Impacts of the Azinphos-methyl Ban in the Apple Industry and Economy of Washington State

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS024E

Abstract

In 2006, the U.S. Environmental Protection Agency (EPA) declared that the pesticide azinphos-methyl (AZM) cannot be used in apple production after September 30, 2012. While it provides important pest control benefits to growers of apples and other crops, AZM also poses potential risks to farm workers, pesticide applicators, and aquatic ecosystems, according to the EPA website. In this fact sheet, we estimate the change to sales, price, and employment in the Washington State apple industry from using likely AZM alternatives had this ban been in effect in 2007, the first year of the pesticide's phase-out schedule. Furthermore, we estimate the ban's effects as it ripples throughout the overall Washington State economy. We conclude that the ban will modestly change sales (–0.8%), prices (0.2%), and employment (0.1%) in the apple industry, with negligible impacts on the overall Washington State economy.

Introduction

The EPA has mandated the nationwide elimination of the pesticide AZM, or Guthion®, by September 30, 2012 (*Federal Register* 2009; EPA 2009). Belonging to the organophosphate (OP) class of pesticides, AZM has been the pesticide most used by Washington State apple growers since the late 1960s (Brunner et al. 2007). As of 2008, 80% of Washington apple growers used AZM (Washington State University Tree Fruit Research and Extension Center 2010) primarily to control codling moth, the leading pest in Western apple orchards.

The EPA's mandate resulted from concerns about the risks of OPs to the health of farm workers and the quality of local water and aquatic ecosystems. Details about AZM toxicity and other supporting data that guided the agency's decision are provided in the EPA's Ecological Risk Assessment (EPA Office of Pollution Prevention and Toxics 2005) and Organophosphorus Cumulative Risk Assessment (EPA Office of Pesticide Programs 2006).

Most growers are expected to shift to an AZM-alternative-based integrated pest management (IPM) strategy rather than relying solely on nonchemical methods or quitting production entirely (Brunner 2009). Though an AZM-alternative-based IPM program is more worker and environmentally friendly, it requires different timing and more precise spray applications than programs based on AZM. Furthermore, AZM-alternative pesticides must be applied an additional time to maintain yield and quality, since the alternatives do not last as long on crops (Brunner 2009). Therefore, codling moth control costs more per acre with an AZM-alternative-based program than with the AZM-based program because the unit price and quantity are higher.

We estimated the economy-wide impact of eliminating AZM for an IPM program based on AZM alternatives in Washington State apple production. We calculated the increase in the per-acre expenditure for growers switching to an AZM-alternative-based program that ensures the same volume and quality of apples produced under an AZM-based program. We then considered the apple industry's response to this cost increase by modeling growers' changes to various production inputs, such as labor or pesticides, in order to maximize profit under the ban, which could result in an output change. The economic effects we studied were changes to sales, prices, and employment for the apple industry, industries that supply inputs to the apple industry, industries using apples as an input, household income, and profit per acre of Washington apples. Our analysis accounted for relationships between different industries in the state economy and price changes.

Method

We used computable general equilibrium (CGE) modeling to compare the economy's reaction in two alternative scenarios. The first, a 2007 base case or benchmark, considered an AZM-based program to control codling moth in Washington apple production. Since the benchmark is the primary production practice actually employed in 2007, we used unmodified 2007 data. The second alternative scenario, called a counterfactual scenario, did not occur in reality, but we used it in our model to predict what would have happened had there been a complete AZM ban in 2007, the first year in the AZM phase-out schedule.

We first calibrated the model to find the parameters needed for the model data to perfectly replicate the actual 2007 data. Then we applied these calibrated parameters to the counterfactual scenario to estimate what would have happened if AZM were banned in 2007. The model results were the estimated percent difference in such economic variables as sales, price, and employment from the actual 2007 economic data and that estimated by the model in the counterfactual scenario.

