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A COMPREHENSIVE EVALUATION OF INTERRELATED PESTICIDE REGULATIONS: THE CASES OF A DBCP BAN ON SOYBEANS AND A TOXAPHENE BAN ON COTTON

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Introduction

For the past decade the public's increasing concern about the environmental and human health hazard of pesticide application in agriculture has resulted in the Federal Insecticide, Fungicide, and Rodenticide Act (Stat. 7 U.S.C. 136D(B). This act gives the government authority to regulate, cancel, or initiate emergency measures restricting use of a pesticide.

Part of the regulatory process consists of the issuance of a Rebuttable Presumption Against Re-registration (RPAR) by the Environmental Protection Agency (EPA).[1] The U.S. Department of Agriculture then provides the EPA with an economic impact study to identify adverse biological and economic effects on agriculture from cancelling the use of the pesticide.

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[1]The RPAR process can be described as follows: When a particular pesticide is identified as a potential hazard to the environment and human health, the Environmental Protection Agency issues a Rebuttable Presumption Against Registration. In response to this document, an assessment team is formed to evaluate the biological and economic impact of withdrawing the pesticide from use. The team consists of scientists and economists from the U.S. Department of Agriculture, the Environmental Protection Agency, and other appropriate agencies of state and federal government. The team's report provides an impact into the EPA's risk/benefit decision. After evaluating the risk/benefit decision, the EPA specifies regulatory options for various uses. Some of the options are cancellation, registration, label modifications, or reclassification as a "restricted use" pesticide. The Secretary of Agriculture, the pesticide manufacturer(s) and other interested parties have 60 days to comment on the regulations imposed. EPA then prepares a final regulatory option, which ends the RPAR process. The next step for adversely affected users is administration law hearings.

There are thousands of pesticides with none absolutely risk free in terms of environmental and human hazards. An ideal situation would be to subject each pesticide to a thorough economic and environmental impact analysis before a specific regulatory option is applied. In reality, any analysis applied to a specific pesticide is always in response to a "trigger"--i.e., new scientific evidence that points to a potential human hazard such as carcinogenicity, mutagenicity, fetotoxicity, or environmental hazards to biological species. Therefore, at any one time, the RPAR process examines only what might be described as a chemical analogue of the FBI's most wanted fugitive list.

A regulation for a specific pesticide may have an immediate and differential cost and/or yield change on any directly affected crop in each region. The change then may affect the crop production and price and subsequently net farm income. The change, thus, may disturb the competitive position of a crop within a region and competitive advantage among regions for production of various crops. Consequently, the regulation may cause changes in crop production patterns within the region and/or a production shift from one region to another over time. To the extent that many of the suspect pesticides are applied to the same, or to the related agricultural commodity, decisions concerning pesticide regulations should be made within the context of relationships among crops as well as among pesticides.

The Need for a Hybrid Model

To evaluate the economic impact of a production technology change due to a pesticide suspension, economists are faced with insufficient historic data to build a proper evaluation model. Types of data required are yield and cost change data obtained either through field surveys or experiments. Often these data are not available and consequently economists must rely upon best judgment estimates. These estimates provide the data basis from which different economic analysis methods are applied. Econometric analysis, interregional linear programming, and partial budgeting techniques are three methods which have been used.

An econometric model can simulate a complex market structure and therefore provide a good evaluation of the price and aggregate production impacts. When sufficient time series data reflecting changes and impacts are available, this method is a proper tool for estimating the aggregate economic impact of a pesticide restriction. However, because sufficient time series data are not available, additional assumptions on supply responses are required to use such a method.

A programming model has an analytical structure for simulating the technical interrelationships between factor inputs and outputs. This method is frequently used to evaluate the probable impact of a technological change when historic data are not available. This method also is useful for examining interregional and intraregional production impacts under competitive conditions. It is, however, not a good method to investigate price impacts because of the difficulty in simulating the complex market activites.

The partial budgeting method is relatively easy to use, and provides good first approximations in estimating the impacts. But, the method does not provide for estimating possible shifts among crops and between regions whan a ban is imposed. It also does not estimate possible price changes and has to rely on an econometric model impact analysis to provide price information for its evaluation analysis.

An ideal evaluation model should incorporate detailed information using a technical structure similar to that found in a programming model to estimate possible supply adjustments resulting from a technical change, also time series information on market structure, process, and prices provided by the econometric simulation model for investigating market activities. A hybrid model which combines features from both the programming and the econometric model is very desirable.

In the past, ESCS and EPA have used partial budgeting methods to investigate aggregate production and income impacts [10, 11]. Niehaus and Reichelderfer estimated welfare costs of a pesticide regulation by using the econometric method [4]. Taylor, Lacewell, and Talpaz used an econometric model to evaluate aggregate impacts of a toxaphene ban [8]. Reichelderfer and Rovinsky evaluated interregional impacts of the toxaphene ban under alternative farm programs [6]. Weisz, Miller, and Quinby studied aggregate stochastic effects of a toxaphene ban on cotton by applying a simulation approach [9]. Each of these impacts studies is somewhat incomplete in producing a comprehansive evaluation of interrelated pesticide regulations. Also, results from any two of these studies may not be compatible because of a different time frame, biological information and assumptions.

A comprehensive evaluation should provide information at both the national and regional levels, consider the interrelationships among both pesticides and consider cross-commodity effects. It should give detailed impact information on market activities as well as regional production activities and resource use. The model should have the ability to simulate a dynamic sequence of the impacts over space and through time and provide a consistent set of economic performance measures. A recently developed hybrid model [1,3] which links a linear programming and an econometric component can be used as a comprehensive evaluation tool. The model takes advantage of the best features of both econometric and programming models and reduces problems associated with each.

The model that will be described in this paper uses an econometric component to estimate the impact of the regulation on national agricultural production and price and uses a programming component to examine the intraregional and interregional production and income shifts. The model is applied to evaluate impacts of a DBCP ban on soybean production, a toxaphene ban on cotton production, and a simultaneous ban on both DBCP and toxaphend, assuming the ban was implemented from 1975 to 1977.

