Economics of Atrazine Remediation for Representative Grain Farms in the Aquilla Watershed, Hill County, Texas

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An economic analysis of alternative best management practices (BMPs) for atrazine remediation in Hill County, Texas, was performed by the Agricultural and Food Policy Center (AFPC) at Texas A&M University. Using the farm-level economic simulation model FLIPSIM, AFPC scientists analyzed the financial effects of the alternative BMPs on the Texas Blackland Prairie representative farm. This farm consists of 2,000 dryland acres divided among corn (600 acres), sorghum (750 acres), wheat (250 acres), and native pasture (150 acres). This farm also maintains a small beef cowherd. Regularly updated, the AFPC maintains more than 95 farms across the nation that form the basis for probabilistic-based agricultural policy evaluation.

A meeting was convened August 16, 2001, of the panel farm members and AFPC personnel. In October of 1999, the same panel met to develop the baseline costs, yields, production systems, and crop mix for a representative grain farm in Hill County. The purpose of the August 16, 2001, meeting was to review the alternative weed management strategies identified by Harmon and Wang (Table 1) and to estimate changes in production costs for the alternatives. The panel farm members indicated none of these strategies would alter the historical yield distributions of any planted crops. This statement by the panel reinforces the EPIC model results reported by Harmon and Wang. The producers evaluated the alternative practices with respect to likely changes in yields and adjusted input costs, acreage mixes, and equipment complements where necessary to alter the baseline situation appropriately. The representative farm was analyzed for the years 2000-2006 assuming the atrazine remediation practices were first implemented in 2002.

The EPIC model subtasks that were applied in the farm panel analysis are denoted as the following alternatives : 4.0- baseline, 4.1- incorporation of atrazine at the time of application, 4.3- non-incorporation of atrazine with the substitution of field cultivator tillage for disc tillage, 4.4- non-incorporation of atrazine with the construction of sediment ponds, 6.1- non-incorporated split applications of atrazine in November and February, 6.2- non-incorporation of atrazine with a row planter, banding at 1/4 the normal rate, 6.3- substitution of alternative herbicides for atrazine, and 6.4-non-incorporation of atrazine and the introduction of no-till Roundup-Ready corn in place of conventionally-tilled corn. It should be noted that for alternatives 4.2 and 4.4, the farmers choose not to implement the practice and opted out of planting corn or sorghum.

Economic activity for this operation was simulated for 100 iterations incorporating historical price and yield risk for grain farms in Hill County. It was assumed the current farm program would continue through 2006 for this analysis. Table 2 summarizes the expected values of the stochastic analyses of various financial measures for each BMP. Average annual net cash farm income from 2000 through 2006 for the subtasks ranges from -$12,210 for subtask 6.2 to -$35,340 for subtasks 4.2 and 4.4. Ranking the subtasks based on average annual net cash farm income, the order of preference is: 6.2, 4.0, 4.1, 6.1, 4.3, 6.4, 6.3, 4.2, and 4.4. Subtask 6.2 calls for non-incorporation of atrazine with a row planter, banding at 1/4 the normal rate. It **should be**

noted the farm panel indicated they presently use one-half as much atrazine as was indicated for the baseline subtask 4.0. As a result, subtask 6.2 was simulated in this study as using 1/8 as much atrazine per acre as was assumed for EPIC modeling.

Despite the wide range in net cash farm income among the BMPs, a key point is that this farm is projected to generate negative net cash farm income and negative annual cash shortfalls under each alternative subtask. Significant cash reserve deficits projected for the farm may result in a sizable loss of net worth, placing the farm in a poor financial position by 2006. Under subtasks 4.2, 4.3, 4.4, 6.1, 6.3, and 6.4, the farm's average ending net worth is projected to be negative.

The results of the stochastic simulations by FLIPSIM were used to perform a ranking of stochastic dominance of the alternative subtasks (Table 3). Stochastic dominance analysis is a mathematical procedure for ranking outcomes that incur risk based on the preferences of a decision-maker. A subtask is preferred if it is ranked higher in the stochastic dominance analysis given decision-maker risk preferences. In this study, the preferences derived from simulated probability distributions for average annual net cash farm income were ranked assuming a moderately risk averse decision-maker. The most preferred dominant strategy was subtask 6.2, non-incorporated banded applications of atrazine at one-quarter the normal rate with a row planter. The next most preferred strategy was the baseline, subtask 4.0, non-incorporation of atrazine at the normal rate. Incorporation of atrazine at the time of application, subtask 4.1, was the next most preferred subtask alternative. The reduced input costs of banding applications of atrazine with no accompanying reduction in yields underlie the dominance of subtask 6.2 relative to the baseline. Similarly, slight increases in herbicide and fuel costs for both corn and grain sorghum production that are part of subtask 4.1 explain its being less preferred than subtask 4.0.

