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ABSTRACT

ECONOMIC IMPACT OF CANCELLING
PESTICIDE X USE ON SOYBEANS

by

Roger Selley, Dennis Cory and Lewis Daugherty*

The yield reduction and increase in cost of production due to the cancellation of pesticide X is estimated to result in a 8.39 per cent increase in the price of soybeans. A single product (soybeans) supply-demand model was used to estimate the impact of cancellation. The net impact upon producers is estimated to be a reduction of profits of $106.8 million. The Lake States and the Corn Belt realize an increase in profits while other regions suffer losses. The reduction in consumer welfare is estimated at approximately $1.2 billion for domestic and foreign consumers ($3.55 per capita for U.S. consumers). The implications of the major simplifying assumptions used in the model are discussed briefly.

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* Assistant Professor, Assistant Professor and Research Assistant, respectively. Department of Agricultural Economics, University of Arizona, Tucson, AZ.

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ECONOMIC IMPACT OF CANCELLING PESTICIDE X USE ON SOYBEANS

The short term economic impact of the cancellation of pesticide X has been evaluated at the producer and consumer level by projecting 1981 soybean production and price. The methodology used and the assumptions made in estimating the impact are discussed below. The detailed calculations are presented in the Appendix tables.

Technological Impact of Cancellation

The 1976 acres treated and expected changes in production costs and yields due to cancellation were provided by Aspelin and Swanson (1981). The 1978 total variable costs (TVC) per acre are reported by state by W.D. McArthur (1980). Where cost of production was not available the regional average was used. Normal yields were based upon the 1976-80 average yield. Yields on the acreage affected by cancellation (treated acres) were estimated by reducing normal yields by the same percentage as those reported for 1976 by Aspelin and Swanson. See Appendix Table 1 for details.

Reduction In Supply

A reduction in supply due to cancellation has been estimated by predicting the reduction in treated acreage due to the reduced yields and increased costs. Detailed calculations are reported for all states in Appendix Tables 2-5.

Fryar and Hoskin (1981) provide regional estimates of the impact that changes in per acre yields and changes in variable costs will have upon the acreage of soybeans planted by region. Since state estimates were not available the percentage acreage response by region was assumed to apply to

each of the states within that region. (The regions defined by Fryar and Hoskin differ from those used here.) The percentage decrease in acreage planted due to the decrease in yields was determined by multiplying the percentage change in yield times the impact multiplier for a yield change expressed as a percentage change in acreage for a 1 percent yield change. The decrease in acreage was determined by multiplying normal planted acres treated times the percentage change in acreage due to the reduction in yields. Similar calculations were followed for estimating the reduction in acreage due to the increase in per acre total variable costs. The use of the yield and TVC impact multipliers is illustrated for representative states in Table 1.

Market Equilibrium

The previous section outlined the procedure for determining the quantity of soybeans that would be supplied after producers adjust to the reduction in yields and increases in TVC/acre due to the pesticide cancellation. The equilibrium prior to cancellation is represented in Figure 1 where the demand schedule D intersects with the supply schedule, S_B and P_B and Q_B represent the market equilibrium price and quantity of soybeans.

The shift in supply due to cancellation is represented in Figure 1 by the supply schedule S_A. If no adjustment in the market price takes place after cancellation, producers would be willing to supply the quantity Q_A but consumers would be interested in purchasing the quantity Q_B at that price (P_B). As a result, consumers will bid up the price to P_E where producers are willing to supply the quantity Q_E which is the amount consumers are willing to buy at that price.

Producers in this analysis are assumed to respond to a higher soybean price by increasing soybean acreage only (no attempt is made to account for

Table 1. Acreage and Production Response Due to Reduction in Yields and Increases in Costs with Constant Product Price, Representative States.

