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Irrigation in Brookings County: Impacts of Credit and Commodity Price Levels

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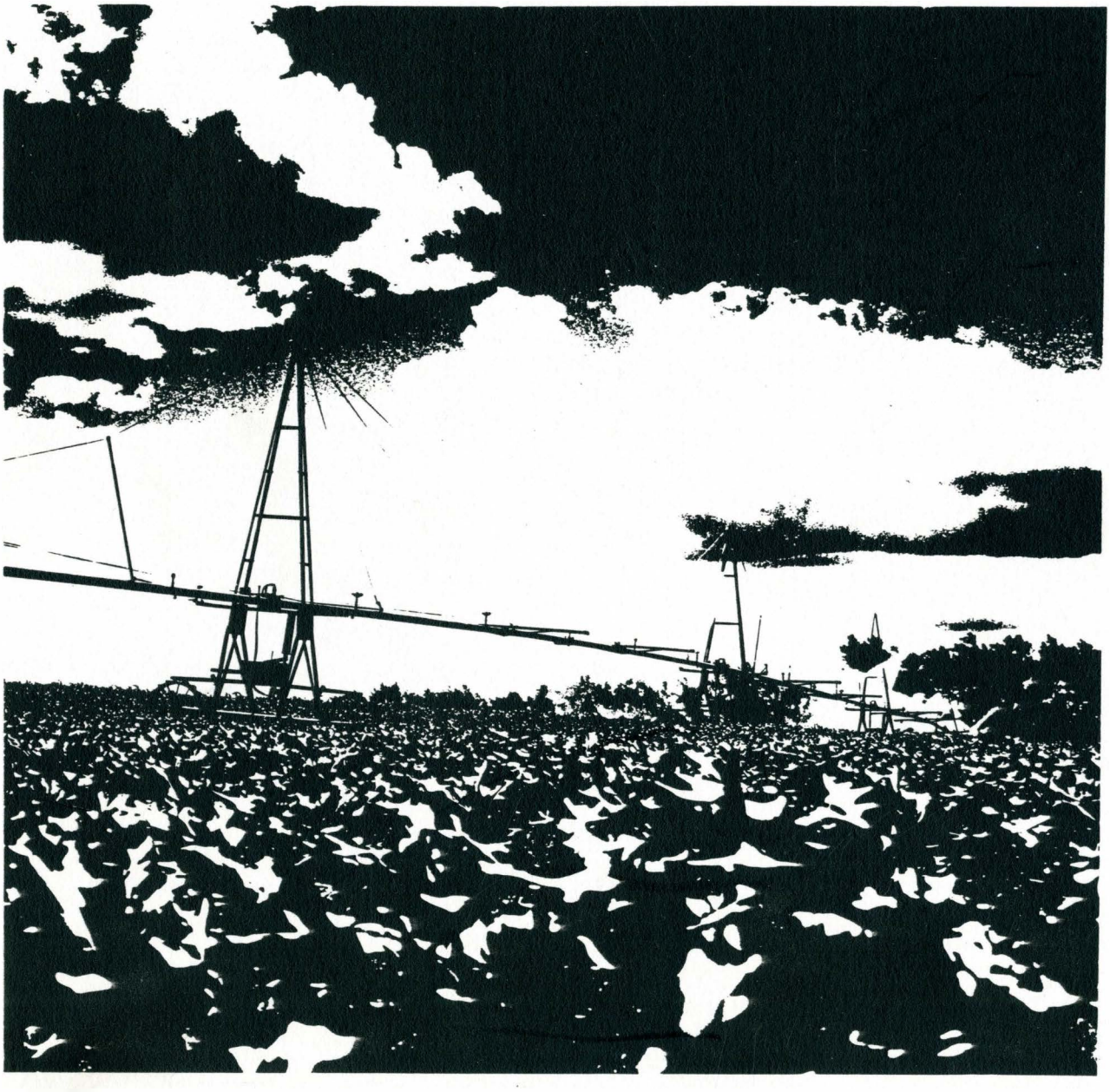

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Irrigation in Brookings County:
IMPACTS OF CREDIT AND COMMODITY PRICE LEVELS

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Paul Kiendl
Donald C. Taylor

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SUMMARY AND CONCLUSIONS

In this bulletin, the results of an investigation to determine the impacts of interest rates, leverage (the ratio of assets to liabilities), and crop prices on the organization and growth of a representative Brookings County irrigated farm are reported.

The most profitable organizational plan is first determined for the farm over a 10 year period with the following assumed economic conditions: $27,500 of initital net operating capital, a 16% interest rate, and projected commodity prices reflecting averages for the past 10 years. This plan is termed the baseline solution.

Values for the three key variables in the study are then changed one-at-a-time to reflect contrasting circumstances for interest rates, degree of leverage, and level of crop prices. The comparisons involve a reduction from 16 to 10% in the operating capital interest rate, a 30% increase in initial net operating capital from $27,500 to $35,700, and crop prices 30% higher than the 10 year average.

Most profitable farm organizational plans are determined for each of the three contrasting situations. The net farm incomes and cashflow balances for the various solutions are compared with each other to reflect the impacts of changed interest rates, leverage, and crop prices. The following findings depend critically on the assumed resource endowment and management goals of the representative farm (indicated in the "Nature of the Model" section).

The organization of resources in the baseline, reduced leverage, and reduced interest rate solutions is essentially the same. Major emphasis is given to hog and soybean production, with enough corn produced to raise and feed out the hogs produced. The maximum permitted acreages of dryland and irrigated alfalfa are also part of the most profitable farm plans. With the 30% increase in the level of crop prices, however, the hog enterprise drops out and the soybean cash grain enterprise further expands.

The growth in resource use in the most profitable baseline, reduced leverage, and reduced interest rate solutions is limited to the renting of 273 acres of cropland. Neither land nor irrigation systems are purchased. With the increased price level, however, the renting of the maximum permitted cropland area (454 acres) becomes profitable. Further, the intensity of farming increases through the purchase and use of two center pivot irrigation systems.

By the end of the 10th production period, with the increased price level model, the cashflow balance builds up to more than $428,000. Over 60% of this balance is invested off-farm, with the return from the off-farm investment amounting to about 25% of the total net income earned on the farm. A main

factor limiting further growth of the farm is a critical labor shortage during the September - October harvesting period.

In none of the optimal solutions is the borrowing of additional intermediate and long-term capital profitable. During the first two production periods in all four solutions, however, substantial amounts of operating credit (ranging from $50,000 to $100,000) are required. Operating credit needs thereafter decrease, with the extent of decrease varying widely among the four models. Operating credit needs with the baseline model in the 10th production period exceed $70,000. With the reduced leverage model, the 10th year operating credit needs drop to $34,000. At the other extreme, operating credit is no longer needed after the 6th production period with the reduced interest rate model, and after the 3rd production period with the increased price level model.

With all four models, cashflow balances and net farm incomes become larger throughout the 10 production periods. However, the dollar values and rates of growth for the different models are widely variable. In general during the final 5 years of the period, the dollar values for both criteria are twice as great for the reduced leverage model as for the baseline model. In turn, the dollar values for the reduced interest rate model are at least twice as great as those for the reduced leverage model, and for the increased price level model they are at least twice as great as those for the reduced interest rate model.

Three major conclusions emerge from the study. The first is that a 1% increase in crop prices has greater positive impacts on cashflow balances and net farm income than a 1% decrease in the interest rate percentage or a 1% decrease in leverage. Of the three, the impacts are least with reduced leverage.

