FARM LEVEL IMPACTS OF REDUCED CHEMICAL USE ON SOUTHERN AGRICULTURE

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In anticipation of Congressional debates over an expanded environmental title in the 1990 farm bill, several studies on pesticide use and the impacts of reduction were undertaken (e.g., Smith et al., Knutson et al., Osteen and Szmedra, and GRC Economics). Osteen and Szmedra reported that the use of herbicides, insecticides, and fungicides increased steadily from post-World War II to 1982 before decreasing as crop prices declined and acreage reduction programs reduced planted acreage. Heightened concerns and perceptions about the presence of pesticides and nitrates in our food and water supplies have led to calls for the reduction and/or elimination of agricultural chemicals. For example, a National Academy of Science study has concluded and therefore fostered the perception that substantial reductions in chemical use are possible without large impacts on production and/or prices.

The economic impacts on U.S. agriculture and the general economy of banning most pesticides and inorganic nitrogen fertilizer use have been estimated by Smith et al. and Knutson et al. Their studies reported that substantially reduced chemical use would likely result in lower crop yields, higher crop prices, reduced crop consumption, and higher food costs. Although the studies provide regional implications of a ban on agricultural chemicals for the major program crops and the livestock sector, the researchers did not specifically estimate the firm level impact on the economic viability of crop and livestock farms.

The Smith et al. and Knutson et al. studies revealed a significant regional difference for many crops in terms of economic impact under the alternative reduced chemical use scenarios, especially in the colder Northern regions versus the warmer, more humid regions of the South. In addition, net income of crop producers improved as increases in crop price more than offset production loss and changes in input cost. The livestock sector, on the other hand, suffered economic losses as the cost of feeding increased. The purpose of this paper, therefore, is to quantify the likely impacts of a pesticide and inorganic nitrogen fertilizer ban on the economic viability of representative farms utilizing the macro results from the Smith et al. and Knutson et al. studies. In the process, it will be determined whether the firm level impacts are consistent with the macro results.

METHODOLOGY

To quantify the farm level impacts of a ban on pesticides and inorganic nitrogen fertilizer, representative farms in selected states were simulated using the Farm Level Income and Policy Simulation Model (FLIPSIM) developed by Richardson and Nixon. Representative crop and livestock farms were simulated under the following three technology scenarios:

BASE - Current use of pesticides and fertilizers as determined by panel farm data.

NOPEST - No pesticides (no herbicides, insecticides, and fungicides except for seed treatments and harvest aid chemicals).

NOCHEM - No chemicals (no pesticides and no inorganic nitrogen fertilizer).

Producer panel surveys were used to obtain information for describing and simulating representative farms under the base level of technology. The base data developed from the panel farm surveys were adjusted to reflect changes in yield, production cost, and prices consistent with the Smith et al. and Knutson et al. studies to simulate the NOPEST and NOCHEM scenarios. Yield and cost adjustments were made regionally on a crop-by-crop basis using the same assumptions as Smith et al. and Knutson et al.

The Smith et al. study utilized a modified Delphi procedure, involving input from more than 140 plant scientists, to obtain estimates of yield changes under the two chemical reduction scenarios for major program crops. A lead plant scientist for each crop was asked to estimate yield responses due to reduced chemical use, by ERS/USDA cost of production region, after allowing for changes in production technology as a substitute for chemicals. An agricultural economist at the lead scientist's university was asked to modify the ERS/USDA cost of production

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Table 1. Description of Representative Grain and Cotton Farms

	Grain Farms			
	Iowa	Missouri	Texas NHP[a]	Kansas
Acres owned	140	550	320	396
Acres leased	540	550	1280	804
Crop acres				
Corn	320	300	400	—
Wheat	—	200	600	1100
Sorghum	—	—	280	75
Soybeans	325	500	—	—
Assets($1,000)				
Real estate	256	558	172	320
Machinery	126	273	299	419
Gross receipts ($1,000)	141	199	310	126

	Cotton Farms		
	Mississippi	Texas SHP[b]	Texas RP[c]
Acres owned	735	340	325
Acres leased	735	1020	975
Crop acres			
Cotton	840	911	606
Sorghum	—	—	—
Wheat	—	—	390
Soybeans	560	—	—
Assets ($1,000)			
Real estate	742	152	174
Machinery	612	125	127
Gross receipts ($1,000)	587	158	117

Source: Agricultural and Food Policy Center, Texas A&M University.

