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Potential Farm-Level Impacts of Proposed FQPA Implementation: The Tennessee Case[1,2]

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AJAE Abstract

This research estimates farm-level impacts of a potential ban on organophosphates and carbamates under the FQPA. Insecticide expenditure and first- and fifth-year yield impacts are estimated for five Tennessee representative farms. Results indicate that within five years, the ban could reduce net farm income on Tennessee farms by 16 to 46 percent.

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INTRODUCTION

The Food Quality Protection Act (FQPA) of 1996, regulated by the Environmental Protection Agency (EPA), mandates that all pesticide tolerance levels be reassessed considering aggregate exposures, cumulative effects from pesticides sharing common mechanisms of toxicity, and special protection for infants and children. Several major producer organizations and commodity groups are concerned that EPA may ban some common and economically important pesticides that meet current safety criteria without considering the potential benefits of particular pesticides. EPA's recent consideration of a ban on all organophosphate and carbamate insecticides has validated this concern.

The objective of this paper is to quantify potential pest control cost increases and yield reductions that may result at the farm level from a ban on organophosphate and carbamate insecticides in 1999 – assuming constant 1997 prices and yields and no changes in acreages or insecticide technologies. Five representative farms typifying major segments of Tennessee agriculture are included in the analysis, which estimates changes in expenditures and initial changes in yields associated with substituting currently available chemicals for banned organophosphates and carbamates. The analysis also estimates the impacts of changes in crop yields that would occur after five years of continuous use of the substitute insecticides to account for the impact of pest resistance that could develop as a result of the ban.

REPRESENTATIVE FARMS

Five representative farms typifying major segments of agriculture in Tennessee are used to estimate farm-level financial impacts of the proposed ban, including large and typical cotton farms, burley and mixed tobacco farms, and a large grain farm. Descriptions of the farms are provided in table 1. The representative farms were developed through the University of Tennessee's AgFIRST project (Agricultural Financial Impact and Risk Strategies for Tennessee), with Texas A&M University.

AgFIRST relies on farmer input for development of representative farms. State extension leaders work with researchers to identify a panel of farmers to provide enterprise, operation, management, and financial information. Panelists use a consensus method to characterize details of the representative farm and verify and update farm data. Representative farm data are analyzed using the FLIPSIM farm-level policy model, which generates pro forma financial statements for each simulation (Richardson, 1999; Richardson and Nixon, 1986).

Table 1. Characteristics of Representative Farms.

Farm Name	Acreage		Enterprises		Cash Receipts	Total Assets
			Commodity	Acres/Head		(Non-Cash)
Large Cotton Farm	Total	1,720	Cotton	2,508.0	1,102,262	3,934,100
	Owned	1,720	Corn	250.0	173,073	
	Leased	2,280	Soybeans	760.0	144,199	
			Wheat	300.0	45,045	
			Cotton Seed	2,508.0	132,847	
Moderate Cotton Farm	Total	1,735	Cotton	837.5	355,120	887,100
	Owned	285	Corn	167.5	47,240	
	Leased	1,450	Soybeans	670.0	137,037	
			Cotton Seed	837.5	58,529	
Large Grain Farm	Total	2,480	Corn	1,200.0	439,109	1,505,288
	Owned	562	Soybeans	1,200.0	292,039	
	Leased	1,918	Wheat	600.0	86,666	
Large Mixed Tobacco Farm	Total	650	Burley	11.0	47,614	873,911
	Owned	250	Dark-Fire	22.0	122,724	
	Leased	400	Hay	70.0	0	
			Pasture	210.0	0	
			Corn	123.0	43,942	
			Soybeans	124.0	29,855	
			Wheat	86.0	13,027	
			Cow/Calf	90.0	41,387	
Moderate Burley Tobacco Farm	Total	275	Burley	10.0	41,492	606,316
	Owned	235	Hay	90.0	0	
	Leased	40	Pasture	75.0	0	
			Cow/Calf	30.0	7982	