Ranking the alternatives, subtask 6.1, non-incorporated split applications of atrazine in November and February, followed subtask 4.1. Figure 1 details the cumulative probability distribution functions (CDFs) of net cash farm income for the baseline and the eight alternative subtasks. In this study, an outcome for a subtask is absolutely preferred to another subtask if its CDF is completely to the right of the other. The CDFs illustrate the preference of the four main strategies. It also reveals the relatively tight grouping of the four most dominant strategies. Of the nine scenarios, the fifth-most preferred was subtask 4.3, non-incorporation of atrazine with the substitution of field cultivator tillage for disc tillage. Following was subtask 6.4, non-incorporation of atrazine and the introduction of no-till Roundup-Ready corn in place of conventionally-tilled corn. Increased seed and herbicide costs for corn effect a decrease in within-year profitability relative subtask 4.3. These two alternatives form a middle zone of preference.

The least preferred strategies under stochastic dominance rankings were subtasks 6.3- substitution of alternative herbicides for atrazine, 4.2- non-incorporation of atrazine with 100-foot wide bermuda grass filter strips, and 4.4- non-incorporation of atrazine with the construction of sediment ponds. Subtask 6.3 imposed substantial herbicide cost increases for sorghum and corn. The increased input costs decreased net cash farm income because there were no related

increase in crop yields. Evaluation of subtasks 4.2 and 4.4 yield similar results. Under each subtask, panel members indicated they would transition feedgrain acreage to cotton production in lieu of establishing/constructing the atrazine remediation structures. As the profit potential of cotton production on this representative farm is less than the projected profitability of feedgrain production, increased cotton production decreases net cash farm income relative to the more preferred strategies.

In summary, analysis of alternative atrazine remediation practices in the Aquilla Watershed reveal preferences for strategies close to the current, baseline situation. Dramatic changes in cultural practices, such as the required construction of on-farm remediation structures, would be met with a change in crop mix.

Table 1. Summary of Sub-Tasks for Remediation of Atrazine on a Representative Grain Farm in the Aquilla Watershed.

Sub-Task	Practice	Application Identified by a Producer Focus Group
1TXBG 4.0	Non-incorporation of Atrazine	Baseline
2TXBG 4.1	Incorporate atrazine immediately after application	Increased sorghum herbicide costs in 2002 from $14.28 to $14.83 and corn herbicide costs from $17.35 to $18.39. Increased sorghum fuel costs in 2002 from $11.36 to $12.00 and corn fuel costs from $11.36 to $12.00.
3TXBG 4.2	Non-incorporation of atrazine with 100'-wide strips	Farmers would not implement this option. In 2002, the farm switched from 750 ac. of sorghum, 600 ac. of corn, 400 ac. of cotton, 250 ac. of wheat and 150 ac. of pasture to 1230 ac. of cotton, 770 ac. of wheat and 150 ac. of pasture.
4TXBG 4.3	Non-incorporation of atrazine, substitute disc tillage with field cultivator tillage	Increased sorghum fertilizer costs in 2002 from $32.55 to $44.72 because of the addition of 1 quart of Roundup. Increased sorghum fuel costs in 2002 from $11.36 to $12.92 and corn fuel costs from $11.36 to $12.92. Added a 20' flail shredder to the equipment list in 2002 at a cost of $17,714.
5TXBG 4.4	Non-incorporation of atrazine, with 20 sediment ponds	Farmers would not implement this option. In 2002, the farm switched from 750 ac. of sorghum, 600 ac. of corn, 400 ac. of cotton, 250 ac. of wheat and 150 ac. of pasture to 1230 ac. of cotton, 770 ac. of wheat and 150 ac. of pasture.
6TXBG 6.1	Non-incorporation of atrazine, two split applications at ½ the normal rate in Nov and Feb	Increased sorghum herbicide costs in 2002 from $14.28 to $15.95 and corn herbicide costs from $17.35 to $19.46.
7TXBG 6.2	Non-incorporation of atrazine with row planter, banding at 1/4 the normal rate	Decreased sorghum herbicide costs in 2002 from $14.28 to $13.21 and corn herbicide costs from $17.35 to $16.23. Incurred an incorporator expense in 2002 of $400.
8TXBG 6.3	Substitute alternative herbicides for atrazine	Increased sorghum herbicide costs in 2002 from $14.28 to $29.50 and corn herbicide costs from $17.35 to $32.52. The increase was due to switching from $2.50/ac. for atrazine to $18/ac. for a comparable herbicide.
9TXBG 6.4	Non-incorporation of atrazine, with no-till using Roundup-ready corn	Increased corn seed costs in 2002 from $21.42 to $17.53 and corn herbicide costs from $17.35 to $32.63. The increased herbicide costs come from three applications of Roundup.

Table 2. Economic Comparison of Alternative Atrazine Remediation Practices on a Representative Grain Farm in the Aquilla Watershed, 2000-2006.

