IMPACTS
OF ELIMINATING ORGANOPHOSPHATES AND CARBAMATES
FROM CROP PRODUCTION

AFPC Policy Working Paper 99-2

Ronald D. Knutson, Agricultural Economist, Texas A&M University
Edward G. Smith, Agricultural Economist, Texas A&M University

Agricultural and Food Policy Center
Department of Agricultural Economics
Texas Agricultural Experiment Station
Texas Agricultural Extension Service
Texas A&M University

April 1999

College Station, Texas 77843-2124
Telephone: (409) 845-5913
http://afpc1.tamu.edu/pesticides.htm

Pesticides and registered trade names included in this report are not intended to be a complete listing. The trade names are included merely as some examples of the pesticides. They are not an endorsement of any particular chemical company's product or an indication that any such product is the exclusive trade name used for any particular purpose.

TABLE OF CONTENTS

FOREWORD

This publication reports the results of scientists' analyses of the three to five-year impacts of eliminating organophosphates and carbamates. The fruits studied include apples, grapes, oranges, and peaches. The vegetables include carrots, potatoes, and tomatoes. The field crops include corn, cotton, peanuts, rice, grain sorghum, soybeans, and wheat.

The estimates of yield impacts for 14 agricultural commodities are made by applied scientists who are agronomic specialists in the production commodities for which they supplied estimates. Their estimates are based on the scientific information available. For each commodity, literature sources relied upon are cited. In addition, other scientists consulted for region-specific data and information are identified.

Yield estimates are made based upon the best available cultural practices. The baseline involves a specification of the current cultural practices. The no organophosphate and carbamate scenario modifies both chemical and other cultural practices in an optimum manner. Both current and alternative pesticide regimes are explicitly identified.

Cost estimates typically are made by a farm management economist working with the agronomic specialist. The baseline for making cost estimates was supplied by USDA's cost of production estimates produced by the Economic Research Service from National Agricultural and Statistics Service farmer surveys. For the no organophosphate and carbamate option, the economist adjusted the baseline to consider changes in the chemical regime as well as cultural practices and harvested yields. In some of the fruit and vegetable crops where the agronomic specialist was also responsible for budget development, yields and cost estimates were made by a single scientist.

Following the development of the yield and cost estimates, the aggregate economic effects were analyzed at Auburn University utilizing a model, AGSIM, that has been peer reviewed and extensively been used for this purpose. These results are reported in Chapter 15.

Ron Knutson and Ed Smith, who are the authors of this report, drew on detailed scientist reports for each of the crops analyzed and for the aggregate economic impact analysis. Copies of the 14 scientists' reports and the aggregate impacts report are published as research reports by the Agricultural and Food Policy Center at Texas A&M University. They are available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm, or they can be obtained at cost from Dawne Hicks at (409) 845-5913 or dhicks@tamu.edu.

CHAPTER 1
APPLES[1/]

Apple production, averaging 106 million cwt over the past five years (1993-1997), was grown on 460,000 bearing acres. The total dollar value of apples produced in the United States in 1997 was $1.7 billion.[2/] From a dollar perspective, apples are the fourth largest fruit and/or vegetable studied. It is a significant fruit in the diet of infants and children.

The analyses in this study are based on estimates from Washington State, which is the largest apple-producing area from a volume perspective, accounting for 49 percent of the production. This production is grown on 33 percent of the bearing acreage. Discussions with scientists in other regions, such as Michigan, New York, and Pennsylvania–which represent 24 percent of the production–led to the conclusion that these regions would experience reduced production at least as great as those experienced by Washington State and the broader western region.

Organophosphates and carbamates were found to be important to apple production with alternatives being higher cost and less effective in some cases. Even in the West, the estimates presented herein for apples were presented as a best case scenario. The estimating scientists, for example, note that it is possible that codling moth damage could approach 100 percent if mating disruption were not a viable alternative control measure. Morever, regular cropping would not be possible with the loss of carbaryl (Sevin) as a post-bloom chemical thinning material. In addition,

[1/]The estimates of the impacts of pesticide use reduction in apples were made by Kathleen Williams, horticulturist, and Herbert Hinman, agricultural economist, both of Washington State University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Red Delicious Apple Production in Washington*, AFPC Research Report 99-1 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]*USDA Crop Values 1998 Summary* (Washington, D.C.: USDA/NASS, February 1998).

if pest pressure is extreme to the point of defoliating trees, then tree vigor could be reduced with the potential of winter injury being increased.

Baseline

Budgets developed by Washington State University were used to establish baseline costs. Yields in Washington were 35,100 pounds per bearing acre (Table 1). This yield was determined to be applicable to apples for the fresh market.

Under the baseline situation for Washington State, total variable costs were $7.50 per cwt. Chemical costs were $0.72 per cwt, nearly 10 percent of variable costs.

The major pests for apples include codling moth, leafrollers, thrips, true bugs, campylomma, apple scab, mealybugs, aphids, and scale (Table 2). The principal organophosphates and carbamates used in apple production include thiram (Thiram), formetanate hydrochloride (Carzol), carbaryl (Sevin), chlorpyrifos (Lorsban) and azinphosmethyl (Guthion). Carbaryl (Sevin) is the workhorse of post-bloom thinning programs.

No Organophosphates and Carbamates

The main substitutes for organophosphates and carbamates include endosulfan (Thiodan) for control of true bugs and campylomma. Imidacloprid (Provado) would be used for controlling leafhoppers, grape mealybugs, and other sporadic insect pests (Table 2). Alternative chemical controls include spinosad (Success) for leafrollers, clofentozine (Apollo), and hexythiazox (Savey) for European red mite eggs, and imidacloprid (Provado) for aphids. Codling moth control would be maintained with pheromone lures for mating disruption and summer oil applications if pressure is light, but control would not be assured. Sterol inhibitors, such as myclobutanil (Rally), or lime sulfur would be substituted for apple scab control.

Table 1. Yields and Costs of Producing Apples in Washington State With and Without Organophosphates and Carbamates

	Washington		
	Baseline	No O&C	% Change
Yield (cwt/acre)	351.00	216.00	-38.46%
Cash expenses ($/acre):			
Chemicals	$253.58	$449.31	77.19%
Other variable cash expenses	$2,378.65	$2,241.13	-5.78%
Total, variable cash expenses	$2,632.23	$2,690.44	2.21%
Variable Cash expenses ($/cwt):			
Chemicals	$0.72	$2.08	187.93%
Other variable cash expenses	$6.78	$10.38	53.11%
Total, variable cash expenses	$7.50	$12.46	66.09%

[a] Apple region included represents 33% of the acreage and 49% of the production during the 1993-1997 period.

[b] Chemicals include only pesticides. Growth regulators that also use carbamates are included in other variable cash expenses.

Table 2. Apple Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
San Jose scale	Chlorpyrifos (Lorsban)	Oil
European red mite eggs	Chlorpyrifos (Lorsban)	Clofentozine (Apollo) Hexythiazox (Savey)
Leafrollers	Chlorpyrifos (Lorsban)	Bacillus thuringiensis (*Bt*) Spinosad (Success[a])
Aphids	Chlorpyrifos (Lorsban)	Imidacloprid (Provado)
Primary scab spray	Thiram (Thiram)	Sterol inhibitors such as Myclobutanil (Rally) Lime-sulfur spray
Codling moth	Azinphosmethyl (Guthion)	Pheromones Summer oil sprays
Growth regulator	Carbaryl (Sevin)	Naphthalene acetic acid (NAA)
Lygus bugs, Stink bugs, Campylomma, Western tentiform leafminer, Grape mealybug, White apple leafhopper, Apple aphid, Mites, Western flower thrips	Formetanate Hydrochloride (Carzol)	Endosulfan (Thiodan)

[a] New in 1998/99.

Source: Kathleen Williams, Herb Hinman, *Impacts of the Elimination of Organophosphates and Carbamates from Red Delicious Apple Production in Washington*, AFPC Research Report 99-1 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

Apple yields could be reduced by 38 percent in the absence of organophosphates and carbamates. Chemical costs per cwt would increase by 188 percent from $0.72 to $2.08 per cwt. The result is a 66 percent increase in the total variable cost of apple production from $7.50 per cwt to $12.46 per cwt. It should be noted that these pest management alternatives have not been commercially tested or utilized in many instances. Many compounds for control are relatively new and require several years of use to fully assess effectiveness on pest management and impact on grower returns.

Scientists Consulted

Jay Brunner, entomologist, Washington State University

John Dunley, entomologist, Washington State University

Gary Grove, plant pathologist, Washington State University

Randy Lee, horticulturist, Beebe Fruit Company, Chelan, Washington

References

Beers, Elizabeth H. and J. F. Brunner, "Washington State Apple and Pear Pesticide Use Survey, 1989-90," Washington State University in-house publication (1991), 135 pp.

Hinman, Herbert R., Paul Tvergyak, Brooke Peterson, Marc Clements, *1992 Estimated Cost of Producing Red Delicious Apples in Central Washington*, EB1720, Washington State University Cooperative Extension (July 1992).

Straub, R. W., E. Stover, P. J. Jentisch, "Carbaryl as a Component in Integrated Crop Management of Apples," *Journal of Economic Entomology*, vol. 90, no. 5 (1997), pp. 1315-23.

Swinton, S. M., E. A. Scorsone, *Short-term Costs and Returns to Michigan Apple, Blueberry, and Tart Cherry Enterprises with Reduced Pesticide Availability* (East Lansing, Michigan: Michigan Agricultural Experiment Station, Michigan State University, Research Report 551, April 1997).

USDA Crop Values 1998 Summary (Washington, D.C.: USDA/NASS, February 1998).

Washington Agricultural Statistics, 1996-1997 (Spokane, Washington: Washington Agricultural Statistics Service, Washington State Department of Agriculture).

Washington Fruit Survey, 1993 (Spokane, Washington: Washington Agricultural Statistics Service, Washington State Department of Agriculture).

CHAPTER 2
CARROTS[1/]

Carrot production, averaging 39.3 million cwt over the past three years (1995-1997), was grown on 119,683 planted acres. From the perspective of dollar value of farm level sales, carrots are the sixth largest fruit and/or vegetable studied. They are an important vegetable in the diets of infants and, for that matter, in the diets of all people spurred by an upward trend in per capita consumption over the past decade. This may be due to the development of sweeter and more nutritious cultivars as well as innovations such as baby peeled carrots which serve as a snack food.

This analysis is based on estimates from five states–California (fresh), Colorado (fresh), Michigan (fresh), Texas (fresh and processed), and Washington (fresh and processed). These states accounted for an average of 78 percent of the US production and 78 percent of planted acres over the 1995-97 period. This includes 91 percent of the fresh and 45 percent of the processed production.

Organophosphates and carbamates are part of the complex of pesticides used in controlling carrot insects and diseases. While pests vary from state to state, leaf blight and carrot weevils consistently create problems for producers. Substitute chemicals exist for most pests and are utilized to a greater extent than organophosphates and carbamates, except for soil insect control.

[1/]The estimates of the impacts of pesticide use reduction in carrots were made by Lynn Brandenberger, horticulturist, Texas A&M University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Carrot Production*, AFPC Research Report 99-2 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

Baseline

Budgets developed by the University of California, Colorado State University, Michigan State University, Texas A&M University, and Washington State University were used to establish baseline costs. Fresh carrot yields ranged from 660 cwt per acre in Colorado to 220 cwt in Texas for a US average of 407 (Table 1). For processed carrots, yields were 800 cwt per acre in Washington and 290 cwt in Texas (Table 2). The extrapolated US average yield for all carrots was 430 cwt per acre (Table 3).

For fresh carrots, total variable costs ranged from $2.69 per cwt in Washington to $11.46 per cwt in Texas, resulting in a US average of $9.65 (Table 1). Chemical costs for fresh carrots ranged from $0.10 per cwt in Colorado to $0.85 in California with a US average of $0.76 per cwt. For processed carrots, total variable costs were $1.51 per cwt in Washington and $2.51 in Texas resulting in a US average of $1.72 per cwt (Table 2). Chemical costs were $0.19 per cwt in Washington and $0.52 in Texas for a US average of $0.26 per cwt. The US average total variable cost for all carrots was $8.25 per cwt with a chemical cost of $0.67 (Table 3).

Pesticides are important to the production of carrots, with costs ranging from $64 per acre in Colorado to $368 in Washington. Both the lowest and the highest costs are for fresh carrots. Organophosphates and carbamates are used in all production areas with the most frequently and widely utilized being diazinon (Spectracide) for the control of soil insects (Table 4). However, seven different organophosphates and carbamates are labeled for use on carrots–bensulide (Prefar), methyl parathion (Penncap-M, Methyl Parathion), diazinon (Spectracide), carbaryl (Sevin), malathion (Fyfanon), methomyl (Lannate), and mancozeb (Dithane).

Table 1. Yields and Costs of Producing Fresh Carrots With and Without Organophosphates and Carbamates

	United States Fresh[a]			California Fresh			Colorado Fresh			Michigan Fresh			Texas Fresh			Washington Fresh		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwts/acre)[b]	406.86	388.35	-4.55%	400.00	384.00	-4.00%	660.00	660.00	0.00%	385.00	385.00	0.00%	220.00	165.00	-25.00%	540.00	432.00	-20.00%
Variable Cash expenses ($/acre):																		
Chemicals	$307.43	$303.33	-1.34%	$341.97	$341.30	-0.20%	$63.95	$63.95	0.00%	$226.62	$226.62	0.00%	$149.73	$89.36	-40.32%	$367.74	$363.49	-1.16%
Other variable cash expenses	$3,617.82	$3,489.94	-3.53%	$4,022.09	$3,899.09	-3.06%	$2,468.00	$2,468.00	0.00%	$2,003.30	$2,003.30	0.00%	$2,372.54	$1,857.46	-21.71%	$1,083.35	$1,029.35	-4.98%
Total, variable cash expenses	$3,925.26	$3,793.27	-3.36%	$4,364.06	$4,240.39	-2.83%	$2,531.95	$2,531.95	0.00%	$2,229.92	$2,229.92	0.00%	$2,522.27	$1,946.82	-22.81%	$1,451.09	$1,392.84	-4.01%
Variable Cash expenses ($/cwt):																		
Chemicals	$0.76	$0.78	3.37%	$0.85	$0.89	3.96%	$0.10	$0.10	0.00%	$0.59	$0.59	0.00%	$0.68	$0.54	-20.43%	$0.68	$0.84	23.56%
Other variable cash expenses	$8.89	$8.99	1.06%	$10.06	$10.15	0.98%	$3.74	$3.74	0.00%	$5.20	$5.20	0.00%	$10.78	$11.26	4.39%	$2.01	$2.38	18.77%
Total, variable cash expenses	$9.65	$9.77	1.24%	$10.91	$11.04	1.21%	$3.84	$3.84	0.00%	$5.79	$5.79	0.00%	$11.46	$11.80	2.91%	$2.69	$3.22	19.98%

[a] Carrot regions included represent 78% of the acreage and 91% of the production during the 1995-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

Table 2. Yields and Costs for Producing Processed Carrots With and Without Organophosphates and Carbamates

	United States Processed[a]			Texas Processed			Washington Processed		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwts/acre)[b]	585.30	462.14	-21.04%	290.00	217.50	-25.00%	800.00	640.00	-20.00%
Variable Cash expenses ($/acre):									
Chemicals	$149.31	$121.43	-18.67%	$149.73	$89.36	-40.32%	$149.00	$144.75	-2.85%
Other variable cash expenses	$854.60	$774.86	-9.33%	$576.71	$497.33	-13.76%	$1,056.63	$976.63	-7.57%
Total, variable cash expenses	$1,003.90	$896.29	-10.72%	$726.44	$586.69	-19.24%	$1,205.63	$1,121.38	-6.99%
Variable Cash expenses ($/cwt):									
Chemicals	$0.26	$0.26	3.01%	$0.52	$0.41	-20.43%	$0.19	$0.23	21.43%
Other variable cash expenses	$1.46	$1.68	14.83%	$1.99	$2.29	14.98%	$1.32	$1.53	15.54%
Total, variable cash expenses	$1.72	$1.94	13.07%	$2.51	$2.70	7.68%	$1.51	$1.75	16.26%

[a] Carrot regions included represent 45% of the acreage and 45% of the production during the 1995-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

Table 3. Yields and Costs for Producing Fresh and Processed Carrots Combined With and Without Organophosphates and Carbamates

	United States[a]			California Fresh			Colorado Fresh			Michigan Fresh			Texas Fresh			Washington Fresh			Texas Processed			Washington Processed		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwts/acre)[b]	429.88	397.86	-7.45%	400.00	384.00	-4.00%	660.00	660.00	0.00%	385.00	385.00	0.00%	220.00	165.00	-25.00%	540.00	432.00	-20.00%	290.00	217.50	-25.00%	800.00	640.00	-20.00%
Variable Cash expenses ($/acre):																								
Chemicals	287.06	279.89	-2.50%	341.97	341.30	-0.20%	63.95	63.95	0.00%	226.62	226.62	0.00%	149.73	89.36	-40.32%	367.74	363.49	-1.16%	149.73	89.36	-40.32%	149.00	144.75	-2.85%
Other variable cash expenses	3261.24	3139.57	-3.73%	4022.09	3899.09	-3.06%	2468.00	2468.00	0.00%	2003.30	2003.30	0.00%	2372.54	1857.46	-21.71%	1083.35	1029.35	-4.98%	576.71	497.33	-13.76%	1056.63	976.63	-7.57%
Total, variable cash expenses	3548.29	3419.45	-3.63%	4364.06	4240.39	-2.83%	2531.95	2531.95	0.00%	2229.92	2229.92	0.00%	2522.27	1946.82	-22.81%	1451.09	1392.84	-4.01%	726.44	586.69	-19.24%	1205.63	1121.38	-6.99%
Variable Cash expenses ($/cwt):																								
Chemicals	0.67	0.70	5.35%	0.85	0.89	3.96%	0.10	0.10	0.00%	0.59	0.59	0.00%	0.68	0.54	-20.43%	0.68	0.84	23.56%	0.52	0.41	-20.43%	0.19	0.23	21.43%
Other variable cash expenses	7.59	7.89	4.02%	10.06	10.15	0.98%	3.74	3.74	0.00%	5.20	5.20	0.00%	10.78	11.26	4.39%	2.01	2.38	18.77%	1.99	2.29	14.98%	1.32	1.53	15.54%
Total, variable cash expenses	8.25	8.59	4.13%	10.91	11.04	1.21%	3.84	3.84	0.00%	5.79	5.79	0.00%	11.46	11.80	2.91%	2.69	3.22	19.98%	2.51	2.70	7.68%	1.51	1.75	16.26%

[a] Carrot regions included represent 78% of the acreage and 78% of the production during the 1995-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

Table 4. Carrot Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Caterpillars, beetles, etc.	Methyl Parathion (Penncap-M, Methyl Parathion)	Cyfluthrin (Baythroid) Endosulfan (Thiodan) Esfenvalerate (Asana)
Soil insects (carrot weevil, etc.)	Diazinon (Spectracide)	None
Caterpillars	Carbaryl (Sevin)	Cyfluthrin (Baythroid) Esfenvalerate (Asana) Endosulfan (Thiodan)
Aphids, flea beetles, & leaf hoppers	Malathion (Fyfanon)	Endosulfan (Thiodan)
Caterpillars, leaf hoppers	Methomyl (Lannate)	Cyfluthrin (Baythroid) Esfenvalerate (Asana)
Leaf blight	Mancozeb (Dithane)	Chlorothalonil (Bravo)
Weeds	Bensulide (Prefar)	Trifluralin (Treflan)

Source: Lynn Brandenberger, *Impacts of the Elimination of Organophosphates and Carbamates from Carrot Production*, AFPC Research Report 99-2 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

No Organophosphates and Carbamates

Eliminating organophosphates and carbamates on carrots primarily impacts the yield, and those yield losses come primarily from soil insects. The alternative pest treatments available for carrot production are indicated in Table 4. No substitutes for diazinon (Spectracide) currently exist. In Texas, chemical costs fall markedly with the replacement of bensulide (Prefar) by trifluralin (Treflan) which is less effective.

With no organophosphates and carbamates, yields for fresh carrots decline in California by 4 percent, in Texas by 25 percent and in Washington by 20 percent. The same percentage declines occurred for processed carrots in Texas and Washington (25% and 20%, respectively.) This decline results from the absence of a substitute for diazinon (Spectracide). The US average yield decline for fresh carrots was 5 percent, 21 percent for processed carrots, and 7 percent overall.

Total variable cost increases per cwt for fresh carrots with no organophosphates and carbamates ranged from zero in Colorado and Michigan to 20 percent in Washington for a US average increase of 1 percent. Chemical cost changes per cwt ranged from a 20 percent drop in Texas to a 24 percent increase in Washington for a US average increase of 3 percent. Total variable costs per cwt for processed carrots would be an 8 percent increase in Texas and a 16 percent increase in Washington, with a 13 percent US average increase. US average chemical costs per cwt for processed carrots increased by 3 percent, the same as for fresh carrots. Overall, US total variable costs increased by 4 percent while chemical costs increased by 5 percent.

