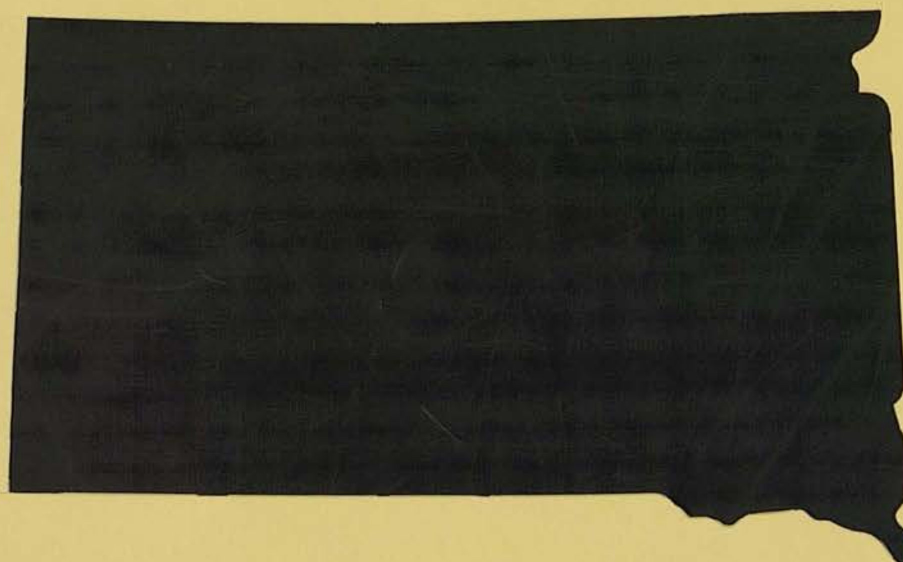

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ECONOMICS DEPARTMENT

South Dakota State University
Brookings, South Dakota

IMPACTS OF RISING ENERGY PRICES ON THE ATTRACTIVENESS OF SUSTAINABLE FARMING SYSTEMS

by

Thomas L. Dobbs and John D. Cole*

Economics Staff Paper 91-4**

June 1991

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PREFACE

This is one of a series of reports by South Dakota State University (SDSU) agricultural economists on economic aspects of sustainable agriculture. Previously released reports have covered the economic profitability of various types of crop and livestock systems, the implications of public policies for relative profitabilities of different systems, and some of the rural economy implications of conversions from "conventional" to "sustainable" farming systems. This report focuses on the impact of rising energy prices on the attractiveness of sustainable farming systems compared to conventional farming systems.

The research leading to this report was supported by the SDSU Agricultural Experiment Station and by Grant No. 88-56 from the Northwest Area Foundation (in St. Paul, MN). We wish to thank Scott Van Der Werff and Kellie Koehne for computer assistance in analyzing the data and in preparing figures. Thanks are also extended to Burton Pflueger and Clarence Mends for reviewing a draft of the manuscript. We are responsible for any errors which may remain, however.

TLD and JDC
June 1991

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Introduction

After several years of relatively stable energy prices during the middle- and late-1980s, events of late-1990 in the Middle East reawakened concerns about rising energy prices. Between July 1990, prior to Iraq's August invasion of Kuwait, and October 1990, diesel fuel prices increased by 77 percent. Natural gas, a major factor of production in urea fertilizer, also experienced price increases last fall in the aftermath of Iraq's invasion. Urea prices were affected by these higher natural gas prices. Moreover, Iraq and Kuwait supplied 7 percent of the world's urea prior to last fall and also provided fuel oil for fertilizer plants in Europe. As a result of tightened supplies of oil, natural gas, and urea, analysts began to expect significantly higher farm fuel and fertilizer prices starting with the 1991 crop year. Since many pesticides are petroleum-based, pesticide prices also were expected to rise.

Fuel prices in early 1991 have fallen from the levels reached last fall. Nevertheless, events of the past year have caused renewed interest in energy policy. Possible actions to become less dependent on Middle East oil could result in rising "real" (inflation-adjusted) energy prices during the 1990s.

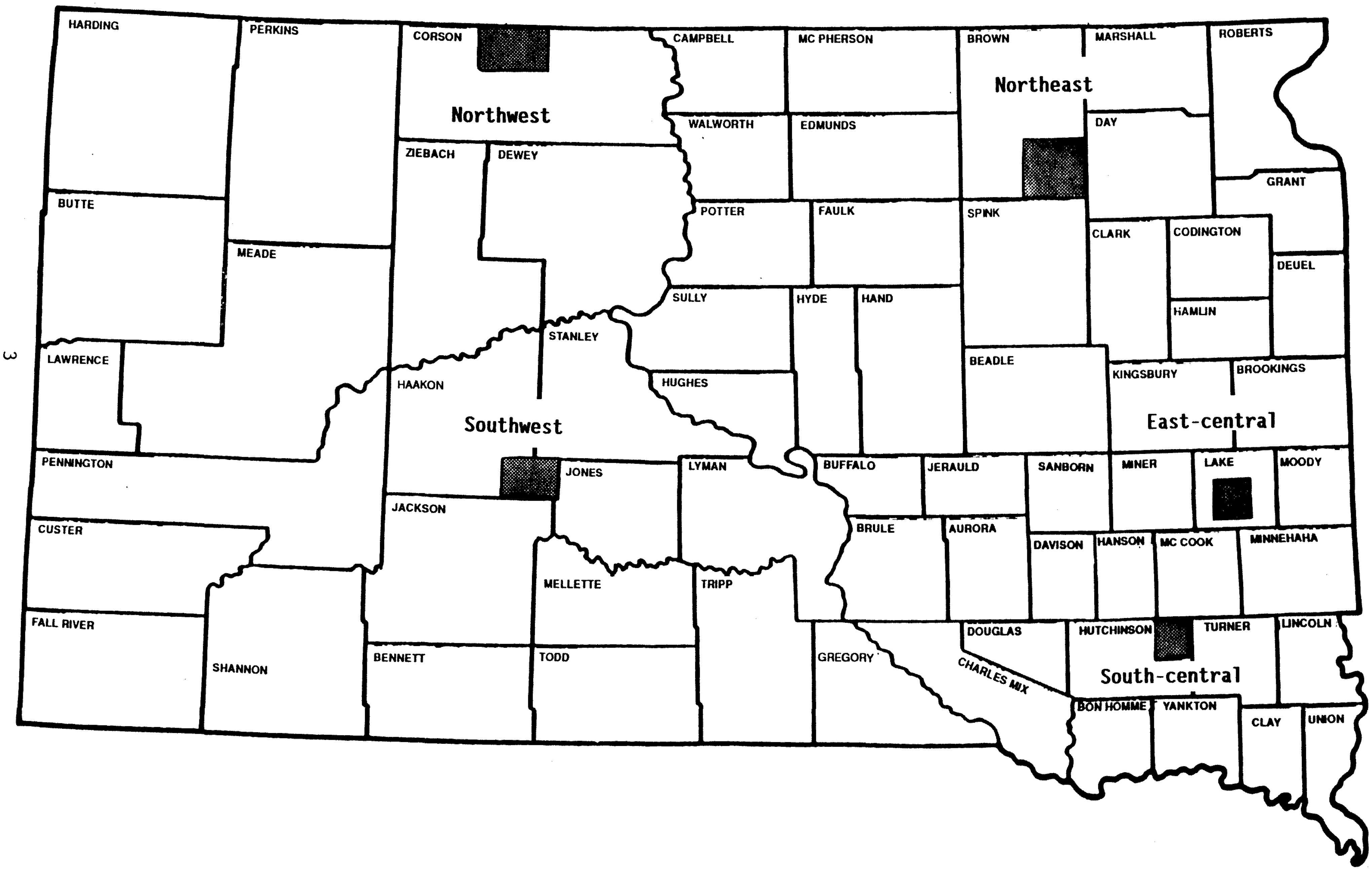
This concern about energy prices comes at a time when interest in "sustainable" agriculture is increasing because of efforts to reduce soil loss and water contamination. Since the mid-1980s, interest of farmers and the public in farming systems which rely on fewer chemical fertilizer and pesticide inputs has steadily increased. These so-called "sustainable" farming systems make greater use of crop rotations which include legumes and small grains than do more "conventional" systems. Thus, fertility and weed control are provided in part through "rotation" effects. Although sustainable systems sometimes involve more mechanical tillage, as a partial substitute for chemical herbicides, some of the techniques of conservation tillage -- which leave a good deal of residue on the surface -- are retained.