[a] NHP is Northern High Plains region of Texas.
[b] SHP is Southern High Plains region of Texas.
[c] RP is Rolling Plains region of Texas.

budgets consistent with the plant scientist's chemical use reduction scenarios. The resulting yield and cost changes reflect the expert's best estimates of how producers would modify their cultural practices if faced with a ban on pesticides and inorganic nitrogen fertilizers.

Knutson et al. projected annual prices for crops, livestock, and feedstuffs under each of the three technology scenarios utilizing the Smith et al. data and the AG+GEM model developed by Penson and Taylor. The price estimates assumed frozen target prices and related program provisions authorized by the 1985 farm bill. Since AG+GEM models the interdependencies within and between the agricultural sector and the rest of the U.S. and world economy, projections of annual interest rates and rates of inflation for inputs and assets, consistent with ag sector prices, were available. Annual prices and interest rates were regionalized to the panel farm area based on local interest rates in 1990 and historical relationships between local and national prices for crops, livestock, and feedstuffs.

REPRESENTATIVE FARMS

Descriptive data for the representative farms used in the analysis are summarized in Tables 1-3. Grain farms representative of moderate size commercial operations in the Texas Northern High Plains, South Central Kansas, Northern Missouri, and North Central Iowa were selected for the analysis (Table 1). Similarly, moderate size commercial cotton farms in the Texas Southern High Plains, Texas Rolling Plains, and the Mississippi Delta were included (Table 1). Five dairy farms were analyzed; they repre-

Table 2. Description of Representative Dairy Farms

	Central Texas	East Texas	Florida
Acres owned	303	200	1340
Acres leased	303	200	—
Crop acres			
Coastal hay	150	250	351
Sudan hay	150	—	—
Corn silage	—	—	—
Sorghum silage	—	—	—
Assets ($1,000)			
Real estate	402	395	3109
Machinery	167	115	271
Livestock	471	172	1351
Gross receipts ($1,000)	651	425	2649
Number of cows	300	180	1000
Production/cow (cwt.)	136.9	136.9	150

	Wisconsin	New York
Acres owned	152	609
Acres leased	38	104
Crop acres		
Hay	48	—
Alfalfa	30	99
Haylage	42	128
Corn	36	89
Corn silage	18	99
Assets ($1,000)		
Real estate	217	506
Machinery	121	170
Livestock	89	218
Gross receipts ($1,000)	116	525
Number of cows	50	175
Production/cow (cwt.)	150	180

Source: Agricultural and Food Policy Center, Texas A&M University.

sent moderate size dairies in Central Texas, East Texas, Southern Florida, Wisconsin, and Western New York (Table 2). The grain-hog farms analyzed represent average size herds in Northern Missouri and Central Indiana (Table 3).

Information to describe the farms for the FLIPSIM model was developed using producer panels in each of the regions. Land-grant university specialists in each state were asked to select five or six producers representing average size commercial operations in

Table 3. Description of Representative Grain-Hog Farms

	Missouri	Indiana
Acres owned	320	280
Acres leased	110	520
Crop acres		
Corn	160	600
Soybeans	80	175
Wheat	80	25
Assets ($1,000)		
Real estate	302	750
Machinery	87	280
Livestock	36	51
Gross receipts ($1,000)	191	472
Number of sows	75	150
Finished hogs sold/year	1144	2460

Source: Agricultural and Food Policy Center, Texas A&M University.

a targeted area (county or multiple county region) to participate in the producer panel. Each producer panel was interviewed in a modified Delphi process designed to get a consensus on values to describe the farm, its enterprise costs, machinery complement, fixed costs, and enterprise mix. Historical yields (crops, milk per cow, pigs per sow, and hog sale weight) obtained from the producers are used with historical prices to develop a multivariate empirical probability distribution for yields and prices.

The producer panels were asked to verify the survey data and to examine a simulated *pro forma* income statement, balance sheet, and cash flow statement for each farm. If changes were made in the farm's data, new *pro forma* financial projections were developed and reviewed by the panel. This iterative procedure was continued until the producers were satisfied that the simulated results accurately reflected their consensus expectations for farms of their size and commodity makeup.

