ECONOMIC IMPLICATIONS OF DISCONTINUING THE TEXAS HIGH PLAINS BOLL WEEVIL SUPPRESSION PROGRAM*

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The federal government has supported and continues to support or share in the support, financially and technically, of several regional pest management programs. Implicit in continued federal support is the concept that the benefits of the program to society exceed the governmental portion of the costs. As these programs are evaluated and consideration is given to discontinuing federal support, improved estimates of program benefits, or costs of discontinuing, are needed.

The objective of this study was to identify and quantify the expected effects in terms of agricultural output, insecticide use, and production costs of discontinuing a regional boll weevil suppression program on the Texas High Plains. Results of this study are useful to governmental decision makers, local producers, environmentalists and economists.

OVERVIEW OF THE PROGRAM

In the late 1950's and early 1960's the boll weevil, *Anthonomus grandis Boheman*, spread into the fringe areas of the Texas High Plains where it previously had not been a pest [3]. In anticipation that this insect might become an established economic pest in the High Plains and perhaps even westward in New Mexico, the High Plains cotton industry (High Plains Cotton Growers, Inc.,) in cooperation with the U.S. Dept. of Agriculture, organized a large-scale suppression program to stop its spread. The program, referred to as the High Plains diapause (or reproductive-diapause) boll weevil control program, was first conducted in 1964 as described by Adkisson et. al. [1, 2].

The primary purpose of this control effort, which was repeated annually during the period 1965-1974, was to prevent boll weevils from becoming established in the High Plains. An extra benefit of the program, in addition to preventing weevil damage, has been to minimize in-season insecticide control against the boll weevil, thereby lessening potential outbreak of *Heliothis* spp. which often results in insecticidal disruption of natural biological control. Through the efforts of this program, economic damage of the boll weevil has been virtually eliminated in the High Plains. Furthermore, *Heliothis* spp. damage to cotton production has been greatly averted, using less insecticide than would have been used without the program.

The "Caprock", an escarpment which defines the eastern and southeastern limits of the High Plains, forms a distinct boundary between the High and Rolling Plains. Vegetative sites favorable for boll weevil overwintering habitat are much more abundant in the Rolling Plains than in the High Plains. The ability of the weevil to survive on the High Plains is therefore restricted. The juncture of the High and Rolling Plains serves as an excellent area in which to apply controls to limit boll weevil spread.

The purpose of this report is to compare production costs and insecticide use under the present program and to estimate costs, quantity of insecticide to be used, and effect on cotton

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production in the absence of a coordinated program [4].

STUDY AREA

The High and Rolling Plains of Texas as shown in Figure 1 was delineated as the primary area of study for this report. An average of 2.1 million acres of cotton was planted on the High Plains, based on 1969, 1970, and 1971 data [7]. Of this, 67 percent was irrigated and 33 percent was dryland cotton. The average yield across both irrigated and dryland cotton was 316 lbs. of lint per acre.

In the Rolling Plains an average of a little more than 1.0 million acres of cotton was planted in 1969, 1970, and 1971. However, irrigated cotton was only 11 percent of the total, and the average yield for the region was 196 lbs. of lint per acre.

By controlling the boll weevil with insecticide along the edge of the caprock, weevil migration into the High Plains of Texas and eastern New Mexico has been reduced to such low levels that economic damage by this pest rarely occurs.

CURRENT SITUATION

The reproductive-diapause boll weevil control program reduces the boll weevil population both on the edge of the High Plains and in the adjacent Rolling Plains. This appreciably reduces the spraying needed by individual producers, who, however, practice some limited insect control. To quantify the current insecticide use situation, costs and insecticide use need to be established for the reproductive-diapause program as well as for individual producers.

Reproductive-Diapause Control Program

Complete records have been maintained by the U.S. Dept. of Agriculture on insecticide applied and its location as related to the operation of the High Plains reproductive-diapause program. For the period 1964 through 1972, 213,000 acres were sprayed an average of 3.8 times each season. Thus, on the average, 807,000 acres were sprayed each year. Average annual quantity of insecticide applied was 921,000 lbs. of malathion and 7,000 lbs. of azinphomethyl. The amount of malathion applied yearly varied from a low of 513,000 lbs. in 1967 to a high of 1.8 million lbs. in 1965. Costs associated with the reproductive-diapause program averaged $998,000 annaully over the nine years.[1] Basic program operation information used for this study is