The issue which this paper addresses is whether rising energy prices will increase the ability of sustainable farming systems to compete economically with more conventional systems. Rising prices of chemical **fertilizers** and **herbicides** should reduce the profitability of conventional systems more than they reduce profitability of sustainable systems. Rising **fuel** costs are less predictable in their effect, since conventional and sustainable systems vary in their relative fuel use.

Case Study Farms

Data for this paper came from a recently completed set of case studies of conventional and sustainable farming systems in five different agro-climatic areas of South Dakota. Baseline whole-farm analysis models represent 1988 costs and returns for pairs of case conventional and sustainable farms in each of these five areas: (1) the south-central corn-soybeans area (Hutchinson County); (2) the east-central corn-soybeans area (Lake County); (3) the northeast spring wheat area (Brown County); (4) the northwest spring wheat area (Corson County); and (5) the southwest winter wheat area (Haakon County). Locations of the case farms are shown in Figure 1.

Figure 1. Locations of the Case Study Farms in South Dakota



The case study sustainable farms in this analysis are also being used in a broad economic and policy study of sustainable agriculture in South Dakota. Detailed crop, livestock, and related economic information on twenty-two sustainable farms in different areas of South Dakota was collected through on-farm interviews in early 1989 (Taylor, et al., 1989a). Whole-farm crop system economic analyses were carried out subsequently for twelve of those sustainable farms (Becker, et al., 1990). The contributions of livestock to net farm incomes of sustainable farms were analyzed and reported by Taylor, et al. (1990). Effects of public policies on the relative profitabilities of sustainable and conventional farms have been conducted, using five of those twelve sustainable farms as case studies (Dobbs, et al., 1990a). Those same five farms are used as cases for the analysis reported in this paper; they represent sustainable systems in different agro-climatic areas within South Dakota.

For purposes of the research reported in this paper, as well as the above mentioned policy analyses (Dobbs, et al., 1990a), these five sustainable farms are compared with five conventional farms, one of which (in the east-central area) is an actual operating farm and four of which are synthetic. Detailed longitudinal analysis of yields and economic returns on the east-central conventional and sustainable (actual operating) farms has been reported elsewhere (Dobbs, et al., 1990b). For other areas of the State, in which we did not have actual operating conventional farms under study as "controls", a variety of information sources was used to construct hypothetical ("synthetic") conventional farms to compare with the actual sustainable farms. Agricultural Census data, Cooperative Extension and Soil

Conservation Service reports, and interviews with key informants were among the information sources used (Cole and Dobbs, 1990).

Detailed information about the crop rotations, cultural practices, and costs and returns associated with the five case sustainable farms is found in Taylor, et al. (1989a) and Becker, et al. (1990). Readers can refer to Rotations D, H, S, T, and V in those reports. Similar information about the five case conventional farms is found in Cole and Dobbs (1990).

Profile of Energy Use on Case Farms

For purposes of this paper, direct costs were grouped into six classifications, including: 1) fertilizer, 2) herbicides, 3) fuel and lubrication, 4) drying, 5) labor, and 6) other direct costs. The percentages of direct costs falling in each category are shown in Figures 2 through 11 for conventional and sustainable case farms in each agro-climatic area in 1988.[1] Supporting data are contained in Annex Table A-1. (Some description of the input cost structure of these farms also is found on pp. 6-9 of Dobbs and Cole, 1991.)

Fertilizer

Except in the northwest area, only the conventional case farms used commercial fertilizers. Fertilizer expense as a percent of direct costs ranges from 10.1 to 14.6 on the conventional case farms. The commercial fertilizer used by the northwest case sustainable farm consisted of naturally mined trace minerals (not petroleum-based). The commercial fertilizer cost per acre as a percent of total direct costs was greater for that sustainable

[1]The base year was 1988. However, farmers were asked about their "typical" practices. Thus, the data actually represent a typical year -- with 1988 crop plans and expected price levels.

