiment Station and USDA and developed A Plan for Boll Weevil Eradication in Texas (Frisbie and Brazzel). The Texas eradication plan relied heavily on area-wide pest management and eradication tactics used in other states. The Texas eradication plan was careful to distinguish the differences in Texas cotton production practices from other states. Also, the Texas plan was carefully designed to minimize outbreaks of secondary pests, such as the bollworm, and the tobacco budworm.

According to the Texas boll weevil eradication plan, the state was subdivided into eradication zones (Figure 1). Each zone, over a period of years beginning in 1993, voted to: (1) enter the eradication program, (2) fund the majority of eradication costs, and (3) elect a representative to the Texas Boll Weevil Eradication Foundation (TBWEF) Board of Directors. The TBWEF was the primary organization charged with implementing the eradication program, first as an independent foundation and later (1997) under the auspices of the Texas Department of Agriculture.

In August 1994, an airplane equipped to apply insecticides to cotton took off near San Angelo and the eradication of the boll weevil in Texas began in the Southern Rolling Plains Zone. The tactics deployed for eradication in this zone would be repeated across other Texas zones as they were added to the program. Zone-wide applications of ultra-low volume (ULV) malathion at the rate of 12 oz per acre were applied in the Fall on all acres to prevent weevils from leaving cotton and entering a state of diapause. Prior to these malathion applications, boll weevil pheromone traps were deployed by TBWEF personnel in late summer to begin

accumulating data on the geographic location of boll weevil populations. The following spring, (during the first full year of eradication), all fields were trapped at the approximate rate of one boll weevil trap per 5 acres. Trapping data was used to locate infested fields and direct insecticide applications throughout the season based upon predetermined trap triggers. The TBWEF, using advanced geographic information system technology, mapped every field within eradication zones, deployed and checked traps, arranged for the targeted application of ULV malathion based upon trap triggers, conducted quality control on all insecticide applications and engaged in environmental monitoring to assure insecticide application safety. The TBWEF worked closely with the Texas Cooperative Extension (TCE) Integrated Pest Management Program (IPM) to monitor secondary pests. The Boll Weevil Technical Advisory Committee worked carefully with the TBWEF to evaluate and recommend improvements in the overall program. Through the use of in-season and fall applications of ULV malathion, in combination with strict adherence to stalk destruction practices in south Texas, boll weevil populations began to fall dramatically and move toward eradication. It was common to see a greater than 90% reduction in weevil numbers by the end of the second year of eradication. Depending on the severity of the weevil population and the effective migration of weevils from other zones, eradication within a particular zone was expected to be accomplished in as short as 4 years. Certain zones in West Texas and, particularly the South Texas Winter Garden zone, are taking much longer due to immigration of weevils from other zones with much higher weevil populations. This problem is being ameliorated with the recent inclusion of the St. Lawrence and the Lower Rio Grande Valley Zones.

As the Texas eradication progressed zone by zone across the state, yields began to increase due to the reduction boll weevil populations. Insecticide use and associated costs

sharply declined as the weevil was pushed toward eradication within a particular zone. The general reduction in the use of insecticides has allowed beneficial arthropods to increase and the use of transgenic cotton varieties containing the Bt gene for insect resistance have largely kept bollworm and tobacco budworm populations in check. To date, all cotton production regions within Texas are in some phase of boll weevil eradication ranging from active eradication programs to those that have accomplished eradication and are in a maintenance phase.

Boll Weevil Eradication in Texas

Extension entomologists, agronomists and agricultural economists, along with Texas Agricultural Experiment Station and USDA scientists, have been heavily involved in the planning, implementation and evaluation of the Texas boll weevil eradication program.

Texas has a long and rich history of boll weevil research and management programs. Much of the knowledge on the boll weevil's basic biology and ecology was developed in Texas. Suppression of the boll weevil through fall application of insecticides, delayed uniform planting of cotton in the Rolling Plains, early and uniform destruction of post harvest cotton stalks, the deployment of short-season-determinant cotton varieties were all developed in Texas. These practices were implemented as primary components in integrated pest management programs and eventually boll weevil eradication. Much of the work regarding the development and use of the boll weevil pheromone trap as a tactical monitoring tool was developed in Texas.

