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The Economics of Irrigated Crop Production in Eastern South Dakota

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THE ECONOMICS OF IRRIGATED CROP PRODUCTION IN EASTERN SOUTH DAKOTA

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SUMMARY

The economics of dryland versus irrigated crop production in two of South Dakota's fast-irrigation-growth counties -- Brookings and Turner -- are examined in this paper. Special attention is given to the economic impacts on the farm economy of rising energy prices and high interest rates. The analysis is in terms of conditions experienced during the 1981 crop year and projected conditions through 1990.

The main findings from the study are as follows.

1. The yields of corn, alfalfa, and soybeans grown by farmers under irrigation are 1.7 to 2.3 times more than when the crops are grown under dryland conditions. Fertilizer applications by farmers are 2.3 to 3.0 times more with irrigation than under dryland conditions.

2. The total costs for producing most dryland crops in 1981 in Brookings County are \$140 to \$150 per acre. The costs range, however, from \$119 per acre for alfalfa to \$192 per acre for corn. The total costs of producing most dryland crops in Turner County are about 15 percent more than those in Brookings County. The per-acre costs of producing irrigated crops in both counties are about twice those for the respective dryland crops.

3. The single largest cost item in all the crop budgets is the charge for land, which most commonly accounts for 35 to 40 percent of the total costs of dryland production and 25 to 35 per-

cent of the total costs of irrigated production. Four categories of cost -- (a) depreciation and insurance, (b) interest on investment, (c) fertilizer, and (d) machinery fuel and lubrication -- each account for roughly eight to 15 percent of the total production costs for most crops.

4. The power and repair expense for irrigation system accounts for about 15, 25, and 30 percent, respectively, of the total variable costs of producing irrigated corn, soybeans, and alfalfa. These percentages are generally lower than those in Colorado, Nebraska, and Texas. One probable explanation is the generally lesser height to which irrigation ground water in South Dakota is lifted.

5. The "direct" energy embodied in the fuel and lubrication for crop production and grain drying, plus the "indirect" energy embodied in fertilizer and plant protection chemicals, comprise about two-fifths of the variable costs for dryland production and about one-half for irrigated production. The energy expenditure per acre for corn, soybeans, and alfalfa is from 2.0 to 2.8 times higher for irrigated than dryland production. The total energy bill (direct and indirect) for a quarter section of corn raised in 1981 under irrigation is about $7,500 greater than if the corn were raised under dryland conditions.

6. Of the eight crops studied, corn is most energy-intensive and alfalfa and soybeans are least energy-intensive. The energy bill for a 350 acre dryland farm under corn production in 1981, for example, is over $10,000 more than the energy bill for that

same farm with alfalfa and soybeans.

7. With the prices prevailing in 1981, alfalfa is clearly the most profitable crop in both Brookings and Turner Counties. The net returns over variable production costs per acre in 1971 from dryland alfalfa, for example, are twice as much as those from the next most profitable dryland crop. Under irrigation, alfalfa provides about 70 percent greater returns than its nearest competitor. But, if the price of alfalfa were to return to its average for 1977 to 1979 and the price of corn were to return to its 1980 level, corn would be more than twice as profitable as alfalfa. Recently experienced variations in relative crop prices, therefore, have had a profound influence on the relative profitability of different crops.

8. The short-run break-even price -- defined as the variable production cost per unit of output produced -- is about 15 percent less for corn raised under irrigation versus under dryland conditions in 1981 in Brookings County. For the other crop situations studied, however, the break-even price for irrigated production is roughly the same as or is more than that for dryland production. Thus, the use of irrigation does not necessarily lead to the production of lower cost farm commodities.

> Note: With the "rapidly rising" energy price projections to 1990 described under Item No. 11 below, the outcomes are generally consistent with those described for 1981 under this and the next two points.

9. The short-term profitability of irrigated production is clearly superior to that of dryland production. The net returns

over the variable costs of producing different crops in 1981, for example, are 1.6 to 3.1 times greater under irrigated than dryland conditions.

10. The study's findings for 1981 raise questions about the longer-term profitability of agricultural production, however. For all crops except alfalfa, under both dryland and irrigated conditions, the net returns over total production costs in 1981 are negative. Further, in each case studied, the net returns over the total production costs in 1981 are lower with than without irrigation.

If these findings for 1981 were interpreted to portray the longer-term economic potential for agricultural production, particularly under irrigation, the future prospects would have to be viewed as somewhat dismal. Four factors temper such a conclusion, however. The input-product price relationships for 1981 (except for alfalfa) are generally acknowledged to have been unusually unfavorable for farmers. Second, a major benefit from irrigation arises in drought years, an aspect not taken into account in this study. Third, the level of management plays a key role in determining the profitability of farming. The future economic prospects for agriculture for above-average managers are, of course, brighter than those for below-average managers. And fourth, the incentives that different farmers have to own land differ. Some farmers, for example, might be willing to own land more for the prospect of future possible appreciation in the value of land, than from the current return from using the land. If so, they could be willing to continue in farming

even if the current returns from their production were not always sufficient to offset all their costs of production, including a "full charge" for land.

11. The assumptions underlying the analysis of the impacts of rising energy prices on the economics of future crop production are explained in the main text. In brief, they are as follows.

- The yields and input-levels reported in 1977 were assumed not to change over the study period.

- The prices of inputs were assumed to grow at their "current trends" from 1977 to 1990, which for most inputs is from 3.0 to 7.5 percent per year.

- For energy, however, two more rapid rates of price increase were also examined, namely, annual growth rates from 1981 to 1990 of 8.0 and 14.9 percent (the latter is termed the "rapidly rising" energy price alternative).

- The prices of farm commodities were assumed to grow at rates based on Chase Econometric forecasts, which for most commodities involve annual increases of 6.4 to 6.6 percent.

- Projections were made to 1990.

12. Assuming current trends in input prices, the net returns over variable costs projected to 1990 are considerably more (ranging from about 15 to 80 percent) for corn and soybeans than for alfalfa. This outcome contrasts sharply with that for 1981 in which alfalfa enjoyed a marked economic advantage compared to all other crops.

13. With the rapidly rising energy price alternative, the pro-

jected net returns from dryland crop production in 1990 are most commonly $35 to $45 per acre less than the projected net returns with the current trends in input prices assumed. The reduction in net returns for corn, however, exceeds $80 per acre. For a 350 acre dryland farm planted to most crops, the projected net returns are $12,000 to $16,000 per year less with the rapidly rising energy price alternative. If the farm were under corn production, however, the reduction in net returns because of high energy prices would be roughly $30,000 per year.

14. With the rapidly rising energy price alternative, the projected net returns from irrigated corn production in 1990 are roughly $190 per acre less than with the current trends in input prices assumed. The corresponding reductions in net returns for irrigated soybeans and alfalfa are less than one-half those for corn. The projected net return for an irrigated quarter section under corn production is about $35,000 per year less under the rapidly rising energy price assumption. If the quarter section were in alfalfa, the reduction in net returns because of higher energy prices would be about $10,000 per year. Nevertheless, under the higher energy price, irrigated corn is still considerably more profitable than irrigated alfalfa.

15. With rapidly rising energy prices and dryland conditions, corn -- the most energy-intensive crop -- loses considerably in its comparative advantage relative to alfalfa and soybeans which are the least energy-intensive crops. With rapidly rising energy prices and irrigated conditions, corn's comparative advantage relative to alfalfa is reduced, but not to the point

where it ceases to maintain a considerable profit margin over alfalfa. With rapidly rising energy prices and under both dryland and irrigated conditions, the 1990 projections show soybeans to be clearly the most profitable of the various crops considered. This outcome contrasts with (a) the 1990 current-trends-in-input-prices-projections in which the profit advantage of corn and soybeans was roughly comparable and (b) the 1981 situation in which alfalfa enjoyed a marked economic superiority to all other crops. Thus, the relative profitability of different crops is rather sensitive to differences in the prices paid for energy and the market prices received for the crops.

16. With rapidly rising energy prices, the projected net returns per acre to farmers from producing the various crops in 1990 would be about 15 to 40 percent less than with the current trends in input prices. Nevertheless, the returns from production exceed the variable production costs for all the crop-energy price situations considered. Further, the amounts of net returns from crops raised under irrigation are larger than those from the crops raised under dryland conditions. Thus, even if energy prices were to escalate rapidly during the 1980's, farmers already having irrigation facilities would appear to be well-advised economically to continue to use those facilities.

17. With the 18 percent annual interest rate commonly experienced for operating and investment capital by farmers during 1981, the total costs of producing dryland crops are from six to 12 dollars per acre more than if the interest rate were 10 percent (as it was only three years earlier). The annual in-

terest bill on a 350 acre dryland farm in 1981 would have been $2,000 to $4,000 less if the interest rate were 10, rather than 18, percent.

18. With an 18, rather than 10, percent annual interest rate, the total costs of producing irrigated crops in 1981 are from $24 to $48 per acre more. The annual interest bill on an irrigated quarter section of corn in 1981 would have been over $5,000 less if the interest rate were 10, rather than 18, percent.

Each of these findings is importantly influenced by the assumptions which underlie the analysis in the study. These assumptions -- outlined in the main body of the study report -- should be carefully considered by the reader in intepreting the study's results.

THE ECONOMICS OF IRRIGATED CROP PRODUCTION IN EASTERN SOUTH DAKOTA

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INTRODUCTION

Irrigation development in South Dakota

The 10 Great Plains states account for one-half of the U.S.'s irrigated cropland (USDA, 1980, 420-421). In 1974, two of these states, Texas and Nebraska, accounted for over one-half of the Great Plains area under irrigation (Table 1). The Dakotas, on the other hand, each accounted for less than one percent of the region's irrigated area. In 1974, over one-half of the total cropland in Wyoming and New Mexico was under irrigation, but less than one percent was in the Dakotas.

Thus, irrigation has traditionally been less important to the agricultural economies in the Dakotas than in the other Great Plains states. Nevertheless, the expansion in South Dakota's irrigation during the past decade has been considerable. For example, South Dakota's Department of Water and Natural Resources (DWNR) reports an over four-fold increase in the state's irrigated area from 77,197 acres in 1969 to 316,043 acres in 1977.[1]

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[1] This information is obtained from an analysis of data which are provided annually by South Dakota's irrigators and are summarized each year by the DWNR's Division of Water Rights. The most recent available data are for 1977. The reference citation for these annually summarized data is simply DWNR (1977).

Informed opinion indicates as much as 450,000 acres was under irrigation in 1981.

In 1978, more than 10,000 acres was under irrigation in each of four South Dakota counties west of the Missouri River and seven counties east of the Missouri (Table 2). From 1969 to 1978, the area irrigated increased in these major West River counties by 1.1 times and in the major East River counties by as much as 4.3 times.

Irrigation in two of the East River counties -- Turner and Brookings -- is the subject of the research reported in this paper. These two counties rank fourth and fifth in the state in the extent to which new land has been brought under irrigation during the past decade (Table 2). In terms of the relative increase in irrigation development, Brookings and Turner Counties rank second and fourth among the state's counties having a major irrigated acreage. Thus, this paper focuses on crop production in counties with relatively large and rapidly increasing irrigated areas.

Whether eastern South Dakota's irrigation resources are likely to and should, from an economic standpoint, continue to be developed at a rapid pace during the 1980's is the principal issue that motivated the study reported in this paper. Of particular concern is the extent to which the recently experienced rapidly increasing energy prices and high interest rates adversely affect the prospective economics of additional dollars (about

$44,000 for a typical new center pivot system in 1981)[2] that could be invested in developing and using South Dakota's irrigation resources. Recent studies show, for example, that rising energy prices (and declining water tables) threaten the future economic viability of irrigated agriculture in several sister Great Plains states.[3] The high interest rates experienced since 1979, of course, have direct repercussions on the profitability of irrigated agriculture and the prospects for adequate cash flows to meet debt obligations on loans to finance the development of irrigation resources.

Study objectives

The study reported in this paper is an extension of work initiated in 1977 through a Masters' thesis (Everson, 1979) in the SDSU Economics Department. That part of the thesis research focusing directly on the economic value of irrigation water in the Big Sioux and Vermillion Drainage Basins was reported in a

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[2] The cost of a "typical" new center pivot system for a quarter-section in 1981 in the study area is roughly as follows: center pivot machine - $30,000, pump panel and meter - $8,000, 40-feet well - $4,000, and electrical connections - $2,000, for a total of $44,000. The costs of particular systems may, of course, vary substantially from this "typical" figure.

[3] See the following studies: Mapp and Dobbins (1977) and Mapp (1981), Oklahoma Panhandle; Lacewell, et al. (1978), Texas Trans Pecos and High Plains areas; Young and Coomer (1980) and Petty, et al. (1980), Texas High Plains area; Lansford, et al. (1980), Southwestern Closed Basins in New Mexico; Benson, et al. (1981), Nebraska; and Short, et al. (1981), Ogallala Zone. Sloggett's (1981) recent study of the U.S.'s 11 major irrigation ground water-using states shows rising energy prices to be a "more serious constraint to pump irrigators than greater pumping depths".

SD Agricultural Experiment Station bulletin by Shane and Everson (1980). With the data collected through the initial study as a starting point, Shane and Everson (1980) projected through 1990 the likely production costs for eastern South Dakota crops.

In this study, the initial 1977 data are updated to 1981, and revised projections from 1981 to 1990 are made. Since the prices for energy and borrowed funds grew so rapidly from 1977 to 1981 -- with annual growth rates of 19 percent or more in Eastern South Dakota -- a major focus of the paper is on the impacts of high energy prices and interest rates on the economics of dryland and irrigated crop production.

Thus, the overall objective of this study is to examine the current and prospective economics of dryland versus irrigated crop production in Brookings and Turner Counties. The study's specific objectives are to:

1. Determine the cost structure for dryland and irrigated crop production;

2. Determine the nature and extent of energy costs in dryland and irrigated crop production;

3. Examine the relative economics of producing different dryland and irrigated crops;

4. Examine the impacts of varying rates of escalation in energy prices on the economics of future crop production; and

5. Examine the impact of different interest rates on the economics of crop production.

The economic analysis is in terms of conditions experienced during the 1981 crop year, and conditions projected through 1990 for each of three assumed rates of increase in energy prices.

The paper should be of interest to decision-makers in both the private and public sectors in South Dakota. Farmers and agriculturally-related businesses should benefit from the information provided on the extent to which higher energy and capital costs are likely to reduce the profitability of irrigated agriculture and shift the comparative advantage away from irrigated to dryland agriculture. Similarly, the information provided in this paper should assist state government agencies in determining the priorities for allocating public funds to facilitate the further development of the state's irrigation resources.

Study areas

Brookings and Turner Counties are in the Big Sioux and Vermillion Drainage Basins that rest adjacent to one another in the far eastern part of South Dakota (Figure 1). Of South Dakota's 17 major drainage basins, the irrigated areas in only two others (Missouri, James) exceed the irrigated areas in these two drainage basins. The annual precipitation in the basins under study ranges from an average of 20 inches in the north to 24 inches in the south.[4] The number of frost-free days ranges from an average of 130 days in the north to 150 days in the

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[4] During the 1970's the levels of irrigation water application were commonly 10 to 12 inches in the Big Sioux Basin and 12 to 15 inches in the Vermillion Basin (DWNR, 1977).

south. The soils in the two counties are mainly loamy and silty, although alluvial and clayey-loam soils are also found in low-lying areas in the south.