Figure 2: Proportion of Direct Costs:
South-central Region Conventional Farm

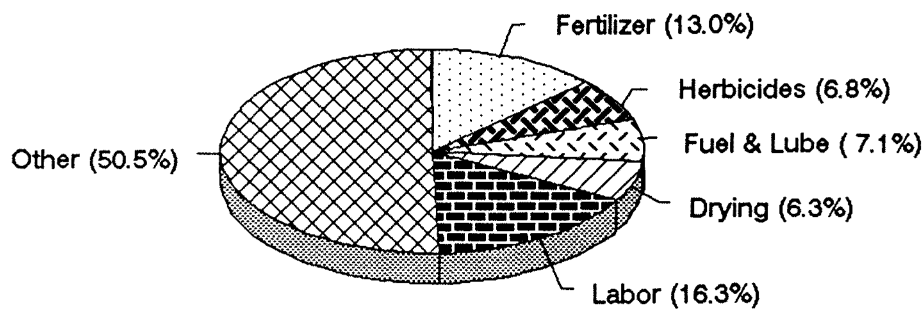


Figure 3: Proportion of Direct Costs:
South-central Region Sustainable Farm

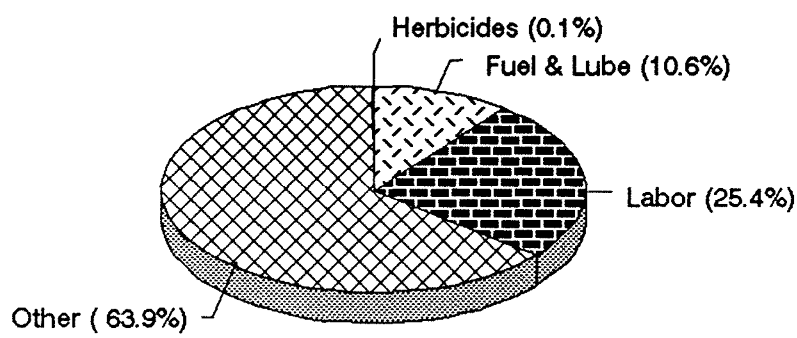


Figure 4: Proportion of Direct Costs:
East-central Region Conventional Farm

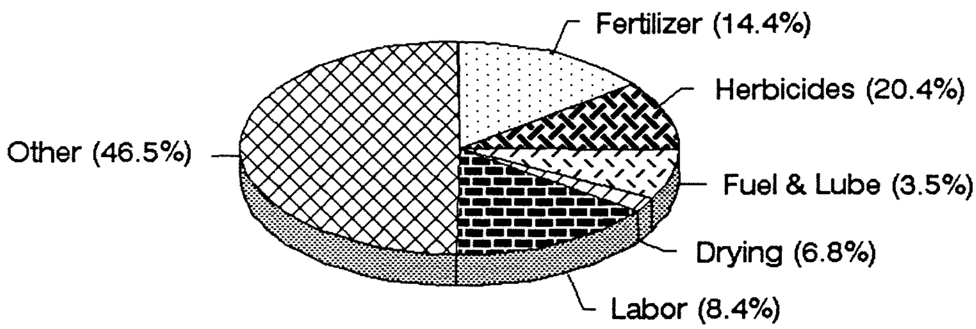


Figure 5: Proportion of Direct Costs:
East-central Region Sustainable Farm

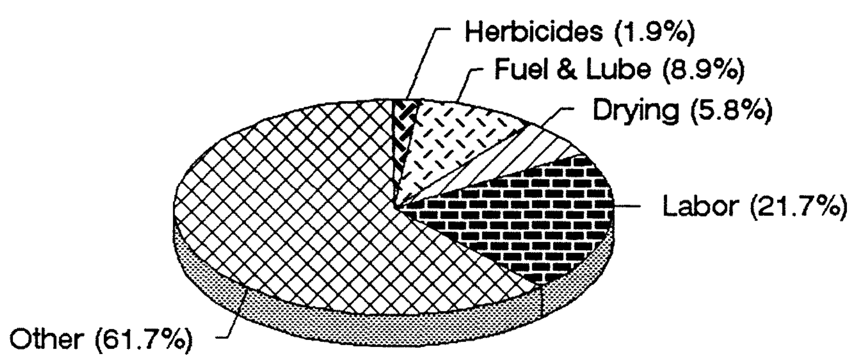


Figure 6: Proportion of Direct Costs:
Northeast Region Conventional Farm

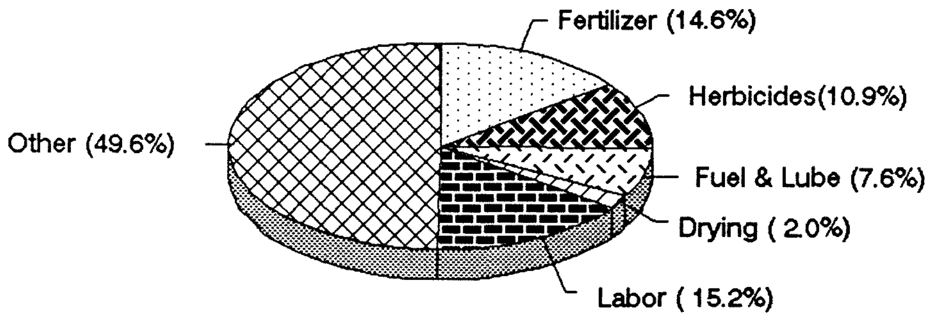


Figure 7: Proportion of Direct Costs:
Northeast Region Sustainable Farm

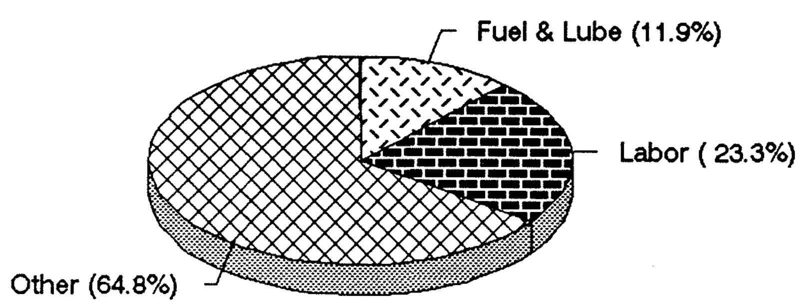


Figure 8: Proportion of Direct Costs:
Northwest Region Conventional Farm

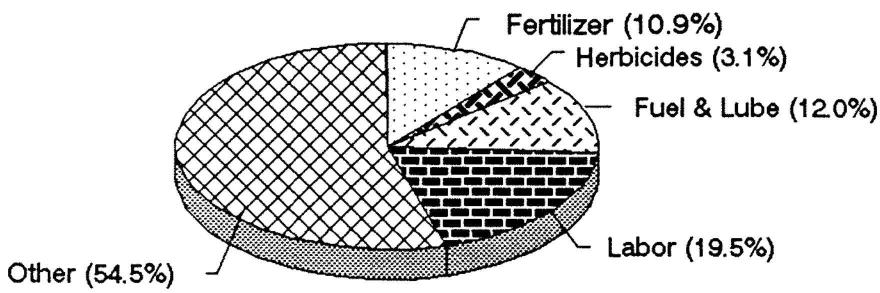


Figure 9: Proportion of Direct Costs:
Northwest Region Sustainable Farm

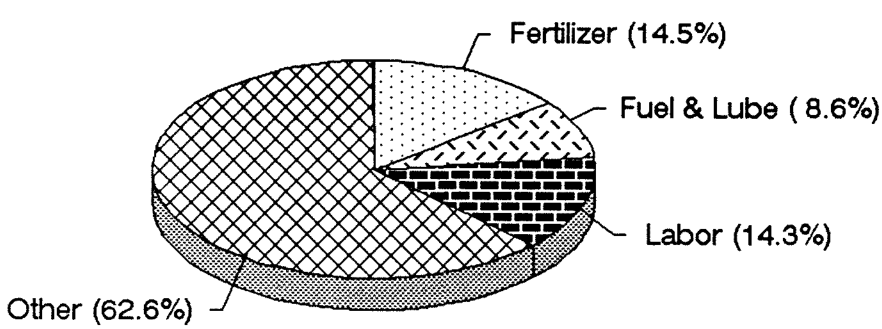


Figure 10: Proportion of Direct Costs:
Southwest Region Conventional Farm

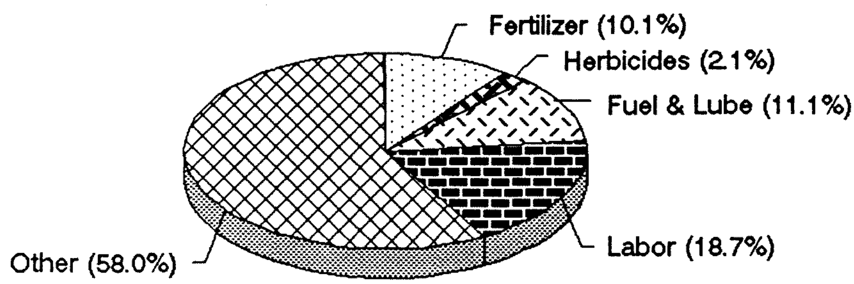
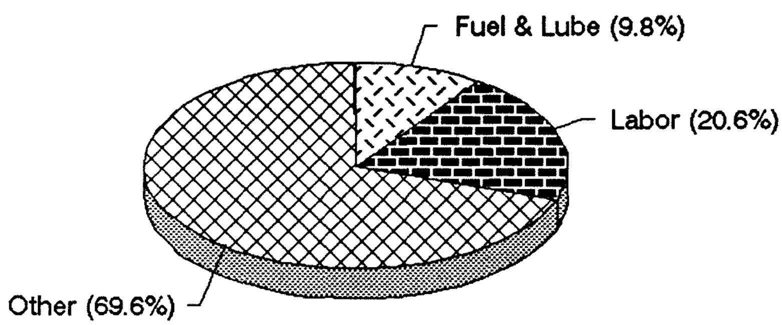


Figure 11: Proportion of Direct Costs:
Southwest Region Sustainable Farm



farm (14.5 percent in Figure 9) than for its paired conventional counterpart, as well as for all but one of the other case conventional farms.

Herbicides

Of the case sustainable farms, only the east-central and the south-central farms used commercial herbicides. (None were using insecticides regularly.) The east-central sustainable farmer used some chemical herbicides on a small portion of his land. Some spot-spraying of chemical herbicides was done on spring wheat on the south-central sustainable farm. Herbicide usage constituted anywhere from 2.1 to 20.4 percent of the total direct costs of the conventional farms (Figures 2, 4, 6, 8, and 10). The highest percentage was in the east-central corn-soybeans area (Figure 4). Percentages for conventional farms were lowest in the wheat growing areas of western South Dakota (Figures 8 and 10).