The second conclusion concerns the economic sustainability and profitability of agriculture. The annual net farm income, after all farm expenses are met and $10,000 is set aside for family living expenses, is positive in all 4 solutions. The income also increases over the 10 production periods with all 4 models. With the baseline solution, the net farm income grows from $800 to $4,800 per year. For the increased price level model, net farm income grows from $35,000 to $66,000 per year. But even in this most favorable situation, the before interest and taxes return on total assets is less than 7%. These results suggest a certain economic survivability of agriculture, but do not show agriculture to be a high profit industry.

Third, the results of analysis show the economics of producing soybeans and alfalfa to be on par with or superior to those for producing corn. A reflection of this is the production of corn only as a source of feed for the hog enterprise in each of the study's optimal solutions. Under different assumed crop prices, of course, the relative profitability of different crops could change.

Corn is the dominant irrigated and dryland crop in Brookings County. That corn is not sufficiently attractive to be grown as a cash crop in the most profitable farm organization plans determined in this study is, therefore, somewhat at variance with actual cultivation practices. On the other hand, production data over the past 15 years in Brookings County show a fairly definite trend for the acreage of soybeans to be increasing relative to that for corn. The findings from our study provide some evidence of the possible economic rationale for this changing pattern of production.

IMPACTS OF CREDIT AND COMMODITY PRICE LEVELS ON THE ORGANIZATION AND GROWTH OF AN IRRIGATED FARM FIRM[1]

by Paul Kiendl and Donald C. Taylor

INTRODUCTION

The agricultural industry plays an important role in maintaining the vitality of the U.S. economy. In 1982, the food and fiber industry produced $529 billion worth of goods (U.S.D.A., 1983a), accounting for 20% of the U.S. Gross National Product. Furthermore, it directly employed 3% of the U.S. workforce and indirectly employed another 19% (U.S.D.A., 1983d). However, the recent economic recession coupled with elevated interest rates have clouded the financial outlook of the agricultural sector.

Problem Situation

In 1981, both short and long-term nominal interest rates reached post-World War II record highs. With the sharp drop in inflation in the 1980's, real (inflation-adjusted) interest rates are no longer negative as in the late 1970's. Rather, they are now in the area of 5 to 6%. This is higher than in any other major industrial country (Edelman, 1984).

The implications of high real rates of interest are to increase costs of production and increase the value of the dollar relative to the value of foreign currencies. From the second half of 1980 to the first half of 1983, for example, the dollar value increased by 46% against a weighted average of the currencies of the other major industrial countries (F.C.A., 1983). Consequently, the value of agricultural exports declined by 20% from 1981 to 1983 (Edelman, 1984). This translates into lower commodity prices and lower earnings -- since 22% of U.S. farmers' cash receipts originate from the sale of agricultural exports.

Besides the increase in interest rates, farmers are experiencing mounting pressure from other quarters. The familiar "cost price squeeze" phrase reflects the fact that since 1979 the prices paid by farmers for production inputs have been rising at a faster pace than the prices received from the sale of agricultural produce. The ratio of prices received by farmers to the index of prices paid, interest, taxes, and wage rates was 107 in 1979. By 1982, the ratio declined to 85 (U.S.D.A., 1983b).

A further complication, which has aggravated the financial standing of agricultural producers, concerns the deterioration of asset values -- especially those for real estate. In the 1970's, the growing value of land provided credit suppliers with "inflation-proof" collateral. However, between 1980 and 1983 the real value of farmland in the U.S. declined by 18%. In the Corn Belt, the situation is more acute, since farmland values fell 16% in nominal terms and 33% in real terms (U.S.D.A., 1983e).

Since real estate assets make up 75% of total farm assets, the diminishing land values have had a negative impact on debt/asset ratios. In the U.S., the farm debt/asset ratio increased from 0.16 in 1979 to 0.21 in 1983. South Dakota has witnessed a similar pattern. In 1983, South Dakota's farm debt/asset ratio was 0.28, which is the highest for any state in the nation (U.S.D.A., 1984). This highlights the precarious position of many South Dakota farmers.

As a consequence of depreciating assets, borrowers have become more highly leveraged (i.e., ratios of liabilities to assets have increased). Bankers are rationing their lending to marginal producers, with much more

[1] In this bulletin, an extension of the analysis in Kiendl's (1984) Master's thesis is reported.

emphasis on a potential borrower's ability to repay loans out of current cashflows than on loan collateral. Producers, in turn, are having to stress margins between costs of production and revenues, with speculation on increases in commodity prices and land values no longer meriting much consideration (Schmiesing, 1984).

Objectives of the Study

This study encompasses two jointly related objectives:

1. To determine the impact of different interest rates, different degrees of leverage, and an increased crop price level on the growth of a typical Brookings County irrigated farm over a 10 year period; and

2. To investigate the changes over time in the scale, organization, and economic health of the irrigated farm firm.

The report is based on the analysis of a representative farm in Brookings County. The county is located in the Big Sioux River Basin in eastern South Dakota. The features of the representative farm reflect mean and median values for selected characteristics of 37 irrigated farms surveyed in 1982 (Taylor, 1984a).

To satisfy the study objectives, most profitable farm organizational plans were determined under four different situations:[1]

1. 16% interest rate, $27,500 of initial net operating capital, and 10 year average projected prices;

2. 10% interest rate, $27,500 of initial net operating capital, and 10 year average projected prices;

3. 16% interest rate, $35,700 of initial net operating capital, and 10 year average projected prices; and

4. 16% interest rate, $27,500 of initial net operating capital, and a 30% increase in the crop price level.[2]

The first run represents the baseline solution. By comparing the results of the first and second solutions, the impacts of reduced interest rates on net farm income and cashflow balances are determined. A comparison of the first and third solutions shows the impacts of different amounts of net operating capital. And third, a comparison of the first and fourth solutions shows the impacts of the increased crop price level.

The values selected in the analysis for the three variables are not based on precise scientific criteria. Factors considered in selecting the values are the following: farm loan interest rates over the past 5 years spanned across the range of 10 to 16%. In 1982, the year of this study, they were at the top end of the range (Melichar, 1984). The debt/asset ratios represented by the $27,500 assumed initial net operating capital and the values for the intermediate and long-term capital categories reflect averages

[1] In fact, most profitable farm organizational plans were determined for all eight possible combinations of 10 versus 16% interest rates; $27,500 versus $35,700 initial net operating capital; and average versus a 30% increased level of crop prices. The conclusions based on the eight models are essentially the same as those based on the following four situations. To simplify the presentation, the results from only the four situations are reported in this bulletin.

[2] The 10 and 16% interest rates indicated above apply to current capital. As indicated below, the owned land on the representative farm was assumed to be financed through an 8 1/2% mortgage taken out in 1970. Further, the interest rate on intermediate and long-term borrowing activated during the 10 year production period is 0.5% less than the corresponding interest rate on operating capital.

of the respective 1980-83 farm debt/asset ratios in South Dakota (Table 1). The average commodity prices for the past 10 years were used in the baseline model, since the model involves a study over 10 years to the future.

In summary, the values of the three key variables in the baseline model were selected so as to roughly reflect current conditions. The alternate 10% interest level reflects a rate experienced only 5 to 6 years ago. The assumed level of increase in net operating capital -- 30%, or from $27,500 to $35,700 -- is somewhat arbitrarily selected, but it is identical to the assumed rate of increase in the level of crop prices.

