**MEMORANDUM**

SUBJECT: Assessment of Potential Mitigation Measures for Atrazine

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Attached is BEAD's Assessment of Potential Mitigation Measures for Atrazine. This version replaces the draft you received on Jan. 31

The assessment documents the work BEAD has performed over the past several months for the atrazine IRED. It focuses on the three major agricultural uses of atrazine - corn, sorghum, and sugarcane. BEAD estimated the biological and economic impacts of three basic mitigation options: 1) localized mitigation based on detection of atrazine residues in drinking water supplies that exceed the Agency's level of concern for human health effects; 2) across-the-board reductions in maximum seasonal application rates; and 3) implementation of best management practices intended to reduce atrazine runoff potential. We believe that the document incorporates the comments made by SRRD at the Peer Review Panel meeting on Jan. 29, 2003 and subsequent comments made by SRRD staff.

Please contact us if you have any questions.

attachment

# Assessment of Potential Mitigation Measures for Atrazine

Biological and Economic Analysis Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

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# I. EXECUTIVE SUMMARY

Atrazine was first registered in 1958 for grass and broadleaf weed control. An average of about 75 million pounds is used annually in agriculture. Three crops, corn, sorghum and sugarcane account for over 98 percent of this use. Corn accounts for the majority of use with approximately 60 to 66 million pounds applied annually. Annual use of atrazine on sorghum is estimated between 6 and 7 million pounds, and annual sugarcane use is estimated at 2.3 million pounds. Total use has remained relatively constant over the past decade. Use rates per acre have decreased but total acres treated with atrazine use have increased.

Atrazine is a widely used herbicide because it is highly effective, inexpensive and has a flexible use pattern. Atrazine is a restricted use herbicide for most uses because of its potential to migrate to ground and surface water. It must be applied by certified applicators or under the direct supervision of certified applicators.

The mitigation approaches that were considered as part of this analysis include localized restrictions for vulnerable geographic areas based on surface water monitoring for atrazine residues and reductions in maximum application rates. In addition, various best management practices were considered for use alone or as possible mitigation efforts in localized areas before cancellation would occur.

## A. CORN

The area planted to corn in the United States varies from year to year but ranges from about 70 to 75 million acres annually. About 75 percent of this crop is treated with atrazine. The majority of atrazine use on corn occurs in the major corn-producing states of Illinois, Iowa, Nebraska, Ohio, and Missouri.

Localized mitigation may involve cancellation in areas where Community Water Systems have found atrazine concentrations in drinking water that exceed the Agency's level of concern. Without the use of atrazine on the corn acreage surrounding these Community Water Systems, BEAD estimates that growers would incur average yield loss of 9 bushels of corn per acre (nationwide corn yield averaged 138 bushels per acre (bu/A) in 2001, USDA/NASS). This yield loss plus increased herbicide cost may result in an average estimated loss of $28 in net revenue per acre. The average loss can vary by region and losses within a particular region depend on climate, soil, weed pressure and the efficacy of alternative herbicides. Detailed crop budget information is available for corn and provides a basis for estimating impacts on net revenue.

An estimate of the total impact of cancellation in localized areas cannot be calculated since vulnerable areas have not been identified. However, the per acre cancellation impact for a major corn production area estimated above can apply to any specific watershed identified for localized mitigation.

BEAD also investigated the impact of potential rate reductions directed toward reducing total seasonal load of atrazine from the current estimated annual total of 63.6 million pounds. BEAD focused on estimating the reduction in total pounds used, assuming that the total corn acreage treated remained constant (at 55.8 million acres) under the different scenarios for restricting maximum seasonal application rates. On a national level, BEAD estimates that a reduction in the maximum seasonal application rate from the current 2.5 pounds of active ingredient per acre (lb ai/A) to 2.0 lb ai/A would decrease total atrazine used by a minimum of about 3.18 million pounds or 5 percent of current total atrazine use in field corn. This total reduction reflects an aggregate reduction across the 2.2 million acres estimated to have seasonal application rates greater than 2.0 lb ai/A. BEAD estimates negligible impact on net revenues under this scenario. Restricting seasonal application rates to 1.5 lb ai/A would lead to reductions in usage on 10.05 million acres, and the average net revenue loss (yield loss + increased herbicide costs) could average $6.45 per acre. BEAD estimates that a 1.5 lb ai/A seasonal rate restriction would decrease total atrazine applied by at least 7.63 million pounds, or 12 percent of current total atrazine use in field corn. Reducing the maximum application rate to 1.0 lb ai/A would lead to seasonal use reductions on 17.8 million acres , with an average net revenue loss of $14.32 per acre. This scenario is estimated to decrease total atrazine use on field corn by at least 18.4 million pounds, or 29 percent of current total. Without the availability of atrazine for all field corn production, 55.8 million acres would be affected (i.e., the total area treated with atrazine), with an average net revenue loss of about $28.31 per acre. Reductions in maximum application rate were analyzed because they are a potential component of any mitigation plan.

There are many best management practices that can be used in field corn to mitigate atrazine transport to bodies of water. Practices such as soil incorporation, banding applications, vegetative filter strips, buffer zones, or adjusting application timing can significantly influence transport of atrazine from treated areas. Best management practices could be implemented as part of any mitigation plan.

## B. SORGHUM

Sorghum is grown on about 10 million acres annually in the U.S., with an estimated 60 percent of the national crop treated with atrazine. The major sorghum atrazine use states are Kansas and Texas.

Localized mitigation may involve cancellation in areas where Community Water Systems have found atrazine concentrations in drinking water that exceed the Agency's level of concern. Cancellation is generally not expected to impact sorghum yields, but using alternative herbicides could increase production costs $11.58 per acre, or approximately 7 percent of gross revenue per acre.

One rate reduction scenario considered for sorghum was to restrict the maximum application rate to 0.75 lb ai/A. Increased costs from alternative herbicide treatments were estimated at $7.97 per acre, or 5.2 percent of gross revenue per acre. This is smaller than the estimate from cancellation because it would allow for some herbicide combinations that continue to include atrazine, albeit at lower rates.

BEAD also estimates how reducing application rates would affect total atrazine use on sorghum, currently estimated at 7.5 million pounds per year. At a maximum rate of 2.0 lb ai/A, total use would decline by approximately 375,000 pounds per year (5 percent of total); at 1.5 lb ai/A, total use would decline by approximately 900,000 pounds per year (12 percent of total); at 1.0 lb ai/A, total use would decline by approximately 2.1 million pounds per year (28 percent of total); and at 0.8 lb ai/A, total use would decline by approximately 2.9 million pounds per year (39 percent of total use).

There are many best management practices that can be used in sorghum to mitigate atrazine transport to bodies of water. Practices such as soil incorporation, banding applications, vegetative filter strips and buffer zones, or adjusting application timing can significantly influence transport of atrazine from treated areas. Best management practices or reductions in maximum application rates can be part of any mitigation program.

C. SUGARCANE

Sugarcane is grown on 1.03 million acres annually, with an estimated 89 percent of the crop treated with atrazine. The major atrazine use states are Florida, Louisiana, and Texas, with smaller amounts used in Hawaii and Puerto Rico.

Impacts from cancellation in vulnerable areas may result in significant localized impacts. For example, BEAD estimates that cancellation in a watershed with major sugarcane production, growers would experience yield losses of 10 to 40 percent and/or increased herbicide costs.

There are many best management practices that can be used in sugarcane to mitigate atrazine transport to bodies of water. Practices such as soil incorporation, banding applications, vegetative filter strips and buffer zones, or adjusting application timing can significantly influence transport of atrazine from treated areas. A best management practice that is practical in sugarcane is banding the herbicide application over the crop row. The potential for runoff reduction is significant (Selim, 2000). Best management practices could be a component of various mitigation plans.

Reductions in seasonal maximum rate to 6.0 lb ai/A would decrease atrazine used by at least 69,000 pounds or 3 percent of current total atrazine use in sugarcane. Reductions to 4.0 lb ai/A per season would decrease the number of pounds of atrazine used by at least 391,000 pounds or 17 percent of current total use in sugarcane. The estimate of total pounds reduced is based on 2.3 million pounds of atrazine used annually on sugarcane.

D. CONCLUSION

Atrazine is the preferred herbicide in warm-season grass crops, such as corn, sorghum, and sugarcane, because it is economical, has a flexible use pattern, and is highly effective against a broad spectrum of weeds. Although other herbicides are available for these crops, these alternatives result in increased herbicide expenditures, possible yield losses, and possible increases in production costs.

Three mitigation options were reviewed: localized mitigation, maximum seasonal use rate restriction, and best management practices. Seasonal use rate restrictions would have various impacts depending on the selected rate. The more the application rates are reduced, the number of acres impacted increases, and growers could face increased herbicide and production costs along with reduced yields.

The extent of acres impacted from localized mitigation will not be known until monitoring results in community water systems are reported and specific geographic areas of concern are defined. However, it is assumed that localized mitigation is intended for vulnerable areas, of which there are a limited number.

Best management practices, which can be used with localized mitigation or incorporated on a label, can significantly reduce runoff of atrazine from treated areas. Additional costs to the grower may include additional equipment or production costs.

All three mitigation options have the potential to reduce atrazine runoff, but with varying costs to the grower.

## II. INTRODUCTION

For over 40 years, atrazine has been the industry standard for broadleaf weed control in grass crops such as corn, sorghum and sugarcane because it has a flexible use pattern, is inexpensive and highly effective. However, coupled with its broad adoption across many farming areas in the U.S., atrazine's physical and chemical properties have led to contamination of some water resources.

During the last 10 years, both voluntary and mandatory risk mitigation measures have been employed to reduce both the environmental loading and the runoff of atrazine to water bodies. The amount of atrazine loading for the United States as a whole, however, has not substantially decreased. Although for the past 10 years the use of atrazine has decreased on a per acre basis, the total pounds of atrazine used has remained relatively constant due to increased acres being treated with atrazine. To further reduce the risk of atrazine contamination of water resources, the Agency has identified certain practices that have been found to reduce the amount of atrazine in water. This analysis examines potential impacts to growers adopting some of these measures.

## A. SCOPE AND LIMITATIONS OF ASSESSMENT

This analysis identifies potential impacts at grower, regional and national levels associated with the following regulatory constraints that may be placed on the use of atrazine: 1) Label restrictions based on geographical considerations such a prohibiting atrazine use in areas vulnerable to surface water contamination; 2) Rate reductions for soil applied, pre-emergence treatments; 3) Requiring incorporation for soil applied treatments; or 4) Restricting application to bands of spray along a crop row. These last two items are among best management practices that have been found to reduce runoff potential of atrazine.

There are limits to our assessment. These represent only potential short-term, one to two year estimates, on the impacts to corn, sorghum and sugarcane production systems. Production data from different sources and different years were used in this analysis. Since production varies from year to year, and sources vary in their survey and calculation methods, there may be differences in production figures within the document. Assumptions about yield and quality losses associated with the various scenarios are based on the best professional judgement of BEAD analysts because reliable, well documented estimates were not available from other sources. These assumptions are based principally on available USDA crop profiles, proprietary data and state crop production guides.

Since applications to corn, sorghum and sugarcane account for over 98 percent of atrazine used in the United States, analysis is limited to these crops. The total use of atrazine exceeded 76 million pounds of active ingredient for all sites in 2001.

## B. LOCAL RESTRICTIONS FOR VULNERABLE AREAS

A localized approach to risk mitigation can be very focused, perhaps dealing with areas within watersheds or individual fields in areas particularly vulnerable to atrazine runoff. Although this approach reduces the chance of over- or under- managing a risk problem, it can require a high level of input. For example, restrictions at a watershed level may require growers to check with a centralized source to see if their fields fall within an area of concern. Or, to work with individual growers, may involve personnel going door-to-door for education or enforcement purposes. There may also be issues to resolve that deal with grower’s privacy, state and local resources for implementation, timeliness of mitigation and federal oversight.

Raising grower awareness of the potential of atrazine to move to surface water and educating growers about Best Management Practices (described below) may be the first level of mitigation used in a localized approach. In a worst-case scenario for a particularly vulnerable area, growers would not be allowed to use atrazine. Estimated grower impacts from not being able to use atrazine for corn grown in Illinois average $28.31 per acre, due to increased herbicide costs and potentially reduced yields (see Corn Section for details). Since EPA does not know to what extent this option may be used for mitigating risk, limited regional or national impacts have been estimated.

## C. RATE REDUCTION IMPACT TO TOTAL LOADING

Three charts were created to illustrate the change in the total annual atrazine use (in pounds) that would result from reducing maximum seasonal application rates for field corn, sorghum, and sugarcane. The data used to develop these charts are based on detailed distributions of application rates availabe to EPA (through proprietary data contracts). The charts show the minimum and maximum pounds of atrazine potentially reduced at different seasonal rates, as well as the number of acres affected. The affected acres represent the cumulative acres treated with atrazine above a specified rate, and the analysis is based on the assumption that a rate reduction will lead to the maximum allowable rate on those acres (although, in fact, a particular grower may choose another weed control regimen utilizing an even lower rate of atrazine, say, in a tank mix).

These charts were developed to give an estimated impact at various rate reductions. The data available were presented as ranges of rates. Therefore, estimates of pounds used (and concomitant reductions in overall use) were computed by assuming that all treated acres within a rate range were treated at the rate representing the midpoint of the range (i.e., a 1.0 - 1.5 lb ai/A rate range would be computed as a rate of 1.25 lb ai/A for the treated acres).

For the minimum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would be treated at the reduced rate. In contrast, for the maximum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would no longer be treated with atrazine.

