Economic Impacts of Removal of Registration for Parathion on Sunflower

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INTRODUCTION

This paper reports on research recently completed with support from the North Central Region Pesticide Impact Assessment Program (NCR-PIAP). The purpose of this research was to determine the impacts of canceling registration of parathion for control of insect pests in sunflower. The Environmental Protection Agency is reviewing the registration for parathion.

North Dakota is a major producer of sunflowers. Over the last 10 years (1980 to 1990), 65 percent of the nation's oil-type and 75 percent of its confectionery type sunflowers were grown in North Dakota. During this time, oil-type sunflower acres in North Dakota have ranged from 960,000 to 3,140,000 acres, while confectionery sunflower acres have ranged from 144,000 to 330,000 acres (North Dakota Agricultural Statistics Service).

The major insect pests associated with sunflower include sunflower bud moth, *Suleima helianthana* (Riley); sunflower midge, *Containia schulzi* Gagne'; sunflower moth, *Homoeosoma electellum* (hulst); red and gray sunflower seed weevil, *Smicronyx fulvus* LeConte and *S. sordidus* LeConte. Parathion (methyl, ethyl, and 6-3 parathion, unless noted) is registered to control the sunflower moth, the seed weevil complex, and grasshoppers in sunflower.

The estimated number of sunflower acres treated with parathion in North Dakota has increased from 6,800 acres in 1978 (Nalewaja et al., 1980) to over 471,000 acres in 1989 (McMullen et al., 1990), which represents about 36 percent of North Dakota's total sunflower acreage in 1989.

METHODOLOGY

The impacts of canceling registration for parathion on sunflower were examined using a four-part analysis. The analysis centered on determining current usage of parathion and other chemical controls; estimating the impact on individual sunflower growers; estimating the impact on aggregate sunflower production and markets; and assessing the current economic benefits of parathion use versus the costs to sunflower growers of canceling registration of parathion use on sunflower.

Parathion and Other Insecticide Use

A mail survey of all aerial chemical applicators in North Dakota was conducted in early September, 1990. A second survey was mailed to nonrespondents in mid-October. The survey listed insecticides registered for seed weevil and grasshopper control for 1988 through 1990. Respondents were asked to list counties sprayed in and acres of sunflower treated in each county for each insecticide listed and to designate whether they were spraying to control seed weevil only, grasshopper only, or both seed weevil and grasshoppers.

Impact on Sunflower Producers in North Dakota

Models of average farms in two North Dakota counties (Foster and McHenry) that rely heavily on sunflower production were developed. These farms were simulated under 1991 government program options using linear programming. Average base acreage for wheat, barley, corn, and oats were developed for the farms, using data from 1987 (Bureau of the Census 1989). Budgets were developed for the major crops grown in each county. Alternative sunflower budgets were developed for different chemical control electives. The linear programming models were solved using different sunflower prices to determine how discontinuing parathion registration would affect the average grower in each county.

Impact on Aggregate Sunflower Production and Markets

The effect of discontinuing registration for parathion on aggregate sunflower production and markets was examined using a marginal analysis of welfare costs following Lichtenberg et al. (1988). This methodology estimates changes in aggregate equilibrium sunflower price and quantities produced, changes in consumers' surplus, and changes in producers' surplus for both current users and non-users of pesticides due to restricting the use of pesticides[1].

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[1]See Kohler, 1986 pp. 200-202 for a description of consumers' and producers' surplus.

This methodology assumes demand and supply for sunflowers are at market clearing levels before canceling registration for parathion (Figure 1a-b). The quantity demanded by the domestic market (Qd) and the export market (Qe) equal the quantity of sunflowers produced (Qs). Canceling registration for parathion increases the cost of producing sunflowers for those producers who currently use parathion (due to changes in costs for chemical controls and differences in efficacy), while the cost for producing sunflowers for non-users of parathion remains constant. This increases the marginal cost of producing sunflowers in North Dakota from MC^P (Figure 1b) to MC^n (Figure 1d) Using this new supply curve, a new equilibrium supply (Q1 in Figure 1d), is calculated along with a new equilibrium market price (P1) and quantity demanded for both domestic and export markets ($Q1_d$ and $Q1_e$ in Figure 1c, respectively).

This methodology requires estimates of supply and demand elasticities for sunflower, quantities produced both for domestic and export markets, and an estimate of the change in marginal costs to current users of parathion. Supply elasticity was developed from a previous study of sunflower (Wendland and Glauber, 1988). Domestic and export demand elasticities were developed from previous studies of soybean (Gardiner and Dixit, 1987). The data profile for the sunflower market is listed in Table 1.