METHODOLOGY

Baseline Insecticide Usage

During the initial development of each representative farm, panels of farmers provided researchers with detailed information about farm enterprises, operations, practices, management, and finances, including insecticide usage and expenditure information. In some cases, farmers provided insecticide expenditure information by chemical for each crop and in other cases, provided aggregate insecticide

expenditure information by crop. In these cases, researchers used the state pricing guide supplied by Tennessee Farmers' Cooperative with chemical use and application information provided by farm panels to estimate insecticide expenditures by chemical by crop. All expenditure data were verified with farm panels and county extension agents. Data were also collected from each farm panel on crop yields for the representative farm, using the insecticide strategies defined. The data provided by each representative farm panel provide a baseline of current insecticide usage, expenditures, and yields.

Post-Ban Scenario

A scenario was then constructed for each representative farm that identifies the strategies the farms would likely employ to manage pest populations if organophosphates and carbamates are banned. A number of entomologists and crop specialists in the state were consulted to identify substitute chemicals that could replace organophosphates and carbamates in the treatment of particular pests on particular crops.[4] In addition to identifying substitute chemicals, crop research specialists provided information about application rates, number of applications, and application technologies for each substitute chemical. Insecticide cost data provided by the Tennessee Farmers' Cooperative were used to determine the expenditures on chemical materials that would be required for the substitute bundle of chemicals. Crop research specialists also provided information about the impact (if any) that using the identified substitute insecticides would have on crop yields over the first year of use.

In several cases, insecticide substitutes for organophosphates and carbamates are currently available and equally efficient in controlling target pests – and in some cases, even less expensive – but not part of the baseline pest control strategy. In such cases, the primary reason that organophosphates and carbamates are widely used is because of the potential for insects to develop resistance to continued use of substitute chemicals. Thus, it is important to consider short-run yield impacts associated with a ban on organophosphates and carbamates as well as long-run yield impacts that may be associated with

[4] Although new products are likely under development or review, crop specialists were asked to limit consideration of substitute chemicals to those available and approved for use on January 1, 1999.

development of pest resistance to substitute insecticides. To incorporate this long-run impact of a ban on organophosphates and carbamates, crop specialists were also asked to estimate any changes in yield that would occur after five years of continued use of the substitute insecticides.[5] For each of the representative farms, table 2 provides information about baseline (current) insecticide use and expenditures, as well as substitute insecticides identified by crop specialists and related expenditures and first- and fifth-year yield impacts associated with the substitutes.

Table 2. Baseline and Post-Ban Insecticide Usage, Expenditures, and Yield Losses.

Crop [a] (Treated Acreage)	Baseline			Alternative Scenario				
	Current Chemicals	Cost per Acre	Baseline Expenditures	Substitute Chemicals	Cost per Acre	Alternative Expenditures	Yield Loss Year 1	Yield Loss Year 5
Large Cotton Farm								
Cotton (2508)	Malathion *	12.00	30,096	Pyrethroid	22.00	55,176	-	-
	Pyrethroids	20.00	50,160	Pyrethroid	20.00	50,160		
Corn (532)	Furdan *	4.00	2,128	Bt Corn Varieties	10.00	5,320	-	25%
	Pyrethroids	2.65	1,410	Pyrethroid	2.65	1,410		
Moderate Cotton Farm								
Cotton (837.5)	Malathion *	12.00	10,050	Pyrethroid	22.00	18,425	-	-
	Pyrethroids	20.00	16,750	Pyrethroid	20.00	16,750		
Corn (167.5)	Lorsban *	1.90	318	Pyrethroid	2.05	343	-	30%
Large Grain Farm								
Corn (1,200)	Bt Corn Varieties			Bt Corn Varieties			-	30%
	Pyrethroids	2.05	2,460	Pyrethroids	2.05	2,460		
Wheat (600)	Pyrethroids	2.05	3,280	Pyrethroids	2.05	1,230	-	10%
Large Mixed Tobacco Farm								
Burley Tobacco (11)	Orthene TPW *	17.00	187	Admire TPW	33.00	363	2%	5%
	Orthene Foliar *	58.00	638	Thiodan	77.00	847	10%	13%
	Thiodan	30.00	330					
Dark-Fired Tobacco (22)	Orthene TPW *	11.00	242	Admire TPW	21.00	462	2%	5%
	Orthene Foliar *	58.00	1,276	Thiodan	77.00	1,694	10%	13%
	Thiodan	30.00	660					
Corn (123)	Furdan *	4.00	492	Bt Corn Varieties	10.00	1,230	-	25%
	Pyrethroids	2.65	326	Pyrethroids	2.65	326		
Moderate Burley Tobacco Farm								
Burley Tobacco (10)	Admire TPW	32.76	328	Admire TPW	32.76	328		
	Orthene Foliar *	34.05	341	Dipel	75.00	750	10%	13%
	Thiodan	26.63	266	Thiodan	26.63	266		