Fuel and Lubrication

Fuel and lubrication expenses were higher in terms of total dollars spent per acre for the conventional farms than for the sustainable farms in all but the east-central area. (Costs per 100 acres are shown in Annex Table A-1.) The differences ranged from 63 percent higher for the conventional farm in the northwest area to 30 percent lower for the conventional farm in the east-central area. (Average fuel and lube costs on the east-central farms over a 5-year period are shown in Annex Figure B-1. Longitudinal data were not available for the other farms.) Fuel costs ranged from 7.1 to 12 percent of total direct costs for all but one case conventional farm; the east-central conventional farm was lower (3.5 percent, in Figure 4). Fuel costs as a percent of total direct costs ranged from 8.6 to 11.9 percent on the sustainable farms. The percentages were higher than for the conventional farm counterparts east of the Missouri River and lower than for the conventional farm counterparts west of the Missouri.

The fact that most of the conventional farms had greater dollar expenditures per acre than their sustainable counterparts was somewhat surprising in that sustainable farms often are perceived to use more tillage (for weed control) and, hence, perhaps more fuel than conventional farms. However, a variety of factors contribute to overall fuel use per unit of farmland, including the mix of crops grown and the management of set-aside and fallow acres.

Labor

Labor use showed a pattern somewhat similar to fuel use. In terms of total dollars spent per acre, labor use was greater for conventional farms in four of the five paired farm comparisons (all except the east-central area comparison). The principal use of labor for crop production on South Dakota farms is in operation of machinery. Machine time, as reflected in part by fuel and lube use, appears to have been greater on the conventional farms in the majority of cases. However, readers should keep in mind that these comparisons, including comparisons of labor use, did not include livestock operations of either the sustainable or the conventional farms.

Labor as a percent of direct costs was higher on the sustainable farms in all areas except the northwest area (Figures 8 and 9).

Drying

Costs were included for drying corn, where applicable. Such costs were applicable to three of the conventional farms, where they ranged from 2.0 to 6.8 percent of the direct costs. They were applicable to only one of the sustainable case farms (in the east-central area), where they constituted 5.8 percent of direct costs (Figure 5).

Other Direct Costs

Other direct costs in the farm enterprise budgets used for this analysis consisted of expenditures for seed, crop insurance, on-farm grain storage, overhead, custom machine hire, machinery repair, and interest on non-labor direct costs. The total of these other direct costs, as shown in Figures 2 through 11, account for the largest proportion of direct costs -- from approximately 47 to 58 percent on the conventional farms and from approximately 62 to 70 percent on the sustainable farms.

Impacts of Rising Energy Prices

Analyses were conducted to determine the effects on **direct** (operating) **costs** and **net income** (income net of all costs except management) on each pair of case farms of: (1) a 50 percent increase in fuel prices and a 25 percent increase in crop drying costs; (2) a 50 percent increase in fuel and fertilizer prices and a 25 percent increase in crop drying costs; and (3) a 50 percent increase in fuel, fertilizer, and herbicide prices and a 25 percent increase in crop drying costs. Agriculture fuel, energy, and chemical prices increased by 12 percent in the U.S. between 1988 and the first half of 1990, and fertilizer prices were the same at the end as at the beginning of that period. Thus, the 50 percent increases over 1988 in fuel, fertilizer, and herbicide prices analyzed for this paper represent 34-50 percent increases over levels of the 1990 crop season.

Effects of these simulated price increases for petroleum-based inputs are shown in Figures 12 through 21. Data for those figures are contained in Annex Table C-1. Labor costs are not included in the direct costs shown in

Fig. 12: Direct Costs (except labor)
South-central Region

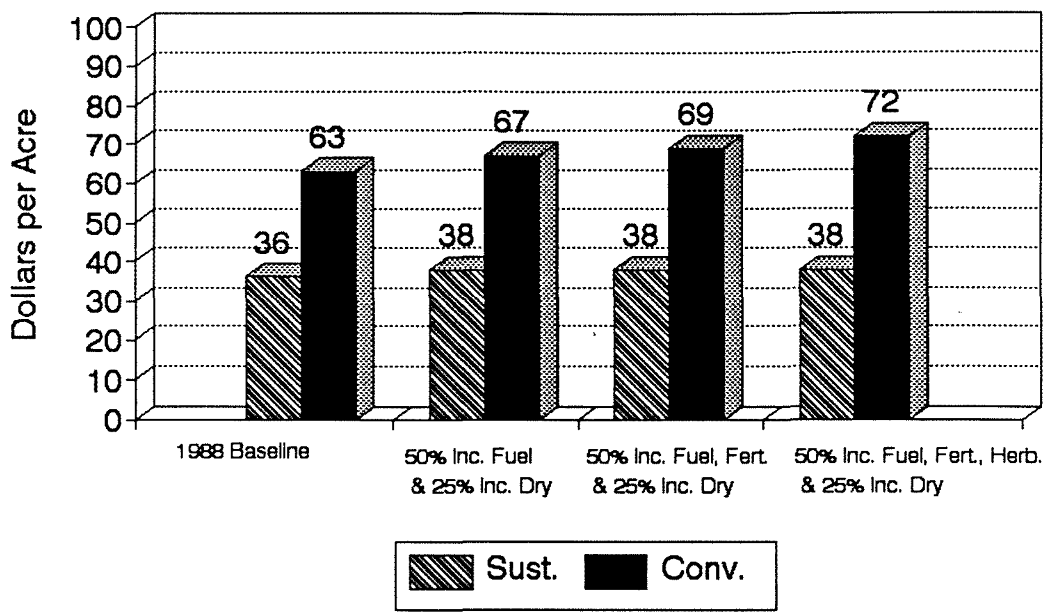


Fig. 13: Inc. Over All Costs (ex. mgmt)
South-central Region

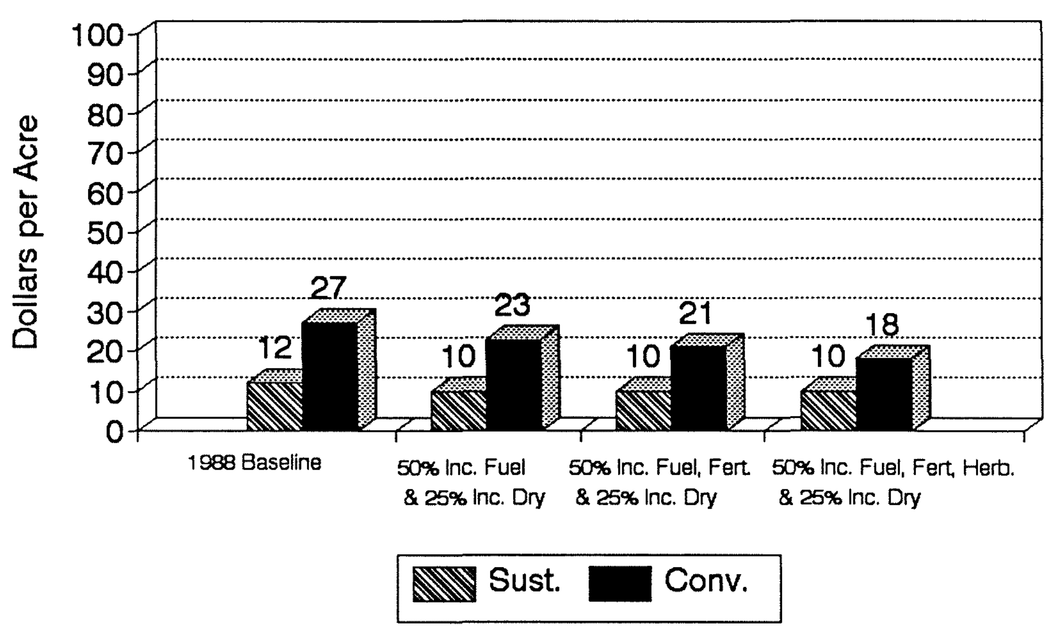


Fig. 14: Direct Costs (except labor)