Assumptions

1. Based on Brunner et al. (2007), we assumed the next best alternative to be an IPM program based on use of AZM alternatives (an assortment of new, safer, but more costly pesticides). Though other OPs such as Lorsban® (chlorpyrifos), diazinon, and Imidan® (phosmet) are legal as of this writing, we predict that, with increased EPA scrutiny, all OP usage will be curtailed in the future. Therefore, we do not consider switching from AZM to another OP to be a realistic option. Though not all of the new pesticides expected to replace AZM were available in 2007, we assumed that these alternatives were available for the counterfactual scenario.

2. Because our pesticide expenditure estimate is based on the cost needed to maintain apple crop yield and quality at the benchmark level, we assumed that there would be no economic impacts from loss in yield or quality.

3. Though real non-AZM-based IPM programs require precise timing of applications that can take time for the grower to learn, we assumed that growers had already learned the best application methods for the counterfactual scenario.

4. There are no differences in the costs of monitoring between AZM-based and AZM-alternative-based IPM programs. Any additional costs, using the new pesticides generated by more precise monitoring and application procedures, are either explicitly given in the quoted price or are captured in the number of spray applications.

5. There was no change to labor efficiency in the apple industry.

6. No foreign countries prevented the importation of Washington apples due to the alternative pesticide.

7. Our economic impact estimate did not include economic changes from a healthier workforce and communities or changes to income or employment from the end of sales of AZM and its replacement by alternatives. Also, we did not consider the additional costs facing the American consumer from potential increased apple prices. Finally, we did not consider any impact from either state or federal government education programs to inform apple growers about the ban and how to effectively manage it.

A more detailed setup of the model and complete description of the above assumptions can be found in the full report at http://impact.wsu.edu/IMPACTProjects.html.

Table 1. 2007 Insect Control Program Costs, Benchmark (with AZM) and Counterfactual Scenarios, Dollars per Acre.

Compound	Trade Name	Benchmark			Counterfactual		
		Input	Application	Total	Input	Application	Total
oil	oil	20.40	25.50	45.90	20.40	25.50	45.90
miticides	miticides	12.00	6.00	18.00	12.00	6.00	18.00
azinphos-methyl	**Guthion®**	**42.07**	**47.52**	**89.59**	—	—	**0.00**
phosmet	**Imidan®**	**3.12**	**3.12**	**6.24**	—	—	**0.00**
methoxyfenozide	**Intrepid®**	**7.78**	**5.61**	**13.39**	**18.30**	**13.20**	**31.50**
spinosad	**Success™**	**31.23**	**16.38**	**47.61**	—	—	**0.00**
imidacloprid	**Provado®**	**3.40**	—	**3.40**	**0.84**	—	**0.84**
novaluron	**Rimon®**	**12.17**	**5.85**	**18.02**	**4.06**	**1.95**	**6.01**
chlorpyrifos	**Lorsban®**	**12.29**	—	**12.29**	**7.68**	—	**7.68**
thiacloprid	CaLypso®	1.49	0.99	2.48	1.49	0.99	2.48
pheromones	pheromones	78.40	21.00	99.40	78.40	21.00	99.40
diazinon	diazinon	2.10	2.97	5.07	2.10	2.97	5.07
AZM alternatives:							
chlorantraniliprole	Altacor®	—	—	—	53.78	30.00	83.78
spinetoram	Delegate®	—	—	—	67.12	36.00	103.12
acetamiprid	Assail®	39.75	23.46	63.21	30.50	18.00	48.50
	Total	*266.19*	*158.40*	*424.59*	*296.65*	*155.61*	*452.26*

Sources: U.S. Department of Agriculture National Agricultural Statistics Service (2008, 2009); Brunner (2009).

Notes: See Appendix Tables 1–2 of the full report at http://impact.wsu.edu/IMPACTProjects.html. Changes from the benchmark to the counterfactual scenarios appear in bold. Numbers were rounded to the nearest hundredth. Total cost per acre was the sum of input cost per acre based on the price of the pesticide times the number of sprays times the percent of acres sprayed and the application cost per acre, which is the cost of the equipment depreciation, labor, and fuel to spray an acre once (assumed to be $30) times the number of sprays times the percent of acres sprayed.