## D. BEST MANAGEMENT PRACTICES

The mitigation measures evaluated below were selected from a series of Best Management Practices (BMPs) identified by the Cooperative Extension Service in Kansas. These practices were evaluated for their effectiveness in reducing runoff of atrazine in surface water. These practices, when adopted by growers, were found to reduce atrazine runoff into surface water. Such reductions are accomplished by reducing the impact of the three primary factors that determine the amount of atrazine in runoff: 1) atrazine availability; 2) water runoff amount, and 3) runoff timing (Franti and Dorn, 1998). These BMPs are appropriate for most corn and sorghum-growing areas. Some changes in application timing might be needed in locations that experience a significantly different rainfall pattern than Kansas. BEAD was asked to assess the impacts from requiring the following best management practices; 1) reduction in rate, 2) require soil incorporation, 3) require application be made within an in-row band, and 4) label restrictions based on geographical considerations. A summary excerpted form a document published by Kansas Cooperative Extension is included below (see table below).

Table 1. Best Management Practices for Reducing Atrazine Run-off in Kansas Sorghum and Corn*

| Practice | Description | Benefits |
|---|---|---|
| 1. Soil Incorporation | Incorporation will reduce atrazine run-off losses by 67 percent compared to surface application without incorporation. Atrazine (for atrazine tank-mix products) can be incorporated into the top two inches of soil with a field cultivator, tandem disc, or other implement. | Less atrazine is present at the soil surface, where it is most vulnerable to run-off. A good option for growers who use tillage prior to planting. |
| 2. Application Timing | The potential run-off of atrazine can be decreased by 50 percent by applying atrazine prior to April 15 compared to applications in May and June, when rainfall intensity peaks. Early applied atrazine is more likely to get moved down into the soil by gentle rains of early spring than swept off the field by run-off water during intense late spring and early summer storms. | Helps reduce run-off potential on no-till or reduced-till fields where soil applications of atrazine are used. |
| 3. Split applications | Applying atrazine and tank-mixes as split application has the potential to reduce atrazine run-off by 25 to 33 percent compared to applying all the product at planting time. Examples include applying half to two-thirds in March and the remainder just prior to or immediately following planting. | Reduces the amount of atrazine on the soil surface during periods of higher rainfall intensities. |
| 4. Reduce Soil-Applied Rates | Formulations with low atrazine content can still provide excellent control of pigweed and other small seeded broadleaf weeds while reducing the amount of atrazine applied by as much as 33 percent. For example, "Bicep Lite" herbicide is a pre-mix of atrazine and "Dual" that at full rates contains only about one pound of atrazine per acre. "Dual", "Lasso", "Harness", "Frontier", and "Surpass" herbicides contribute substantially to pigweed control. | Maintains good weed control of small seeded broadleaf weeds while reducing atrazine rates. |
| 5. Post-emergence application of atrazine | Post-emergence mixtures contain very low rates of atrazine yet provide excellent broadleaf weed control. Using post-emergence mixtures results in 67 percent less atrazine run-off compared to typical pre-emergence soil applied atrazine applications. | By reducing the amount of atrazine applied to the soil, run-off potential is reduced. |
| 6. Combine surface applications with post-emergence atrazine. | Applying reduced soil-applied rates of approximately one pound active ingredient of atrazine per acre at planting time followed, if necessary, by a post-emergence atrazine application can reduce atrazine run-off by 25 percent compared to applying all at planting. This two-step program often provides the best control of velvetleaf, cocklebur, and other tough broadleaf weeds. | Flexible option. Can maintain excellent broadleaf weed control while reducing run-off potential. |
| 7. Alternative herbicides or non-chemical weed control methods. | New herbicides containing no atrazine are now available. Using these herbicides reduces atrazine run-off by 100 percent. However, some of these herbicides do not control ALS-resistant weeds. The use of crop rotations, cultivation, and other non-chemical weed control methods may reduce or eliminate the need for herbicides. | Can remove atrazine from the picture entirely if alternative herbicides or if non-chemical weed control methods alone provide sufficient control . |
| 8. Vegetative filter strips. | Vegetative filter strips that reduce water flow rate from the field can reduce atrazine loss up to 25 percent. Removal of atrazine from runoff water by filter strips is directly proportional to the amount of run-off water that soaks down into the filter strip. | Can reduce atrazine loss without affecting weed control effectiveness or cost. |
| 9. Band Application | Banding atrazine over the row at planting or during cultivation reduces the total amount applied on a field by 50 to 67 percent. As a result, less atrazine is available for possible run-off than when the herbicide is broadcast over the entire field. | When cultivation will be used, a good way to reduce atrazine used and still get good control. |
| 10. Buffer Zones | Avoid atrazine applications near water supplies and environmentally sensitive areas. For example, do not apply atrazine within 66 feet of inlets to tile outlet terraces. | Can reduce atrazine loss without affecting weed control effectiveness or cost. |

*Excerpted from a bulletin entitled "Best Management Practices for Atrazine" by Daniel Devlin and David Regehr, Cooperative Extension Service, Kansas State University, 1996.

## E. APPROACH TO ECONOMIC ANALYSES

The economic analysis is presented for three crops: corn, sorghum and sugarcane. Each section discusses the potential net effect on agricultural producers that a regulatory action on atrazine might generate for these crops. In 2000, EPA conducted analyses that estimated the effect of canceling or reducing maximum atrazine application rates. The analyses estimated the impacts for maximum application rates of 1.5 lb ai/A and 1.0 lb ai/A and cancellation of atrazine on field corn. Additionally, the analysis addressed production and cost-of-control changes for sorghum and sugarcane.

One limitation to this analysis is the precision of estimates of yield losses and changes in the cost of controls for each crop, and linking those to changes in revenue. Given the vast array of control alternatives and systems, as well as local variables that affect use - including soil type, rainfall events, slope, determining the proximity of treated fields to water bodies - economic impact estimates may incorporate simplifications that over estimate the true impact.

# III. IMPACTS TO FIELD CORN

## A. GENERAL INFORMATION ON FIELD CORN

1. Corn Production: The North Central region of the United States provides a favorable environment for field corn (*Zea mays*), a warm-weather annual grass requiring abundant moisture for best development. The top five corn-producing states are located in the North Central region, with Iowa and Illinois leading in United States production (see table below).

Table 2. 2001 Corn Production - Nationwide and in Top Five Producing States

| State | Area Harvested for Grain (1,000 acres) | Estimated Grain Yield Per Harvested Acre (bushels) |
|---|---:|---:|
| Iowa | 11,400 | 146 |
| Illinois | 10,850 | 152 |
| Nebraska | 7,750 | 147 |
| Minnesota | 6,200 | 130 |
| Indiana | 5,670 | 156 |
| United States | 68,808 | 138.2 |

USDA National Agricultural Statistics Service, 2001

Field corn is grown annually for grain on 60 to 70 million acres, with production exceeding 7 billion bushels. In addition, around 6 million acres of this type are harvested for silage. About 75 percent of the grain corn produced in the United States is fed to livestock, which is another common agricultural enterprise in the North Central region. From 12 to 15 percent is processed for starch, corn sugar, syrup, corn oil, corn-oil meal, gluten feed and meal, whiskey, alcohol, and for direct human consumption in the form of corn flakes, corn meal, hominy, and grits. Over 10 percent is exported (Markle, 1998).

2. Value of Production: USDA estimates that the total value of corn grain produced in 2001 at just over $19 billion based on production of about 9.5 billion bushels at the market price of $2.00 per bushel (Agricultural Statistics, 2001).

## B. ATRAZINE USE IN FIELD CORN

1. Current Use: For 2001, USDA estimates 75 percent of the corn grown in the United States was treated with atrazine, with one application at an average rate of 1.0 lb ai/A. The average rate applied per year was just slightly higher at 1.1 lb ai/A. Atrazine is used widely on corn, but the total amount varies from year to year.

   Application timing for atrazine-treated acres is apportioned as follows:
   1) pre-emergence (61 percent),
   2) post-emergence (27 percent), or
   3) both pre-emergence and post-emergence (12 percent).

   Various cultivation methods are used on atrazine-treated corn acres. About 7 percent of acres are treated with banded applications. About 12 percent of acres receiving atrazine treatments are incorporated into the soil. Conventional tillage is practiced on 42 percent of atrazine-treated acres. Conservation tillage and no-till practices account for 34 percent and 24 percent, respectively, of the atrazine-treated acres.

2. Target Pests: Atrazine controls both grass and broadleaf weeds, however it is most effective on broadleaf weeds. The table below lists weeds which atrazine controls when applied alone.

Table 3. Weeds Controlled With Atrazine Applied Alone in Corn

| **Broad leaf Weeds** | **Grass Weeds** |
|---|---|
| Annual Morningglory | Barnyardgrass |
| Cocklebur | Giant foxtail |
| Groundcherry | Green foxtail |
| Jimsonweed | Large crabgrass |
| Kochia | Watergrass |
| Lambsquarters | Wild oat |
| Mustard | Witchgrass |
| Nightshade | Yellow foxtail |
| Pigweed | |
| Purslane | |
| Ragweed | |
| Sicklepod | |
| Velvetleaf | |

(MeisterPro Information Resources, 2001)

3. <u>Use of Atrazine Compared to Other Herbicides in Field Corn</u>: USDA's National Agricultural Statistics Service reported the use of herbicides in corn for 2000 (see table below). Although about 6 percent of the atrazine is applied alone, the majority (~94 percent) of atrazine is combined with another herbicide. Metolachlor, acetochlor and alachlor are common partners for weed control in field corn because each increases the range of grass weeds controlled. All are in the top five herbicides used on field corn (see table below).

Table 4. Field Corn: Six Most Common Herbicides Applied in 2000

| Herbicide | Area Applied Percent | Number of Applications | Ave. Rate/Application lb ai/A | Total Applied (1000 lb) |
|---|---|---|---|---|
| Atrazine | 68 | 1.0 | 1.00 | 53,954 |
| Metolachlor | 27 | 1.0 | 1.37 | 27,567 |

| | | | | |
|---|---|---|---|---|
| Acetachlor | 25 | 1.0 | 1.70 | 31,442 |
| Dicamba | 21 | 1.0 | 0.20 | 3,132 |
| Alachlor | 10 | 1.0 | 1.93 | 695 |
| Nicosulfuron | 15 | 1.0 | 0.02 | 199 |

4. <u>Specific Uses of Atrazine in Field Corn Production Systems</u>: In Nebraska, a major corn-growing state, the University of Nebraska Cooperative Extension Service identified several weed control practices for various corn production methods. A description of how weed control with atrazine fits into these production practices has been included below. This document discusses weed control scenarios where atrazine is a recommended choice and uses these scenarios as the basis for assessing the potential impact from the proposed risk mitigation measures.

   a. *No-till Corn*. No-till corn planting is defined as the practice of directly planting into undisturbed soil. Vegetative cover is left on the soil surface to retard soil erosion and, in some cases, to preserve soil moisture. In conventionally tilled corn, weed control is accomplished, in part, by tilling and, usually, applying herbicide. In no-till corn, weed control is accomplished without tilling the soil. The alternative to this use of atrazine is glyphosate used alone. However, glyphosate used alone has no residual weed control; weeds emerging after application will not be controlled.

   b. *Ridge-till Corn*. In this production system, the soil is left undisturbed from harvest to planting except for strips up to one-third of the row width. Planting is completed on the ridge and usually involves the removal of the top of the ridge. Residue is left on the surface between the ridges. Ridges are rebuilt during cultivation. Ridge till is sometimes referred to as plant-till.

   c. *Treatment to a tilled seed-bed for field corn, popcorn, sweet corn and silage.* In this production system, the soil is typically tilled one or more times using mechanical implements such as a plow, disc, or harrow. This tillage disturbs established weeds and stimulates germination of seeds of annual weeds, thus killing them with tillage or making them easier to control with herbicides. Atrazine is generally not applied alone but with another herbicide targeted more toward control of grass weeds. Many alternatives to this treatment are available ranging in cost from $7.00 to nearly $55 per acre with varying levels of efficacy and ease of use.

4. *Post-emergence Treatment.* In this production practice, weed control products are applied to the field after weeds have emerged. Herbicides used at this stage in the crop cycle must be effective when applied to weed foliage. Many alternatives to this treatment are available ranging in cost from about $2.00 to $27.00 with varying levels of efficacy and ease of use.

## C. FIELD CORN: IMPACTS FROM POTENTIAL RISK MITIGATION MEASURES:

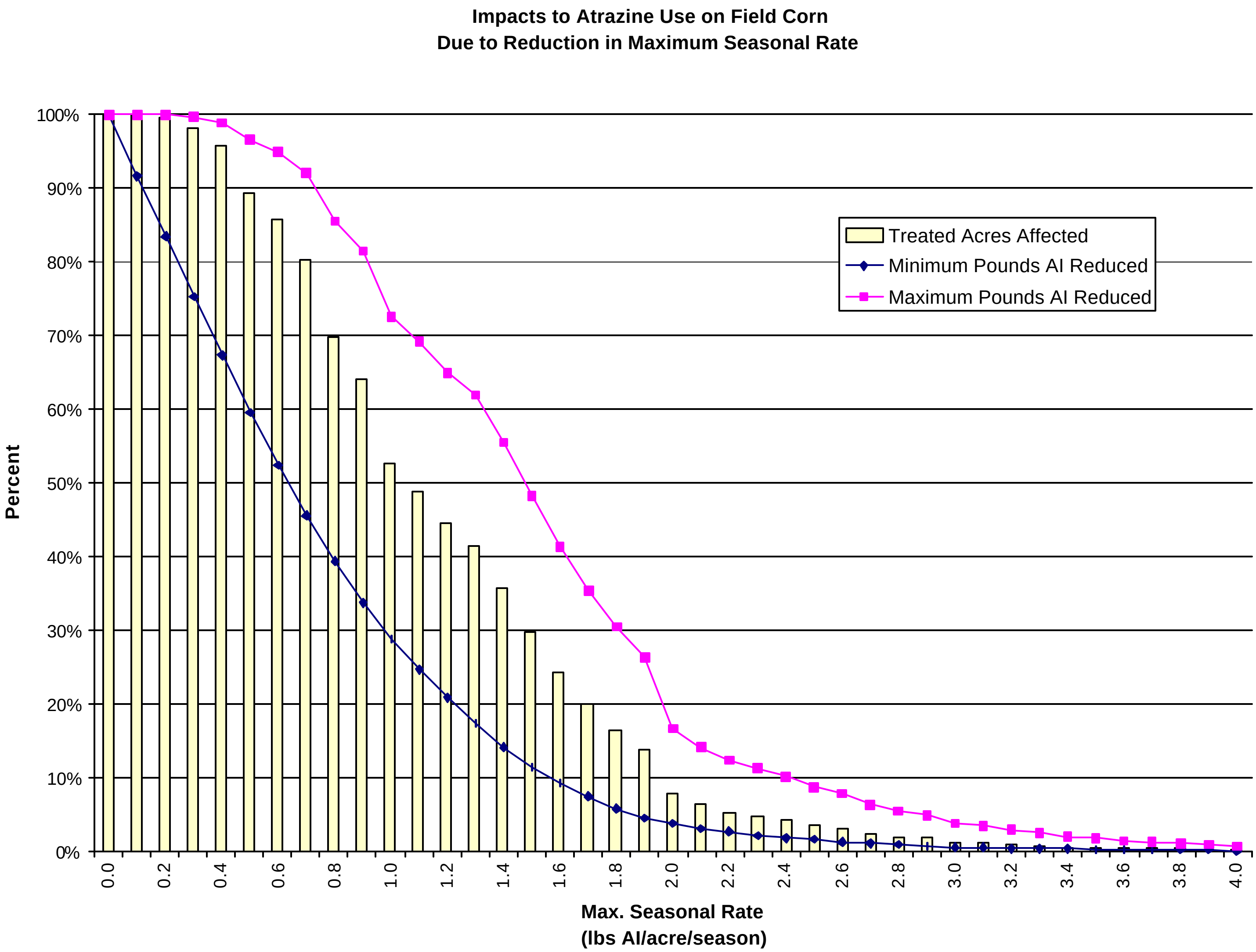
The mitigation scenarios considered include: 1) localized restrictions for vulnerable areas, 2) across-the-board reductions in seasonal maximum application rate; and 3) best management practices - soil incorporation and banding.