East-central Region

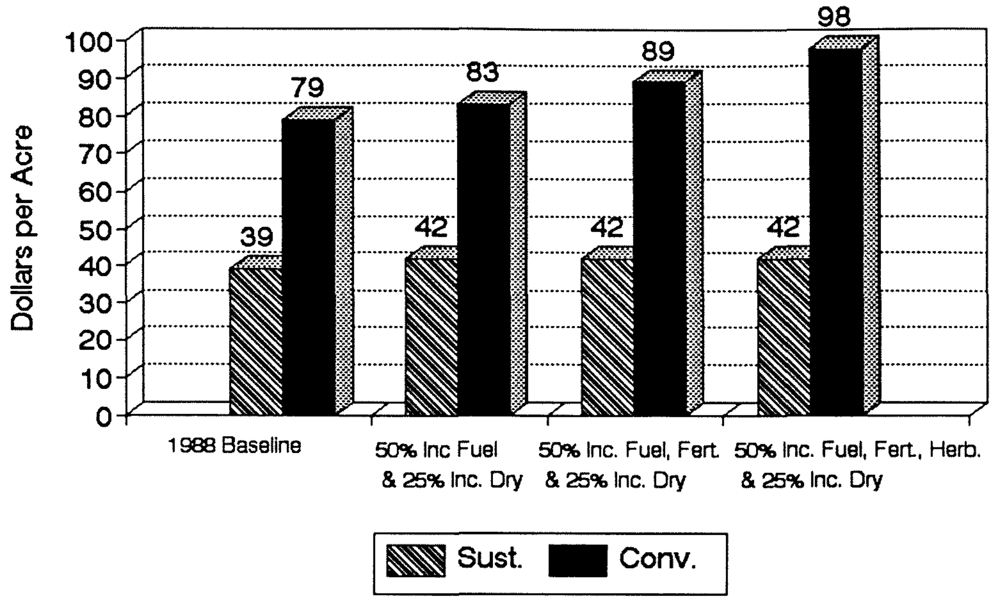


Fig. 15: Inc. Over All Costs (ex. mgmt)

East-central Region

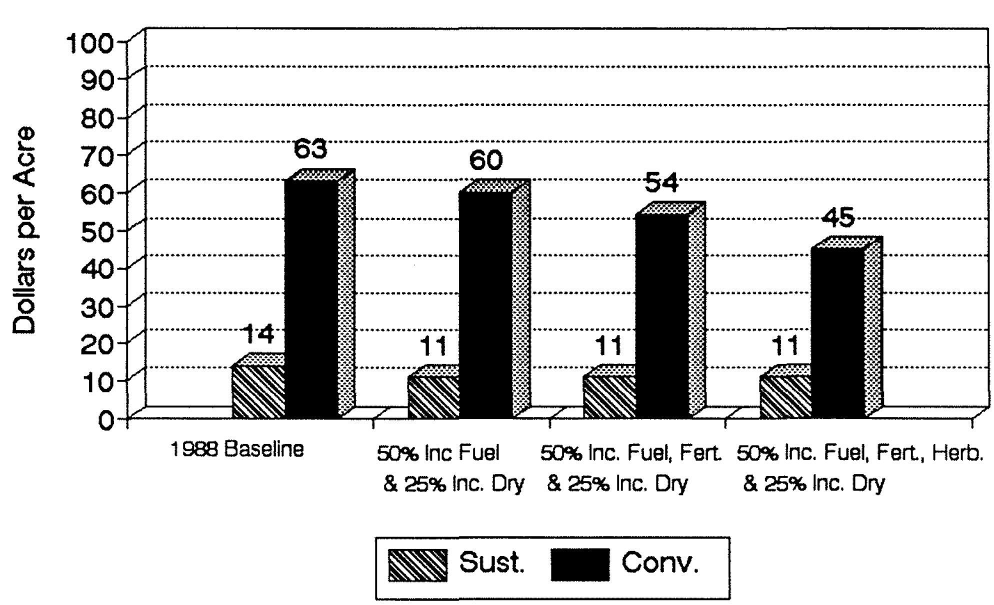


Fig. 16: Direct Costs (except labor)

Northeast Region

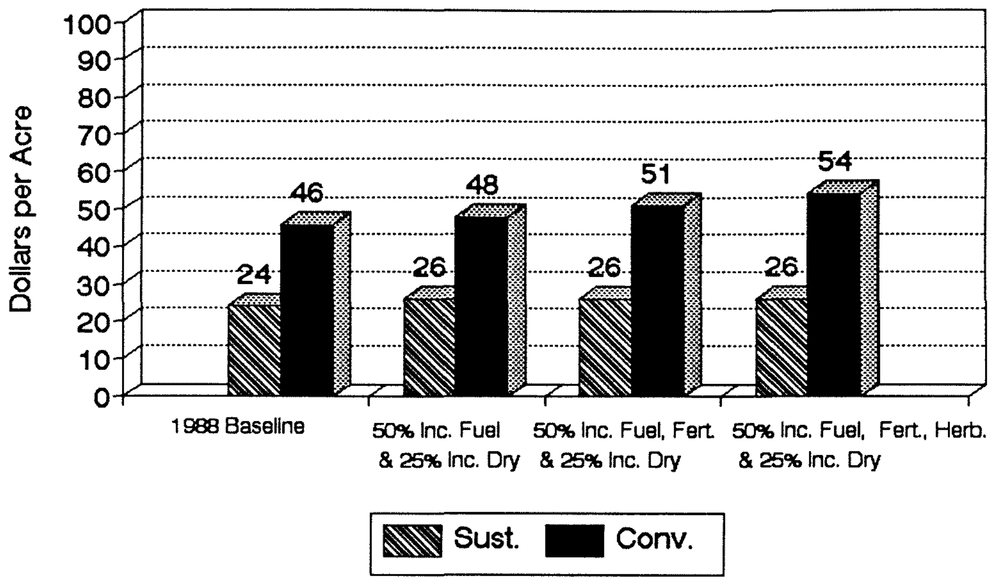


Fig. 17: Inc. Over All Costs (ex. mgmt)

Northeast Region

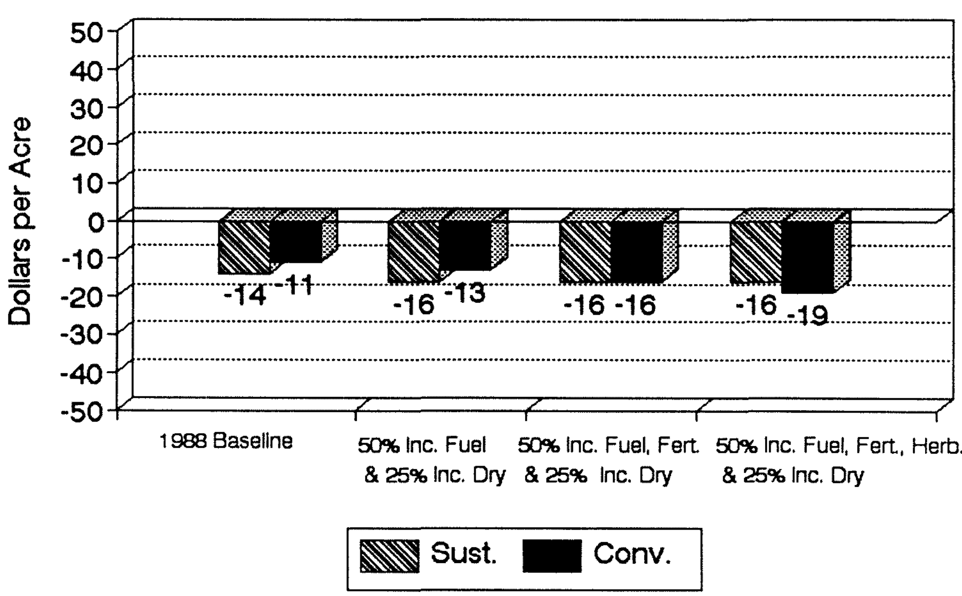


Fig. 18: Direct Costs (except labor)