* Organophosphate or Carbamate

[a] Includes only crops for each representative farm that are treated with insecticides.

[5] In reality, a ban on all organophosphates and carbamates would likely increase efforts to develop and approve new insecticides, with specific attention to pest resistance management, but consideration of a hypothetical

For both the large and moderate cotton farms, malathion is used in the baseline as part of the Boll Weevil Eradication Program. Under a ban, cotton specialists indicated that pyrethroids could substitute for malathion with no additional yields losses.[6] None of the soybean acreage on the farms is currently treated with insecticides. Among the farms, only the wheat acreage on the large grain farm is treated with pyrethroids, which are not subject to the ban. However, wheat specialists expect that long-term reliance on pyrethroids – without the option of rotating organophosphates and carbamates – will lead to development of pest resistance that could result in a 10 percent yield loss after five years. Corn pest control on the representative farms is currently achieved with Furdan (an organophosphate), Lorsban (a carbamate), pyrethroids, and Bt corn varieties. In the event of a ban, the representative farms are expected to rely more heavily on Bt corn varieties and pyrethroids. Without the ability to rotate Bt plantings with other chemicals, experts anticipate no initial yield losses, but yield reductions of 25 to 30 percent after five years of continuous use.

Transplant water and foliar applications of Orthene, a carbamate insecticide, are currently used to control aphids, budworms, cutworms, hornworms, flea beetles, and grasshoppers in both burley and dark-fired tobacco. Without Orthene, the representative farms would rely much more heavily on Admire, Thiodan, and Dipel. Tobacco production specialists agree that these alternative chemicals will not be sufficient to achieve current yield levels. Initial (first-year) yields could be reduced by up to two percent due to reliance on Admire, and up to 10 percent due to reliance on Thiodan. Continued use of the alternative chemical bundle would result in an additional three to five percent yield loss in the fifth year.

Estimating Impacts of a Ban

Current (baseline) insecticide expenditure data are combined with other baseline representative farm data and processed using the FLIPSIM farm-level policy model to generate a baseline of farm performance projections and pro forma financial statements. The baseline uses 1997 prices and yields

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future rate of insecticide research, development, approval, and adoption could not be included in this analysis.

and is projected over five years, holding yields and prices constant over the five-year period. A post-ban scenario is then simulated for each representative farm using the FLIPSIM model and the baseline representative farm data, substituting the alternative insecticide expenditures and any reductions in crop yields over the five-year simulation period. In the post-ban scenario, prices and baseline yields (from which yield losses are calculated) are again assumed to remain constant at their 1997 level. A comparison of the baseline and post-ban simulations reveals changes in crop and farm insecticide expenditures, total variable costs, production, cash receipts, and net farm income that result from the ban on organophosphates and carbamates. A comparison of first- and fifth-year results from each simulation estimates the changes in receipts and net returns that result from continued use of the substitute chemicals. Changes in the financial stability of each representative farm are the results of ban-induced changes in production costs and crop yields.