		Great Plains Nebraska	Corn Belt Illinois	Appalachia N. Carolina
(1)	% Decrease in Yield	35.0	12.12	27.27
	X	X	X	X
(2)	% Change in Acreage Due to 1% Change in Yield	.651	.444	.516
	=	=	=	=
(3)	% Decrease in Treated Acres Due to Change in Yield/100	22.8/100	5.4/100	14.1/100
	X	X	X	X
(4)	Acres Treated (1000 A)	410.02	3376.88	963.50
	=	=	=	=
(5)	Decrease in Acres Due to Change in Yield (1000 A)	93.4	181.7	135.6
(4)-(5) =				
(6)	Treated Acreage (1000 A) After Adjustment for Change in Yield	316.62	3195.18	827.90
	X	X	X	X
(7)	Increase in TVC/Acre	$5.54	$0.23	$1.61
	X	X	X	X
(8)	% Acreage Response to $1 Change in TVC/Acre/100	.262/100	.161/100	.315/100
	=	=	=	=
(9)	Decrease in Acres (1000 A) Due to Change in TVC/Acre	4.59	1.28	4.22
(6)-(9) =				
(10)	Treated Acreage (1000 A) W/O Pesticide (Constant Product Price)	312.03	3193.90	823.68
	X	X	X	X
(11)	Yield on Treated Acres After Cancellation (bu/A)	19.92	31.01	15.08
	=	=	=	=
(12)	Production (1000 bu) on Treated Acres W/O Pesticide (Constant Product Price)	6215.64	99042.84	12421.09

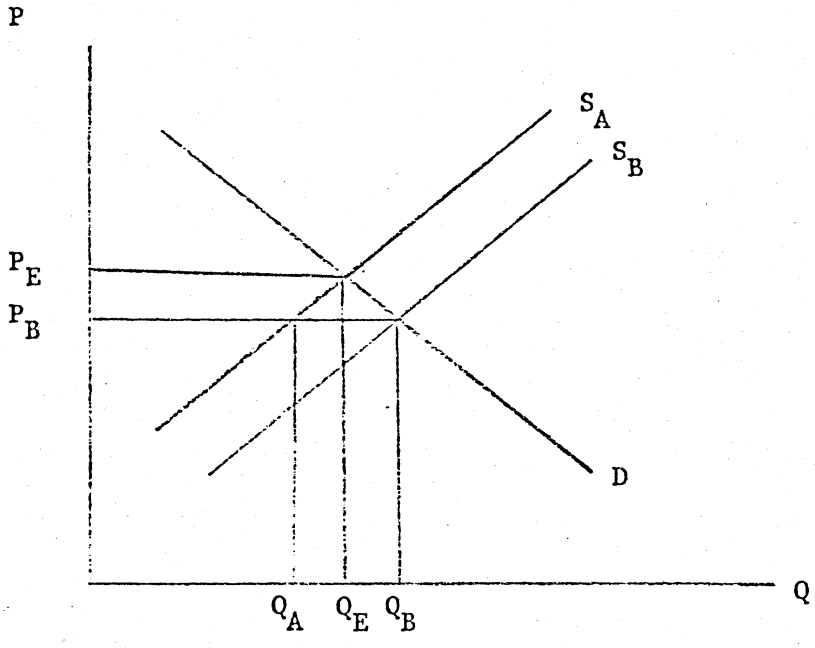

Figure 1. Illustration of Determination of Market Equilibrium Following a Supply Shift Due to Reduced Yield and Increased TVC/acre.

possible response by increasing yields). Fryar and Hoskin (1981) provide regional estimates of the soybean acreage response to a $1 change in the price of soybeans. Their multipliers have been converted to acreage response for a one per cent change in price based upon the 1976-80 average price received. With constant yields, a one per cent increase in acreage will result in a one per cent increase in production.

A new equilibrium price and quantity can be calculated by setting the equilibrium quantity supplied equal to the equilibrium quantity demanded and solving for the percentage change in price required to establish a new equilibrium. The new equilibrium quantity supplied is the quantity supplied after cancellation, Q_A, plus the increase in production due to the price increase. The increase in production due to the price increase is equal to Q_A times the percentage increase in production due to a one per cent price increase, times the percentage increase in price. The new equilibrium quantity demanded is the original quantity demanded, Q_B, minus the decrease in quantity

demanded due to the price increase. The decrease in quantity demanded due to the price increase is equal to Q_B times the percentage decrease in quantity demanded due to a one per cent price increase, times the percentage increase in price. These calculations are represented in equation form as follows:

Equilibrium quantity supplied = Equilibrium quantity demanded

$$Q_A + Q_A \, (\% \, \Delta \, Q^s / \% \, \Delta \, P) \times \% \, \Delta \, P = Q_B + Q_B \times (\% \, \Delta \, Q^d / \% \, \Delta \, P) \times \% \, \Delta \, P$$

where

$\% \, \Delta \, Q^s / \% \, \Delta \, P$ = the percentage change in quantity supplied for a one per cent change in price and

$\% \, \Delta \, Q^d / \% \, \Delta \, P$ = the percentage change in quantity demanded for a one per cent change in price.

