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IMPACTS OF REDUCED PESTICIDE USE ON THE PROFITABILITY OF THE FRUIT AND VEGETABLE SECTOR

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The fruit and vegetable industry has become a focal point for policy decisions relating to minor-use pesticides. Of all agricultural segments, fruits and vegetables are being the most profoundly affected by policy changes mandated by the courts requiring interpretation of the zero tolerance provisions of the Delaney clause. Ironically, economic research on the tradeoffs involved in reduced pesticide use is seriously lacking.

Most studies of the implications of reduced pesticide use deal with the implications of taking an individual chemical off the market. This orientation results from the requirement under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) that the costs of licensing a pesticide be weighed against the benefits. The major benefit from pesticide use is the increased yield experienced by farmers, the improved ability to store produce, and the increased availability of domestic products to consumers throughout the year. The costs relate to environmental concerns such as the impact on health. For example, a recent National Academy of Science study explores the impacts that pesticide residues have on infants and children (National Academy of Sciences, 1993).

To date, for most individual pesticides there are substitute pesticides that can be used when and if they are withdrawn from the market. Therefore, the withdrawal of a pesticide has not, as a general rule, meant the product could not be produced or could only be produced in the absence of a means of controlling particular pests. However, after years of winnowing down the number of pesticides registered, questions of the availability of any chemicals to control particular pests have become more real. Significant forces impacting the registration and availability of pesticides could converge during this decade to bring seeds of change that will likely affect American agriculture and the nation's food supply for years to come. These forces include the following:

- All pesticides registered before 1984 should be reregistered by 1997, holding the potential for eliminating use of many pesticides that control pests and disease on fruits and vegetables.

- FIFRA, under which cost/benefit standards and requirements for the registration of pesticides are established, must be reauthorized.
- The Ninth Circuit Court of Appeals decision enforcing a zero-tolerance Delaney standard of the Federal Food, Drug, and Cosmetic Act for processed foods must be rationalized against the reduced supply and availability of fruits and vegetables resulting from strict application of Delaney. The Clinton administration has proposed a negligible risk alternative.
- The Clean Water Act and Endangered Species Act, both of which can affect the use of pesticides generally or on specific lands, must be reauthorized.
- The results of studies such as that of the National Academy of Sciences, which express caution about diet as an important source of pesticides (particularly in infants and children), must be reconciled by finding a satisfactory balance between the level of risk and the public's need for a varied diet and a plentiful supply of fresh fruits and vegetables.

Objective and Methodology

The objective of this study is to quantify the supply, availability and cost consequences of reduced pesticide use on fruit and vegetable crops. The nine crops analyzed include potatoes, oranges, tomatoes, grapes, apples, lettuce, onions, sweet corn and peaches. These crops represent approximately 82 percent of the 1992 value of U. S. production for major fruit and vegetable crops.

The yield estimates used in this analysis were provided by leading university horticultural scientists in the major production areas (a total of 19 regions) associated with each crop. Each horticultural scientist specified current cultural practices as a baseline and indicated changes in cultural practices associated with each individual pesticide-use-reduction option. These cultural practices could, for example, include increased use of labor to control weeds or sorting out inferior quality products unacceptable to the market, but were designed to minimize the yield losses.

The cost impacts generally were estimated by a separate horticultural economist using the yield and cultural practice information provided by the horticultural scientist. The economist was responsible for developing the baseline budget reflecting cultural practices currently used in commercial production of the crop.

This baseline budget only included the cash costs involved in producing and harvesting a crop. The baseline budget was then adjusted for each pesticide-reduction scenario to account for the changes in cultural practices specified by the horticulturist making the yield estimates. Impacts, on a cash cost per pound basis, could

then be calculated from the yield- and cost-per-acre information for each reduced-chemical-use scenario. This cash cost per pound of *commercially acceptable* production is a conservative estimate of the changes in total cost since it does not recognize any increases in overhead, management or capital replacement costs that would be associated with reduced pesticide use.