The BASE pesticide/fertilizer scenario represents the actual costs of production, yields, and cultural practices indicated by the producer panels. The NOPEST and NOCHEM scenarios called for a reduction in mean crop yields and generally a decrease in variable costs of production. The changes in yields and per acre variable cash costs for the seven grain and cotton farms projected by Smith et al. are summarized in Table 4.

The Smith et al. data base provided input cost changes, by ERS cost of production region and chemical scenario, for individual inputs including seed, fertilizer, chemicals, fuel, lube, custom opera-

Table 4. Summary of Percentage Changes is Yields and Per Acre Costs for Crop Farms in Selected Regions, Assuming No Pesticides and No Chemicals[a]

	No Pesticides		No Chemicals	
	Yields	Per Acre Costs	Yields	Per Acre Costs
	percentage change			
Iowa				
Corn	-31.0	-30.0	-48.0	-51.0
Soybeans	-33.0	-28.0	-33.0	-28.0
Missouri				
Corn	-31.0	-30.0	-48.0	-51.0
Soybeans	-33.0	-28.0	-33.0	-28.0
Wheat	-17.0	12.0	-35.0	70.0
Kansas				
Wheat	-7.0	13.0	-14.0	2.0
Sorghum	-20.0	-11.0	-35.0	34.0
Texas Northern High Plains				
Wheat irr.	-12.0	0.0	-30.0	-13.0
Sorghum irr.	-20.0	-11.0	-35.0	34.0
Corn irr.	-60.0	-37.0	-72.0	-47.0
Mississippi				
Cotton	-49.0	-25.0	-68.0	-37.0
Soybeans	-51.0	-18.0	-51.0	-18.0
Texas Southern High Plains				
Cotton	-38.0	-2.0	-63.0	-38.0
Texas Rolling Plains				
Cotton	-38.0	-2.0	-63.0	-38.0
Wheat	-12.0	0.0	-30.0	-13.0

Source: Smith et al.

[a] Smith et al. cost and yield changes were reported by ERS cost of production regions; changes for the typical farms were assumed the same as the regions where the farms were located.

tions, hired labor, repair, and technical services. The data for each panel farm was then modified by the projected changes in yield and per acre cost reflective of the chemical scenario and the ERS cost of production region where the farm was located.

For example, corn yields in Missouri under the NOPEST scenario would fall 31 percent and per acre variable costs of production would decline by 30 percent. Under the no chemical scenario, corn yields in Missouri would fall 48 percent and costs would decline by 51 percent (Table 4).

In most cases, lower yields were associated with lower variable cost of production. There were exceptions, however. Variable cost of production increased for wheat in Kansas and Missouri as reductions, primarily in fertilizer and chemicals, were offset by increases in other costs such as hired labor and machinery repair. Similar results were noted for sorghum under the NOCHEM scenario.

In addition to those cultural practice changes captured by variable cash expenditures, an annual green manure plow down crop was assumed for the no chemical scenario on 25 percent of the wheat acres for the Kansas farm (59 percent for Texas) and 30 percent of the sorghum acres for the Texas and Kansas farms. Rotated acreage was assumed to be planted to a green manure crop at an annual per acre cost of $35.

Yield and per acre production cost adjustments specified by Smith et al. were also made for crops produced on the dairy farms and hog farms. These farms did not use large quantities of inorganic nitrogen fertilizer so the NOCHEM scenario did not cut their costs appreciably. As with the crop farms, mean annual yields were not decreased to their lower values in the first year simulated, but they were gradually reduced to correspond to the assumption of residual effects of chemicals on production.[1]

The absence of adequate information on how yield and price risk would change under the NOPEST and NOCHEM scenarios led the authors to maintain the historical relative variability of crop yields and prices. While one would expect increases in yield and price variability without chemical technology, the magnitude of these effects was not quantified by Smith et al. and Knutson et al. It can, therefore, be anticipated that the results presented here with respect to risk are conservative.

To insure consistency with the Knutson et al. price projections, the farms were simulated under the assumption that the 1985 farm bill would be continued through 1994. Target prices were frozen at their nominal 1990 levels for 1991-1994. Loan rates were set at their 1985 farm bill formula levels and set aside levels were set annually by Knutson et al. to maintain the ending stocks to use ratio within targeted ranges, based on recent administrative decisions. Annual prices, loan rates, ARP percentages, and target prices for all three scenarios were reported by Knutson et al.