Solving for the percentage change in price required to attain a new equilibrium results in

$$\% \, \Delta \, P = \frac{Q_B - Q_A}{(\% \, \Delta \, Q^s / \% \, \Delta \, P) \, Q_A + (\% \, \Delta \, Q^d / \% \, \Delta \, P) \, Q_B}$$

This formula was used to determine the percentage change in price required to reach a new market equilibrium where the supply response was calculated by state. An 8.39 percentage increase in price was estimated to be required to reach equilibrium after cancellation. The calculations for determining the after cancellation equilibrium production are illustrated in Table 2. Details by state are provided in Appendix Tables 6 and 7.

Table 2. Illustration of Determination of After Cancellation Equilibrium Production for Representative States.

		Great Plains Nebraska	Corn Belt Illinois	Appalachia N. Carolina
(1)	Untreated Acres (1000 A)	1166.98	6090.12	963.50
	+	+	+	+
(2)	% Price Increase Due to Cancellation	8.39	8.39	8.39
	X	X	X	X
(3)	% Production (Acreage) Increase from 1% Price Increase/100	.712/100	.476/100	.556/100
	X	X	X	X
(4)	Untreated Acres (1000 A)	1166.98	6090.12	963.50
	=	=	=	=
(5)	Equilibrium Untreated Acres (1000 A)	1236.69	6333.34	1008.45
	X	X	X	X
(6)	Normal Yield (bu/A)	30.64	35.29	20.73
	=	=	=	=
(7)	Equilibrium Production (1000 bu) Untreated Acres	37892.23	223503.58	20905.08
(8)	Treated Acres (1000 A) W/O Pesticide (Constant Price)	312.03	3193.90	823.68
	+	+	+	+
(9)	% Price Increase Due to Cancellation	8:39	8.39	8.39
	X	X	X	X
(10)	% Production (Acreage) Increase from 1% Price Increase/100	.712/100	.476/100	.556/100
	X	X	X	X
(11)	Treated Acres (1000 A) W/O Pesticide (Constant Price)	312.03	3193.90	823.68
	=	=	=	=
(12)	Equilibrium Treated Acres (1000 A)	330.67	3321.45	862.10
	X	X	X	X
(13)	Yield after Cancellation (bu/A)	19.92	31.01	15.08
	=	=	=	=
(14)	Equilibrium Production (1000 bu) Treated Acres	6586.95	102998.16	13000.47

Net Impact Upon Producers

With equilibrium acreage and production determined it is then possible to determine the effect of cancellation upon revenues and costs of the producers. The details of these calculations are presented in Appendix Tables 7-9. A summary table by region is presented in Table 3.

The net impact upon producers of cancellation is a reduction of profits of $106.8 million. The Great Plains, Appalachia, Southeast and Delta all experience a decline in profits while the Lake States and Corn Belt realize an increase in profits. There is only one state in each of the Great Plains, Corn Belt and the Southeast that experience changes in profits that are opposite to the rest of the states in the respective regions. See Appendix Table 9.

Consumer Impact

Cancellation of Pesticide X on U.S. soybeans is estimated to increase the U.S. market price $0.67 per bushel ($8.00 to $8.67), causing consumers to cut their consumption of soybeans by 156.8 million bushels. Clearly, soybean consumers would be adversely impacted if a policy of cancelling the use of Pesticide X is implemented. The following sections discuss the magnitude and distribution of the loss in consumer welfare.

Estimates of Consumer Welfare Loss

Fortunately there are two easily calculated, straight forward measures of consumer welfare change which bound the welfare loss experienced by consumers of a good whose price has risen. The first measure is Laspeyres Variation (LV) and is defined as the exact change in income required to allow the purchase of the original quantity of the good after the price has changed. In this case, LV = ($8.67/bu. - $8.00/bu.) (1,916.5 mil.bu.) = $1,286.4