The two main potential sources of irrigation water are surface water from streams and lakes, and ground water from wells. The latter predominates in the study area. For example, the relative importance of ground water sources in the Big Sioux Basin increased from about 80 percent in the early 1970's to over 90 percent in the late 1970's. Virtually all of the irrigation in the Vermillion Drainage Basin throughout the 1970's has been from ground water sources.[5]

The main type of irrigation water distribution in both drainage basins in the late 1970's involves center pivot machines. For example, in 1977 in the Big Sioux and Vermillion Drainage Basins, 58 and 75 percent of the irrigation systems, respectively, involved center pivot irrigation. The gated pipe, hand moved sprinklers, and big gun sprinklers that were more common than center pivot machines in the Big Sioux area in the early 1970's each accounted for 10 to 15 percent of the Big Sioux systems in 1976-77. In the Vermillion Basin in the early 1970's, about 40 percent of the irrigation systems involved portable booms. By 1976-77, this proportion dropped to about 10 percent. Throughout the 1970's, about 10 percent of the irrigation systems in the Vermillion Basin have involved big guns. The growing predominance of center pivot irrigation in both

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[5] The source of the information reported in this and the following two paragraphs is DWNR(1977).

drainage basins reflects the successive movement of irrigation into hillier areas less well-suited for other types of irrigation and the lesser labor requirement of center pivot water distribution.

The main source of energy for irrigation in both drainage basins in the late 1970's was electricity. In 1977 in the Big Sioux and Vermillion Basins, for example, 70 and 87 percent of the irrigation systems, respectively, were powered by electricity. Even in the early 1970's, as many as two-thirds of the irrigation systems in the Big Sioux Basin used electricity. Diesel fuel has been used by 10 to 15 percent of the systems in the Big Sioux Basin throughout the 1970's, and by 20 to 30 percent of the systems in the Vermillion Basin. Major differences in the Vermillion Basin are that only 35 to 40 percent of its irrigation systems were powered by electricity in the early 1970's, and that propane's importance as a fuel source dropped from 25 to 35 percent in the early 1970's to less than 10 percent in the late 1970's.

About 25 percent of South Dakota's total cropland is planted to corn, and between 15 and 20 percent of the cropland is in each of oats, alfalfa, and spring wheat (Table 3). In both Brookings and Turner Counties, corn and oats are more prevalent than at the state level. For example, nearly two-fifths and nearly one-half of the Brookings and Turner County cropland areas, respectively, are in corn production, and well over one-fourth is in oats production. The dryland component of the study reported in this paper covers all the crops shown in

Table 3 except for winter wheat and winter rye, which are relatively uncommon in the two counties under study.

About 55 percent of the state's total irrigated area is under corn production, and about 25 percent is under alfalfa (Table 4). Corn dominates the irrigated agriculture in Brookings and Turner Counties, accounting for over three-fourths of the irrigated area in each county. Alfalfa accounts for about 10 percent of the irrigated acreage in Brookings County and for about five percent in Turner County. These two crops, plus soybeans in Turner County, are the focus of attention in the irrigation component of the study.

EMPIRICAL ANALYSIS AND FINDINGS

A separate section is used to report the results of the empirical data analysis concerning each of the five study objectives. The analytic procedures used in each section are explained prior to the presentation of findings.

The cost structure for dryland and irrigated crop production

Analytic procedures

The per-acre costs of producing a particular crop depend on the physical quantities of the various inputs used to produce the crop and on the prices paid for the respective inputs. Insofar as possible, information is provided on both physical quantities and prices.

In this study, production costs that must be met by farmers, whether or not they use their cropland in a particular growing season, are termed "fixed". Real estate taxes and the

time depreciation on owned machinery are examples. Production costs that could be varied or changed by farmers within a particular growing season are termed "variable". Expenditures for fertilizer and crop insurance are examples. It is profitable to produce in the short-run as long as gross returns exceed variable costs. In the long-run, only if gross returns exceed total production costs is it economical to continue production.

The various costs considered in this study are listed in Tables 5 and 6. The underlying assumptions and procedures for calculating each are briefly discussed.

The land charges in the crop budgets are based on the value of land reported in 1977. The mean values in Brookings and Turner Counties for irrigable dryland in 1977 were \$600 and \$750 per acre, respectively. Corresponding values for irrigated land are \$1,000 and \$1,200. The assumed annual rate of appreciation in land values is 12 percent. The annual charges for land -- including real estate taxes -- in the crop budgets are six percent of current land values.

Depreciation on farm machinery, irrigation systems, and storage facilities was computed using the actual investment figures provided by farmers. Lengths of useful life of 10, 15, and 20 years, respectively, were assumed. Straight-line depreciation and 10 percent salvage values were also assumed. Insurance and repair data were obtained directly from farmers, as was the information on the amount of electrical power required to pump irrigation water.

The interest rate used in the cost computations in Tables 5 and 6 is 18 percent, the rate commonly experienced by farmers who borrowed investment and operating capital in 1981.[6] The most common items of investment capital are farm machinery, irrigation systems, and storage facilities. Operating capital is used to finance the purchase of inputs like fertilizer, fuel, plant protection chemicals, and seeds. The average loan period for operating capital was assumed to be six months. The interest on investment capital is calculated on the average value over the lifetime of assets.

Information on the amounts of the various types of fertilizer applied to particular crops and the nutrient content of each was obtained.[7] The amounts of nitrogen (N), phosphorous (P_2O_5), and potassium (K_2O) applied per acre for each crop were then determined (Table 7).

For dryland crops in Brookings County, nitrogen application levels vary from zero for alfalfa and six pounds per acre for soybeans to 60 lb per acre for corn. Phosphorous application

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6 For farmers with equity operating and investment capital, a more realistic interest rate for 1981 might have been 14 to 16 percent. The impact of differing interest rates on crop profitability is covered in the final section of the paper.

7 As shown in the footnotes to various tables, the basic data on irrigated crop production were obtained through a farmer survey by Everson (1979). Data on dryland crops, on the other hand, reflect the judgments of selected extension and farm management research personnel at the SDSU.

levels vary from 10 lb P_2O_5 per acre for flax to 45 lb P_2O_5 per acre for alfalfa. The levels of dryland crop fertilization in Turner County are either the same as, or slightly more than, those in Brookings County.

Nitrogen applications for irrigated corn are 2.5 times as much as those for dryland corn. Phosphorous applications for irrigated crops are also considerably higher than those for dryland crops.[8] Potassium applications ranging from 13 lb K_2O per acre for soybeans to 60 lb K_2O per acre for corn in Turner County were reported by farmers with irrigation.

The fertilizer costs shown in Tables 5 and 6 reflect the quantities of fertilizer for the various crops shown in Table 7 multipled by the prices for the fertilizer nutrients shown in Table 8.[9] Similarly, the seed costs reflect the cross-products of the seeding rates shown in Table 9 and the respective seed costs shown in Table 8.

<u>Fuel</u> costs per acre were determined through a four-step

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[8] The reported nitrogen and phosphorous levels on irrigated crops in Turner County are higher than those recommended as "maintenance" levels (i.e., following the initial three to four years of crops being raised with irrigation) by the Cooperative Extension Service.

[9] This procedural statement, and others like it in the paper, reflect the basic principles underlying the calculations undertaken. Since the actual calculations frequently involved several rather circuitous steps, and hence required rounding at several junctures, the data reported in the various tables may not agree "to the penny" with those that would be obtained from calculations corresponding directly with the procedural statements indicated in the text.

process. The first step involved listing the field operations performed on each crop, and for each operation the width of the implement used and the speed traveled. The acres per hour for each field operation, calculated through the use of this information, were divided by a 0.75 field efficiency factor. The second step involved using hourly fuel consumption data (UN, 1977, N31-N43), in conjunction with the hours required per acre, to compute the fuel consumption per acre. Third, the after-tax fuel price (Table 8) was multiplied by the gallons consumed per acre. Finally, five percent of the fuel cost was added to reflect engine oil and other lubrication costs.

Expenditures for certain items -- namely, grain storage, grain drying, plant protection chemicals, custom hiring, and crop insurance -- were not incurred by all respondents. The total expenditure by all farmers for each such item for each crop was divided by the total acreage cultivated by all surveyed farmers raising the crop. The resulting per-acre averages that are reported in Tables 5 and 6, therefore, should not be interpreted as the average costs of those following the particular practice.

Finally, five percent of all variable costs, excluding interest on operating capital, was added to the various crop budgets to cover miscellaneous overhead costs. Examples are membership fees for farm organizations, record-keeping fees, income tax consultant fees, legal fees, and farm magazine subscriptions.

Not covered in this study are expenditures on hired labor

and charges for crop and irrigation management. The expenditures on hired labor are relatively small.[10] The level of management is critical in determining the economic performance of crops. To quantify the precise value of management, however, is complicated and was beyond the terms of reference of this study.

Findings

The total variable costs of production per acre in 1981 in Brookings County range from $41 for alfalfa to $97 for corn (Table 5). They are about $50 per acre for oats, barley, and flax, and about $60 per acre for soybeans, spring wheat, and sunflowers. The total variable production costs per acre of dryland crops are about the same in Turner County as in Brookings County for barley and soybeans, but 10 to 15 percent higher for corn, flax, and oats, and about 45 percent higher for alfalfa (Tables 5 and 6). The total per-acre costs of producing various dryland crops in Brookings County range from $119 for alfalfa to $192 for corn. They are commonly 12 to 17 percent less than those for corresponding crops in Turner County. For alfalfa, however, the Brookings County costs are 47 percent less. The costs of producing irrigated crops in both counties are about twice those for the respective dryland crops.

The various cost items in Tables 5 and 6 are listed roughly in their relative orders of magnitude. The fixed costs, as

[10] Brown and Shane (1981, 81-87) show, for 1980, hired labor charges on various crops in South Dakota of five to eight dollars per acre.

a group, constitute between 50 and 70 percent of the total costs of producing the various crops. The proportions of fixed costs for most crops are slightly higher in Turner than in Brookings County.

The single largest cost item in all the crop budgets is the charge for land, which most commonly accounts for 35 to 40 percent of the total costs of dryland production and 25 to 35 percent of the total costs of irrigated production. The next four line items -- (1) depreciation and insurance, (2) interest on investment, (3) fertilizer, and (4) machinery fuel and lubrication -- each account for roughly eight to 15 percent of total production costs for the various crops. For irrigated production, however, the interest on investment accounts for more than 15 percent, and fuel and lubrication for less than eight percent of total production costs.

The final aspect of cost structure examined is the expenditure on irrigation system power and repair as a percentage of the total variable production costs. In Brookings and Turner Counties, the percentages are as follows: corn - 15 and 16, soybeans - 25, and alfalfa - 30 and 32.

To help interpret these findings, data from similar studies of irrigated crop production in the Great Plains states are presented. Irrigation costs vary with the height to which irrigation water is lifted, the type of water distribution system used (particularly whether via surface or sprinkler systems), the amount of irrigation water applied, the type of energy used

to power irrigation pumps, the efficiency of pumps, and the year when the costs are evaluated. Therefore, the information available on these various items in the references cited is noted below. Irrigation and repair expenditures, as percentages of total variable costs of production, in these other studies are as follows:

1. Aanderud (1977,6,7), Central South Dakota, 1977: corn - 18 percent, wheat and barley - 20 percent, sorghum - 22 percent, soybeans - 24 percent, and alfalfa - 31 percent;

2. Brown and Shane (1981, 81-87), Central and East Central South Dakota, 1980: corn - 11 to 13 percent, soybeans - 16 percent, and alfalfa - 26 to 28 percent;

3. Skold (1977, 4), corn raised under center pivot irrigation, 1975: Texas Panhandle - 20 percent, and Southwestern Nebraska and Northeastern Colorado - 26 percent;

4. Benson, et al. (1981, 16, 21, 26), Nebraska, 100-ft. well, gated pipe with re-use, electric power, 1978: corn for grain on farms of three different sizes - 14 to 25 percent, and alfalfa on a large livestock farm - 55 percent; and

5. Schneeberger, et al. (1981, Table 2), Missouri, center pivot irrigation, 1980-1990 projections: corn - eight percent, and soybeans - 11 percent.

With these findings, irrigation system power and repairs consistently account for two or more times the proportion of total variable costs for alfalfa as for corn. The proportion is intermediate for soybeans. Further, the proportions appear to be lower in South Dakota than in Colorado, Nebraska, and Texas. One probable explanation for the latter outcome is the generally lesser height to which irrigation ground water is lifted in South Dakota (Sloggett, 1977, 11)[11].

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[11] The average well depths of the farmers surveyed by Everson (1979) in Brookings and Turner Counties are 45 and 85 feet, respectively.

Energy costs in dryland and irrigated crop production

In 1980, the food and fiber sector accounted for about 13 percent of the total energy consumed in the U.S.[12] About 21 percent of food and fiber energy is for farm production activities.[13] Thus, farm production accounts for less than three percent [(0.13 x 0.21 = 0.027) x 100 = 2.7] of the U.S.'s total energy consumption. Efforts by farmers to conserve energy, therefore, cannot be expected to have much influence on the national "energy-picture". Nevertheless, rising energy prices do provide economic incentives to individual farmers to conserve energy.

To determine possible areas in which farm-consumed energy might be conserved, the uses of energy in agricultural production are examined. The focus is first on overall agricultural production in South Dakota and the U.S., and then on specific dryland and irrigated crops in South Dakota.

Analytic procedures

The total energy required in agricultural production can be envisioned to consist of "direct" and "indirect" components. "Direct" energy is embodied in the fuel and lubrication for farm machinery and irrigation systems, and the power for grain drying.

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[12] The percentages of total energy consumed in non-food sectors are as follows: industry - 35, transportation - 24, residential - 16, and commercial - 12 (Waelti, 1975,5).

[13] The percentages of total food and fiber energy used in non-production activities are as follows: food and kindred product processing -30, input manufacturing - 20, manufacturing and distribution - 19, and farm family living - 10 (Duncan and Webb, 1980,4).

"Indirect" energy is that energy required to produce and deliver the inputs -- materials and human services -- used in agricultural production.

In examining the indirect energy content of specific South Dakota crops in this study, attention is given to the energy embodied in fertilizer and plant protection chemicals, but not to the generally smaller amounts embodied in seeds, machinery, transportation, and human labor.[14] The procedures for determining the energy content in fertilizer and plant protection chemicals are as follows.

Natural gas and electricity are involved in the production of fertilizer. The amounts of natural gas (cu ft) and electricity (kilowatt hour = KWH) required to produce one pound of fertilizer nutrient are as follows (Maryland, n.d., 29):

-Nitrogen (N) - 30.674 and 0.120;

-Phosphorous (P_2O_5) - 1.030 and 0.060; and

-Potassium (K_2O) - 1.275 and 0.088.

In 1977, the price of natural gas was $0.0052 per cu ft and the price of electricity was $0.023 per KWH. Thus, the energy embodied in one pound of nutrient had values in 1977 as follows:

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14 Pimental, et al. (1973, 445) show the manufacture of machinery, transportation, seeds, and labor to account for 14.5, 2.4, 2.2, and 0.2 percent, respectively, of the total energy inputs for irrigated corn production in 1970. Mapp and Stigler (1977,4) show machinery manufacture, seeds, and labor to account for 5.0, 0.5, and 0.02 percent, respectively, of the total energy inputs for irrigated corn in the Oklahoma Panhandle. The corresponding percentages for irrigated wheat in the Mapp and Stigler study are 4.7, 2.1, and 0.3.