Parathion and alternate chemical controls were assumed to be equally effective in controlling sunflower insects. The change in marginal cost was the difference in prices paid for parathion and alternative chemicals. The change in marginal cost was developed as the weighted average price of other chemical control alternatives registered in 1990. Chemical control alternatives were weighted by their amount of usage on sunflower in 1990.

Assessment of Benefits and Costs

The final calculation of benefits and costs was based on the results of the preceding sections. Sensitivity of the ratio to changes in each of the components was performed to determine which conditions must be met for benefits of parathion registration equal or are less than the cost of removal. The benefit-cost (B/C) ratio analysis was structured as follows:

$$B/C = \sum_{1}^{n} \frac{[\,Pw(Sw) - VCw]/(1+i)t}{[\,P(S) - VC\,]/(1+i)^t}$$

where

n	is the time period under consideration
P_w	is sunflower market price with parathion use
P	is sunflower market price without parathion use
S_w	is sunflower quantity supplied with parathion use
S	is sunflower quantity supplied without parathion use
VC_w	is variable costs with parathion use
VC	is variable costs without parathion use
$(1+i)^t$	is the discount factor to transform all values to present value

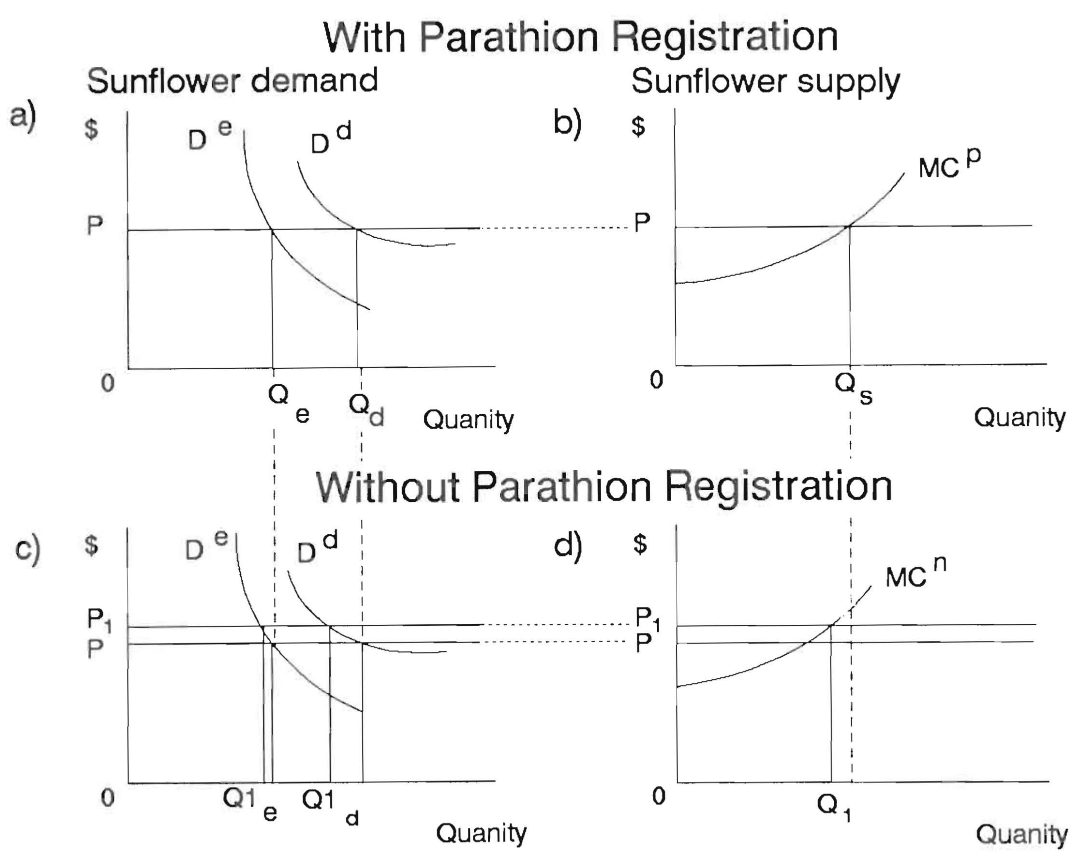

Figure 1. Equilibrium sunflower supply and demand with and without parathion registration.

Table 1. Profile of sunflower.