Use of the Model

The CARD-NRED LP model [2] is used to construct the programming component of the hybrid model, while the CARD national agricultural econometric simulation [5] model provides the base for building the econometric component. The impact is measured as the production and price differences between a base run and a policy run of the hybrid model. The base run has no yield and cost adjustment in either component of the hybrid model. The policy run uses estimated regional yield and cost changes to adjust national average yields and costs in the econometric component and regional yields and costs in the linear programming component.

Figure 1 depicts the logical steps to follow in using the hybrid model for estimating national and regional production as well as price impacts. The adjusted yields and costs in the econometric component, with additional lagged price information, determine the profitability of crop production. The crop profitability and the land opportunity cost determine the expected planted acres of the directly affected crop and of other indirectly affected crops. The planted acres and their yields determine the expected quantities of production supply and subsequently the expected crop prices. These expected quantities of production of the crop and other crops serve as inputs to the LP model as the national production responses, while their expected prices are used to formulate the range of regional crop production responses and as the price coefficients in its objective function.

A linear programming component, with an objective function of maximizing net farm income subject to resource supply restraints, econometrically estimates national production, and regional production response is used to generate regional production. For a policy run, the procedures described use the econometric component to estimate the range of national aggregate production and uses the LP component to estimate the final regional production. This regional production is used to validate the econometrically estimated national production, and to adjust the quantity of national production when the econometric estimates become infeasible for the regions to respond. The procedure is proper for estimating the impacts only for an affected crop that is grown nationally and when the growers in or out of the affected regions have adequate time to adjust their cropping patterns before a particular pesticide ban is implemented.

Because the regional land opportunity costs and expected net incomes from growing each crop were not available at the time of this application, the regression equations (see Table 3) recently estimated by Roberts and Heady [7] are used for estimating the harvested acres for feed grain ($FG\text{-}AT_t$), wheat ($W\text{-}AC_t$), soybeans (SNB_t), and cotton ($CT\text{-}AC_t$). The immediate cost effect does not enter in determining either the harvested acres or the prices at this stage of model development. It does affect the interregional and intraregional crop production through the programming component. The immediate yield, however, does enter when determining both the national and regional production.

Empirical Results

This paper presents primarily estimates of the likely impact of national production and price changes, and the change in regional net income over the time period 1975 to 1977, associated with a DBCP and a toxaphene ban. Although a considerable amount of impact information is generated through the econometric and programming components, they are not included in this paper.[2] The model is run under four alternative economic settings:

1. Base Run--This initial run of the model establishes a baseline setting, assuming a free market situation and no pesticide ban.

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[2] Model outputs regarding impact on regional yields, costs and resource utilization, and impacts on national factor inputs, livestock production and market activities can be obtained from the authors.

(See Table 1 for a comparison of the national historical and baseline estimates.) The base run attempts to simulate the real world as much as possible.

2. DBCP Run--This run estimates a free market situation in the absence of DBCP use in soybean production.
3. Toxaphene Run--This run estimates a free market situation in the absence of toxaphene use in cotton production.
4. Simultaneous Run--This run estimates a free market situation in the absence of DBCP use in soybean production and toxaphene use in cotton production.

For alternatives 2 through 4, the cost and yield coefficients in the Base Run of the model were modified to "shock" the system for the purpose of policy analysis. These cost and yield changes (see Table 2) were derived from earlier partial budgeting and yield analyses [10,11].

Because this is the first application of the hybrid model to a policy analysis, there are still considerable areas in the model requiring further improvement. However, these results illustrate the type of information that can be produced from our methodology. The results reflect only what might have been the impact if the ban were implemented during 1975 to 1977, given the 1974 production pattern and prices and values of endogenous variables during the simulation period. For estimating future impacts, one should use the data reflecting a likely future economic setting in the period to be examined.

A. National Aggregate Impacts

The national price and production impacts of alternative pesticide regulations are illustrated in Table 1. The DBCP run shows no impact in either prices or production of soybean and other crops (cotton, corn, barley, oats, sorghum, wheat) considered. The toxaphene ban or the simultaneous ban on both pesticides yields the same price and production impacts. This indicates that the cancellation of toxaphene determines the impact results when both are banned. The annual cotton price increments over the baseline (in 1974 dollars) for three years (1975-1977) are $1.41, $3.55, and $5.94, respectively, per bale. The increasing price difference between the base run and the policy run over time reflects the transitory impact of a proposed toxaphene restriction. These estimates, especially the first and second year price impacts, are smaller than those in previous studies [8,9]. This is because the reduction of cotton supplies resulting from the ban is partially compensated by the transfer of the cotton from the inventory. A small price increase on soybeans also is observed. The price increase for 1976 and 1977 is $.002 and $0.0042 per bushel, respectively.

There is an annual departure from national baseline cotton production in each year of -2.7, -2.2, and -1.9 percent. The toxaphene ban also disturbs soybean and feed grain production. Soybean production is reduced in the second year, while feed grain production increases in the third year after the ban. These production changes are mainly due to a crop rotation adjustment process that minimizes the yield and cost impact of the toxaphene ban. Although these changes are very small, they do indicate that at the national level the cotton crop is complementary to the soybean crop production, but competitive to feed grains.

Evidently, as this study indicates, the toxaphene ban has a considerable aggregate impact on cotton production. It causes price increases and production decreases in cotton production. The "social costs" (in 1974 dollars), defined as the sum of reduction in net income and reduction of consumer surplus, are presented in the last column in Table 4. The net income reduction is attributed to the cost increase and yield decrease. The reduction of consumer surplus assumes the cotton demand curve does not change and is mainly because of the upward shift in the cotton supply curve. The DBCP ban has the social costs of approximately $22, $19, and $20 million for the years 1975, 1976, and 1977, respectively. These costs mainly are due to added costs for using an alternative pesticide. The approximate soical costs of the toxaphene ban are approximately $94, $86, and $105 million, respectively, over the three years. The reduction in net farm income declines from $76 to $31 million, while the reduction of consumers' surplus increases from $17 to $73 million in the three year period.