The specific scenarios analyzed for each crop included eight pesticide-use-reduction alternatives in addition to the baseline. Four of these scenarios involved complete elimination of the following:

- Pesticides, including the combination of herbicides, insecticides and fungicides.
- Herbicides, including growth regulators.
- Fungicides, including fumigants.
- Insecticides, including natural, synthetic, biological and chemical methods of control.

Each of these four scenarios was then modified to involve an approximate 50 percent reduction in the *number of pesticide applications*. Because of the choices that had to be made by the lead scientist in accomplishing the 50 percent reduction, the 50 percent target is only an approximation. If only one application of a particular pesticide was used in the baseline, for example, this option would not be applicable (NA) unless the lead scientist specified an alternative means that would reasonably accomplish a 50 percent reduction.

Overall Results

The yield and cost impacts generally were substantial but highly variable among regions and crops. The fresh market tended to experience larger yield reductions than the processed market. If the goal of public policy were to reduce pesticide applications by 50 percent, for example, average yields would be expected to fall by about 20 percent for processing vegetables and 42 percent for fresh vegetables. If pesticide applications were eliminated, fresh vegetable yields would experience a 76 percent decline, while processed vegetable yields would decrease 45 percent. Fresh vegetables, therefore, would suffer the greatest yield reduction in the first 50 percent reduction in pesticide use. For processed vegetables, the greater yield reductions would lean marginally toward the second 50 percent reduction in pesticide applications.

The vegetable generalizations appear to apply only partially in the case of fruits. Fruits produced for the fresh market would experience greater yield reductions (79 percent) in the absence of pesticides than those produced for the processed market (68 percent). When pesticide applications are reduced by 50 percent, yields

of fresh fruit decline by 40 percent while those for processed fruit decline by 35 percent. Thus, severity of yield losses for fruits would tend to be split between the first and second 50 percent cut in pesticide use rather than favor one or the other. In other words, the yield reduction "curve" could be concave, convex or linear depending on the pesticide option.

Sweeping pesticide-use reduction involving more than one pesticide category would have more adverse (synergistic) impacts on yield than strategies targeted toward particular pesticides. Stated differently, pesticide-reduction strategies that simultaneously decrease the use of herbicides, fungicides and insecticides would have more adverse impacts on yields because fungi and insects would tend to be more prolific in the presence of weeds.

Issues Impacting Profitability

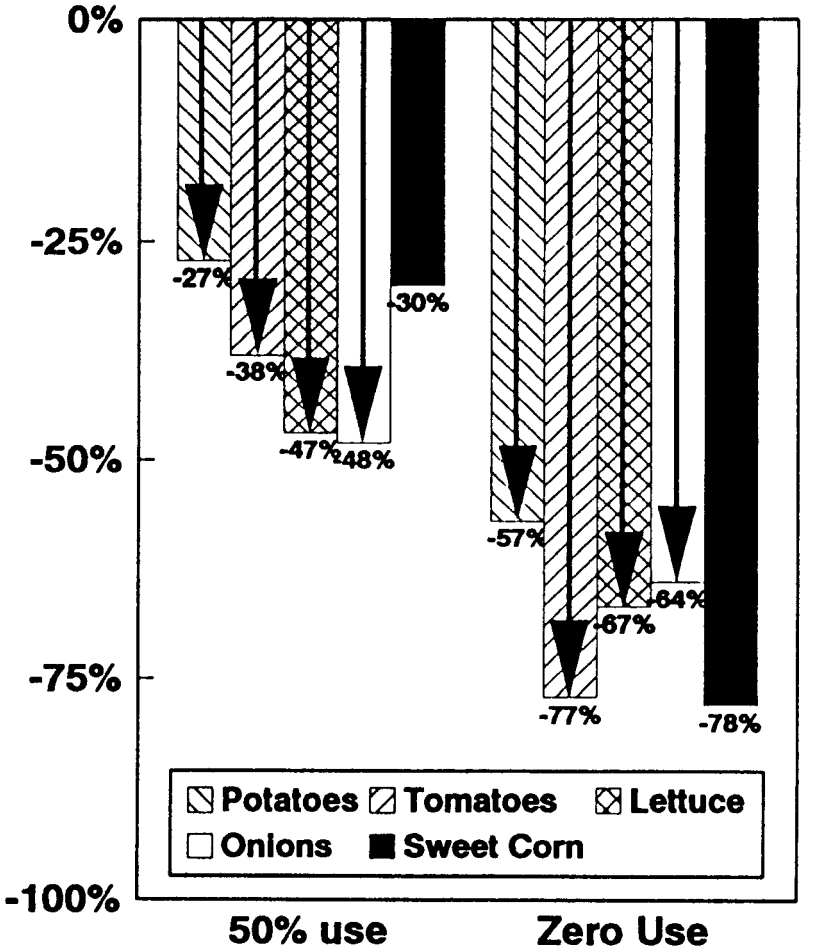
This study clearly reveals several complex issues impacting profitability of fruit and vegetable production that would be associated with the decision to reduce pesticide use. In some cases, such as yields and costs, it is possible to estimate the magnitude of those trade-offs. In other cases, the trade-offs can only be identified as being an important and substantial consideration in the decision to reduce pesticide use. Some of these trade-offs apply to all crops while others appear to be crop specific.