Subtask	4.0	4.1	4.2	4.3	4.4	6.1	6.2	6.3	6.4
Overall Financial Position									
2000-2006 Ranking	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Total Cash Receipts ($1000)									
2000	356.99	356.99	356.99	356.99	356.99	356.99	356.99	356.99	356.99
2001	329.79	329.79	329.79	329.79	329.79	329.79	329.79	329.79	329.79
2002	332.34	332.34	412.95	332.34	412.95	332.34	332.34	332.34	332.34
2003	337.87	337.87	419.25	337.87	419.25	337.87	337.87	337.87	337.87
2004	341.39	341.39	420.60	341.39	420.60	341.39	341.39	341.39	341.39
2005	352.97	352.97	425.58	352.97	425.58	352.97	352.97	352.97	352.97
2006	356.76	356.76	435.00	356.76	435.00	356.76	356.76	356.76	356.76
2000-2006 Average	344.02	344.02	400.02	344.02	400.02	344.02	344.02	344.02	344.02
Net Cash Farm Income ($1000)									
2000	27.32	27.32	27.32	26.94	27.32	27.32	27.32	27.32	27.32
2001	-13.87	-13.87	-13.87	-14.28	-13.87	-13.87	-13.87	-13.87	-13.87
2002	-7.77	-9.81	-26.92	-18.40	-26.92	-12.72	-6.62	-29.70	-21.50
2003	-8.38	-10.62	-30.46	-19.74	-30.46	-13.79	-6.66	-32.84	-23.66
2004	-24.67	-27.15	-53.75	-37.17	-53.75	-30.65	-22.73	-52.28	-41.86
2005	-28.74	-31.51	-69.07	-42.62	-69.07	-35.39	-26.57	-59.86	-48.09
2006	-38.80	-41.90	-80.64	-54.28	-80.64	-46.23	-36.35	-73.86	-60.55
2000-2006 Average	-13.56	-15.36	-35.34	-22.79	-35.34	-17.90	-12.21	-33.59	-26.03
Ending Cash Reserves ($1000)									
2000	-21.05	-21.05	-21.05	-21.88	-21.05	-21.05	-21.05	-21.05	-21.05
2001	-81.59	-81.59	-81.59	-83.23	-81.59	-81.59	-81.59	-81.59	81.59
2002	-140.74	-142.73	-160.68	-153.38	-160.68	-145.57	-139.62	-162.44	-154.27
2003	-203.97	-207.98	-245.54	-227.48	-245.54	-213.66	-201.26	-248.32	-231.42
2004	-309.93	-316.35	-380.57	-346.29	-380.57	-325.43	-305.37	-381.23	-354.12
2005	-401.41	-410.49	-511.53	-452.12	-511.53	-423.34	-394.74	-503.40	-464.58
2006	-497.01	-509.16	-648.29	-563.17	-648.29	-526.32	-487.96	-633.87	-581.83
2000-2006 Average	-236.53	-241.34	-292.75	-263.93	-292.75	-248.14	-233.09	-290.27	-269.84
Nominal Net Worth ($1000)									
2000	470.82	470.82	470.82	483.41	470.82	470.82	470.82	470.82	470.82
2001	413.36	413.36	413.36	424.52	413.36	413.36	413.36	413.36	413.36
2002	349.50	347.51	329.57	349.17	329.57	344.67	350.62	327.80	335.97
2003	284.94	280.93	243.36	273.38	243.36	275.25	287.65	240.59	257.49
2004	196.05	189.63	125.41	171.40	125.41	180.55	200.60	124.75	151.86
2005	120.11	111.03	9.99	81.01	9.99	98.18	126.78	18.12	56.94
2006	26.21	14.07	-125.07	-29.12	-125.07	-3.10	35.26	-110.64	-58.60
2000-2006 Average	265.86	261.05	209.63	250.54	209.63	254.25	269.30	212.11	232.55

Table 3. Stochastic Dominance Results for Atrazine Remediation Alternatives on a Representative Grain Farm in the Aquilla Watershed.

Preference Level	Subtask	Mean NCFI	Std. Dev.	Coefficient of Variation	Minimum
1	6.2	-12.21	26.77	-219.18	-64.36
2	4.0	-13.56	26.79	-197.58	-65.72
3	4.1	-15.36	26.82	-174.58	-67.55
4	6.1	-17.90	26.86	-149.99	-70.12
5	4.3	-22.79	26.92	-118.11	-75.07
6	6.4	-26.03	26.94	-103.51	-78.32
7	6.3	-33.59	27.01	-80.41	-85.93
8	4.2	-35.34	30.02	-84.95	-95.63
9	4.4	-35.34	30.02	-84.95	-95.63

Figure 1. CDF of Alternative Sub-Tasks for Remediation of Atrazine for the Texas Blackland Grain Representative Farm