Table 3. Net Impact Upon Producers of Pesticide Cancellation

	GREAT PLAINS	LAKE STATES	CORN BELT	APPALACHIA	SOUTHEAST	DELTA	US
Normal Revenue	763.1	1409.7	8601.1	1341.0	993.8	2214.2	15323.0
Equilibrium Revenue Untreated Acres	655.2	1165.9	6681.4	713.1	556.5	1132.5	10904.6
Equilibrium Revenue Treated Acres	98.9	260.0	2317.7	505.5	347.3	817.1	4346.4
Change in Revenue	(9.0)	16.3	398.1	(122.5)	(89.9)	(264.7)	(71.7)
Normal TVC	193.7	349.7	2009.5	599.3	667.4	990.7	4810.3
Equilibrium TVC Untreated Acres	153.3	265.3	1441.8	295.5	340.2	467.5	2963.6
Equilibrium TVC Treated Acres	42.6	90.5	615.1	300.7	309.4	523.5	1881.8
Change in TVC	2.2	5.9	47.4	(3.1)	(17.8)	0.3	35.1
Change in Revenue - TVC	(11.2)	10.4	350.7	(119.5)	(72.2)	(265.0)	(106.8)

million. That is, if consumers purchased the same quantity of soybeans as they did before the cancellation but at the higher price, then an additional expense of $1,286.4 mil would be incurred.

An alternative estimate is provided by the Paasche variation measure of consumer welfare change (PV) which is defined as the exact change in income required to allow the purchase of the subsequent quantity of the commodity when facing the initial price situation. In this case, PV = ($8.67/bu. - $8.00/bu.) (1,759.7 mil.bu.) = $1,181.1 million. That is, if consumers could purchase the post-policy quantity of soybeans at the original price, a savings of $1,181.1 mil. would occur.

The PV and LV measures of consumer welfare change provide a range in which the actual welfare loss will occur. Thus, cancelling Pesticide X on U.S. soybeans can be expected to impose a loss on consumers of U.S. soybeans of no less than $1,181.1 mil. and no more than $1,286.4 mil. A midpoint estimate of (1,181.1 + 1,286.4)/2 = $1,233.8 million will be used below.

Distributive Considerations

The loss in consumer welfare resulting from cancellation of Pesticide X can be made more comprehensible by changing the aggregate estimates to per capita figures. Approximately 63.5% of soybean consumption occurs domestically with the remaining sales occurring abroad. Of the total loss of $1,233.8 million to consumers, $783.5 million would be incurred by U.S. soybean consumers while the remaining $450.3 million loss would be borne by foreign consumers. On a per capita basis, a consumer welfare loss of approximately $3.55 would be incurred domestically upon cancellation based upon a 1979 U.S. population estimate of 220.4 million.

Assumptions and Their Implications

Any analytical approach involves assumptions that help simplify the computations and reduce the empirical information required. In some cases the bias implied by the assumptions can be determined. The main assumption of the present analysis are discussed briefly below.

1. Producers are likely to adjust their inputs applied per acre in response to higher prices. The assumption that yields are not varied with soybean prices would be expected to result in an overestimate of the impact of cancellation upon producers and consumers.

2. The production of other crops would be expected to increase with the reduction in soybean acreage. If other crops are demand substitutes and supply substitutes, ignoring other crops results in an underestimate in the shift in supply and the increase in soybean price due to cancellation. However, if the production of other crops is increased consumers would gain from the larger quantities and lower prices of those crops and producers profits from the other crops would be affected as well. The effect of ignoring other crops in estimating producer and consumer welfare impact is therefore indeterminate without use of a more complex model.

3. The theoretically precise measures of consumer welfare change advocated by economists are compensating variation (CV) and equivalent variation (EV). Estimating these welfare measures requires additional information and incurs higher estimation costs. It suffices here to note that $PV<EV<CV<LV$.

4. The market shares for domestic and foreign consumption use could be expected to change slightly as soybean prices rose since domestic and foreign demand elasticities are slightly different. The effect of changing market shares, while small, would tend to increase domestic welfare losses and decrease foreign losses.

References

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USDA/ESS "Crop Production, 1980 Annual Summary , Acreage, Yield, Production", Cr Pr 2-1, January 1981.

USDA/ESS "Working Data For Demand Analysis", Table 8 - Consumer Price Index, Revision of March 1981.

APPENDIX Table 1. Short-run Cost and Yield Changes for Soybeans from Cancellation of Pesticide X.