Texas is globally recognized for its multidisciplinary integrated pest management programs for cotton. Extension entomology specialists at the district, and particularly Extension Agents-IPM at the county level, have demonstrated the feasibility and economic soundness of IPM programs. Extension set up an efficient and successful infrastructure through its statewide IPM Program that supported the Texas boll weevil eradication program through education and

technology transfer. Historically, IPM was successfully implemented on a farm-by-farm basis. In order for boll weevil eradication to succeed, IPM was extended to the regional or area-wide level. This was accomplished through the Texas boll weevil eradication program. The eradication program stands as a shining example of how an IPM program can effectively evolve from the individual farm to the area-wide level.

Economic Impact of Boll Weevil Eradication Efforts

The economic impact of the Boll Weevil Eradication Program was measured in terms of the change in net cash flow to cotton producers in 11 of the 16 boll weevil eradication zones in Texas (Table 1). Zones 2, 13, 16, and 17 were excluded from this analysis because they just entered the program (2004 and 2005) and thus have not had enough time to realize any affects of eradication efforts. Zone 12 was excluded due to a unique situation where the primary pest was pink bollworm rather than boll weevil.

This analysis expanded on a boll weevil eradication economic assessment by J. Robinson and D. Barham. The analytical approach involved quantifying a multi-year average boll weevil treatment cost and yield loss for each zone prior to the start of the boll weevil eradication program. This formed a baseline prior to the eradication program for each zone. To assess the economic changes relative to the baseline, for each eradication zone, the baseline was compared to post-boll weevil eradication program annual boll weevil yield losses, boll weevil program assessment fees, other boll weevil treatment costs, and harvesting and ginning costs associated with the changes in production.

Yield Losses and Insecticide Costs

Several data sets were used in the analysis. Secondary yield data consisted of county yield data collected by the USDA - National Agricultural Statistics Service for both irrigated and

non-irrigated cotton (USDA-NASS) (Table 2). To estimate yield losses caused by boll weevils, and insecticide costs for controlling boll weevils, annual yield loss and insecticide costs data from the Beltwide Cotton Conference - Cotton Pest Loss Database (2006) were used (Cotton Pest Loss Database). Historical BWE program assessments were obtained from the Texas Boll Weevil Eradication Foundation (Allen).

The secondary yield and spray cost savings data were used in grower meetings within the respective zones to facilitate data collection from the growers. These meetings were held in November-December, 2004. The participants were invited growers and consultants who were considered by Extension entomologists as being knowledgeable and representative of different areas within the particular zone. A modified Delphi process was used to elicit participant expectations of average yield and on-farm spray cost savings resulting from boll weevil eradication, with subjective weighting for dry, average, and above average rainfall during the growing season. In addition, other potential cost and revenue impacts from BWE were solicited, e.g. savings from precluded secondary pest problems, improvements in harvest turnout or grade, etc.

Using the data from the Beltwide Cotton Pest Loss Database, boll weevil insecticide costs per acre over multiple years prior to the eradication program (Pre-BWE) were averaged to form a baseline for boll weevil insecticide costs (Table 2). The time-frame contained in the average varies and was based on when each zone entered the BWE program, the availability of data in the Beltwide Pest Loss Database, and how long each zone had been infested with boll weevils. For the years after each zone entered the eradication program, annual boll weevil insecticide costs were subtracted from the baseline, resulting in the change in boll weevil insecticide costs. Similarly, pre-BWE yield loss estimates were averaged to form a baseline for yield losses

attributable to boll weevils (Table 3). Post-BWE average yield loss percentages were compared to the average pre-BWE yield loss to obtain an average annual savings in yield loss percentage, which were multiplied by the regional cotton yields, resulting in an estimate of the average annual yield savings (Johnson, Sansone, Fuchs, and Minzenmayer). The yield savings was valued at the state average cotton price, except in years when the average price was below the USDA cotton marketing loan rate (\$0.52/lb). In these years, the yield savings was valued at the loan rate. Cotton seed was valued at the state's average cotton seed price each year.