Northwest Region

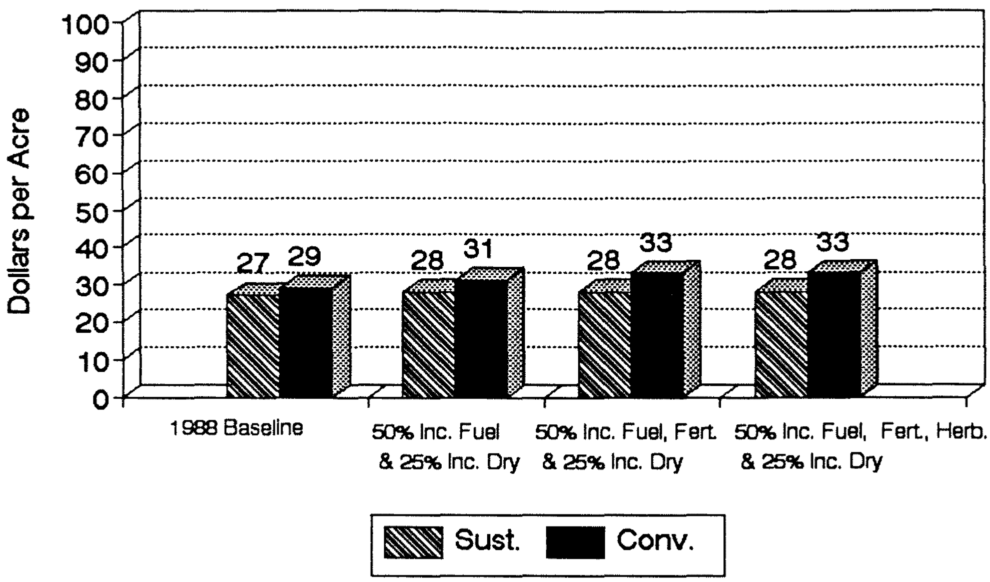


Fig. 19: Inc. Over All Costs (ex. mgmt)

Northwest Region

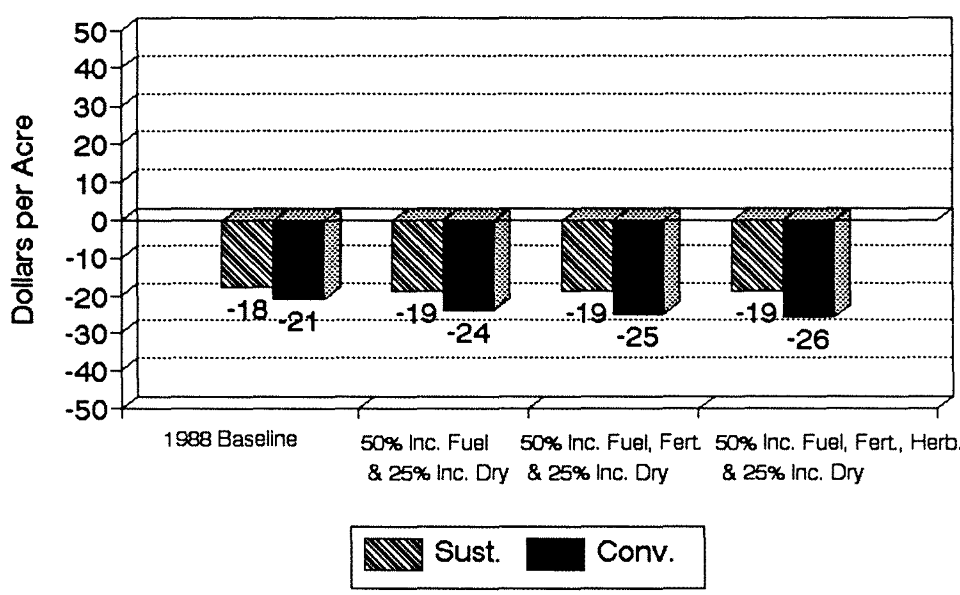


Fig. 20: Direct Costs (except labor)

Southwest Region

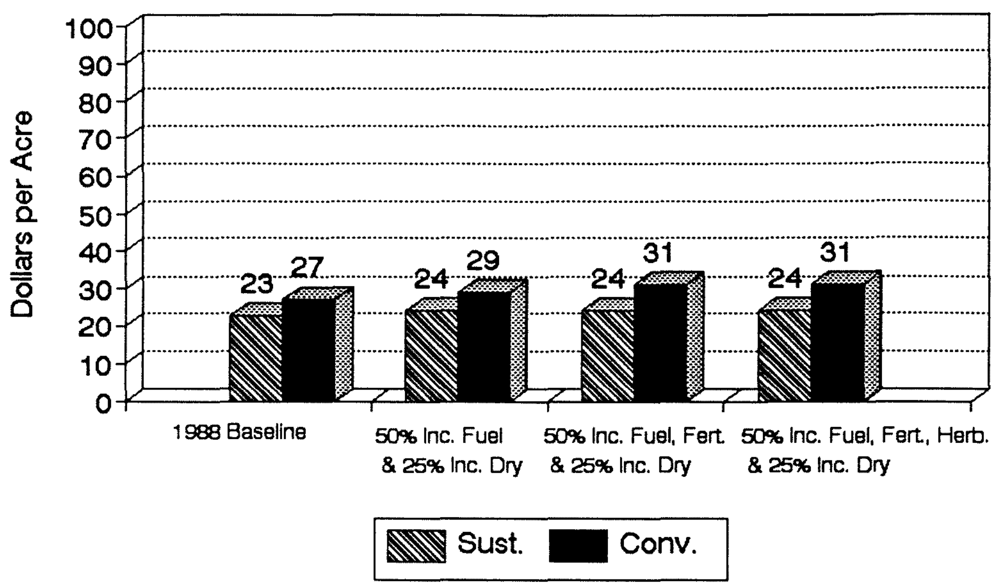
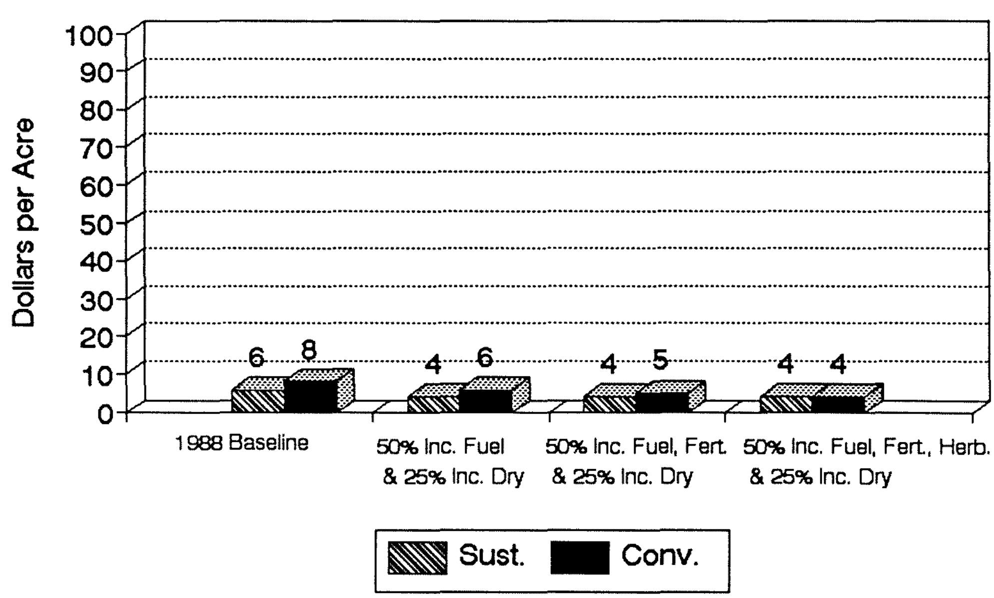


Fig. 21: Inc. Over All Costs (ex. mgmt)

Southwest Region



Figures 12, 14, 16, 18 and 20 and in Table C-1. Otherwise, the direct costs correspond to those found in Table A-1.