In interpreting the empirical data

TABLE 1. INITIAL ASSETS AND LIABILITIES ASSUMED FOR THE REPRESENTATIVE FARM, 1982.

Capital Item		Assets	Liabilities	Debt/ Asset Ratio
Current				
Operating capital[a]		$ 50,000	$ 22,500	0.45
Intermediate-term				
Machinery		139,115	40,600	
Irrigation system		23,729	8,000	
Livestock breeding stock		17,160	0	
Sub-total		180,004	48,600	0.27
Long-term				
Dryland	287 ac. x $510/ac.	146,370	36,595	
Irrigated land	130 ac. x $801/ac.	104,130	26,035	
Pasture land	62 ac. x $255/ac.	15,810	3,950	
Buildings, farmstead		40,000	10,000	
Sub-total		306,310	76,580	0.25
Total		$536,314	$147,680	0.28

Sources: Data on the intermediate and long-term assets are based on the results of the 1982 irrigation survey. They reflect estimated current depreciated values of the various capital assets. The other data represent debt/asset ratios for the three capital item categories on the representative farm which reflect the average of the 1980-83 respective farm debt/asset ratios in South Dakota (U.S.D.A., 1984), with three adjustments: (1) only 60% of the long-term (real estate) asset values reported in U.S.D.A. (1984) were included in the ratio calculations, since farm operators own only about 60% of the total U.S. farm real estate; (2) the "CCC loan" debt was omitted from the ratio calculations; and (3) the 0.45 and 0.27 debt/asset ratios for current and intermediate-term capital items were chosen consistent with the 0.38 debt/asset ratio for the "current and intermediate" category reported in U.S.D.A. (1984).

[a]The current net operating capital in the baseline model is $27,500. In the reduced leverage model, the net operating capital is increased by 30% to $35,700. To do this, the current liability was reduced from $22,500 to $14,300.

results from the study, two points should be kept in mind. No predicted changes concerning the future are embedded in the values selected for the variables in the study. Second, the absolute net farm income and cashflow values determined in the study depend critically on the many assumptions made in the study. In interpreting the results of the study, greater attention should be given to relative relationships -- than to the absolute values -- reflected in the study's empirical results.

NATURE OF THE MODEL

Polyperiod Linear Programming

Linear programming is a mathematical technique for solving maximization and minimization problems faced by decision makers, e.g., farmers achieving maximum farm income, feed processors determining least-cost rations. Through linear programming, the value of an objective function involving income is maximized for a particular production period, subject to a set of linear restrictions involving the land, labor, capital, and technology used in production. Polyperiod linear programming (P.L.P.) is an extension of this technique in that the program selects an optimal or most profitable solution based on farm operations over a number of successive time periods. Often in agriculture, P.L.P. is used to determine a firm's long-run organization and growth path. In this research project, the P.L.P. technique is applied to the representative irrigated farm (Beneke and Winterboer, 1973).

Objective Function

The objective function relates to the optimization procedure. In this instance, the objective of the model is to maximize the representative farm's net farm income over a period of 10 years. The main managerial assumptions in the model -- as elaborated below -- are as follows: the farm manager is presumed to want to (1) maximize his net farm income, rather than to maximize his net worth or the rate of return on his investment; (2) give primary consideration to investing capital surpluses in farm operations and assets, but to be open to making off-farm investments as well; (3) retain a substantial cash grain component in his farm, rather than for the farm to become dominated by livestock and/or alfalfa production; (4) avoid undue credit risk; and (5) limit the amounts of labor he hires and land that he rents so as to avoid exceeding his supervisory capacities.

The P.L.P. determines the organization and scale of the farm that will result in the greatest amount of discounted net farm income being generated over the planning horizon.[1] Net farm income is defined as the surplus revenue remaining after variable and fixed costs are subtracted from the activity receipts. Input-output coefficients for the farm production activities, commodity and input prices, and asset values are all assumed to be constant throughout the 10 year production period.

The criteria for assessing the performance of the farm unit under each of the four situations examined are (a) annual net farm income and (b) annual cashflow. Net farm income indicates the profitability of a firm. A positive net farm income indicates that an owner's gross returns exceed the economic costs of his operation.

The annual cashflow reflects the liquidity of a farming operation. It determines the magnitude and timing of potential borrowing and repayment activities. Cashflow differs from net income. Cashflows reflect dollar balances of a firm over time after

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[1] "Net farm income," as determined in the model and reported in the bulletin, takes into account the returns from not only farming operations but also any off-farm investments that are made with capital surpluses generated during the 10 year production period.

taking into account actual cash inflows and outflows. Because the calculation of net income includes attention to annual economic costs on depreciable multi-period assets, its value for most firms in most production periods differs from the same firm's cashflow balance value.

A positive and increasing cashflow balance provides an operator with opportunity to further invest in resources. Conversely, a negative and decreasing cashflow leads to the deterioration of a farmer's financial position and loss of liquidity.

In the analysis, the cash generated in any one period is transferred to the subsequent period. Crop and livestock receipts and off-farm investment returns add to cashflow balances. The meeting of operating expenses, debt payments on capital borrowed during the 10 year production period, and fixed costs, on the other hand, draw down on cashflow balances.

Resources Available and Restrictions

Land. The area in the representative farm is assumed to be 1,019 acres. This area and the apportionment of it into owned and rented areas are based on the results of the farm survey. About 47% of the total land area is owned and 53% is rented. Thus, the farm acreage is divided into 479 acres of owned land and 540 acres of rented land. The owned land consists of 287 dryland acres, 130 irrigated acres, and 62 acres of pasture land. The rented land consists of 324 dryland acres, 130 irrigated acres, and 86 acres of pasture land. These are the maximum acreages that can be rented in the P.L.P.

The land base of the representative farm can be expanded by renting or purchasing. Renting permits the farmer to expand without having to incur a large cash expenditure or being saddled with additional long-term financial obligations. The rent charges are based on an 8 year history of rent to value ratios (S.D.C.L.R.S., annual). The rented land is assumed to have the same productive capacity as the owned land.

The annual rental rate for irrigated land with either a low or high pressure center pivot is $50/acre. The rental rate for dryland is $33/acre, and for pasture it is $16/acre.

Extending the resource area can also be accomplished by outright purchase of land (i.e., by cash payment) or by making a 30% down-payment and initiating a series of equal annual interest-principal payments over a 30 year amortization period.

The acquisition of an acre of land adds to the resource base in the period in which it is purchased and in all subsequent periods. The cost of an acre of dryland is assumed to be $510/acre (U.S.D.A., 1983c) plus a $4/acre transactional fee. In addition, it is assumed that the operator would have to invest in equipment to permit production on the new land. The machinery capital required is $254/acre, which was determined by dividing the new purchase price of the machinery inventory by the present acreage of owned and rented cropland.

Irrigation Systems. The producer owns a quarter-section of irrigated land which may be left idle or utilized. The fixed and variable costs were derived from the PUMP program available from the AGNET computer system.

Expansion of the irrigated area can be achieved by leasing or purchasing with cash low or high pressure systems for use on quarter-sections of dryland.[1] The purchase cost of a high pressure unit is estimated at $42,498; for a low pressure unit, the cost is $43,145. With a leasing arrangement, the operator makes a payment during each of 7 years. In the 8th year, the producer has the option of taking ownership of the equipment by paying a final sum equal to 10% of the original value.

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[1]See Taylor (1984b) for an economic analysis of reduced pressure irrigation.