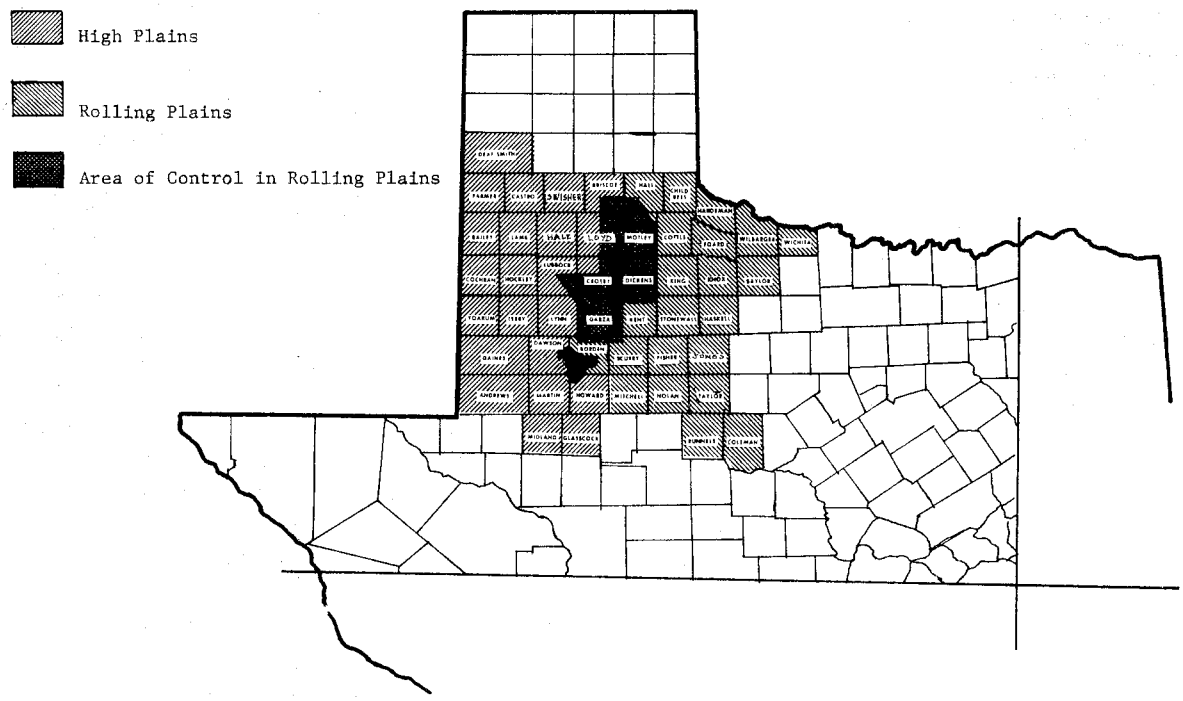

Figure 1. DELINEATION OF THE HIGH AND ROLLING PLAINS AND AREA WHERE THE REPRODUCTIVE-DIAPAUSE BOLL WEEVIL CONTROL PROGRAM HAS BEEN CONCENTRATED

[1] The Plains Cotton Growers, Inc., pay about one-half the costs of the reproductive-diapause boll weevil control program, and the U.S. Dept. of Agriculture the rest.

an average annual insecticide use of 928,000 lbs. and a cost of $998,000.[2]

Producer Insecticide Use[3]

To estimate total pounds of insecticide applied annually in the High and Rolling Plains, the quantity of insecticide applied by producers as well as through the reproductive-diapause program is needed.

It is emphasized that data are very limited relative to producers' usage and pattern of application of insecticides. In this study, the quantity of insecticides used by producers was derived by taking information on the number of acres treated with insecticides and, in conjunction with entomologists most knowledgeable about insect problems and producer pest control practices in the area, applying typical insecticide treatments. These estimates represent "ball park" figures and, although they serve the purpose of this report, the reader should be aware of limitations associated with the estimates. To account somewhat for this uncertainty, high and low estimates were made of current pecticide use and the effect of withdrawing the boll weevil control program.