Costs of Pest Management

The insect management program costs are one piece of the total production costs of apples obtained from Mon and Holland's (2006) enterprise budget. In the 2007 benchmark, 66% of apple-producing acres were treated with AZM, pheromones for mating disruption, and the pesticides Intrepid® and Rimon® to make up an IPM program. There is no one-for-one replacement for AZM, so in the 2007 counterfactual scenario, three pesticides substituted for AZM—Delegate®, Altacor®, and Assail®. The use of pheromones and pesticides for other pests, like mites, leafrollers, and aphids, was the same across the two cases, though the acres sprayed changed.

Table 1 gives the projected costs of an insect control program in 2007 for the two scenarios. Input cost per acre is the pesticide's quoted purchase price times the number of sprays times the percent of acres sprayed. Application cost per acre is the cost of equipment depreciation, labor, and fuel to spray an acre once (assumed to be $30) times the number of sprays times the percent of acres sprayed. Total cost per acre is the sum of the input cost and application cost per acre.

The total insecticide program cost was $425 per acre when AZM was used to control codling moth, compared to $452 per acre when AZM alternatives were used. Thus, we estimated a 6.5% increase in pesticide cost in the counterfactual scenario. The per-acre cost in the counterfactual scenario was greater because the non-AZM alternatives were more expensive on a per-acre basis, and an additional spray was required to achieve the level of crop protection provided by AZM (from 1.58 applications of AZM per acre to 2.80 applications of AZM alternatives per acre). Provado® and Lorsban did not have application costs because we assumed these pesticides were always mixed with other pesticides. Note that these budgets included the cost of controlling other insects. The cost of codling moth control alone is $211 per acre (AZM + Imidan + pheromones + half sprays of Intrepid and Rimon) in the benchmark scenario and $354 per acre (Delegate + Altacor + Assail + pheromones + half sprays of Intrepid and Rimon) in the counterfactual scenario, a 67% increase. The cost differences between the two scenarios were attributed not only to the cost of AZM and AZM alternatives but also to the resulting change in chemicals that control other pests.

Results

The results for sales, prices, and employment are listed in Table 2. The benchmark scenario shows the 2007 data with AZM. The counterfactual scenario shows the model's estimates for what would have occurred in 2007 if AZM had been banned. The percent change was calculated as follows:

$$((\text{counterfactual} - \text{benchmark}) / \text{benchmark}) * 100.$$

Apples are the featured industry, so those results are given in the first row of Table 2. We estimated that the change in apple sales would have been –0.8% or –$11.6 million. The corresponding price change to Washington consumers would have been an increase of 0.2% and a decrease in production by 0.8%. Employment in the apple industry increased by 22 workers in the counterfactual scenario. This is because the model compensated for the decrease in pesticide efficiency by substituting more labor. We estimated that the aggregate Washington apple industry would have had $16 million less profit in 2007 if AZM had been banned, about $101 per acre, due to the increase in pesticide cost and decrease in sales.

The rows immediately following apples in the table are the horizontal industries: other fruit and crops. The results showed a slight increase in the consumer price of other fruit (0.203%), though unlike apples, their overall sales also slightly increased (0.038%). The other crops sector showed a slight decrease in price but with a very small increase in sales.

The next group in Table 2 is the upstream industries. Besides apples and other fruit, pest management was, not surprisingly, the sector most affected by the AZM ban. The increase in pesticide cost resulted in a decrease in total sales. Here, too, the ban's economic impact was relatively mild. Both the electric and utilities sectors decreased slightly in sales because of the decrease in apple production. Since the change to apples was small, the change to these upstream industries was small also.