After comparing preliminary results using the Beltwide Cotton Pest Lost Database loss estimates versus subjective grower estimates, there were some notable differences in the results. In general, the yield impacts estimated with the published Beltwide Cotton Pest Lost Database were five to ten times smaller than results obtained using grower panel data. Upon consultation with the entomologists that made the original Beltwide estimates, they revisited their original boll weevil yield loss estimates. This resulted in increasing the yield loss estimates in wet years. Extension Entomologists revised some of the published Beltwide boll weevil yield loss percentages, increasing them in wet years by 25% for Zones 1, 4, 8, 9, and 11, 20% in Zones 5, 6, 7, and 10, and tripling the yield loss in Zones 3 and 14 (Fuchs, Sansone, Lesser, and Parker).

One of the difficulties in assessing the yield impacts attributable to boll weevil eradication is the almost simultaneous introduction of improved cotton varieties, including the Bt transgenic cotton varieties. Both boll weevil eradication and the adoption of improved cotton varieties have resulted in increased yields, however, the impacts of improved varieties would not have been as significant without boll weevil eradication.

Annual insecticide cost savings, yield loss savings, boll weevil eradication assessments, and other cost changes (harvesting and ginning) were used in calculating growers' annual change

in net cash flow per acre due to boll weevil eradication, beginning with the year the eradication program began in each zone. Cotton acreage in each zone, by year, was provided by the Texas Boll Weevil Eradication Foundation (Allen). Total acres for all zones are listed in Table 4.

Boll weevil yield loss estimates have declined since the eradication program, causing production to increase relative to the pre-BW eradication timeframe and creating downward pressure on cotton prices. Given estimates of market conditions, the estimated price impacts were $-\$0.003$ per pound for 1996, $-\$0.002$ for 1997, $-\$0.003$ for 1998, and $-\$0.002$ for 2003.¹ Applying these price adjustments to cotton production statewide resulted in the following reductions in statewide net benefits: \$6.1 million (1996), \$5.9 million (1997), \$5.6 million (1998), and \$4.1 million (2003).

Cumulative Economic Benefits

Using the acreage by zone, and the data and methods previously described, the change in total net cash flow was estimated for each zone from 1996 to 2005. Statewide totals are shown in Table 4. Annual net benefits to growers are first presented in nominal dollars in the third column. These net benefits were then adjusted to 2005 dollars (real dollars) which is the basis for the cumulative net benefits (far-right column). Annual net benefits have increased as acreage in the eradication program has increased from 1.4 million acres in 1996, to over 6 million acres in 2005. The statewide cumulative net benefit (1996-2005) of the boll weevil eradication program is an estimated \$946 million (Table 4).

¹ Price impact estimates were obtained from the Food and Agricultural Policy Research Institute at the University of Missouri (March 2007).

Economic Output and Employment

For 2005, The IMPLAN input-output model was used to estimate the economic impact of the boll weevil eradication program to both growers and cotton ginners. IMPLAN is a widely used economic impact analysis system which uses economic data for each sector of the economy and can be used to estimate how a change in one sector effects economic output, employment, and value added in other sectors of the economy that supply inputs to that sector. This analysis focuses on employment impacts, and economic output - a measure of gross sales (business activity) throughout the economy (Minnesota IMPLAN Group, Inc).

The estimated direct impact of the boll weevil eradication program at the farm-level in 2005 was \$206 million (Table 4). Economic impact analyses at the farm-level was based on the impacts of the spending of the improved income using household expenditure patterns within the IMPLAN system. An estimated \$137.4 million of the increased income was available to be spent and represents the direct impact. The remaining amount that is not spent, \$68.8 million, accounts for savings, taxes and interest paid to state and federal government, and purchases of goods outside the state and goods imported from outside the U.S.

The direct impact to the ginning sector was based on the estimated cost of ginning the additional production resulting from boll weevil eradication. A study by USDA-ARS estimated an average ginning variable cost of \$24.87 per bale (Valco, Collins, Findley, Green, Todd, Isom, and Willcutt). Based on this ginning cost estimate, the cost of ginning the additional production in 2005 (1.12 million bales) was \$28 million and represents the direct impact of ginning.

Table 5 summarizes the farm-level and ginning impacts for 2005. Economic output resulting from expenditures associated with the improved farm-level income was an estimated \$236 million, which helped support an additional 2,050 jobs. For the ginning sector, economic

output was estimated at \$38.3 million, which helped support an additional 221 jobs. Total economic output associated with improved cotton production resulting from boll weevil eradication was an estimated \$274 million, which helped support over 2,200 jobs, directly and indirectly, statewide.