Scientists Consulted

Mark Conner, agri-chemical salesman, Mid Valley Chemicals, Texas

Mike Davis, plant pathologist, University of California, Davis

Todd Dekryger, agriculture research specialist, Gerber, Michigan

Chris Falak, produce buyer, Gerger, Michigan

Kent Hill, production manager, High Plains Carrots, Texas

John Lacky, general manager, McManis Produce, Texas

Joe Lucio, production manager, Holden Wallace Produce, Texas

Marvin Miller, plant pathologist, Texas A&M University

Scott Nissen, weed scientist, Colorado State University

Gregg Nuessly, vegetable entomologist, IFAS, Florida

Joe Nunez, farm advisor vegetable crops & plant pathology, University of California, Davis

Jose Peña, agricultural economist, Texas A&M University

Roland Roberts, horticulturist, Texas A&M University

Kent Smith, plant pathologist, USDA Office of Pest Management

Erik Sorenson, horticulturist, Washington State University

Larry Stein, horticulturist, Texas A&M University

Carol Suter, nutritionist, Texas A&M University

Dorothy Valdez, general manager, Holden Wallace Produce, Texas

Holden Wallace, CEO, Holden Wallace Produce, Texas

Bernard Zandstra, vegetable specialist, Michigan State University

References

Davis, M., *Cello Carrot Projected Production Costs 1992-1993* (Imperial County, California: University of California Cooperative Extension).

"Fruit and Vegetable Baseline," National Food and Agricultural Policy Project (NFAPP), Morrison School of Agribusiness, Arizona State University, Memo (1998).

Hinman, H., G. Pelter, and E. Sorensen, *Carrot Enterprise Budgets, Columbia Basin, Washington* (Pullman, Washington: Cooperative Extension, Washington State University, 1994).

Johnson, J., *Texas Crop Enterprise Budgets Winter Garden Area Projected 1997, Carrots Irrigated South Texas 1998 Projected Costs and Returns per Acre* (Weslaco, Texas: Texas Agricultural Extension Service District 12).

Peña, J., *Texas Crop Enterprise Budgets Winter Garden Area Projected 1997, Carrots Irrigated Wintergarden Region 1997 Projected Costs and Returns per Acre* (Uvalde, Texas: Texas Agricultural Extension Service District 10).

Peña, J., *Texas Crop Enterprise Budgets Winter Garden Area Projected 1997, Processed Carrots Irrigated Wintergarden Region 1997 Projected Costs and Returns per Acre* (Uvalde, Texas: Texas Agricultural Extension Service District 10).

Shapley, A.E., and T.A. Dudek, *Costs of Producing Carrots*, Agricultural Economics Report No. 520 (East Lansing, Michigan: Department of Agricultural Economics, Michigan State University, January 1989).

CHAPTER 3
CORN[1/]

Corn production, averaging 8.5 billion bushels over the past five years (1993-1997), was grown on approximately 77 million acres. From the perspective of dollar value of farm level sales, corn is the most important commodity studied. As such, changes in the cost of producing corn can be anticipated to have the largest impacts on the cost of food for consumers.

The analyses in this study are based on estimates from 20 major corn-producing states divided into four regions by the scientists making the estimates.[2/] These states accounted for 94 percent of the 1993-97 production and acreage planted.

Researchers have found that each of these regions has production uniquenesses in terms of growing seasons, yields, extent of irrigation, and pest pressures. These differences were clearly demonstrated in this study.

Despite technological advances such as *Bt* corn for corn borers, organophosphates and carbamates still are very important to corn production to control pests such as stink bugs, billbugs, wire worms, rootworms, cutworms, and grubs. While substitute chemicals exist for many of the pests that adversely impact corn yields, generally, they are higher cost and less effective, resulting in reduced yields. Yield reductions are particularly severe in the Southeast where longer growing seasons and mild winters foster greater insect and weed problems.

[1/]The estimates of the impacts of pesticide use reduction in corn were made by Richard Wiese, agronomist, Glen Helmers, agricultural economist, and Saleem Shaik, agricultural economist, all of the University of Nebraska. Wiese is a professor emeritus. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Corn Production*, AFPC Research Report 99-3 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]The states and regions included are: North Central (IL, IN, IA, MI, MN, MO, OH, WI), Plains (CO, KS, NB, ND, SD, TX), Southeast (GA, KY, LA, NC) and Northeast (NY, PA).

However, even traditional corn-growing areas are adversely impacted by the withdrawal of organophosphates and carbamates.

Withdrawal of most organophosphates and carbamates will force corn growers into a transition from broad-spectrum, economical insect controlling materials to other alternatives. Where feasible and appropriate, shifts to biological pesticides, low risk pyrethroids, insect growth regulators, or to *Bt* corn offer change in corn insect management strategies. *Bt* corn was planted in the 1998 corn growing season on a small fraction of the total US corn acres. Corn growers are willing to accept the *Bt* corn when it proves to be advantageous over non-*Bt* corn. In a recent Nebraska survey, 35 percent of the first year *Bt* corn growers eliminated use of a soil applied insecticide. Corn growers are planting *Bt* corn primarily to experience a potential savings in insect control.

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These budgets were applied to average 1993-97 yields that ranged from 70 bushels per acre in the Northeast to 124 bushels in the North Central region, for a US average of 118 bushels per acre (Table 1).

Variable cash expenses averaged in the range from $1.51 per bushel in the North Central region to $2.48 in the Northeast, for a US average of $1.72 per bushel. Chemical costs in the range of $26 to $32 per acre varied from $0.22 per bushel in the Plains States to $0.39 per bushel in the Northeast for a US average of $0.23 per bushel.

As suggested by their costs and effectiveness, organophosphates and carbamates are important to efficient corn production (Table 2). They are used in all production regions. Those

Table 1. Yields and Cost of Producing Corn With and Without Organophosphates and Carbamates

	United States[a]			Northeast			Southeast			North Central			Plains States		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (bu/pl acre)[b]	118.31	114.11	-3.55%	69.51	68.81	-1.00%	97.67	92.42	-5.38%	123.63	118.90	-3.83%	114.81	111.72	-2.69%
Variable Cash expenses ($/ac)															
Chemicals	$27.56	$30.76	11.61%	$26.80	$29.80	11.19%	$32.24	$39.74	23.26%	$27.96	$30.96	10.73%	$25.80	$28.80	11.63%
Other variable cash expenses	$175.91	$175.91	0.00%	$145.35	$145.35	0.00%	$179.82	$179.82	0.00%	$158.85	$158.85	0.00%	$224.31	$224.31	0.00%
Total, variable cash expenses[c]	$203.47	$206.67	1.57%	$172.15	$175.15	1.74%	$212.06	$219.56	3.54%	$186.81	$189.81	1.61%	$250.11	$253.11	1.20%
Variable Cash expenses ($/bu)															
Chemicals	$0.23	$0.27	15.71%	$0.39	$0.43	12.32%	$0.33	$0.43	30.27%	$0.23	$0.26	15.14%	$0.22	$0.26	14.71%
Other variable cash expenses	$1.49	$1.54	3.68%	$2.09	$2.11	1.01%	$1.84	$1.95	5.69%	$1.28	$1.34	3.98%	$1.95	$2.01	2.76%
Total, variable cash expenses[c]	$1.72	$1.81	5.31%	$2.48	$2.55	2.77%	$2.17	$2.38	9.42%	$1.51	$1.60	5.65%	$2.18	$2.27	4.00%

[a] Corn states included represent 94% of the acreage planted to corn for all purposes and production 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

Table 2. Corn Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Rootworm Larvae and adults	Chlorpyrifos (Lorsban) Terbufos (Counter) Phorate (Thimet) Ethoprop (Mocap) Disulfoton (Di-Syston) Isofenfos (Oftenol) Tebupirimphos (Aztec)[a] Carbofuran (Furadan) Carbaryl (Sevin) Dimethoate (Cygon) Malathion (Fyfanon) Methomyl (Lannate) Chlorethoryfos (Fortress)	Cyhalothrin (Warrior, Karate) Permethrin (Ambush, Pounce) Esfenvalerate (Asana-XL) Tefluthrin (Force) Fipronil (Regent)
Cutworm Wireworm Billbugs Grubs	Terbufos (Counter) Chlorpyrifos (Lorsban) Carbofuran (Furadan) Diazinon[b] Methyl Parathion (Penncap-M, Methyl Parathion)	Tefluthrin (Force) Permethrin (Ambush, Pounce) Cyhalothrin (Warrior, Karate) Esfenvalerate (Asana-XL) Fipronil (Regent)
European Corn Borer	Chlorpyrifos (Lorsban) Carbofuran (Furadan) Diazinon[b] Carbaryl (Sevin) Methomyl (Lannate)	Permethrin (Ambush, Pounce) Cyhalothrin (Warrior, Karate) Esfenvalerate (Asana-XL) Fipronil (Regent)
Stink Bug	Ethyl Parathion (Parathion) Methyl Parathion (Penncap-M, Methyl Parathion) Pyrethrin + Piperonyl (Pyrenone)	Permethrin (Ambush, Pounce)

[a] Organophosphate + Pyrethroid.

[b] Diazinon has several trade names.

Note: More than 20 insects are capable of becoming a threat to corn yields. Emergency treatments will always be a necessity where high populations of insects develop and attack the corn plant. Only the more prevalent insect pests are listed in the table above.

Source: Richard Wiese, Glen Helmers, Saleem Shaik, *Impacts of the Elimination of Organophosphates and Carbamates from Corn Production*, AFPC Research Report 99-3 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

identified as being most frequently and widely used include two organophosphates (chlorpyrifos [Lorsban] and terbufos [Counter]) and one pyrethroid (tefluthrin [Force]).

To a lesser extent, the organophosphates (phorate [Thimet], ethoprop [Mocap]), a carbamate (carbofuran [Furadan]), an organophosphate/pyrethroid mix (tebupirimphos [Aztec]), several pyrethroids (cyhalothrin [Warrior/Karate], permethrin [Ambush/Pounce]), and fipronil (Regent) are soil applied for insect control (Table 2).

The primary foliar applied insect control materials are three organophosphates, (chlorpyrifos [Lorsban], methyl parathion [Penncap-M, Methyl Parathion] and ethyl parathion [Parathion]). Foliar applied materials are based upon outbreaks or periodic infestations of insects like stink bugs and others. Several pyrethroids are also registered for foliar application and are used to a lesser extent.

No Organophosphates and Carbamates

The impacts of eliminating organophosphates and carbamates on corn would be on both yields and chemical costs. Corn yields decline by an estimated US average of 4 percent from 118 bushels per acre to 114. The range in yield reduction is from 1 percent in the Northeast to 5 percent in the Southeast while reducing 4 percent in the North Central and 3 percent in the Plains States.

Without organophosphates and carbamates, total variable cash costs per bushel increase in the range of 3 percent in the Northeast to 9 percent in the Southeast for a US average of 5 percent–from $1.72 per bushel to $1.81. Chemical costs rise substantially in the range of from 12 percent on a per bushel basis in the Northeast to 30 percent in the Southeast for a US average increase of 16 percent. Without organophosphates or carbamates, the principal chemical substitutions leading to upward shifts in costs will be the use of a group of pyrethroids (tefluthrin [Force], cyhalothrin [Warrior/Karate], permethrin [Ambush/Pounce], and fipronil [Regent]).

Scientists Consulted

B. Bender, USDA-ARS geneticist, Iowa State University

D. Boethal, entomologist, Louisiana State University

D. Brassard, Office of Pest Management, US EPA

R. Higgins, entomologist, Kansas State University

R. Hudson, entomologist, Tifton Experiment Station, University of Georgia

K. Jarvi, pesticide management, University of Nebraska

B. Johnson, entomologist, University of Wisconsin

J. Obermeyer, entomologist, Purdue University

G. O'Connor, entomologist, University of Connecticut

K. Ostlie, entomologist, University of Minnesota

F. Pierce, entomologist, Colorado State University

R. Pope, entomologist, Iowa State University

R. H. Smith, entomologist, Auburn University

K. Steffey, entomologist, University of Illinois

J. Tollefson, entomologist, Iowa State University

L. Townsend, entomologist, University of Kentucky

T. Van Arsdale, National Council of Farm Cooperatives

J. VanDuyn, entomologist, North Carolina State University

H. Wilson, entomologist, Ohio State University

R. Wright, entomologist, University of Nebraska

References

"Agricultural Chemical Use," Ag Ch 1 (98), (Washington, D.C.: USDA/NASS, 1998).

Angstadt, W.D., "Reflections on Electrons," *Dealer Progress Magazine* (July/August 1998), p. 20.

"Feasibility of Prescription Pesticide Use in the United States," Issue Paper No. 9 (Ames, Iowa: CAST, August 1998).

Gianesse, L. P., “The Use and Benefits of Organophosphate and Carbamate Insecticides in US Crop Productions,” Report (Washington, D.C.: National Center for Food and Agricultural Policy, 1997).

Gray, M.E. and K.L. Steffey, “Corn Rootworm (Coleoptera: Chysomelidae) Larvae Injury and Root Compensation of 12 Maize Hybrids: An Assessment of the Economic Injury Index,” *Journal of Economic Entomology*, 91 (1998), pp. 723-40.

Insect Pests of Field Crops, Bulletin No. 545 (Columbus, Ohio: Ohio State University, 1998).

Insects and Related Parts of Field Crops, AG-271 (Raleigh, North Carolina: North Carolina State University Extension Service, 1996).

Jury, W.A. and M. Ghodrati, “Overview of Organic Chemical Environmental Fate and Transport Modeling Approaches in Reactions and Movement of Organic Chemicals in Soils” Soil Science Society of America Special Publication No. 22, B.L Sawhney and K. Brown (eds), 1989, pp. 271-304

Klassen, P., “An ‘Alternative’ View: An Interview with Charles Benbrook,” *Farm Chemicals Magazine* (September 1998), p. 18.

Manley, D.G., “Corn Insect Control,” news release (Clemson, South Carolina: Clemson University Extension Service, 1992).

McGahen, J.H., “Corn Insect Control: European Corn Borer,” *Agronomy Guide* (State College, Pennsylvania: Pennsylvania State University, 1990), pp. 45-6.

Ohermeyer, J. and A. Bledsoe, “Should You Control Corn Rootworm in Young Soybean Fields?” news release (West Lafayette, Indiana: Purdue University, 1998).

Peterson, J., “Comparison of Management Practices Used by Producers Growing Transgenic Crops vs Conventional Varieties,” Research Symposium address (Lincoln, Nebraska: Department of Agronomy, University of Nebraska, November 17, 1998).

“Pest Management Practices,” Sp Cr 1 (98) Summary (Washington, D.C.: USDA/NASS, 1997).

Spike, B.P. and J.J. Tullefson, “Relationships of Plant Phenology to Corn Yield Loss Resulting from Western Corn Rootworm (Coleoptera Chrysomelidae) Larvae Injury, Nitrogen Deficiency and High Plant Density,” *Journal of Economic Extension*, 82 (1989), 226-31.

Staff Background Paper No. 5.1, TRAC (Washington, D.C.: US EPA Office of Pesticide Programs, May 27, 1998).

Staff Background Paper No. 5.2, TRAC (Washington, D.C.: US EPA Office of Pesticide Programs, September 1, 1998).

CHAPTER 4
COTTON[1/]

Total US upland cotton production, averaging 17.9 million bales over the past five years (1993-1997), was grown on an average of 14.3 million planted acres. Cotton was the fourth largest field crop in terms of sales in 1997.

The analyses in this study are based on estimates from nine major cotton-producing states in the four USDA growing regions.[2/] These states on average account for 83 percent of the production and 89 percent of the planted acres. Each region has its unique production problems due to differences in rainfall, humidity, and soil conditions.

While varying in intensity, the same set of pests are reasonably common to all regions. Massive eradication programs have been undertaken for the boll weevil, the most invasive of all pests on cotton. These programs would effectively end with the loss of one organophsophate–malathion (Fyfanon). The result would be serious disruption of cropping patterns, cotton supplies, and the US competitive position in world markets.

Cotton was one of the first commodities to be impacted by biotechnology with the introduction of *Bt* cultivars. This technology was rapidly accepted by producers who could profitably use it as early as 1996. It has been most extensively adopted by producers with high yields and budworm or pinkworm problems. The costs and effects of *Bt* cotton are included in these estimates.

[1/]The estimates of the impacts of pesticide use reduction in cotton were made by Christopher Sansone, entomologist, and Jackie Smith, agricultural economist, both on the faculty of Texas A&M University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Cotton Production*, AFPC Research Report 99-4 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]The states and regions included are: Southwest (CA); Southern Plains (OK, TX); Delta (AR, LA, MS); and Southeast (AL, GA, SC).

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These costs per acre budgets were analyzed utilizing average planted acre yields (1993-1997) that ranged from 402 pounds per acre on the Southern Plains to 1,163 pounds in the Southwest and a US average of 584 pounds (Table 1). Variable cash expenses ranged from $0.61 per pound in the Southeast and Southwest to $0.68 in the Delta, for a US average of $0.64 per pound. The competitive cost in the Southeast is a recent phenomenon attributable to effective boll weevil eradication programs that are organophosphate-dependent. Of the total variable costs, chemical costs ranged from $0.05 per pound on the Southern Plains ($21.73 per acre or 8% of variable cost) to $0.13 per pound in the Delta ($92.14 per acre) and in the Southeast (22% of variable cost), for a US average of $0.09 per pound ($55.14 per acre or 15% of variable costs).

The introduction of transgenic technology into the cotton industry has caused some interesting shifts in production and pest management. While some observers felt that this technology would lessen the importance of field scouting, the opposite has become the case. The large investment by the producer and some of the pest problems associated with this technology have increased the importance of field scouting of the *Bt* transgenic cotton. This technology has been widely accepted in areas that consistently produce over 500 lbs lint per acre and where tobacco budworm or pink bollworm is the dominant lepidopteran pest. The *Bt* toxin produced by the plant is more active against tobacco budworms than the bollworm, thus making the technology important in areas where resistant tobacco budworms are the primary problem. Bollworms can still cause economic damage when populations are high.

Table 1. Yields and Costs for Producing Upland Cotton With and Without Organophosphates and Carbamates

	United States[a]			Southeast			Delta			Southern Plains			Southwest		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (lbs/planted acre)[b]	583.51	499.94	-14.32%	640.84	563.94	-12.00%	687.99	632.95	-8.00%	401.92	325.56	-19.00%	1163.32	923.67	-20.60%
Variable Cash expenses ($/acre):															
Chemicals	$55.14	$82.85	50.24%	$86.20	$135.85	57.60%	$92.14	$122.54	32.99%	$21.73	$39.33	80.99%	$60.40	$96.64	60.00%
Other variable cash expenses	$320.07	$309.51	-3.30%	$306.09	$294.29	-3.86%	$374.07	$365.42	-2.31%	$235.46	$227.22	-3.50%	$646.88	$618.33	-4.41%
Total, variable cash expenses[c]	$375.21	$392.36	4.57%	$392.29	$430.14	9.65%	$466.21	$487.96	4.67%	$257.19	$266.55	3.64%	$707.28	$714.97	1.09%
Variable Cash expenses ($/lb):															
Chemicals	$0.09	$0.17	75.34%	$0.13	$0.24	79.11%	$0.13	$0.19	44.59%	$0.05	$0.12	123.29%	$0.05	$0.10	101.54%
Other variable cash expenses	$0.55	$0.62	12.87%	$0.48	$0.52	9.25%	$0.54	$0.58	6.18%	$0.59	$0.70	19.14%	$0.56	$0.67	20.37%
Total, variable cash expenses[c]	$0.64	$0.78	22.05%	$0.61	$0.76	24.60%	$0.68	$0.77	13.77%	$0.64	$0.82	27.94%	$0.61	$0.77	27.31%

[a] Upland cotton states included represent 89% of the acreage planted to cotton and 83% of the production in the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

In the Southeast, where boll weevil eradication has been highly successful, the transgenic varieties must be scouted closely due to problems from stink bugs and the plant bug complex as well as bollworms. These pests have become more important because many of the insecticide applications for boll weevils also kept stink bugs and plant bugs below economic problems. The absence of insecticide applications targeted for boll weevils has allowed stink bugs and the plant bug complex to acquire key pest status in much of the area.

No Organophosphates and Carbamates

Whether measured in yield, costs, or effects on bottom line profitability, organophosphates and carbamates are very important to efficient and competitive cotton production. Table 2 indicates the current organophosphates and carbamates used in treating cotton as well as the alternatives available. Without organophosphates and carbamates, the boll weevil eradication program would not likely be successful. This program is the sole factor leading to a resurgence of cotton production in the Southeast and currently is being pursued on the Delta and Southern Plains. Malathion (Fyfanon), an organophosphate, is the most cost effective material available for boll weevil eradication.

However, organophosphates and carbamates are important in other respects in controlling pests. That is, while higher-cost alternative chemicals exist (such as pyrethroids and imidacloprid [Provado]), they are limited in number, not equally effective on a number of pests; and pests can be expected to become resistant to the alternatives. A combination of chemicals, including organophosphates and carbamates, is considered essential to staving off the development of resistance.