The downstream industries were also largely unaffected by the AZM ban. The downstream industry most impacted by the ban was the frozen foods sector. But even here, sales were estimated to have been only $704,000 less in the counterfactual scenario, resulting in five less employees. The remaining sectors were aggregated because of their weak economic connections with the apple industry, and the ban's impact on them was negligible.

The AZM ban did not strongly affect the overall Washington economy. Although the apple industry makes up much of the state economy, this small impact on the apple industry created even smaller ripples throughout the upstream and downstream industries. We estimated that Washington would have had 21 more employed workers if the AZM ban had been in effect in 2007, and overall state sales would have been 0.003% smaller. The slight impact to the overall economy was consistent with theoretical results on tax increases to specific intermediate inputs and sector-specific factor taxes (Sue Wing 2004). We estimated the change to indirect taxes and state government revenue to be negligible.

Other estimates from our simulation of the AZM ban were similar in nature. Household income did not change appreciably, and there was no macroeconomic change to wages. We did estimate a change in household apple consumption by –0.122%. This was due to the slight increase in apple price. This reduction in apple consumption means there could be a very minor negative health consequence for consumers, offsetting the health benefits to orchard workers and their families. This is conjecture, however, and as such is outside of our formal model.

Table 2. Results for Sales, Employment, and Domestic Consumer Price

	SALES (VALUE OF ACTIVITY PRODUCED)			EMPLOYMENT			WASHINGTON CONSUMER PRICE
	Benchmark (Millions)	Counterfactual (Millions)	Percent Change (%)	Benchmark	Counterfactual	Percent Change (%)	Percent Change (%)
Apples	1545.96	1534.36	–0.751	15857	15879	0.139	0.203
Other Fruit	614.11	614.34	0.038	7811	7822	0.141	0.203
Other Crops	3599.81	3599.90	0.002	34523	24527	0.010	–0.006
Upstream Industries							
Pest Management	100.69	100.35	–0.335	61	60	–0.764	–0.394
Nursery	401.18	401.19	0.002	3819	3819	0.004	–0.001
Electric	5916.96	5916.96	–0.004	21851	21850	–0.005	–0.002
Utilities	1644.18	1644.18	–0.004	2316	2316	–0.008	–0.001
Downstream Industries							
Wholesale Food	25174.77	25174.28	–0.002	136000	136000	–0.002	–0.001
Frozen Food	990.43	989.73	–0.071	7277	7272	–0.077	0.015
Canned/Dry Food	2205.53	2204.91	–0.028	3447	3446	–0.055	0.006
Other Food	12088.83	12087.42	–0.012	28174	28169	–0.016	0.004
Transportation	16891.14	16890.92	–0.001	111000	111000	–0.001	–0.001
Other Sectors	476831.34	476829.16	–0.000	3511530	3511529	–0.000	—
Total	548004.93	547987.36	–0.003	3882668	3882689	0.001	—

Notes: Percent Change = ((Counterfactual – Benchmark) / Benchmark) * 100. Values are rounded. Sales equal the quantity of activity times the price of activity and are the revenue received by the producer. Employment is the quantity demanded of labor by activity. Washington consumer price is the market demand price for the commodity produced and sold within Washington to consumers or intermediate producers and includes indirect taxes and transaction costs.

Conclusion

Because of the size of the apple industry in Washington's economy, the EPA's ban on AZM could have greatly impacted the apple industry economically, causing ripples throughout upstream and downstream industries, as well as the overall economy. We used realistic prices for the likely IPM program that includes AZM alternatives to estimate the percent increase in expenditure for spraying an acre of apple orchard if the AZM ban had been in effect in Washington in 2007. We entered this cost estimate into a model of the Washington economy. Then we simulated the Washington economy in 2007 with the ban in effect. We estimated that though the apple industry would have seen multimillion-dollar decreases in sales and profit, the ban's direct impact was not large relative to the industry's more than $1.5 billion size. Because the direct impact was small, the economic ripples throughout the general economy were also small. We estimated a negligible change to Washington sales and employment due to the AZM ban.

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