N - \$0.1623, P_2O_5 - \$0.0067, and K_2O - \$0.0087. The prices of these nutrients increased from 1977 to 1981 by 41, 44, and 44 percent, respectively (see Table 8). Therefore, the 1981 values of energy in one pound of each N, P_2O_5, and K_2O are \$0.2288, \$0.0097, and \$0.0125, respectively.[15]

Pimental, <u>et al</u>. (1973, 445) report that about 11,000 kilocalories (KCAL) of energy are embodied in one pound of insecticide or herbicide. One KCAL of energy is equivalent to 0.00116 KWH (Waelti, 1975, 18). The price of one KWH in 1981 is \$0.051. Thus, the value of energy embodied in each pound of plant protection chemicals in 1981 is:

11,000 KCAL x 0.00116 KWH per KCAL x \$0.051 per KWH,
or \$0.65.[16]

<u>Findings</u>

The Federal Energy Administration (now part of the Department of Energy) and the U.S. Department of Agriculture's Economic Research Service cooperatively developed in 1974 the first comprehensive farm production energy data base in the U.S. The data base -- revised and updated in 1978 (Torgerson and Cooper, 1980) -- shows at the individual state-level and nationally the energy consumed on farms for each of 18 crop operations and 16 livestock operations.

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15 In this study, energy constitutes 95, 4, and 10 percent of the total cost (see Table 9) of nitrogen, phosphorous, and potassium, respectively.

16 In this study, energy accounts for about 30 percent of the total cost of plant protection chemicals.

These USDA data on energy consumption in 1978 are summarized for South Dakota and the U.S. in Table 10. About 32 percent of the energy used in the U.S.'s total agricultural production is accounted for by the fertilizer used in crop production. Irrigation, which accounts for 12.4 percent of the total, is among three other "second-ranking" energy-consuming agricultural operations, namely, preharvest field activities, farm vehicles, and livestock care.

The use of energy in agriculture in South Dakota is quite different from that in the U.S. as-a-whole. Major contrasts are relatively greater importance in South Dakota for farm vehicles, livestock care, and crop harvesting, on the one hand, and relatively less importance for fertilizer manufacture and irrigation, on the other. That irrigation accounts for only 2.4 percent of the energy used in South Dakota's agriculture -- as compared to 12.4 percent nationally -- is consistent with the relatively greater importance of irrigation in other Great Plains states noted at the outset in this paper.

The individual crop energy-analysis in Brookings and Turner Counties shows the per-acre energy bill in 1981 for most dryland crops to range from \$22 to \$26 (Tables 11 and 12). The \$13 to \$19 per acre energy bills for alfalfa and soybeans, and the \$35 for sorghum and \$57 and \$54 for corn, however, are outside this range. In relative terms, energy accounts for about one-third to one-half of the total variable costs of dryland production, with the ratios lowest for alfalfa and soybeans and highest for barley and corn. Thus, of the dryland crops, corn

is considerably the most energy-intensive and alfalfa and soybeans are least energy-intensive.

> FARM APPLICATION: The energy bill for a 350 acre-dryland farm[17] under corn production in 1981 is over $10,000 per year more than the energy bill for that same farm with alfalfa and soybeans.

Of the various energy components in dryland production, "machinery fuel and lubrication" is definitely the largest. The expenditures on this component, which range most commonly from $15 to $18 per acre, account for over one-half the energy bill for all crops except corn (which also involves grain drying) and sorghum. For soybeans and alfalfa -- for which fertilizer levels are low and no grain drying is required -- machinery fuel and lubrication account for well over three-fourths of the total energy costs. For all dryland crops except alfalfa and soybeans, fertilizer is the second most important energy cost component, and the energy in plant protection chemicals is only a small fraction (one-third or less)[18] of that in fertilizer.

The energy bill for corn and soybeans raised under irrigation is 2.0 to 2.2 times as much as that for the crops grown under dryland conditions. For alfalfa, the irrigation-dryland differential is 2.7 to 2.8 times. Energy accounts for slightly

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17 The USDC (1980) shows average per-farm cropland acreages in 1978 in Brookings and Turner Counties of 370 and 300 acres, respectively. The 350 acres in the "farm application" illustrations is used to typify these farms.

18 For sunflowers, however, the energy embodied in plant protection chemicals is almost one-half that in fertilizer.

over one-half of the total variable cost for irrigated corn,[19] 40 to 46 percent for irrigated alfalfa, and 35 percent for irrigated soybeans. These data, of course, reflect the much greater energy-intensity of irrigated than dryland agriculture.

> FARM APPLICATION: The energy bill for a quarter section of corn (130 acres under a center pivot) raised under irrigation in 1981 is about $7,500 greater than if the corn were raised under dryland conditions.

The largest energy cost component in irrigated corn production, fertilizer, accounts for 34 and 47 percent of total energy costs in Brookings and Turner Counties, respectively. The fuel to power irrigation pumps accounts for 28 percent of the total crop production energy costs. Machinery fuel and lubrication and grain drying are next in importance, with the energy embodied in plant protection chemicals of least importance. For alfalfa and soybeans, on the other hand, well over 60 percent of the total energy expenditure is on the fuel to power irrigation pumps. From one-quarter to one-third of the energy is for machinery fuel and lubrication. Fertilizer and plant protection chemicals account for only 10 percent of the

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[19] The only other researcher of Great Plains crop production that reports total crop energy as a percentage of production costs, of whom the authors are aware, is Skold (1977,4). He indicates that between 53 and 54 percent of the total variable costs of producing corn under center pivot irrigation in 1975 in each of the Texas Panhandle, Southwestern Nebraska, and Northeastern Colorado is for "energy-related" inputs. Since Skold includes the full cost of nitrogen fertilizer, herbicides, and insecticides -- as well as the cost of fuel and lubricants -- in his energy-input calculations, his data are not fully comparable to those of the authors.

total soybean energy cost and from three to four percent of the total alfalfa energy cost.

Relative economics of dryland and irrigated crop production

Analytic procedures

The relative economics of dryland and irrigated crop production are examined largely in terms of the energy and capital intensity involved in the production of the various crops and the net returns from producing the various crops.

To compute the net returns, yields were multiplied by farm market prices, and farm production costs were deducted. The dryland and irrigated yields are shown in Table 13. The assumed crop prices for 1981 are shown in Table 14. The yields under irrigation are generally 1.7 to 1.9 times as much as under dryland conditions. For corn in Brookings County, however, the irrigation-dryland yield differential is 2.3 times. Dryland corn is used as the point of reference in the initial comparative analysis because of its dominance in the crop agriculture of both Brookings and Turner Counties (recall Tables 3 and 4).

An additional criterion used in the comparative analyses is "break-even" prices. A "break-even" price is defined as the cost per unit of output produced. Unless otherwise noted, break-even prices in this paper are computed with respect to the total variable costs of production. In the "short-run", as long as the actual market price for a commodity exceeds its break-even price (relative to total variable production costs), production can profitably be continued. In the longer-run,

when the possible disposition of a farm's fixed assets -- such as land, irrigation equipment, farm machinery, and storage facilities -- is actively considered by a farmer, however, a break-even price defined with respect to total rather than variable production costs is the appropriate criterion for deciding whether farm production should be continued.

Findings

The most popular crop in Brookings and Turner Counties, corn, is also the most energy-intensive crop produced in these counties (Tables 15 and 16). Except for irrigated corn whose energy bill is 2.1 to 2.2 times that for dryland corn, the $47 and $54 per acre energy bills for dryland corn are greater than those for any other crop--dryland or irrigated--in either county.. The energy expenditure for most of the dryland crops is roughly one-half that for dryland corn, but the proportions are somewhat higher for sorghum (65 percent) and somewhat lower for soybeans and alfalfa (29 to 39 percent). The energy bills for irrigated alfalfa in Brookings County and irrigated soybeans in Turner County are only three-fourths as much as those for dryland corn. The amount of energy used for irrigated alfalfa in Turner County is about the same as that used for dryland corn production in the same county.

The total variable dryland production costs are most commonly $50 to $65 per acre. They range, however, from $41 per acre for alfalfa in Brookings County to $109 per acre for corn in Turner County.

FARM APPLICATION: The total variable costs for a 350 acre dryland farm under corn production are $18,000 per year greater than if the farm were in alfalfa production.

Total dryland production costs are most commonly $150 to $175 per acre, with the range from $119 for alfalfa in Brookings County to $217 for corn in Turner County. The relative intensity with which capital is used in producing the various dryland crops is the same as that for energy, except for soybeans which ranks third or fourth in capital-intensity and only seventh or eighth in energy-intensity. The relatively greater capital-intensity of soybean production is explained largely by the generally greater expenditures on seeds and plant protection chemicals used in soybean production (recall Tables 5 and 6).

The total variable production costs for irrigated alfalfa and soybeans are roughly the same as those for dryland corn. The total production costs for irrigated alfalfa and soybeans, however, are from 39 to 84 percent higher than those for dryland corn. This differential arises because of the annual costs associated with the substantial investment in irrigation facilities and the higher land price for irrigated than for dryland production. The total variable production costs and the total production costs for irrigated corn are both roughly double what they are for dryland corn.

Under the prices assumed for 1981, alfalfa is by far the

most profitable crop in both counties.[20] The net returns over total variable costs for dryland alfalfa are $120 and $168 per acre in Brookings and Turner Counties, respectively, with the corresponding figures for irrigated alfalfa being $206 and $275. Furthermore, alfalfa is the only crop whose gross returns exceed the total costs of production (irrigated alfalfa in Turner County is a minor exception). If the price of alfalfa were $33.50 per ton (as it averaged in South Dakota in 1977-1979) rather than $65 per ton as assumed for 1981, however, alfalfa would lose its profit superiority. Under irrigation, for example, its net return over total variable costs would be 95 percent less than that for corn in Brookings County, and from 65 to 75 percent less than that for corn and soybeans in Turner County. Under dryland production, alfalfa would occupy an intermediate profit-position among the other dryland crops.

Among the dryland crops other than alfalfa, the differences in net returns are rather limited. In Brookings County, for example, the net returns from the most profitable crop -- soybeans -- are only about $25 per acre more than those for the least profitable crops (flax and sunflowers). In Turner County, the profit-differential between the most profitable crop (soybeans) and

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[20] A presupposition of the analysis underlying this and other statements concerning inter-crop profitability is that technical conditions would not preclude the satisfactory production of different crops on the same piece of land. In particular situations, this presupposition, of course, is not completely valid.

the least profitable crops (spring wheat and barley) is somewhat greater, namely, about $40 per acre.[21]

If the price of corn were $3.00 per bu (as it was in 1980) rather than $2.40 per bu as assumed for 1981, however, corn would have a rather clear profit-advantage relative to all dryland crops except alfalfa in both counties. At this higher price for corn and under irrigation, corn would enjoy a definite economic advantage over alfalfa priced at $33.50 per ton in both counties and over soybeans priced at $5.75 per bu in Turner County.

One of the most significant findings emerging from this comparative analysis is that, under the prices prevailing in 1981, the gross returns from producing the various crops exceed the total variable production costs but are less than the total production costs (alfalfa is an exception to the latter). This outcome suggests that farmers in 1981 had positive short-run economic incentives to farm. The economic incentives for farmers to remain in farming over the longer-run, however, were not altogether positive. In interpreting these findings, however, the motivation of farmers to hold land -- and hence the way that land costs should most appropriately be handled -- is a crucial issue. This point is discussed in a later section.

A second significant finding is that, under 1981 prices, alfalfa is clearly the most profitable crop -- under both dryland and irrigated conditions. But, if the price of alfalfa were to

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21 The latter finding undoubtedly is related to the very limited acreage of barley and spring wheat in Turner County (recall Table 3).

return to its average for 1977 to 1979 and the price of corn were to return to its 1980 level, corn would emerge as the most profitable crop.[22] Recently experienced variations in relative crop prices, therefore, can be seen to influence profoundly the relative economics of producing different crops. That corn production is highly energy and capital-intensive tends to limit the economic attractiveness of corn. On the other hand, corn enjoys certain distinctive advantages relative to alfalfa. Since corn is an annual and alfalfa is a perennial, corn farmers have greater year-to-year flexibility than alfalfa farmers in adjusting their cropping plans. Further, markets for handling corn are more firmly established than are markets for alfalfa, and corn is much less bulky to transport. Whether corn or alfalfa, or some combination of the two, is selected for production by a farmer, therefore, depends on several interrelated factors. Many of these factors reflect the values and priorities unique to individual farmers.

The economics of raising alfalfa, corn, and soybeans under dryland versus irrigated conditions are now examined in more detail (Tables 17 and 18). The per-acre capital intensity -- for both total variable production costs and total production costs -- is about twice as much under irrigation as under dryland conditions. The irrigation-dryland capital-intensity differential is slightly greater for alfalfa than for corn or soybeans.

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[22] Hewlett and Bateman (1979) also show the profitability of corn versus alfalfa in Butte County to depend on the relative market prices assumed for the two crops.

Judged from any of three perspectives, irrigated production is generally more energy-intensive than dryland production. For example, and as noted above, the energy cost per unit of land is 2.0 to 2.2 times as much under irrigation as under dryland conditions for corn and soybeans, and 2.7 to 2.8 as much for alfalfa. The energy cost per unit of output produced is also greater under irrigation (except for corn in Brookings County). The irrigation-dryland energy cost differential is smaller per unit of output than per unit of land, however, because of higher yields under irrigation. Thirdly, the energy cost relative to total variable costs is four to seven percentage points higher under irrigated than dryland conditions for corn and soybeans, and from nine to 13 percentage points higher for alfalfa.

The break-even price for corn raised under irrigation in Brookings County is 16 percent less than that for corn raised under dryland conditions. For the other crop situations studied, however, the break-even price for irrigated production is roughly the same as (corn and soybeans in Turner County) or is more than (alfalfa in both counties) that for dryland production. These findings show that the use of irrigation does not necessarily lead to the production of lower cost farm commodities.

The relative profitability of irrigated versus dryland production differs depending on whether the point of reference in the profit calculations is total variable costs or total costs. To illustrate, the net returns over variable costs are 1.6 to

3.4 times higher under irrigation than under dryland conditions.[23] Thus, farmers with cropland already under irrigation in 1981 appear to have earned considerably greater returns per acre to their fixed assets (i.e., above their variable costs) than farmers raising crops without irrigation.

In the cases studied, however, the net returns over total production costs are without exception lower with than without irrigation.[24] The net returns with irrigation versus without irrigation range from $11 per acre less for corn in Brookings County to $62 per acre less for alfalfa in Turner County. If these findings for 1981 were interpreted to portray the longer-term economic potential for agricultural production, particularly under irrigation, in the two counties studied, the future prospects would have to be viewed as somewhat dismal.