Region	Annual Production	Yield	Share of production: Users'	Share of production: Exports'	Price	Supply	Elasticity: Domestic Demand	Elasticity: Export Demand
	(million lbs)	(lbs/a)	----------percent----------		$/lb			
N.D.	2,041.86[a]	1170[a]	24.9[b]	--	--	--	--	--
U.S.	2,189.17[a]	1178[a]	24.9[b]	19.9[a].	0971[a]	1.25	-.0019	-.0025

[a] Average of years 1984-1988.
[b] Average of years 1988-1990.
Sources: North Dakota Agricultural Statistics Service (1990);
USDA-ERS Oil Crops Outlook and Situation Report - various issues

RESULTS AND DISCUSSION

Parathion and Other Chemical Use

Of the 204 surveys mailed to aerial applicators operating within the state, 103 returned the survey, a 50 percent response rate. Response rates for the individual crop reporting districts in North Dakota ranged from 39 percent in the northwestern district to 80 percent in the southwestern district. Estimates for insecticides applied in selected years from 1978 to 1990 for the state are shown in Table 2.

Insecticide usage on sunflowers in North Dakota has increased since 1978. Over the last two years, about half of the sunflowers grown in North Dakota were treated with insecticides. More than a third of the sunflower acreage was treated with parathion (Table 3).

The largest number of acres treated with parathion in the last three years were to control seed weevil (Table 4). Fenvalerate and esfenvalerate were the only other major chemicals used to control seed weevil in North Dakota over the last three years. Of these, fenvalerate is no longer labeled for use on sunflower in North Dakota.

Insecticide usage for grasshopper control has increased from 1988 levels. North Dakota had high levels of grasshopper infestations in 1989 and higher levels in 1990. Major chemical control alternatives for grasshopper in sunflower for 1988 to 1990 were fenvalerate, esfenvalerate, parathion, and carbofuran F.

Impact on Sunflower Producers in North Dakota

Farmers in both Foster and McHenry Counties of North Dakota are limited in the number of available cropping alternatives that compete with sunflower production. Cropping of wheat, barley, oats, and corn are limited largely by base acreage constraints in current government programs. In Foster and McHenry counties flax and rye are two crops that compete for acreage with sunflower. Because of few alternatives to sunflower, the farmer largely absorbs the cost of removing registration for parathion on sunflower. The optimal mix of cropping

Table 2. Estimates of sunflower acreage treated with insecticides, North Dakota, selected years,1978-1990.

Chemical	1978[a]	1984[b]	1988	1989[c]	1990
	----------(acres)----------				
Methyl Parathion	6800	10887	99673	168700	47865
6-3 Parathion		387813	24562	330320	450847
Carbofuran F		327700	26051	39300	46732
Fenvalerate		1276700	123705	149700	0
Carbaryl		12500	0	4200	10000
Esfenvalerate		0	0	43000	148602
Malathion		35000	0	66000	0
Methidathion	9900	6000	0	1600	0
Toxophene	32600	2600	0	0	0
Total Parathion	6800	398700	345296	471900	498702
Total Insecticides	49600	2067700	495053	780700	704047

[a] Nalewaja et al. 1980
[b] McMullen et al. 1985
[c] McMullen et al. 1990

Table 3. Acres planted, treated, and percent of total acres treated with parathion and all insecticides for sunflower, North Dakota, selected years, 1978-1990.

Year	Acres planted	Acres Treated: Parathion	Acres Treated: Insecticide	Percent of total Acres Treated: Parathion	Percent of total Acres Treated: Insecticide
1978	1,920,000	6,800	49,600	0.4%	2.6%
1984	2,850,000	398,700	1,276,700	14.0%	44.8%
1988	1,500,000	345,296	495,053	23.0%	33.0%
1989	1,320,000	471,900	708,100	35.8%	53.6%
1990	1,370,000	498,702	704,047	36.4%	51.4%

Sources: Nalewaja et al., 1980; McMullen et al., 1985; McMullen et al., 1990; North Dakota Agricultural Statistics Service.

Table 4. Sunflower acres treated for seed weevil only, grasshopper only, or both concurrently by chemical, North Dakota, 1988-1990.

	Seed Weevil			Grasshopper			Both		
Chemical	1988	1989	1990	1988	1989	1990	1981	1989	1990
	(acres)								
Methyl Parathion	89789	156184	33350	3563	3563	12128	6321	8953	2387
6-3 Parathion	228212	266166	328560	10498	24636	45443	6912	12397	76844
Carbofuran F	0	0	503	26051	39300	46063	0	0	166
Fenvalerate	120242	93612	0	2253	56088	0	1210	0	0
Carbaryl	0	0	100	0	4200	9900	0	0	0
Esfenvalerate	0	39805	59405	0	1990	76868	0	1206	12328
Total	438824	55576	421918	42365	129777	190403	14444	22556	91726

enterprises does not change with the removal of parathion as an option for insect control. Only the gross margin (return over variable costs) declines when more costly chemical control alternatives are available (Table 5).