1. <u>Localized Risk Mitigation</u>. The impacts from the following examples of localized risk mitigation are discussed below: cancellation of atrazine use in the Community Water Systems (CWSs) with atrazine residues in drinking water in concentrations that exceed EPA's level of concern for human health risk.

   EPA estimates that yield impacts and increased weed control costs may average $28.31 per acre where atrazine is no longer allowed to be used in field corn (the next section on economic impacts for corn contains more details).

2. <u>Rate Reductions</u>: EPA also assessed the impact that a nation-wide reduction in the seasonal maximum application rate would have on growers. This assessment estimated the reduction in total amount of atrazine applied to the environment.

   a. *Acres Affected and Pounds Reduced*. The chart below describes how many acres would be impacted, nation-wide, by seasonal rate reductions for current use of atrazine for field corn. While rates in vulnerable areas would likely vary from the national distribution, this information does provide some insight into what portion of a given area would likely be impacted.




This chart illustrates the impact of reducing maximum labeled (seasonal) application rates for atrazine on field corn. EPA developed this chart using detailed data on application rates (proprietary data was obtained from private sector). The chart shows estimates of the minimum and maximum pounds of atrazine and the number of acres affected by application rate reductions. The affected acres represent the cumulative acres treated with atrazine above a specified rate.

For the minimum pounds of active ingredient curve, it was assumed that the acres treated at rates higher than a particular maximum seasonal rate would be treated at the maximum rate. This assumption probably underestimates the reduction in total atrazine use, because it is likely that a rate restriction would lead to some of those (currently exceeding) acres being treated with alternative tank mixes containing atrazine at less than the maximum rate. The curved labeled "minimum pounds AI reduced" reflects this assumption. In contrast, for the maximum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would no longer be treated with atrazine.

In estimating the impact from various atrazine rate reductions directed toward reducing total seasonal load, BEAD assumed that there would be no change in the current estimated number of corn acres treated (55.8 million). On a national level, BEAD estimates that a reduction in the maximum seasonal application rate from the current 2.5 pounds of active ingredient per acre (lb ai/A) to 2.0 lb ai/A would decrease total atrazine used by a minimum of about 3.18 million pounds or 5 percent of current total atrazine use in field corn. This total reduction reflects an aggregate reduction across the 2.2 million acres estimated to have seasonal application rates greater than 2.5 lb ai/A. BEAD estimates negligible impact on net revenues under this scenario. Restricting seasonal application rates to 1.5 lb ai/A would lead to reductions in usage on 10.05 million acres, and the average net revenue loss (yield loss + increased herbicide costs) could average $6.45 per acre. BEAD estimates that a 1.5 lb ai/A seasonal rate restriction would decrease total atrazine applied by at least 7.63 million pounds, or 12 percent of current total atrazine use in field corn. Reducing the maximum application rate to 1.0 lb ai/A would lead to seasonal use reductions on 17.8 million acres , with an average net revenue loss of $14.32 per acre. This scenario is estimated to decrease total atrazine use on field corn by at least 18.4 million pounds, or 29 percent of current total. Without the availability of atrazine for all field corn production, 55.8 million acres would be affected (i.e., the total area treated with atrazine), with an average net revenue loss of about $28.31 per acre.

b. *A Case Study on Atrazine Rate Reductions - Wisconsin*. In addition, EPA also assessed the possible impact of reductions in atrazine rates by looking at examples where rate reduction has been implemented. For example, Wisconsin promulgated the Atrazine Rule in 1991 to reduce groundwater contamination. Subsequent amendments to the rule were made for several years after original promulgation, generally to add or expand both atrazine management areas and atrazine prohibition areas. Maximum use rates in the 1993 amendment restricted rates for the entire state to: 0.75 lb ai/A for coarse textured soils; 1.0 or 1.5 lb ai/A for medium/fine textured soils (1.5 lb was only allowed on medium and fine soils if no atrazine was applied the previous year.) A rescue treatment for sweet or seed corn is allowed if total annual application does not exceed 1.5 lb ai/A on coarse soils and 2.0 lb ai/A on medium/fine textured soils. Atrazine could not be applied to 1.2 million acres in Wisconsin in 2001.

The effect of this rule on atrazine use over time was reported in Wisconsin's Final Environmental Impact Statement for Proposed 2002 Amendments to the Atrazine Rule. The information presented in the table below was obtained mostly from grower surveys:

Table 5: Effect of Atrazine Rule on Use of Atrazine Within Wisconsin

| Year | Average Rate (lb ai/A) | Corn Acres Treated with Atrazine |
|---|---|---|
| 1969 | Average not reported but up to 4 allowed by product labeling | unreported |
| 1978 | 1.5 | unreported |
| 1985 | 1.6 | unreported |
| 1990 | 1.6 | 56 percent |
| 1991 | 1.1 | 52 percent |
| 1992 | 0.89 | 59 percent |
| 1993 | 0.89 | 48 percent |
| 1994 | 0.84 | 52 percent |
| 1995 | 1.02 | 52 percent |
| 1996 | 0.75 | 51 percent |
| 1997 | 0.80 | 64 percent |
| 1998 | 0.87 | 56 percent |
| 1999 | 0.8 | 37 percent |

| | | |
|---|---|---|
| 2000 | 0.79 | 52 percent |

Over the past 10 years the percentage of the Wisconsin corn crop treated with atrazine has not changed significantly (56 percent of corn acres in 1990 versus 52 percent in 2000), but the current application rate is about one-half of what it was when the rule was promulgated in 1991(1.6 lb ai/A versus 0.79 lb ai/A).

c. *Research on Reducing Atrazine Rates.* In addition to the experience outlined above, researchers in Wisconsin were able to reduce rates to 0.8 lb ai/A or less in corn while maintaining yield and weed control by including a timely mechanical cultivation (Doll, 1992). However the researchers cautioned that reducing rates to these levels may not always be appropriate for the following reasons:

> "Cultivation, labor, and time must be available when needed. Herbicides degrade over time, and at some point a soil-applied herbicide degrades to a concentration too low to control weeds. When lower herbicide rates are used, the concentration reaches the level where weed control falls-off earlier in the growing season. Generally, if a normal rate gives 8 or more weeks of control with half the normal rate, expect 4 or more weeks of control with half the normal rate. For this reason, it is critically important to cultivate in a timely manner. Growers must be ready with a cultivator to control weeds until the crop can compete with the weeds. Cultivations must be timely (30 to 40) days after planting to be effective."

Researchers cautioned that reduced herbicide rates generally require more intense crop management. Fields must be scouted carefully to determine whether herbicides are working and, if not, timely remedial measures must be taken (Doll, 1992).

In addition, researchers stated that reduced-rate herbicide applications are not suitable for all fields. Weeds that are difficult to control with normal herbicide rates will not be adequately controlled at reduced rates. For example, in Wisconsin, shattercane, wild proso millet, woolly cupgrass, and quackgrass are difficult to control at full herbicide rates (Doll, 1992).

It appears that reductions of atrazine application rates are technically feasible, especially with the recent registration of the new herbicide, mesotrione, which is marketed in combination with atrazine (application rate of 0.75 lb ai/A of atrazine). However, weed control cost would likely be greater than using atrazine alone. The cost for this treatment would be about $23.80 per acre for mesotrione at a pre-emergence rate (6.0 oz product) plus $1.73 per acre for 0.75 lb ai/A of atrazine.

3. Impacts of Best Management Practices:

a. *Soil Incorporation.* EPA estimates that about 12 percent of the field corn acres receive soil-incorporated atrazine. Soil incorporation reduces runoff of atrazine residues with surface water. In addition, about 24 percent of the corn treated with atrazine is grown using no-till practices where soil incorporation is not an option. So EPA estimates that about 60 percent of the atrazine treated field corn would be impacted by a requirement for soil incorporation because these acres are currently part of reduced or no-till soil conservation programs. EPA has not attempted to quantify the economic impact of soil incorporation.

b. *Banded Application*. Currently, about 7 percent of atrazine-treated corn acres are being applied in bands along the corn row. About 93 percent of the atrazine-treated corn acres would be impacted by requiring banding for all applications. Growers may have to modify or obtain equipment to apply atrazine in bands. In addition, growers would likely choose to achieve weed control in the area between the rows by mechanical cultivation, which could raise issues for reduced tillage production systems, as noted above. EPA has not attempted to calculate the economic impact of this mitigation measure.

Many growers already practice mechanical cultivation. According to a survey conducted by the Wisconsin Agricultural Statistics Service, 69 percent of the corn acreage was cultivated at least once in 1990 (Doll, 1992). About 86 percent of growers surveyed in Nebraska reported using cultivation in addition to herbicides for weed control in corn. Additional cost would be associated with another trip over the field (Franti and Dorn, 1998).

## D. ECONOMIC IMPACTS TO FIELD CORN PRODUCTION FROM POTENTIAL ATRAZINE MITIGATION

Nationally, atrazine use on corn accounts for approximately 85 percent of the total pounds used in agriculture. Field corn accounts for nearly all the corn use. Sweet corn and popcorn together account for about one percent of atrazine use in agriculture. The average annual rate per acre is 1.1 lb ai/A per year and the number of applications is about 1.1 per year. To calculate the economic impacts of restricting use of atrazine on field corn, EPA used the 1998 North Central Weed Science Society comparative performance data to determine yield and changes in yield from different herbicide rates in corn. EPA also used USDA and proprietary data that contained national and state-level information on application rate, crop price and production estimates.

1. Total Economic Impacts. To calculate the total impacts of reducing maximum application rates nation-wide, aggregate impacts were calculated for the expected 'impacted' acres, and not simply the total acres treated with atrazine. For example, BEAD analyzed a scenario reducing the maximum seasonal application rate for atrazine from 2.5 lb ai/A to 1.5 lb ai/A. Only those atrazine users who intended to apply atrazine at a rate higher than 1.5 lb ai/A would be impacted by the 1.5 lb ai/A restriction. Based on 2000 pesticide use survey data, that amounts to about 18 percent of all acres treated with atrazine. The total economic impacts of implementing a national restriction is the per acre impact multiplied by 18 percent of the base acres treated nationally. Table 6 highlights the estimated impacted acres for atrazine. An additional rate restriction scenario of 2.0 lb ai/A was added for illustrative purposes.

Table 6. Acres Impacted by Regulatory Scenario

| Herbicide: Use Restriction Scenario | percent Base Acres | Total Acres Impacted |
|---|---|---|
| Atrazine: Total Base Acres Treated | | 55,831,000 |
| Scenario 1: Rate: 2.0 lb ai/A | 4 percent | 2,233,000 |
| Scenario 2: Rate: 1.5 lb ai/A | 18 percent | 10,049,000 |
| Scenario 3: Rate: 1.0 lb ai/A | 32 percent | 17,866,000 |
| Scenario 4: Ban | 100 percent | 55,831,000 |

Table 7 below presents the total economic impact for three scenarios of national rate restrictions based on 2000 year EPA data. The three scenarios include a maximum seasonal rate restriction of 1.5 lb ai/A, a 1 lb ai/A restriction and total ban. The yield and cost impacts are disaggregated by region, and pertain to the atrazine-treated acres.

In Table 7, the first column lists the eleven regions in the U.S. that were analyzed. These regions are those used in the AGSIM© model developed by C. Robert Taylor. AGSIM© is an econometric simulation model of regional crop and livestock production in the United States. It is used to evaluate aggregate effects of changes in crop yields; production costs by region; changes in target prices and set-aside rates; changes in paid land diversion for both crop and region; as well as other exogenous changes in regional agricultural production. Because previous BEAD analyses were oriented around analyses using this economic tool, the regional delineations used in BEAD's analysis mirror the AGSIM© model (these regions are also aligned with eleven farm production regions formerly used by the Economic Research Service at USDA). Alabama is considered a separate region because of Taylor's research at Auburn University. The regions include the following states:

Region 1: Alabama - considered a separate region for analytical purposes;
Region 2: Appalachian - Kentucky, Tennessee, West Virginia, Virginia and North Carolina;
Region 3: Corn Belt - Iowa, Missouri, Illinois, Indiana, and Ohio;
Region 4: Delta - Mississippi, Louisiana and Arkansas;
Region 5: Lake States - Minnesota, Wisconsin, and Michigan;
Region 6: Mountain - Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico;
Region 7: Northeast - Maine, Vermont, New Hampshire, New York, Massachusetts, Connecticut, Rhode Island, Pennsylvania, New Jersey, Maryland and Delaware;
Region 8: Northern Plains - North Dakota, South Dakota, Nebraska and Kansas;
Region 9: Southeast - South Carolina, Georgia, Alabama, and Florida;
Region 10: Southern Plains - Oklahoma and Texas;
Region 11: West - California, Oregon and Washington.