Social costs of the simultaneous ban are $116, $105, and $126 million, for the three year period, respectively. The reduction of the net farm income and consumers' surplus over the years follows the same pattern as the toxaphene ban. It has the same amount of reduction of consumers' surplus as the toxaphene ban. The change in net farm income is approximately the sum of the net income change from the DBCP ban and the toxaphene ban. The slight difference between the net farm income of reduction of the simultaneous ban and the sum of the net farm income reduction of the DBCP and toxaphene bans is caused by a slight difference in soybean production between the DBCP ban and the simultaneous ban.

B. Regional Impact

As mentioned earlier, a pesticide ban has a differential affect on production costs and yields by region. The effect may result in interregional or intraregional production shifts because of competition among crops for using production resources and a regional comparative advantage in a particular crop production.

The hybrid model allows production shifts from one crop to another and from one region to another to minimize aggregate net farm income. These shifts, however, are subject to the following two important restraints:

1. The shifts are subject to regional production flexibility restraints. The restraints use supply elasticity with respect to price to establish ranges which allow production changes from one year to the next.
2. The sum of the regional production of a crop is set close to the national production estimated by the econometric component.[3]

The USDA farm production regions are used as the basis for estimating regional impacts. The impacts by state from the model output are aggregated into these regions. Only the affected states requiring yield or cost adjustment according to the ban are included in the region. This system allows empirical results from the model to be comparable with the results shown in the reports by the USDA and EPA [10,11].

The general results from these runs are: (1) A ban on DBCP does not cause any interregional and intraregional shift of crop production.

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[3]The national production in the economic component will be set equal to the sum of the regional production if the latter can provide better estimation than the former.

The reason probably is that the cost increase in the affected region is not substantial enough to cause crop rotation changes within and/or between regions. The regional net income decrease in soybean production is primarily caused by the added cost of using alternative pesticides. These results are comparable to those obtained by the partial budgeting method. (2) The toxaphene ban causes not only a regional change of cotton production but also regional production changes of some other crops. (3) The simultaneous ban reflects the same production change as the toxaphene ban. This implies that the effect of a toxaphene withdrawal in the simultaneous ban determines the regional crop production pattern.

Tables 5, 6, 7, and 8 give the annual regional net income impacts obtained from the three policy runs. These impacts are discussed sequentially.

DBCP Ban on Soybeans

Table 5 shows the first year net income impacts on soybean production because of a ban of DBCP on soybean production with, and also without, a ban of toxaphene on cotton production. The figures in the first column show the net income change in each affected state. Accumulative net income decreases $23 million for all these states. At the regional level, the Delta leads in net income reduction, amounting to $11.5 million. The figures in the second column illustrate the ESCS-EPA estimated net income change in each state. Their figures are very comparable to the figures in the first column. Any discrepancy between the model estimates and the ESCS-EPA estimates is mainly because of the difference in estimated acreage used in their computation. The model uses predicted acres of 1975 soybean production in computing the net income, while the ESCS-EPA uses soybean acres from the average actual acres of 1974 to 1976. The figures in the third column show the regional change in net soybean income if a toxaphene is also withdrawn from use in cotton production. Adding the toxaphene ban causes a further net income decrease of about $1.4 million for soybean production. Income is reduced because of a decrease in the cotton-soybean rotation which has higher production costs. At the state level, however, inclusion of a toxaphene ban has a differential effect. A positive effect (net income increase) is observed in Arkansas, Tennessee, and Kentucky, while a negative effect is observed in Mississippi and Louisiana. Other states are not affected by the added ban. An increase in soybean production in the affected states is the main reason for the positive effect, and a decrease in the soybean production for the negative effect.

The regional net income changes over time is shown in Table 6. As indicated by the figures in the first column, the net income change over time is not significant. The percentage of annual net income reduction, however shows a steady decline. This is primarily due to the steady increase in net income caused by the price increase predicted by the model. The regional total cross-commodity effect of the DBCP is shown in column 4. These figures are the same as the ones in column 2, because the effect of the ban on other crops is negligible.

The Toxaphene Ban

Table 7 gives the regional net income impacts of the toxaphene ban. Only the directly affected states, as shown in the table, are included in the region. The ban will incur a total of $68.5 million income reduction from cotton production in these regions. The total income reduction, however, consistently improves over time because the ban causes an increase in the cotton lint price through a reduction in production as compared with production in the base run. At the regional level, again the Delta has the highest net income decrease, followed by the Southeast, Southern Plains, and Appalachian. Arizona, in the Southwest, shows a net income increase. In the Delta and the Southeast, net income decrease becomes less significant over time. This can be explained by the price increase due to a decrease in production.

The figures in column 3 show the ESCS-EPA estimates of net income decrease adjusted for the year 1975. In comparing each of the figures with the figure in column 1, there is a considerable difference in estimates between our results and those obtained in the earlier ESCS-EPA studies. The result, showing less total net income reduction from the model than from the ESCS-EPA estimates, can be explained partly by the interregional production adjustments allowed in using the model, and partly by their differences in estimating total production changes and the prices. Production predicted by the model is less than the actual production in 1975. This leads to the lower added cost due to the ban. The low estimated production can be partially explained by the shift of cotton production to production of other crops. These shifts were not considered in the ESCS-EPA estimates. The explanation also applies to the Southern Plains (Texas), which has the largest discripancy between the two estimates.[4]

The figures in columns 4 to 9 show the effects of net income changes of other crops when the toxaphene ban is imposed. Among the crops, sorghum and corn have a positive change in net income, while soybeans and oats have a negative change. Very little net income change is observed in barley. Over time, wheat, oats, and soybeans show a consistent negative net income change. At the regional level, the ban causes a considerable net income reduction for soybeans in the Delta area, while a considerable increase is shown in the Appalacian regions. In the Southern Plains, the ban causes a net income increase for both wheat and sorghum as cotton acreage is shifted to these two crops.