Table 1 indicates estimated acres sprayed, times sprayed, and type and rate of insecticide application, with and without the coordinated program, as well as expected per-acre yield decline, by acreage, due to

Table 1. ESTIMATED ACRES TREATED, POUNDS, AND TYPE OF INSECTICIDE APPLIED AND THE NUMBER OF APPLICATIONS WITH AND WITHOUT THE REPRODUCTIVE-DIAPAUSE BOLL WEEVIL CONTROL PROGRAM, BASED ON AN UPPER AND LOWER RANGE OF EXPECTED PRODUCER RESPONSE

	Cotton yield decline[a]		Acres sprayed		Application	Time sprayed	
	Upper Estimate	Lower Estimate	Upper Estimate	Lower Estimate	Rate and Insecticide	Upper Estimate	Lower Estimate
	-------percent-------		--thousand acres---		---lbs @ acre--	--------number------	
High Plains							
With Program							
Early season	N.A.	N.A.	126	84	0.244# Bidrin	1	1
Late season	N.A.	N.A.	126	84	2#Tox,1.5#MP[c]	1	1
Net change without program[b]							
Early season	15	10	350	350	0.5#MP[c]	3	2
					2#Tox,1.5#MP[c]	5	3
Late season	10	5	1,100	1,100	2#Tox,1.5#MP[c]	3	1.5
Rolling plains[d]							
With program[e]	N.A.	N.A.	369	260	0.5#MP[c]	1	1
	N.A.	N.A.	185	130	0.244# Bidrin	1	1
	N.A.	N.A.	185	130	2#Tox,1.5#MP[c]	1	1
Net change without program[b]	15	10	123	123	0.5#MP[c]	3	2
					2#Tox,1.5MP[c]	7	5

N.A. = not applicable

[a]Per-acre yield decline of cotton due to withdrawing the reproductive-diapause boll weevil control program; i.e., primarily boll weevil damage even with increased insecticide treatments.

[b]The without program estimates indicate the net increase in expected insect control above current control if the diapause program were withdrawn; i.e., with the reproductive-diapause program discontinued, insect control would be the sum of the with program estimates and the without program estimates.

[c]Tox refers to the toxaphene and PM refers to methyl parathion.

[d]Early season and late season insect control is not separated for the Rolling Plains since such a differentiation was not needed for the analysis.

[e]The rows indicate acres on which each of the alternative insect control treatments were applied. In the Rolling Plains With Program, the acres treated for different pests were not constant as in the other cases, hence, specific identification was required.

[2]Recent price increases of petrochemical feed-stock has caused a price increase in insecticides. This suggests the $998,000 may be low for 1974 and succeeding years. Further, the expected increase in cotton production costs due to discontinuing the program also would be under-estimated and to a larger degree, since producers, if the program were discontinued, would use several times the quantity of insecticide used in the program. Expected quantity of insecticides that would be used with and without the program is presented in results.

[3]Current acreage sprayed was obtained from annual estimates as provided by county extension directors.

program withdrawal. Data in Table 1 show that the effect on total output and insecticide use for the High Plains would be much greater with program withdrawal than for the Rolling Plains, due principally to the larger affected cotton acreage.

Table 2 shows current per-acre yields and production costs and expected effect of withdrawal of the diapause boll weevil control program. With the program, yield in the High Plains averaged 316 lbs. of lint per acre [7]. Costs of production were an estimated $56.92 per acre (i.e., $72.19 for the 67 percent irrigated and $25.92 for the 33 percent produced dryland) [5, 6]. Yield on the Rolling Plains averaged 196 lbs. of lint per acre [7]. Costs of production were approximately $33.29 per acre ($64.69 for the 11 percent irrigated and $29.41 for the 89 percent produced dryland) [5, 6]. The variable cost of producing cotton averaged $.18 per pound of lint in the High Plains and $.17 in the Rolling Plains.

SITUATION WITH PROGRAM WITHDRAWAL

Reflecting on the difficulties discussed above regarding estimation of the quantity of insecticide presently being used by producers, the difficulties and possible error in estimates are magnified when an alternative situation is proposed, such as discontinuing the reproductive-diapause boll weevil control program. For the proposed situation, it is necessary to estimate resulting insect problems, if

Table 2. A COMPARISON OF EXPECTED PER-ACRE COTTON YIELD AND PRODUCTION COSTS WITH AND WITHOUT THE REPRODUCTIVE-DIAPAUSE BOLL WEEVIL CONTROL PROGRAM