Increases in Fuel Prices and Drying Costs

A 50 percent increase in fuel and lube costs, coupled with a 25 percent increase in crop drying costs, has slightly less adverse effect on the sustainable farms than on the conventional farms. Increases in direct costs range from $1 to $3 per acre (for all crop acres, including fallow and set-aside acres) on sustainable farms, and average $1.80. The increases in direct costs range from $2 to $4 per acre -- and average $2.80 -- on the conventional farms. The increase in direct costs is slightly greater on the case conventional farm than on the case sustainable farm in all areas except the northeast, where the cost increase is essentially the same (with data rounded). The south-central and east-central area row-crop conventional farms had the greatest increases in direct costs ($4 per acre).

This first set of energy cost increases is not sufficient to lower the profitability of any conventional case farm to that of its paired sustainable farm. Keep in mind that the northwest sustainable farm already was more profitable (less unprofitable) in the baseline analysis than its paired conventional farm, and it remained so with the change in fuel and drying costs.[2]

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[2]The profitability comparisons in this paper ignore organic price premiums which some of the sustainable farms receive for portions of their crop production. We have incorporated organic premium considerations in analyses reported elsewhere (Dobbs, et al., 1990a and 1990b).

Increases in Fuel Prices, Drying Costs, and Nitrogen Fertilizer Prices

The next sensitivity analysis involved adding a 50 percent increase in the price of commercial inorganic nitrogen fertilizer to the fuel and drying cost increases described in the previous section. We did not increase the price of the commercial trace mineral fertilizer purchased by the northwest case sustainable farm. Since that was the only commercial fertilizer used by any of the case sustainable farms, the sustainable farms were not adversely affected by this energy cost increase.

Direct costs increase by $2 to $6 per acre on the conventional farms when nitrogen fertilizer prices are increased by 50 percent. Cost increases are $2-$3 per acre, except on the east-central corn-soybeans farm, where it is $6. This increase in fertilizer costs, coupled with the increase in fuel and drying costs, lowers the profitability of the northeast case conventional farm to that of the paired sustainable farm (Figure 17).

Increases in Fuel Prices, Drying Costs, Fertilizer Prices, and Herbicide Prices

Next, we added a 50 percent increase in chemical herbicide prices to the cost increases described in the previous two sections. The south-central and east-central sustainable farms use only very small quantities of commercial herbicides, and the other case sustainable farms use none at all. Amounts used on the south-central and east-central sustainable farms are so small that increases in direct costs and corresponding decreases in net income due to the herbicide price increase round to zero in Table C-1 and Figures 12 through 15.

Since herbicide use on the case conventional farms in the western wheat growing areas of South Dakota is quite limited, effects of the herbicide price increase on direct costs and net incomes of those farms rounds to $1 per acre or less (Table C-1 and Figures 18 through 21). The $1 per acre decline in net income for the southwest conventional farm does bring the profitability of that farm down to the same level as that of its paired sustainable farm, however.

The higher herbicide costs add $3 per acre to direct costs (and reduce net income correspondingly) on the south-central and northeast conventional farms. This makes the northeast conventional farm less profitable than its sustainable counterpart, but the south-central conventional farm remains more profitable.

Direct costs increase (and net income decreases) by $9 per acre on the east-central conventional farm as a result of the herbicide price increase. The conventional farm remains much more profitable than its sustainable counterpart, however.[3]

Summary

The effects of energy price increases on direct costs and relative profitabilities of conventional and sustainable farming systems in South Dakota were simulated for this paper. Such price increases could result either from supply and demand factors in petroleum markets or from special taxes placed on petroleum-based inputs. The price increases discussed thus far were not of sufficient magnitude to reduce the profitability of conventional farming systems in the south-central and east-central corn-soybeans areas to levels of their sustainable system counterparts. However, in the northeast spring wheat area, a 50 percent increase in fuel and

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[3]Analyses over a 5-year (1985-1989) time period showed less difference in profitability between the east-central conventional and sustainable farms than does the "typical year" analysis contained in this paper (Dobbs, et al., 1990b).

inorganic nitrogen fertilizer prices and a 25 percent increase in crop drying costs -- over 1988 levels -- reduced the conventional system's profitability to that of the sustainable system. That equality of profits between conventional and sustainable systems was brought about in the southwest winter wheat area by a 50 percent increase in fuel, fertilizer, and herbicide prices and a 25 percent increase in drying costs. The conventional system in the northwest spring wheat area was already less profitable than its sustainable system counterpart in the 1988 baseline energy scenario.

Additional simulations we have conducted show that the profitability of the south-central conventional farm would be reduced to that of the sustainable farm if fuel, fertilizer, and herbicide prices were to increase by 110-115 percent and crop drying costs were to increase by 55-58 percent. The east-central conventional and sustainable farming systems would be equally profitable if fuel, fertilizer, and herbicide prices were to increase by 185 percent (over 1988 levels) and drying costs were to increase by 92-93 percent. The equality between profitability of the conventional and the sustainable system in the east-central area occurs at such a large energy price increase because the profitability of the conventional system is so much higher in the baseline scenario (Figure 15) and because baseline fuel and lube costs per unit of land are less for the conventional system than for the sustainable system (Table A-1).

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Annex A

Detailed Support Data for Pie Charts

The following table contains the baseline cost data used in this paper. Data came from enterprise and whole-farm budgets reported in Becker, et al. (1990) and Cole and Dobbs (1990).

Table A-1. Direct Costs Per 100 Acres and as a Percent of the Total

	Sust.	Conv.	% of Direct Costs Sust.	% of Direct Costs Conv.
	---per 100 acres----			
South-central Region - Hutchinson County				
Direct Costs:				
Fertilizer	$0.00	$979.31	0.0%	13.0%
Herbicides	$4.70	$510.36	0.1%	6.8%
Fuel & Lube	$509.17	$530.58	10.6%	7.1%
Drying	$0.00	$471.75	0.0%	6.3%
Labor	$1,220.42	$1,225.16	25.4%	16.3%
Other	$3,063.71	$3,792.84	63.9%	50.5%
Total Direct Costs	$4,798.00	$7,510.00	100%	100%
East-central Region - Lake County				
Direct Costs:				
Fertilizer	$0.00	$1,246.96	0.0%	14.4%
Herbicides	$93.92	$1,767.08	1.9%	20.4%
Fuel & Lube	$438.20	$305.81	8.9%	3.5%
Drying	$286.88	$588.52	5.8%	6.8%
Labor	$1,073.96	$727.53	21.7%	8.4%
Other	$3,050.08	$4,028.95	61.7%	46.5%
Total Direct Costs	$4,943.00	$8,664.85	100%	100%
Northeast Region - Brown County				
Direct Costs:				
Fertilizer	$0.00	$785.89	0.0%	14.6%
Herbicides	$0.00	$589.12	0.0%	10.9%
Fuel & Lube	$376.94	$410.11	11.9%	7.6%
Drying	$0.00	$110.00	0.0%	2.0%
Labor	$737.62	$821.91	23.3%	15.2%
Other	$2,054.21	$2,677.14	64.8%	49.6%
Total Direct Costs	$3,168.77	$5,394.17	100%	100%
Northwest Region - Corson County				
Direct Costs:				
Fertilizer	$450.00	$392.15	14.5%	10.9%
Herbicides	$0.00	$112.24	0.0%	3.1%
Fuel & Lube	$265.39	$433.16	8.6%	12.0%
Drying	$0.00	$0.00	0.0%	0.0%
Labor	$444.37	$705.00	14.3%	19.5%
Other	$1,942.16	$1,967.36	62.6%	54.5%
Total Direct Costs	$3,101.92	$3,609.91	100%	100%
Southwest Region - Haakon County				
Direct Costs:				
Fertilizer	$0.00	$335.15	0.0%	10.1%
Herbicides	$0.00	$70.26	0.0%	2.1%
Fuel & Lube	$279.08	$368.91	9.8%	11.1%
Drying	$0.00	$0.00	0.0%	0.0%
Labor	$589.05	$619.12	20.6%	18.7%
Other	$1,987.95	$1,925.67	69.6%	58.0%
Total Direct Costs	$2,856.00	$3,319.11	100%	100%