At least four factors temper such a conclusion, however. The input-product price relationships for 1981 (except for alfalfa) are generally acknowledged to have been unusually unfavorable for farmers. Second, a major benefit from irrigation

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[23] Brookings County is most similar to the "central North Central" region and Turner County is most similar to the "West Southwestern" Region in Brown's and Shane's (1981) study. Their 1980 data, inflated to 1981 price levels, show this same general outcome except that the range in ratios is 1.7 to 3.3. Matson et al. (1969) show ratios of net returns over variable production costs under irrigation versus dryland conditions for different sizes and types of farms on different classes of land in the Upper Big Sioux Basin in the late 1960's as follows: corn 1.8-2.3, soybeans 2.2-2.9, and alfalfa (class 1 and Class 2 soils) 1.1-1.6

[24] The Brown and Shane (1981) study shows this same outcome for irrigated versus dryland corn and soybeans. For alfalfa, under 1981 conditions, however, the net returns over total costs are somewhat higher for irrigated than dryland production.

arises in drought years (Brown and Shane, 1981), an aspect not taken into account in this study. Third, the level of management plays a key role in determining the profitability of farming. The future economic prospects of agriculture for above-average managers are, of course, brighter than those for below-average managers. And fourth, the incentives that different farmers have to own land differ. Some farmers, for example, might be willing to own land more for the prospect of future possible appreciation in the value of the land, than from the current return from using the land.[25] If so, the most appropriate approach for farmers in assessing the longer-term economic potential of farming would be to compare, with market prices, break-even prices which take into account all production costs except land charges.

The analysis presented in Table 19 shows data on existing market prices, and 1981 break-even prices computed with respect to variable production costs, total production costs minus land charges, and total production costs. The 1981 market prices are higher than the break-even prices which take into account only variable production costs for each crop -- whether irrigated or dryland -- in both counties. This finding, of course, affirms the economic value of farmers continuing in the short-run to operate their farms.

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[25] Farmers whose land is heavily mortgaged, of course, have no choice. Their current returns from farming must be adequate to meet their debt obligations on the land, or they will be forced out of the farming business.

In each case, except for alfalfa, however, the 1981 market prices are less than the break-even prices which take into account the total costs of production. And for alfalfa, the market prices (not adjusted for inflation) prevailing between 1978 and 1980 are from 12 to 57 percent less than the 1981 break-even price for alfalfa. These findings -- which generally reflect a poor economic performance of the crops -- are consistent with the earlier ones based on the net returns to the total assets in farming.

If the 1981 market prices are compared with the 1981 break-even prices which take into account all production costs except for the land change, the "picture" is somewhat more clouded. In a majority of instances, the market prices exceed the break-even prices. In three instances, however, they do not (corn, flax, and sunflowers in Brookings County), and in two instances the market and break-even prices are essentially the same (barley and spring wheat in Turner County). Thus, those farmers who believe that the product-input price relationships of 1981 were unusually unfavorable, and who are willing to continue farming, even if the return they receive on land is not necessarily comparable with what they could earn from other uses of their funds, will likely find it economically advantageous to continue over the long-run in farming. Those who are less optimistic about the prospect of more favorable farm product-input price relationships, do not place a special value on land (versus other asset) ownership, and are qualified for non-farming occupations, on the other hand, may find it advantageous to entertain the possibility of

leaving farming for other more attractive income-earning opportunities.

Impacts of rising energy prices on the economics of future crop production

The prices paid by farmers for farm inputs have increased much during the past two decades. At the national level, for example, the prices farmers paid for all production inputs, services, interest, taxes, and wages more than doubled between 1965 and 1977 (Figure 2a). In the four years since 1977 these prices increased an additional 50 percent.

In the years prior to 1977, the prices of various farm inputs -- as classified in the 1982 Economic Report of the President (Reagan, 1982, 342) -- increased at rather similar rates (Figure 2b-2f).[26] Since 1977, however, the prices of fuels and energy have more than doubled, whereas the prices of other farm inputs have increased by no more than about 50 percent. Even compared to the farm real estate market (Figure 2g) which has "boomed" since the early 1970's (Hasbargen, 1980), farm fuels and energy have experienced more rapid price increases. Unless major energy-consumers like the U.S. substantially curb their appetites for energy, the prospect of a continuing escalation in energy prices is highly likely (Sivard, 1980).

[26] The unusually high price of fertilizer in 1975 is an exception.

Analytic procedures

In this study, the impacts of rising energy prices on the economics of crop production are projected to 1990. Assumptions on the projected rates of change in technology and prices are as follows.

The yields and input-levels reported in 1977 are assumed to not change over the study period. While this assumption may be rather conservative,[27] a review of the annually reported yield data for individual crops in each of Brookings and Turner Counties over 1965 to 1980 (CLRS, 1971, 1976, and 1981) shows evidence of only one crop -- namely, soybeans -- experiencing definitely higher yields in the late 1970's. Other crops show either modestly increasing or unchanging yields over time. From year to year, however, yield variations have been very marked.

The prices of the various farm inputs in 1981 were assumed to increase at the rates projected by Shane (1980). These rates of increase[28] -- ranging among inputs from 1.5 to 2.8 percent per year, except for interest paid on borrowed funds which was assumed

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[27] The yield assumption is probably more conservative for crops raised with than without irrigation. The improved moisture environment for crops provided through irrigation alleviates a common critical constraint to the achievement of higher yields. Since achieving possibly higher yields would require the use of additional inputs, however, providing in the analysis for increased yields over time would have required providing also for the payment for additional inputs over time.

[28] Here and elsewhere in the paper, the rates of price increase are in "nominal", not "real," terms.

to not change[29]-- are shown in Table 8. Because of the particularly rapid price rises for most farm inputs experienced between 1977 and 1981, the growth rates in input prices over the full period of 1977 to 1990 most commonly range from 3.0 to 7.5 percent per year. The analysis, based on these projected prices, is described as reflecting "current trends in input prices".

Two alternative levels of price increase are assumed for energy. An intermediate rate of increase involves an assumed doubling of the 1981 energy price by 1990.[30] The high rate reflects an assumed doubling of the 1981 energy price by 1986. In contrast with the 1981 to 1990 "current trend" annual rates of increase in diesel fuel and electricity prices of 2.7 to 2.8 percent, the intermediate and high rates of price increase involve

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29 The authors do not believe that interest rates will remain constant over the decade of the 1980's. Forecasting with any precision how the interest rate will change from year to year, however, is infeasible. The authors therefore used the simplifying assumption of unchanging interest rates over the study period. The impact on crop profitability of interest rates higher and lower than 18 percent is indicated in the final section of this paper.

30 Account was taken of both the direct and indirect (namely, overhead and interest charges) implications on costs of a doubling in energy prices. For example, if the cost of energy to produce a crop in 1981 was $25.00 per acre, and the price of energy was assumed to double in 1990, the energy cost for that crop in 1990 would be:
- Direct: $25.00 x 2 = 50.00; and
- Indirect: $25.00 x 0.05 = 1.25 for overhead plus (50.00 + 1.25) x 0.09 = 4.61 for interest,

for a total of $55.86 per acre.

annual growth rates of 8.0 and 14.9 percent, respectively.[31]

Based on the current trends in input prices, the variable costs of producing various crops would increase from 1977 to 1990 at annual rates of 4.9 to 5.8 percent per year (Table 20). If the 1981 energy price were to double by 1990,[32] the increment in the annual growth rates in variable production costs for different crops, because of the higher energy prices, would most commonly be between 1.7 and 2.0 percent. If the 1981 energy price were to double by 1986, the corresponding production cost growth rate increment would most commonly be 3.0 to 3.6 percent. Thus, the assumed higher rates of escalation in energy prices would augment substantially the prospective rates of increase over the 1980's in the variable costs of producing the various crops.

The projected growth rates in product prices are based on forecasts provided by Chase Econometrics (1981). Their projections for corn, soybeans, and wheat reflect the time period 1978 to 1990, and for alfalfa 1981 to 1990. Based on these forecasts and commodity interrelationships, the authors projected prospective growth rates for the other commodities covered in this study.

The annual growth rates in product prices projected in this

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[31] The U.S. Department of Energy (USDE, 1981, 40) projects oil prices to increase between 1980 and 1990 at "low", "medium", and "high" rates of 6.8, 9.2, and 11.0 percent per year.

[32] In those situations in which "the 1981 energy price is assumed to double by 1990 (1986)", the prices of all other inputs are assumed to rise according to current trends in their prices.

study for 1977 to 1990 are most commonly 6.4 to 6.6 percent (Table 20). They do range, however, from 5.8 percent for alfalfa to 7.7 percent for corn and sorghum. These projected growth rates for product prices -- roughly comparable with those for the variable production costs under the intermediate energy price increase assumption -- were applied against the mean prices for the various crops during 1978 to 1980 to obtain the projected prices in 1990 shown in Table 14.

The impacts of rising energy prices on the economics of future crop production are evaluated in terms of the absolute and relative expenditures on energy, net returns over variable production costs, net returns over total production costs, and break-even prices (relative to variable production costs).

Findings

The crops are listed in Table 21 in accordance with their relative profitability (over total variable production costs) in 1981. Under the conditions of 1981, and as indicated above, alfalfa is the most profitable crop covered in the study. The net returns per acre from dryland alfalfa, for example, are 2.0 times more than those from the next most profitable dryland crop. Under irrigation, alfalfa provides about 70 percent greater returns than the nearest competitor.

Assuming current trends in input prices, however, the net returns over variable costs projected to 1990 are considerably more (ranging from about 15 to 80 percent) for corn and soy-

beans than for alfalfa.[33] In Turner County, under both irrigated and dryland conditions, corn is more profitable than soybeans. In Brookings County, dryland soybeans has a slight edge over dryland corn. Alfalfa's profit superiority in 1981 appears to have reflected its unusually high price in that (and the preceding) year.

Assuming that the 1981 energy price doubles by 1986, the projected net returns from dryland crop production in 1990 are most commonly $35 to $45 per acre less than the projected net returns with the current trends in input prices assumed. The reduction in net returns for corn, however, exceeds $80 per acre.

> FARM APPLICATION: The projected net return in 1990 for a 350 acre dryland farm under the "high energy price increase" assumption for crops other than corn is $12,000 to $16,000 per year less than under the "current trends in input prices" assumption. If the farm were under corn production, however, the difference in net returns because of high energy prices would be roughly $30,000 per year.

In relative terms, the projected net returns in 1990 under dryland conditions are most commonly from 35 to 50 percent less with rapidly increasing energy prices, although the reduction in net returns is as low as 14 to 19 percent for alfalfa and soybeans.

[33] The net returns per acre from crop production projected to 1990 are much higher than the net returns in 1981 (except for alfalfa). This outcome arises because (1) the base point for most calculations underlying the 1990 projections is 1977, and (2) input prices -- especially for energy and borrowed funds -- rose much more rapidly than output prices between 1977 and 1981.

Under irrigation and with rapidly increasing energy prices, the projected net returns from corn production in 1990 are roughly $190 per acre less than with the current trends in input prices assumed. The corresponding reductions in net returns for irrigated soybeans and alfalfa are less than one-half as much as those for corn.

> FARM APPLICATION: The projected net return in 1990 for an irrigated quarter section of corn under the "high energy price increase assumption" is about $25,000 per year less than under the "current trends in input prices" assumption. If the quarter section were in alfalfa, the reduction in net returns because of higher energy prices would be about $10,000 per year. Nevertheless, under higher energy prices, irrigated corn is still considerably more profitable than irrigated alfalfa.

The relative reduction in net returns from rapidly rising energy prices ranges from 16 percent for irrigated soybeans to about 40 percent for irrigated corn.[34]

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[34] In other studies of Great Plains irrigation having an analagous analytic focus, the following results were obtained.

1. Petty, et al. (1980) report that the net annual returns to irrigators in the Texas High Plains would be 5 to 18 percent less if the price of natural gas were $2.50 per thousand cubic feet (mcf) rather than $1.50 per mcf.
2. Young and Coomer (1980) report that net crop income in the Texas High Plains would be 17 percent less if the price of natural gas were to rise from $1.36 per mcf in 1976-80 to $5.33 per mcf in 2001-05 rather than to remain constant at the 1976-80 level.
3. Lansford, et al. (1980) report that the net return to land and risk in the Southwestern Closed Basins of New Mexico would be 62 percent less in 1998 if the real price of natural gas, liquified petroleum gas, and diesel fuel were to increase eight percent annually (and electricity were to increase four percent annually), than if the "real" energy price in 1978 were to be maintained until 1998. The 60 percent differential, however,

The ranking in the projected relative profitability among crops in 1990 is rather different under the high energy price assumption from that under the current trends in input prices assumption. The most striking difference is the emergence of soybeans as the most profitable crop under both dryland and irrigated conditions. Its net return per acre ranges from 13 to 25 percent more than that from its nearest competitor. Under dryland conditions in Brookings County, alfalfa has a marked profit advantage over corn (46 percent). In Turner County, alfalfa and corn are about equal in their profitability. Under irrigation, however, corn continues to enjoy a considerable economic advantage over alfalfa (32 to 41 percent higher net returns), even under rapidly rising energy prices.

Differences in the relative ranking of crops under different rates of escalation in energy prices, of course, reflect differences in the amounts of energy required to produce the different crops. Thus, in summary, under rapidly rising energy prices and dryland conditions, corn which is the most energy-intensive crop,

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includes account of factors other than rising energy prices, e.g., groundwater depletion.

4. Miranowski (1979) reports the net returns from irrigated crop production on a representative farm in Iowa would be 46 percent less if the energy price were five times higher than the then current energy price.
5. Mapp and Dobbins (1977) report that net returns to irrigation in the Oklahoma Panhandle would be 11 to 25 percent less after five years and 13 to 38 percent less after 10 years, if the price of natural gas were to rise from $0.75 mcf to $1.75 per mcf after five years and $5.00 per mcf after 10 years, than if the energy price was fixed at the $0.75 per mcf level.

loses considerably in its comparative advantage relative to alfalfa and soybeans which are the least energy-intensive crops. Under rapidly rising energy prices and irrigated conditions, corn's comparative advantage relative to alfalfa is reduced, but not, however, to the point where it ceases to maintain a considerable profit margin over alfalfa. Irrigated corn's profit superiority relative to irrigated soybeans in Turner County is eroded away under high energy prices. Under the high energy prices, irrigated soybeans provides a 19 percent greater net return per acre than does irrigated corn.[35]

The focus of analysis shifts now from comparisons among crops in their relative profitability to comparisons for given crops raised under dryland versus irrigated conditions. The projected values for the various economic criteria in 1990 are compared for the high rate of energy price increase assumption (namely, a doubling of the 1981 energy price by 1986) versus the current trends in input prices assumption.

The projected cost of energy per acre with high energy prices for the various crops is about 2.4 times as much as with current trends in input prices (Tables 22 and 23). Under high energy prices, the total variable costs per dryland acre are about 45 percent higher for alfalfa and soybeans and about 70 percent higher for corn. Under irrigation, the total variable cost

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[35] The findings from this study, especially the projections to 1990, show the prospective profitability of oats relative to that of other crops to be inconsistent with the relatively strong popularity of oats in Brookings and Turner Counties during the 1970's (recall Table 3).

increments are about 10 percentage points higher than under dryland conditions.

The energy cost relative to the total variable costs of producing various crops is about 20 percentage points higher under the high energy price increase assumption. The least energy-intensive situations -- namely, dryland alfalfa and soybeans -- involve energy comprising about 34 percent of the total variable costs under current trends in input prices versus about 54 percent under high energy price increases. The corresponding percentage comparison for the most energy-intensive crop situation -- irrigated corn -- is about 55 versus 75 percent.

In some situations, the 1990 projected break-even prices are higher for irrigated than dryland crops, and in others they are lower. For example, the break-even prices for alfalfa produced with irrigation are from 15 to 30 percent higher than those for alfalfa produced without irrigation. For corn in Brookings County, on the other hand, the projected break-even price in 1990 with irrigation is from 12 to 17 percent less than that without irrigation. For corn and soybeans in Turner County, the break-even prices for dryland and irrigated production are almost the same (they differ by seven percent or less).