The impact estimates for these regions are based on actual field conditions (atrazine application rates, weed pressure), and the estimates can be overlaid with trigger/action information from individual states. This allows one to generate national estimates of yield and costs changes.

The second column lists an estimate of yield impact, or the reduction in yield (in bushels), for growers that use atrazine above the rate restriction scenario. To determine yield impacts, a product performance database was developed from data submitted to EPA by the Triazine Network, in support of the special review for the triazine herbicides (Triazine Network, 1996). The Triazine Network database consisted of comparative performance field studies submitted to the North Central Weed Science Society, and published in research reports from 1986 to 1995. The studies in the Triazine Network report were almost all conducted by university scientists and compared corn and sorghum yields from herbicide treatments containing various rates of atrazine and other herbicides.

Yield impacts are based on the treatment scheme under an atrazine rate restriction (for example, 1.5 lb ai/A) that leads to the least impact on net revenue. The least impact is a combination of yield and price impacts (revenue) and the change in herbicide application costs, calculated using prices for pesticides from EPA databases. Having determined the net revenue impact of various treatment scenarios, the weed pressures occurring in herbicide trials were matched to EPA data on weed infestations on actual corn farms in various locations around the country. This allowed us to determine the most likely alternative treatment in a given region where the chosen treatment may have been a combination of atrazine (at less than 1.5 lb ai/A) and other herbicides. Differences in weed infestations across regions are the primary reason that impacts vary across regions. Cost impacts are given as increases in costs, and net revenue impacts in the last column represent losses (using parentheses). The results probably overestimate losses due to the age of the data and the availability of new, more effective and affordable tank mixes of herbicides.

The economic impacts of restricting rates to 1.5 lb ai/A nationally (Scenario 1) is presented in the top one-third of Table 7. Under this scenario, an average estimated yield loss of 1.2 bu/A, and costs increase of $3.33 per acre are expected on average, nationally. From a partial budget approach, this amounts to a decline in net revenues of $6.45 per acre (based on an assumed price of corn of $2.60 per bushel), or total economic losses of $64.8 million across 18 percent (10.05 million acres) of the 55.8 million acres treated with atrazine. In 2000, 9.968 billion bushels of corn were produced. At $2.60 per bushel, a 1.5 lb ai/A rate restriction would result in estimated revenue losses that account to a total revenue reduction of less than 1 percent for corn nationally. (In this analysis, BEAD used the target price under the 2002 Farm Bill, rather than the market price, because growers use target price to make many decisions).

The impacts of the (unlikely) scenario of a national ban on atrazine use (Scenario 3) are: national average yield losses of 8.8 bu/A, and a cost increase of $5.43 per acre. From a partial budgeting approach, this amounts to a decline in net revenues of $28.31 per acre (assuming the price of corn is $2.60 per bushel) or total economic losses of $1.580 billion over the 55.8 million acres.

Table 7. 2000 Economic Impacts of Restricting Use of Atrazine on Field Corn

| Atrazine Use Restrictions, Scenario 1 (application rate restricted to 1.5 ai/A per season). | | | |
|---|---|---|---|
| | Yield Impact | Cost Impact | Net Rev Impact |
| REGION | (Bu/A) | ($/A) | ($/A) |
| Alabama | -0.1 | $0.22 | ($0.48) |
| Appalachian | -1.3 | $2.70 | ($6.08) |
| Corn Belt | -1.1 | $3.72 | ($6.58) |
| Delta | -0.2 | $0.60 | ($1.12) |
| Lake States | -1.3 | $4.48 | ($7.86) |
| Mountain | -1.3 | $2.12 | ($5.50) |
| Northeast | -0.9 | $3.96 | ($6.30) |

| | | | |
|---|---|---|---|
| Northern Plains | -1.6 | $2.84 | ($7.00) |
| Southeast | -0.7 | $1.73 | ($3.55) |
| Southern Plains | -0.5 | $0.81 | ($2.11) |
| West | -0.6 | $1.88 | ($3.44) |
| **US Total** | **-1.2** | **$3.33** | **($6.45)** |
| Atrazine Use Restrictions, Scenario 2 (application rate restricted to 1.0ai/A per season). | | | |
| | Yield Impact | Cost Impact | Net Rev Impact |
| REGION | (Bu/A) | ($/A) | ($/A) |
| Alabama | -5.1 | $7.80 | ($21.06) |
| Appalachian | -4.9 | $5.31 | ($18.05) |
| Corn Belt | -3.5 | $4.30 | ($13.40) |
| Delta | -4.7 | $5.52 | ($17.74) |
| Lake States | -3.5 | $5.10 | ($14.20) |
| Mountain | -2.6 | $4.71 | ($11.47) |
| Northeast | -3.5 | $5.17 | ($14.27) |
| Northern Plains | -3.9 | $4.85 | ($14.99) |
| Southeast | -5.1 | $4.83 | ($18.09) |
| Southern Plains | -2.6 | $5.69 | ($12.45) |
| West | -2 | $1.97 | ($7.17) |
| **US Total** | **-3.7** | **$4.70** | **($14.32)** |
| Atrazine Use Restrictions, Scenario 3 (application rate restricted to 0 ai/A per season). | | | |
| | Yield Impact | Cost Impact | Net Rev Impact |
| REGION | (Bu/A) | ($/A) | ($/A) |
| Alabama | -13.6 | $9.23 | ($44.59) |
| Appalachian | -13.1 | $6.34 | ($40.40) |
| Corn Belt | -9.1 | $5.23 | ($28.89) |
| Delta | -12.3 | $6.01 | ($37.99) |
| Lake States | -8.5 | $5.94 | ($28.04) |
| Mountain | -5.3 | $4.72 | ($18.50) |
| Northeast | -8.3 | $6.25 | ($27.83) |
| Northern Plains | -7.5 | $4.87 | ($24.37) |
| Southeast | -11.1 | $5.33 | ($34.19) |
| Southern Plains | -5.1 | $6.76 | ($20.02) |
| West | -6.1 | $0.66 | ($16.52) |
| **US Total** | **-8.8** | **$5.43** | **($28.31)** |

Not surprisingly, per acre impacts decrease with the more relaxed use restrictions. We assumed that in the unrestricted case (baseline), growers can choose any treatment. The effect of lowering the maximum seasonal application rate (or any restriction) would force growers to choose a treatment regime with the lowest impact on net revenues, with the impact a combination of decreased yields and increases in pesticide application cost. A more restrictive maximum seasonal rate (reducing the maximum from 1.5 to 1 lb ai/A) had the effect of taking away more tools available to the grower; thereby further reducing his/her potential maximum returns. It is also important to recognize that as seasonal maximum rates become more restrictive, more growers are acres are likely be affected. For example, 18 percent of the acres treated with atrazine would be impacted by the 1.5 lb ai/A maximum, while 49 percent of the acreage is affected by the 1.0 lb ai/A maximum per season restriction.

To estimate the impact in percentage terms, we used 2001 USDA Agricultural Statistics where the average yield per harvested acre in 2000 was 137 bushels. Using this estimate, yield losses based on a rate restriction of 1.5 lb ai/A amount to less than 1 percent of the average acre bushel production. The estimated average $6.45 loss in per acre net revenues equates to a per acre decrease of about 1.7 percent on those 18 percent of acres affected by this restriction (using national averages yield of 137 bu/A and a price at $2.60 per bushel).

If the maximum rate were restricted to 1.0 lb ai/A per season, the estimated yield losses amount to 2.7 percent (-3.7bu/A / 137 bu/A). The average reduction in net revenues of $14.77 per acre represents a 4 percent net revenue loss, for the 49 percent of corn acres affected (again, using national averages for yield and price).

Given that current corn prices, including support payments, are about $2.60 per bushel, that the number of acres in production fluctuates but has declined slightly, and that the number of alternatives to atrazine has increased since the triazine network gathered their product performance data, these loss estimates are considered conservative and probably overestimate the actual losses. But, for those individual growers who use atrazine according to label directions much above the hypothetical rate restrictions in regions where atrazine could be restricted or banned, the impact could be much greater. For impacted growers to switch to an alternative control, the return to revenue would have to be equal to or greater than the cost of the alternative control that would be substituted for atrazine.

2. Local Level Impacts Under a Ban Scenario. Impacts at the local level are dependent upon local mitigation strategies and the impacts on producer's yield. EPA does not yet know the number of acres that will be impacted under a localized mitigation scenario. The average per acre yield loss expected under a cancellation scenario is 8.8 bu/A, which would result in a net revenue impact of $28.31, although with localized mitigation, growers may have an opportunity to use other methods to reduce run-off including best management practices, such as band application or soil incorporation.
At the more restrictive use rates, impacts are assumed to be overestimates, because as the maximum seasonal rate is further restricted, decreases in yields and increases in production costs will probably force growers to seek economically viable alternatives, based on various alternative control costs and their associated efficacy.

## IV. IMPACTS TO SWEET CORN

### A. GENERAL INFORMATION ON SWEET CORN

Sweet corn (*Zea mays* rugosa) is a food crop that is harvested for both processing and the fresh market. Processing accounts for roughly two-thirds of the sweet corn market, and fresh corn accounts for the remaining one-third. The total amount of sweet corn harvested in the U.S. was 705,800 acres in 2000 and about 702,000 acres in 2001. Minnesota produces the most sweet corn for processing, and Florida is produces the most fresh market corn (growing about 75 percent of their fresh corn on muck soils). Popcorn is grown on a much smaller scale. (Markle, 1998; FL Sweet Corn Timeline, 2002; Crop Profile for Sweet Corn in FL, 2002).

1. <u>Processing Sweet Corn</u> In 2000, about 460,000 acres of sweet corn were harvested for processing. In 2001, about 446,000 acres of processing sweet corn were harvested. The North Central Region, consisting of Minnesota and Wisconsin, harvested about 48 percent of the sweet corn grown for processing in 2000 and about 51 percent in 2001. The Northwest Region, consisting of Washington, Oregon, and Idaho, harvested about 33 percent in 2000 and about 28 percent in 2001 (2001 figure does not include Idaho).

   The top five states in 2000 were: Minnesota (28 percent of U.S. production), Washington (21 percent), Wisconsin (20 percent), Oregon (8 percent) and New York (6 percent).

Table 8. Production of Sweet Corn Grown for Processing

| State | Area Harvested, Acres (2000) | Area Harvested, Acres (2001)[1] |
|---|---|---|
| Minnesota | 129,400 | 130,200 |
| Washington | 98,600 | 95,100 |
| Wisconsin | 92,900 | 98,800 |
| Oregon | 35,700 | 29,100 |
| New York | 29,000 | 29,200 |
| Total U.S. | 459,700 | 446,450 |

USDA Agricultural Statistics, 2002.

[1] The 2001 information was based on preliminary data.

2. Fresh Market Sweet Corn In 2000, 246,000 acres of fresh market sweet corn were harvested in the U.S. In 2001, approximately 256,000 acres were harvested. The top five states in 2000 were: Florida (15 percent of U.S. production), New York (11 percent), California (10 percent), Georgia (9 percent), and Pennsylvania (8 percent).

Table 9. Fresh Market Sweet Corn Production

| **State** | **Area Harvested, Acres (2000)** | **Area Harvested, Acres (2001)[1]** |
|---|---|---|
| Florida | 37,400 | 37,900 |
| New York | 27,500 | 33,400 |
| California | 24,000 | 25,000 |
| Georgia | 21,000 | 25,000 |
| Pennsylvania | 18,900 | 17,100 |
| Total U.S. | 246,100 | 255,900 |

USDA Agricultural Statistics, 2002.
[1] The 2001 information was based on preliminary data.

## B. ATRAZINE USE IN SWEET CORN

1. Current Use The Agency estimates that approximately 501,000 lb of atrazine is applied to 513,000 acres of sweet corn annually (based on a four-year average, using EPA proprietary data).

Of the sweet corn acreage receiving atrazine applications, 20 percent receive atrazine alone, and 80 percent receive atrazine in a mix. About 72 percent of the atrazine is applied pre-emergence and about 28 percent is applied post-emergence. Over 99 percent of atrazine on sweet corn is applied with ground equipment (EPA proprietary data).

In Florida, higher rates of atrazine are necessary on most acreage because 75 percent of production occurs on muck soils. Atrazine binds more easily to muck soils than other soils due to high organic matter; therefore, more atrazine must be used for effective control. Herbicides are typically applied between October and April (FL Sweet Corn Timeline, 2002).

Atrazine rates vary across regions. In the North Central region, which includes

Minnesota, Wisconsin, and Michigan, the average application rate is 0.8 lb ai/A. In California, the average rate is 1.3 lb ai/A. In the Southeast, including Florida and Georgia, the average rate is 1.2 lb ai/A. In the Northwest, including Washington, Oregon, and Idaho, the average application rate is 1.0 lb ai/A (EPA proprietary data).

2. Target Pests Atrazine is used to control annual broadleaf weeds and annual grasses. These weeds include barnyardgrass, giant foxtail, green foxtail, large crabgrass, watergrass, wild oat, witchgrass, yellow foxtail, cocklebur, buttonweed, groundcherry, jimsonweed, kochia, lambsquarters, annual morning glory, mustard, nightshade, pigweed, purslane, ragweed, sicklepod, smartweed, velvetleaf, and wild buckwheat.