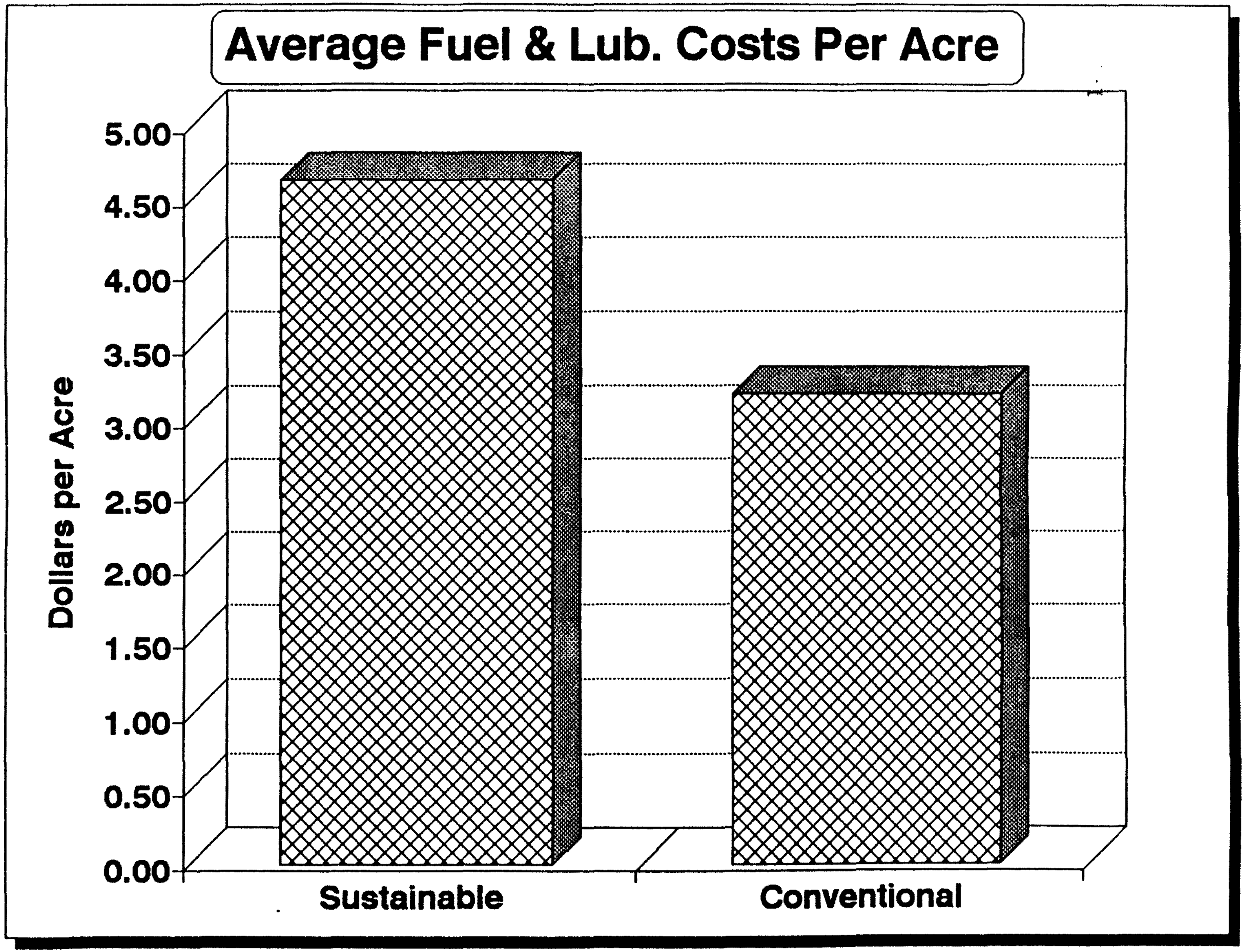
Annex B

Five-year Average Fuel and Lubrication Costs for East-central Farms

Certain longitudinal data were available for the east-central case farms that were not available for case farms in the other areas. For the sake of analytical consistency, our analyses for the east-central case farms used the same "typical year" approach as was used in analyses for the other case farms. However, the following figure is presented for comparison with data used in the "typical year" analysis of east-central case farms. It shows average fuel use over a 5-year period (1985-1989) on the east-central sustainable and conventional farms. Over the 5-year period, fuel and lube costs averaged $4.64/acre on the sustainable farm and $3.19/acre on the conventional farm.

We are indebted to Clarence Mends for developing the data in Figure B-1 and for providing the graphic display.

Fig. B-1: Average Fuel and Lubrication Costs on East-central Region Case Farms, 1985-1989



Annex C

Detailed Data from Sensitivity Analyses

Baseline and sensitivity analyses data for Figures 12 through 21 are contained in the following table.

Table C-1. Per Acre Baseline and Sensitivity Analyses Data

	Direct Costs (except labor)		Income Over All Costs (except mgmt.)	
	Sust	Conv.	Sust	Conv.
	Dollars per Acre			
South-central Region - Hutchinson County				
1988 Baseline	36	63	12	27
50% Inc. Fuel & 25% Inc. Dry	38	67	10	23
50% Inc. Fuel, Fert. & 25% Inc. Dry	38	69	10	21
50% Inc. Fuel, Fert., Herb. & 25% Inc. Dry	38	72	10	18
East-central Region - Lake County				
1988 Baseline	39	79	14	63
50% Inc. Fuel & 25% Inc. Dry	42	83	11	60
50% Inc. Fuel, Fert. & 25% Inc. Dry	42	89	11	54
50% Inc. Fuel, Fert., Herb. & 25% Inc. Dry	42	98	11	45
Northeast Region - Brown County				
1988 Baseline	24	46	-14	-11
50% Inc. Fuel & 25% Inc. Dry	26	48	-16	-13
50% Inc. Fuel, Fert. & 25% Inc. Dry	26	51	-16	-16
50% Inc. Fuel, Fert., Herb. & 25% Inc. Dry	26	54	-16	-19
Northwest Region - Corson County				
1988 Baseline	27	29	-18	-21
50% Inc. Fuel & 25% Inc. Dry	28	31	-19	-24
50% Inc. Fuel, Fert. & 25% Inc. Dry	28	33	-19	-25
50% Inc. Fuel, Fert., Herb. & 25% Inc. Dry	28	33	-19	-26
Southwest Region - Haakon County				
1988 Baseline	23	27	6	8
50% Inc. Fuel & 25% Inc. Dry	24	29	4	6
50% Inc. Fuel, Fert. & 25% Inc. Dry	24	31	4	5
50% Inc. Fuel, Fert., Herb. & 25% Inc. Dry	24	31	4	4