Under rapidly increasing energy prices, break-even prices are from about 45 percent (for dryland alfalfa) to 75 percent (for irrigated corn) higher than with the current trends in input prices assumed. These differences in the increase in break-even prices, of course, are directly related to the amounts of energy

required to produce the various commodities.

For each crop-energy price situation, the net returns over total variable costs per acre are positive. Further, they are higher with than without irrigation. The irrigated-dryland increment in net returns ranges from 40 to 60 percent for alfalfa in Turner County to 2.6 to 3.0 times for corn in Brookings County. Thus, even if energy prices were to escalate rapidly during the 1980's, farmers already having irrigation facilities would appear to be well-advised economically to continue to use those facilities.[36]

Nevertheless, the net returns from production would be adversely affected if energy prices were to rise rapidly. Under the high energy price rise assumption in this study, the net returns per acre range from 14 percent (dryland soybeans in Turner County) less to over 40 percent (corn in Brookings County) less than with the current trends in input prices.

The results of this study show the longer-term economics of irrigated agriculture -- especially if faced with rapidly rising energy prices -- to vary considerably by crop. Under each of the three energy price situations considered, for example, the net returns over the total costs of producing alfalfa in both Brookings and Turner Counties are negative. For irrigated soybeans in Turner County, on the other hand, the net returns over

[36] This statement presupposes that the salvage value of used irrigation equipment is relatively low.

total costs are positive under all three energy price situations. Irrigated corn in both counties occupies an intermediate position. With current trends in input prices, the projected net returns over total costs in 1990 exceed $160 per acre. Under the high energy price increase assumption, however, the total costs of producing irrigation corn exceed gross returns by over $20 per acre.

Thus, these results show that, if energy prices were to rise rapidly, farmers having to borrow funds to invest in new irrigation equipment could encounter some trouble in meeting their principal and loan payments from the annual cash flows realized through crop production. Also, irrigated corn is shown to be especially vulnerable to rapidly rising energy prices.

Impacts of different interest rates on the economics of crop production

The rapid rise over time in the prices of various farm inputs nationally was noted at the outset of the prior section. In this section the various farm inputs are classified differently, with interest shown separately from four other categories of farm inputs (Figure 3).

Since 1977, the rate of interest -- defined by the USDA (1981, 12) as that payable per acre on farm real estate debt -- increased at the national level by about 95 percent. The prices paid for production items and family living items increased, over this same time period, by only about 50 percent. Wage rates and taxes increased at even lower rates. Thus, at

the national level as well as in South Dakota, the rate of increase since 1977 in the interest rate has been exceeded only by that in the prices paid for fuels and energy (recall also Figure 2 and Table 8).

In this section, the impacts of different interest rates on the economics of crop production are examined. The examination is in terms of the impacts on total production costs and break-even prices in 1981 of two interest rates lower than the 18 percent commonly experienced by farmers who borrowed funds in 1981 -- namely, 10 and 14 percent -- and one higher rate (22 percent). The interest rates likely to prevail over the next few years are assumed to probably fall within this range of interest rates. Since the actual interest rates during the past four years have rested between 10 and 18 percent, however, the textual discussion is in terms of comparisons involving these two interest rates.

With an 18, rather than 10, percent annual interest rate on operating and investment capital, the total costs of producing dryland crops are from six to 12 dollars per acre higher (Table 24). These differences imply relative production cost increases ranging from 5.1 to 7.7 percent.

> FARM APPLICATION: The annual interest bill on a 350 acre dryland farm in 1981 would be $2,000 to $4,000 less -- depending on which crops were grown -- if the interest rate were 10, rather than 18, percent.

Under irrigation, both the absolute and relative increments in cost are considerably higher than under dryland conditions.

For example, farmers having to pay an 18 percent interest rate on borrowed funds have to incur $24 to $48 per acre more than if they had to pay only 10 percent interest. The difference in costs, because of an 18 rather than 10 percent interest rate for crops raised with rather than without irrigation is three to four times, or $18 to $36 per acre.

> FARM APPLICATION: The annual interest bill on an irrigated quarter section of corn would be over $5,000 less if the interest rate were 10, rather than 18, percent.

The irrigated production costs with 18 percent interest are from 9.5 to 13.8 percent higher than with 10 percent interest. The relative magnitude of impact on production costs among crops of different interest rates, of course, reflects differences in the intensity with which capital is used in producing the crops (recall Tables 5 and 6). Interest rates alone, however, are not responsible for any change in the relative profitability among the crops produced in either county.

With an 18, rather than 10, percent annual interest rate the break-even prices for various crops are higher for Brookings and Turner Counties, respectively, by the following amounts:

-Irrigated alfalfa, $5.25 and 8.06 per ton;

-Dryland alfalfa, $2.45 and 3.54 per ton;

-Irrigated soybeans (Turner County), $0.76 per bushel;

-Dryland soybeans, $0.41 and 0.53 per bushel;

-Irrigated corn, $0.25 and 0.30 per bushel;

-Dryland corn, $0.14 and 0.19 per bushel;

-Dryland flax, $0.46 and 0.86 per bushel; and

-Other dryland crops, $0.15 to 0.37 per bushel (Table 25).[37]

The increments in break-even prices because of the higher interest rate are 1.2 to 2.3 times larger for crops produced with than without irrigation. The increments are from 3.8 to 13.2 percent of the assumed 1981 market prices for the various crops.

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[37] For sunflowers and sorghum, the increments in break-even prices are $1.02 and 0.36 per cwt, respectively.

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	Total cropland ('000 acres)	Irrigated cropland ('000 acres)	Irrigated land as a percent of total cropland
Wyoming	2,101	1,460	69.5
New Mexico	1,553	867	55.8
Colorado	9,159	2,874	31.4
Texas	24,383	6,594	27.0
Nebraska	19,724	3,967	20.1
Montana	14,504	1,759	12.1
Kansas	26,821	2,010	7.5
Oklahoma	10,731	515	4.8
South Dakota	16,655	152	0.9
North Dakota	27,275	71	0.3
Total	152,906	20,269	12.3

Source: USDA (1980, 420-421)

Table 2. South Dakota Counties; 10,000 Acres or More under Irrigation; 1969 and 1978

County	Acres under irrigation 1969	1978	Increase from 1969 to 1978 Acres	Ratio
West River				
Meade	6,035	10,001	3,966	1.7
Fall River	12,388	15,764	3,376	1.3
Pennington	9,689	10,752	1,063	1.1
Butte	50,262	50,344	82	1.0
Sub-total	(78,374)	(86,861)	(8,487)	(1.1)
East River				
Union	1,048	19,510	18,462	18.6
Beadle	2,524	14,250	11,726	5.7
Spink	6,602	18,139	11,537	2.8
Turner	3,123	13,139	10,016	4.2
Brookings	984	10,697	9,713	10.9
Charles Mix	4,047	11,877	7,830	2.9
Hughes	4,675	10,853	6,178	2.3
Sub-total	(23,003)	(98,465)	(75,462)	(4.3)

Sources: USDC (1972, 269-270); USDC (1980, 121-122)

Table 3. Planted Acres of Selected Crops, Brookings and Turner Counties, Average for 1970-1979

Crop	Brookings County[a] Acres	Percent	Turner County Acres	Percent	South Dakota Acres ('000)	Percent
Corn	115,300	39.0	131,300	49.4	3,466.0	25.6
Oats	83,700	28.3	70,300	26.4	2,551.0	18.9
Alfalfa[b]	39,300	13.3	23,000	8.7	2,487.7	18.4
Spring wheat	13,100	4.4	1,100	0.4	2,053.4	15.2
Winter wheat	2,000	0.7	c	n/a	930.3	6.9
Barley	8,100	2.7	1,600	0.6	568.5	4.2
Sorghum	1,300	0.4	2,900	1.1	439.0	3.3
Flax	20,800	7.0	c	n/a	425.4	3.1
Soybeans	9,400	3.2	35,700	13.4	351.3	2.6
Winter rye	3,000	1.0	c	n/a	247.3	1.8

Sources: CLRS (1980, 1981)

a
The planted acreages of sunflowers in 1978, 1979, and 1980 in Brookings County were 3,000, 13,400, and 10,500 acres, and in South Dakota they were 165,000, 620,000, and 525,000 acres, respectively.

b
The harvested, rather than planted, acreage of alfalfa is shown.

c
Less than 500 acres.

Table 4. Areas under Irrigation, Selected Crops, Brookings and Turner Counties, 1978

	Brookings County Acres	Percent	Turner County Acres	Percent	South Dakota[a] Acres	Percent
Corn	8,045	75.2	10,069	76.6	175,323	54.6
Alfalfa	1,012	9.5	636	4.9	79,222	24.6
Soybeans	369	3.4	1,852	14.1	12,596	3.9
Other[b]	1,271	11.9	582	4.4	54,198	16.9
Total	10,697	100.0	13,139	100.0	321,339	100.0

Source: USDC (1980; 18-20, 202, 204, 487, 490)

a
The DWNR (1977) reports 62% of the East River irrigated area under corn and only 15% under alfalfa, whereas over 40% of the West River irrigated area is under alfalfa and only 29% is under corn.

b
The principal "other" crops in Brookings County are oats (303 acres) and wheat (228 acres), and in South Dakota they are wheat (10,896 acres) and oats (7,166 acres).

Table 5. Cost Structure, Selected Dryland and Irrigated Crops, Brookings County, 1981

Cost item	Dryland crops								Irrigated Crops	
	Alfalfa	Barley	Corn	Flax	Oats	Soybeans	Spring wheat	Sunflowers	Alfalfa	Corn
Dollars per acre										
Fixed costs										
Land charge	53.62	53.62	53.62	53.62	53.62	53.62	53.62	53.62	89.35	89.35
Depreciation and insurance	13.36	19.49	23.92	18.70	19.19	19.19	19.49	17.85	40.31	41.06
Interest on investment	10.49	17.92	17.56	19.24	17.72	18.31	17.82	15.74	47.37	61.05
Fixed cost sub-total	77.47	91.03	95.10	91.56	90.53	91.12	90.93	87.21	177.03	191.46
Variable costs										
Fertilizer	10.28	16.57	20.28	11.93	12.93	5.57	16.57	11.93	23.77	55.13
Machinery fuel and lubrication	11.96	14.64	18.14	14.10	14.10	14.78	14.88	13.70	9.24	11.23
Seeds	2.53	4.26	10.69	12.00	6.02	13.32	10.00	4.60	5.20	15.75
Plant protection chemicals	1.73	3.63	15.38	2.12	2.90	7.80	4.46	13.77	0	15.45
Interest on operating capital	3.26	4.12	6.96	3.87	3.82	4.30	4.34	4.88	6.40	13.42
Machinery repair	9.59	3.88	5.25	3.77	3.77	4.23	3.88	3.94	9.46	8.12
Miscellaneous overhead costs	1.80	2.27	4.29	2.33	2.17	2.55	2.66	2.80	2.38	6.69
Crop insurance	0	2.49	3.45	2.38	2.43	2.54	2.54	2.70	0	1.88
Grain storage[a]	0	0	2.36	.30	1.18	2.71	.80	5.30	0	1.53
Grain drying	0	0	10.20	0	0	0	0	0	0	24.74
Custom hiring	0	0	0	0	0	0	0	0	6.55	6.04
Irrigation system repair	0	0	0	0	0	0	0	0	.99	.44
Irrigation system power	0	0	0	0	0	0	0	0	25.92	29.03
Variable cost sub-total	41.15	51.86	96.99	52.80	49.32	57.80	60.13	63.62	89.91	189.45
Total costs	118.62	142.89	192.09	144.36	139.85	148.92	151.06	150.83	266.94	380.91
Percentage of total costs										
Fixed costs										
Land charge	45.2	37.5	27.9	37.2	38.4	36.0	35.5	35.6	33.5	23.5
Depreciation and insurance	11.3	13.6	12.5	12.9	13.7	12.9	12.9	11.8	15.1	10.8
Interest on investment	8.8	12.5	9.1	13.3	12.7	12.3	11.8	10.4	17.8	16.0
Fixed cost sub-total	65.3	63.6	49.5	63.4	64.8	61.2	60.2	57.8	66.4	50.3
Variable costs										
Fertilizer	8.7	11.6	10.6	8.3	9.3	3.7	10.9	7.9	8.9	14.5
Machinery fuel and lubrication	10.1	10.3	9.4	9.8	10.1	9.9	9.9	9.1	3.5	2.9
Seeds	2.1	3.0	5.6	8.3	4.3	8.9	6.6	3.1	1.9	4.1
Plant protection chemicals	1.5	2.5	8.0	1.5	2.1	5.2	2.9	9.1	0	4.1
Interest on operating capital	2.7	2.9	3.6	2.7	2.7	2.9	2.9	3.2	2.4	3.5
Machinery repair	8.1	2.7	2.8	2.6	2.7	2.9	2.6	2.6	3.5	2.1
Miscellaneous overhead costs	1.5	1.6	2.2	1.6	1.5	1.7	1.8	1.9	.9	1.8
Crop insurance	0	1.8	1.8	1.6	1.7	1.7	1.7	1.8	0	0.5
Grain storage	0	0	1.2	.2	.8	1.9	.5	3.5	0	0.4
Grain drying	0	0	5.3	0	0	0	0	0	0	6.5
Custom hiring	0	0	0	0	0	0	0	0	2.4	1.6
Irrigation system repair	0	0	0	0	0	0	0	0	.4	0.1
Irrigation system power	0	0	0	0	0	0	0	0	9.7	7.6
Variable cost sub-total	34.7	36.4	50.5	36.6	35.2	38.8	39.8	42.2	33.6	49.7
Total costs	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Some respondents reported storage costs, not separately as reported in this line item, but as part of their overall building investment. These "grain storage" costs, therefore, do not necessarily reflect the total costs actually involved in storage.