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[4] The net income change in the Southern Plains estimated by the model is significantly different from the ESCS-EPA estimate by the partial budgeting method. A further detailed explanation is given: The net income change is the sum of the income change (N_1) and the cost change (N_2). These two values (N_1 and N_2) are computed as follows:

$$N_1 = P_1Q_1 - P_0Q_0$$

$$N_2 = \sum_k A_{1k} (C_{0k} + \Delta C) - \sum_k A_{0k}C_{0k}$$

where P_0, Q_0, P_{0k}, and C_{0k} are the price, production, acres of crop rotation k and its acre production cost determined in the base run P_1, Q_1, A_{1k}, and ΔC are the prices, production, acres of the rotation k and added cost per acre in the policy run.

The value of N_2 is estimated to be \$-16,295 as contrasted with the added cost \$-19,400 in the ESCS-EPA estimation. Discrepancy between these two values is because the model slightly underestimates the 1975 harvest acres in the base run. The estimated value for N_1 is \$3.4 million as contrasted with the value of the loss of lint production, \$-13.5 million in the ESCS-EPA estimation. This discrepancy can be explained as: 1. An increase of production acres occurs in the policy run because the Southern Plains has comparative advantages of the cotton production over other production regions. The acres increase partially compensates for the production decline resulting from reduction in yield due to the ban. 2. An increase of cotton lint price in the policy run leads to an increase in income which also partially compensates for the income loss due to the decline in the yield resulting from the ban.

The total cross-commodity net income effects in these regions are shown in column 10. Because the total net income reductions for all crops ($71, $52, and $49 million in 1975, 1976, and 1977, respectively) are greater than the corresponding total net income reductions for cotton ($69, $45, and $41 million, respectively), tht net cross-commodity effect from the ban in these regions is negative.

The Simultaneous Ban

Table 8 shows the regional net income impacts of the simultaneous ban. Each state included in each region is either directly affected by the toxaphene ban and/or the DBCP ban. The total net income reduction over these regions is $94 million in the first year, but decreases to $66 million for the second and third years. The ban also produces a positive net income change for sorghum and corn. The Southeast, the Appalacian, and Corn Belt have a positive income change over time for corn. The Southern Plains also has an increase of net income for sorghum and wheat.

The Delta suffers the largest net income reduction, followed by the Southeast and Southern Plains. The Mountain, the Appalacian, and the Corn Belt regions have a net income increase over time.

Summary and Conclusions

A comprehensive evaluation of interrelated pesticide regulations is needed for making more rational decisions. A hybrid model which links an econometric component with a programming component is an appropriate evaluation tool. The model, using an econometric component to estimate the impact of the regulation on national agricultural production and price and a programming component to examine the intraregional and interregional production and income shifts, can simulate a dynamic sequence of the impacts over space and through time and can provide a consistent set of economic performance measures.

The model is applied to evaluate impacts of a DBCP ban on soybean production, a toxaphene ban on cotton production, and a simultaneous ban on both DBCP and toxaphene, assuming the ban was impletmented from 1975 to 1977. Some preliminary results indicate that the DBCP ban has little effect on soybean and other major crop production. Changes in net farm income are largely due to the added costs of using an alternative pesticide on soybeans. The change is comparable to results obtained with the partial budget method.

The toxaphene ban and the simultaneous ban cause increases in the price of cotton and a reduction in production. Each also affects soybean and feed grain production and to some extent soybean prices. The first year "social costs" of the simultaneous ban, for instance are estimated to be $116 million. The Delta suffers the largest net income reduction, followed by the Southeast and the Southern Plains in sequence, while the Mountain, the Appalacian, and the Corn Belt regions have substantial increases in net income over time.

The model is not completely developed. For instance, most of the regression equations in the econometric component were built in 1970 and need to be updated and reestimated. A better procedure for adjusting regional crop yields and production costs is yet to be developed. The data base (for instance, exogenous data file for the econometric component and the LP coefficient matrix for the programming component) which represents the years to be simulated, should be prepared to provide more rapid turnaround time for runs of the model.