3. Use of Atrazine Compared to Other Herbicides Used in Sweet Corn Atrazine is the most widely used herbicide used in sweet corn. Other major herbicides are listed in the tables below.

Table 10. Top 5 Herbicides Used in Fresh Market Sweet Corn

| Herbicides | percent Area Applied | Applications (Ave. No.) | Rate/CropYear (Total Apps.) | Total applied (1000 lb) |
|---|---|---|---|---|
| Atrazine | 61 | 1.0 | 1.20 | 149.3 |
| Metolachlor | 40 | 1.0 | 1.79 | 146.2 |
| Alachlor | 9 | 1.1 | 1.79 | 33.8 |
| Pendimethalin | 6 | 1.0 | 1.20 | 15.6 |
| Bentazon | 5 | 1.2 | 0.92 | 9.3 |

USDA NASS Agricultural Chemicals, 2000.

Table 11. Top 6 Herbicides Used in Processing Sweet Corn

| Herbicides | percent Area Applied | Applications (Ave. No.) | Rate/CropYear (Total Apps.) | Total applied (1000 lb) |
|---|---|---|---|---|
| Atrazine | 63 | 1.0 | 0.75 | 198.8 |
| Metolachlor | 28 | 1.0 | 1.70 | 203.0 |
| Bentazon | 23 | 1.0 | 0.53 | 51.4 |

| | | | | |
|---|---|---|---|---|
| Alachlor | 19 | 1.0 | 2.17 | 173.9 |
| Dimethenamid | 17 | 1.0 | 1.28 | 91.0 |
| Pendimethalin | 11 | 1.0 | 0.77 | 34.4 |

USDA NASS Agricultural Chemicals, 2000.

4. Alternatives to Atrazine Listed in the table below are other herbicides registered on sweet corn, the type of weeds controlled by each herbicide, and the use and/or limitations of each herbicide as an alternative to atrazine.

Table 12. Potential Alternatives for Sweet Corn

| Alternative | Weeds Controlled | Use/Limitations |
|---|---|---|
| 2,4-D | broadleaf weeds | may cause crop injury |
| alachlor | grasses, sedges, broadleaf weeds | PPI, PRE |
| ametryn | broadleaf weeds, grasses, sedges | POST; do not wet corn foliage or spray into whorl or crop injury will occur; post directed - need specialized equipment |
| bentazon | broadleaf weeds | early POST |
| butylate | grasses | |
| carfentrazone | broadleaf weeds | POST; narrow spectrum control, some suppression of other weeds; often mixed with atrazine; some sensitivity concerns; not registered in CA |
| dimethenamid | grasses, broadleaf weeds, sedges | PP, PPI, PRE, POST |
| EPTC | grasses, broadleaf weeds | PPI; crop injury possible with unfavorable conditions or certain hybrids |
| glyphosate | grasses, sedges, broadleaf weeds | PP, PRE; may not contact corn foliage |
| halosulfuron | broadleaf weeds | not for use on “Jubilee” sweet corn; rotational restrictions |

| | | |
|---|---|---|
| linuron | broadleaf weeds, grasses | POST; do not wet corn foliage or spray into whorl or crop injury will occur - post directed - need specialized equipment |
| s-metolachlor | primarily grasses, broadleaf weeds | PP, PPI, PRE, POST; do not use on muck or peat soils; nor in Nassau Co. or Suffolk Co., NY |
| nicosulfuron | grasses and broadleaf weeds | registered on select processed sweet corn hybrids; cannot be used on fresh market corn |
| paraquat | annual broadleaf, grasses | PP, PRE, POST; post must be directed and to plants $ 10 in. - need specialized equipment |
| pendimethalin | grasses, broadleaf weeds | PRE, early POST; PPI will cause crop injury; not peat or muck soils |
| simazine | annual broadleaf, grasses | PP, PRE; rotational restriction (see label for state restrictions) |

(Crop Profile for Sweet Corn in NC Region, 2001; Weed Control Manual, 2002).
In addition, fluroxypyr was used under provisions of emergency exemption and oxyfluorfen was used in an eradication program in North and South Carolina. Cyanazine was not included since its use is prohibited after December 31, 2002.
PPI - Preplant incorporated application timing.
PRE - Pre-emergence application timing.
POST - Post-emergence application timing.
PP - Preplant application timing.

C. IMPACTS FROM POTENTIAL RISK MITIGATION MEASURES

The following mitigation scenarios were considered: 1) localized mitigation in vulnerable areas; 2) rate reductions.

1. Localized Mitigation At this time EPA cannot reasonably estimate the number of acres of sweet corn that would be affected under this mitigation scenario. However, EPA believes that there would be minimal impact on sweet corn because its production patterns are widely distributed and hence atrazine use on sweet corn would not be concentrated in any area.

In Wisconsin, in areas where atrazine use on sweet corn has been cancelled locally, the alternatives have not always been adequate. Not only have they been less effective, but they are also more expensive. The State has needed emergency exemptions (carfentrazone, glufosinate, and mesotrione) for weed control in 1999 - 2002 (Crop Profile for Sweet Corn in NC Region, 2001). Some sweet corn varieties are sensitive to certain pesticides and may sustain crop injury, limiting the number of alternatives available for certain varieties.

There are several herbicides registered on sweet corn. Atrazine at the 2.2 lb product per acre rate is $6.20 per acre. Other products range in price from $0.90 to $22.80 per acre, although they may have limitations or may already be used for weed control in sweet corn (University of Nebraska Cooperative Extension, Guide for Weed Management, 2002).

2. Rate Reduction Approximately 20 percent of the atrazine applied to sweet corn is applied alone and about 80 percent is applied in a mixture. The table below describes the distribution of single application rates for atrazine in sweet corn. A indication of the acres impacted from various reductions in maximum application rate can be obtained from this table. For example, from the overall reduction to a maximum seasonal rate of 2 lb ai/A from 2.5 lb ai/A, less than 1 percent of the acres will be impacted. The impact is expected to be minimal given the average number of applications (1.0 application per year) with the average application rate (1.11 ai/A for fresh market and 0.71 ai/A processed). According to an impact curve, reducing the rate to 2 lb ai/A will result in a 3 to 6 percent reduction in the pounds applied for sweet corn, and would affect about 5 percent of the acreage. However, because the curve was developed using single application rates and does not account for multiple applications, this reduction may be underestimated.

**Table 13.** Atrazine Use in Sweet Corn: Cumulative Rate Distribution From Single Applications

| Atrazine Applied: | Total Atrazine Applied: Certain Rates (lb ai/A) - Cumulative Percentage | | | | | | |
|---|---|---|---|---|---|---|---|
| | #0.5 | #0.8 | #1.0 | #1.3 | #1.5 | #1.8 | #2.0 |
| Alone | 4% | 17% | 60% | 65% | 80% | 91% | 99% |
| Mixed | 22% | 56% | 78% | 85% | 90% | 95% | 99% |

(EPA proprietary data)

## V. IMPACTS TO POPCORN

### A. GENERAL INFORMATION ON POPCORN

The major popcorn (*Zea mays* everta) growing region in the U.S. is the Midwest.

Based on acres harvested in 1999 the major popcorn growing states were Indiana, Nebraska, Illinois, Indiana, and Iowa. These accounted for approximately 85 percent of the 247,400 acres harvested in 1999. A smaller percentage of the acreage is from other states in this region and in others (From 2000 Popcorn Board Acreage Report, USDA Crop Profile for Corn (Pop) in the U.S., 2001).

## B. ATRAZINE USE ON POPCORN

Although some popcorn acreage is treated with atrazine alone, the majority of the acreage is treated with atrazine combined with another herbicide such as, metolachlor, dimethenamid, and bentazon. The average rate when atrazine is used alone is 0.85 lb ai/A to 1.35 lb ai/A. According to the USDA Crop Profile, growers consider atrazine to be critical. Without atrazine, it is expected that yields would be reduced and that fewer acres would be planted to popcorn. Also, many alternatives have a tendency to cause injury to the crop (Crop Profile for Corn (Pop) in U.S. (North Central Region), 2001).

## C. IMPACT FROM POTENTIAL RISK MITIGATION MEASURES

The impact of the mitigation scenarios is expected to be similar to sweet corn. However, because limited information is available about which counties have popcorn acreage, it is difficult to estimate the impacts of cancelling geographically or of reducing the maximum seasonal application rate to 0.75 lb ai/A. Given that the average use rates are above 0.75 lb ai/A, EPA expects some impact if atrazine is prohibited in vulnerable areas or the rate is reduced in areas of concern. EPA cannot quantify the impacts due to limited information available for popcorn growing counties. A seasonal maximum rate of 2 lb ai/A is expected to impact less than 5 percent of the popcorn acres grown.

There are several chemicals registered on pop corn. Atrazine at the 2.0 lb ai/A rate is $6.20 per acre. Other products range in price from $2.65 to $25.00, although they may have limitations or may already be used for weed control in pop corn (Nebraska Cooperative Extension).

# VI. IMPACTS TO SORGHUM

## A. GENERAL INFORMATION ON SORGHUM

1. Sorghum Production A description of sorghum and its significance has been included so that readers may better understand the impact from potential changes in the allowed use of atrazine for weed control in sorghum.

Sorghum (*Sorghum halapense*) is a coarse annual cereal crop grown worldwide for grain, forage, syrup and fiber. Each of these uses of sorghum are discussed below. In the U.S., sorghum is grown principally for grain to feed livestock in the plains states. The table below includes production from the top five sorghum-producing states in the U.S. Kansas and Texas dominate domestic sorghum production.

Grain Sorghum. More than 95 percent of the grain sorghum consumed in the U.S. is used as feed for livestock. Historically, about one third of the U.S. sorghum grain crop has been exported for food, mainly to Japan, India and Europe, mostly to make bread and beer. Some grain sorghum is used domestically for industrial purposes, such as for adhesives, sizing for paper and fabrics, and in the "mud" used in drilling for oil. Grain sorghum is also used to produce butyl and ethyl alcohol.

Grain sorghum is well suited to the dry plains states because of its resistance to drought. Although dryland production is far more prevalent, sorghum is also grown under irrigated conditions. Dwarf varieties are grown domestically since they grow no more than five feet tall and are suitable for harvest by combine. (Crop Profile for Sorghum in Kansas).

Sorghum for Forage. In 2001, USDA reports that 336,000 acres of sorghum were harvested for forage with an average yield of about 11 tons per acre.

Sorghum for Syrup. Sweet sorghum, which is closely related to grain sorghum, is grown for syrup on small plots, usually less than one acre per farm.

Table 14. Sorghum Grain Production - Nationwide and in Top Five Producing States for 2001

| State | Total Area Planted For All Purposes (1,000 acres) | Area Harvested for Grain (1,000 acres) | Estimated Bushels Harvested/Acre |
|---|---|---|---|
| Kansas | 4,000 | 3,750 | 62 |

| | | | |
|---|---|---|---|
| Texas | 3,500 | 2,600 | 50 |
| Nebraska | 550 | 425 | 84 |
| Oklahoma | 500 | 420 | 36 |
| Colorado | 310 | 220 | 43 |
| USA total | 10,252 | 8,584 | 60 |

Agricultural Statistics 2001

2. Value of Production In 2001, a total of 524 million bushels of sorghum grain were harvested nationwide. Total value of grain production was estimated at $1.02 billion, with an average reported price per bushel of $1.95. Total area of sorghum harvested for silage was 336,000 acres, with an average yield of 11.1 tons per harvested acre.

B. ATRAZINE USE IN SORGHUM

1. Current Use On a national average, nearly all of the atrazine used in sorghum is applied at rates ranging from less than 0.5 to 2 lb ai/A with nearly two-thirds of the area being treated with one pound or less of active ingredient per acre (EPA proprietary data). However, a significant portion of sorghum treated with atrazine is treated at 2 lb ai/A. Atrazine is used to control annual broadleaf weeds and some annual grass weeds. Atrazine is effective at many application timings including: winter weed control, and pre-plant for control of weeds prior to planting through post-plant as long as weeds are no more than one and one-half inches and sorghum is six to 12 inches tall.

2. Target Pests Atrazine is used mainly for control of annual broadleaf weeds in grass crops although it does provide some control of annual grass weeds. The weeds below are listed on the label as being controlled by atrazine when applied alone (MeisterPro, 2002):

Table 15. Weeds Controlled With Atrazine Applied Alone

| Broad leaf Weeds | Grass Weeds |
|---|---|
| Annual Morning-glory | Barnyardgrass |
| Cocklebur | Giant foxtail |
| Groundcherry | Green foxtail |

| | |
|---|---|
| Jimsonweed | Large crabgrass |
| Kochia | Wild oat |
| Lambsquarters | Witchgrass |
| Mustard | Yellow foxtail |
| Nightshade | |
| Pigweed | |
| Purslane | |
| Ragweed | |
| Sicklepod | |
| Velvetleaf | |

3. Comparison of Atrazine to Other Herbicides Used in Sorghum Production

USDA/NASS reported the following uses of herbicide in sorghum in Kansas for 1998 (the most recent data available from USDA).

Table 16. Sorghum: Herbicide Applications in Kansas, 1998

| Herbicide | Area Applied (Percent) | Applications (Number) | Rate/Application (lb ai/A) | Total Applied (1000 Lb.) |
|---|---|---|---|---|
| Atrazine | 82 | 1.1 | 1.12 | 3,572 |
| Metolachlor | 40 | 1.0 | 1.55 | 2,207 |
| 2,4-D | 18 | 1.1 | 0.29 | 205 |
| Glyphosate | 17 | 1.5 | 0.45 | 414 |
| Alachlor | 10 | 1.0 | 1.93 | 695 |
| Dicamba | 10 | 1.2 | 0.22 | 97 |
| Dimethenamid | 5 | 1.0 | 1.26 | 215 |
| Prosulfuron | 5 | 1.0 | 0.02 | 5 |
| Propachlor | 3 | 1.0 | 2.44 | 249 |

Planted acres in 1998 for Kansas were 3.50 million acres.