Table 2. Cotton Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Boll weevil	Azinphosmethyl (Guthion) Carbaryl (Sevin) Dicrotophos (Bidrin) Malathion (Fyfanon) Methyl parathion (Penncap-M, Methyl Parathion) Oxamyl (Vydate)	Pyrethroids Endosulfan (Thiodan)
Thrips	Aldicarb (Temik) Acephate (Orthene) Azinphosmethyl (Guthion) Carbaryl (Sevin) Dicrotophos (Bidrin) Dimethoate (Cygon) Disulfoton (Di-Syston) Methyl parathion (Penncap-M, Methyl Parathion)) Phorate (Thimet)	Imidacloprid (Provado) Pyrethroids Spinosad (Tracer)
Plant bugs (including Cotton fleahopper)	Acephate (Orthene) Carbaryl (Sevin) Chlorpyrifos (Lorsban) Dicrotophos (Bidrin) Dimethoate (Cygon) Ethyl parathion (Parathion) Methomyl (Lannate) Methyl parathion (Penncap-M, Methyl Parathion) Oxamyl (Vydate) Oxydemeton-methyl (Metasystox)	Imidacloprid (Provado) Pyrethroids
Bollworm, tobacco budworm (including ovicides)	Acephate (Orthene) Methomyl (Lannate) Methyl parathion (Penncap-M, Methyl Parathion) Profenofos (Curacron) Thiodicarb (Larvin)	Amitraz (Ovasyn) (ovicide) Pyrethroids Spinosad (Tracer) *Bt* transgenic technology
Aphids	Carbofuran (Furadan) Chlorpyrifos (Lorsban) Dicrotophos (Bidrin) Dimethoate (Cygon) Methamidophos (Monitor) Methomyl (Lannate) Methyl parathion (Penncap-M, Methyl Parathion) Profenofos (Curacron)	Amitraz (Ovasyn) Imidacloprid (Provado)
Nematodes	Aldicarb (Temik) Fenamiphos (Nemacur) Oxamyl (Vydate)	1,3-dichloropropene (Telone II)
Stink Bugs	Carbaryl (Sevin) Ethyl parathion (Parathion) Methyl parathion (Penncap-M, Methyl Parathion)	Pyrethroids

Table 2 (Continued).

Pink bollworm	Carbaryl (Sevin) Chlorpyrifos (Lorsban) Methyl parathion (Penncap-M, Methyl Parathion)	*Bt* transgenic technology Pyrethroids Pheromones
Whiteflies (All species)	Acephate (Orthene) Chlorpyrifos (Lorsban) Oxamyl (Vydate) Profenofos (Curacron)	Amitraz (Ovasyn) Azadirachtin (Bollwhip) Endosulfan (Thiodan) Pyrethroids Pyriproxyfen (Knack)
Defoliant	Tribufos (Def, Folex)	Thidiazuron (Dropp) Diuron plus Thidiazuron (Ginstar) Ethephon (Prep) Ethephon plus Cyclanilide (Finish) Ethephon plus AMADS (Cotton Quick) Dimethipin (Harvade) Sodium Cacodylate plus Cacodylic acid (Quick Pik) Paraquat (Cyclone)

Source: Jackie Smith, Christopher Sansone, *Impacts of the Elimination of Organophosphates and Carbamates from Cotton Production*, AFPC Research Report 99-4 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

Integrated pest management (IPM) programs likewise could be severely handicapped by the loss of organophosphates and carbamates. IPM relies on maintaining high natural enemy populations to control pests. The loss of organophosphates and carbamates as in-furrow insecticides would create greater reliance on foliar applications. Such applications lead to greater exposure of natural enemies to insecticides and are less efficacious against pests such as thrips and aphids. This leads to more applications, higher costs, and potentially to more environmental concerns.

The loss of organophosphates and carbamates in cotton affects resistance management of lepidopteran pests. The loss of methomyl (Lannate), thiodicarb (Larvin), methyl parathion (Penncap-M, Methyl Parathion), and profenofos (Curacron) will increase the reliance on the alternative spinosad (Tracer) for lepidopteran pest control as well as increase the use of pyrethroids for stink bugs and plant bugs. The acreage of *Bt* transgenic cotton does not change significantly with the loss of the organophosphates and carbamates. The acreage shifts with this technology are dependent on the pest complex present in a particular region. In areas where bollworm is the dominant pest, the *Bt* transgenic cotton is averaging one application for bollworms since economic damage can occur with high populations of bollworms. Many producers cannot afford to pay the technology fee, increased seed costs, and continue to make an insecticide application for bollworms so the percentage of *Bt* transgenic cotton will continue to be low unless the costs of the technology are reduced for the producer. If increases occur with this technology, it will be due to the development of *Bt* transgenic varieties that are adapted to the regions (e.g. stripper type cotton for the Southern Plains).

Eliminating the organophosphates and carbamates used to produce cotton is estimated to reduce the average cotton yield by 14 percent from 584 to 500 pounds per acre (Table 1). The reduction ranged from 8 percent in the Delta to 21 percent in the Southwest. This yield reduction increases over the four-year estimated time horizon in the Southeast where boll weevil eradication has occurred. Alabama, for example, is not likely to continue its eradication program due to the costs of alternative controls. In this case, boll weevil reinfestation, from states to the west, would occur within the four-year time span assumed in this study. Georgia is judged to avoid reinfestation within four years but would subsequently be infested. Therefore, the 12 percent yield reduction for the Southeast is conservative when extended over a longer time frame. An additional impact, primarily in the Southeast, would be the elimination of the organophosphate, tribufos (Def/Folex), a defoliant, which would increase harvest costs by $4.00 to $5.00 per acre. Alternatives to tribufos (Def/Folex) would be thidiazuron (Dropp), diuron plus thidiazuron (Ginstar), ethephon (Prep), ethephon plus cyclanilide (Finish), ethephon plus AMADS (Cotton Quick), dimethipin (Harvade), sodium cacodylate plus cacodylic acid (Quick Pik) and paraquat (Cyclone).

The elimination of organophosphates and carbamates increased US chemical costs per pound of cotton by an estimated 75 percent, ranging from 45 percent in the Delta to 123 percent in the Southern Plains. Without organophosphates and carbamates, chemical costs in the Southeast were estimated to increase to $135.85 per acre, up from $86.20 ($0.24 per pound compared with $0.13 per pound).

While cost increases would be experienced for chemicals, reductions due to lower yields occurred for other variable expenses such as fuel, repairs, hired labor, and ginning. As a result, total variable cash expenses per pound increased by a US average of 22 percent, ranging from 14 percent in the Delta ($0.09 per pound) to 28 percent on the Southern Plains ($0.17 per pound). The US average increase in total variable cost was estimated to be $0.14 per pound. With the average market price for cotton in 1998-1999 being an estimated $.625[3/] per pound, such a cost increase would be staggering, making US producers uncompetitive in world markets if reflected in the price.

[3/]FAPRI, *January 1999 Baseline*.

Scientists Consulted

Charles Allen, entomologist, University of Arkansas at Monticello
Ralph Bagwell, entomologist, Louisiana State University
Emory Boring, entomologist, Texas A&M University
James Brazzle, entomology farm advisor-Kern County, University of California
Charles Curtis, agricultural economist, Clemson University
Pete Goodell, IPM advisor, University of California
Jason Johnson, economist, Texas A&M University
Mike Jones, cotton specialist, Clemson University
Miles A. Karner, entomologist, Oklahoma State University
Allen Knutson, entomologist, Texas A&M University
Blake Layton, entomologist, Mississippi State University
Robert Lemon, agronomist, Texas A&M University
Jim Leser, entomologist, Texas A&M University
Glen Moore, entomologist (PM), Texas A&M University
Mark Muegge, entomologist, Texas A&M University
Ed Murdock, weed scientist, Clemson University
John Norman, entomologist (PM), Texas A&M University
Roy Parker, entomologist, Texas A&M University
Charles Payne, entomologist (PM), Texas A&M University
Phillip Roberts, entomologist, University of Georgia
Mitchell E. Roof, entomologist, Clemson University
Ron Smith, entomologist, Auburn University
Alton Sparks, entomologist, Texas A&M University
Noel Troxclair, entomologist, Texas A&M University

References

Cate, J.R., "Cotton: Status and Current Limitations to Biological Control in Texas and Arkansas," M.A. Hoy and D. C. Herzog (eds.), *Biological Control in Agricultural IPM Systems* (Orlando, Florida: Academic Press, Inc., 1985), pp. 531-56.

Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri-Columbia and Iowa State University, *January 1999 Baseline*.

Holloway, J.W., R. Leonard, J.A. Ottea, J.H. Pankey, and J.B. Graves, "Insecticide Resistance and Synergism of Pyrethroid Toxicity in the Tarnished Plant Bug, *Lygus lineolaris*," *Proceedings of Beltwide Cotton Production and Research*, Conference, National Cotton Council, Memphis, Tennessee (1998), pp. 947-48.

Ring, D.R., J.H. Benedict, S.M. Masud, R.D. Lacewell, R.D. Parker, and R.L. Huffman, *Concepts in Managing Bollworm, Tobacco Budworm and Cotton Fleahopper on Cotton in the Lower Gulf Coast of Texas*, Texas Agricultural Experiment Station Bulletin B01 (College Station, Texas: Texas A&M University, 1996), 34 pp.

Rousch, R.T. and R.G. Luttrell, "Expression of Resistance to Pyrethroid Insecticides in Adults and Larvae of Tobacco Budworm (Lepidoptera: Noctuidae): Implications for Resistance Monitoring, *Journal of Economic Entomology*, Vol. 82 (1989), pp. 1305-10.

Ruberson, J.R., G.A. Herzog, W.R. Lambert and W.J. Jones, "Management of the Beet Armyworm (Lepidoptera: Noctuidae) in Cotton: Role of Natural Enemies," *Florida Entomologist*, Vol 77 (1994), pp. 440-53.

Rummel, D.R., J.F. Leser, J.E. Slosser, G.J. Puterka, C.W. Neeb, J.K. Walker, J.H. Benedict, M.D. Heilman, L.N. Namken, J.W. Norman, and J.H. Young, "Cultural Control of *Heliothis* spp. In Southwestern U.S. Cropping Systems," S.J. Johnson, E.G. King, and J.R. Bradley, Jr. (eds.), *Theory and Tactics of Heliothis Population Management: I-Cultural and Biological Control*, Southern Cooperative Service Bulletin 316 (1986), pp. 38-53.

Williams, M.R., "Cotton insect losses 1997," *Proceedings of Beltwide Cotton Production and Research*, Conference, National Cotton Council, Memphis, Tennessee (1998), pp. 904-26.

CHAPTER 5
GRAPES[1/]

Grape production, for use as table grapes for fresh consumption and as raisin grapes, totaled 122 billion pounds over the past five years (1993-1997). This production was grown on 765,000 bearing acres. From a dollar value of sales perspective, grapes are the second largest fruit and/or vegetable studied and are an important fruit in the diet of children.

The estimates in this report are based on the Thompson Seedless cultivar produced in the central San Joaquin Valley of California. This region accounts for virtually 100 percent of the Thompson Seedless grape production, 50 percent of all grapes (including wine grapes), and 45 percent of the bearing acreage. This analysis, however, only represents table grapes and raisin grapes.

Organophosphates and carbamates are important for controlling insects, mites, and nematodes. No chemicals containing organophosphates are listed for control of diseases and weeds.

Baseline

Budgets developed by the University of California were utilized to establish baseline costs. Yields were 14,700 pounds per bearing acre for table grapes and 4,000 pounds (dry weight) for raisin grapes for a US average of 17,266 pounds (fresh grape basis) (Table 1).

[1/]The estimates of the impacts of pesticide use reduction in grapes were made by William L. Peacock, viniculture farm advisor, University of California. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Table Grape and Raisin Grape Production*, AFPC Research Report 99-5 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

Table 1. Yields and Costs of Producing Grapes With and Without Organophosphates and Carbamates

	United States[a]			California Table			California Raisin		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwts/acre)[b]	172.66	156.61	-9.30%	147.00	99.96	-32.00%	180.00	172.80	-4.00%
Cash expenses ($/acre):									
Chemicals	$177.45	$171.01	-3.63%	$249.00	$220.00	-11.65%	$157.00	$157.00	0.00%
Other variable cash expenses	$2,006.07	$1,876.39	-6.46%	$5,214.00	$4,677.20	-10.30%	$1,089.00	$1,075.70	-1.22%
Total, variable cash expenses	$2,183.53	$2,047.39	-6.23%	$5,463.00	$4,897.20	-10.36%	$1,246.00	$1,232.70	-1.07%
Variable Cash expenses ($/cwt):									
Chemicals	$1.03	$1.09	6.25%	$1.69	$2.20	29.93%	$0.87	$0.91	4.17%
Other variable cash expenses	$11.62	$11.98	3.13%	$35.47	$46.79	31.92%	$6.05	$6.23	2.89%
Total, variable cash expenses	$12.65	$13.07	3.38%	$37.16	$48.99	31.83%	$6.92	$7.13	3.05%

[a] Grape regions included represent 45% of the grape acreage and 50% of the production during the 1993-1997 period.
[b] US yields and costs are derived by weighting the analyzed region's planted acreage by their respective yield.

For table grapes, the total variable cash expenses were $37.16 per cwt of which $1.69 was chemical costs. For raisin grapes, the total variable cash expenses were $6.92 per cwt of which $0.87 was chemical costs. The US average variable cost, therefore, was $12.65 per cwt, of which $1.03 was chemical costs.

The major grape pests and chemicals used for control are indicated in Table 2. Organophosphates and carbamates are particularly important in the control of insects, mites, and nematodes.

No Organophosphates and Carbamates

The main substitutes for organophosphates and carbamates are listed in Table 2. The only grape pests for which substitutes are available include leafhoppers, grape leaffolders, omnivorous leafroller, western grapeleaf skeletonizer, grape phylloxera, and nematodes. With the substitution of alternative chemicals for the organophosphates and carbamates indicated in Table 2, table grape yields fall by 32 percent, while raisin grape yields decline by 4 percent for a US average decline of 9 percent.

Chemical costs per acre for table grapes decline by 12 percent while those for raisins remain constant. The result is a 30 percent increase in chemical costs on a per cwt basis for table grapes and 4 percent for raisins, with an average 6 percent increase in chemical costs per cwt.

Total variable costs per cwt increase by 32 percent for table grapes and 3 percent for raisins, with a US average increase of 3 percent.

Table 2. Grape Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophoshate/ Carbamate Treatment	Alternative Treatment
Leafhoppers	Naled (Dibrom) Methomyl (Lannate) Carbaryl (Sevin)	Imidacloprid (Provado) Insecticidal soaps and Narrow Range Oil[a]
Grape leaffolder	Methomyl (Lannate) Carbaryl (Sevin) Phosmet (Imidan) Diazinon (Spectracide)	Sodium alumino-fluoride (Cryolite) Bacillus thuringiensis (*Bt*)
Omnivorous leafroller	Methomyl (Lannate) Carbaryl (Sevin) Phosmet (Imidan) Diazinon (Spectracide)	Sodium alumino-fluoride (Cryolite) Bacillus thuringiensis (*Bt*)
Cutworms	Carbaryl (Sevin, Sevin bait) Methomyl (Lannate) Diazinon (Spectracide) Methyl Parathion (Penncap-M, Methyl Parathion)	None
Grape bud beetle	Azinphosmethyl (Guthion) Dimethoate (Cygon) Phosmet (Imidan)	None
Grape mealybug	Azinphosmethyl (Guthion) Chlorpyrifos (Lorsban) Methyl parathion (Penncap-M, Methyl Parathion)	None
Grape phylloxera	Carbofuran (Furadan)	Sodium tetrathiocarbonate (Enzone)
Thrips	Carbaryl (Sevin) Methomyl (Lannate) Dimethoate (Cygon)	None
Western grapeleaf skeletonizer	Methomyl (Lannate) Carbaryl (Sevin)	Sodium alumino-fluoride (Cryolite) Bacillus thuringiensis (*Bt*)
False chinch bug	Diazinon (Spectracide) Malathion (Fyfanon)	None
Branch and twig borer	Carbaryl (Sevin)	None
Hoplia	Carbaryl (Sevin)	None
Sharpshooter	Dimethoate (Cygon)	Imidacloprid (Provado)
Nematode (Postplant)	Fenamiphos (Nemacur) Carbofuran (Furadan)	Sodium tetrathiocarbonate (Enzone)

[a] Marginally efficacious.

Source: Bill Peacock, *Impacts of the Elimination of Organophosphates and Carbamates from Table Grape and Raisin Grape Production*, AFPC Research Report 99-5 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

Scientists Consulted

Walt Bentley, Integrated Pest Management advisor, University of California

Robert Gaddie, vine production consultant, Bakersfield, California

Ross Jones, director/research, California Table Grape Commission, California

Hans Koop, Sun-Maid Growers, Fresno, California

Don Luvisi, farm advisor, University of California

Rudy Neja, farm advisor, University of California

Steve Randall, independent pest control advisor, Visalia, California

Jack Sexton, pest control advisor, Visalia, California

Ron Worthly, Raisin Advisory Committee, Fresno, California

References

California Grape Acreage (Sacramento, California: California Agricultural Statistics Service, 1998).

County Agricultural Crop and Livestock Reports for Fresno, Tulare, Kern, and Riverside Counties (Davis, California: University of California Cooperative Extension Service, 1998).

Klonsky, K., R. Beede, P. Christensen, M. Costello, N. Dokoozlian, G. Leavitt, D. Luvisi, B. Peacock, L. Tourte, P. Livingston, *Sample Costs to Establish a Vineyard and Produce Raisins* (Davis, California: University of California Cooperative Extension Service, 1997).

Klonsky, K., R. Beede, P. Christensen, M. Costello, N. Dokoozlian, G. Leavitt, D. Luvisi, B. Peacock, P. Livingston, *Sample Costs to Establish a Vineyard and Produce Table Grapes* (Davis, California: University of California Cooperative Extension Service, 1998).

The 1997-1998 Distribution and Per Capita Consumption of California Table Grapes by Major Varieties in the United States, Canada and Export Markets (Fresno, California: California Table Grape Commission, 1998).

UC IPM Pest Management Guidelines: Grapes, University of California, Division of Agriculture and Natural Resources, publication 3343, 2nd edition (July 1998).

CHAPTER 6
ORANGES[1/]

Orange production, averaging 24 billion pounds over the past five years (1993-1997), is grown on 792,000 bearing acres. From the perspective of dollar value of sales, oranges are the third largest fruit and/or vegetable studied, but they are not as extensively consumed by infants as apple juice.

The analyses in this study are based on estimates from the two major orange-producing states–Florida and California. These two states account for 98 percent of the bearing acreage and 99 percent of the production. Florida processes over 90 percent of its oranges while California markets about 75 percent of its oranges in the fresh market. Therefore, Florida is treated here as a processed orange state while California oranges are assumed to go to the fresh market.

The different end uses result in a primary concern in Florida juice production for yield and internal fruit quality (pounds solid and sugar/acid ratio), and in California fresh market production for yield, packout, external peel appearance, and fruit quality. Although many of the listed organophosphates and carbamates are used in both Florida and California, Florida with its humid subtropical climate and California, with its dry Mediterranean climate, have different pest problems. However, generally speaking, due to the differences in end use objectives, the elimination of organophosphates and carbamates has more adverse impacts on California than on Florida.

[1/]The estimates of the impacts of pesticide use reduction in oranges were made by James Ferguson, horticulturist, and Gary Fairchild, agricultural economist, both of University of Florida. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Orange Production*, AFPC Research Report 99-6 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

Baseline

The budgets utilized included those developed by the University of Florida for a mature southwest Florida Hamlin orange grove and for a mature Valencia/Navel San Joaquin Valley orange grove. Yields were 42,933 pounds per bearing acre in Florida and 25,648 pounds in California for a US average of 38,441 pounds (Table 1). Variable cash expenses were $0.038 per pound in Florida and $0.069 in California for a US average of $0.044 per pound. Chemical costs per bearing acre in California are more than four times that of Florida ($430.55 versus $99.97). On a per pound basis, however, chemical costs are only $0.002 in Florida compared with $0.017 in California. For the US, the average chemical cost was $185.88 per bearing acre or $0.005 per pound.

The organophosphates and carbamates used in orange production to control specific pests and their substitutes are indicated in Table 2. The trend in processed oranges is toward reduced spray programs with limited use of organophosphates and carbamates. For example, the basic spray program for Hamlin fruit in southwest Florida includes a post bloom spray (copper to control fungal diseases and micronutrients) and a summer oil spray for disease and pest control. Heavy mite infestations may warrant one or two miticide applications. In California, the major orange pests are armored scales, thrips, and spider mites. For control, miticides are generally applied in the spring and/or fall. Scale is controlled with a combination of azinphosmethyl (Guthion) and biological control agents.

No Organophosphates and Carbamates

The impact of eliminating organophosphates and carbamates on oranges differs greatly between Florida and California.