Marketable Yields

As indicated previously, reduced pesticide use would mean lower commercially marketable yields and this would affect fresh market products to a greater degree than processed products. For all the crops and regions analyzed in this study combined, the weighted average yield reduction would be an estimated 70 percent with no pesticides and 37 percent with a 50 percent reduction in applications. Figures 1 and 2 illustrate the reductions in yield associated with each individual fruit and vegetable crop when weighted by the value and sales that the study regions represented.

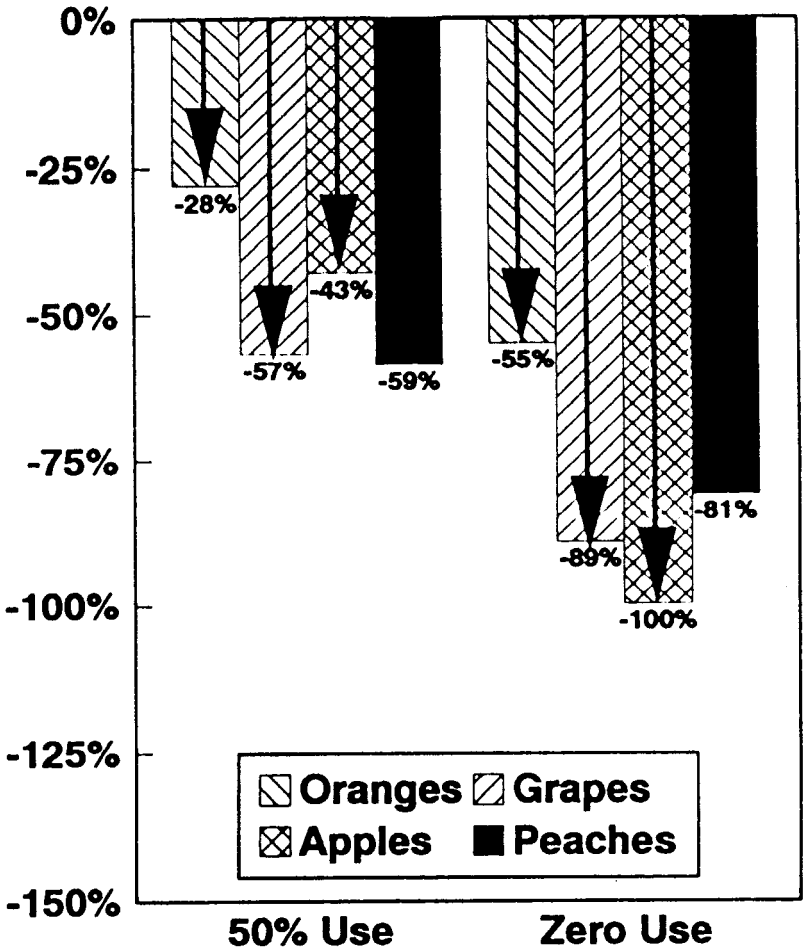
The amount of yield reduction would vary, however, by crop, pesticide and combinations of pesticides (Table 1). For example, sixteen (11 percent) of the one hundred and fifty-two total pesticide-reduction scenarios (nineteen regions with eight scenarios each) would result in total crop wipeout (100 percent crop loss). That is, no crop (NC) would be produced without the use of a particular pesticide. Additionally, there were six other scenarios in which the reductions in yield were estimated to be 70 percent or greater. Among those crops and regions most adversely affected were Maine potatoes, California grapes, Florida tomatoes, Washington and Michigan apples, Florida sweet corn and Georgia/South Carolina peaches. For these crops, the impacts are greater in cases in which