4. Specific Uses of Atrazine in Sorghum

The Texas Agricultural Extension Service recommends atrazine for the following weed control scenarios in sorghum.

a. *Winter Weed Control*: Atrazine is recommended alone at 0.9 to 1.1 lb ai/A.

The only recommended alternative is thifensulfuron-methyl plus tribenuron-methyl (Harmony Extra 75DF™) at 0.5 to 0.6 oz/A (Fehlis).

*Potential for Risk Mitigation* - Since this application of atrazine is made in fall instead of spring it employs a recommended Best Management Practice. Atrazine is less likely to get swept off the field by run-off water if applied in the fall instead of the period of peak rainfall intensity which is usually in May and June (Kansas BMPs). BEAD does not have adequate information to determine the lowest rate at which atrazine is likely to be effective for this use. However, growers do have the option to use thifensulfuron-methyl plus tribenuron-methyl (Harmony Extra 75DF™) as an alternative (Texas State Recommendations).

*Impact* - EPA estimates the impact from the unavailability of atrazine for this weed control practice to be increased cost of herbicide of about $5 per acre. EPA used recommended herbicides and rates from Texas A&M University for calculating this estimate. Efficacy was assumed to be similar for purposes of this analysis. Cost of an application of Harmony Extra 75DF™ at 0.5-0.6 ounce per acre application is $6.30 - $7.56 per acre ($12.60 per ounce). Atrazine total cost ranges from $1.85 to $2.54 per acre when applied at 0.9-1.1 lb ai/A (Boerboom, 2002).

Table 17. Herbicide Costs for Winter Weed Control in Sorghum

| Herbicide | Cost per Acre for Recommended Rate |
|---|---|
| atrazine | $1.85 to $2.54 |

| | |
|---|---|
| thifensulfuron-methyl plus tribenuron-methyl | $6.30 to $7.56 |

b. *For Pre-plant Incorporated and Preemergence for Residual Weed Control Applied Alone*:

Atrazine is recommended alone at 1.9 to 2.2 lb ai/A or in pre-mixes containing another herbicide such as metolachlor and alachlor.

There is no direct replacement for atrazine applied preemergence in sorghum. One alternative would be to apply a pre-emergence herbicide to control grass weeds and then follow with a post-emergence herbicide to control broadleaf weeds (which is a popular current practice). For example, growers might apply halosulfuron (Permit®) at 0.67 ounces per acre ($10.22) with a surfactant ($ 4.00) nonionic surfactant in combination with 2,4-D amine at one half pound per acre ($1.55) for a total cost of about $16.00 per acre. In contrast, atrazine-based treatments may cost as little as $2.00 to $3.00 per acre.

c. *Postemergence*: Postemergence weed control at 1.3 lb ai/A.

About 25 percent of the sorghum acres are now treated with a post-emergence treatment of atrazine. There are several alternatives to atrazine for post-emergence application and they are listed in the table below.

Table 18. Comparison of Price and Costs for Selected Post-Emergence Herbicides in Sorghum

| Herbicide | Trade Name | Rate ai/Acre | Price/Unit | Cost/Acre/App. |
|---|---|---|---|---|
| Atrazine | AAtrex®Nine-O | 1.3 lb | $2.31/pound ai* | $3.00 |
| 2,4-D | many | 0.5 - 2.0 pt. | $12.36/gallon product | $0.77 - $3.09 |
| Halosulfuron | Permit® 75WG | 0.67 oz. | $15.26/oz. | $10.22 |
| Prosulfuron | Peak® | 0.75 - 1.0 oz. | $11.21/oz. | $8.41 - $11.21 |
| Dicamba | Banvel® | 0.5 pt. | $86.15/gallon product | $5.38 |

(Boerboom, 2002)

* Substituted price for the 90DF formulation, since price not available for the liquid formula.

d. *Chemical Fallow*: To conserve soil moisture in sorghum-growing areas with low rainfall, a fallow period is often incorporated into the rotation with sorghum. Atrazine is registered for use in a wheat-sorghum-fallow rotation. Atrazine may be applied at three pounds ai/A following wheat harvest. Tillage is eliminated since it depletes soils moisture; sorghum is planted directly into stubble from the previous wheat crop. The elimination of tillage for weed control conserves soil moisture which can result in significant gains in sorghum yields. In areas of low rainfall, no tillage sorghum is considered to be more profitable than conventionally tilled sorghum (Harman, undated).

## C. IMPACTS FROM POTENTIAL RISK MITIGATION MEASURES

1. Localized Mitigation If atrazine use were cancelled in a CWS where sorghum is a major crop, no yield impact would be expected. However, BEAD estimates an increased cost of production of $11.58 per acre and an average decrease of 7 percent in per acre net revenues.

2. Rate Reduction The purpose of atrazine is to control growth of weeds so that sorghum plants can outgrow the weeds and shade uncropped areas in the field. Shading reduces germination of weed seeds in the soil and inhibits growth of existing weeds. When a reduced rate of soil-applied herbicide is used, the concentration of herbicide in the soil reaches a level where weeds are no longer controlled earlier in the season than when used at a higher rate. Therefore, to reduce rates of atrazine and still maintain adequate weed control, growers will have to substitute either another herbicide or mechanical weed control.

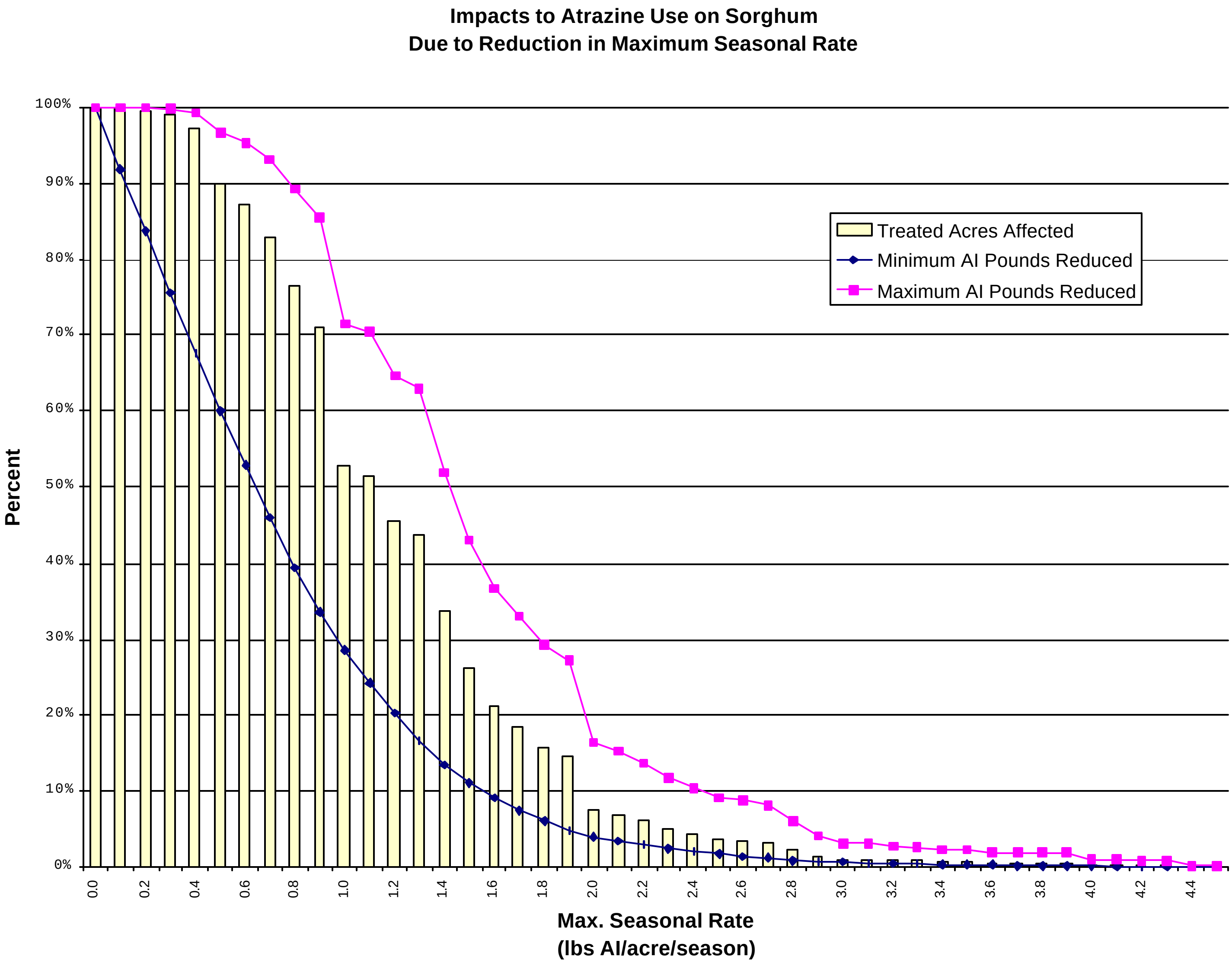
   In estimating potential impacts to growers from reductions in rates of atrazine, BEAD considered the effect on weed control that growers might experience from reducing rates, changes in input such as additional tillage, and the percent of the market that may be affected.

   The table below describes the cumulative distribution of atrazine use in sorghum at selected rates up to 2.0 lb ai/A, which accounts for nearly all atrazine use on sorghum. This table may be used to indicate what percentage of the atrazine market would be impacted if maximum rates were lowered to certain levels. For example, if rates were lowered to 1.0 lb ai/A, about 40 percent of the sorghum market for atrazine applied alone would be impacted (100 percent minus 60 percent).

Table 19. Single Application of Atrazine Use in Sorghum: Cumulative Rate Distribution (EPA proprietary data)

| Atrazine Applied: | Total Atrazine Applied: Certain Rates (lb ai/A) - Cumulative Percentage | | | | | |
|---|---|---|---|---|---|---|
| | #0.5 | #1.0 | #1.2 | #1.5 | #1.7 | #2 |
| Alone | 11% | 60% | 66% | 79% | 81% | 97% |
| Mixed | 13% | 16% | 65% | 85% | 93% | 99% |

Impact is also affected by the climate in which sorghum is grown. Annual precipitation declines dramatically moving from the east to west in the major sorghum-producing area of the United States. For example, annual average precipitation varies from about 17 inches in the western part of the state to 40 inches in the southeast part (Kansas Climate Collection). The cultural methods for growing sorghum also change in response to the annual precipitation. Lower levels of atrazine provide more effective weed control in dry climates than in the wet climate due to lower weed pressure, and slower degradation of herbicide under drier conditions.


Impacts to Atrazine Use on Sorghum
Due to Reduction in Maximum Seasonal Rate
Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Treated Acres Affected
Minimum AI Pounds Reduced
Maximum AI Pounds Reduced
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
Max. Seasonal Rate
(lbs AI/acre/season)

This chart illustrates the change in the total annual atrazine use (in pounds) that would result from reducing maximum seasonal application rates for sorghum. The data used to develop these charts are based on detailed distributions of application rates available to EPA (through proprietary data contracts). The charts show the minimum and maximum pounds of atrazine potentially reduced at different seasonal rates, as well as the number of acres affected. The affected acres represent the cumulative sorghum acres treated with atrazine above a specified rate, and the analysis is based on the assumption that a rate reduction will lead to the maximum allowable rate on those acres (although, in fact, a particular grower may choose another weed control regimen utilizing an even lower rate of atrazine, say, in a tank mix).

For the minimum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would be treated at the reduced rate. In contrast, for the maximum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would no longer be treated with atrazine.

BEAD estimated how reducing application rates would affect total atrazine use on sorghum, currently estimated at 7.5 million pounds per year. At a maximum rate of 2.0 lb ai/A, total use would decline by approximately 375,000 pounds per year (5 percent of total). Although no analysis was performed, yield and revenue losses resulting from reducing the maximum rate to 2.0 lb ai/A are expected to be minimal. At 1.5 lb ai/A, total use would decline by approximately 900,000 pounds per year (12 percent of total); at 1.0 lb ai/A, total use would decline by approximately 2.1 million pounds per year (28 percent of total); and at 0.8 lb ai/A, total use would decline by approximately 2.9 million pounds per year (39 percent of total use). If atrazine were not available for sorghum, an estimated 6.2 million acres would be affected.

3. <u>Best Management Practices</u>

a. *Soil Incorporation*. Requiring incorporation for soil-applied atrazine would reduce runoff. The Agency estimates that between 15-20 percent of the sorghum acreage currently uses incorporation (EPA proprietary data). However, it is not practical in no-till sorghum.

b. *Banded Application*. Banding is an application method that only puts the chemical on a portion of the field (along the crop row) and uses an alternative method of control, mechanical cultivation, to control weeds in the rest of the field. The soil area in the row receives the same amount of atrazine as with a broadcast spray, but because the spray is not applied between the rows, the application rate is essentially reduced per acre.

The Agency estimates that about 8-12 percent of the sorghum acres treated with atrazine are being treated with banded applications. About 74 percent of growers surveyed in Nebraska reported using at least one cultivation operation in addition to herbicides for weed control in sorghum (Franti, 1998).

## D. ECONOMIC IMPACTS TO SORGHUM PRODUCTION FROM POTENTIAL ATRAZINE MITIGATION

Nationally, sorghum accounts for approximately 10 percent of the atrazine used in agriculture. Atrazine use on sorghum is similar to corn with respect to the average application rates (1.2 lb ai/A) and the number of applications per year (1.1). Nationally, about 60 percent of the crop is treated with atrazine (higher than 80 percent in Kansas). To calculate the economic impacts of restricting use of atrazine on sorghum, yield changes and alternative control costs are needed to determine the impact. To help identify these impacts, an analysis conducted by EPA in 2000 was used.