FARM LEVEL IMPACTS

The results of simulating the 14 representative farms under three chemical use scenarios are summarized in Tables 5-8. Results for the 1990-1994 planning horizon are summarized in terms of the projected effects on income (average annual cash receipts, cash expenses, net cash farm income) and net worth (present value of ending net worth [PVENW], PVENW as a percent of beginning net worth, and ending equity to assets ratio).

Grain Farms

The Midwestern grain farms experienced increases in average annual cash receipts and net cash farm incomes under both the NOPEST and NOCHEM scenarios (Table 5). The Iowa farm experienced a 12.5 percent increase in average annual cash receipts in the absence of pesticides and a 28.9 percent increase in receipts in the absence of both pesticides and inorganic nitrogen fertilizers (NOCHEM). Couple the increases in cash receipts with over a 20 percent decline in average annual cash expenses and the net cash farm income for the Iowa farm increases by 52.8 percent for NOPEST and 94.2 percent for NOCHEM. Similar percentage changes in receipts, expenditures, and net incomes were observed for the Missouri grain farm.

In contrast, the Kansas and Texas Northern High Plains grain farms experienced decreases in net cash income under the NOPEST and NOCHEM scenarios (Table 5). Cash receipts increased modestly (4.6 percent) for the Kansas farm but decreased 11.6 percent for the Texas farm as pesticides were removed. Under the no chemicals scenario, both the Kansas and Texas farms experienced lower cash receipts, 15.7 and 10.6 percent, respectively. The lower revenues for these grain farms can be explained, in part, by the assumption that sorghum and wheat producers in Texas and Kansas need to include a legume plow down crop on 30 percent of the sorghum land and 25 percent of the wheat land (5 percent in Texas) in order to maintain fertility. A second explanation for the lower incomes for the Kansas and Texas grain farms is that yields decreased relatively more than other regions (Table 4) so that the price elasticity effect that increased receipts for the Midwestern farms did not benefit the Texas and Kansas farms as much.

Under both chemical reduction scenarios, the Kansas grain farm experienced an increase in total cash expenses from 10 to 13.4 percent as increases in labor, repair, seed, and fuel costs offset the reduction in chemicals and fertilizer (Table 5). The Texas Northern High Plains farm experienced a 9.1 percent decline in cash expenditures under NOPEST but an increase of 1.7 percent under NOCHEM. The results differ from Kansas in that the Texas farm had a greater proportion of its land devoted to sorghum, a crop that experienced an 11 percent decline under NOPEST but a 34 percent increase in production cost under NOCHEM (Table 4).

Eliminating pesticides and inorganic nitrogen fertilizer was projected to increase the net worth of Midwestern grain farms substantially (12-27 percent) while decreasing considerably more the net worth (34-40 percent) of Kansas and Texas Northern High Plains grain farms (Table 5).

The farm level results reinforce the findings of Smith et al. and Knutson et al. in terms of differential impacts between the grain farms in the Midwest and those in Southern regions. Higher crop producer

[1] Knutson et al. assumed no reduction in yields for 1990, a 50 percent residual chemical carryover in 1991, a 30 percent residual carryover in 1992, a 10 percent residual carryover in 1993, and no carryover for 1994 and beyond.

Table 5. Economic Impacts for NOPEST and NOCHEM on incomes and net worth of Average Size Grain Farms in Iowa, Missouri, Kansas, and Texas Northern High Plains

	Iowa			Missouri		
	BASE	NOPEST	NOCHEM	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)						
Mean	150.09	168.90	193.51	204.38	234.34	258.34
Average Annual Cash Expenses ($1000)						
Mean	81.64	64.34	60.58	116.75	99.21	94.03
Average Annual Net Cash Income ($1000)						
Mean	68.45	104.57	132.93	87.63	135.12	164.31
Present Value Ending Net Worth (PVENW) ($1000)						
Mean	419.96	490.16	530.49	857.16	937.25	965.73
PVENW as % of Beginning Net Worth (%)						
Mean	127.92	149.30	161.59	120.88	132.18	136.20
Ending Equity Ratio (fract.)						
Mean	0.87	0.92	0.92	0.92	0.95	0.95