RESULTS

First-Year Impacts

The baseline and post-ban scenario results for each representative farm for the first year following a ban on organophosphates and carbamates are presented in table 3. For the large cotton farm, there were no yield impacts associated with the ban in the first year, meaning that crop production and crop cash receipts are unchanged across the two simulations. Insecticide material expenditures for the farm increase by one third, from $83,794 to $112,066. Most of this increase is attributable to the loss of malathion, used to control boll weevils. Expenditures on insecticides for corn nearly doubled under the ban, but the relatively small acreage (532 acres) compared to cotton (2,508 acres) tempers the total impact of significantly higher corn insecticide expenditures. The increase in insecticide costs increases total cash expenses by 2.4 percent. The result is a $29,530 reduction in net cash farm income, from $446,442 to $416,912, which represents a 6.61 percent decline.

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[6] Crop specialists did indicate that use of pyrethroids could have indirect implications on resistance of other pests, but the impact is not quantifiable with available data.

Table 3. Baseline and Post-Ban Scenario Results for the First Year.

	Large Cotton Farm		Moderate Cotton Farm		Large Grain Farm		Large Mixed Tobacco Farm		Moderate Burley Tobacco Farm	
	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative
Production										
Cotton	1,881,000	1,881,000	598,813	598,813						
Cotton Seed	1,311	1,311	509	509						
Corn	69,160	69,160	19,263	19,263	182,400	182,400	18,450	18,450		
Soybeans	22,800	22,800	22,110	22,110	48,000	48,000	4,960	4,960		
Wheat	15,000	15,000			30,000	30,000	4,558	4,558		
Burley Tobacco							29,150	25,652	22,000	19,800
Dark-Fired Tobacco							62,700	55,176		
Insecticide Costs (Total)	83,794	112,066	27,118	35,518	3,690	3,690	4,151	4,922	934	1,344
Cotton	80,256	105,336	26,800	35,175						
Cotton Seed										
Corn	3,538	6,730	318	343	2,460	2,460	818	1,556		
Soybeans										
Wheat					1,230	1,230				
Burley Tobacco							1,155	1,210	934	1,344
Dark-Fired Tobacco							2,178	2,156		
Cash Receipts for Crops	1,597,426	1,597,426	597,926	597,926	817,814	817,814	257,162	236,722	41,492	37,343
Total Cash Receipts	1,684,930	1,684,930	630,559	630,559	872,935	872,935	298,550	278,109	50,474	46,325
Total Cash Expenses	1,238,488	1,268,018	469,871	478,643	532,076	532,076	147,579	148,419	34,606	35,049
Net Cash Farm Income	446,442	416,912	160,688	151,917	340,860	340,860	150,970	129,690	15,068	11,276

First-year results for the moderate cotton farm are roughly comparable. No initial changes in yields, production, or crop cash receipts are present. Total insecticide expenditures increase by $8,400, a 31 percent increase. Again, most of the change in expenditures is due to the loss of malathion for boll weevils in cotton, with only $25 of the change due to the loss of Lorsban for corn. The result is a reduction in net cash farm income of $8,771, from $160,688 in the baseline to $151,917 in the post-ban scenario, which represents a 5.46 percent decline. The baseline insecticide strategy for the large grain farm does not include any organophosphate or carbamate insecticides, so that the production, expenditures, and net income remain unchanged across the two scenarios.

In terms of percentage reduction in net farm income, the effect of the ban in the first year is much greater for the two tobacco farms than for the cotton and grain farms. In the case of the large mixed tobacco farm, lower yields for both burley and dark-fired tobacco, coupled with higher insecticide expenditures for burley tobacco and corn, result in a 14.1 percent reduction in net cash income, a decline of $21,280. Most of this reduction in net income is the result of lower tobacco yields, and thus lower crop

cash receipts, combining 1997 prices with estimated production. The loss of Orthene to manage aphids, budworms, and cutworms and the lack of a substitute chemical with comparable efficiency are responsible for the yield losses, which account for $20,440 of the reduction in net farm income.