Atrazine, the most commonly used herbicide in sorghum production, is generally used for broadleaf control and is most often applied before weeds emerge (pre-emergence). If atrazine were eliminated from the market, the most likely chemical broadleaf weed control options would be post-emergence applied herbicides (dicamba, 2,4-D, bromoxynil and prosulfuron). Post emergence application of herbicides carries certain risks. These include: 1) greater competition of the weeds with the crop early in the season as weed control is delayed into the growing season; 2) crop injury from herbicides applied directly to the emerged crop and weeds; and 3) if the opportunity to apply the herbicide is missed due to weather or some other factor, there are fewer or no emergency remedies for weed control.

1. <u>Total Economic Impacts</u> Because of the number of alternatives available to sorghum producers, cancellation of atrazine use in sorghum would not be expected to impact yields. However, it is expected that there would be slight changes in the cost of production due to increases in cost of control. Below are some of BEAD’s findings for sorghum.

   Herbicides are critical for production of the 9 to10 million acres of sorghum grown annually in the U.S. (USDA, 2001). USDA surveyed growers in

Kansas, the state with the highest sorghum production, where 3.5 million acres were planted to sorghum in 2000. USDA reported that "herbicides were applied to 91 percent of the total 1998 sorghum acreage in Kansas" and that "atrazine was the most widely used herbicide with 82 percent of the reported acreage being treated." Kansas was the only state surveyed in 1998 which was the last year USDA surveyed sorghum for the Agricultural Chemical Usage Survey

Texas was second to Kansas in sorghum production, with 3.0 million acres planted in 1997 (USDA, 2000). Atrazine is used on about 50 percent of the sorghum crop in Texas each year (EPA proprietary data, 1999). Kansas and Texas comprise approximately 73 percent of sorghum production in the U.S. (USDA, 2001).

The table below illustrates expected increases in the cost of production per acre assuming that atrazine use is either restricted or banned. In an attempt to quantify economic impacts the per acre costs are used as an estimate for national sorghum production based on 2000 USDA data.

In 2000 about 9.1 million acres were in production. It is estimated that approximately 60 percent of the national acreage is treated with atrazine resulting in about 5.46 million acres treated. If the per acre costs were to increase by $7.97 for acres treated with atrazine under a rate restriction scenario of 0.75 lb ai/A, this cost increase represents approximately 5.2 percent of average gross revenue for sorghum growers nationally.

If atrazine was completely banned on sorghum, the production costs per acre may increase an estimated $11.58, or a total of $63.2 million across all acres nationally. This would result in an increase of production costs estimated at 7 percent of average gross revenue per acre for atrazine-treated sorghum.

Table 20. U. S. Average Yield and Cost Impact of Potential Restrictions in Sorghum in 2000

| **Pesticide** | **Atrazine Effect** | | |
|---|---|---|---|
| **Crop/ Regulatory Response** | Yield Loss | Cost per Acre ($2002) | Percent of Reduction in Gross Revenue per Acre |
| Rate limit: 0.5 -0.75 lb/acre | None | $7.97 | 5.2% |
| Cancellation | None | $11.58 | 7% |

2. <u>Local Level Impacts Under a Ban Scenario and Rate Restriction</u>

*For Kansas*, with about 82 percent of the 3.6 million acres in sorghum production treated with atrazine, a rate restriction would result in about $23.4 million increase in production costs, again representing about 7 percent of gross revenues. Under a ban scenario that cost increase is expected to be about 10.3 percent of gross revenues.

*For Texas*, about 50 percent of the 3.3 million sorghum acres are treated annually with atrazine. Under the rate restriction scenario of 0.75 lb ai/A, an increase of $7.97 in production costs per acre represents 5.1 percent of gross revenue, and under a ban scenario, gross revenue would decrease by about 7.5 percent.

These estimates do not account for differences in yield between Texas and Western Kansas which has dry production conditions and Eastern Kansas which produces sorghum under wetter conditions.

## VII. IMPACTS TO SUGARCANE

### A. GENERAL INFORMATION ON SUGARCANE

Sugarcane (*Saccharum officinarum* L.), a perennial tropical grass, is planted between August and November in the continental U.S. Florida sugarcane is grown primarily on muck soils with some production occurring on sandy soils. In other states, sugarcane is grown on mineral soils. Lay-by, which is when canopy closure occurs and the ground is completely shaded, occurs about 5 to 8 months after planting. In Florida, harvest occurs between November and March. Harvest occurs from the middle of October until early January in Louisiana and Texas. After the first harvest, several ratoon crops (subsequent crops from the initial planting) may be grown and harvested. Each crop takes about a year from planting (or harvest, in the case of ratoon crops) before it is ready to harvest. Sugarcane can be harvested for several years after planting. Controlling weeds, grassy weeds in particular, is important for successful harvests from ratoon crops. Generally there are two to three ratoon crops but more are possible if weeds can be controlled, especially perennial grasses (Smith, 1997; Keitt, 1989; Crop Profile for Sugarcane in TX, 1999; Markle, 1998; Muchovej, 2002).

Sugarcane production in Florida is concentrated in south central Florida, in the Everglade Agricultural Area, which is south of Lake Okeechobee. Palm Beach County, Florida leads the country in sugarcane production. In Louisiana, sugarcane production occurs primarily along the Mississippi River. The top five producing parishes are Iberia, St. Mary, Assumption, Iberville, and St. Martin. In Texas, production is concentrated in the Lower Rio Grande Valley in Cameron, Hidalgo, and Willacy counties. Sugarcane is also produced in Hawaii and Puerto Rico (Palm Beach Ext., 2002; Frank, 2002; Crop Profile for TX, 1999).

Hawaii sugarcane production occurs primarily on the islands of Maui and Kauai. Production differs from other U.S. sugarcane producing areas in several ways. Many of the sugarcane fields have slopes and uneven terrain. Also, Hawaii does not have a winter dormant period, which creates pest pressures throughout the year. In Hawaii, sugarcane is often allowed to ratoon only once before a field is replanted (Crop Profile for Sugarcane in HI, 2000).

In the U.S., sugarcane is grown for both sugar and seed. Approximately 1,029,200 acres of sugarcane were harvested in the U.S. in 2001, of which 971,900 acres were harvested for sugar. A total of about 34.8 million tons were produced that year (32.9 million tons for sugar). Hawaii sugarcane is harvested throughout the year and the other states produce the crop seasonally (USDA/ NASS Agricultural Statistics, 2002). Sugarcane production in Hawaii and Puerto Rico has declined in recent years (Smith, 1997)

Table 21. Total Sugarcane (Sugar and Seed) Acreage and Production, 2001.

| State | Area Harvested - Sugar only (1,000 acres) | Area Harvested - Sugar and Seed (1,000 acres) | Production (1,000 tons) |
|---|---|---|---|
| Louisiana | 460.0 | 495.0 | 14,850 |
| Florida | 446.0 | 465.0 | 16,472 |
| Hawaii | 21.4 | 23.2 | 1,972 |
| Texas | 44.5 | 46.0 | 1,507 |
| **Total** | 971.9 | 1,029.2 | 34,801 |

USDA NASS Agricultural Statistics, 2002.

B. ATRAZINE USE IN SUGARCANE

1. Current Use. Approximately 2.3 million pounds of atrazine are used on sugarcane each year. Florida is the largest user of atrazine, using an average of 1.6 million pounds. Louisiana used an average of 605,000 pounds, and Texas used an average of 85,000 pounds (EPA proprietary data, 1998-2001 average). The labeled maximum seasonal application rate for sugarcane is 10 lb ai/A.

About 25 percent of atrazine is applied pre-emergence and about 75 percent is applied post-emergence. Approximately 35 percent of the atrazine used on sugarcane is applied alone and about 65 percent is applied in either a tank mix or premix. Banding is used on about 30 percent of the acreage and soil incorporation is used on just over 5 percent of the acreage. Aerial applications occur on less than 1 percent of the acres and custom applications occur on less than 10 percent of the acreage (EPA proprietary data).

Table 22. Atrazine Applications to Sugarcane, United States, 1998 - 2001

| State | Pre-emergence (%) | Post-emergence (%) | Total (% Alone vs. Mix) |
|---|---|---|---|
| Alone | 9 | 27 | 36 |
| Tank Mix or Pre Mix | 17 | 47 | 64 |
| Total (% Timing): | 26 | 74 | 100 |

Based on EPA proprietary data

Banding atrazine is already being used on some of the sugarcane acreage in the United States (Table 23). The recommended practice is to use a 36 inch band on a 72 inch row. A study of atrazine runoff on a Louisiana soil was conducted in 1994 and 1995. Atrazine was applied only for winter weed control and metribuzin was applied as the pre-emergence herbicide. Each year, three treatments of atrazine were used: 1) broadcast (2.0 lb ai/A); 2) 36 inch banded (1.0 lb ai/A); and, 3) 24 inch banded (0.66 lb ai/A). The same amount per area of coverage was used but banding the pesticide results in less active ingredient per acre. The average annual rainfall (57.06 inches) was not significantly different from the normal of 56.87 inches. The study found that using a 36 inch band resulted in 63 percent less runoff than the broadcast application, and that using a 24 inch band resulted in 78 percent less runoff than the broadcast application. Although runoff still occurred with banded applications, it was significantly less than the runoff from broadcast applications (Selim, et al, 2000).

Table 23. Atrazine Applications to Sugarcane by State, 1998 - 2001

| **State** | **Banded** | **Broadcast** | **Incorporation** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Florida | 18% | 78% | 4% |
| Louisiana | 40% | 61% | 6% |
| Texas | 29% | 73% | 35% |
| United States | 27% | 73% | 6% |

(EPA proprietary data)

Table 24. Atrazine Use Rates on Sugarcane by State

| **State/Application Type** | | **Min. Appl. - lb ai/appl. (% appl. in State)** | **Max. Appl. - lb ai/appl. (% appl. in State )** | **90$^{th}$ Percentile (lb ai/appl.)** |
|---|---|---|---|---|
| Florida: | Alone | 0.4 (<1%) | 4.0 (15%) | 3.5 |
| | Mix | 0.4 (1%) | 4.0 (6%) | 3.0 |
| Louisiana: | Alone | 0.4 (1%) | 4.0 (9%) | 2.5 |
| | Mix | 0.4 (5%) | 4.0 (3%) | 2.0 |
| Texas: | Alone | 0.2 (1%) | 2.3 (13%) | 2.0 |
| | Mix | 0.4 (<1%) | 4.0 (<1%) | 3.0 |

(EPA proprietary data)

Sugarcane is grown on muck (80 percent) or sandy (20 percent) soils in Florida. The percentage of Florida production on sandy soils has increased since 1989, when about 15 percent of the production was on sandy soils (Muchovej, 2002; Keitt, 1989). Soil type influences atrazine efficacy. Atrazine adsorbs more readily to muck and fine textured soils than coarser soils and those with lower organic content, hence the application rates in Florida are generally higher than in other states. Fewer alternatives are available or recommended on Florida sugarcane acreage.

Herbicide use data from 1998 are available for atrazine and other herbicides in Hawaii. Atrazine is applied one to three times at 2.0 to 4.0 lb ai/A per two-year crop at an average rate of 3.2 lb ai/A per year. Approximately 85 percent of the acreage is treated with atrazine, for a total of 158,056 pounds per year (Crop Profile for Sugarcane in HI, 2000).

2. <u>Target Pests</u> Atrazine is used to control broadleaf weeds and some annual grasses. Labeled weeds include: amaranths, crabgrass, fireweed, Flora's

paintbrush, foxtails, junglerice, wiregrass, pellitory weed, alexandergrass, large crabgrass, spiny amaranth, barnyard grass, pigweed, purslane, and sunflower. Additional weeds may also be controlled, such as morning-glories. Atrazine is generally applied at planting (or after harvest for ratoon crops), in the spring, and/or at layby, which is just before canopy closure (Smith, 1997; Selim, 2000).

3. Other Weed Control Methods in Sugarcane Sugarcane growers use a variety of cultural methods to control weeds. There are also several other herbicides registered for use on sugarcane.

a. *Cultural Control* Growers currently use a variety of cultural control techniques. Depending on soil conditions, growers use cultivation to control weeds in sugarcane fields. In Texas, sugarcane is typically cultivated three to four times and in Louisiana up to five times. Tillage is used in conjunction with herbicide application, such as at layby. Tillage in between the rows is also used with banding so less area needs to be treated with the herbicide. Several cultivators are available for use. Once the sugarcane plants have a chance to develop, the plants form a canopy over the row middles, creating shade and reducing weed competition. Many areas use crop rotations after the last ratoon crop as an opportunity to control difficult weeds. Texas and northern Louisiana rotate sugarcane with annual row crops, such as cotton, corn or sorghum. Florida growers may rotate sugarcane with vegetables. In other areas, fields are left fallow for up to a full growing season to allow the grower to control difficult weeds using alternate herbicides and tillage. In some areas, fallow fields are flooded, creating anaerobic conditions to aid in control of difficult weeds (Smith, 1997; Bennett, 2002).

b. *Other Herbicides* Several herbicides are registered for use on sugarcane; however, Florida growers, and to some extent Texas producers, have fewer alternatives available than Louisiana. Although ametryn, a triazine, provides good control of a broad spectrum of weeds, it has a shorter residual than atrazine. Metsulfuron-methyl is only registered in Hawaii. Glyphosate, paraquat, and flumioxazin are burndown (non-selective) herbicides that may be applied with a hooded sprayer for spot control. These herbicides are limited to pre-plant sprays or post-emergence spot sprays. Usually these herbicides would injure the sugarcane but the hooded sprayer keeps the spray from reaching the sugarcane. In Louisiana, glyphosate is also used in fallow fields for control of perennial grasses. Other alternatives, including 2,4-D, dicamba, and terbacil, are limited in use because of spray drift concerns to sensitive crops. Asulam, hexazinone, pendimethalin, and trifluralin are primarily grass herbicides but may provide control to some annual broadleaf weeds. Clomazone is used to control grasses and some broadleaf weeds but there may be concerns for off-site movement. Diuron is less effective on broadleaf weeds than atrazine and can injure sugarcane that has emerged. Halosulfuron-methyl is used primarily for control of nutsedges but does provide some control of broadleaf weeds. It only provides partial control of kochia and morning-glories. Metribuzin cannot be used on sandy soils prohibiting its use on 20 percent of Florida sugarcane. It cannot be used in Texas or Hawaii because of concerns with crop tolerance (Smith, 1997).