Figure 1. Reduction in Yield Resulting From No Pesticides and a 50 Percent Reduction in Pesticide Applications for Vegetables.*



*Percentages represent a weighted average by the value of producer sales for the states included in the study. In the cases where only one application prevented a 50% use scenario, the yield reduction was approximated at 50% of the zero use impact.

Figure 2. Reduction in Yield Resulting From No Pesticides and a 50 Percent Reduction in Pesticide Applications for Fruits.**



**Percentages represent a weighted average by the value of producer sales for the states included in the study. In the cases where only one application prevented a 50% use scenario, the yield reduction was approximated at 50% of the zero use impact.

Table 1. Summary of yield reductions per acre and percentage change in total costs per pound for fresh and processed fruits and vegetables, 1992.

	Yield reductions per acre (%)								Percentage change in total cost per pound							
	Herbicides		Fungicides		Insecticides		Pesticides		Herbicides		Fungicides		Insecticides		Pesticides	
Crop	Zero use	50% use	Zero use	50% use	Zero use	50% use	Zero use	50% use	Zero use	50% use	Zero use	50% use	Zero use	50% use	Zero use	50% use
Potatoes																
Idaho	30%	15%	15%	10%	25%	NA	50%	20%	59.89%	19.95%	17.33%	7.92%	35.60%	NA	109.87%	30.69%
North Dakota	30%	15%	50%	15%	50%	25%	65%	35%	67.14%	30.66%	107.31%	13.26%	87.85%	26.20%	202.83%	84.34%
Maine	25%	15%	100%	25%	50%	10%	100%	70%	59.79%	23.10%	NC	36.08%	112.86%	11.27%	NC	289.65%
Oranges																
Florida	0%	0%	50%	17%	15%	8%	63%	25%	17.68%	0.53%	34.45%	6.59%	1.85%	1.04%	91.86%	9.48%
California	15%	15%	25%	24%	0%	0%	36%	35%	14.70%	5.96%	30.65%	32.01%	−7.41%	−3.70%	33.54%	33.55%
Tomatoes																
Florida	27%	NA	70%	28%	100%	30%	100%	50%	17.80%	NA	83.38%	14.26%	NC	18.17%	NC	36.02%
California	25%	10%	10%	4%	22%	9%	37%	17%	81.14%	29.31%	12.84%	5.81%	31.41%	12.35%	112.99%	48.57%
Grapes																
California	50%	25%	97%	44%	58%	36%	99%	68%	20.44%	13.74%	1475.32%	55.80%	61.70%	27.01%	3045.56%	114.53%
New York	12%	5%	37%	12%	10%	4%	59%	21%	21.51%	7.75%	70.69%	4.50%	11.28%	3.23%	140.42%	17.32%
Apples																
Washington	20%	15%	6%	3%	100%	14%	100%	30%	68.22%	17.87%	9.11%	4.41%	NC	22.90%	NC	49.20%
Michigan	60%	30%	100%	90%	100%	75%	100%	100%	185.93%	47.49%	NC	509.55%	NC	163.56%	NC	NC
Lettuce																
California	13%	NA	47%	27%	53%	13%	67%	47%	14.46%	NA	35.57%	18.57%	36.10%	7.40%	84.55%	42.06%
Onions																
Idaho	46%	15%	20%	NA	12%	8%	60%	45%	58.89%	17.59%	2.43%	NA	9.29%	4.46%	57.69%	23.50%
California	35%	25%	30%	10%	10%	NA	60%	45%	37.65%	20.01%	17.98%	5.82%	2.71%	NA	66.51%	37.27%
Texas	25%	10%	60%	40%	40%	15%	80%	60%	24.24%	10.01%	49.34%	27.35%	28.17%	8.81%	134.31%	68.74%
Sweet Corn																
Florida	8%	NA	60%	20%	100%	15%	100%	30%	5.16%	NA	60.19%	9.64%	NC	1.23%	NC	9.37%
Wisconsin	50%	20%	NA	NA	13%	7%	63%	30%	85.97%	22.34%	NA	NA	12.65%	9.24%	139.34%	38.21%
Peaches																
California	1%	0%	45%	30%	40%	25%	75%	45%	3.55%	0.42%	57.27%	33.21%	40.62%	20.81%	196.13%	57.61%
Georgia/S.C.	20%	0%	100%	80%	100%	60%	100%	100%	7.74%	0.96%	NC	124.74%	NC	45.93%	NC	NC