Table 6. Cost Structure, Selected Dryland and Irrigated Crops, Turner County, 1981

Cost item	Dryland Crops								Irrigated Crops		
	Alfalfa	Barley	Corn	Flax	Oats	Sorghum	Soybeans	Spring wheat	Alfalfa	Corn	Soybeans
Dollars per acre											
Fixed costs											
Land charge	67.02	67.02	67.02	67.02	67.02	67.02	67.02	67.02	107.23	107.23	107.23
Depreciation and insurance	25.19	23.56	25.19	23.31	22.58	23.01	22.28	23.56	76.06	49.64	44.13
Interest on investment	23.32	18.39	15.92	13.68	18.08	17.46	18.98	18.36	100.85	81.51	68.25
Fixed cost sub-total	115.53	108.97	108.13	104.01	107.68	107.49	108.28	108.94	284.14	238.38	219.61
Variable costs											
Fertilizer	13.71	16.57	25.71	14.35	16.57	23.85	5.57	16.57	34.27	74.64	16.71
Machinery fuel and lubrication	18.13	14.40	18.40	14.40	14.64	16.40	15.30	14.88	17.20	12.01	10.21
Seeds	4.13	4.26	12.25	18.00	7.20	3.38	13.20	12.00	4.72	19.88	13.92
Plant protection chemicals	1.73	1.84	13.93	.67	2.12	7.75	9.25	2.06	0	13.56	10.03
Interest on operating capital	4.52	4.00	7.76	4.28	4.30	5.82	4.48	4.16	8.00	15.12	8.32
Machinery repair	14.33	4.05	4.91	3.94	4.05	4.29	4.00	4.05	8.50	7.46	7.99
Miscellaneous overhead costs	2.60	2.21	4.80	2.72	2.43	3.29	3.18	2.64	3.23	7.42	3.33
Crop insurance	0	3.08	3.78	2.70	2.54	2.75	2.54	2.49	0	9.22	6.74
Grain storage[a]	0	0	3.24	.41	1.53	7.36	3.54	.71	0	0	1.06
Grain drying	0	0	13.86	0	0	0	0	0	0	11.60	0
Custom hiring	0	0	0	0	0	0	0	0	2.63	4.23	6.56
Irrigation system repair	0	0	0	0	0	0	0	0	3.11	1.34	2.24
Irrigation system power	0	0	0	0	0	0	0	0	33.81	30.36	25.72
Variable cost sub-total	59.15	50.41	108.64	61.47	55.38	74.89	61.06	59.56	115.47	206.84	112.83
Total costs	174.68	159.38	216.77	165.48	163.06	182.38	169.34	168.50	399.61	445.22	332.44
Percentage of total costs											
Fixed costs											
Land charge	38.4	42.1	30.9	40.5	41.1	36.8	39.6	39.8	26.8	24.1	32.3
Depreciation and insurance	14.4	14.8	11.7	14.1	13.9	12.6	13.1	13.9	19.0	11.1	13.3
Interest on investment	13.4	11.5	7.3	8.3	11.1	9.6	11.2	10.9	25.2	18.3	20.5
Fixed cost sub-total	66.1	68.4	49.9	62.9	66.1	59.0	63.9	64.6	71.0	53.5	66.1
Variable costs											
Fertilizer	7.9	10.4	11.9	8.7	10.2	13.1	3.3	9.9	8.6	16.8	5.0
Machinery fuel and lubrication	10.4	9.0	8.5	8.7	8.9	8.9	9.0	8.8	4.3	2.7	3.1
Seeds	2.4	2.7	5.7	10.9	4.4	1.9	7.8	7.1	1.2	4.5	4.2
Plant protection chemicals	.9	1.2	6.4	.4	1.3	4.2	5.5	1.2	0	3.0	3.0
Interest on operating capital	2.6	2.5	3.4	2.6	2.6	3.2	2.6	2.5	2.0	3.4	2.5
Machinery repair	8.2	2.5	2.3	2.4	2.5	2.4	2.4	2.4	2.1	1.7	2.4
Miscellaneous overhead costs	1.5	1.4	2.2	1.6	1.5	1.8	1.9	1.6	.8	1.7	1.0
Crop insurance	0	1.9	1.8	1.6	1.6	1.5	1.5	1.5	0	2.1	2.0
Grain storage[a]	0	0	1.5	.2	.9	4.0	2.1	.4	0	0	0
Grain drying	0	0	6.4	0	0	0	0	0	0	2.6	0.3
Custom hiring	0	0	0	0	0	0	0	0	0.7	0.9	1.9
Irrigation system repair	0	0	0	0	0	0	0	0	0.8	0.3	0.7
Irrigation system power	0	0	0	0	0	0	0	0	8.5	6.8	7.8
Variable cost sub-total	33.9	31.6	50.1	37.1	33.9	41.0	36.1	35.4	29.0	46.5	33.9
Total costs	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Some respondents reported storage costs, not separately as reported in this line item, but as part of their overall building investment. These "grain storage" costs, therefore, do not necessarily reflect the total costs actually involved in storage.

Table 7. Levels of Fertilizer Application, Selected Dryland and Irrigated Crops, Brookings and Turner Counties, 1977

Crop	Nitrogen(N)		Phosphorous(P_2O_5)		Potassium(K_2O)	
	Brookings	Turner	Brookings	Turner	Brookings	Turner
			(pounds per acre)			
Dryland crops						
Alfalfa	0	0	45	60	0	0
Barley	40	40	30	30	0	0
Corn	60	75	25	33	0	0
Flax	40	45	10	15	0	0
Oats	30	40	25	30	0	0
Sorghum	n/a	70	n/a	30	n/a	0
Soybeans	6	6	17	17	0	0
Spring wheat	40	40	30	30	0	0
Sunflowers	35	n/a	15	n/a	0	n/a
Irrigated Crops						
Alfalfa	0	0	95	138	15	22
Corn	150	220	70	60	20	60
Soybeans	n/a	0	n/a	66	n/a	13

Sources: The levels of fertilizer application for dryland crops reflect the judgments of selected extension and farm management research personnel at the SDSU. Application rates for irrigated crops are those reported by the farmers surveyed in the Everson (1979) study.

Table 8. Prices of Inputs for Selected Crops, Brookings and Turner Counties, Actual Prices in 1977 and 1981 and Projected Prices in 1986 and 1990[a]

		Prices				Compound annual growth rate(%)[b]		
		Actual		Projected		1977-	1981-	1977-
Input	Unit	1977	1981	1986	1990	1981	1990	1990
Energy								
Diesel fuel	$/gal.	0.45	1.20	1.42	1.54	27.8	2.8	9.9
Electricity	¢/KWH	2.30	5.10	5.90	6.50	22.0	2.7	8.3
Interest rate								
Operating capital	Percent	9	18	18	18	18.9	0	5.5
Investment capital	Percent	7	18	18	18	26.9	0	7.5
Fertilizer								
Nitrogen (N)	$/lb.	0.17	0.24	0.28	0.30	9.0	2.5	4.5
Phosphorous (P_2O_5)	$/lb.	0.16	0.23	0.27	0.28	9.5	2.2	4.4
Potassium (K_2O)	$/lb.	0.09	0.13	0.15	0.16	9.6	2.3	4.5
Seeds								
Alfalfa	$/lb.	2.05	2.36	2.65	2.81	3.6	2.0	2.5
Barley	$/pk.	0.75	0.85	0.93	0.97	3.2	1.5	2.0
Corn	$/MVK	0.55	0.75	0.83	0.87	8.1	1.7	3.6
Flax	$/pk.	1.85	3.00	3.24	3.41	12.9	1.4	4.8
Oats	$/pk.	0.55	0.60	0.66	0.70	2.2	1.7	1.9
Sorghum	$/lb.	0.40	0.48	0.53	0.56	4.7	1.7	2.6
Soybeans	$/bu.	9.00	12.00	13.44	14.36	7.5	2.0	3.7
Spring Wheat	$/pk.	0.97	2.00	2.19	2.33	19.8	1.7	7.0
Sunflowers	$/lb.	1.50	2.00	2.16	2.29	7.5	1.5	3.3

Sources: The actual prices for 1977 are those reported by the farmers surveyed in the Everson (1979) study. The originally projected prices for 1981 were checked against the prices actually charged to farmers in 1981, as reported by selected input suppliers. Where the actual prices differred from those projected, the actual prices were used. The prices projected from 1981 to 1990 reflect the relative rates of projected increase reported by Shane (1980).

[a] Alternative levels to those shown in the table were also projected for the energy and capital inputs. The alternatives are (1) an assumed doubling of the 1981 prices for energy -- i.e., for diesel fuel and electricity and the energy embodied in fertilizer and plant protection chemicals -- by 1990, on the one hand, and by 1986, on the other and (2) an examination of 10, 14, and 22 percent rates of interest on operating and investment capital for 1981 through 1990. The assumed doubling of the 1981 energy price by 1990 and by 1986 involve compound annual growth rates from 1981 to 1990 of 8.0 and 14.9 percent, respectively. Under the assumed high rate of escalation in energy prices, the price of diesel fuel in 1990 would be 9.3 times as much as it was in 1977. The corresponding multiple for electricity is 7.7 times.

[b] Compound annual growth rates from 1977 to 1990 for cost items not shown in the table are as follows: custom-hire (primarily diesel fuel)-9.9 percent; irrigation system repair-8.7 percent; plant protection chemicals - 3.8 percent; depreciation, taxes, and farm and equipment insurance - 3.3 percent; grain storage - 2.9 percent; machinery repair - 2.1 percent; and crop insurance - 1.6 percent.

Table 9. Per-Acre Seeding Rates, Selected Dryland and Irrigated Crops, Brookings and Turner Counties, 1977

Crop	Unit	Brookings	Turner
Dryland crops			
Alfalfa	Pound	4.4	7.2
Barley	Peck	5.0	5.0
Corn	1000 kernals(MVK)	14.3	16.3
Flax	Peck	4.0	6.0
Oats	Peck	10.0	12.0
Sorghum	Pound	n/a	7.0
Soybeans	Bushel	1.1	1.1
Spring Wheat	Peck	5.0	6.0
Sunflowers	Pound	2.3	n/a
Irrigated crops			
Alfalfa[a]	Pound	8.8	8.0
Corn	1000 kernals(MVK)	21.0	26.5
Soybeans	Bushel	n/a	1.2

Sources: The seeding rates for dryland crops reflect the judgments of selected extension and farm management research personnel at the SDSU. The seeding rates for irrigated crops are those reported by the farmers surveyed in the Everson (1979) study.

[a] Alfalfa stands are assumed to be in production for four years. The amounts of seed chargeable against annual budgets, therefore, are one-fourth the amounts shown in the table.

Table 10. The Use of Energy in Agricultural Production, South Dakota and United States, 1978

	Percent of total BTU's[a] consumed	
Agricultural operation	South Dakota	United States
Fertilizer manufacture	18.1	31.9
Preharvest field operations	11.8	14.8
Farm vehicles	24.9	12.6
Irrigation	2.4	12.4
Livestock care	16.4	10.9
Crop harvesting	15.5	7.6
Grain handling and drying	2.0	3.6
Pesticide manufacture	2.5	3.3
Other	6.4	2.9
Total	100.0	100.0

Source: Adapted from Torgerson and Cooper (1980,54,64)

[a] A BTU is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near its maximum density.

Table 11. Estimated Energy Cost Components in the Production of Selected Dryland and Irrigated Crops, Brookings County 1981

Crop	Irrigation system power	Machinery fuel and lubrication	Fertilizer manufacture	Grain drying	Plant protection chemicals manufacture	Total[a]
Dollars per acre						
Dryland crops						
Corn	0	18.14	14.17	10.20	4.35	46.86(48.3)
Sunflowers	0	13.70	8.09	0	3.91	25.70(40.4)
Spring wheat	0	14.88	9.40	0	1.26	25.54(42.5)
Barley	0	14.64	9.40	0	1.03	25.07(48.3)
Flax	0	14.10	9.17	0	0.63	23.90(45.3)
Oats	0	14.10	7.08	0	0.81	21.99(44.6)
Soybeans	0	14.78	1.53	0	2.19	18.50(32.0)
Alfalfa	0	11.96	0.51	0	0.49	12.96(31.5)
Irrigated crops						
Corn	29.03	11.23	35.07	24.74	4.32	104.39(55.1)
Alfalfa	25.92	9.24	1.28	0	0	36.44(40.5)
Percentage of total energy cost						
Dryland crops						
Corn	n/a	38.7	30.2	21.8	9.3	100.0
Sunflowers	n/a	53.3	31.5	n/a	15.2	100.0
Spring wheat	n/a	58.3	36.8	n/a	4.9	100.0
Barley	n/a	58.4	37.5	n/a	4.1	100.0
Flax	n/a	59.0	38.4	n/a	2.6	100.0
Oats	n/a	64.1	32.2	n/a	3.7	100.0
Soybeans	n/a	79.9	8.3	n/a	11.8	100.0
Alfalfa	n/a	92.3	3.9	n/a	3.8	100.0
Irrigated crops						
Corn	27.8	10.8	33.6	23.7	4.1	100.0
Alfalfa	71.1	25.4	3.5	n/a	n/a	100.0

[a] The total energy costs as percentages of the total variable costs of production are shown in brackets.

Table 12. Estimated Energy Cost Components in the Production of Selected Dryland and Irrigated Crops, Turner County, 1981

Crop	Irrigation system power	Machinery fuel and lubrication	Fertilizer manufacture	Grain drying	Plant protection chemicals manufacture	Total[a]
Dollar per acre						
Dryland crops						
Corn	0	18.40	17.39	13.86	3.95	53.60 (49.3)
Sorghum	0	16.40	16.19	0	2.20	34.79 (46.5)
Flax	0	14.40	10.34	0	0.19	24.93 (40.6)
Spring wheat	0	14.88	9.40	0	0.59	24.87 (41.8)
Oats	0	14.64	9.40	0	0.60	24.64 (44.5)
Barley	0	14.40	9.40	0	0.52	24.32 (48.2)
Soybeans	0	15.30	1.53	0	2.53	19.36 (31.7)
Alfalfa	0	18.13	0.67	0	0.49	19.29 (32.6)
Irrigated crops						
Corn	30.36	12.01	51.39	11.60	4.34	109.70 (53.0)
Alfalfa	33.81	17.20	1.61	0	0	52.62 (45.6)
Soybeans	25.72	10.21	0.80	0	3.01	39.74 (35.2)
Percentage of total energy cost						
Dryland crops						
Corn	n/a	34.3	32.4	25.9	7.4	100.0
Sorghum	n/a	47.1	46.6	n/a	6.3	100.0
Flax	n/a	57.8	41.5	n/a	0.7	100.0
Spring wheat	n/a	59.8	37.8	n/a	2.4	100.0
Oats	n/a	59.4	38.2	n/a	2.4	100.0
Barley	n/a	59.2	38.7	n/a	2.1	100.0
Soybeans	n/a	79.0	7.9	n/a	13.1	100.0
Alfalfa	n/a	94.0	3.5	n/a	2.5	100.0
Irrigated crops						
Corn	27.7	10.9	46.8	10.6	4.0	100.0
Alfalfa	64.2	32.7	3.1	n/a	n/a	100.0
Soybeans	64.7	25.7	2.0	n/a	7.6	100.0

[a] The total energy costs as percentages of the total variable costs of production are shown in brackets.

Table 13. Per-Acre Yields of Selected Dryland and Irrigated Crops, Brookings and Turner Counties, 1977

Crop	Unit	Brookings	Turner
Dryland crops			
Alfalfa	Ton	2.5	3.5
Barley	Bushel	41	41
Corn	Bushel	55	75
Flax	Bushel	12	17
Oats	Bushel	50	65
Sorghum	Cwt	n/a	29
Soybeans	Bushel	19	25[a]
Spring wheat	Bushel	28	27
Sunflowers	Cwt	9	n/a
Irrigated Crops			
Alfalfa	Ton	4.55	6.0
Corn	Bushel	129	145
Soybeans	Bushel	n/a	45[a]

Sources: The yields for dryland crops are those reported by Allen et al. (1979). Yields for irrigated crops are those reported by the farmers surveyed by Everson (1979).

[a] The Cooperative Extension Service reports that soybeans yields on farmers' fields in Turner County in 1981 are commonly 30 to 35 bu per acre under dryland conditions and 55 to 60 bu per acre with irrigation.

Table 14. Farm Prices for Selected Crops; Brookings and Turner Counties; Three-Year Mean, 1978-80; Assumed for 1981; and Projected for 1990

Crop	Unit	Three-year mean 1978-80[a]	Assumed for 1981[b]	Projected for 1990[c]
		(dollars per unit)		
Alfalfa	Ton	42.50	65.00	79.02
Barley	Bushel	2.23	2.25	4.50
Corn	Bushel	2.34	2.40	5.29
Flax	Bushel	6.42	6.75	12.83
Oats	Bushel	1.36	1.80	2.75
Sorghum	Cwt	3.67	4.20	8.30
Soybeans	Bushel	6.53	5.75	12.92
Spring wheat	Bushel	3.59	3.75	7.25
Sunflowers	Cwt	9.82	10.00	19.43

[a] The data used in the calculation of the three-year means are "seasonal average prices" published by CLRS (1981).