Labor. Labor for the representative farm is assumed to be provided in six bi-monthly periods. It is supplied by the operator and the immediate family, with provision also for the possible hiring of labor (students) during two bi-monthly periods (Table 2). Limits are placed on the amounts of labor that can be hired so that the farmer's capacity for supervising labor is not exceeded.

The operator is assumed to supply 3,224 hours (an average of 62 hours per week) and the family 1,152 hours per year.[1] A total of 1,167 hours of labor can be hired from July to October. From the total supply, 900 hours of overhead labor required for such tasks as accounting and collecting supplies are deducted. Thus, the net annual supply of labor is 4,643 hours.

Capital. The supplies of livestock and livestock facility capital were determined by allowing the linear program to compute a solution for a one year period. It is assumed that the sale of the facilities could provide capital to permit the construction of new or modified buildings for use by other livestock enterprises if they were more profitable than the livestock enterprise in the first-year solution.

An important assumption in the analysis concerns the preferences of the farm manager. It is presumed that the manager is interested in a farm that maintains a considerable amount of cash grain sales.[1] This was done through limiting livestock to the number that can be accommodated in the buildings currently available (and limiting the area of alfalfa that can be grown).

In addition to the livestock capital available, the producer can borrow money to invest in the purchase of breeding stock for the beef, hog, and dairy enterprises. The capital borrowed must be repaid within one time period.

The supply of operating capital is defined as "the total dollars available to pay for cash operating expenses be-

[1]For simplicity of analysis, the annual labor supply is assumed to be uniform throughout the 10 year production period. In practice, of course, the amount of family labor available for use on a farm usually varies from year to year depending on the number of "working-age" children in the family.

[1]The average gross value added from cash grain sales on the 37 irrigated farms surveyed in 1982 is roughly equal to that from livestock sales.

TABLE 2. THE BI-MONTHLY SUPPLY OF LABOR (HOURS) FOR THE REPRESENTATIVE FARM.

Months	Operator and family hours	Hired labor limit	Overhead labor	Net labor supply
Jan.-Feb.	552	0	108	444
Mar.-Apr.	716	0	126	590
May.-Jun.	941	0	162	779
Jul.-Aug.	1,050	650	180	1,520
Sept.-Oct.	637	517	180	974
Nov.-Dec.	480	0	144	336
Total hours	4,376	1,167	900	4,643

Sources: Wolf (1970) and personal communication with W. Aanderud, Extension Farm Management Specialist, SDSU.

fore it becomes necessary to borrow" (Allen, 1983). Two levels of initial net operating capital are supplied, namely, $27,500 and $35,700. To supplement the initital supply of operating capital, the model can activate a short-term borrowing activity. This activity permits the model to borrow operating capital with the stipulation that all sums loaned must be repaid within the production period.

The interest rate charged on borrowed operating capital is about 60% of the assumed annual rate. This reflects an assumed average loan period for operating capital of slightly more than 7 months. The reasoning is that operating capital is seldom borrowed for 12 months at a time, and repayment of an operating loan is a continuous flow process rather than an annual event.

The intermediate and long-term borrowing activity allows the farm operator to finance a cashflow deficit, a land purchase, and an irrigation system purchase. Consistent with real-world practice, the interest rate on intermediate and long-term credit is assumed to be slightly less (0.5%) than on operating credit. With the baseline assumption of $27,500 initial net operating capital, the initial values of assets and liabilities on the representative farm are $536,314 and $147,680, respectively (Table 1). This implies an overall debt/asset ratio at the outset of 0.28. Provision is made in the model for a maximum additional intermediate and long-term liability of $119,972.[1] The model has no feature to control the maximum permissible debt/asset ratio, but borrowing up to the indicated maximum would lead to a debt/asset ratio of no more than about 0.50.

[1]There is no provision in the model for the early retirement of intermediate and long-term debt, or for "real" asset growth during the 10 year production period. If additional capital assets are purchased in the profit maximizing solutions, additional intermediate and long-term borrowing capacity is created.

An off-farm investment activity is provided within the model. The interest rate reflects the opportunity cost that must be met before capital is distributed to the farm activities. Furthermore, this investment function reflects the discount rate for the activities (Beneke and Winterboer, 1973). The annual interest rate for this activity is 6%. If the farm manager had been assumed to be aggressively seeking off-farm investment outlets for his capital surpluses, a somewhat higher off-farm investment interest rate would probably have been warranted.

Fixed Costs. Two sets of fixed costs were prepared: one under a 10% interest rate and the other at a 16% rate. The fixed costs with 10% are $71,368 and with 16% they are $81,009 (Table 3). The land charge is based on the assumption that the property had an original debt in 1970 of $80,921 amortized at 8 1/2% over a 30 year period. The machinery fixed costs are based on the current depreciated value of the implement inventory. Purchase of replacement machinery involved a cash purchase equal to the annual depreciation cost. The living expenses are estimated at $10,000 annually.

Production Activities

Crop Activities. The crop activities included in the model are the most common ones on the surveyed farms. The dryland crops in the model are corn, oats, soybeans, and alfalfa, while the irrigated crops are corn, soybeans, and alfalfa.

In the model, the dryland and irrigated alfalfa areas are limited to 90 and 30 acres, respectively. These restrictions are imposed because of special marketing difficulties associated with alfalfa, e.g., high transport costs, volatile prices, various sources of difficult-to-quantify quality differences, the lack of organized regional and national markets. The operator is assumed to produce only a limited amount of alfalfa that can be sold in rather immediate proximity to his farm.

The dryland crop budgets are based on the production costs published by Aanderud and Allen (1982). It is assumed that the crops can be cultivated in continuous sequence. This allowed the identification of the most profitable crops year-by-year in the poly-period model.

TABLE 3. ANNUAL FIXED COSTS FOR THE REPRESENTATIVE FARM, 10 AND 16% INTEREST RATES.

Cost item	Interest rate 10%	16%
Farm machinery		
Depreciation	$17,101	$17,101
Interest	14,607	22,953
Housing and insurance	3,617	3,617
Land		
Interest and principal	7,530	7,530
Taxes	3,045	3,045
Irrigation equipment		
Interest, taxes & depreciation	7,789	9,084
Livestock		
Insurance, taxes, & depreciation	7,679	7,679
Living expenses	10,000	10,000
Total	$71,368	$81,009

Sources: Allen (1982) for farm machinery and irrigation equipment, Allen and Aanderud (1982) for livestock, an assumed land debt in 1970 (see text), and assumed living expenses.

TABLE 4. ASSUMED PER-ACRE YIELDS OF IRRIGATED AND DRYLAND CROPS IN BROOKINGS COUNTY.

Crop	Unit	Yield per acre Dryland	Irrigated	Ratio[a]
Corn	bushel	69.0	130	1.88
Oats	bushel	56.0	n/a	n/a
Soybeans	bushel	26.0	40	1.54
Alfalfa	ton	2.5	4.5	1.80

Sources: Dryland crop yields are based on a 5 year average (S.D. C.L.R.S., annual). Irrigated yields are derived from Taylor and Shane (1983) and the 1982 sample survey of Brookings County irrigators.

[a]Ratio of irrigated to dryland yield.

The irrigated crop budgets are derived from Taylor and Shane (1983). The AGNET program was used to determine the variable center pivot costs with the low and high pressure systems. The low pressure center pivot is assumed to operate at 30 p.s.i. and the high pressure system at 75 p.s.i.