Table 1. Yields and Costs for Producing Oranges With and Without Organophosphates and Carbamates

	United States[a]			Florida Processed			California Fresh		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (lbs/planted acre)[b]	38,441.12	37,441.14	-2.60%	42,933.00	42,933.00	0.00%	25,648.00	21,800.00	-15.00%
Variable Cash expenses ($/acre):									
Chemicals	$185.88	$169.10	-9.03%	$99.97	$99.97	0.00%	$430.55	$365.99	-14.99%
Other variable cash expenses	$1,490.95	$1,493.54	0.17%	$1,548.51	$1,548.51	0.00%	$1,327.00	$1,337.00	0.75%
Total, variable cash expenses	$1,676.82	$1,662.65	-0.85%	$1,648.48	$1,648.48	0.00%	$1,757.55	$1,702.99	-3.10%
Variable Cash expenses ($/lb):									
Chemicals	$0.0048	$0.0045	-6.60%	$0.0023	$0.0023	0.00%	$0.0168	$0.0168	0.01%
Other variable cash expenses	$0.0388	$0.0399	2.85%	$0.0361	$0.0361	0.00%	$0.0517	$0.0613	18.54%
Total, variable cash expenses	$0.0436	$0.0444	1.80%	$0.0384	$0.0384	0.00%	$0.0685	$0.0781	14.00%

[a] Orange regions included represent 94% of the acreage bearing oranges and 95% of the production during the 1993-1997 period.

[b] US yields and costs are derived by weighting the analyzed region's planted acreage by their respective yield.

Table 2. Orange Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Citrus root weevils	Carbaryl (Sevin) & oil Azinphosmethyl (Guthion) Formetanate Hydrochloride (Carzol)	Sodium aluminofluoride, Cryolite (Kryocide) Diflubenzuron (Micromite) & oil
Mites	Chlorpyrifos (Lorsban) Methidathion (Supracide) Carbaryl (Sevin) Aldicarb (Temik) Organothiophosphate (Ethion) & oil	Abemectin, Avermectin (Agrimek) & oil Propargite (Comite) Dicofol (Kelthane) Diflubenzuron (Micromite) Pyridaben (Nexter) Oil Sulfur Fenbutatin oxide (Vendex)
Miscellaneous fruit feeders	Azinphosmethyl (Guthion) Chlorpyrifos (Lorsban)	Bacillus thuringiensis (*Bt*) Sodium aluminofluoride, Cryolite (Kryocide)
Nematodes	Aldicarb (Temik) Fenamiphos (Nemacur) Oxamyl (Vydate)	Dichloro-propene (Telone) Metan-sodium (Vapam)
Mediterranean fruit fly	Malathion (Fyfanon)	None
Citrus leaf miner	None	Abemectin, Avermectin (Agrimek) & oil Fenoxycarb (Logic) Oil Imidacloprid (Admire, Provado)
Aphids	Aldicarb (Temik) Dimethoate (Cygon)	Imidacloprid (Admire, Provado) Biological control agents
Ants	Diazinon (Spectracide) Chlorpyrifos (Lorsban)	Fenoxycarb (Logic) Bifenthrin (Talstar)
Orange dog caterpillars	Carbaryl (Sevin) Diazinon (Spectracide) Methidathion (Supracide)	Bacillus thuringiensis (*Bt*)
Scale	Carbaryl (Sevin) Organothiophosphate (Ethion) & oil Chlorpyrifos (Lorsban) Azinphosmethyl (Guthion) Methidathion (Supracide)	Buprofezin (Applaud) Pyriproxyfen (Knack) Oil
Thrips	Formetanate Hydrochloride (Carzol) Dimethoate (Cygon) Methomyl (Lannate) Naled (Dibrom)	Sabadilla (a botanical insecticide) Ryania (a botanical insecticide)

Source: Jim Ferguson, Gary Fairchild, *Impacts of the Elimination of Organophosphates and Carbamates from Orange Production*, AFPC Research Report 99-6 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

In Florida, since organophosphates and carbamates are not a first line of defense in basic mite control programs, yields would not be reduced, and costs would not change significantly from the baseline. Therefore, neither yields nor costs change from the baseline for the no organophosphates and carbamates scenario. It should be noted, however, that new or continually introduced pests, including the Mediterranean fruit fly, the citrus psyllid, bacterial diseases, the giant white fly, the pink mealybug, the citrus leaf miner, the brown citrus aphid, and citrus tristeza virus, may require organophosphates and carbamates (such as malathion [Fyfanon]) for control. They, therefore, are important second lines of defense even in Florida.

In California, the situation is different. Broad spectrum organophosphate and carbamate pesticides like chlorpyrifos (Lorsban), methidathion (Supracide), and carbaryl (Sevin) have been used for more than 35 years although researchers indicate that in red scale, resistance is developing. Oils could be substituted but with 15 percent reduced yields. Formetanate hydrochloride (Carzol) is used on 55 percent of the acreage and dimethoate (Cygon) on 45 percent to control thrips. Sabadilla and Ryania could be substituted, but Ryania would result in a 20 percent fresh packout reduction.

Overall, the California yield reduction would be 15 percent if organophosphates and carbamates were eliminated. This would result in no perceptible change in chemical costs but a 14 percent increase in total variable costs.

For US oranges, the yield would decline by 2.6 percent from 38,441 pounds per planted acre to 37,441 pounds. Chemical costs per pound would decline by 7 percent, and total variable costs would increase by 2 percent.

Scientists Consulted

Michael Aertz, associate in pesticide information, University of Florida

Beth Grafton-Cardwell, entomologist, University of California

Bob Bullock, entomologist, University of Florida

Joe Knapp, citrus IPM specialist, University of Florida

Joe Morse, entomologist, University of California

Joe Noling, citrus nematologist, University of Florida

References

Florida Agricultural Statistics Service, *Citrus Commercial Citrus Tree Inventory: Preliminary Report* (September 3, 1998).

Knapp, J.L., chair, "Citrus Commodity: A Biologic and Economic Assessment of Pesticide Usage," National Agricultural Pesticide Impact Assessment Program (to be published 1999).

Knapp, J. L., ed., *1998 Florida Citrus Pest Management Guide*, University of Florida Cooperative Extension Service Bulletin SP 43 (1998).

Muraro, R. P., F. M. Roka, and R. E. Rouse, *Budgeting Costs and Returns for Southwest Florida Citrus Production, 1997-1998*, Florida Cooperative Extension Service Economic Information Report 98-4.

O'Connell, N., K. Klonsky, M. Freeman, C. Kallsen, and P. Livingston, *Sample Costs to Establish an Orange Orchard and Produce Oranges*, University of California Cooperative Extension Service (1995).

UC IPM Online, "UC Pest Management Guidelines," *Statewide IPM Project*, Division of Agriculture and Natural Resources, University of California (1998), http://www.ipm.ucdavis.edu/PMG/r107200111.html.

CHAPTER 7
PEACHES[1/]

Peach production, averaging 2.5 billion pounds over the past five years (1993-1997), was grown on 171,000 bearing acres. From a dollar value of sales perspective, peaches are the seventh largest fruit and/or vegetable studied. It is an important fruit in the diet of infants and is representative of a broader category of stone fruits, particularly apricots.

The analyses in this study are based on estimates from two major peach-growing states–California and Georgia. These two states accounted for 49 percent of the US peach acreage and 75 percent of the production over the 1993-1997 period. For California, separate estimates are made for the fresh (freestone) market, which accounts for nearly half of its production, and for processing (cling) peaches. In Georgia, all peaches are assumed to go to the fresh market. As in apples, the West has substantially different peach growing seasons, climatic conditions, yields, and pest pressures than the rest of the United States.

Organophosphates and carbamates are very important to peach production with the only viable substitutes being pyrethroids and mating disruption. Pyrethroids may be as threatened for elimination as are organophosphates and carbamates. A not-yet-registered pesticide, spinosad (Success), holds potential as a substitute for organophosphates.

Baseline

Budgets developed by the University of California and the University of Georgia were utilized to establish baseline costs. Yields in California were 340 cwt per bearing acre for

[1/]The estimates of the impacts of pesticide use reduction in peaches were made by Walt Bentley, entomologist, University of California.

processed and fresh peaches but only 120 cwt in Georgia (Table 1). The US average yield was 285 cwt per bearing acre.

For fresh peaches, total variable cash expenses in California were $6.75 per cwt and in Georgia $17.33 with a US average of $8.71 per cwt. Chemical costs for California fresh peaches were $0.56 per cwt and in Georgia $2.38 with a US average of $0.90 per cwt for fresh peaches (Table 2). California processed peaches had a total variable cost of $4.36 per cwt, of which $0.41 was chemical costs (Table 1).

The major pests in California are the oriental fruit moth and the peach twig borer (Table 3). In Georgia they also have the plum curculio which by itself can devastate a peach crop. Azinphosmethyl (Guthion) and methyl parathion (Penncap-M, Methyl Parathion) are used to control this pest.

No Organophosphates and Carbamates

The main substitutes for organophosphates and carbamates would be pyrethroids such as permethrin (Pounce/Ambush) and esfenvalerate (Asana) (Table 3). Pyrethroids present two problems. In addition to encountering increased spider mite problems, it is anticipated that resistance would develop over a 5-6 year use pattern. If pyrethroids were pulled along with organophosphates, growers would be forced to rely on mating disruption.

Total variable costs for fresh peaches in California increase by 1.70 percent from the elimination of organophosphates and carbamates to $6.87 per cwt with the same 340 pound yield (Table 2). In Georgia, the cost increase is by 19 percent to $20.60 per cwt. In California, the entire cost increase is for chemicals while, in Georgia, chemical costs rise by 12 percent and

Table 1. Yields and Cost of Producing Fresh and Processed Peaches Combined With and Without Organophosphates and Carbamates

	United States[a]			California Fresh			Georgia Fresh			California Processed		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwt/acre)[b]	285.02	280.02	-1.75%	340.00	340.00	0.00%	120.00	100.00	-16.67%	340.00	340.00	0.00%
Variable Cash expenses ($/acre):												
Chemicals	$196.29	$218.74	11.44%	$191.00	$230.00	20.42%	$286.00	$266.00	-6.99%	$140.00	$174.00	24.29%
Other variable cash expenses	$1,751.31	$1,751.31	0.00%	$2,105.00	$2,105.00	0.00%	$1,794.00	$1,794.00	0.00%	$1,342.00	$1,342.00	0.00%
Total, variable cash expenses	$1,947.60	$1,970.05	1.15%	$2,296.00	$2,335.00	1.70%	$2,080.00	$2,060.00	-0.96%	$1,482.00	$1,516.00	2.29%
Variable Cash expenses ($/cwt):												
Chemicals	$0.69	$0.78	13.42%	$0.56	$0.68	20.42%	$2.38	$2.66	11.61%	$0.41	$0.51	24.29%
Other variable cash expenses	$6.14	$6.25	1.78%	$6.19	$6.19	0.00%	$14.95	$17.94	20.00%	$3.95	$3.95	0.00%
Total, variable cash expenses	$6.83	$7.04	2.96%	$6.75	$6.87	1.70%	$17.33	$20.60	18.85%	$4.36	$4.46	2.29%

[a] Peach regions included represent 49% of the acreage and 75% of the production during the 1993-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

Table 2. Yields and Cost of Producing Fresh Peaches With and Without Organophosphates and Carbamates

	United States[a]			California Fresh			Georgia Fresh		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwt acre)[b]	162.05	157.05	-3.08%	340.00	340.00	0.00%	120.00	100.00	-16.67%
Variable Cash expenses ($/acre):									
Chemicals	$145.66	$155.81	6.97%	$191.00	$230.00	20.42%	$286.00	$266.00	-6.99%
Other variable cash expenses	$1,265.92	$1,265.92	0.00%	$2,105.00	$2,105.00	0.00%	$1,794.00	$1,794.00	0.00%
Total, variable cash expenses	$1,411.57	$1,421.72	0.72%	$2,296.00	$2,335.00	1.70%	$2,080.00	$2,060.00	-0.96%
Variable Cash expenses ($/cwt):									
Chemicals	$0.90	$0.99	10.37%	$0.56	$0.68	20.42%	$2.38	$2.66	11.61%
Other variable cash expenses	$7.81	$8.06	3.18%	$6.19	$6.19	0.00%	$14.95	$17.94	20.00%
Total, variable cash expenses	$8.71	$9.05	3.92%	$6.75	$6.87	1.70%	$17.33	$20.60	18.85%

[a] Peach regions included represent 31% of the acreage and 31% of the total peach production during the 1993-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

Table 3. Peach Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Oriental fruit moth	Diazinon (Spectracide) Azinphosmethyl (Guthion) Chlorpyrifos (Lorsban)	Permethrin (Pounce, Ambush) Esfenvalerate (Asana)
Peach twig borer	Chlorpyrifos (Lorsban) Azinphosmethyl (Guthion) Carbaryl (Sevin)	Permethrin (Pounce, Ambush) Esfenvalerate (Asana)
Omnivorous leafroller San Jose scale Stink bugs	Diazinon (Spectracide) Chlorpyrifos (Lorsban)	Permethrin (Pounce, Ambush) Esfenvalerate (Asana)
Spider mites	Fenbutatin oxide (Vendex)	None
Thrips	Formetanate hydrochloride (Carzol) Methomyl (Lannate)	Permethrin (Pounce, Ambush) Esfenvalerate (Asana)
Plum curculio	Azinphosmethyl (Guthion) Methyl parathion (Penncap-M, Methyl Parathion)	Permethrin (Pounce, Ambush) Esfenvalerate (Asana)

other variable costs by 20 percent. The US average variable cost for fresh peaches increases by 4 percent to $9.05 per cwt while chemical costs rise by 10 percent.

California processing peach total variable costs increase by 2 percent to $4.46 per cwt with a chemical cost rise of 24 percent.

The result for all peaches is a US variable cost increase of 3 percent to $7.04 per cwt with chemical costs increasing by 13 percent.

Scientists Consulted

Kevin Day, University of California

Roger Duncan, University of California

Janine Hasey, University of California

Dan Horton, entomologist-tree crops, University of Georgia

Scott Johnson, University of California

Dick Rice, entomologist, University of California, Davis

CHAPTER 8
PEANUTS[1/]

Peanut production, averaging 37 million cwt over the past five years (1993-1997), was grown on an average of 1.5 million planted acres. As such, peanuts are the seventh largest field crop studied in terms of farm sales.

The analyses in this study are based on estimates from six peanut-growing states in three regions.[2/] These states account for 92 percent of the US peanut production and 92 percent of planted acreage. In each region, different types of peanuts are produced under varying rainfall, temperature, humidity, and soil conditions. As a result, one might anticipate that the elimination of pesticides would have differential regional effects.

Organophosphates and carbamates are important to peanut production. There are no alternatives for nematode control. Alternatives for insect control fall in the pyrethroid category.

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These costs per acre were analyzed using average planted acre yields that ranged from 2,215 pounds in the Southern Plains to 2,613 pounds in the Virginia-North Carolina region for a US average of 2,376 pounds (Table 1).

[1/] The estimates of the impacts of pesticide use reduction in peanuts were coordinated by Rodrigo Rodríguez-Kábana, plant pathologist, and C. Robert Taylor, agricultural economist, both of Auburn University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Peanut Production*, AFPC Research Report 99-8 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/] The regions and states included are: Virginia-North Carolina, Southeast (AL and GA) and Southern Plains (OK and TX).

Table 1. Yields and Costs for Producing Peanuts With and Without Organophosphates and Carbamates

	United States[a]			Virginia/North Carolina			Southeast			Southern Plains		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwt/planted acre)[b]	23.76	21.60	-9.08%	26.13	21.58	-17.41%	23.87	21.74	-8.95%	22.15	21.33	-3.69%
Variable Cash expenses ($/acre):												
Chemicals	$105.60	$96.90	-8.24%	$149.61	$131.61	-12.03%	$123.35	$114.35	-7.30%	$43.00	$40.30	-6.28%
Other variable cash expenses	$258.02	$256.33	-0.65%	$277.84	$275.76	-0.75%	$255.86	$254.15	-0.67%	$251.08	$249.68	-0.56%
Total, variable cash expenses[c]	$363.62	$353.23	-2.86%	$427.45	$407.37	-4.70%	$379.21	$368.50	-2.83%	$294.08	$289.98	-1.40%
Variable Cash expenses ($/cwt):												
Chemicals	$4.44	$4.49	0.92%	$5.72	$6.10	6.51%	$5.17	$5.26	1.82%	$1.94	$1.89	-2.69%
Other variable cash expenses	$10.86	$11.87	9.27%	$10.63	$12.78	20.18%	$10.72	$11.69	9.09%	$11.34	$11.71	3.25%
Total, variable cash expenses[c]	$15.31	$16.35	6.84%	$16.36	$18.87	15.39%	$15.89	$16.95	6.73%	$13.28	$13.60	2.38%

[a] Peanut states included represent 92% of the acreage planted to peanuts and 92% of the production in the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

Variable cash expenses ranged from $13.28 per cwt on the Southern Plains to $16.35 in the Virginia-North Carolina region for a US average of $15.31 per cwt. Chemical costs account for as much as 35 percent of total variable costs on a cwt basis in the Virginia-North Carolina region. On a per cwt basis, chemical costs range from $1.94 per cwt in the Southern Plains to $5.72 in the Virginia-North Carolina region for a US average of $4.44.

Table 2 indicates the major pests and the organophosphates and carbamates used to control them for states in each of the peanut-growing regions. It is important to note that the incidence of pests such as nematodes, cornstalk borers, and rootworms is more common in the Virginia-North Carolina and Southeast regions, making them more reliant on organophosphates and carbamates.

No Organophosphates and Carbamates

Table 2 indicates the feasible alternatives to organophosphates and carbamates identified by plant scientists working with peanuts on a day-to-day basis. There are no alternatives for nematode and rootworm control. The alternatives for control of other pests are limited to *Bt* (Dipel) and pyrethroids, such as cyhalothrin (Karate) and esfenvalerate (Asana), which create substantial potential for the development of resistance.

The elimination of organophosphates and carbamates reduces yields in the range of 4 percent on the Southern Plains to 17 percent in the Virginia-North Carolina region for a US average of 9 percent. Variable costs per cwt increase in the range of 2 percent in the Southern Plains to 15 percent in the Virginia-North Carolina region for a US average of 7 percent. Chemical costs change in the range of a 3 percent decrease in the Southern Plains to a 7 percent increase in the Virginia-North Carolina region for a US average of a 1 percent increase.

Table 2. Peanut Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/Carbamate Treatment	Alternative Treatment
Nematodes	Aldicarb (Temik) Fenamiphos (Nemacur)	None
Lesser cornstalk borer	Chlorpyrifos (Lorsban)	Cyhalothrin (Karate) Esfenvalerate (Asana)
Rootworm	Chlorpyrifos (Lorsban)	None
Early season pests such as thrips	Phorate (Thimet) Acephate (Orthene) Disulfoton (Di-syston)	Cyhalothrin (Karate) Esfenvalerate (Asana)
Mid-to-late season foliar feeders	Methomyl (Lannate) Carbaryl (Sevin)	Cyhalothrin (Karate) Esfenvalerate (Asana) Bolrav *Bt* (Dipel)

Source: Rodrigo Rodríguez-Kábana, C. Robert Taylor, *Impacts of the Elimination of Organophosphates and Carbamates from Peanut Production*, AFPC Research Report 99-8 (College Station, TX: Agricultural and Food Policy Center, Texas A&M University, April 1999).

Scientists Consulted

Kira Bowen, plant pathologist, Auburn University

Ron Smith, entomologist, Auburn University

Ron Weeks, entomologist, Auburn University

CHAPTER 9
POTATOES[1/]

Potato production, averaging 461 million cwt over the past five years (1993-1997), was grown on 1.4 million planted acres. From the perspective of dollar value of farm level sales, potatoes are the largest fruit and/or vegetable studied. It is a significant staple in the diet of people in all age groups except infants.

The analyses in this study are based on estimates for ten major potato-producing states divided into four regions by the scientists making the estimates.[2/] These states account for 80 percent of the production and 77 percent of the planted acres.

Each of these potato production regions is unique. While the Pacific Northwest is frequently considered to be a single potato production area due to differences in growing seasons, yields, and pest pressure, it was separated into two production areas. Likewise, while the Central and Northeast regions have similar pests, they differ in yields and climate. Moreover, Idaho and Columbia Basin producers must irrigate, but many growers in the Central and Northwest regions dryland farm. All regions produce for the fresh, processed, and seed potato markets.

Organophosphates and carbamates are very important to potato production. However, substitute chemicals do exist for most pests. Nonpesticide control methods generally are not

[1/]The estimates of the impacts of pesticide use reduction in potatoes were made by Maury Wiese, plant pathologist, and Joe Guenthner, agricultural economist, both on the faculty of the University of Idaho. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Potato Production*, AFPC Research Report 99-9 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]The states and regions included are: Idaho (ID); Columbia Basin (OR, WA); Central (MI, MN, ND, WI); and Northeast (ME, NY, PA).

effective alternatives. The general consequences of the elimination of organophosphates and carbamates would include:

- # Reduced yields
- # Reduced quality
- # Increased pest control costs
- # Reduced supply of seed potatoes meeting quality standards
- # Reduced storability of fall-crop potatoes
- # Higher risk of pests developing resistance to a narrower remaining array of chemicals.