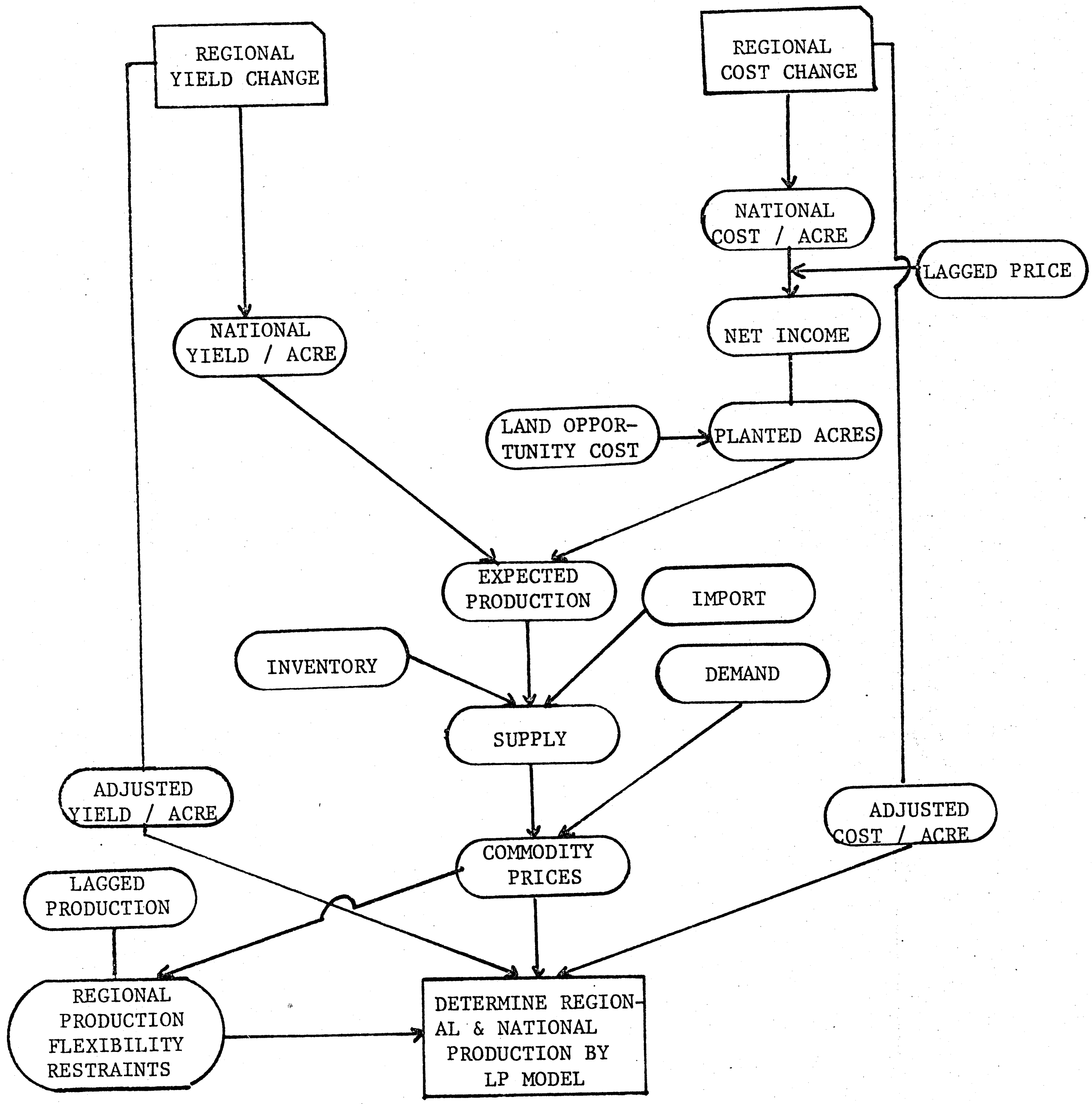

Figure 1. Procedure for estimating regional and national production impacts of a pesticide withdrawal

CHANGES IN COMMODITY PRICES (1974 dollars)

Year	Commodity	Actual	Base estimate	Change from Base Estimates: DBCP restriction on soybean	Change from Base Estimates: Toxaphene restriction on cotton only or with DBCP restriction on soybean	(%)
1975	CRN	2.32[1/]	2.11	0	0	
	BRL	2.21	1.79	0	0	
	OTS	1.33	.92	0	0	
	SRG	2.16	1.84	0	0	
	WHT	3.25	2.95	0	0	
	SBN	4.49	3.65	0	0	
	CTN	223.82	195.30	0	1.41	(.7)
1976	CRN	1.86	2.30	0	0	
	BRL	1.95	1.93	0	0	
	OTS	1.35	.99	0	0	
	SRG	1.76	2.01	0	0	
	WHT	2.37	2.40	0	0	
	SBN	5.91	5.78	0	.002	
	CTN	265.63	213.61	0	3.55	(1.6)
1977	CRN	1.66	2.77	0	0	
	BRL	1.47	2.22	0	0	
	OTS	.93	1.13	0	0	
	SRG	1.42	2.38	0	0	
	WHT	1.89	2.18	0	0	
	SBN	4.47	7.20	0	.0042	
	CTN	202.13	236.10	0	5.49	(2.3)

1/ CRN(Corn), BRL(Barley), OTS(Oats), SRG(Sorghum), WHT(Wheat), SBN(Soybean) : $/bu
CTN(Cotton) : $/bale

CHANGES IN CROPS PRODUCTION

Year	Commodity	Actual	Base estimate	Change from Base Estimates: DBCP restriction on soybean	Change from Base Estimates: Toxaphene restriction on cotton or with DBCP restriction on soybean	(%)
1975	F.G.	203.75[2/]	201.6	0	0.0	
	WHT	2,122.5	2,291.8	0	0	
	SBN	1,574.4	1,405.4	0	0	
	CTN	8.2	12.63	0	-341[3/]	(-2.7)
1976	F.G.	213.3	218.8	0	0.0	
	WHT	2,142.4	2,105.2	0	-0.0	
	SBN	1,287.6	1,277.8	0	-0.66	
	CTN	10.5	10.91	0	-245	(-2.2)
1977	F.G.	222.1	215.0	0	9.8	
	WHT	2,025.8	1,807.2	0	0.0	
	SBN	1,716.3	1,606.8	0	-1.27	
	CTN	14.3	12.50	0	-232	(-1.9)

2/ F.G. (Feed Grain) : million tons
WHT, SBN, BRL, OTS, SRG : million bu.
CTN : million bales

3/ F.G. : thousand tons
WHT, BRL, OTS, SRG, SBN : thousand bu.
CTN : thousand bales

Table 1. Aggregate estimates from Base Run and Aggregate impacts of banning DBCP and Toxaphene pesticides

	Cotton					Soybean	
Region	Yield Change[a/] (lbs. of lint)	Cost Change ($/acre)	Proportion of Acre Treated (percent)	Adjusted[b/] Yield Change (lbs./lint/acre)	Adjusted[b/] Cost Change ($/acre)	Cost Change[c/] ($/acre)	Adjusted Cost Change[d/] ($/acre)
Delta							
Arkansas	-64	5.69	31	-19.84	1.76	25.00	1.25
Louisiana	-64	5.69	1	- 8.32	0.74	25.00	1.25
Mississippi	-64	5.69	62	-39.68	3.53	17.00	0.85
Southeast							
Alabama	-38	5.02	19	- 7.22	0.95	17.00	0.85
Georgia	-38	5.02	85	-32.30	4.267	17.00	0.85
S. Carolina	-38	5.02	86	-32.68	4.32	17.00	0.85
Florida	0	0	0	0	0	17.00	0.85
Appalachian							
Virginia	0	0	0	0	0	4.00	0.2
N. Carolina	-38	5.02	91	-34.58	4.57	4.00	0.2
Tennessee	-38	5.02	10	- 3.8	0.50	25.00	1.25
Kentucky	0	0	0	0	0	25.00	1.25
Northeast							
Maryland	0	0	0	0	0	4.00	0.2
Mountain							
Arizona	-2	-2.73	29	0.58	-0.79	0.0	0.0
Southern Plains							
Texas	-16	12.13	33	-5.28	4.00	0.0	0.0
Oklahoma	0	0	0	0	0.0	25.00	1.25
Corn Belt							
Missouri	0	0	0	0	0.0	25.00	1.25

[a/] These data were taken from a report by USDA and EPA (11).