The yields for the crop budgets are shown in Table 4. The dryland crop yields reflect average Brookings County yields between 1977 and 1981 (S.D. C.L.R.S., annual). The irrigated crop yields are derived from the sample survey and from the data presented by Taylor and Shane (1983). The irrigated yields for corn, alfalfa, and soybeans are 88, 80, and 54% higher than the respective dryland yields.

The "average projected prices" used in the study reflect the average prices in South Dakota for the 10 year period 1973 to 1982 (Table 5). Part of the analysis also involved an assumed 30% increase in the crop prices.

For the dryland crops, the gross margins (i.e., receipts minus variable costs) under the average projected prices range from $25/acre to $98/acre (Table 6). When the crop prices are increased by 30%, the gross margins increase from 44 to 93%. The gross margin for soybeans is in both situations the highest.

Of the irrigated crops, alfalfa has the lowest gross margin under both sets of price assumptions and for both low and high pressure production. Under average projected prices, corn and soybeans are equally profitable. With a 30% increase in crop prices, however, the gross margin for corn is about 10% greater than that for soybeans.

TABLE 5. AVERAGE PROJECTED CROP AND LIVESTOCK PRICES, SOUTH DAKOTA.

Item	Unit	Price
Crops[a]		
Corn	bushel	$ 2.35
Oats	bushel	1.37
Soybeans	bushel	5.98
Alfalfa	ton	46.39
Livestock		
Feeder steer	Cwt.	60.18
Feeder heifer	Cwt.	58.57
Replacement heifer	Cwt.	51.29
Fat heifer choice	Cwt.	52.10
Fat steer choice	Cwt.	52.64
Cull cow	Cwt.	34.65
Slaughter hogs	Cwt.	43.00
Aged sow	Cwt.	36.00
Manufacturing milk	Cwt.	12.00
Dairy calf	Cwt.	100.00

Sources: S.D.C.L.R.S. (1984) for the crop prices. Livestock prices, U.S.D.A. (annual). Manufacturing milk and dairy calf price, Allen and Aanderud (1982).

[a]The crop prices are averages of the annual "seasonal average prices" reported for South Dakota. The 30% higher prices for crops are as follows: corn $3.05 per bu., oats $1.78 per bu., soybeans $7.77 per bu., and alfalfa $60.30 per ton.

Gross margins are only one aspect of crop production that determines which crop(s) will be selected by the P.L.P. The labor hours required per activity also play an important role in the optimization procedure. Of the dryland crops, corn silage has the greatest labor demand followed by corn for grain at 2.43 hrs/acre (Appendix Table A.4).[1] Alfalfa has the lowest requirement at 1.1 hrs/acre. The per acre labor requirements for the irrigated crops are 1.4 (soybeans) to 2.6 (alfalfa) times as great as those for the dryland counterparts.

[1]Further, over 60% of the corn for grain labor requirement is during September - October -- the period in the optimal solutions when a labor shortage is very critical.

Livestock Activities

The livestock enterprises included in the model involve beef cow-calf, full fed steer and heifer, hog farrowing and finishing, hog finishing, and dairy activities.

The beef cow enterprise produces a 92% calf crop (Appendix Table A.5). Replacement heifers start calving at 2 years of age. Production is assumed to be represented by 0.18 of a 375 lb. heifer per cow as a replacement, and 0.46 of a 425 lb. steer and 0.28 of a 375 lb. heifer for sale.

The fattening units involve a 425 lb. steer calf being fed to a weight of 1,075 lb. (Appendix Table A.6) and a 375 lb. heifer calf being fed to a weight of 925 lb. (Appendix Table A.7). In both cases, a 2% mortality rate is assumed.

TABLE 6. GROSS MARGINS FOR DRYLAND AND IRRIGATED CROPS, AVERAGE PROJECTED PRICES AND A 30% INCREASE IN THE LEVEL OF CROP PRICES.

Item	Gross margin per acre: Average projected prices	Gross margin per acre: 30% increase in prices	Ratio[a]
Dryland			
Soybeans	$ 97.83	$144.37	1.48
Corn	66.35	114.65	1.73
Alfalfa	75.95	109.70	1.44
Oats	24.62	47.58	1.93
Irrigated			
Low pressure			
Corn	139.15	230.15	1.65
Soybeans	138.29	209.89	1.52
Alfalfa	118.08	178.78	1.51
High pressure			
Corn	127.36	218.36	1.71
Soybeans	127.88	199.48	1.56
Alfalfa	106.78	167.48	1.57

Source: This is a summary of the data presented in Appendix Tables A.1-A.3.

[a]Ratio of gross margins for "30% increase in prices" relative to "average projected prices."

The sow enterprise produces two litters of eight piglets each in January and July (Appendix Table A.8). The pigs are finished to a selling weight of 225 lb. One pig is retained from the January litter for replacement of the breeding sow.

The feeder pig activity involves the purchase of 40 lb. pigs which are fed to a weight of 225 lb. (Appendix Table A.9). The number of pigs per activity is initially 10 but, by the time slaughter weight is achieved, the number has decreased by 0.15 due to death loss.

The dairy activity consists of one milk cow producing 12,500 lbs. of manufacturing milk, 0.92 of a dairy calf, and 0.02 of a cull cow (Appendix Table A.10). Breeding stock replacements are purchased.[1]

[1]The labor requirements for the various livestock enterprises are presented in Appendix Table A.11.

TABLE 7. OPTIMAL RESOURCE ORGANIZATION OF THE REPRESENTATIVE FARM FOR EACH YEAR IN THE 10 YEAR PLANNING HORIZON, AVERAGE PROJECTED PRICES.

Selected characteristics of the most profitable farm organizational plan	Unit	Value
Resource expansion		
Irrigated land rented	acre	48
Dryland rented	acre	225
Total cropland added	acre	(273)
Pasture rented	acre	65
Hired labor (Sept.-Oct.)	hour	517
Irrigation system purchased	cen. piv.	0
Cropland use		
Irrigated corn	acre	90
Irrigated alfalfa	acre	30
Irrigated soybeans	acre	58
Total irrigated land[a]	acre	(178)
Dryland corn	acre	0
Dryland alfalfa	acre	90
Dryland soybeans	acre	422
Total dryland	acre	(512)
Total cropland	acre	690
Livestock		
Hog farrowing & finishing	sow	63
Selling & buying activities		
Sell corn	bushel	0
Sell alfalfa	ton	335
Sell soybeans	bushel	13,277
Buy oats	bushel	1,903