However, care must be taken in interpreting such generalizations since neither yields nor quality decreased in some regions with the ban on organophosphates and carbamates. Also, new products such as azoxystrobin (Quadris) (registration set for 1999) would ease the impact of a ban on carbamate (EBDC) fungicides.

Baseline

Budgets developed by the University of Idaho, Washington State University, North Dakota State University, and the University of Maine, updated to 1998, were utilized to establish baseline costs. Yields in the five regions ranged from 57,000 pounds per acre in the Columbia Basin to 28,500 pounds in the Northeast with a US average of 37,744 pounds (Table 1). Variable cash expenses ranged from \$2.39 per cwt in Idaho to \$3.93 in the Northeast with a US average of \$2.69 per cwt. Idaho's chemical costs of \$0.40 per cwt (\$132.60 per acre or 17 percent of variable costs) are less than half that of two of the other four production regions where chemical costs were as high as \$487.91 per acre in the Columbia Basin and 30 percent of variable costs. The US average chemical cost was \$0.64 per cwt and 24 percent of variable costs.

Table 1. Yields and Costs of Producing Potatoes With and Without Organophosphates and Carbamates

	United States[a]			Idaho			Columbia Basin			Central States			Northeast		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (lbs/planted acre)[b]	37744	36473	-3.37%	33000	33000	0.00%	57000	54150	-5.00%	35000	33250	-5.00%	28500	27075	-5.00%
Variable Cash expenses ($/acre)															
Chemicals	$240.95	$278.22	15.47%	$132.60	$176.49	33.10%	$487.91	$485.34	-0.53%	$219.64	$283.34	29.00%	$238.69	$247.53	3.70%
Other variable cash expenses	$775.02	$770.61	-0.57%	$655.96	$655.96	0.00%	$1,119.48	$1,106.73	-1.14%	$668.16	$667.35	-0.12%	$882.52	$867.72	-1.68%
Total, variable cash expenses	$1,015.97	$1,048.83	3.23%	$788.56	$832.45	5.57%	$1,607.39	$1,592.07	-0.95%	$887.80	$950.69	7.08%	$1,121.21	$1,115.25	-0.53%
Variable Cash expenses ($/cwt):															
Chemicals	$0.64	$0.76	19.49%	$0.40	$0.53	33.10%	$0.86	$0.90	4.71%	$0.63	$0.85	35.79%	$0.84	$0.91	9.16%
Other variable cash expenses	$2.05	$2.11	2.90%	$1.99	$1.99	0.00%	$1.96	$2.04	4.06%	$1.91	$2.01	5.14%	$3.10	$3.20	3.50%
Total, variable cash expenses	$2.69	$2.88	6.83%	$2.39	$2.52	5.57%	$2.82	$2.94	4.26%	$2.54	$2.86	12.72%	$3.93	$4.12	4.70%

[a] Potato regions included represent 77% of the acreage planted to potatoes and 80% of the production during the 1993-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

As indicated by their costs, pesticides are very important to the production of potatoes. Organophosphates and carbamates are among the most frequently used pesticides in each of the production regions (Table 2). Those identified as being most frequently and widely used include carbofuran (Furadan), methamidophos (Monitor), EBDC fungicides, and phorate (Thimet).

No Organophosphates and Carbamates

The impacts of eliminating organophosphates and carbamates on potatoes would be on both yield and chemical costs. US average chemical costs per cwt increase by $0.13 per cwt while yields decline by 5 percent in all regions except Idaho. As a result, total variable costs for the US rise by an average of 7 percent.

Potato yields decline by an estimated US average of 3.4 percent from 377 cwt per acre to 365. The range in reduction is from zero in Idaho to 5 percent in each of the other three regions. There is also a decline in quality, which is not captured in Table 1 but directly affects the returns received by potato producers.

With no organophosphates and carbamates, chemical costs per cwt rise by 33 percent in Idaho, 5 percent in the Columbia Basin, 36 percent in the Central States, and 9 percent in the Northeast. The increase in costs of nearly $63 per acre for the Central States results primarily from the substitution of endosulfan (Thiodan/Phaser) for carbofuran (Furadan) (Table 2). Scientists in each region pointed out that with fewer substitute chemicals available, there is greater likelihood that pests would develop resistance. It is also notable that the effects on seed stock of eliminating organophosphates and carbamates will be greater than the effects on market potatoes. For example, seed potato production in the Central States meeting current quality and health standards would be reduced by 50 percent with the substitution of endosulfan

Table 2. Potato Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
CPB	Aldicarb (Temik) Carbofuran (Furadan) Phorate (Thimet)	Endosulfan (Thiodan, Phaser) Imidacloprid (Admire) *Bt* biologicals (Agree, Javelin, etc.) Sodium alumino-fluoride (Cryolite)
Leafhopper	Carbofuran (Furadan) Dimethoate (Cygon) Phorate (Thimet)	Endosulfan (Thiodan, Phaser) Imidacloprid (Admire) Permethrin (Ambush, Pounce) Esfenvalerate (Asana)
Aphids	Aldicarb (Temik) Methamidophos (Monitor)	Imidacloprid (Admire) Endosulfan (Thiodan, Phaser)
Late Blight Early Blight	EBDC fungicides (Dithane, Manzate, Polyram, etc.)	Chlorothalonil (Bravo) Azoxystrobin (Quadris-available in 1999) Copper compounds (Kocide, etc.)
Wire worms Grubs Potato scab	Ethoprop (Mocap) Phorate (Thimet)	Imidacloprid (Admire)
Post-Harvest:		
Sprouting in storage	Chlorpropham (Sprout Nip, CIPC)	Maleic hydrazide (Royal MH30, Fair Plus)

Source: Maury V. Wiese, Joseph F. Guenthner, *Impacts of the Elimination of Organophosphates and Carbamates from Potato Production*, AFPC Research Report 99-9 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

(Thiodan/Phaser) for methamidophos (Monitor). In Wisconsin, no seed potato production would meet tolerance levels for insect-borne viruses.

After production, the loss of the sprout inhibitor chlorpropham (Sprout Nip/CIPC), would decrease fall tuber storage for fresh markets from six or more months to approximately three months since substitute sprout inhibitors such as maleic hydrazide (Royal MH30/Fair Plus) are less effective. Without chlorpropham (Sprout Nip/CIPC), therefore, the fresh market of fall potatoes, after three months' storage, would be significantly reduced.

The combination of generally higher chemical costs and lower yields resulted in the US average potato variable costs increasing by 7 percent with a range from 4 percent in the Columbia Basin to a 13 percent increase in the Central States.

Scientists Consulted

Phil Glogoza, entomologist, North Dakota State University
Steve Johnson, potato pathologist, University of Maine
Matt Kleinhanz, entomologist/potato specialist, University of Maine
Gale Kleinkopf, plant pathologist, University of Idaho
Phil Nolte, horticulturist, University of Idaho
Duane Preston, horticulturist, North Dakota State University & University of Minnesota
Bob Stoltz, entomologist, University of Idaho
Bob Thornton, horticulturist, Washington State University
Jeffery Wyman, entomologist, University of Wisconsin

References

Bowman, J., M. Graustein, S. Hafez and G. Kleinschmidt, "Aldicarb Use on Potato," *The Biologic and Economic Assessment of Aldicarb*, USDA ES NAPIAP Report for US EPA (1991), pp. 41-64.

Cornell, T.R., J.P. Koenig, W.R. Stevenson, K.A. Kellings, D. Curwen, J.A. Wyman, and L.K. Binning, "An Integrated Systems Approach to Potato Crop Management," *Journal of Production Agriculture,* 4 (1991), pp. 453-60.

Farm Chemicals Handbook, Meister Publishing (Willoughby, Ohio: 1998).

Guenthner, J. F., M. V. Wiese, A. D. Pavlista, J. B. Sieczka, and J. Wyman, "Assessment of Pesticide Use in the US Potato Industry," American Journal of Potato Research, 76 (1999), pp. 1-5.

Hinman, H., E. Kulp, E. Sorensen, G. Pelter, and R. Gillespie, "Enterprise Budgets for Potatoes, et al under Center Pivot Irrigation, Columbia Basin, Washington," *Farm Business Management Reports*, EB 1667, Cooperative Extension (Pullman, Washington: Washington State University, 1997).

Johnson, S., *Farmplan: An Interactive Enterprise Budgeting Program for Potato Growers,* Cooperative Extension Bulletin #2277 (Orono, Maine: University of Maine, 1993).

Lin, B., M. Padgitt, L. Bull, H. Delvo, D. Shank, and H. Taylor, *Pesticide and Fertilizer Use and Trends in Us Agriculture*, Agricultural Economics Report No. 717, US Government Printing Office (Washington, D.C.: 1995).

National Potato Council, *Potato Statistical Yearbook* (Denver, Colorado: 1998).

Patterson, P., W. Bohl, and R. Smathers, *Southeastern Idaho Crop Costs and Returns Estimate: Russet Burbank Commercial Potatoes: On-farm Storage*, EBB4-Po2-97 (Moscow, Idaho: University of Idaho, 1997).

"Potato Statistics," *Chemical Statistics (1995)*, USDA Economics and Statistics System, Albert R. Mann Library, Cornell University, http://usda.mannlib.cornell.edu.

Preston, D. and D. Norquist, "Cost of Production Estimates for 1998," *Valley Potato Grower Magazine* (April 1998), pp. 15-20.

Rinehold, J. and J.J. Jenkins, "Pesticide Use Survey;" *Oregon Pesticide Use Estimates for Vegetable Crops*, (Corvallis, Oregon: Oregon State University Extension Service Bulletin EMXXXX, 1994).

USDA ERS, *RTD Updates: Chemical Use Practices, Pest Management*, US Government Printing Office (Washington, D.C.: 1993).

USDA ERS, *RTD Updates: Pest Management Practices*, USDA Publication No. 2, US Government Printing Office (Washington, D.C.: 1994).

USDA NASS, *Agricultural Chemical Usage Field Crop Summaries*, US Government Printing Office (Washington, D.C.: 1998).

USDA NASS, *Agricultural Prices, 1997*, US Government Printing Office (Washington, D.C.: 1998).

USDA NASS, *National Crop Summaries*, US Government Printing Office (Washington, D.C.: 1997).

Wiese, M., J. Guenthner, A. Pavlista, J. Wyman, J. Sieczka, *Use, Target Pests and Economic Impact of Pesticides Applied to Potatoes in the United States*, (Washington, D.C.: USDA NAPIAP Report 2-CA-98, 1998).

Wyman, J.A, "Phorate Use on Potato," *The Biological and Economic Assessment of Phorate and Terbufos*, eds. M. Fitzner, J. Bowman, and H. Stockdale (Washington, D.C.: USDA ES Technical Bulletin No. 1785, 1990), pp. 43-54.

CHAPTER 10
RICE[1/]

Rice production, averaging 176 million cwt over the past five years (1993-1997), is grown on an average of 3.1 million planted acres. As such, rice is the fifth largest field crop in terms of farm sales.

The analyses in this study are based on estimates from 100 percent of US production and 100 percent of planted acreage in three USDA growing regions.[2/] Each region has its unique problems in terms of temperature, rainfall, irrigation water availability, soil conditions, costs, and the type of rice grown.

Organophosphates and carbamates are important to rice production. Alternative chemicals to carbofuran (Furadan) or thiobencarb (Bolero) have not been developed, are not used in all production areas, and/or are less effective when used.

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These budgets were used with 1993-97 yields that ranged from 5,100 pounds on the Gulf Coast to 8,000 pounds in California for a US average of 5,800 pounds per acre (Table 1). Variable cash expenses ranged from $6.92 per cwt on the Delta to $8.60 on the Gulf Coast for a US average of $7.38 per cwt.

[1/]The estimates of the impacts of pesticide use reduction in rice were made by Joe Musick, agricultural economist, Louisiana State University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Rice Production*, AFPC Research Report 99-10 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]The regions and states included are: Mississippi River Delta (AR, MS, Northeast LA, MO), Gulf Coast (TX, Southwest LA) and California.

Table 1. Yields and Costs of Producing Rice With and Without Organophosphates and Carbamates

	United States[a]			Mississippi River Delta			Gulf Coast[a]			California		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwt/planted acre)[b]	57.53	52.83	-8.16%	54.35	51.48	-5.28%	50.77	43.28	-14.77%	80.02	72.73	-9.11%
Variable Cash expenses ($/acre):												
Chemicals	$69.38	$68.11	-1.82%	$67.62	$68.53	1.34%	$63.68	$67.00	5.21%	$84.85	$68.26	-19.55%
Other variable cash expenses	$355.16	$352.81	-0.66%	$308.68	$307.99	-0.22%	$372.94	$368.45	-1.20%	$504.07	$498.71	-1.06%
Total, variable cash expenses[c]	$424.54	$420.92	-0.85%	$376.30	$376.52	0.06%	$436.62	$435.45	-0.27%	$588.92	$566.97	-3.73%
Variable Cash expenses ($/cwt):												
Chemicals	$1.21	$1.29	6.90%	$1.24	$1.33	6.98%	$1.25	$1.55	23.45%	$1.06	$0.94	-11.49%
Other variable cash expenses	$6.17	$6.68	8.17%	$5.68	$5.98	5.34%	$7.35	$8.51	15.92%	$6.30	$6.86	8.86%
Total, variable cash expenses[c]	$7.38	$7.97	7.96%	$6.92	$7.31	5.63%	$8.60	$10.06	17.02%	$7.36	$7.80	5.92%

[a] Rice states included represent 100% of the acreage planted to rice and 100% of the production in the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[C] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

Chemical costs ranged from $1.06 per cwt in California to $1.25 on the Gulf Coast. Chemicals ran as high as $68 per acre or 18 percent of cash expenses in the Delta. Organophosphates and carbamates most frequently utilized include methyl parathion (Penncap-M, Methyl Parathion) for stinkbug control, carbofuran (Furadan) for rice water weevil control, and thiobencarb (Bolero) for weed control (Table 2).

No Organophosphates and Carbamates

Organophosphates and carbamates are important to rice production because lower yields and higher costs would be experienced without them. While cyhalothrin (Karate) is a substitute for methyl parathion (Penncap-M, Methyl Parathion) and carbofuran (Furadan), two distinct problems arise:

- Cyhalothrin (Karate) could result in serious damage to crawfish which is an important joint product making rice production more feasible on the Gulf Coast.
- A pre-harvest interval of 21 days limits cyhalothrin (Karate) as an alternative in all three production regions.

There is no substitute for thiobencarb (Bolero) in Texas, California, Arkansas, Mississippi, and Missouri although molinate (Ordram) is considered to be a substitute in Louisiana, albeit at a higher cost (Table 2).

Eliminating organophosphates and carbamates used to produce rice is estimated to reduce yields in the range of from 5 percent on the Delta to 15 percent on the Gulf Coast for a US average decline of 8 percent. Chemical costs rise on a per cwt basis in the range of 7 percent on the Delta to 23 percent on the Gulf Coast while declining by 11 percent in California. The US average increase is estimated at 7 percent. Total variable costs per cwt rise in the range of 6

Table 2. Rice Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Water weevil	Carbofuran (Furadan)	Cyhalothrin (Karate) Fipronil (Icon)
Leaf miner	Methyl Parathion (Penncap-M, Methyl Parathion)	None
Armyworm	Malathion (Fyfanon) Methyl Parathion (Penncap-M, Methyl Parathion)	Cyhalothrin (Karate)[a]
Tadpole Shrimp	Methyl Parathion (Penncap-M, Methyl Parathion)	None
Stink Bug	Methyl Parathion (Penncap-M, Methyl Parathion) Carbaryl (Sevin)	None
Weeds	Thiobencarb (Bolero)	Molinate (Ordram)

[a] Current label restricts use prior to 21 days to harvest.

Source: Joe Musick, *Impacts of the Elimination of Organophosphates and Carbamates from Rice Production*, AFPC Research Report 99-10 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

percent on the Delta and in California to 17 percent on the Gulf Coast, for a US average increase of 8 percent. These cost increases may appear to be small. However, rice operates in an international market where exports are an important outlet, and US costs are relatively high. Any increase in costs has the potential for doing serious damage to the US international competitive position. The southern Gulf Coast area, including Texas and southwest Louisiana, would be placed at a serious competitive disadvantage which could result in large reductions in rice acreage.

Scientists Consulted

Ford Baldwin, weed specialist, University of Arkansas
John Bernhardt, entomologist, University of Arkansas
Marlin Brandon, rice specialist, University of California
Garry McCauley, agronomist, Texas A&M University
John K. Saichuk, rice specialist, Louisiana State University
Dearl E. Sanders, weed specialist, Louisiana State University
Joe Street, rice specialist, Mississippi State University
M.O. Way, entomologist, Texas A&M University

References

Fryar, E.O., L.D. Parsch, S.H. Holder, and N.P. Tugwell, "The Economics of Controlling Peck in Arkansas Rice," *Arkansas Farm Research* (May-June 1986), p. 7.

Harper, J.K., "Developing Economic Thresholds for Rice Stink Bug Management in Texas Using Dynamic Programming," unpublished thesis (College Station, Texas: Texas A&M University, 1988).

Musick, J.A. and M. Muegge, "Louisiana Comments Regarding: EPA Analysis of Rice Water Weevil Management Alternatives," Rice Federation - EPA Meeting (Washington, D.C.: September 1996), 19 pp.

Spradley, J.P. and T.E. Windham, *Biological and Economic Assessment of Pest Management in Rice*, a special funded project of USDA, National Agricultural Pesticide Impact Assessment Program, Document Number 2-CA-95 (Washington, D.C.), 289 pp.

CHAPTER 11
GRAIN SORGHUM[1/]

Grain sorghum production, averaging 620 million bushels over the past five years (1993-1997), was grown on an average of 10.5 million planted acres. As such, grain sorghum is the sixth largest field crop in terms of sales.

The analysis in this study is based on estimates from six major grain sorghum-producing states in two USDA growing regions.[2/] These states account for 91 percent of US production and 89 percent of planted acres. Each region has its unique problems due to differences in temperature, rainfall, humidity, and soil conditions.

The emphasis in this study is on the effects of eliminating organophosphates and carbamates. However, in the case of grain sorghum, an additional important chemical, triazine (Atrazine), has been listed for its potential elimination under the FQPA. Accordingly, in this analysis, two chemical use reduction scenarios are included:

- Scenario 1. Elimination of organophosphates and carbamates.
- Scenario 2. Elimination of organophosphates, carbamates, and triazine.

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These costs per acre budgets were analyzed using 1993-97 yields per planted acre that averaged 68 bushels

---

[1/]The estimates of the impacts of pesticide use reduction in sorghum were made by Carl Patrick, entomologist, and Larry Falconer, agricultural economist, both on the faculty of Texas A&M University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Grain Sorghum Production*, AFPC Research Report 99-11 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]The regions and states included are: Southern Plains (AR, OK, TX) and Central Plains (KS, MO, NE).

per acre on the Central Plains and 51 bushels on the Southern Plains, with a US average of 61 bushels per acre (Table 1). Variable cash expenses averaged $1.60 per bushel on the Central Plains, and $2.41 on the Southern Plains resulting in a $1.88 per bushel average for the United States.

Of the total variable costs, chemical costs were $0.22 per bushel (14 percent of variable costs) on the Central Plains and $0.19 per bushel (8 percent of variable costs) on the Southern Plains for a US average of $0.21 per bushel (11 percent of variable costs). As indicated in Table 2, the following organophosphates and carbamates were identified as being used in grain sorghum production: terbufos (Counter), disulfoton (Di-Syston), dimethoate (Cygon), malathion (Fyfanon), chlorpyrifos (Lorsban), phorate (Thimet), aldicarb (Temik), carbofuran (Furadan), methomyl (Lannate), and carbaryl (Sevin).

No Organophosphates and Carbamates

Organophosphates and carbamates are important to grain sorghum production in that lower yields and higher costs would be experienced without them because there are no viable substitute chemicals available (Table 2).

Eliminating the organophosphates and carbamates used to produce grain sorghum is estimated to reduce the average US grain sorghum yield by 12 percent. The reduction was estimated to be 10 percent on the Central Plains and 14 percent on the Southern Plains.