	Kansas			Texas Northern High Plains		
	BASE	NOPEST	NOCHEM	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)						
Mean	126.77	132.60	106.85	328.04	289.90	293.26
Average Annual Cash Expenses ($1000)						
Mean	102.35	112.62	116.15	265.87	241.70	270.39
Average Annual Net Cash Income ($1000)						
Mean	24.42	19.98	-9.30	62.17	48.20	22.86
Present Value Ending Net Worth (PVENW) ($1000)						
Mean	374.00	343.55	224.23	492.20	428.38	325.73
PVENW as % of Beginning Net Worth (%)						
Mean	87.42	80.30	52.41	113.94	99.16	75.40
Ending Equity Ratio (fract.)						
Mean	0.66	0.63	0.42	0.96	0.88	0.71

Annual Cash Receipts - Total cash receipts from crops, dairy, livestock, government payments, and other farm-related activities.
Annual Cash Expenses - Total cash costs for crops, dairy, and livestock production, including interest costs and fixed cash costs; excludes depreciation.
Annual Net Cash Income - Total cash receipts minus total cash expenses; excludes family living expenses, principal payments, and costs to replace capital assets.
Present Value Ending Net Worth - Discounted value of farm's net worth in the last year simulated.
PVENW as Percent of Beginning Net Worth - Ration of present value of ending net worth and initial net worth (measures real change in equity).
Ending Equity Ratio - Total net worth divided by total assets in the last year simulated..

income overall masks the specific farm level effects and the magnitude of the regional impact differences.

Cotton Farms

The impacts of NOPEST and NOCHEM on average annual net cash farm income for the three cotton farms were mixed (Table 6). Cash receipts on the Mississippi and Southern High Plains farms decreased (8 percent and 1 percent) while receipts for the Rolling Plains farm increased slightly (1 percent) in the absence of pesticides. Higher cotton prices roughly offset reduced yields for cotton farmers. The NOCHEM scenario also resulted in mixed increases and decreases in receipts for the three farms. With the one exception of the Southern High Plains farm under the NOPEST scenario, all farms experienced lower average annual cash expenses under the

Table 6. Economic Impacts for NOPEST and NOCHEM on Incomes and Net Worth of Average Size Cotton Farms in Mississippi and Texas

	Mississippi			Texas Southern High Plains		
	BASE	NOPEST	NOCHEM	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)						
Mean	597.77	550.34	596.41	175.55	174.27	185.69
Average Annual Cash Expenses ($1000)						
Mean	592.35	563.45	529.97	134.29	141.64	100.71
Average Annual Net Cash Income ($1000)						
Mean	5.42	-13.11	66.43	41.26	32.63	84.97
Present Value Ending Net Worth (PVENW) ($1000)						
Mean	862.23	722.65	920.87	286.26	241.62	383.11
PVENW as % of Beginning Net Worth (%)						
Mean	76.68	64.27	81.90	122.88	103.72	164.45
Ending Equity Ratio (fract.)						
Mean	0.65	0.57	0.74	0.91	0.81	0.96

	Texas Rolling Plains		
	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)			
Mean	125.37	127.46	131.59
Average Annual Cash Expenses ($1000)			
Mean	122.29	108.31	88.48
Average Annual Net Cash Income ($1000)			
Mean	3.08	19.15	43.10
Present Value Ending Net Worth (PVENW) ($1000)			
Mean	212.73	258.38	312.34
PVENW as % of Beginning Net Worth (%)			
Mean	76.26	92.62	111.97
Ending Equity Ratio (fract.)			
Mean	0.58	0.72	0.86

Annual Cash Receipts - Total cash receipts from crops, dairy, livestock, government payments, and other farm-related activities.
Annual Cash Expenses - Total cash costs for crops, dairy, and livestock production, including interest costs and fixed cash costs; excludes depreciation.
Annual Net Cash Income - Total cash receipts minus total cash expenses; excludes family living expenses, principal payments, and costs to replace capital assets.
Present Value Ending Net Worth - Discounted value of farm's net worth in the last year simulated.
PVENW as Percent of Beginning Net Worth - Ration of present value of ending net worth and initial net worth (measures real change in equity).
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NOPEST and NOCHEM scenarios. The Southern High Plains farm grew only cotton, and reductions in chemicals and fertilizer were more than offset by increases in fuel, labor, and repair.