[b/] These figures were used to adjust the yield and cost coefficients in the model.

[c/] These data were taken from a report by USDA and EPA (8).

[d/] The report indicated that the cost changes would affect only 5 percent of the soybean acreage in each region. These data were used to adjust the production costs in the model.

Table 2. Cost and yield changes resulting from restriction of Toxaphene use in cotton production and DBCP use in soybean production

$$FG\text{-}AC_t = 148.3190 - \underset{(1.663)}{.1936}\ FG\text{-}DIV_t - \underset{(2.742)}{8.3925}\ FGBASE$$

$$- \underset{(1.869)}{284.4673}\ SB\text{-}PR_{t-1}/FG\text{-}PR_{t-1} - \underset{(3.877)}{177.1842}\ (W\text{-}PR_{t-1}/FG\text{-}PR_{t-1})WPRDUM \qquad (B.1)$$

$$- \underset{(5.165)}{.6876}T,$$

$$OLS,\ R^2 = .9475,\ MSE = 13.7008,\ DW = 1.919.$$

$$W\text{-}AC_t = 110.9438 - \underset{(13.575)}{18.1472}\ W\text{-}ALTDUM + \underset{(6.538)}{9.5091}\ W\text{-}VLPGDM$$

$$- \underset{(4.262)}{.5906}\ W\text{-}SBAR_t - \underset{(8.092)}{.8150}\ W\text{-}DIV_t - \underset{(3.722)}{8.0934}\ SB\text{-}PR_{t-1}/W\text{-}PR_{t-1}, \qquad (B.13)$$

$$ALS,\ \hat{\rho} = \underset{(2.168)}{-.3892},\ R^2 = .9523,\ MSE = 4.8141,\ DW = 2.1553.$$

$$SB\text{-}AC_t = 13.5195 + \underset{(5.470)}{7.2507}\ FMDUM1 - \underset{(3.684)}{.7137}\ FG\text{-}PR_{t-1}/SB\text{-}PR_{t-1}$$

$$- \underset{(1.432)}{4.4876}\ W\text{-}PR_{t-1}/SB\text{-}PR_{t-1} - \underset{(1.761)}{.3029}\ CT\text{-}PR_{t-1}/SB\text{-}PR_{t-1} \qquad (B.25)$$

$$+ \underset{(11.287)}{1.1104}T,$$

$$ALS,\ \hat{\rho} = .5920,\ R^2 = .9943,\ MSE = 1.3149,\ DW = 1.4148.$$

$$CT\text{-}AC_t = 29.0791 - \underset{(7.540)}{4.7336}\ CT\text{-}ALTDUM - \underset{(4.304)}{.7010}\ CT\text{-}DIV_t - \underset{(5.136)}{1.0053}\ CT\text{-}SBAR_t$$

$$+ \underset{(1.981)}{.0405}\ CS\text{-}PR_{t-1} - \underset{(1.858)}{54.1563}\ W\text{-}PR_{t-1}/CT\text{-}PR_{t-1}$$

$$- \underset{(1.520)}{1.7811}\ FG\text{-}PR_{t-1}/CT\ RP_{t-1} - \underset{(10.448)}{.4602}\ T, \qquad (B.33)$$

$$OLS,\ R^2 = .9727,\ MSE = 1.0415,\ DW = 2.3281.$$

Definition of Variable Code Names

The prescripts used in the equations refer to commodity groups: feed grain (FB), wheat (W), soybeans (SB), and cotton lint (CT).

Variable code name	Definition
AC	Harvested acreage (million acres) acres diverted for production under commodity programs (million acres)
DIV	Feed grain base dummy with 1961-1970-71 and 0 otherwise.
PR	Average crop year price received by farmers (FG, dollars per short ton; W and SB, dollar per bushel; and CT, cents per pound)
WPRDUM	Feed grain, wheat government program substitution dummy with 1954-1964=0 and elsewhere
T	Time trend with 1949=1,...1976=28
ALTDUM	Acreage allotment dummy set equal to 1 for years when the allotment was in effect and 0 otherwise
ULPGDM	Dummy for voluntary wheat program with 1965-1970=1 and 0 otherwise
SBAR	Acreage withheld from production under the Soil Bank Acreage Reserve Program (million acres)
FMDUM1	Free market dummy with 1973-1976=1 and 0 otherwise

Table 3. Regression equations for estimation harvested acres of feedgrain, wheat, soybean, and cotton (Roberts and Heady, 7)

	Change in net[a] farm income	Change in[b] consumers' surplus	Total change
		(thousand dollars)	
1. DBCP Ban			
Year			
75	-22,477	0	-22,477
76	-19,073	0	-19,073
77	-20,644	0	-20,644
2. Toxaphene Ban			
Year			
75	-76,404	-17,568	-93,972
76	-48,045	-38,296	-86,341
77	-31,713	-73,568	-105,281
3. Simultaneous Ban			
Year			
75	-99,143	-17,568	-116,802
76	-67,506	-38,296	-105,802
77	-52,800	-73,568	-126,368

[a] The figures are obtained from the output of the model.