Because of the absence of substitutes for organophosphates and carbamates, US chemical costs per bushel would fall by 11 percent, with the reduction being 4 percent on the Central Plains and 26 percent on the Southern Plains. US total variable costs per bushel were estimated

Table 1. Yields and Costs for Producing Grain Sorghum With and Without Organophosphates and Carbamates

	United States[a]			Central Plains			Southern Plains		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (bu/planted acre)[b]	60.91	53.88	-11.54%	68.00	61.19	-10.01%	51.00	43.67	-14.37%
Variable cash expenses ($/acre):									
Chemicals	$12.70	$10.04	-20.97%	$15.03	$12.93	-13.97%	$9.44	$5.99	-36.55%
Other variable cash expenses	$101.93	$101.40	-0.52%	$93.74	$93.34	-0.43%	$113.38	$112.66	-0.64%
Total, variable cash expenses[c]	$114.63	$111.43	-2.79%	$108.77	$106.27	-2.30%	$122.82	$118.65	-3.40%
Variable cash expenses ($/bu):									
Chemicals	$0.21	$0.19	-10.66%	$0.22	$0.21	-4.40%	$0.19	$0.14	-25.90%
Other variable cash expenses	$1.67	$1.88	12.45%	$1.38	$1.53	10.66%	$2.22	$2.58	16.04%
Total, variable cash expenses[c]	$1.88	$2.07	9.89%	$1.60	$1.74	8.58%	$2.41	$2.72	12.82%

[a] Grain sorghum states included represent 88% of the acreage planted to grain sorghum and 91% of production in the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

Table 2. Grain Sorghum Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Southern corn rootworm	Chlorpyrifos (Lorsban) Carbofuran (Furadan) Terbufos (Counter)	None
Spider mites	Dimethoate (Cygon) Chlorpyrifos (Lorsban)	None
Greenbugs	Aldicarb (Temik) Chlorpyrifos (Lorsban) Carbofuran (Furadan) Disulfoton (Di-Syston) Malathion (Fyfanon) Methyl Parathion (Penncap-M, Methyl Parathion) Phorate (Thimet) Terbufos (Counter) Carbaryl (Sevin)	None
Midge or headworms	Methomyl (Lannate)	Cyfluthrin (Baythroid) Esfenvalerate (Asana) Lambda-cyhalothrin (Karate)
Chinch bugs	Carbofuran (Furadan) Chlorpyrifos (Lorsban) Terbufos (Counter) Carbaryl (Sevin)	Imidacloprid (Gaucho) Cyfluthrin (Baythroid) Esfenvalerate (Asana) Lambda-cyhalothrin (Karate)[a]

[a] Less effective than carbamates and organophosphates.

Source: Carl Patrick, Larry Falconer, *Impacts of the Elimination of Organophosphates and Carbamates from Grain Sorghum Production*, AFPC Research Report 99-11 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

to increase by an average of 10 percent (19 cents per bushel) with a 9 percent rise on the Central Plains (14 cents per bushel) and 13 percent on the Southern Plains (31 cents per bushel).

As a benchmark for the resulting distorted cost relationship, variable cash expenses for the Southern Plains would exceed the national average CCC loan rate for grain sorghum by $0.95 per bushel while the Central Plains cash cost would be $0.03 below the loan rate. With the Southern Plains already having high costs relative to grain sorghum or corn produced in other regions, substantially reduced acreage could be anticipated.

No Triazine (Atrazine), Organophosphates, and Carbamates

In addition to organophosphates and carbamates, it was concluded that triazine (Atrazine) was being seriously considered for elimination on grain sorghum. Accordingly, the consequence of eliminating the combination of triazine (Atrazine), organophosphates, and carbamates was estimated.

In this case, metolachlor (Dual) and alachlor (Lasso) are less effective than triazine (Atrazine) and are much more expensive–likely prohibitively expensive on the Southern Plains. Therefore, the yield reductions would increase if organophosphates, carbamates, and triazine (Atrazine) were eliminated–20 percent from the US baseline, 15 percent on the Central Plains, and 28 percent on the Southern Plains (Table 3). However, US chemical costs per bushel increase by 45 percent. The result is a much larger increase in total variable costs per bushel–26 percent for the US ($0.49 per bushel), 20 percent on the Central Plains ($0.32 per bushel), and 40 percent on the Southern Plains ($0.96 per bushel).

The Southern Plains total variable cost increased from $2.41 per bushel to $3.37. Variable cash expenses for the Southern Plains would exceed the national average CCC loan rate

Table 3. Yields and Costs for Producing Grain Sorghum With and Without Organophosphates, Carbamates, and Triazine (Atrazine)

	United States[a]			Central Plains			Southern Plains		
	Baseline	No O&C&T	% Change	Baseline	No O&C&T	% Change	Baseline	No O&C&T	% Change
Yield (bu/planted acre)[b]	60.91	48.92	-19.69%	68.00	57.69	-15.16%	51.00	36.66	-28.12%
Variable Cash expenses ($/acre):									
Chemicals	$12.70	$14.82	16.67%	$15.03	$17.56	16.83%	$9.44	$10.98	16.31%
Other variable cash expenses	$101.93	$101.19	-0.73%	$93.74	$93.13	-0.65%	$113.38	$112.45	-0.82%
Total, variable cash expenses[c]	$114.63	$116.00	1.20%	$108.77	$110.69	1.77%	$122.82	$123.43	0.50%
Variable Cash expenses ($/bu):									
Chemicals	$0.21	$0.30	45.27%	$0.22	$0.30	37.71%	$0.19	$0.30	61.81%
Other variable cash expenses	$1.67	$2.07	23.60%	$1.38	$1.61	17.10%	$2.22	$3.07	37.98%
Total, variable cash expenses[c]	$1.88	$2.37	26.00%	$1.60	$1.92	19.95%	$2.41	$3.37	39.81%

[a] Grain sorghum states included represent 88% of the acreage planted to grain sorghum and 91% of production in the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

by $1.60 per bushel, while Central Plains' cash cost would exceed the loan rate by $0.15 per bushel. This increase has the potential for eliminating grain sorghum as a cropping alternative on the Southern Plains. With cotton production likewise being adversely impacted by the elimination of organophosphates and carbamates, options that generate considerably lower revenue per acre, such as wheat and/or haying and grazing, may replace grain sorghum production on much of the Southern Plains.

Scientists Consulted

Alan Baquet, agricultural economist, University of Nebraska
Brent Bean, agronomist, Texas A&M University
Emory P. Boring, III, entomologist, Texas A&M University
H. Leroy Brooks, entomologist, Kansas State University
John B. Campbell, entomologist, University of Nebraska
Jim Criswell, entomologist, Oklahoma State University
Mike Hardin, agricultural economist, Oklahoma State University
Larry Langemeir, agricultural economist, Kansas State University
Raymond Massey, agricultural economist, University of Missouri
Roy D. Parker, entomologist, Texas A&M University
Tony Windham, agricultural economist, University of Arkansas

References

Amosson, S.H., *Texas Crop and Livestock Enterprise Budgets - Texas Panhandle District - Projected for 1998,* B-1241(C1), (Amarillo, Texas: Texas Agricultural Extension Service, Texas A&M University, November, 1997).

Becker, S.A. et al., *Grain Crop Pesticide Use Missouri, 1992* (Columbia, Missouri: Integrated Pest Management Unit, University of Missouri, 1993).

Bevers, S.J., *Texas Crop and Livestock Enterprise Budgets - Texas Rolling Plains District - Projected for 1998,* B-1241(C3), (Vernon, Texas: Texas Agricultural Extension Service, Texas A&M University, November, 1997).

Brook, H.L. et al., *Sorghum Insect Management 1998* (Manhattan, Kansas: Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Kansas State University, 1998).

Brooks, N. and B. McElroy, *FBEI Updates: Costs of Production*, FBEI 97-1 (Washington, D.C.: USDA, February 1997).

Ciba Crop Protection, *Special Review Report: The Facts about Atrazine and Simazine* (Greensboro, North Carolina: Ciba-Geigy Corporation, 1995).

Cronholm, G. et al., *Managing Insect and Mite Pests of Texas Sorghum*, B-1220 (College Station, Texas: Texas Agricultural Extension Service, Texas A&M University, 1993).

Dhuyvetter, K.C., *Grain Sorghum Cost-Return Budget in North Central Kansas*, MF-2159 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Dhuyvetter, K.C., *Grain Sorghum Cost-Return Budget in Northeast Kansas*, MF-573 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Economic Research Service, *FBEI UPDATES: Costs of Production*, FBEI 97-1 (Washington, D.C.: ERS, USDA, February 1997).

Falconer L. L., *Texas Crop and Livestock Enterprise Budgets - Texas Coastal Bend District - Projected for 1998*, B-1241(C11), (Corpus Christi, Texas: Texas Agricultural Extension Service, Texas A&M University, November 1997).

Fausett, M.R., *Grain Sorghum Cost-Return Budget in Southeast Kansas*, MF-995 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Hall, K.O. et al., *1993 Texas Pesticide Use for Selected Crops*, E-8005-1 (College Station, Texas: Agricultural and Environmental Safety, Texas Agricultural Extension Service, Texas A&M University, 1993).

Hobbs, J., W. Burton, and G. Strickland, *Grain Sorghum - Owned Harvest Equipment* (Stillwater, Oklahoma: Department of Agricultural Economics, Oklahoma State University, September 1997).

Hobbs, J. and G. Strickland, *Grain Sorghum, Irrigated, Circular Sprinkler* (Stillwater, Oklahoma: Department of Agricultural Economics, Oklahoma State University, September 1997).

Langemier, L.N. et al., *Cost-Return Budgets - Irrigated Crops*, MF-941 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Massey, Ray, *Projected 1998 Grain Sorghum Cost of Production Worksheet* (Columbia, Missouri: University of Missouri Commercial Agriculture Program, October 1997).

Morrison, W.P. et al., *The Biological and Economic Assessment of Pesticides on Grain Sorghum*, 3-CA-94 (Washington, D.C.: National Agricultural Pesticide Impact Assessment Program, USDA, 1994).

Sartwelle, J.D. III and D.M. O'Brien, *Center-Pivot-Irrigated Grain Sorghum Cost-Return Budget*, MF-582 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Sartwelle, J.D. III and D.M. O'Brien, *Flood Irrigated Grain Sorghum Cost-Return Budget*, MF-580 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Sartwelle, J.D. III and D.M. O'Brien, *Grain Sorghum Cost-Return Budget (W-S-F) Rotation in Western Kansas*, MF-904 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Sartwelle, J.D. III, C.R. Thompson, and D.M. O'Brien, *Grain Sorghum Cost-Return Budget (Continuous) in Southwest Kansas*, MF-2098 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Selley, R., *Continuous Grain Sorghum - South Central* (Lincoln, Nebraska: Nebraska Cooperative Extension Service, 1996).

Selley, R., *Continuous Grain Sorghum - Southwest* (Lincoln, Nebraska: Nebraska Cooperative Extension Service, 1996).

Smith, E.G., et al., *Impacts of Chemical Use Reduction on Crop Yields and Costs* (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, September 1990).

Warmann, G.W., *Grain Sorghum Cost-Return Budget in South Central Kansas*, MF-575 (Manhattan, Kansas: Department of Agricultural Economics, Kansas State University, October 1997).

Windham, T.E., *Estimated Costs per Acre, Grain Sorghum, Mixed Soils, Arkansas*, AG 512 (Fayetteville, Arkansas: Arkansas Cooperative Extension Service, 1998).

CHAPTER 12
SOYBEANS[1/]

Soybean production, averaging 2.3 billion bushels over the past five years (1993-1997), was grown on an average of 64 million acres. From the perspective of dollar value of farm level sales, soybeans are the second most important field crop studied. Because soybeans are a high valued crop and its joint products are primarily used as a source of vegetable oil and animal protein supplement, changes in the costs of producing soybeans have large impacts on the cost of food for consumers.

The analyses in this study are based on estimates from 20 major soybean-producing states divided into four regions by the scientists making the estimates. These states accounted for 96 percent of the 1993-97 production and 95 percent of the acres planted.[2/] Research has indicated that the Southeast and Delta have production conditions that are uniquely different relative to the North Central and Northern Plains regions.

Despite technological advances such as Roundup Ready soybeans for weed management, organophosphates and carbamates still are very important to soybean production to control insects such as spider mites and stinkbugs. While substitute pesticides exist for many of the pests that adversely impact soybean yields, they are generally higher cost and less effective, resulting in reduced yields. Yield reductions are particularly severe in the Delta, where longer growing

---

[1/] The estimates of the impacts of pesticide use reduction in soybeans were made by Richard Wiese, agronomist, Glen Helmers, agricultural economist, and Saleem Shaik, agricultural economist, all of the University of Nebraska. Wiese is a professor emeritus. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Soybean Production*, AFPC Research Report 99-12 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/] The states and regions included are: North Central (IL, IN, IA, MI, MN, MO, OH), Northern Plains (KS, NB, ND, SD), Southeast (AL, GA, KY, NC, SC, TN) and Delta (AR, LA, MS).

seasons and mild winters foster insect and weed problems. However, even traditional soybean growing areas are adversely impacted by the withdrawal of organophosphates and carbamates.

Roundup Ready soybeans are genetically engineered to withstand exposure to glyphosate (Roundup), a herbicide. Glyphosate (Roundup) is a broad-spectrum, non-selective herbicide, which kills all plants. Weed-free soybean fields can be a deterrent to some insect pests that use weeds as host plants.

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These budgets were used with 1993-97 yields that ranged from 29 bushels per planted acre in the Delta to 41 bushels in the North Central region for a US average of 38 bushels per acre (Table 1).

Variable cash expenses averaged in the range of from $2.43 per bushel in the North Central region to $4.13 in the Southeast for a US average of $2.72 per bushel. Chemical costs in the range of $20.55 per acre in the Northern Plains to $26.94 in the North Central region yield a US average of $25.58. On a per bushel basis, chemical costs range from $0.58 in the Northern Plains to $0.85 in the Delta for a US average of $0.67 per bushel.

As indicated by their costs and effectiveness, organophosphates and carbamates are quite important to efficient soybean production. They are used in all production regions.

The major soil borne pest for soybeans is the cyst nematode. Its prevalence in most US soybean growing states does impact soybean yields. It is reported to cause a 48 million soybean bushel loss annually. Losses are not easily seen since the root attaching nematode shows no

Table 1. Yields and Cost of Producing Soybeans With and Without Organophosphates and Carbamates

	United States[a]			North Central			Northern Plains			Southeast			Delta		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (bu/planted acre)[b]	38.07	36.12	-5.10%	41.08	38.63	-5.96%	35.53	35.53	0.00%	30.12	29.32	-2.65%	29.11	26.87	-7.70%
Variable Cash expenses ($/acre):															
Chemicals	$25.58	$29.03	13.46%	$26.94	$29.94	11.14%	$20.55	$20.55	0.00%	$24.21	$31.71	30.98%	$24.88	$32.38	30.14%
Other variable cash expenses	$78.04	$78.04	0.00%	$72.71	$72.71	0.00%	$79.04	$79.04	0.00%	$100.22	$100.22	0.00%	$92.36	$92.36	0.00%
Total, variable cash expenses[c]	$103.62	$107.07	3.32%	$99.65	$102.65	3.01%	$99.59	$99.59	0.00%	$124.43	$131.93	6.03%	$117.24	$124.74	6.40%
Variable Cash expenses ($bu):															
Chemicals	$0.67	$0.08	19.57%	$0.66	$0.78	18.18%	$0.58	$0.58	0.00%	$0.80	$1.08	34.54%	$0.85	$1.21	41.00%
Other variable cash expenses	$2.05	$2.16	5.38%	$1.77	$1.88	6.34%	$2.22	$2.22	0.00%	$3.33	$3.42	2.72%	$3.17	$3.44	8.34%
Total, variable cash expenses[c]	$2.72	$2.96	8.88%	$2.43	$2.66	9.54%	$2.80	$2.80	0.00%	$4.13	$4.50	8.91%	$4.03	$4.64	15.27%

[a] Soybean states included represent 95% of the acreage planted and 96% of the production over the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

effect on above-ground parts. Rotations to non-host crops and variety selection are the means of management. Any chemical treatment on a field scale would be cost prohibitive.

The principal insecticides used on plant feeding insects on soybeans are fairly evenly distributed between organophosphates and carbamate materials (Table 2). Chlorpyrifos (Lorsban), ethyl parathion (Parathion), methyl parathion (Penncap-M, Methyl Parathion), and dimethoate (Cygon) represent the organophosphates. Carbaryl (Sevin), carbofuran (Furadan), and methomyl (Lannate) represent the carbamates. Other organophosphates and carbamates are used to a lessor extent but are just as critical and necessary for specific insect control.

Substitute insecticides for stink bug control in the Delta states are generally less effective and can cost more due to an increase in the number of foliar treatments.

No Organophosphates and Carbamates

The impacts of eliminating organophosphates and carbamates on soybeans would be reduced yields in all regions except the Northern Plains and increased chemical costs per acre in the Southeast, Delta, and North Central regions. Yields declined in the range of no change in the Northern Plains to 8 percent in the Delta for a US average of 5 percent.

Without organophosphates and carbamates, total variable costs on a per bushel basis range from no change in the Northern Plains to a 15 percent increase in the Delta for a US average increase of 9 percent. Variable costs in the Delta rise from $4.03 per bushel to $4.64 while chemical costs rise 41 percent from $0.85 to $1.21 per bushel.

Substitute insecticide material in the Delta and Southeast soybean regions to control stink bugs are possibly tefluthrin (Force), cyhalothrin (Warrior), and fipronil (Regent). Proven consistency for control of a lessor impact upon natural predators leaves some questions

Table 2. Soybean Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Stink bugs	Ethyl parathion (Parathion) Methyl parathion (Penncap-M, Methyl Parathion)	Fipronil (Regent) Tefluthrin (Force) Cyhalothrin (Warrior, Karate)
Spider mites	Dimethoate (Cygon) Chlorpyrifos (Lorsban) Methyl parathion (Penncap-M, Methyl Parathion) Ethyl parathion (Parathion) Carbaryl (Sevin) Carbofuran (Furadan) Methomyl (Lannate)	Tefluthrin (Force) Fipronil (Regent) Cyhalothrin (Warrior, Karate) Tralomethrin (Scout X-Tra)

Note: Approximately 30 different insects can threaten the economic production of soybeans. Each year treatment will become a necessity somewhere to prevent yield losses in excess of 10 percent. Only the more prevalent insect pests are listed in the table.

Source: Richard Wiese, Glen Helmers, Saleem Shaik, *Impacts of the Elimination of Organophosphates and Carbamates from Soybean Production*, AFPC Research Report 99-12 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

remaining with use of substitutes. Substitute insecticides for the North Central region have not been satisfactory to control spider mite outbreaks.

Scientists Consulted

B. Bender, geneticist, Iowa State University

D. Boethal, entomologist, Louisiana State University

D. Brassard, Office of Pest Management, US EPA

R. Higgins, entomologist, Kansas State University

R. Hudson, entomologist, Tiftou Experiment Station, Georgia

K. Jarvi, pesticide management, University of Nebraska

B. Johnson, entomologist, University of Wisconsin

J. Obermeyer, entomologist, Purdue University

G. O'Connor, entomologist, University of Connecticut

K. Ostlie, entomologist, University of Minnesota

F. Pierce, entomologist, Colorado State University

R. Pope, entomologist, Iowa State University

R. H. Smith, entomologist, Auburn University

K. Steffey, entomologist, University of Illinois

J. Tollefson, entomologist, Iowa State University

L. Townsend, entomologist, University of Kentucky

T. Van Arsdale, National Council of Farm Cooperatives

J. VanDuyn, entomologist, North Carolina State University

H. Wilson, entomologist, Ohio State University

R. Wright, entomologist, University of Nebraska

References

"Agricultural Chemical Use," Ag Ch 1 (98), (Washington, D.C.: USDA/NASS, 1998).

Angstadt, W.D., "Reflections on Electrons," *Dealer Progress Magazine* (July/August 1998) p. 20.

Baldwin, J., "Controlling Soybean Insects," internet news release (Baton Rouge, Louisiana: Louisiana State University, 1997).

"Feasibility of Prescription Pesticide Use in the United States," Issue Paper No. 9 (Ames, Iowa: CAST, August 1998).

Gianesse, L. P., "The Use and Benefits of Organophosphate and Carbamate Insecticides in US Crop Productions." Report (Washington, D.C.: National Center for Food and Agricultural Policy, 1997).

Insect Pests of Field Crops, Bulletin No. 545 (Columbus, Ohio: Ohio State University, 1998).

Insects and Related Parts of Field Crops, AG-271 (Raleigh, North Carolina: North Carolina State University Extension Service, 1996).

Jury, W.A. and M. Ghodrati, "Overview of Organic Chemical Environmental Fate and Transport Modeling Approaches in Reactions and Movement of Organic Chemicals in Soils." Soil Science Society of America Special Publication No. 22, B.L Sawhney and K. Brown (eds), 1989, pp. 271-304.

Klassen, P., "An 'Alternative' View: An Interview with Charles Benbrook," *Farm Chemicals Magazine* (September 1998), p. 18.

Mulrooney, R.P., *Management of Soybean Cyst Nematode* (Newark, Delaware: Cooperative Extension Service, University of Delaware, 1997).

Ohermeyer, J. and A. Bledsoe, "Should You Control Corn Rootworm in Young Soybean Fields?" news release (West Lafayette, Indiana: Purdue University, 1998).

Peterson, J., "Comparison of Management Practices Used by Producers Growing Transgenic Crops vs Conventional Varieties," Research Symposium address (Lincoln, Nebraska: Department of Agronomy, University of Nebraska, November 17, 1998).

"Pest Management Practices," Sp Cr 1 (98) Summary (Washington, D.C.: USDA/NASS, 1997).