Assuming BASE technology, the Mississippi and Rolling Plains cotton farms lost 24 percent of their equity over the 1990-1994 planning horizon (Table 6). The Texas Southern High Plains cotton farm increased net worth 23 percent. Eliminating pesticides did not cause cotton revenues/cost to increase sufficiently to reverse the loss in net worth on the Mississippi and Rolling Plains farms. In addition, real equity growth was dampened on the Southern High Plains farm under the NOPEST scenario.

Eliminating all chemicals led to the Mississippi farm continuing to lose equity, albeit at a slower rate (18 percent as compared to 23 percent), over the 1990-1994 period while the two other farms experienced increased net worth. The Rolling Plains farm experienced a 47 percent increase in real net worth

(Table 6) relative to the BASE. The Southern High Plains farm increased net worth by 34 percent compared to the BASE.

Dairy Farms

All five dairy farms experienced increased revenues due to higher milk and livestock prices under the NOPEST and NOCHEM scenarios. Average annual cash receipts increased 1 to 4 percent (Table 7). However, these increased receipts were not sufficient to overcome the increased feed costs resulting from increases in the price of purchased feeds. Average annual cash expenses increased 20 to 44 percent for the NOPEST scenario and from 39 to 51 percent for the NOCHEM scenario. Net cash incomes for the five dairy farms decreased 25 to 559 percent as a result of banning pesticides. On average, both Texas dairies lost more than 100 percent of their equity under the no pesticides scenario while the Florida dairy experienced a real equity decline of 37 percent. Under the no chemicals scenario, all three Southern dairies lost more than 100 percent of their equity while the Wisconsin and New York dairies, although hurt, were able to maintain 71 to 78 percent of their initial equity.

Dairies that grow their own feed are better able to survive significant increases in purchased input prices. If these farmers have options outside dairying, however, they may opt to take advantage of the higher opportunity cost associated with selling grain and/or become crop farmers. Accordingly, the farm level results suggest that the Knutson et al. study may have underestimated the impacts of the NOPEST and NOCHEM options on the price of milk nationally, as well as regionally.

Grain-Hog Farms

In contrast to the dairies, the Missouri and Indiana grain-hog farms experienced slightly lower to about the same net incomes under the reduced chemical scenarios (Table 8). These farms raised almost all of the corn required for their hogs and the increased value of their soybeans helped offset the higher prices for soybean meal. In addition, changes in rotation patterns and the availability of livestock manure made these farms less dependent on inorganic nitrogen fertilizer. These factors combined to bolster net farm incomes relative to the representative dairy farms. The Indiana farm had more hogs and was more profitable (greater net cash farm income) than the Missouri farm under the base. The Indiana farm was better able to maintain its income under the NOPEST and NOCHEM scenarios, due in part to higher initial corn yields, more acres of corn, and smaller yield reductions. In terms of real ending net worth, the Indiana farm increased real net worth 26 percent under both scenarios. The Missouri farm increased real net worth 8 percent for the NOPEST scenario and decreased it 9 percent for the NOCHEM scenario. These results are far different from the ending net worths for the Southern dairy farms.

SUMMARY AND CONCLUSIONS

Knutson et al. provided sector level forecasts of pesticide and inorganic nitrogen fertilizer reductions on U.S. agriculture. They concluded that crop producers' net farm incomes would improve as crop prices increase, while livestock and diary producers would suffer economic losses due to increases in the price of purchased feedstuffs. The purpose of this study was to test the consistency of these results on the economic viability of representative crop, livestock, and dairy farms.

This test was accomplished by simulating representative grain farms (Iowa, Missouri, Kansas, and Texas), cotton farms (Mississippi and Texas), dairy farms (Texas, Florida, Wisconsin, and New York), and hog farms (Missouri and Indiana) under alternative technology scenarios using FLIPSIM. The technology scenarios were: (a) current levels of pesticide and inorganic nitrogen fertilizer use, (b) no pesticides (insecticides, herbicides, and fungicides), and (c) no chemicals (no pesticides and no inorganic nitrogen fertilizer). Assumed yield and production cost changes for the no pesticide and no chemical scenarios were taken from the data base developed by Smith et al. and used by Knutson et al.

Projected crop, livestock, and feedstuff prices; interest rates; and inflation rates for the three technology scenarios were developed by Knutson et al. using the AG+GEM model to provide a consistent set of prices and costs. Fourteen representative farms were simulated over the 1990-1994 planning horizon using the projected prices, interest rates, and inflation rates, and assuming a continuation of the 1985 farm program.