The loss of Orthene has a very significant impact on the moderate burley tobacco farm. Substituting Dipel for Orthene to control budworms, hornworms, and aphids increases insecticide material expenditures by $410, from $93.44 per acre to $134.39 per acre, a 44 percent increase. While the expenditure impact is relatively small ($410), the reduced efficiency of the substitute chemicals in controlling target pests reduces production by 2,200 pounds (220 pounds per acre). Applying baseline prices to the yield reduction results in a loss of $4,149 in crop cash receipts. Together, higher expenditures and lower yields combine to reduce net cash farm income by $4,592, a 29 percent reduction.

Fifth-Year Impacts

Baseline and post-ban scenario results for the fifth year of continuation of the substitute pest control strategy following a ban on organophosphates and carbamates are presented in table 4. Because the same strategy is followed for five years, insecticide expenditure impacts in the fifth year are identical to those in the first year. Further yield reductions in five years due to development of insect resistance to the substitute chemicals (without organophosphates and carbamates to rotate) are reflected in lower levels of production and cash receipts, and thus net cash income. Additionally, cash expenditures may be lower in some cases if lower yields reduce harvesting, storage or labor expenses.

Table 4. Baseline and Post-Ban Scenario Results for the Fifth Year Following a Ban on Organophosphates and Carbamates.

	Large Cotton Farm		Moderate Cotton Farm		Large Grain Farm		Large Mixed Tobacco Farm		Moderate Burley Tobacco Farm	
	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative
Production										
Cotton	1,881,000	1,881,000	598,813	598,813						
Cotton Seed	1,311	1,311	509	509						
Corn	69,160	51,870	19,263	13,484	182,400	127,680	18,450	13,838		
Soybeans	22,800	22,800	22,110	22,110	48,000	48,000	4,960	4,960		
Wheat	15,000	15,000			30,000	27,000	4,558	4,558		
Burley Tobacco							29,150	23,903	22,000	19,140
Dark-Fired Tobacco							62,700	51,414		
Cash Receipts for Crops	1,597,426	1,554,158	597,926	583,754	817,814	677,415	257,432	215,786	49,592	44,198
Cotton	1,102,262	1,102,262	355,120	355,120						
Cotton Seed	132,847	132,847	58,529	58,529						
Corn	173,073	129,805	47,240	33,068	439,109	307,376	43,942	32,957		
Soybeans	144,199	144,199	137,037	137,037	292,039	292,039	29,855	29,855		
Wheat	45,045	45,045			86,666	78,000	13,027	13,027		
Burley Tobacco							47,614	39,043	49,592	44,198
Dark-Fired Tobacco							122,724	100,634		
Total Cash Receipts	1,659,527	1,616,259	618,810	604,639	843,535	703,135	307,652	266,005	61,128	55,734
Total Cash Expenses	1,211,522	1,246,031	476,200	485,698	538,341	538,341	133,916	134,723	40,731	42,974
Net Cash Farm Income	448,005	370,228	142,611	118,940	305,194	164,795	173,736	131,283	20,397	12,759

After five years of continuation of the alternative insect control strategy, crop specialists expect increased dependence on pyrethroids in combination with larger acreages of Bt corn varieties to significantly reduce corn yields due to development of pest resistance. Cotton specialists do not expect significant pest resistance to develop from continuous use of pyrethroids in cotton. Thus, the majority of the impacts of the ban after five years on the two cotton farms are from lower corn production levels. Applying 1997 prices to the simulated yields shows a $43,266 reduction in corn receipts for the large cotton farm and $14,172 reduction in corn receipts for the moderate cotton farm. Coupled with the higher levels of insecticide expenditures (equivalent to first-year expenditure changes), the reduction in corn receipts contributes to a $77,777 decline in net farm income for the large cotton farm (17.4 percent) and a $23,671 decline for the moderate cotton farm (16.6 percent).

While the bottom line for the large grain farm was initially unaffected by the ban, continuous use of the current insecticide regime without the availability of organophosphates and carbamates to rotate with other insecticides to manage pest resistance results in a 46 percent reduction in net cash income after five years. Net cash income in the post-ban scenario is $164,795, compared to a baseline level of $305,194.