Item	Unit	Reproductive-Diapause Boll Weevil Control Program		
		With	Without	
			Upper estimate[a] of response	Lower estimate[b] of response
High Plains				
Yield				
Early season damages[c]	lbs.	316	269	285
Late season damages[d]	lbs.	316	284	300
All acres[e]	lbs.	316	291	302
Production costs				
Early season damages[c]	dol.	56.92	80.19	72.23
Late season damages[d]	dol.	56.92	67.43	62.36
All acres[e]	dol.	56.92	66.26	62.30
Per pound of lint	dol.	0.18	0.23	0.21
Rolling Plains				
Yield				
Affected acres[f]	lbs.	196[g]	167[h]	176[h]
All acres	lbs.	196[g]	192[h]	193[h]
Production costs				
Affected acres[f]	dol.	33.29[g]	56.22[h]	54.84[h]
All acres	dol.	33.29[g]	36.09[h]	35.92[h]
Per pound of lint	dol.	0.17	0.19	0.19

[a]The values are based on the upper estimates shown in Table 1.

[b]The values are based on the lower estimates shown in Table 2.

[c]Refers to 350,000 acres of cotton that incur damages due to boll weevil infestation in July and August.

[d]Refers to 1.1 million acres of cotton that incur late season damages due to boll weevil infestation.

[e]Refers to 2.1 million acres of cotton.

[f]Refers to 122,500 acres of cotton.

[g]Refers to 1.04 million acres of cotton.

[h]Refers to 1.01 million acres remaining in cotton resulting from a shift of 27,500 acres into grain sorghum.

any, and further, to estimate the producer reaction. This means there is no historical base to use for the area, because the program actually was initiated soon after the first significant threat of boll weevil migration into the High Plains and has been continued every year since. Further, two types of estimates (insect problems and producer reaction) provide two sources of error. As discussed earlier, an upper and lower estimate of effects of program withdrawal are presented.

High Plains

Should the program be discontinued, there is evidence that the boll weevil would become established farther west, principally in the southern part of the High Plains [2]. After the first year, with no coordinated boll weevil control program, it is expected that the boll weevil would be well established along the edge of the caprock.

After three to five years, the boll weevil could move around the southern part of the High Plains and overwinter along the New Mexico border on the west side of the upper High Plains. Established boll weevil infestations would be limited to the High Plains of Texas and perhaps to eastern New Mexico, but would not be expected to continue westward into Arizona and California.

Because of the favorable overwintering habitat around the caprock and along the west side of the High Plains, the boll weevil would be expected to cause damage during July and August, about two to four miles in from the overwintering habitat. The nature of this damage would be an estimated 15 percent yield reduction on 350,000 acres of cotton (see Table 1). In addition, for these 350,000 acres, the producer would find it necessary to undertake a more rigorous insect control program as indicated in Table 1.

There would be another area around the High Plains that lies from three to 15 miles in from the overwintering habitat, in which cotton producers would be expected to be affected by discontinuance of the reproductive-diapause control program. This part of the High Plains would receive late season damage (late August and September) from the boll weevil. Damages probably would amount to about a 10 percent reduction in cotton yield on 1.1 million acres and an increase in pest control treatments.

To provide a basis for estimating aggregate effects if a decision were made to withdraw the boll weevil control program, yield and production costs per acre were adjusted, based on response indicated in Table 1. For the High Plains, the expected effect would be an overall per-acre yield decline from 316 lbs. of lint to 291 lbs. using upper response estimates, and to 302 lb. using lower response estimates (see Table 2). At the same time, a $.03-.05 increase in production costs per pound of lint would be expected.

Rolling Plains

Although the boll weevil presently overwinters throughout most of the Rolling Plains, the population, and hence, damages would be expected to increase if the reproductive-diapause program were withdrawn.

Of the 1 million acres of cotton in the Rolling Plains, 150,000 acres would be affected if the coordinated boll weevil control program were withdrawn. Of the 150,000 affected cotton acres, 122,500 would be expected to incur a yield reduction and be sprayed several additional times annually as shown in Table 1.

The other 27,500 acres of cotton likely would be shifted to grain sorghum or cattle production. Given that such a shift would occur, a cotton yield of 196 lbs. of lint per acre would be replaced with 17.75 cwt. of grain sorghum.

The expected effect of program withdrawal on the Rolling Plains cotton production would be a slight yield decline and an increase of less than $.02 in production costs per pound of lint (see Table 2).

Aggregate Impact

The expected effect of discontinuing the reproductive-diapause boll weevil control program is presented in this paper for the High Plains, Rolling Plains, and in aggregate. Table 3 presents data with and without the program (assuming the high level and also low level of response) and shows how output of cotton, costs to produce this cotton, and associated pounds of insecticide used would be expected to change without the control program[4]. The base from which change or adjustments would be made is associated with production under the coordinated boll weevil program.