[b] Since only part of the 1981 crop was sold by October 1981 when these calculations were performed, attention in estimating 1981 prices was given not only to the prices during any peak marketing months already experienced in 1981, but also futures prices (minus appropriate "bases") for subsequent peak marketing months in which the 1981 crop is likely to be sold, seasonal average prices from recent years, 1981 government loan rates (where applicable), and the judgment of grain marketing specialists.

Postscript: The seasonally adjusted "1981" prices for the various crops, as first reported on February 1, 1982 by the South Dakota Statistical Reporting Service (SRS, 1982), are all within 10 percent of the "assumed for 1981" prices indicated below, except sorghum whose actual price was reported to be $3.45 per cwt.

[c] The projected compound annual growth rates for product prices for 1977 through 1990 reported in Table 20 were applied against the three-year means for 1978-80 to obtain the projected prices for 1990.

Table 15. Energy and Overall Production Costs, Net Returns, Selected Dryland and Irrigated Crops, Brookings County, 1981.

Crop	Energy cost	Overall production costs: Variable	Total	Net returns over: Variable costs	Total costs
Dollars per acre					
Dryland crops					
Corn[a]	46.86	96.99	192.09	35.01	-60.09
Sunflowers	25.70	63.62	150.83	26.38	-60.83
Spring wheat	25.54	60.13	151.06	44.87	-46.06
Barley	25.07	51.86	142.89	40.39	-50.64
Flax	23.90	52.80	144.36	28.20	-63.36
Oats	21.99	49.32	139.85	40.68	-49.85
Soybeans	18.50	57.80	148.92	51.45	-39.67
Alfalfa[b]	12.96	41.15	118.62	121.35	+43.88
Irrigated crops					
Corn[a]	104.39	189.45	380.91	120.15	-71.31
Alfalfa[b]	36.44	89.91	266.94	205.84	+28.81
Dollars per acre for each crop as a ratio to the dollars per acre for dryland corn					
Dryland crops					
Sunflowers	0.55	0.66	0.79	0.75	n/a
Spring wheat	0.55	0.62	0.79	1.28	n/a
Barley	0.53	0.53	0.74	1.15	n/a
Flax	0.51	0.54	0.75	0.81	n/a
Oats	0.47	0.51	0.73	1.16	n/a
Soybeans	0.39	0.60	0.78	1.47	n/a
Alfalfa	0.28	0.42	0.62	3.47	n/a
Irrigated crops					
Corn	2.23	1.95	1.98	3.43	n/a
Alfalfa	0.78	0.93	1.39	5.88	n/a

[a] If the price of corn were $3.00 per bu (as it was in 1980), rather than the $2.40 per bu which is assumed in the table, the net returns over variable and total costs from dryland corn production would be $68.01 and -$27.09 per acre, repsectively, and from irrigated corn production $197.55 and $6.09 per acre, respectively.

[b] The prices of alfalfa in 1980 and 1981 were unusually high. If the price of alfalfa were $33.50 per ton (as it averaged in 1977-1979), rather than the $65 per ton which is assumed in the table, the net returns over variable and total costs from dryland alfalfa production would be $42.60 and -$34.87 per acre, respectively, and from irrigated alfalfa production $62.52 and -$114.52 per acre, respectively.

Table 16. Energy and Overall Production Costs, Net Returns, Selected Dryland and Irrigated Crops, Turner, 1981

Crop	Energy cost	Overall production costs		Net returns over	
		Variable	Total	Variable costs	Total costs
Dollars per acre					
Dryland crops					
Corn[a]	53.60	108.64	216.77	71.36	-36.77
Sorghum	34.79	74.89	182.38	46.91	-60.58
Flax	24.93	61.47	165.48	53.28	-50.73
Spring wheat	24.87	59.56	168.50	41.69	-67.25
Oats	24.64	55.38	163.06	61.62	-46.06
Barley	24.32	50.41	159.38	41.84	-67.13
Soybeans	19.36	61.06	169.34	82.69	-25.59
Alfalfa[b]	19.29	59.15	174.68	168.35	+52.82
Irrigated crops					
Corn[a]	109.70	206.84	445.22	141.16	-97.22
Alfalfa[b]	52.62	115.47	399.61	274.53	- 9.61
Soybeans	39.74	112.83	332.44	145.92	-73.69
Dollars per acre for each crop as a ratio to the dollars per acre for dryland corn					
Dryland crops					
Sorghum	0.65	0.69	0.84	0.66	n/a
Flax	0.47	0.57	0.76	0.75	n/a
Spring wheat	0.46	0.55	0.78	0.58	n/a
Oats	0.46	0.51	0.75	0.86	n/a
Barley	0.45	0.46	0.74	0.59	n/a
Soybeans	0.36	0.56	0.78	1.16	n/a
Alfalfa	0.36	0.54	0.81	2.36	n/a
Irrigated crops					
Corn	2.05	1.90	2.05	1.98	n/a
Alfalfa	0.98	1.06	1.84	3.85	n/a
Soybeans	0.74	1.04	1.53	2.04	n/a

[a] If the price of corn were $3.00 per bu (as it was in 1980), rather than $2.40 per bu, which is assumed in the table, the net returns over variable and total costs from dryland corn production would be $116.36 and -$8.23 per acre, respectively, and from irrigated production $228.17 and -$10.21 per acre, respectively.

[b] The prices of alfalfa in 1980 and 1981 were unusually high. If the price of alfalfa were $33.50 per ton (as it averaged in 1977-1979), rather than the $65 per ton which is assumed in the table, the net returns over variable and total costs from dryland alfalfa production would be $58.10 and -$57.43 per acre, respectively, and from irrigated alfalfa production $85.53 and-$198.61 per acre, respectively.

Table 17. Economics of Dryland versus Irrigated Production, Alfalfa and Corn, Brookings County, 1981

Economic criterion	Unit	Alfalfa		Corn	
		Dryland	Irrigated	Dryland	Irrigated
Variable costs	$ per acre	41.15	89.91	96.99	189.45
Total cost	$ per acre	118.62	266.94	192.09	380.91
Energy cost					
Per unit of land	$ per acre	12.96	36.44	46.86	104.39
Per unit of output[a]	$ per ton/bushel	5.18	8.01	0.85	0.81
Energy cost relative to variable costs	Percent	31.5	40.5	48.3	55.1
Break-even price[a]	$ per ton/bushel	16.46	19.76	1.76	1.47
Net returns over:					
Variable costs	$ per acre	121.35	205.84	35.01	120.15
Total cost	$ per acre	43.88	28.81	-60.09	-71.31

[a] The dryland and irrigated yields used in these calculations for alfalfa are 2.5 and 4.55 t per acre, respectively, and for corn they are 55 and 129 bu per acre, respectively. The variable costs of production are used in the break-even price calculations.

Table 18. Economics of Dryland versus Irrigated Production; Alfalfa, Corn, and Soybeans; Turner County; 1981.

		Alfalfa		Corn		Soybeans	
Economic criterion	Unit	Dry-land	Irri-gated	Dry-land	Irri-gated	Dry-land	Irri-gated
Variable costs	$ per acre	59.15	115.47	108.64	206.84	61.06	112.83
Total cost	$ per acre	174.68	399.61	216.77	445.22	169.34	332.44
Energy cost							
Per unit of land	$ per acre	19.29	52.62	53.60	109.70	19.36	39.74
Per unit of output[a]	$ per ton/bushel	5.51	8.77	0.71	0.76	0.77	0.88
Energy cost relative to variable costs	Percent	32.6	45.6	49.3	53.0	31.7	35.2
Break-even price[a]	$ per ton/bushel	16.90	19.25	1.45	1.43	2.44	2.51
Net returns over:							
Variable costs	$ per acre	168.35	274.53	71.36	141.16	47.41	145.92
Total cost	$ per acre	52.82	-9.61	-36.77	-97.22	-60.08	-73.69

[a] The dryland and irrigated yields used in these calculations for alfalfa are 3.5 and 6.0 t per acre, respectively; for corn they are 75 and 145 bu per acre, respectively; and for soybeans they are 25 and 45 bu per acre, respectively. The variable costs of production are used in the break-even price calculations.

Table 19. Market Prices versus Break-Even Prices, Selected Dryland and Irrigated Crops, Brookings and Turner Counties , 1981

		Market prices		1981 break-even prices, taking into account					
				Variable production costs		Total production costs except the charge for land		Total production costs	
Crop	Unit	Average price received 1978-80[a]	Assumed 1981 price	Brkgs. County	Turner County	Brkgs. County	Turner County	Brkgs. County	Turner County
Dryland									
Alfalfa	Ton	42.50	65.00	16.46	16.90	26.00	30.76	47.45	49.91
Barley	Bu	2.23	2.25	1.26	1.23	2.18	2.25	3.49	3.89
Corn	Bu	2.34	2.40	1.76	1.45	2.52	2.00	3.49	2.89
Flax	Bu	6.42	6.75	4.40	3.62	7.56	5.79	12.03	9.73
Oats	Bu	1.36	1.80	0.99	0.85	1.72	1.48	2.80	2.51
Sorghum	Cwt	3.67	4.20	n/a	2.58	n/a	3.98	n/a	6.27
Soybeans	Bu	6.53	5.75	3.04	2.44	5.02	4.09	7.84	6.77
Spring wheat	Bu	3.59	3.75	2.15	2.21	3.48	3.76	5.40	6.24
Sunflowers	Cwt	9.82	10.00	7.07	n/a	10.80	n/a	16.76	n/a
Irrigated									
Alfalfa	Ton	42.50	65.00	19.76	19.25	39.03	48.73	58.67	66.60
Corn	Bu	2.34	2.40	1.47	1.43	2.26	2.33	2.95	3.07
Soybeans	Bu	6.53	5.75	n/a	2.51	n/a	5.00	n/a	7.39

[a] These are averages of the "seasonal average price" for each of the three years as reported in CLRS(1981,3). The average price shown for alfalfa in the table is for the CLRS's "all hay" category, and the average price for spring wheat is for the CLRS's "all wheat" category.

Table 20. Projected Compound Annual Growth Rates, Product Prices and Variable Production Costs, Selected Crops, Brookings and Turner Counties, 1977 through 1990

		Variable production costs[b]		
		Current trends	An assumed doubling in the 1981 energy price by	
Crop	Product prices[a]	in input prices assumed	1990	1986
		(percentage growth rate)		
Alfalfa	5.8	4.9-5.8	6.3-7.9	7.6-9.6
Barley	6.6	4.9	6.8	8.4
Corn	7.7	4.9-5.2	6.9-7.4	8.5-9.2
Flax	6.5	5.2-5.3	6.9-7.1	8.3-8.6
Oats	6.6	4.8	6.5-6.6	8.0-8.1
Sorghum	7.7	4.7	6.5	8.0-
Soybeans	6.4	4.7-4.9	6.1-6.6	7.4-8.0
Spring wheat	6.6	5.5-5.6	7.2-7.3	8.6-8.7
Sunflowers	6.4	4.6	6.1	7.6

[a] The projected growth rates for alfalfa, corn, soybeans, and wheat are the growth rates forecast by Chase Econometrics (1981) for 1978 through 1990 (except for 1981 through 1990 for alfalfa). Based on these forecasts and commodity-interrelationships, the authors projected the indicated growth rates for the other commodities.

[b] The ranges in growth rates shown below reflect a usually somewhat higher growth in variable production costs for irrigated crops than for dryland crops, and differences in the growth rates for particular crops in Brookings versus in Turner County.

Table 21. Impacts of Rising Energy Prices on the Net Returns over Total Variable Production Costs, Selected Dryland and Irrigated Crops, Brookings and Turner Counties, 1981 and Projected to 1990

Crop	Net returns in 1981	Net returns projected to 1990: Current trends in input prices assumed	Assumed doubling in the 1981 energy price by 1990	Assumed doubling in the 1981 energy price by 1986	Reduction in net returns because of a doubling in the 1981 energy price by 1986[a]
Brookings County			(dollars per acre)		
Dryland crops					
Alfalfa	121	147	136	124	23(15.6)
Soybeans	51	173	157	140	33(19.1)
Spring wheat	45	128	106	83	45(35.2)
Oats	41	76	57	38	38(50.0)
Barley	40	118	96	73	45(38.1)
Corn	35	168	128	85	83(49.4)
Flax	28	89	68	46	43(48.3)
Sunflowers	26	93	71	48	45(48.4)
Irrigated crops					
Alfalfa	206	247	216	182	65(26.3)
Corn	120	443	353	257	186(42.0)
Turner County					
Dryland crops					
Alfalfa	168	204	187	169	35(17.2)
Soybeans	83	245	229	211	34(13.9)
Corn	71	259	213	164	95(36.7)
Oats	62	110	89	66	44(40.0)
Flax	53	144	122	99	45(31.3)
Sorghum	47	146	116	84	62(42.5)
Barley	42	121	100	78	43(35.5)
Spring wheat	42	122	100	78	44(36.1)
Irrigated crops					
Alfalfa	275	330	284	236	94(28.5)
Soybeans	146	440	406	370	70(15.9)
Corn	141	508	413	312	196(38.6)

[a] The reductions are with respect to the net returns under the current trends in input prices assumption. The reductions, in percentage terms, are shown in brackets.