[b] Aggregate change of consumers' surplus is computed by:

$$-\sum_{i=1}^{q} [(p_{i1} - p_{i0})q_{i1} + \frac{1}{2}(p_{i1} - p_{i0})(q_{i0} - q_{i1})]$$

where P_{i0} and P_{i1} are price of ith crop without and with the ban respectively

q_{i0} and q_{i1} are quantity of production of ith crop without and with the ban.

Table 4. Estimated "social costs" of a DBCP ban on soybean, a toxaphene ban on cotton production, and of a simultaneous ban of both DBCP and toxaphene.

	DBCP ban on soybean (1975) (1)	ESCS Estimate (1974-76) (2)	The simultaneous ban (1975) (3)
Delta			
Arkansas	-5,586	-5,550	-34
Louisiana	-2,898	-2,425	-6,820
Mississippi	-3,065	-2,515	-11,097
Subtotal	-11,549	-10,490	-17,951
Southeast			
Alabama	-1,066	-1,003	-1,066
Florida	- 346	- 238	- 346
Georgia	-1,006	- 918	-1,005
S. Carolina	-1,203	-1,088	-1,203
Subtotal	-3,621	-3,247	-3,620
Appalachian			
Virginia	- 84	- 84	- 84
N. Carolina	- 240	-264	-240
Tennessee	-1,591	-2,159	614
kentucky	- 926	-1,450	-623
Subtotal	-2,841	-3,948	-333
Norhteast			
Maryland	- 59	- 60	- 59
Southern Plain			
Oklahoma	- 291	- 300	-291
Corn Belt			
Missouri	-4,617	-5,425	-2,063
Total	-22,978	-23,470	-24,367

Table 5. First year Net Soybean Income changes (in thousand dollars) from a ban of DBCP on soybean production, and a simultaneous ban of DBCP on soybean production and a ban of toxaphene on cotton production

Region[1]	Soybean Meal	(%)	other crops (CRN, SRG, OTS, BRL, COT)	total
	(1)	(2)	(3)	(4)
Delta				
75	-11,549	(6.7)	negligible	-11,549
76	-11,339	(3.6)	"	-11,334
77	-10,864	(3.0)	"	-10,864
Southeast				
75	-3,620	(2.2)	"	- 3,621
76	-2,647	(3.1)	"	- 2,647
77	-2,845	(0.7)	"	- 2,845
Appalachian				
75	-2,841	(1.9)	"	- 2,841
76	-2,338	(0.9)	"	- 2,338
77	-2,701	(0.7)	"	- 2,701
Northeast				
75	- 59	(0.3)	"	- 59
76	- 44	(0.1)	"	- 44
77	- 60	(0.1)	"	- 60
Southern Plains				
75	- 291	(3.5)	"	- 291
76	- 203	(1.4)	"	- 203
77	- 243	(0.9)	"	- 243
Corn Belt				
75	-4,617	(2.3)	"	-4,617
76	-3,523	(1.4)	"	-3,523
77	-4342	(1.0)	"	-4,342
Total				
75	-22,978			-22,978
76	-20,094			-20,094
77	-21,053			-21,055

[1] See Table 3 for states in each region.

Table 6. Temporal net income change (in thousand dollars) of banning DBCP use on soybean production.

	Net Income change	Cotton (%)	Adjusted ESCS Estimate a/	Wheat	Barley	Oats	Sorghum	Corn	Soybean Meal	Total b/ Toxaphene ban only
				Net Income Change (Thousand $)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Delta (Arkansas, Louisiana, Mississippi)										
75	-35,735	(-18.93)	(-39,054)	- 0.04	0	0	-0.02	-0.10	-6,402	-42,137
76	-32,549	(-10.90)		-48.17	0	-9.50	-0.08	-0.89	-10,881	-43,488
77	-26,975	(- 5.98)		-319.90	0	-17.95	-0.13	-1.31	-10,642	-37,956
SE (Alabama, Georgia, S. Carolina)										
75	-16,105	(-73.40)	(-7,737)	0	0	0	-0.00	409.63	0.03	-15,695
76	- 8,490	(-25.48)		-430.45	-0.06	-59.34	0	312.76	-13.84	- 8,681
77	- 2,084	(- 3.65)		-396.34	-0.08	-113.79	-0.18	625.19	-1398.03	- 3.367
APPA (North Carolina, Tennessee)										
75	- 4,867	(-18.85)	(-2,136)	-0.02	-0.04	0	-0.00	251.94	2,205.02	- 2,410
76	- 2,191	(- 5.05)		-0.05	-0.09	-0.25	-0.02	174.27	4,265.02	2,250
77	- 514	(- .71)		-119.08	-0.31	-0.20	-0.18	376.23	3,043.00	2,786
SP (Texas)										
75	-12,916	(-7.29)	(-29,657)	158.27	-0.03	-0.01	248.94	-0.19	-0.10	-12,509
76	- 4,423	(-2.76)		116.57	-0.10	13.10	125.01	-5.09	-0.87	- 4,175
77	-13,585	(-5.41)		625.95	7.49	-70.60	335.75	-6.41	-3.70	-12,697
Mountain (Arizona)										
75	1,102	(5.56)	(156)	- 1.00	0	0	-.01	-0.06	0.0	1,101
76	1,771	(6.25)		- 1.14	-0.50	0	-.69	-0.07	0.0	1,769
77	2,008	(6.92)		- 0.88	-0.49	-0.49	-.54	-0.26	0.0	2,005
Total										
75	-68,521		(78,428)	157.21	-0.07	-0.01	248.91	661.22	-4,197	-71,650
76	-45,882			-363.74	-0.75	-55.99	124.22	480.98	-6,627	-52,325
77	-41,150			-210.25	6.4	-203.03	334.72	993.44	-9,000	-49,230

a/ The equation for computing the net income change is: $IC \times \frac{AP}{AP_2}$

where IC is the 1976 regional income change (including added cost and value of lost lint production) reported in USDA and EPA (1978).

AP_1 is regional planted acres in 1975.