Upper Response Estimates. For simplicity, the discussion is initially limited to the analysis based on the upper estimate of yield and producer response to withdrawal of the boll weevil control program. With the program in effect, there is production of about 1.7 million bales of cotton, with associated

[4] A detailed discussion of effects for specific areas within the High and Rolling Plains is presented in a forthcoming Texas Agricultural Experiment Station publication [4] and is available from the senior author.

Table 3. EXPECTED EFFECT OF WITHDRAWING THE HIGH PLAINS REPRODUCTIVE-DIAPAUSE BOLL WEEVIL CONTROL PROGRAM BASED ON AN UPPER AND LOWER RESPONSE ESTIMATE[a]

Item	Unit	With the boll weevil control program	Production characteristic without the boll weevil control program			
			Upper estimates		Lower estimates	
			Total	Change from base	Total	Change from base
Cotton output						
High Plains	thousand bale	1,332	1,227	-105	1,275	-57
Rolling Plains	thousand bale	408	386	- 22	388	-20
Total	thousand bale	1,740	1,613	-127 (7%)	1,663	-77 (4%)
Production costs						
High Plains	million dol.	120.0	139.6	19.6	131.3	11.3
Rolling Plains	million dol.	34.6	46.2	1.6	36.0	1.4
Total	million dol.	154.6	175.8	21.2 (13.7%)	167.3	12.7 (8.2%)
Cost of producing cotton						
Total	million dol.	155.6[b]	175.8	20.2	167.3	11.7
Per pound of lint	dol.	0.179[b]	0.218	.039 (21%)	0.208	.029 (16%)
Insecticides used						
Malathion	thousand lb.	921	0	-921	0	-921
Toxaphene	thousand lb.	572 (395)[c]	12,387	11,815	5,367	4,972
Methyl Parathion	thousand lb.	614 (427)[c]	10,184	9,570	4,628	4,201
Azinphosmethyl	thousand lb.	7	0	-7	0	-7
Bidrin	thousand lb.	76 (52)[c]	76	0.0	52	0.0
Total	thousand lb.	2,190 (1,802)[c]	22,647	20,457(933%)	10,047	8,245 (457%)

[a]The upper and lower estimates of acres sprayed, number of times sprayed, and change in cotton yield are presented in Table 1.

[b]Includes the typical cost of the reproductive-diapause boll weevil control program of $998,000.

[c]With the lower estimates, pounds of insecticide applied with the boll weevil control program were less than for the upper estimate, hence, the base for lower estimates is the value in parentheses.

production costs of $156 million or $0.179 per pound of lint for the High and Rolling Plains. Insecticide use was estimated in thousands of pounds at approximately 921, 572, 614, 7, and 76 for malathion, toxaphene, methyl parathion, azinphosmethyl and bidrin, respectively, or a total of 2.2 million lbs. of insecticide.

Without the coordinated program, cotton output would decline more than 127,000 bales to about 1.6 million. Eighty percent of the expected decline would be in the High Plains. Costs to produce this cotton output would be $176 million or $20.4 million more than with the reproductive-diapause program (an increase of $0.039 per pound of lint). In addition to the reduced output and increased costs, the total pounds of insecticide used also would be expected to increase without the reproductive-diapause program. The total pounds of insecticide used on cotton would increase from an estimated 2.2 million lbs. with the program to about 22 million pounds in its absence, based on the upper estimates of response.

Narrowing the discussion to cotton production costs and returns throughout the High and Rolling Plains, at a specific price for cotton, program withdrawal would cause, simultaneously, an increase in production costs and a decrease in gross returns to cotton as shown in Table 4. For example, based on the upper estimate of response at a cotton price of $0.40 per pound, gross returns to cotton would decline about $25 million (from approximately $348 million to around $323 million). Due to the more than $20 million increase in expected production costs, total net returns to cotton producers would decline $46 million without the boll weevil control program, compared to the estimated current situation. This is due to reduced gross returns in conjunction with increased production costs.

The implications of this evaluation, based on upper estimates of response, are that society, for its share of the reproductive-diapause boll weevil control program ($499,000 annually), is reducing the quantity of insecticides used in cotton production by over 20 million lbs. annually and increasing cotton output by over 125,000 bales.