NA = Not Applicable (situation where 50% reduction was not possible because only one application is currently used)
NC = No Crop (due to 100% yield loss)

they are used primarily for the fresh market and the crops would not be seasonally available except for imports.

There were scenarios, of course, in which the impact on marketable yields was less severe. For example, in twenty-four scenarios, the impact on marketable yield was estimated to be 10 percent or less. However, all but eight of these scenarios dealt with 50 percent reductions in applications. In other words, there were only a handful of crops in which the total elimination of a particular pesticide resulted in less than 10 percent yield reduction. These cases included: a) the application of herbicides on Florida oranges, Florida sweet corn and California peaches; b) the application of fungicides on California tomatoes and Washington apples; and c) the use of insecticides on California oranges, New York grapes and California onions.

Costs

Per unit costs of production would increase if pesticide use were reduced (Table 1). This would happen even if the cost of production per acre were to fall because the yield invariably would fall by a greater percentage than the cost per acre. In many cases, however, the cost per acre also would rise because of increases in cultivation and/or labor costs. There were seventeen scenarios in which the estimated cash costs per pound more than doubled from the reduction in pesticide use. Another seven cases were estimated to result in per pound cost increase of 80 percent or higher. The existence of higher unit costs with less use of pesticides seems reasonable since farmers would never have adopted pesticides in the first place without a cost benefit.

Prices/Imports

Because a large number of growers compete in markets for fruits and vegetables, they do not have the power to "pass on" increases in cost. Over time, however, less production and higher costs would mean higher prices. In the long run, the price increase would be at least as much as the cost increase. In the short run, the price increase might be much more than the cost increase because the demand for fruits and vegetables is believed to be quite inelastic, which means that a small percentage reduction in supply would result in a larger percentage increase in price.

However, the price effect depends on U.S. policy regarding imports. Higher prices in the United States combined with the periodic lack of supplies due to reduced pesticide use would also mean a higher proportion of the U.S. fruit and vegetable supply would have to be imported in order to meet current consumer demand, particularly for those crops in which a total crop wipeout (100 percent loss) was estimated to occur. All of the crops studied have viable alter-

native sources of supply. In addition, the United States has little control over pesticide use in the supplying countries.

Product Appearance, Quality, and Perishability

Most consumers will not buy corn or apples if worms or maggots are present in them. Even if some purchases were to be made, waste and spoilage would increase as perishability increased and product turnover in the grocery store declined. Spoilage means even higher costs.

Likewise, processed products have less appeal with increased insect parts and greater potential spoilage. Processed product tolerances for insect parts would almost certainly have to be increased with substantially reduced pesticide use. Costs of processing would likewise rise as processing plants attempted to maintain quality through increased product sorting.