Table 25. Potential Alternative Herbicides to Atrazine in Sugarcane

| Alternative | Weeds Controlled | Use/Limitations |
|---|---|---|
| 2,4-D | broadleaf weeds (escaped) | often post-emergence and often mixed; TX proximity to sensitive crops - can't use; in FL - drift concerns to sensitive plants; can't use in some LA parishes |
| Ametryn | broadleaf and annual grasses | short residual |
| Asulam | perennial grasses | does not target many weeds controlled by atrazine; limited spectrum. |
| Clomazone | annual grasses and broadleaf weeds | partial control of pigweeds |
| Dicamba | annual, biennial, and perennial broadleaf weeds | often pre-mix with 2,4-D and banded, applied post-emergence; in FL - drift concerns to sensitive plants |
| Diuron | broadleaf weeds and grasses | usually tank mix, pre-emergence |

| | | |
|---|---|---|
| Flumioxazin | broad spectrum | burndown |
| Glyphosate | annual and perennial weeds | spot treatment or fallow fields |
| Halosulfuron-methyl | primarily nutsedge, some broadleaf weeds | only partial control of kochia, morning glory |
| Hexazinone | grasses, some broadleaf weeds | pre-emergence; heavy rains limit use - root sensitivity |
| Metribuzin | annual grasses and broadleaf weeds, seedling grasses (perennials) | used in mixes; pre or post emergence; not on sandy soils |
| Metsulfuron-methyl | broadleaf | Hawaii only |
| Paraquat | broad spectrum | LA - winter cleanup; spot treatment |
| Pendimethalin | annual grasses and certain broadleaf weeds | used in newly planted cane or at emergence |
| Terbacil | annual grasses and broadleaf weeds | not in FL; usually banded and in mix; some varieties susceptible to injury; crop rotational restrictions |
| Trifluralin | grasses | requires incorporation or rainfall |

(Smith, 1997; Bennett, et al., 2001)

## C. IMPACT FROM POTENTIAL RISK MITIGATION MEASURES

### 1. Localized Mitigation

EPA does not yet know the number of acres that will be impacted under a localized mitigation. Local mitigation would be implemented in watersheds feeding drinking water systems where atrazine residues are detected in concentrations above EPA's level of concern. Based on a 10 percent yield loss, a net revenue impact of about $75 per acre is expected. With localized mitigation, growers may have an opportunity to use other methods to reduce run-off, including best management practices such as band application.

A number of other herbicides are available for Louisiana sugarcane. Likely alternatives to atrazine are metribuzin and terbacil or diuron at planting (Aug. to Oct.). Also 2,4-D with or without dicamba would be used. At first post-emergence application, alternatives would be any of the following: diuron, terbacil, metribuzin, trifluralin, fluometuron, or hexazinone. At the second post-emergence application an ametryn application may be needed. At layby, any of the following herbicides may be used: metribuzin, terbacil, trifluralin, or 2,4-D with or without dicamba. Ratoon crops would receive the same applications except for diuron.

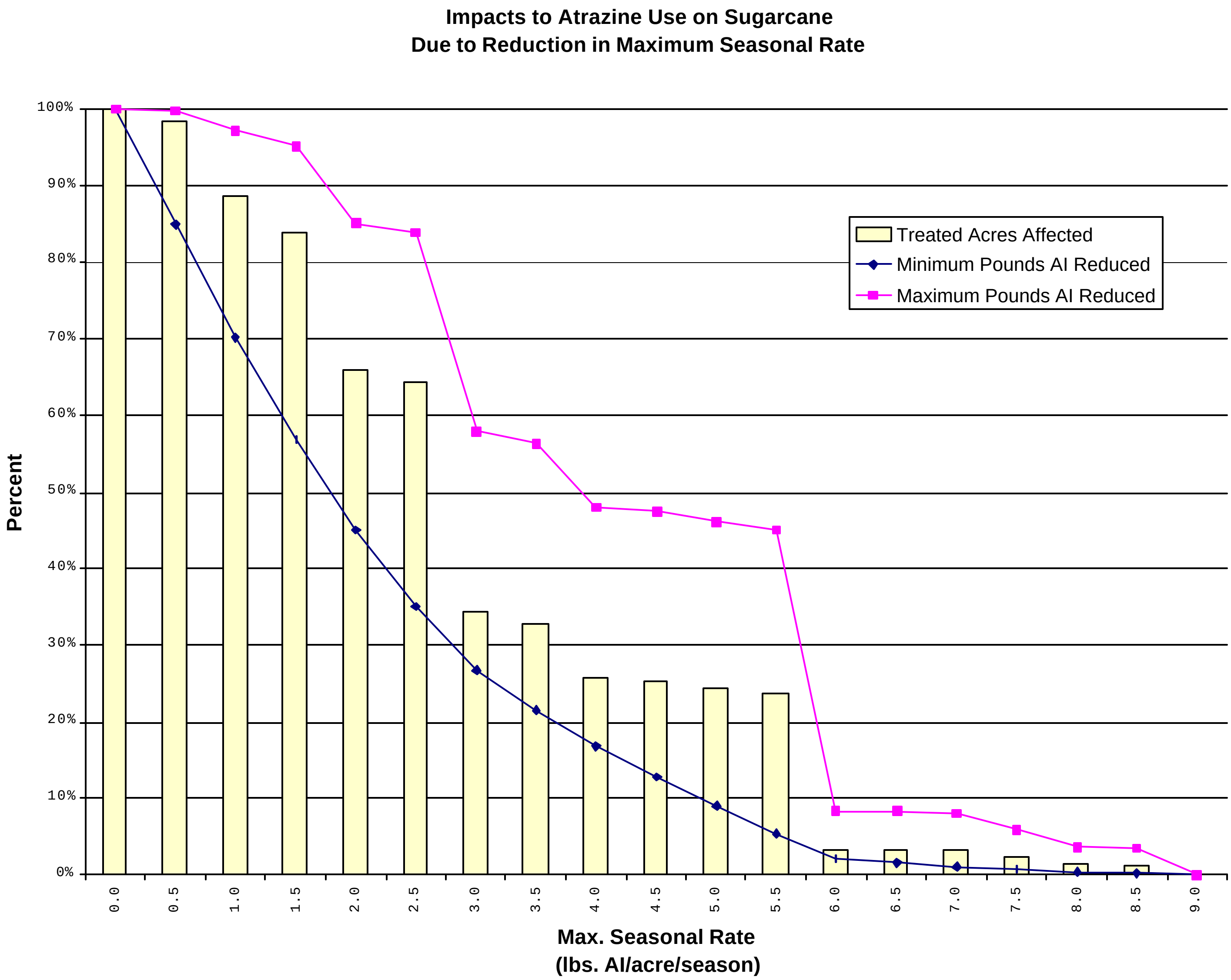
In Texas, there are several alternatives available. Likely alternatives are ametryn (which is already applied on many acres) with or without one of the following herbicides: hexazinone, metribuzin, or dicamba. A post-emergence application would consist of the same option. Some of the alternatives may cause phytotoxicity losses or lead to quality losses.

There are also alternatives available in Florida. For muck soils, likely alternatives are diuron, at planting, and the first post-emergence application. Diuron or metribuzin may be applied for the second post-emergence application. The layby application would include metribuzin. Some quality and phytotoxicity losses are expected. For sandy soils, likely alternatives are diuron at planting, first and second post-emergence applications. At layby, there are no viable alternatives. Ametryn is currently used with atrazine and can continue to be used. For sandy soils, yield, quality, and phytotoxicity losses may occur.

2. <u>Rate Reductions</u> About 80 percent of Florida sugarcane production occurs on muck soils, which because of the high organic matter content and high adsorption, require that atrazine be applied at a higher rate than mineral soils. Therefore, lower rates may be less feasible on organic soils than on mineral soils.

With lower application rates, growers may need to combine an alternate herbicide with atrazine to get good weed control. There may also be certain weeds that will not be controlled by a lower rate of atrazine.

A seasonal rate reduction from 10 lb ai/A atrazine, the current maximum labeled rate, to 8 lb atrazine, is expected to have minimal impact for sugarcane growers. This expected impact is shown in the chart below.


Impacts to Atrazine Use on Sugarcane
Due to Reduction in Maximum Seasonal Rate
Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Treated Acres Affected
Minimum Pounds AI Reduced
Maximum Pounds AI Reduced
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Max. Seasonal Rate
(lbs. AI/acre/season)

This chart illustrates the change in the total annual atrazine use (in pounds) that would result from reducing maximum seasonal application rates for sugarcane. The data used to develop these charts are based on detailed distributions of application rates available to EPA (through proprietary data contracts). The charts show the minimum and maximum pounds of atrazine potentially reduced at different seasonal rates, as well as the number of acres affected. The affected acres represent the cumulative sugarcane acres treated with atrazine above a specified rate, and the analysis is based on the assumption that a rate reduction will lead to the maximum allowable rate on those acres (although, in fact, a particular grower may choose another weed control regimen utilizing an even lower rate of atrazine, say, in a tank mix).

For the minimum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would be treated at the reduced rate. In contrast, for the maximum pounds of active ingredient curve, it was assumed that the acres treated above the reduced seasonal rate would no longer be treated with atrazine.

BEAD estimated how reducing application rates would affect total atrazine use on sugarcane, currently estimated at 2.3 million pounds per year. At a maximum rate of 6.0 lb ai/A, total use would decline by approximately 69,000 pounds per year (3 percent of total). No analysis was performed for the impact on yield and revenue losses. At 4.0 lb ai/A, total use would decline by approximately 391,000 pounds per year (17 percent of total). If atrazine were not available for sugarcane, about 890,000 acres would be affected.

3. <u>Best Management Practice - Banded Applications</u> Banding is an application method that only puts the chemical on a portion of the field (along the crop row) and uses an alternative method of control, cultivation, to control weeds in the rest of the field. Weeds in the crop row receive the same amount of atrazine that they would have in a broadcast spray, but because the spray is not applied between the rows, the application rate is essentially reduced. In sugarcane, the recommendation is to apply atrazine in a 36 inch band on a 72 inch row, essentially cutting the rate in half. Another option is to reduce the spray width further, to a 24 inch band, to reduce the rate applied per acre to one-third of the broadcast rate. (If 2.0 lb ai/A is applied in a broadcast spray, only 1 lb ai/A would be used in a 36 inch band, and 0.66 lb ai/A would be used in a 24 inch band).

BEAD estimates that 27 percent of the total U.S. sugarcane acreage is receiving banded applications. However, estimates of the extent of banded application vary widely. Approximately 73 percent of sugarcane acreage in the continental U.S. could reduce their atrazine use by one-half to one-third by switching from broadcast to banded spray method.

However, additional costs are expected from wider adaptation of this spray method. These may include any equipment cost (may need new or modified equipment) and the cost of cultivation to control weeds between the rows. Many atrazine applications are currently used in conjunction with cultivation which is required less frequently with a broadcast application of atrazine.

In Florida and Louisiana sugarcane, BEAD estimates that total atrazine use would be reduced by 18 percent to 34 percent if banded application were required. However, banded applications may not be practical in many sugarcane producing areas due to inability to cultivate, weed pressure, and other factors.

## D. ECONOMIC ANALYSIS OF SUGARCANE SCENARIOS

Nationally, about 3.5 percent of the agricultural use is on sugarcane. In 2001, 1.029 million acres of sugarcane were harvested in the U.S. with an average yield of 35 tons per acre (USDA, 2002). Florida, Louisiana and Texas account for most U.S. sugarcane production and most atrazine use on this crop. Nationwide, 89 percent of the sugarcane crop was treated with atrazine, with over 75 percent of the atrazine applied at annual rates ranging from 0.75 to 3.9 lb ai/A (EPA, 1999).

1. Total Economic Impacts Because of limited yield loss estimates or information that identifies primary atrazine alternatives and their corresponding rates and cost of application, impact estimates were based on a worst-case scenario of banning atrazine use on sugarcane and assuming no alternative. Using expert opinion, BEAD estimated yield losses for sugarcane in Florida would most likely be about 10 percent, though yield losses could be as much as 40 percent (Dusky, 1999). These yield loss estimates were used to generate national and state impacts.

   Nationally, if atrazine use on sugarcane were banned, yield losses of about 10 percent could generate expected losses of about $85.9 million but could be as much as $343.6 million if a 40 percent loss were realized. This is based on USDA data for 1999 value of production (the latest year available).

2. Louisiana Sugarcane Louisiana is the largest sugarcane growing region in the

U.S. with 465,000 acres in production comprising 47 percent of the acres harvested for sugar in the U.S. in 2000. Ninety-five percent of the Louisiana sugarcane acres are treated with atrazine.

EPA does not yet know the number of acres that could be impacted under a localized mitigation scenario. Based on a 10 percent yield loss, a net revenue impact of about $75 per acre is expected. With localized mitigation, growers may have an opportunity to use other methods to reduce run-off, including best management practices such as banding.

3. <u>Florida Sugarcane</u> Florida is the second largest sugarcane growing area in the U.S. comprising 45 percent of the sugarcane acres harvested for sugar in the U.S. in 2000. In Florida over 90 percent of the sugarcane was treated with atrazine (Dusky, 1999). The complete loss of atrazine could result in an estimated reduction in sugarcane yield of 10 to 40 percent due to reduced control of broadleaf weeds (Dusky, 1999). With use of the registered alternative, metribuzin, yield loss would likely be about 10 percent due to its reduced spectrum of weeds compared to atrazine and also due to the potential of crop injury. Additional economic impact from use of metribuzin would come from the increased cost of metribuzin compared to atrazine.

If atrazine were not available for use on Florida sugarcane, a yield loss of 10 to 40 percent is estimated. The value of Florida sugarcane production would be reduced by an estimated $42.1 million to $168.6 million.

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