Conclusion

Acreage involved in the Texas Boll Weevil Eradication program has grown from 1.4 million in 1995 to over 6 million today. The growth and acceptance of boll weevil eradication was a direct result of the strong public-private partnership that was formed.

While the full economic benefits will not be realized until eradication is achieved statewide, economic benefits of close to \$1 billion have already been realized.

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Table 1. Texas Boll Weevil Eradication Program Zones

Zone 1	Southern Rolling Plains
Zone 3	South Texas/Winter Garden
Zone 4	Rolling Plains Central
Zone 5	Southern High Plains
Zone 6	Northern High Plains
Zone 7	Western High Plains
Zone 8	Permian Basin
Zone 9	Northern Rolling Plains
Zone 10	Northwest Plains
Zone 11	Southern Blacklands
Zone 14	Upper Coastal Bend

Source: Texas Boll Weevil Eradication Foundation, 2006.

Table 2. Post BWE Average Annual Yields, By Zone (lbs lint per acre)

	TBWEF Zones											State Avg Price*
	1	3	4	5	6	7	8	9	10	11	14	
1996	372	353	288				378			392	523	\$0.656
1997	392	492	396				417			498	581	\$0.601
1998	375	407	339				460			412	353	\$0.561
1999	280	810	240			421	317	310	547	612	659	\$0.520
2000	178	751	250			378	294	237	520	406	543	\$0.520
2001	248	627	257	342	579	391	320	310	713	504	723	\$0.520
2002	298	641	377	455	636	493	351	390	844	676	783	\$0.520
2003	310	783	327	371	643	491	323	354	725	620	643	\$0.577
2004	515	885	506	686	757	720	452	556	817	743	701	\$0.520
2005	538	744	547	650	811	803	576	612	976	724	593	\$0.520

* Higher of price or loan rate

Table 3. Average Pre-Treatment Cost and Average Pre-Yield Loss

	Avg. Pre-BWE Treatment Cost	Pre-BWE BW % Yield Loss	Time Frame
Zone 1	\$10.26	15.45%	(1986-1993)
Zone 3	\$15.94	15.00%	(1986-1995)
Zone 4	\$8.74	15.52%	(1986-1995)
Zone 5	\$9.93	14.87%	(1994-2000)
Zone 6	\$9.93	14.87%	(1994-2000)
Zone 7	\$6.76	9.28%	(1994-1998)
Zone 8	\$6.04	11.21%	(1991-1998)
Zone 9	\$5.40	15.97%	(1986-1998)
Zone 10	\$6.76	9.28%	(1994-1998)
Zone 11	\$12.43	9.39%	(1990-2000)
Zone 14	\$23.61	8.08%	(1992-2001)

Table 4. Statewide Summary of the Net Benefits to Cotton Producers of the Texas Boll Weevil Eradication Program

	Total No. of Land Acres	Total Net Benefit Real Dollars (2005)	Cumulative Net Benefit
1996	1,476,745	\$18,444,848	\$18,444,848
1997	1,113,748	\$17,315,355	\$35,760,202
1998	1,203,037	\$28,922,518	\$64,682,720
1999	3,892,387	-\$42,334,288	\$22,348,432
2000	4,266,331	\$76,662,917	\$99,011,349
2001	5,803,719	\$125,679,398	\$224,690,747
2002	5,664,936	\$144,237,988	\$368,928,735
2003	5,723,436	\$162,128,300	\$531,057,035
2004	5,982,985	\$209,560,486	\$740,617,521
2005	6,070,076	\$206,283,986	\$946,901,507

1. Price impact estimates were obtained from the Food and Agricultural Policy Research Institute at the University of Missouri (March 2007).

Table 5. Economic Impact of Boll Weevil Eradication (2005)

	Direct Impact	Total Economic Output	Employment
Impacts Farm-Level	\$137.4 Mill.	\$236.0 Mill.	2,050
Impacts to Ginning Sector*	\$28.0 Mill.	\$38.3 Mill.	221
Total Farm-Level and Ginning Sector	\$165.4 Mill.	\$274.6 Mill.	2,271

*This is the impact associated with costs incurred by cotton gins in ginning the additional production

Figure 1. Texas Boll Weevil Eradication Zones