Most of this reduction is attributable to the 30 percent corn yield reduction that results from increasing the acreage planted to Bt corn varieties in combination with sole reliance on pyrethroids. Of the $140,399 reduction in net cash farm income, $8,666 is attributable to a 10 percent reduction in wheat yields after relying solely on pyrethroids for five years to control aphids and armyworms.

On the large mixed tobacco farm, further reductions in burley and dark-fired tobacco yields and a 25 percent reduction in corn yield (due to pest resistance) after five years result in cash receipts $41,647 lower than in the baseline. Net cash farm income is reduced by $42,453 (24.4 percent). An additional three percent reduction in the burley yield on the moderate burley tobacco farm, coupled with higher insecticide material expenditures, results in net cash income that is $7,638 lower than the baseline level in the fifth year of the ban, representing a 37.5 percent reduction in net farm income. In part because of its reliance on tobacco for a large portion of total income, the moderate burley tobacco farm is especially hard hit by relatively small changes in yields over time.

SUMMARY AND DISCUSSION

This study was conducted to estimate the changes in net cash farm income for five Tennessee representative farms that would result from a ban on organophosphate and carbamate insecticides. In the study, estimated changes in net farm cash income are attributable to (1) changes in costs of purchasing substitute chemical insecticides and (2) changes in crop receipts due to changes in crop yields on treated acres in the first and fifth years following a ban on organophosphates and carbamates. The substitutions considered in the analysis and the subsequent implications for crop yields are the result of extensive consultations with various crop specialists and researchers in the state.

In terms of expenditures on insecticide materials, the ban results in nearly a one-third increase in total farm insecticide expenditures for the large and moderate cotton farms. Total insecticide expenditures are up nearly 50 percent for the moderate burley tobacco farm and up nearly 20 percent for the large mixed tobacco farm. Expenditures on the large grain farm remain unchanged.

In the first year of the ban, only burley and dark-fired tobacco experience yield reductions as a result of substitute insecticides being less efficient in the control of target pests. This results in a $20,440 reduction (8 percent) in crop receipts – using 1997 average prices – on the large mixed tobacco farm and a $4,149 reduction (10 percent) on the moderate burley tobacco farm. Together, higher costs of substitute insecticides and lower tobacco yields in the first year following a ban reduce net cash farm income by less than three percent on the two cotton farms and by 14 percent and 29 percent, respectively, on the large mixed and moderate burley tobacco farms. After five continuous years of using the substitute insecticides – with no introduction of new chemicals considered – corn yields are projected to be reduced by 25 to 30 percent due to development of insect resistance to the substitute chemicals. Wheat yields are projected to fall by 10 percent and tobacco yields by an additional three to five percent. This results in a reduction of crop cash receipts less than three percent for the large and moderate cotton farms, but a reduction of more than 17 percent for the large grain farm and 11 to 16 percent for the two tobacco farms. Combined with changes in expenditures on insecticide materials, the result for net farm cash income is a reduction of approximately 16 percent for the large and moderate cotton farms, 46 percent for the large grain farm, 24 percent for the large mixed tobacco farm, and 37 percent for the moderate burley tobacco farm.

This study applies crop experts' estimates of insecticide substitutions and associated yield impacts to a set of representative farms typifying major sectors of agriculture in Tennessee. While providing insight into potential impacts at the farm level and a starting point for estimating aggregate impacts of a potential ban on organophosphates and carbamates, results from this study are limited by a number of simplifying assumptions. Crop prices are assumed constant over the projection period. Given that the ban would be nationwide and would likely affect most yields and production, price impacts should be considered. To the extent that crop prices increase, net revenues would be adjusted upward and could offset a portion or all of the effect of reduced yield. The study also does not consider potential changes in prices for replacement insecticides, changes in insecticide application costs (e.g., labor, variable and fixed machinery costs), introduction of new products or technologies, or changes in environmental and health

risks of alternative pesticides and possible increases in food imports. A national study is underway which estimates the price and acreage adjustments of banning organophosphates and carbamates. As these and other estimates of aggregate impacts of such a ban become available, those effects could be incorporated into the farm-level analysis to refine the impact estimates.

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