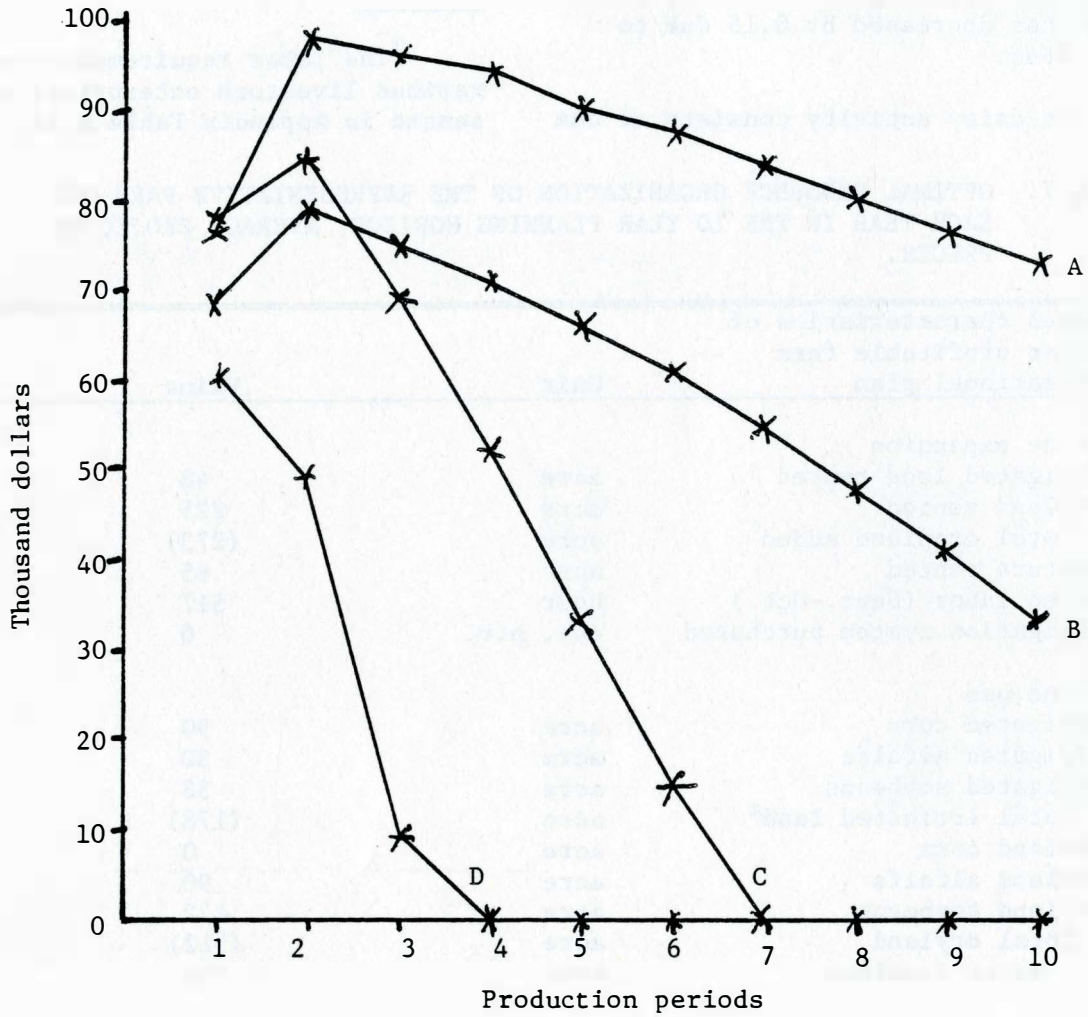
[a]All the irrigated land involves low pressure water distribution.

RESULTS OF THE ANALYSIS

Nature of the Baseline Solution

The most profitable resource organization of the representative farm with the baseline model is the same for each year in the 10 year planning period. The baseline solution involves a hog-soybean cash grain farm with enough irrigated corn to raise and feed out the hogs produced (Table 7). Hog production consists of a 63 sow farrowing and finishing unit. Soybeans cover over 80% of the dryland cropped area and 32%

FIGURE 1. CURRENT CAPITAL BORROWING, OPTIMAL FARM PLANS FOR THE REPRESENTATIVE FARM, FOUR BASIC MODELS.



FARM PLAN MODEL LEGEND

A = Baseline solutions: $27,500 initial net operating capital; 16% interest rate; 10 year average projected prices

B = Reduced leverage solutions: $35,700 initial net operating capital; 16% interest rate; 10 year average projected prices

C = Reduced interest rate solutions: $27,500 initial net operating capital; 10% interest rate; 10 year average projected prices

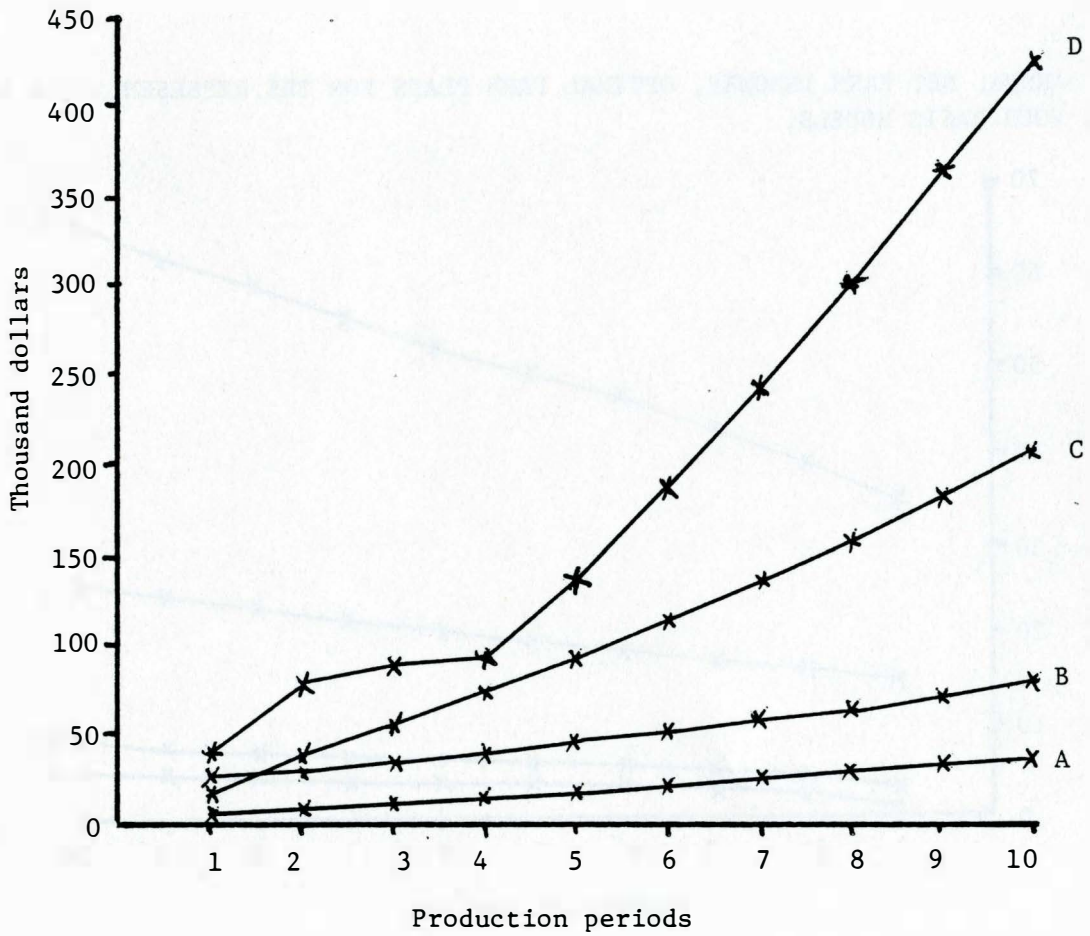
D = Increased crop price solutions: $27,500 initial net operating capital; 16% interest rate; 30% increased price level

of the irrigated area. The maximum permitted areas of dryland and irrigated alfalfa are also part of the baseline solution.[2]

[2]See the final part of the results section for a brief treatment of the relative economics of producing corn, soybeans, and alfalfa.

In terms of resource expansion, between $75,000 and $100,000 of operating capital is borrowed during different years of the 10 year production period (Figure 1). Since no land or irrigation systems are purchased (and cashflow balances do not become negative), no intermediate or long-term credit is borrowed. Further, no capital surpluses

FIGURE 2. ANNUAL CASHFLOW BALANCES, OPTIONAL FARM PLANS FOR THE REPRESENTATIVE FARM, FOUR BASIC MODELS.