"Pests of Soybeans," internet news release extracted from AG-271 (Raleigh, North Carolina: North Carolina Agricultural Cooperative Extension Service, North Carolina State University, 1997).

"Soybean Insect Pests," internet news release (Raleigh, North Carolina: North Carolina Agricultural Cooperative Extension Service, North Carolina State University).

"Soybean Pests," internet news release (Suffolk, Virginia: Tidewater Agricultural Research and Extension Center, Virginia Tech).

Staff Background Paper No. 5.1, TRAC (Washington, D.C.: US EPA Office of Pesticide Programs, May 27, 1998).

Staff Background Paper No. 5.2, TRAC (Washington, D.C.: US EPA Office of Pesticide Programs, September 1, 1998).

CHAPTER 13
TOMATOES[1/]

Tomatoes, with average production of 251 million cwt over the past five years (1993-1997), were grown on 466 million planted acres. From the perspective of dollar value of farm sales, tomatoes are the fifth largest fruit and/or vegetable studied.

The analyses in this study are based on estimates from two states–Florida (fresh) and California (fresh and processed). These two states account for 74 percent of the US fresh tomato production and 63 percent of the acreage. California accounts for 93 percent of the US processed tomato production and 91 percent of the acreage.

The quantity and quality of data available for Florida tomatoes were found to be considerably better than for California. For example, the most recent budget available for California was for the 1994-95 crop year. Moreover, while estimates were available on US fresh and processed yield impacts, they were not available for individual states or for the removal of combinations of pesticides.[2/] Discussion by the lead scientists from the University of Florida with scientists located in California, combined with the results of the NAPIAP study, served as the basis for the California estimates contained in this report. This discussion in terms of pesticide use is weighted toward Florida but is also believed to be representative of California.

[1/]The estimates of the impacts of pesticide use reduction in tomatoes were made by Phyllis Gilreath, horticulturist; Scott Smith, agricultural economist; and Timothy G. Taylor, agricultural economist; all from the University of Florida. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Tomato Production*, AFPC Research Report 99-13 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]M. Davis, G. Hamitor, W. Lanini, T. Spreen and C. Osteen, *Importance of Pesticides and Pest Management Practices in US Tomato Production*, USA/NAPIAP Document No. 1-CA-98, 1998.

Organophosphates and carbamates are among a set of chemicals that are essential to growing tomatoes. Substitute chemicals exist for most pests but are often less effective, particularly when high insect or disease pressures develop. Moreover, with reductions in the number of chemicals available to control particular pests, concern increases that resistance may become more pervasive.

The use of biotechnology as a practical tool for insect and disease management in tomatoes is being researched and will likely be a valuable asset in the future. Based on current projections, the inclusion of biotechnology tools such as *Bt* tomatoes will probably not be ready for commercialization for at least five years.

Baseline

Budgets developed by the University of Florida were used to establish baseline costs. In the case of California, the most recent tomato budgets identified were for crop year 1994-95. These were updated to 1998.

Fresh tomato yields in Florida were set at 342 cwt per acre and in California at 276 cwt for a US average of 306 cwt per acre (Table 1). The California baseline processing tomato yield was 663 cwt per acre (Table 2).

Total variable cash expenses for fresh tomatoes were $32.90 per cwt in Florida, of which $3.64 was chemical costs ($1,242 per acre). In California, the fresh tomato variable costs totaled $28.32 per cwt, of which $1.50 was chemical costs. The US average variable cost for fresh tomatoes was $30.64 per cwt of which $2.58 was chemical costs (Table 1). Variable costs for California processing tomatoes totaled $2.91 per cwt with a chemical cost of $0.11 per cwt. The variable cost for all tomatoes was $6.04 per cwt, of which $0.39 was chemical cost (Table 2).

Table 1. Yields and Costs for Producing Fresh Tomatoes With and Without Organophosphates and Carbamates

	United States[a]			Florida Fresh			California Fresh		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwt/acre)[b]	305.73	251.29	-17.81%	341.56	271.41	-20.54%	276.00	234.60	-15.00%
Variable Cash expenses ($/acre):									
Chemicals	$789.52	$785.79	-0.47%	$1,242.18	$1,233.95	-0.66%	$413.92	$413.92	0.00%
Other variable cash expenses	$8,578.11	$8,079.36	-5.81%	$9,993.87	$9,444.85	-5.49%	$7,403.38	$6,946.35	-6.17%
Total, variable cash expenses	$9,367.63	$8,865.15	-5.36%	$11,236.05	$10,678.80	-4.96%	$7,817.30	$7,360.27	-5.85%
Variable Cash expenses ($/cwt):									
Chemicals	$2.58	$3.13	21.09%	$3.64	$4.55	25.01%	$1.50	$1.76	17.65%
Other variable cash expenses	$28.06	$32.15	14.59%	$29.26	$34.80	18.94%	$26.82	$29.61	10.38%
Total, variable cash expenses	$30.64	$35.28	15.14%	$32.90	$39.35	19.61%	$28.32	$31.37	10.77%

[a] Fresh tomato regions included represent 63% of the fresh tomato acreage and 74% of the fresh production during the 1993-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

Table 2. Yields and Costs for Producing Fresh and Processed Tomatoes Combined With and Without Organophosphates and Carbamates

	United States[a]			Florida Fresh			California Fresh			California Processed		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (cwt/acre)[b]	585.71	496.00	-15.32%	341.56	271.41	-20.54%	276.00	234.60	-15.00%	663.00	563.55	-15.00%
Variable Cash expenses ($/acre):												
Chemicals	$225.92	$225.11	-0.36%	$1,242.18	$1,233.95	-0.66%	$413.92	$413.92	0.00%	$70.30	$70.30	0.00%
Other variable cash expenses	$3,313.01	$3,167.02	-4.41%	$9,993.87	$9,444.85	-5.49%	$7,403.38	$6,946.35	-6.17%	$1,859.43	$1,810.82	-2.61%
Total, variable cash expenses	$3,538.94	$3,392.13	-4.15%	$11,236.05	$10,678.80	-4.96%	$7,817.30	$7,360.27	-5.85%	$1,929.73	$1,881.12	-2.52%
Variable Cash expenses ($/cwt):												
Chemicals	$0.3857	$0.4539	17.67%	$3.6368	$4.5465	25.01%	$1.4997	$1.7644	17.65%	$0.1060	$0.1247	17.65%
Other variable cash expenses	$5.6564	$6.3851	12.88%	$29.2593	$34.7995	18.94%	$26.8238	$29.6093	10.38%	$2.8046	$3.2132	14.57%
Total, variable cash expenses	$6.0421	$6.8390	13.19%	$32.8960	$39.3460	19.61%	$28.3236	$31.3737	10.77%	$2.9106	$3.3380	14.68%

[a] Tomato regions included represent 83% of the tomato acreage and 91% of the production during the 1993-1997 period.

[b] US yields and costs are derived by weighting the analyzed regions' planted acreage by their respective yield.

The major pests in Florida tomatoes include mole crickets, armyworms, whiteflies, leaf miners, and nematodes (Table 3). Organophosphates and carbamates used to control these pests include diazinon (Spectracide), methomyl (Lannate), methamidophos (Monitor), chlorpyrifos (Lorsban) and oxamyl (Vydate). These same pesticides are used in varying combinations in California.

No Organophosphates and Carbamates

The impacts of eliminating organophosphates and carbamates are much more on yield than on chemical costs. The main substitute chemicals include dichloropropene (Telone) (for diazinon), spinosad (Spin Tor) (for methomyl), imidacloprid (Admire), abamectin (Agri-Mek), cyromazine (Trigard), bacillus thuringiensis (*Bt*) and insect growth regulators such as pyriproxyfen (Knack) and buprofezin (Applaud) (for methamidophos) (Table 3). There is no substitute for oxamyl (Vydate) for post-plant nematode control in tomatoes. Preplant alternatives include methyl bromide, scheduled to be phased-out in 2001, and Telone C-17/C-35, both currently labeled. Total expenditures on chemicals change by less than 1 percent per acre both regionally and for the United States. Yields per acre, on the other hand, decline by 21 percent for Florida fresh tomatoes and by 15 percent for both California fresh and processed tomatoes. The US average yield declined by 15.3 percent.

With no organophosphates and carbamates, total variable costs per cwt for fresh tomatoes increase by 20 percent in Florida and by 11 percent in California. Chemical costs per cwt increase by 25 percent in Florida and by 18 percent in California, for a US average increase of 21 percent (Table 1). For processing tomatoes, variable costs per cwt increase by 15 percent, while

Table 3. Tomato Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Treatment
Mole Crickets	Diazinon (Spectracide)	Dichloropropene (Telone C-17, Telone C-35)[a]
Leaf miners	Methamidophos (Monitor)	Abamectin (Agri-Mek) Cyromazine (Trigard)
Armyworms and other worms	Chlorpyrifos (Lorsban) Methomyl (Lannate)	Pyrethroids Bacillus thuringiensis (*Bt*) Spinosad (SpinTor)
Nematodes	Oxamyl (Vydate)[b]	Dichloropropene (Telone C-17, Telone C-35)-35
Whiteflies	Chlorpyrifos (Lorsban) Methamidophos (Monitor)	Imidacloprid (Admire, Provado) Endosulfan (Thiodan) Pyriproxyfen (Knack) Buprofezin (Applaud)

[a] Dichloropropene (Telone) controls mole crickets and is applied during bedding operations. The problem is the mole crickets move back in from field perimeters after tomatoes are transplanted and this is when diazinon (Spectracide) is used. There are no alternatives for treating mole crickets at this time of the season.

[b] Oxamyl (Vydate) is sometimes used during the season when nematode problems arise. Dichloropropene (Telone) is a pre-season treatment. Thus, the time of use is somewhat different.

Source: Phyllis Gilreath, Scott Smith, Tim Taylor, *Impacts of the Elimination of Organophosphates and Carbamates from Tomato Production*, AFPC Research Report 99-13 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

chemical costs rise by 18 percent (Table 2). On the average, US variable costs per cwt for fresh and processed tomatoes rise by 13 percent, while chemical costs increase by 18 percent.

Scientists Consulted

R. Michael Davis, plant pathologist, University of California-Davis

References

Aertz, M. and N. Nesheim, "University of Florida Integrated Pest Management and Pesticide Use Survey for 1997," unpublished data.

Davis, M., G. Hamilton, W. Lanini, T. Spreen, and C. Osteen, *The Importance of Pesticides and Pest Management Practices in US Tomato Production*, USA/NAPIAP Document Number 1-CA-98 (1998).

Fresh Market Mature Green Tomatoes, Bush Grown Production Costs 1994-95, Extension Circular TM-IM-95-2, University of California Cooperative Extension Service (1995).

Processing Tomato Production Cost, 1994-95, Extension Circular TM-IM-95-1, University of California Cooperative Extension Service (1995).

Smith, S. A. and T. G. Taylor, *Production Costs for Selected Vegetables in Florida, 1996-97*, Extension Circular 1202 (Gainesville, Florida: Food and Resource Economics Department, University of Florida, December 1997).

CHAPTER 14
WHEAT[1/]

Wheat production, averaging 2.3 billion bushels over the past five years (1993-1997), was grown on an average of 71.7 million planted acres. As such, wheat is the third largest field crop in terms of sales in 1997.

The analysis in this study is based on estimates from 19 major wheat-producing states in the five USDA wheat growing regions.[2/] These states account for 88 percent of US production and 79 percent of planted acreage. In each region, different types of wheat[3/] are produced under different rainfall, temperature, humidity, and soil conditions. As a result, one might anticipate that the elimination of pesticides would have differential regional effects.

While the yield and cost impacts of eliminating organophosphates and carbamates are small, except in the Southeast, it is important that these chemicals be available in the event of widespread outbreaks of pests. A limited number of substitutes for organophosphate and carbamate insecticides are available, and for some pests, none are available.

Baseline

USDA regional 1996 budgets, updated to 1998, were utilized in the study. These budgets were used with average 1993-97 yields that ranged from 30 bushels per acre in the Northern

---

[1/]The estimates of the impacts of pesticide use reduction in wheat were coordinated by Michael Peel, agronomist, and Dwight Aakre, agricultural economist, both on the faculty of North Dakota State University. These estimates are reported with greater detail in the publication *Impacts of the Elimination of Organophosphates and Carbamates from Wheat Production*, AFPC Research Report 99-14 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

[2/]The states and regions included are Pacific (WA, OR, ID, CA); Northern Plains (ND, SD, MN, MT); Central/South Plains (NB, MO, CO, KS, OK, TX); North Central (OH, IL, MI); and Southeast (GA, NC).

[3/]The major classes of wheat include hard red spring and winter, soft red spring and winter, durum, and soft white wheat.

Plains to 64 bushels in the Pacific region and 36 bushels for the United States (Table 1). Variable cash expenses ranged from $1.75 per bushel in the North Central region to $2.92 on the Northern Plains, for a US average of $2.66. Of the total variable costs, chemical costs ranged from $0.02 per bushel in the North Central region to $0.28 on the Northern Plains, with a US average of $0.18 per bushel. Therefore, the importance of chemicals varies greatly regionally in both absolute and relative terms.

No Organophosphates and Carbamates

Organophosphate and carbamate pesticides used in wheat production are listed in Table 2. Substitute insecticides were often either unavailable or cost prohibitive. Organophosphate and carbamate fungicides are those that contain benomyl (Benlate), maneb (Maneb), and mancozeb (Dithane). In this case, replacement fungicides would be propiconazole (Tilt) and triadimefon (Bayleton), albeit at a higher cost. Alternative seed treatments to organophosphates or carbamates include carboxin (Vitavax-M), captan (Captan), and difenoconazole (Dividend).

Eliminating organophosphates and carbamates utilized to produce wheat is estimated to reduce the US average yield by 1 percent (Table 1). The reduction ranged from 0.11 percent in the North Central region to 5 percent in the Southeast. Only in the Southeast was the yield reduction greater than 2 percent.

The elimination of organophosphates and carbamates reduced chemical costs on a per bushel basis in all regions in a range of less than 1 percent in the Northern Plains to 21 percent in the Central and Southern Plains. The US average reduction in chemical costs per bushel was 5 percent.

Table 1. Yields and Cost of Producing Wheat With and Without Organophosphates and Carbamates

	United States[a]			North Central			Southeast			Northern Plains			Central and Southern Plains			Pacific		
	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change	Baseline	No O&C	% Change
Yield (bu/planted acre)[b]	36.25	35.77	-1.34%	61.90	61.83	-0.11%	45.90	43.79	-4.60%	30.20	29.83	-1.23%	32.06	31.51	-1.72%	63.60	63.05	-0.86%
Variable Cash expenses ($/acre):																		
Chemicals	$6.42	$6.00	-6.45%	$0.96	$0.93	-3.12%	$7.61	$6.59	-13.40%	$8.48	$8.34	-1.65%	$3.14	$2.45	-21.97%	$16.41	$16.08	-2.01%
Other variable cash expenses	$90.08	$89.99	-0.12%	$107.33	$107.30	-0.03%	$111.74	$110.94	-0.72%	$79.70	$79.53	-0.21%	$81.86	$81.86	0.00%	$156.73	$156.47	-0.17%
Total, variable cash expenses[c]	$96.52	$95.99	-0.55%	$108.29	$108.23	-0.06%	$119.35	$117.53	-1.52%	$88.18	$87.87	-0.35%	$85.00	$84.31	-0.81%	$173.14	$172.55	-0.34%
Variable Cash expenses ($/bu):																		
Chemicals	$0.18	$0.17	-5.18%	$0.02	$0.02	-3.02%	$0.17	$0.15	-9.23%	$0.28	$0.28	-0.43%	$0.10	$0.08	-20.61%	$0.26	$0.26	-1.16%
Other variable cash expenses	$2.49	$2.52	1.23%	$1.73	$1.74	0.09%	$2.43	$2.53	4.07%	$2.64	$2.67	1.02%	$2.55	$2.60	1.75%	$2.46	$2.48	0.70%
Total, variable cash expenses[c]	$2.66	$2.68	0.81%	$1.75	$1.75	0.06%	$2.60	$2.68	3.22%	$2.92	$2.95	0.88%	$2.65	$2.68	0.92%	$2.72	$2.74	0.53%

[a] Wheat states included represent 80% of the acreage planted to wheat and 88% of the production in the 1993-1997 period.

[b] Average yields calculated for the 1993-1997 crop years with the US average weighted by the regions included.

[c] Variable cash expenses including capital replacement from ERS/USDA budgets for 1996 adjusted to 1998 using USDA Baseline.

Table 2. Wheat Pests, Organophosphates and Carbamates Used to Control Them, and Alternative Treatments Currently Available

Pest	Current Organophosphate/ Carbamate Treatment	Alternative Pesticide
Insect Pests		
Aphids	Dimethoate (Cygon) Disulfoton (Di-Syston) Ethyl Parathion (Parathion) Chlorpyrifos (Lorsban) Methyl Parathion (Penncap-M, Methyl Parathion) Methomyl (Lannate)	Cyhalothrin (Warrior)[a]
Wireworm	Fonofos (Dyfonate)	Lindane
Thrips	Disulfoton (Di-Syston) Dimethoate (Cygon) Carbofuran (Furadan) Methomyl (Lannate) Chlorpyrifos (Lorsban) Malathion (Fyfanon) Methyl Parathion (Penncap-M, Methyl Parathion) Phorate (Thimet)	Cyhalothrin (Warrior)[a]
Hessian fly	Phorate (Thimet)	None
Orange wheat blossom midge	Chlorpyrifos (Lorsban)	None
Grasshoppers	Dimethoate (Cygon) Carbaryl (Sevin) Ethyl Parathion (Parathion) Carbofuran (Furadan) Chlorpyrifos (Lorsban) Malathion (Fyfanon) Methyl Parathion (Penncap-M, Methyl Parathion)	Cyhalothrin (Warrior)[a]
Cutworm	Carbaryl (Sevin) Methomyl (Lannate) Chlorpyrifos (Lorsban)	Cyhalothrin (Warrior)[a]
Sawfly	Dimethoate (Cygon) Methomyl (Lannate) Chlorpyrifos (Lorsban) Carbaryl (Sevin)	None
Armyworm	Carbaryl (Sevin) Ethyl Parathion (Parathion) Methomyl (Lannate) Chlorpyrifos (Lorsban) Malathion (Fyfanon) Methyl Parathion (Penncap-M, Methyl Parathion)	Cyhalothrin (Warrior)[a]
Mites	Dimethoate (Cygon) Methyl Parathion (Penncap-M, Methyl Parathion)	None

Table 2 (Continued).

Cereal leaf beetle	Carbaryl (Sevin) Malathion (Fyfanon) Methomyl (Lannate) Carbofuran (Furadan)	Cyhalothrin (Warrior)[a]
Fungi		
Powdery Mildew	Benomyl (Benlate)	Sulfur (Thiolux) Propiconazole (Tilt)
Leaf spot, Leaf rust, Stem rust	Mancozeb (Dithane)	Propiconazole (Tilt) Triadimefon (Bayleton)
Fusarium head blight	Benomyl (Benlate)	Propiconazole (Tilt)
Seed Treatments		
Damping-off, Covered smut, Seed rots, Seedling blights, Bunts	Maneb (Maneb) Mancozeb (Dithane)	Carboxin (Vitavax-M) Captan (Captan) Difenoconazole (Dividend)
Storage	Malathion (Fyfanon) Chlorpyrifos-methyl (Reldan)	Bacillus thuringiensis (*Bt)* (Dipel) (caterpillar pests, only) Aluminum phosphide (Fumitoxin, Phostoxin) Methyl bromide[b] Diatomaceous earth[a] (Insecto) No insecticide protectants

[a] Product(s) typically not used due to prohibitive cost and/or poor control.

[b] Scheduled for elimination in 2001.

Source: Michael Peel, Dwight Aakre, *Impacts of the Elimination of Organophosphates and Carbamates from Wheat Production*, AFPC Research Report 99-14 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999).

While chemical costs fell, reduced yields resulted in higher unit total variable costs by an average of 0.8 percent. Regionally, total variable costs on a bushel basis increased in a range of from 0.06 percent in the North Central region to 3 percent in the Southeast.

Scientists Consulted

Stephen B. Bambara, entomologist, North Carolina State University
Emory Boring, plant pathologist, Texas A&M University
Bob Bowden, plant pathologist, Kansas State University
H. Leroy Brooks, insecticide specialist, Kansas State University
Steve Brown, entomologist, University of Georgia
John Campbell, entomologist, University of Nebraska
Christina DiFonzo, entomologist, Michigan State University
Marty Draper, plant pathologist, South Dakota State University
Bruce Esely, entomologist, Ohio State University
Glenn C. Fisher, entomologist, Oregon State University
Bob Forrester, small grains specialist, University of Idaho
Phil Glogoza, entomologist, North Dakota State University
Paul Guillebeau, entomologist, University of Georgia
Pat Hart, plant pathologist, Michigan State University
Randy Hudson, entomologist, University of Georgia
Gregory D. Johnson, entomologist, Montana State University
Jerry Johnson, plant breeder, small grains, University of Georgia
Walker Kerby, plant pathologist, University of Illinois
Pat Lipps, plant pathologist, Ohio State University
Ian MacRae, entomologist, University of Minnesota
Don Mathre, plant pathologist, Montana State University
Marcia McMullen, plant pathologist, North Dakota State University
Tim Murray, plant pathologist, Washington State University
Carl D. Patrick, entomologist, Texas A&M University

Frank B. Peairs, entomologist, Colorado State University

David Pike, entomologist, University of Illinois

Keith S. Pike, entomologist, Washington State University

Tom R. Royer, entomologist, Oklahoma State University

Brad Ruden, entomologist, South Dakota State University

Larry E. Sandvol, entomologist, University of Idaho

George Smith, entomologist, University of Missouri

Kevin L. Steffey, entomologist, University of Illinois

References

Pesticide Use and Pest Management Practices for Major Crops in North Dakota, 1996 (Fargo, North Dakota: NDSU Extension Service).