Table 22. Economic Impacts of Rising Energy Prices, Projected to 1990, Dryland versus Irrigated Production, Alfalfa and Corn, Brookings County

Crop and economic criterion	Unit	Dryland production: Current trends in input prices assumed	Dryland production: An assumed doubling in the 1981 energy price by 1990	Dryland production: An assumed doubling in the 1981 energy price by 1986	Irrigated production: Current trends in input prices assumed	Irrigated production: An assumed doubling in the 1981 energy price by 1990	Irrigated production: An assumed doubling in the 1981 energy price by 1986
Alfalfa							
Energy Cost	$ per acre	16.71	27.79	39.66	46.50	78.14	111.53
Variable costs	$ per acre	50.96	62.04	73.91	112.16	143.80	177.19
Total cost	$ per acre	170.46	181.54	193.41	372.62	404.26	437.65
Energy cost relative to:							
Variable costs	Percent	32.8	44.8	53.7	41.5	54.3	62.9
Total cost	Percent	9.8	15.3	20.5	12.5	19.3	25.5
Break-even price	$ per ton	20.38	24.82	29.56	24.65	31.60	38.94
Net returns over:							
Variable costs	$ per acre	146.59	135.51	123.64	247.38	215.74	182.35
Total cost	$ per acre	27.09	16.01	4.14	-13.08	-44.72	-78.11
Corn							
Energy cost	$ per acre	60.70	100.28	143.39	133.14	223.86	319.43
Variable costs	$ per acre	123.36	162.94	206.05	239.17	329.89	425.46
Total cost	$ per acre	265.29	304.87	347.98	518.22	608.94	704.51
Energy cost relative to:							
Variable costs	Percent	49.2	61.5	69.6	55.7	67.9	75.1
Total cost	Percent	22.9	32.9	41.2	25.7	36.8	45.3
Break-even price	$ per bushel	2.24	2.96	3.75	1.85	2.56	3.30
Net returns over:							
Variable costs	$ per acre	167.59	128.01	84.90	443.24	352.52	256.95
Total cost	$ per acre	25.66	-13.92	-57.03	164.19	73.47	-22.10

Table 23. Economic Impacts of Rising Energy Prices; Projected to 1990; Dryland versus Irrigated Production; Alfalfa, Corn, and Soybeans; Turner County

Crop and economic criterion	Unit	Dryland production: Current trends in input prices assumed	Dryland production: An assumed doubling in the 1981 energy price by 1990	Dryland production: An assumed doubling in the 1981 energy price by 1986	Irrigated production: Current trends in input prices assumed	Irrigated production: An assumed doubling in the 1981 energy price by 1990	Irrigated production: An assumed doubling in the 1981 energy price by 1986
Alfalfa							
Energy Cost	$ per acre	24.76	41.37	59.04	67.19	112.85	161.04
Variable costs	$ per acre	73.02	89.63	107.30	144.39	190.05	238.34
Total cost	$ per acre	246.27	262.88	280.55	548.61	594.27	642.46
Energy cost relative to:							
Variable costs	Percent	33.9	46.2	55.0	46.5	59.4	67.6
Total cost	Percent	10.1	15.7	21.0	12.3	19.0	25.1
Break-even price	$ per ton	20.86	25.61	30.66	24.00	31.56	39.54
Net returns over:							
Variable costs	$ per acre	203.55	186.94	169.27	329.73	284.07	235.88
Total cost	$ per acre	30.30	13.69	-3.98	-74.49	-118.73	-168.34
Corn							
Energy cost	$ per acre	68.83	114.70	164.02	139.48	234.76	335.68
Variable costs	$ per acre	137.47	183.34	232.66	258.94	354.22	455.14
Total cost	$ per acre	301.18	347.05	396.37	604.92	700.20	801.12
Energy cost relative to:							
Variable costs	Percent	50.1	62.6	70.5	53.9	66.3	73.8
Total cost	Percent	22.9	33.1	41.4	23.1	33.5	41.9
Break-even price	$ per ton	1.83	2.44	3.10	1.79	2.44	3.14
Net returns over:							
Variable costs	$ per acre	259.28	213.41	164.09	508.11	412.83	311.91
Total cost	$ per acre	95.57	49.70	0.38	162.13	66.85	-34.07
Soybeans							
Energy cost	$ per acre	25.09	41.43	59.24	51.22	85.28	121.71
Variable costs	$ per acre	77.52	93.86	111.67	140.91	174.97	211.40
Total cost	$ per acre	241.50	257.84	275.65	462.84	496.90	533.30
Energy cost relative to:							
Variable costs	Percent	32.4	44.1	53.1	36.4	48.7	57.6
Total cost	Percent	10.4	16.1	21.5	11.1	17.2	22.8
Break-even price	$ per bushel	3.10	3.75	4.47	3.17	3.95	4.79
Net returns over:							
Variable costs	$ per acre	245.48	229.14	211.33	440.49	406.43	370.00
Total cost	$ per acre	81.50	65.16	47.35	118.56	84.50	48.07

Table 24. The Impact of Different Interest Rates on Total Production Costs, Selected Dryland and Irrigated Crops, Brookings and Turner Counties, 1981.

Crop	Cost per acre ($) with the following assumed interest rates				Increment in cost for an 18 percent versus 10 percent interest rate	
	10 percent	14 percent	18 percent	22 percent	Dollars per acre	Percen
Brookings County						
Dryland Crops						
Alfalfa	112.51	115.57	118.62	121.67	6.11	5.4
Barley	133.10	137.99	142.89	147.80	9.79	7.4
Corn	181.20	186.64	192.09	197.55	10.89	6.0
Flax	134.09	139.22	144.36	149.49	10.27	7.7
Oats	130.26	135.05	139.85	144.62	9.59	7.4
Soybeans	138.86	143.89	148.92	153.94	10.06	7.3
Spring wheat	141.21	146.14	151.06	155.98	9.85	7.0
Sunflowers	141.66	146.25	150.83	155.41	9.17	6.5
Irrigated Crops						
Alfalfa	243.04	254.99	266.94	278.88	23.90	9.8
Corn	347.81	364.36	380.91	397.45	33.10	9.5
Turner County						
Dryland Crops						
Alfalfa	162.31	168.50	174.68	180.37	12.37	7.6
Barley	149.42	154.40	159.38	164.35	9.96	6.7
Corn	206.24	211.51	216.77	222.02	10.53	5.1
Flax	157.50	161.49	165.48	169.47	7.98	5.1
Oats	153.11	158.08	163.06	168.03	9.95	6.5
Sorghum	172.03	177.21	182.38	187.55	10.35	6.0
Soybeans	158.91	164.13	169.34	174.56	10.43	6.6
Spring wheat	158.49	163.50	168.50	173.50	10.01	6.3
Irrigated Crops						
Alfalfa	351.23	375.42	399.61	423.80	48.38	13.8
Corn	402.27	423.74	445.22	466.69	42.95	10.7
Soybeans	298.40	315.42	332.44	349.45	34.04	11.4

Table 25. The Impact of Different Interest Rates on Break-Even Prices, Selected Dryland and Irrigated Crops, Brookings and Turner Counties, 1981.

Crop	Unit	Break-even price ($ per unit) with the following assumed interest rates				Increment in cost for an 18 versus 10 percent interest rate	
		10 percent	14 percent	18 percent	22 percent	Dollars per unit	As a percent of the assumed 1981 market price
Brookings County							
Dryland crops							
Alfalfa	Ton	45.00	46.23	47.45	48.67	2.45	3.8
Barley	Bushel	3.25	3.37	3.49	3.60	0.24	10.7
Corn	Bushel	3.29	3.39	3.49	3.59	0.20	8.3
Flax	Bushel	11.17	11.60	12.03	12.46	0.86	12.7
Oats	Bushel	2.61	2.70	2.80	2.89	0.19	10.6
Soybeans	Bushel	7.31	7.57	7.84	8.10	0.53	9.2
Spring Wheat	Bushel	5.04	5.22	5.40	5.57	0.36	9.6
Sunflowers	Cwt	15.74	16.25	16.76	17.27	1.02	10.2
Irrigated crops							
Alfalfa	Ton	53.42	56.04	58.67	61.53	5.25	8.1
Corn	Bushel	2.70	2.82	2.95	3.08	0.25	10.4
Turner County							
Dryland crops							
Alfalfa	Ton	46.37	48.14	49.91	51.53	3.54	5.4
Barley	Bushel	3.64	3.77	3.89	4.01	0.25	11.1
Corn	Bushel	2.75	2.82	2.89	2.96	0.14	5.8
Flax	Bushel	9.26	9.50	9.73	9.97	0.47	7.0
Oats	Bushel	2.36	2.43	2.51	2.59	0.15	8.3
Sorghum	Cwt	5.93	6.11	6.29	6.47	0.36	8.6
Soybeans	Bushel	6.36	6.57	6.77	6.98	0.41	7.1
Spring wheat	Bushel	5.87	6.06	6.24	6.43	0.37	9.9
Irrigated crops							
Alfalfa	Ton	58.54	62.57	66.60	70.63	8.06	12.4
Corn	Bushel	2.77	2.92	3.07	3.22	0.30	12.5
Soybeans	Bushel	6.63	7.01	7.39	7.77	0.76	13.2

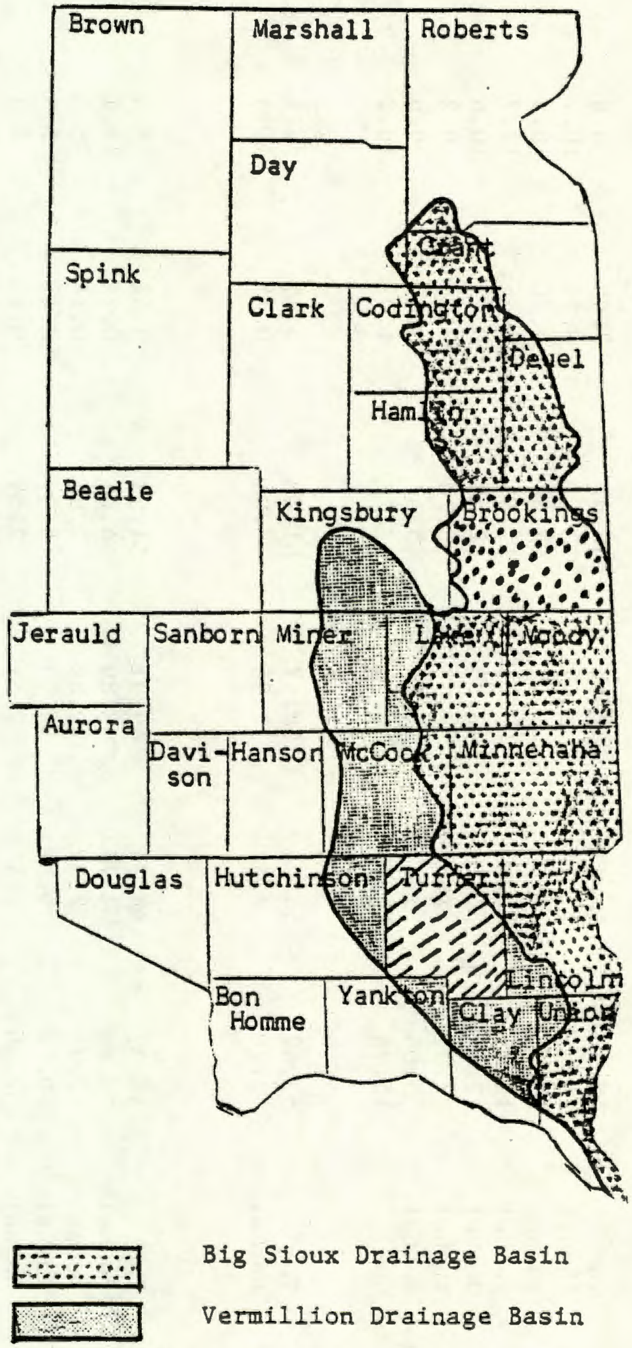


Figure 1. Location of Big Sioux and Vermillion Drainage Basins in Eastern South Dakota.

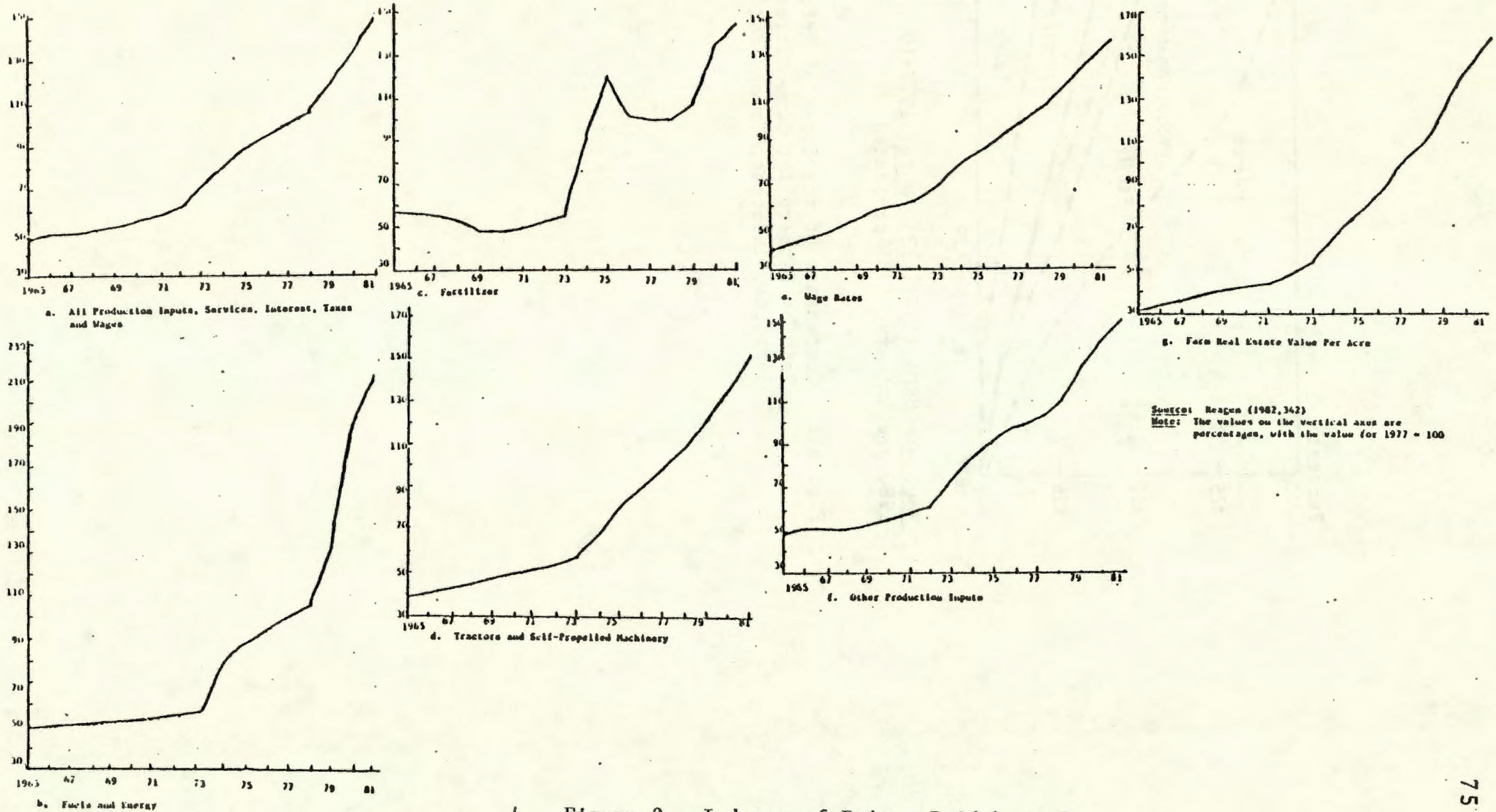
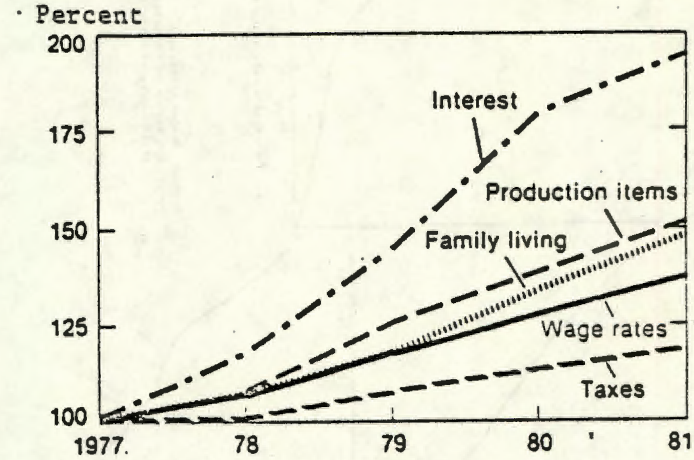


Figure 2. Indexes of Prices Paid by U.S. Farmers, 1965-1981



Source: USDA (1981, 12) Note: 1977=100, 1980 preliminary, 1981 projected

Figure 3. Components of the Index of Prices Paid by Farmers for Commodities, Services, Interest, Taxes, and Wages