AP_2 is regional planted acres in 1976.

b/ (10) = (1) + (4) + (5) + (6) + (7) + (8) + (9).

Table 7. Regional net income changes (in thousand dollars) from a ban of toxaphene use in cotton production.

	Cotton	Wheat	Barley	Oats	Sorghum	Corn	Soybean Meal	Total[a/] Toxaphene Ban Only
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delta (Arkansas, Louisiana, Mississippi)								
75	-35,735	-0.04	0	0	-0.02	-0.10	-17,951	-53,68
76	-32,549	-48.98	0	-9.50	-0.08	-0.89	-21,626	-54,234
77	-26,975	-319.94	0	-17.95	-0.13	-1.31	-21,503	-48,817
SE (Alabama, Florida, Georgia, South Carolina)								
75	-16,365	0.0	-0	-.0	-0.0	409.56	-3,620	-19,575
76	-8,711	-430.37	-0	-59.35	-0.0	311.66	-2,780	-11,669
77	-2,153	-396.34	-0	-113.81	-0.24	623.94	-3,043	-5,082
Appalacian (Virginia, N. Carolina, Tennessee, Kentucky)								
75	-4,927	-0.05	-0.25	0	-0.0	238.63	-333	-5,023
76	-2,226	-1.0	-0.68	-0.28	-0.6	146.77	2,517	435
77	-548	-144.71	-0.84	-0.22	-0.51	311.52	819	436
Mountain (Arizona)								
75	1,102	-1.0	0	0	-0	-0.06	0	1,100
76	1,771	-0.14	-0.49	0	-0.69	-0.07	0	1,768
77	2,008	-0.87	-0.49	0	-0.54	-0.26	0	2,005
SP (Texas, Oklahoma)								
75	-13,885	158.23	-0.02	-0.01	248.92	-0.47	-291	-13,769
76	-4,696	296.13	-0.32	24.14	121.00	-6.32	-204	-4,465
77	-18,850	1,808.34	7.30	-151.81	371.20	-8.43	-249	-17,072
Corn Belt (Missouri)								
75	-913	-0.0	-0.01	-0.0	-1.18	-20.16	-2,063	-2,997
76	-201	1.00	-0.07	-0.07	-5.24	562.00	1,420	1,716
77	1,096	-285.89	-0.08	-0.06	-5.03	536.75	580	1,921
Northeast (Maryland)								
75	0	-0.0	-0.0	-0.0	0	-3.66	-58.99	-62
76	0	-0.04	-0.40	-0.03	0	-11.03	-44.37	-55
77	0	-0.27	-0.35	-0.03	0	-10.23	-65.44	-76
Total								
75	-70,672	157.14	-0.28	-0.01	247.72	623.74	-24,317	-94,011
76	-46,672	-183.27	-2.02	-45.09	114.39	1,002.12	-20,717	-66,502
77	-45,422	660.32	5.44	-283.78	364.75	1,451.98	-23,461	-66,684

[a/] (8) = (1) + (2) + (3) + (4) + (5) + (6) + (7).

Table 8. Regional net income changes (in thousand dollars) from a simultaneous ban on cotton production and DBCP on soybean production

LITURATURE CITED

1. Huang, W. Y., E. O. Heady, and R. N. Weisz
Linkage of a National Recursive Econometric Model and An Interregional Programming Model for Agricultural Policy Analysis. Paper presented at meeting of the American Association for Advancement of Science, San Francisco, January 4, 1980.

2. Huang, W. Y., R. Weisz, and K. Alt.
An Overview of Data Processing Activities in CARD-NRED LP Model. Working paper, Center for Agricultural and Rural Development, Iowa State University, Ames, 1979.

3. Huang, W. Y., R. N. Weisz, K. H. Baum, E. O. Heady, and L. Teigen
"The Recursive Adaptive Programming Hybrid Model: A Tool for Analyzing Agricultural Policies." Agricultural Economics Research, Vol. 32, No. 1, January 1980.

4. Niehaus, R. D. and K. H. Reichelderfer
The Welfare Costs of Pesticide Regulation: The Case of Toxaphene on Cotton. USDA, ESCS, NRED. Unpublished working paper, 1978.

5. Ray, Daryll E.
An Econometric Simulation Model of United States Agriculture with Commodity Submodels. Unpublished Ph.D. thesis, Library, Iowa State University, Ames, 1971.

6. Reichelderfer, H. K. and R. K. Rovinsky
Interregional Impacts of a Pesticide Ban Under Alternative Farm Programs. A Linear Programming Analysis. USDA, ESCS, DSC. ESCS Staff Paper, April 1979.

7. Roberts, R. K. and E. O. Heady
An Analysis of Selected Policy Impacts on the U.S. Livestock Sector by an Econometric Simulation Model of U.S. Agriculture. CARD Report 92, Center for Agricultural and Rural Development, Iowa State University, Ames, 1980.

8. Taylor, C. R., R. D. Lacewell, and H. Talpaz
Use of Extraneous Information With An Econometric Model to Evaluate Impacts of Pesticide Withdrawals. Department of Agricultural Economics, Texas A & M University, 1978.

9. Weisz, R. N., R. R. Miller, and W. Quinby
"The Stochastic Effects of a Ban on Toxaphene Use on Cotton." Agricultural Economics Research, Vol. 31, No. 3, July 1979.

10. U.S. Department of Agriculture and Environmental Protection Agency "Economic and Social Impacts of Canceling Use of DBCP as a Pesticide for All Registered Use Sites with Known Current Usage." Report to the Administrator of EPA by the EPA Office of Pesticide Programs and NRED, ESCS, USDA, March 1978.

11. U.S. Department of Agriculture and Environmental Protection Agency "Impact of the Loss of Toxaphene on Selected Agricultural Uses: A Partial Budgeting Analysis," prepared by USDA State Assessment Team on Toxaphene in cooperation with the Environmental Protection Agency. U.S. Department of Agriculture, March 23, 1978.