FARM PLAN MODEL LEGEND

A = Baseline solutions: $27,500 initial net operating capital; 16% interest rate; 10 year average projected prices

B = Reduced leverage solutions: $35,700 initial net operating capital; 16% interest rate; 10 year average projected prices

C = Reduced interest rate solutions: $27,500 initial net operating capital; 10% interest rate; 10 year average projected prices

D = Increased crop price solutions: $27,500 initial net operating capital; 16% interest rate; 30% increased price level

are invested off-farm in the baseline solution. The expansion of resources is limited, then, to the renting of 273 acres of cropland (48 of which are irrigated), 65 acres of pasture (for the brood sows), and the hiring of the maximum permitted amount of labor (517 hours) during September - October.

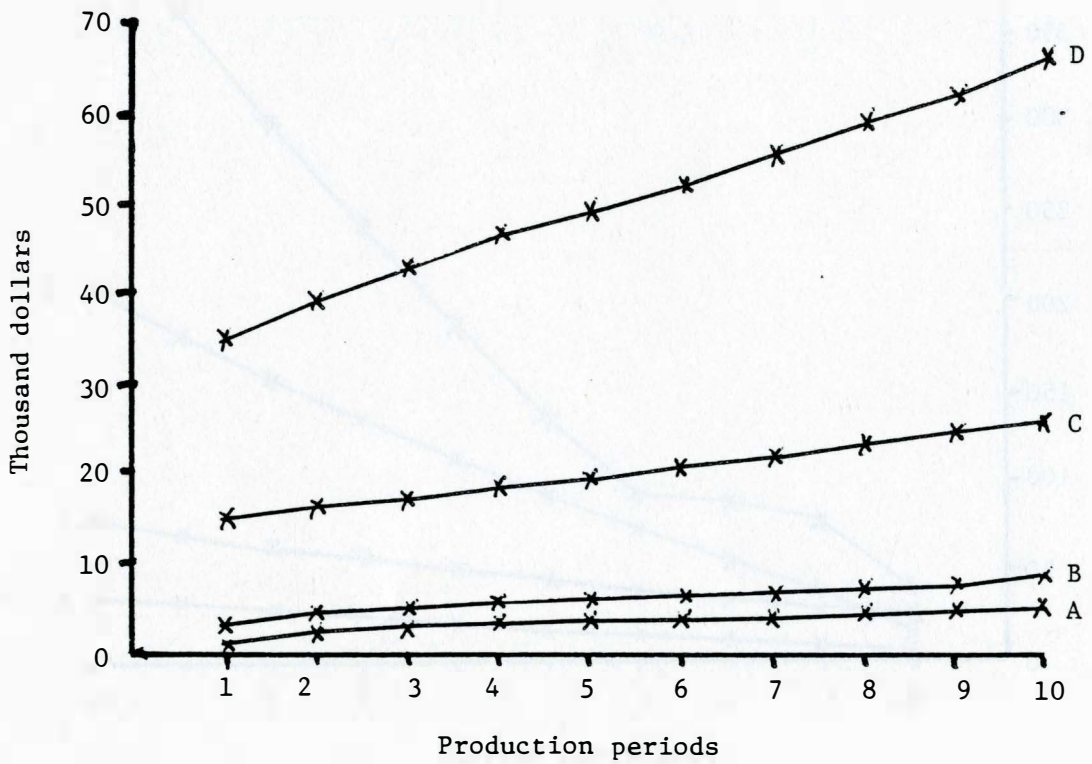
The end-of-year cashflow balances in the baseline solutions for the representative farm are all positive (Figure 2, Function A). They are modest in size, however, amounting to less than $6,000 in the 1st year and growing to about $35,000 in the 10th year.

The annual net farm incomes in the baseline solutions are also all positive (Figure 3, Function A). They, too, are modest -- amounting to less than $1,000 in the 1st year and approaching but not reaching $5,000 in the 10th year.

The Impact of Increased Net Operating Capital

To assess the impact of reduced leverage, the initial net operating capital was increased by 30% from $27,500 in the baseline model to $35,700 in the reduced leverage model.

FIGURE 3. ANNUAL NET FARM INCOMES, OPTIMAL FARM PLANS FOR THE REPRESENTATIVE FARM, FOUR BASIC MODELS.



FARM PLAN MODEL LEGEND

A = Baseline solutions: $27,500 initial net operating capital; 16% interest rate; 10 year average projected prices

B = Reduced leverage solutions: $35,700 initial net operating capital; 16% interest rate; 10 year average projected prices

C = Reduced interest rate solutions: $27,500 initial net operating capital; 10% interest rate; 10 year average projected prices

D = Increased crop price solutions: $27,500 initial net operating capital; 16% interest rate; 30% increased price level

This was accomplished by reducing the current liability level from $22,500 to $14,300. The 16% interest rate and 10 year average projected prices in the baseline model continue to apply in the reduced leverage model.

The most profitable resource organization of the representative farm with the reduced leverage model is identical to that for the baseline model (Table 7). The amount of current operating capital borrowed in the 1st year is $8,200 less ($35,700 - $27,500 = $8,200) in the reduced leverage solution than in the baseline solution (Figure 1, Function B versus Function A). The reduction in operating credit needs widens throughout the remaining nine production periods. In the 10th year, the operating credit need with the reduced leverage solution ($33,830) is less than half that for the baseline solution.

The end-of-year annual cashflow balances with the reduced leverage solution are at least twice as much as with the baseline solution (Figure 2, Function B versus Function A). In the earlier production periods, the relative differences in cashflow balances are greater, but the absolute differences are less. The same general patterns of relationship apply to the annual net farm incomes (Figure 3, Function B versus Function A) as to cashflow balances.

The Impact of Reduced Interest Rates

The reduced interest rate model involves a decrease from 16% to 10% in the annually based interest rate for operating capital, and from 15.5% to 9.5% in the interest rate on any newly activated intermediate and long-term borrowing in the most profitable farm solutions. The baseline model $27,500 initial net operating capital and 10 year average projected prices continue to apply in the reduced interest rate model.

The most profitable resource organization of the representative farm with the reduced interest rate is almost identical to that for the baseline model (Table 7). The three main differences are 3 acres less of rented irrigated land, 3 acres more of rented dryland, and 3 full-fed heifers also being included in the reduced interest rate solutions for the 1st through the 10th production periods.

The current operating credit needs are much less with the reduced interest rate model than with either of the two prior models (Figure 1, Function C versus Functions A and B). The credit need with the reduced interest rate does peak at $85,000 in the 2nd year, but rapidly drops thereafter and becomes zero beginning in the 7th production period.

The end-of-year cashflow balance with the reduced interest model begins with a level intermediate between that for the baseline and reduced leverage models (Figure 2, Function C versus Functions A and B). Beginning with the 2nd year, however, cashflow balances with the reduced interest rate rapidly accumulate. By the 10th production period, they exceed $200,000.

The net farm incomes show steady growth throughout the period of analysis -- beginning in the 1st year at about $15,000 and rising to over $26,000 in the 10th year (Figure 3, Function C). These levels are several-fold those for the baseline and reduced leverage models. In the reduced interest rate solution, some off-farm investment is made. In the 10th year, the return on the off-farm investment represents 17% of the total net income earned.