University of California State-Wide Integrated Pest Management web site, http://www.ipm.ucdavis.edu.

CHAPTER 15
SUMMARY:
IMPACTS OF ELIMINATING ORGANOPHOSPHATES AND CARBAMATES UNDER FQPA[1/]

Organophosphates and carbamates are two categories of chemicals utilized in the production of crops primarily to control insects, although some are also used to counteract plant disease, weeds, seed treatment, defoliants, and growth regulators. Eliminating organophosphates and carbamates and even eliminating specific critical uses could be counterproductive as a matter of public policy. The results would include:

- Reduced yields and product quality with regionally different effects
- More variable yields and prices
- Increased production costs and an increased transition to fewer but larger farms that are better able to cope with greater risk
- Increased pest resistance with less ability to control future outbreaks
- Increased food prices, the burden of which would have a greater effect on low income families
- Reduced exports and the potential loss of the United States' competitive advantage in certain crops
- Increased imports of fruits and vegetables over which there is questionable US control of chemical use

---

[1/]The estimates of the aggregate impacts of pesticide use reduction were made by C. Robert Taylor, agricultural economist, Auburn University. C. Robert Taylor and H. Arlen Smith, *Aggregate Economic Evaluation of Eliminating Organophosphate and Carbamate Pesticides*, AFPC Research Report 99-15 (College Station, Texas: Agricultural and Food Policy Center, Texas A&M University, April 1999) which is available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

- Reduced consumption of fruits and vegetables at a time when the US government is trying to encourage greater consumption to improve nutrition, diet, and health.

These tradeoffs suggest that the concept of the risk cup utilized by EPA to evaluate whether a chemical should be listed for use on specific crops is too small and too narrowly defined. Specifically, the risk cup needs to consider the impact on overall nutrition as well as on imports of products over which there is no effective US control of chemical use.

These conclusions are based on input from 22 land grant university scientists who advise farmers on production practices for the individual commodities studied. The 14 commodities analyzed include apples, carrots, corn, cotton, grapes, oranges, peaches, peanuts, potatoes, rice, grain sorghum, soybeans, tomatoes, and wheat.[2/] These scientists were asked to utilize available research results and their experience to assess the yield and production cost impacts of eliminating organophosphates and carbamates from major US production areas. In doing so, the scientists utilized a baseline budget for current production practices, including prevailing chemicals used in commercial production of the commodities analyzed. They then identified and evaluated the availability of alternatives to organophosphates and carbamates for pest control and the impacts of their use on yields and costs.

Organophosphates and Carbamates Used

Table 1 indicates the organophosphates and carbamates found to be most frequently used in the commercial production of the 14 commodities studied.

[2/]Individual commodity reports are available on the AFPC home page, http://afpc1.tamu.edu/pesticides.htm.

Table 1. Pests Controlled by Most Frequently Used Organophosphates and Carbamates and Commodities Affected[1/]

Organophosphates and Carbamates	Pests Controlled	Commodities Affected
Chlorpyrifos (Lorsban)	Mites Scale Leaf rollers Rootworm Cutworm Wireworm Billbugs Grubs Aphids Cotton fleahopper Pink bollworm Whiteflies Mealybug Mites Miscellaneous fruit feeders Ants Stink bugs Oriental fruit moth Peach twig borer Cornstalk borer Greenbugs Chinch bugs Spider mites Armyworm Thrips Sawfly	Apples Corn Cotton Grapes Oranges Peaches Peanuts Grain Sorghum Soybeans Tomatoes Wheat
Carbaryl (Sevin)	Caterpillar Growth regulator Rootworm Thrips Plant bugs Stink bug Pink bollworm Citrus root weevil Mites Orange Dog caterpillar Scale Twig borer foliar feeders Spider mite Grasshopper Cutworm Sawfly Armyworm Cereal leaf beetle Grape leaffolder Western grapeleaf skeletonizer Hoplia	Apples Carrots Corn Cotton Grapes Oranges Peaches Rice Soybeans Wheat

Table 1 (Continued).		
Organophosphates and Carbamates	**Pests Controlled**	**Commodities Affected**
Methomyl (Lannate)	Leaf hoppers Rootworm Corn borer Aphids Cotton fleahopper Bollworm Tobacco budworm Thrips Leaf rollers Cutworm Grape leaffolder Western Grapeleaf Skeletonizer Foliar Feeders Midge or Headworms Spider Mites Armyworm Sawfly Cereal Leaf Beetle	Carrots Corn Cotton Grapes Peaches Peanuts Grain Sorghum Soybeans Tomatoes Wheat
Carbofuran (Furadan)	Rootworm Cutworm Wireworm Billbugs Grubs Corn borer Aphids Nematodes Grape phylloxera Leaf hoppers CPB Stink bugs Water weevil Green bugs Chinch bugs Spider mites Thrips Grasshoppers	Corn Cotton Grapes Potatoes Rice Grain Sorghum Soybeans Wheat

Table 1 (Continued).		
Organophosphates and Carbamates	**Pests Controlled**	**Commodities Affected**
Methyl Parathion (Penncap-M, Methyl Parathion)	Beetles Stink bugs Cutworm Wireworm Billbugs Grubs Bollweevil Pink bollworm Mealybug Leaf miner Armyworm Tadpole shrimp Spider mites Aphids Thrips Mites Grasshoppers	Carrots Corn Cotton Grapes Rice Soybeans Wheat
Malathion (Fyfanon)	Flea beetles Rootworm False chinch bug Mediterarnean fruit fly Armyworm Greenbugs Thrips Grasshoppers Cereal leaf beetle Wheat storage	Carrots Corn Grapes Oranges Rice Grain Sorghum Wheat
Diazinon (Spectracide)	Soil insects Cutworm Wireworm Billbugs Grubs Corn borer Leaf rollers Grape leaffolder False chinch bug Ants Orange dog caterpillar Stink bug Scale Oriental fruit moth Mole crickets	Carrots Corn Grapes Oranges Peaches Tomatoes

Table 1 (Continued).		
Organophosphates and Carbamates	**Pests Controlled**	**Commodities Affected**
Dimethoate (Cygon)	Rootworm Thrips Plant bugs Aphids Leafhopper Spider mite Grasshopper Sawfly Mites	Corn Cotton Grapes Oranges Potatoes Grain Sorghum Soybeans Wheat
Phorate (Thimet)	Rootworm Thrips Leaf hoppers Scab Wireworm Grubs CPB Greenbugs Hessian fly	Corn Cotton Peanuts Potatoes Grain Sorghum Wheat
Azinphosmethyl (Guthion)	Codling moth Boll weevil Thrips Beetles Mealy bug Mites Miscellaneous fruit feeders Scale Oriental fruit moth Peach twig borer Citrus root weevils	Apples Cotton Grapes Oranges Peaches
Aldicarb (Temik)	Thrips Nematodes Mites Aphids CPB Midge or Headworms	Cotton Oranges Peanuts Potatoes Grain Sorghum
Disulfoton (Di-Syston)	Rootworm Thrips Greenbugs Aphids	Corn Cotton Peanuts Grain Sorghum Wheat

Yield Impacts

Table 2 summarizes the yield and cost impacts estimated by the commodity specialists. It also indicates the proportion of US production from which these estimates were derived. In all cases except apples, the estimates accounted for a majority of US production. Washington apple production accounted for 49 percent of total apple production over the 1993-1997 period. Yield reductions resulting from the elimination of organophosphates and carbamates ranged from 1 percent for wheat to 38 percent for apples.

These national estimates were derived from regional estimates of yield reduction. The regional yield reduction range was frequently wider than the averages for the commodities in Table 2. The biggest regional reductions in yields and costs occurred in the most vulnerable areas which are identified by commodity in Table 3.

In addition to lower yields, if organophosphates and carbamates were eliminated, production would be more unstable and vulnerable. When production instability interacts with inelastic demand for farm products, the result is substantially increased price variability. Moderate-size family farmers are relatively more vulnerable to increased price variability than part-time producers who use off-farm income to reduce risk or larger operations that are capable of internalizing risk reduction management.

For some pests, farmers already have shifted from organophosphates and carbamates to alternative methods of control. However, for other pests, there are no alternatives–such as diazinon used to control soil insects in the production of carrots. Even where there are one or more alternatives, scientists expressed concern about the increased vulnerability to the development of resistance and the need to have organophosphates and carbamates as a second or third line of defense to prevent crop failures and production shortfalls.

Table 2. US Yield and Cost Effects of Eliminating Organophosphates and Carbamates

Crop	Acre Coverage[a/]	Production Coverage[a/]	Yield Reduction	Total Variable Cost Increase Per Unit
	----------------------------Percent-----------------------------			
Apples	33	49	38	66
Carrots	78	78	7	4
Corn	94	94	4	5
Cotton	89	83	14	22
Grapes	45	50	9	3
Oranges	98	99	3	2
Peaches	49	75	2	3
Peanuts	92	92	9	7
Potatoes	77	80	3	5
Rice	100	100	8	8
Grain Sorghum	88	91	12	10
Soybeans	95	96	5	9
Tomatoes	83	91	15	13
Wheat	79	88	1	1

[a/] Percent of total planted acreage and production represented by the states analyzed by the scientists. For all crops except carrots, the percentages were established over the 1993-1997 period, but due to data problems, carrot relationships were established over the 1995-1997 period.

Table 3. Commodities and Regions Found To Be Most Vulnerable to Reduced Yields and Increased Costs If Organophosphates and Carbamates Were Eliminated

Commodity	Region/states most adversely affected[a/]	Yield reduction	Variable cost increase
		----------------------Percent----------------------	
Apples	Washington[b/]	38	66
Carrots	Texas/Washington	25/20	3/20
Corn	Southeast	5	9
Cotton	Southwest/Southern Plains	21/19	27/28
Grapes	California (Table)	32	32
Oranges	California	15	14
Peaches	Georgia	17	19
Peanuts	Virginia/North Carolina	17	15
Potatoes	Central States	5	13
Rice	Gulf Coast	15	17
Grain Sorghum	Southern Plains	14	13
Soybeans	Delta	8	15
Tomatoes	Florida Fresh	21	20
Wheat	Southeast	5	3

[a/] This table only highlights the region most adversely impacted by the loss of organophosphates and carbamates. This does not imply that other regions of the US are not impacted. All regional differences are discussed in each of the specific commodity chapters.

[b/] Only region studied.

Production Cost Impacts

Table 2 indicates the percentage increases in total variable costs per unit of production for each of the 14 commodities. US average variable cost (based on regional impacts weighted by the region's historical planted acreage to the crop) increases range from 1 percent for wheat to 66 percent for apples. While chemical costs per unit actually declined due to the absence of chemical substitutes for grain sorghum and oranges, total variable costs per unit for all commodities increased–primarily due to lower yields. Regional reductions in yields and increases in variable costs for those areas most adversely affected are indicated in Table 3. For several of the commodities, adverse impacts on the competitiveness of farmers operating in the region could be expected to result in a restructuring of crops produced and of farming operations in the region.

Increased Food Prices

Table 4 indicates retail price and consumption changes for the major commodities studied and the products produced from them. Retail price increases greater than 1 percent are indicated for apples, tomatoes, fruit juice, sweeteners, other fats and oils, eggs, and grapes. Pork, chicken, turkey, and egg price increases result primarily from the 3 percent reduction in the production of corn and soybeans, which leads, respectively, to a 10 percent and a 15 percent increase in their prices (Table 5). Sweetener prices likewise increase due to higher corn prices–the second largest sweetener being high fructose corn sweetener (HFCS).

Except for apples, farm price increases are less spectacular for fruits and vegetables (Table 6). Retail price increases range from 1 percent to 6 percent for fresh peaches, fresh tomatoes, fresh apples, fresh grapes, and juices. Fresh apple prices are projected to increase by 24 percent.

Table 4. Consumption Changes Induced by Retail Price Changes

Consumption Item	Retail Price Change (%)	Consumption Change (%)
Apples	6.24	-1.95
Tomatoes	5.02	-4.25
Fruit juice	4.17	-2.58
Sweeteners	2.00	0.36
Other fats & oils	2.00	-1.04
Eggs	1.18	-0.33
Grapes	1.04	0.37
Canned tomatoes	0.78	-0.11
Canned peas	0.75	-0.68
Turkey	0.62	0.10
Pork	0.62	-0.50
Chicken	0.50	0.42
Carrots	0.47	0.54
Canned fruit cocktail	0.45	-0.11
Rice	0.44	0.06
Celery	0.40	-1.21
Onions	0.40	0.72
Lettuce	0.40	0.05
Fresh & frozen fish	0.35	-0.14
Wheat flour	0.33	-0.10
Potatoes	0.16	-0.87
Peanuts & tree nuts	0.10	0.63
Oranges	0.08	-0.34
Grapefruits	0.07	-1.39
Butter	0.03	-1.69
Evaporated & dry milk	0.03	0.83
Fluid milk	0.03	0.12
Ice cream & other frozen dairy	0.03	0.62
Margarine	0.02	1.38
Non-food	0.00	-0.21
Coffee & tea	0.00	-0.37
Sugar	0.00	-0.10
Canned & cured fish	0.00	0.62
Cheese	0.00	-1.23
Bananas	0.00	1.16
Income	-0.11	NA
Beef & veal	-0.20	0.11

Table 5. Farm Level Effects for Field Crops Resulting from Banning Organophosphate and Carbamate Pesticides

Commodity	Change in Per-Unit Production Costs (%)	Change in Farm Price (%)	Change in Net Exports (%)	Change in Domestic Production (%)
Corn	5	10.4	-4.7	-3.4
Grain Sorghum	10	18.8	-2.5	-8.7
Barley	1	1.5	-2.7	-1.1
Oats	1	0.6	0.1	-1.6
Wheat	1	2.0	-2.7	-0.8
Soybeans	9	14.7	-11.1	-3.3
Cotton Lint	22	23.0	-0.6	-9.1
All Hay	0	1.4	0.0	0.4
Rice	8	2.6	-0.3	-0.6
Peanuts	7	0.1	-14.4	-4.0

Table 6. Fruit & Vegetable Impacts of Eliminating Organophosphates and Carbamates on Prices, Trade, Production, and Consumption

Commodity	Item Impacted (percent)					
	Farm Price	Retail Price	Exports	Imports	Production	Consumption
Fresh Peaches	1.9	1.5	-2.3	3.3	-1.8	-1.3
Canned Peaches	2.2	0.5	-1.2	2.3	-0.8	-0.6
Fresh Tomatoes	7.0	5.0	-2.9	3.3	-3.2	-2.9
Processed Tomatoes	3.4	0.8	-10.8	3.8	-1.6	-0.6
Carrots	0.4	0.5	-0.3	0.6	-1.0	-0.9
Fresh Apples	24.3	6.2	-34.3	16.8	-12.8	-4.3
Potatoes	4.6	0.9	-2.3	3.9	-0.5	-0.3
Fresh Oranges	0.3	0.1	-0.1	0.3	-0.2	-0.1
Fresh Grapes	2.6	1.0	-0.1	1.6	-3.7	-2.4
Juices	2.1	4.2	-1.7	4.3	-3.8	-1.9
Canned Fruit	2.0	0.5	-8.0	1.1	-1.3	-0.7
Raisins	1.7	0.2	-1.3	1.9	-1.0	-0.6
Fresh Fruit	1.2	0.9	-0.2	0.1	-0.2	-0.2
Fresh Vegetables	0.8	0.4	-0.6	0.4	-0.7	-0.4
Processed Vegetables	3.3	0.8	-1.5	0.7	-1.2	-1.0

Increased retail food prices of a few percentage points, resulting in a $5.90 to $8.60 increase in annual food expenditures, may not seem like much to those whose household income is in the mid to upper levels (Table 7). However, to the household whose income is already under the poverty level (currently $16,500 annually for a family of four), any increase in food spending takes away from expenditures on other necessities and will likely result in these families eating a less nutritionally adequate diet.

Reduced Exports

Higher prices mean reduced exports of commodities affected by the elimination of organophosphates and carbamates. For fruits and vegetables, these reductions fall in the range of less than 1 percent for fresh oranges, fresh grapes, and carrots to 34 percent for fresh apples (Table 6). In the case of processed products, some of these reductions may be underestimated because of lower product quality. Scientists frequently expressed concern that without organophosphates and carbamates, the resulting processed products might not meet importing country standards for insect parts or fragments; there could also be a problem with meeting FDA standards in the United States.

Net reductions in exports for corn and soybeans were 5 percent and 11 percent, respectively. While US producers are a dominant supplier of corn and soybeans for exports, price increases in the range of 10-15 percent have an adverse impact, which likely could be even greater in the longer term as competitors increase production (Table 5). The increase in per unit cost of grain sorghum relative to other feed grains raises questions about the long-term competitiveness of grain sorghum in the feed grain complex.

Table 7. Change in Food Spending Resulting From the Elimination of Organophosphates and Carbamates

Item	All	$5,000-$10,000	$15,000-$20,000	$30,000-$40,000
		Dollars/Household/Year		
Vegetables	0.70	0.40	0.60	0.70
Fruits	3.80	2.70	3.50	3.70
Milk	0.50	0.30	0.40	0.50
Meat Consumption	3.30	2.30	3.60	3.40
Sugar & Sweeteners	0.30	0.20	0.20	0.30
Fats & Oils	0.70	0.50	0.70	0.70
Nonalcoholic Beverages	-0.90	-0.60	-0.90	-0.90
Miscellaneous	-0.90	-0.50	-0.80	-0.90
Food Away From Home	-0.20	-0.00	-0.10	-0.20
Total Food	8.40	5.90	8.60	8.50
Change in Expenditure (%)	0.18	0.25	0.22	0.18

Increased Imports

Reductions in production of fruits and vegetables are offset substantially by increases in imports (Table 6). For this higher level of imports, there is less effective control over the use of organophosphates and carbamates, as well as–for that matter–more dangerous chemicals. Increased imports, therefore, reduce the effectiveness of the ban in reducing consumer exposure to organophosphates and carbamates.

Reduced Fruit and Vegetable Consumption

For many years, a major nutrition policy goal has been to increase the consumption of fruits and vegetables as a means of improving nutrition, diet, and health. Despite increased imports, higher fruit and vegetable prices mean reduced consumption ranging from 0.1 percent for fresh oranges to as much as 4.3 percent for fresh apples (Table 6).

Reduced US Economic Output, Income and Employment

Small percentage changes in prices and output have large impacts when spread throughout the US economy (Table 8). Total economic output would decrease by $17 billion. Total value added would decline by $10 billion. Income (employee, proprietor, and other property) would decline by $9 billion. Employment would be reduced by 209,000 jobs. These impacts could hardly be considered small.

Table 8. Impacts of the Elimination of Organophosphates and Carbamates on the United States Economy

Aggregate Effect	Direct	Indirect	Induced	Total
Output (million dollars)	-4,126	-2,035	-11,110	-17,271
Total Value Added (million dollars)	-2,934	-1,084	-6,405	-10,423
Employee Compensation (million dollars)	-1,018	-521	-3,281	-4,821
Proprietors Income (million dollars)	-136	-113	-471	-720
Other Property Income (million dollars)	-1,321	-356	-2,019	-3,696
Employment (# jobs)	-58,988	-22,860	-127,034	-208,882

References

Huang, Kuo S., *A Complete System of US Demand for Food*, USDA/ERS Technical Bulletin No. 1821 (September 1993).

Huang, Kuo S., *How Economic Factors Influence the Nutrient Content of Diets*, USDA/ERS Technical Bulletin No. 1894 (November 1997).

Huang, Kuo S., "Nutrient Elasticities in a Compete Food Demand System," *American Journal of Agricultural Economics*, 78: 21-29 (February 1996).

Minnesota IMPLAN Group, Inc., "IMPLAN Professional: Social Accounting & Impact Analysis Software," 2nd Printing, MIG, Inc., 1940 South Greely St., Stillwater, MN 55082 (February 1997).

Taylor, C.R., "AGSIM: An Econometric-Simulation Model of Regional Crop and National Livestock Production in the United States," Ch. 3 in Taylor, C.R., S.R. Johnson, and K.H. Reichelderfer (ed), *Agricultural Sector Models for the United States: Description and Selected Policy Applications*, Iowa State Press (1993).