Results of the farm level simulations indicate that Midwest grain farmers would initially gain from a NOPEST and a NOCHEM scenario in terms of greater net cash farm incomes and more rapid growth in real net worth due to a favorable climate and resource base. In contrast, grain farms in Kansas and Texas experienced lower net cash incomes and real losses in net worth under the NOPEST and NOCHEM scenarios.

Removing pesticides resulted in a negative impact on the Mississippi and Texas Southern High Plains cotton farms but improved the situation for the Texas Rolling Plains. The NOCHEM scenario led to an increase in real net worth for the three cotton farms

Table 7. Economic Impacts for NOPEST and NOCHEM on incomes and Net Worth of Average Size Dairy Farms in Texas, Florida, Wisconsin, and New York

	Erath County Texas			Hopkins County Texas		
	BASE	NOPEST	NOCHEM	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)						
Mean	697.02	719.95	713.39	458.19	471.16	470.84
Average Annual Cash Expenses ($1000)						
Mean	628.34	841.56	899.50	373.94	475.06	521.56
Average Annual Net Cash Income ($1000)						
Mean	65.08	-125.21	-189.70	16.16	-74.11	-122.05
Present Value Ending Net Worth (PVENW) ($1000)						
Mean	855.42	-121.12	-520.30	452.58	-23.14	-308.39
PVENW as % of Beginning Net Worth (%)						
Mean	98.08	-13.89	-59.66	77.33	-3.95	-52.69
Ending Equity Ratio (fract.)						
Mean	0.91	-0.31	-0.98	0.70	-0.12	-0.89

	Florida			Wisconsin		
	BASE	NOPEST	NOCHEM	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)						
Mean	2821.91	2881.02	2922.02	126.60	128.84	132.02
Average Annual Cash Expenses ($1000)						
Mean	2488.10	2993.45	3570.16	70.66	86.64	106.78
Average Annual Net Cash Income ($1000)						
Mean	231.02	-214.00	-752.24	55.94	42.20	25.24
Present Value Ending Net Worth (PVENW) ($1000)						
Mean	4333.30	2600.02	-231.38	379.89	341.81	269.95
PVENW as % of Beginning Net Worth (%)						
Mean	104.83	62.90	-5.60	108.90	97.98	77.38
Ending Equity Ratio (fract.)						
Mean	0.97	0.62	-0.09	0.95	0.87	0.71

	Central New York		
	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)			
Mean	558.42	572.77	582.23
Average Annual Cash Expenses ($1000)			
Mean	381.71	460.26	559.65
Average Annual Net Cash Income ($1000)			
Mean	176.70	112.50	22.58
Present Value Ending Net Worth (PVENW) ($1000)			
Mean	1042.74	870.56	528.25
PVENW as % of Beginning Net Worth (%)			
Mean	139.53	116.49	70.69
Ending Equity Ratio (fract.)			
Mean	0.96	0.94	0.62

Annual Cash Receipts - Total cash receipts from crops, dairy, livestock, government payments, and other farm-related activities.
Annual Cash Expenses - Total cash costs for crops, dairy, and livestock production, including interest costs and fixed cash costs; excludes depreciation.
Annual Net Cash Income - Total cash receipts minus total cash expenses; excludes family living expenses, principal payments, and costs to replace capital assets.
Present Value Ending Net Worth - Discounted value of farm's net worth in the last year simulated.
PVENW as Percent of Beginning Net Worth - Ration of present value of ending net worth and initial net worth (measures real change in equity).
Ending Equity Ratio - Total net worth divided by total assets in the last year simulated..

Table 8. Economic Impacts for NOPEST and NOCHEM on Incomes and Net Worth Average Size Grain-Hog Farms in Missouri and Indiana

	Missouri			Indiana		
	BASE	NOPEST	NOCHEM	BASE	NOPEST	NOCHEM
Average Annual Cash Receipts ($1000)						
Mean	197.90	188.36	189.94	493.14	481.79	482.22
Average Annual Cash Expenses ($1000)						
Mean	121.63	132.30	148.55	255.65	262.42	244.39
Average Annual Net Cash Income ($1000)						
Mean	71.87	52.12	37.29	235.55	217.89	236.53
Present Value Ending Net Worth (PVENW) ($1000)						
Mean	442.80	378.87	316.95	1189.87	1117.79	1104.13
PVENW as % of Beginning Net Worth (%)						
Mean	126.99	108.65	90.89	136.12	127.87	126.31
Ending Equity Ratio (fract.)						
Mean	0.94	0.92	0.83	0.94	0.95	0.94