Exports

Higher prices in the United States due to reduced pesticide use would suggest a marked reduction in U.S. ability to compete in the international fruit and vegetable market. Several of the lead horticultural scientists and economists mentioned the inevitable loss of export markets as a result of lower pesticide use. This loss of markets would not only be a result of the lack of competitiveness on the basis of price and cost but also a result of rejection by customer countries because of increased insect parts in either fresh or processed products. The countries that buy our fruits and vegetables have phytosanitary regulations that prevent lower-quality products from entering.

Labor

Although the reduced use of pesticides would contribute to a national goal of employing more labor, the labor supply required to grow crops without pesticides may not be readily available under any circumstances. History has shown that it is difficult to attract labor to agriculture.

Production without pesticides would reduce the use of mechanical harvesting equipment due to reduced product quality. If products such as tomatoes or sweet corn were damaged and softened by insect infestation, further damage by mechanical harvesting would render the product unusable. In the absence of an adequate labor supply, the result could be even lower yields of marketable crops than those indicated in this study.

Land and Water Utilization

It is well-known, but not generally recognized, that pesticides are resource-conserving. About 5.83 million acres of land is being used for fruit and vegetable production in the United States. Because pesticide use results in higher yields, less land is required for farming.

Based on the results of this study, however, land requirements could easily increase by 40 to 50 percent if pesticide use were eliminated. These additional acres would be required to meet market demands, but the acreage would have to come from land devoted to other crops or from more fragile lands not in production.

If more land were placed in production, more water would be required for irrigation, particularly if the loss of herbicides allowed weeds to compete with crops for water. More weeds also would mean more rodents, a pest notorious for spreading disease. With more weeds in the fields, growers would be forced to use more cultivation to control weed growth, and more cultivation would mean more soil erosion.

Management and Size of Farms

This study assumes management is a fixed expense. Although considerable management skills are employed when pesticides are used on a regular basis, greater management skills and time would be required if the level of pesticide use were to decline. In other words, pesticide use reduces the requirements for one of agriculture's most scarce resources—management skill.

If pesticide use were to decline and growers were faced with low yields, farm size probably would increase as growers tried to meet market demands by farming more acreage. Few farm managers would have the required management skills to farm under reduced chemical systems. This scenario is contrary to conventional wisdom, which maintains that reduced pesticide use would mean a return to small farms.

Implications for Policy Decisions

Because of the large yield reductions generally experienced and related cost increases, and the potential for imports, it becomes clear that farm profitability is directly impacted. The magnitude of that impact depends on, more than anything else, on the policy toward imports.

This study follows an earlier study (Knutson, et al., and Smith et.al.) that used similar methodology to evaluate the impact of

pesticide use reduction on the major program crops. Although the results for fruits and vegetables are similar to the program crop study, they are more dramatic in that some fruit or vegetable crops would be completely wiped out in certain regions as a result of the absence of pesticides. Of course, this would not only have severe short-run effects on individual farm profitability and survival, but would also impact the long-run competitiveness of the produce industry.

The major difference between this study and the earlier study is the inclusion of a 50 percent pesticide-reduction option for fruits and vegetables. The results suggest that a substantial variation exists from crop-to-crop regarding whether the largest incidence of yield reduction would occur in the first 50 percent decrease or in the final 50 percent. There are situations in which the 50 percent reduction would be possible for some crops in some regions, but broad sweeping legislation would not achieve this goal with being detrimental to other major production regions.

The need to proceed with caution on policies involving the elimination or substantial reduction of pesticides was a primary emphasis in the earlier study of major program crops. This emphasis is even more important in a study of fruits and vegetables because the number of pesticide options is often very limited and the potential yield reductions are large and sometimes even dramatic.

Further research and technological innovations will be required before significant reductions in pesticide use will be possible without substantial yield reductions and large cash cost increases. The nation's policymakers will likely want to consider all economic, environmental, nutritional and social tradeoffs as they consider pesticide policy changes that will impact every link of America's food chain for years to come.

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