Lower Response Estimates. Although the effect of withdrawing the High Plains reproductive-diapause boll weevil control program is calculated to be much less with the lower estimates of response, compared to results based on the upper estimates, the effects remain somewhat large. Based on the lower estimates of response given in Table 1, withdrawal of the High Plains control program would (1) reduce cotton output more than 75,000 bales, (2) increase production costs of cotton more than 8 percent or $12.7 million, and (3) increase quantity of

Table 4. ESTIMATED EFFECT ON PRODUCER COSTS AND RETURNS OF WITHDRAWING THE HIGH PLAINS REPRODUCTIVE-DIAPAUSE BOLL WEEVIL CONTROL PROGRAM BASED ON UPPER AND LOWER ESTIMATES OF RESPONSE

Item	Unit	With the boll weevil control program	Without the boll weevil control program			
			Upper estimates		Lower Estimates	
			Total	Change from base	Total	Change from base
Gross returns[a]						
Total	$1,000,000	348.0	322.6	-25.4	332.6	-15.4
Per acre[b]	$	112	104	- 8	107	- 5
Cost of production[c]						
Total	$1,000,000	155.6	175.8	20.2	167.3	11.7
Per acre[b]	$	50	57	7	54	4
Net return						
Total	$1,000,000	192.4	146.8	-45.6	165.3	-27.1
Per acre[b]	$	62	47	-15	53	- 9

[a]Based on output given in Table 3 and a cotton lint price of $0.40 per pound.

[b]Based on 3.11 million acres of cotton in the Texas High and Rolling Plains.

[c]From Table 3.

insecticides applied by 457 percent or 8.2 million lbs. (Table 3). This suggests that even with a conservative estimate of producer response to withdrawal of the boll weevil control program, the economic and environmental effects would be significant.

A Comparison of Upper and Lower Response Estimates. The reduction in cotton output for the High and Rolling Plains due to withdrawal of the boll weevil control program was an estimated 127,000 bales (7 percent) using the upper estimates, compared to (4 percent) using the lower estimates. Similarly, the increase in production costs was over $20 million (13.7 percent) compared to about $12 million, using the upper and lower estimates, respectively. This indicates that the cost to produce a pound of cotton, without the boll weevil control program, would be 21.8 cents based on the upper estimates and 20.8 cents based on the lower estimates.

Quantity of insecticide used was estimated at 2.2 million pounds with the boll weevil control program and upper estimates and 2 million pounds with the lower estimates (a reduction of 200,000 pounds). The quantity of insecticide used, without the boll weevil control program, was estimated to increase 933 percent to 22.6 million pounds, based on the upper estimates, compared to a 476 percent increase (8 million pounds) with the lower estimates.

The final comparison of results obtained with the upper and lower response estimates relates to producer costs and returns as given in Table 4. At $0.40 a pound, net returns to cotton over-all of the High and Rolling Plains would decline over $15 per acre, based on the upper estimate, if the boll weevil control program were withdrawn. For the lower response estimates, the reduction would be only $9 per acre at $0.40 per pound of lint. The aggregate reduction in net returns in the High and Rolling Plains would be about 60 percent of that estimated using the upper estimate of response; i.e., about a $27 million reduction with lower estimates compared to a $46 million reduction with upper estimates at $0.40 per pound. Naturally, near the caprock the effect is expected to be much larger.

Some final points are needed relative to this study. First, even though a fairly wide range of estimates of response in yield and producer pest management practices was developed, concern has been expressed by some that the upper response was not large enough, while others feel that the lower response is not low enough. The response of the authors is that the data represent the "best estimate" of those most knowledgeable with the area. The limitations cannot, however, be taken lightly. There is the possiblity that if this program were continued, marginal cotton producers in the Rolling Plains near the caprock would shift to grain sorghum or cattle production and the boll weevil would naturally move away from the High Plains. If this is the case, the High Plains producers are subsidizing marginal cotton producers in the Rolling Plains with the reproductive-diapause boll weevil control program and in doing so are providing the economic incentive for continued cotton production near the caprock. Thus, the subsidy is perpetuating the boll weevil threat to the High Plains. Opinions such as these cannot be verified without further research and analysis.

Given the limitations of the study, the analysis indicates any proposal of discontinuing the reproductive-diapause boll weevil control program should be given very serious consideration as to implications on insecticide load in the environment, costs of cotton production, and output of cotton.

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