REGION State a/	(1) ACRES TREATED AS PER CENT OF ACRES PLANTED b/	(2) INCREASE IN COST PER ACRE TREATED b/	(3) INCREASE IN COST PER ACRE TREATED c/	(4) NORMAL TVC PER ACRE d/	(5) TVC ON TREATED ACRES AFTER CANCELLATION (4)+(3)	(6) DECREASE IN YIELD PER ACRE TREATED b/	(7) 1976 YIELD e/	(8) DECREASE IN YIELD AS A PER CENT OF 1976 YIELD (6)/(7)	(9) NORMAL YIELD PER PLANTED ACRE f/	(10) YIELD ON TREATED ACRES AFTER CANCELLATION (9)-[(8)X(9)]
	(%)	(1976 $)	(1980 $)	(1980 $)	(1980 $)	(bu/acre)	(bu/acre)	(%)	(bu/acre)	(bu/acre)
GREAT PLAINS										
N.Dakota	26.0	3.83	5.54	49.02	54.56	7	12.5	56.0	20.72	9.12
S. Dakota	26.0	3.83	5.54	49.02	54.56	7	17.0	41.12	27.71	16.32
Nebraska	26.0	3.83	5.54	45.87	51.41	7	20.0	35.0	30.64	19.92
Kansas	26.0	3.83	5.54	52.19	57.73	7	15.0	46.67	20.29	10.82
LAKE STATES										
Minnesota	26.0	3.83	5.54	57.57	63.11	7	22.0	31.8	31.64	21.58
Wisconsin	35.67	0.16	0.23	61.32	61.55	4	22.0	18.2	31.16	25.49
Michigan	35.67	0.16	0.23	65.06	65.29	4	20.5	19.5	27.24	21.93
CORN BELT										
Iowa	26.0	3.83	5.54	61.79	67.33	7	31.0	22.58	36.19	28.02
Illinois	35.67	0.16	0.23	63.02	63.25	4	33.0	12.12	35.29	31.01
Indiana	35.67	0.16	0.23	67.65	67.88	4	34.0	11.76	35.26	31.11
Missouri	26.0	3.83	5.54	61.27	66.81	7	20.0	35.0	27.16	17.65
Ohio	35.67	0.16	0.23	69.12	69.35	4	33.0	12.12	34.23	30.08
APPALACHIA										
Kentucky	53.85	3.36	4.86	79.96	84.82	7	27.0	25.92	27.89	20.66
Tennessee	53.85	3.36	4.86	82.75	87.61	7	22.5	31.0	22.17	15.30
Virginias	50.0	1.11	1.61	84.49	86.10	6	20.5	29.27	21.70	15.35
Maryland	50.0	1.11	1.61	84.49	86.10	6	25.0	24.0	26.94	20.47
N. Carolina	50.0	1.11	1.61	90.76	92.37	6	22.0	27.27	20.73	15.08
SOUTHEAST										
Alabama	53.85	3.36	4.86	109.94	114.80	7	24.0	29.16	20.42	14.47
Georgia	50.0	1.11	1.61	105.36	106.97	6	23.5	25.53	18.39	13.70
Florida	50.0	1.11	1.61	105.18	106.79	6	26.0	23.08	24.78	19.06
S. Carolina	50.0	1.11	1.61	100.24	101.85	6	18.0	33.33	19.05	12.70
DELTA										
Arkansas	53.85	3.36	4.86	78.65	83.51	7	19.0	36.84	21.75	13.74
Louisiana	53.85	3.36	4.86	88.31	93.17	7	28.0	25.0	24.28	18.25
Mississippi	53.85	3.36	4.86	77.13	81.99	7	22.0	31.82	21.48	14.65

a/ Minor soybean producing states omitted are Delaware, New Jersey, New York, Oklahoma, Pennsylvania, and Texas.

b/ Provided by Aspelin/Swanson letter dated April 28, 1981.

c/ Adjusted to 1980 dollars with CPI.

d/ Source is W.C. McArthur, "Soybean Production Practices and Costs in the United States", Research Report 360, The University of Georgia, College of Agriculture, October 1980. Prices adjusted to 1980 dollars using CPI.

e/ Source is USDA/ESS Statistical Bulletin 646 "FIELD CROPS" Estimates By States, 1974-1978", December, 1980.

f/ 1976-80 Production divided by 1976-80 Planted Acreage. Sources are USDA/ESS Annual Publications "CROP PRODUCTION " for 1976-80.