Without parathion, producers face increased cost of insect control, which decreases the extent that sunflower is more profitable than alternative crops (primarily flax and rye). Lower yields or prices that decrease gross revenue by 16.8 percent and 2.4 percent would change the crops producers would grow in Foster and McHenry Counties, respectively.

Impact on Aggregate Sunflower Production and Markets

The effect on sunflower markets due to removing registration of parathion for sunflower was calculated based on the assumption that current chemical control alternatives were equally effective in controlling sunflower insects. Removing registration of parathion for sunflower would influence present users of parathion to reduce production of sunflowers by 12,038 acres or 2.6 percent. Growers who do not use parathion would increase acreage by 11,967 acres or .9 percent. The increase in costs of alternative chemical controls for current users of parathion would increase their marginal costs by about a quarter of a cent per pound of sunflower sold (Table 6). Sunflower market prices should increase minimally (about $.07 per hundredweight).

The net effect on sunflower producers who use parathion is a loss of about $1.07 million. The net loss occurs because these producers must switch to higher cost chemical alternatives which more than offsets the higher equilibrium price of sunflower. Nonusers of parathion would receive about $1.1 million more in revenues because of the higher equilibrium price of sunflower, increased acres, and no change in their cost of production.

Removal of registration for parathion on sunflower would cost consumers $1,457,806. Domestic consumers would pay 80 percent of the total costs while foreign consumers would pay about 20 percent of the total costs. Total welfare costs of removing registration for parathion are $1.14 million for domestic producers and consumers and $1.43 million for all world consumers and producers.

Assessment of Benefits and Costs

The benefit-cost analysis used the results of the previous sections. All benefits or costs of removing registration for parathion on sunflower beyond the effects on producers are difficult to quantify, i.e., the impact of alternative insecticides on non-target species (honey bees). Therefore, this analysis concentrated on those impacts that could be adequately quantified.

The costs to producers of removing the registration for parathion on sunflower production would be a lower quantity of sunflower produced at a slightly higher price with increased

Table 5. Estimated crop acreage and gross margins for an average Foster and McHenry county farm, with and without parathion use, North Dakota, 1991.

	Foster		McHenry	
Item	With	Without[a]	With	Without[a]
	(acres)			
Wheat	468	468	505	505
Barley	60	60	137	137
Corn	27	27	34	34
Sunflower	270	270	570	570
Flax	32	32	0	0
Alfalfa	0	0	356	356
Set aside	87	87	125	125
Summerfallow	93	93	375	375
Gross margin	$53,087	$51,845	$73,305	$70,681
Difference				
Total		($1,242.00)		($2,624.00)
Per acre of sunflower		($4.60)		($4.60)

[a]Parathion use replaced with esfenvalerate.

Table 6. Welfare costs of canceling parathion.

Market Impacts	
Change in marginal cost	$0.002688
Change in price	$0.000666
Change in outpu	t-83750 lbs
Impact on current users	
Change in revenue	($1,023,619)
Change in pesticide cost	$1,426,167
Change in other costs	($1,376,922)
Change in producers' surplus	($1,072,863)
Impact on current nonusers	
Change in producers' surplus	$1,099,726
Impact on domestic consumers	
Change in consumers' surplus	($1,167,501)
Impacts on foreign consumers	
Change in export revenues	$288,280
Change in consumers' surplus	($290,305)
Net welfare impacts	
Change in domestic surplus	($1,140,639)
Change in world surplus	($1,430,944)

variable costs. These costs would decrease net income for sunflower producers compared to what they would have received if they could have applied parathion. The benefit-cost ratio (ratio of net income with parathion registration / net income without parathion) was estimated at 1.045. Total benefits to producers from registration of parathion for use on sunflower outweigh the costs of removing registration.

The sensitivity of changes in variables in the benefit-cost analysis were analyzed further. Sunflower producers would need an increase in sunflower prices of 2.1 percent or producers would need to increase production 2.1 percent to achieve equal net incomes either with or without parathion registration. Even then, parathion would be more cost effective for the producer than present alternatives. If an alternative insecticide to parathion was available at less than 119 percent of the average cost of parathion (using 1990 average retail costs, this would be about $4.96/acre), then the net income for producers with parathion registration would be equal or less than the net incomes they would receive without registration.

CONCLUSIONS

Parathion use in North Dakota has increased from 6,800 acres treated in 1978 to 471,000 acres treated with parathion in 1989. Removing registration would cause growers in North Dakota to move to more costly chemical control alternatives. Aggregate sunflower production would be reduced, and sunflower prices would be higher ($.066 per cwt). Domestic consumers and producers who use parathion would pay the majority of the increased costs of removing parathion registration. Benefits to producers from parathion use on sunflower outweigh the costs of removing registration unless a control alternative was available at less than 119 percent of the cost of parathion.

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