Annual Cash Receipts - Total cash receipts from crops, dairy, livestock, government payments, and other farm-related activities.
Annual Cash Expenses - Total cash costs for crops, dairy, and livestock production, including interest costs and fixed cash costs; excludes depreciation.
Annual Net Cash Income - Total cash receipts minus total cash expenses; excludes family living expenses, principal payments, and costs to replace capital assets.
Present Value Ending Net Worth - Discounted value of farm's net worth in the last year simulated.
PVENW as Percent of Beginning Net Worth - Ratio of present value of ending net worth and initial net worth (measures real change in equity).
Ending Equity Ratio - Total net worth divided by total assets in the last year simulated.

relative to the BASE. However, the Mississippi farm would continue to lose equity over the time period even though its revenue/cost relationship was improved.

All five dairy farms experienced substantially lower net incomes under the NOPEST and NOCHEM scenarios. Their cash receipts increased 1 to 4 percent due to higher milk and livestock prices. Increased product prices did not cover the increased prices of purchased feedstuffs. As a result, the three representative Southern dairy farms experienced negative net cash incomes and lost most or all of their equity over the five-year planning horizon. Wisconsin and New York dairies were less impacted due to less reliance on purchased feeds.

Midwest grain-hog farms fared much better, as did the Midwest grain farms. The Indiana hog farm continued to build net worth even under the more restrictive (NOCHEM) scenario. The Missouri farm increased real net worth under the NOPEST scenario and only experienced a 9 percent loss in real net worth for the NOCHEM scenario.

These results indicate that eliminating pesticides and inorganic nitrogen fertilizer would have mixed economic impacts. Grain farms in the Midwest would benefit while grain farms in Kansas and Texas would suffer. Cotton producers in Texas would increase real net worth from higher cotton prices under the NOCHEM scenario while Mississippi cotton producers would continue to see equity eroded. Dairy farmers in the South would be forced to exit the industry or make dramatic changes in how they produce milk. Midwestern hog producers who raise their own grain would generally see their condition improve from higher livestock prices. Swine operations less self-sufficient in feed production certainly would experience the same loss in revenue as the Southern dairy producers.

In general, the findings of this farm level analysis do not contradict the results and conclusions of Smith et al. and Knutson et al. However, by combining farm level analysis with the predictions of macro models, it is possible to develop more precise indications of the direction and magnitude of impacts. If anything, this analysis suggests that agriculture in the South would be even more adversely affected than the Knutson et al. conclusions indicated. In addition, potential underestimations of impacts, such as in milk price increases, could have been detected by combining macro and farm level analysis.

REFERENCES

GRC Economics. "The Value of Crop Protection Chemicals and Fertilizers in American Agriculture and the Consumer." Washington, D.C.: National Agricultural Chemicals Association, 1989.

Knutson, R.D., C.R. Taylor, J.B. Penson, and E.G. Smith. *Economic Impacts of Reduced Chemical Use.* College Station, Texas: Knutson and Associates, 1990.

National Research Council, National Academy of Science. *Alternative Agriculture.* Washington, D.C.: National Academy Press, 1989.

Osteen, C.D. and P.I. Szemdra. *Agricultural Pesticide Use Trends and Policy Issues.* USDA ERS, Agr. Econ. Rep. 622, September 1989.

Penson, J.B., and C.R. Taylor. "Modeling the Interface Between Agriculture and the General Economy." Dept. Agr. Econ., Agricultural and Food Policy Center Working Paper No. 90-13, Texas A&M University, 1990.

Richardson, J.W. and C.J. Nixon. *Description of FLIPSIM V: A General Firm Level Policy Simulation Model.* Texas Agricultural Experiment Station Bulletin B-1528, 1986.

Smith, E.G., R.D. Knutson, C.R. Taylor, and J.B. Penson. *Impacts of Chemical Use Reduction on Crop Yields and Costs.* AFPC, Department of Agricultural Economics, Texas A&M University, in cooperation with the National Fertilizer and Environmental Research Center of the Tennessee Valley Authority, 1990.