The Impact of an Increased Crop Price Level

The impact of higher crop prices is examined through an analysis of 30% higher prices for each of the crops included in the model. The analysis of a change in the price level for one crop versus that for other crops or of the impacts of differences in the year-to-

year stabilities in crop prices[1] was beyond the scope of the research reported in this bulletin.

[1]The variability over time in the prices of the four crops examined in this study is quite different. The coefficients of variation -- which reflect relative price stability in percentage terms -- for South Dakota seasonal average crop prices over the past 10 years are as follows: alfalfa 28.8, oats 20.1, corn 16.4, and soybeans 11.1.

The most profitable resource organization of the representative farm with the increased crop price level differs from that for the three prior models. Further, the most profitable farm plan differs substantially for the 1st and 2nd years compared with that for the 6th through 10th production periods (Table 8).

The most profitable farm plans for each of the years with the 30% higher level of crop prices involve 26% more cropped acres (871 versus 690 acres) than with the three prior models. The maximum permitted acres of rented cropland are brought under production but

TABLE 8. OPTIMAL RESOURCE ORGANIZATION OF THE REPRESENTATIVE FARM, ASSUMING A 30% INCREASE IN THE LEVEL OF CROP PRICES.

Selected characteristics of the most profitable farm organizational plan	Unit	Value	
		Years 1-2	Years 6-10
Resource expansion			
Irrigated land rented	acre	130	130
Dryland rented	acre	324	324
Total cropland added	acre	(454)	(454)
Hired labor (Sept.-Oct.)	hour	517	517
Irrigation system purchased	cen. piv.	0	2.0
Cropland use			
Irrigated corn	acre	19	0
Irrigated alfalfa	acre	30	30
Irrigated soybeans	acre	211	490
Total irrigated land[a]	acre	(260)	(520)
Dryland corn	acre	0	0
Dryland alfalfa	acre	90	90
Dryland soybeans	acre	521	261
Total dryland	acre	(611)	(351)
Total cropland	acre	871	871
Livestock			
Hog farrowing & finishing	sow	14	0
Selling & buying activities			
Sell corn	bushel	0	0
Sell alfalfa	ton	355	360
Sell soybeans	bushel	21,969	26,401
Buy oats	bushel	412	0

[a]All the irrigated land involves low pressure water distribution.

no new land is purchased. Soybeans are by far the dominant farm enterprise. The importance of hog production with the higher crop prices is considerably less, with only 14 sows in the 1st and 2nd year solutions and no hog production in the 6th through 10th year solutions.

During the 3rd, 4th, and 5th years, two low pressure center pivot systems -- each irrigating 130 acres -- are purchased. Thus, in the 6th through 10th production periods, 260 acres that earlier were under dryland production are placed under irrigation.

The irrigation systems are purchased outright with cash, rather than via the lease-purchase arrangement. As in the earlier models, no intermediate or long-term borrowing takes place in the increased crop price model. The borrowing of current operating capital is limited to the first three production periods (Figure 1, Function D).

The end-of-year cashflow balances during the first four production periods with the higher crop prices -- while greater than with any of the three prior models -- grow at a relatively modest rate (from $40,000 to $90,000) (Figure 2, Function D). During this period, two center pivot systems are purchased for cash. Thereafter, however, the balances rapidly accumulate, and by the 10th production period they amount to more than $428,000.

Over 60% of the 10th year cashflow balance ($271,895) is invested off-farm, with the return from the off-farm investment amounting to about 25% of the total net income earned on the farm. A main factor limiting the further growth of the farm is the limited labor supply during September - October, a time when all available labor is fully employed in the various farm activities.

The annual net incomes with the higher crop prices increase from $35,000 in the 1st year to $66,000 in the 10th year. They are more than twice as large as those with the reduced interest rates (Figure 3, Function D versus Function C).

To further describe the empirical outcomes of the study, two additional criteria are used. Both are applied to 10th year financial conditions.

That part of total net farm income represented by the returns from off-farm investments is shown in Table 9. In neither the baseline or reduced leverage solutions are any off-farm investments made. The $4,550 return from off-farm investments in the reduced interest rate solution represents 17% of the total earnings on the farm. For the increased crop price solution, the $16,315 off-farm investment return represents about 25% of total farm earnings.

The annual rate of return on total assets -- before interest and taxes -- ranges among the solutions from 0.8% for the baseline solution to 6.6% for the increased crop price solution. In the reduced interest rate solution, the annual return on farm assets (3.2%) is slightly less than that on total assets. With the increased crop price solution, on the other hand, the return on farm assets (6.8%) is slightly more than that on total assets. That the rates of return on farm assets are no larger than they are reflects a rather sober picture on the profit potential for agriculture.

The second criterion involves the calculation of arc elasticities in which the responsiveness of cashflow balances (and net farm incomes) to differences in each of net operating capital, interest rates, and crop price levels are determined. Tenth year financial conditions are used in the calculations. The reference points in the arc elasticity calculations are the baseline solution values. The point of comparison in computing the net operating capital elasticity is the reduced leverage solution value. The points of comparison in computing the interest rate and crop price elasticities are the reduced interest rate and increased crop price solution values, respectively.

The formula for computing the elasticities involves the use, in the denominators, of average values rather than the value at one end or the other

of the arc (Ferguson and Maurice, 1974, 30). The formula is illustrated with the responsiveness of cashflow (CF) balances to differences in net operating capital (OC). Tenth year data from the reduced leverage (RL) solution are compared with tenth year data from the baseline (BL) solution.[1]

$$\text{Elasticity}_{CF-OC} = \frac{\frac{CF_{RL} - CF_{BL}}{\frac{CF_{RL} + CF_{BL}}{2}}}{\frac{OC_{RL} - OC_{BL}}{\frac{OC_{RL} + OC_{BL}}{2}}} = \frac{\frac{78,932 - 36,719}{\frac{78,932 + 36,719}{2}}}{\frac{35,700 - 27,500}{\frac{35,700 + 27,500}{2}}} = 2.81\%$$

[1]In computing the interest rate elasticities, approximate weighted averages among 10 and 16% operating capital, 9 1/2% and 15 1/2% newly activated intermediate and long-term capital, and 8 1/2% farmland mortgage capital were used in the calculation. The weighted averages used in computing the overall interest rate elasticities are 12 1/4% and 9 1/4%.

The elasticity impacts on both cashflow balances and net farm income are greatest with respect to differences in the level of crop prices and least with respect to differences in net operating capital (Table 10). A 1% increase in crop prices, for example, is shown to have an approximate 6.7% im-

TABLE 9. TENTH YEAR RATES OF RETURN, OPTIMAL FARM PLANS FOR THE REPRESENTATIVE FARM, FOUR BASIC MODELS.

	Type of solution[a]			
Type of return	Baseline	Reduced leverage	Reduced interest rate	Increased crop prices
Dollar return to:				
Farm assets	4,770	8,465	21,480	49,960
Off-farm investment	0	0	4,550	16,315
Total	4,770	8,465	26,030	66,275
Annual percentage rate of return on:				
Total assets[b]	0.83	1.38	3.50	6.55
Farm assets[c]	0.83	1.38	3.22	6.75

[a]The baseline solution involves $27,500 initial net operating capital, 16% interest, and 10 year average projected prices. The reduced leverage, reduced interest, and increased crop price solutions involve one-at-a-time changes from the baseline situation as follows: $35,700 initial net operating capital, 10% interest, and a 30% increase in the level of crop prices, respectively.

[b]This is the return on total assets before interest and taxes.

[c]The return to and asset value of off-farm investments are eliminated in computing the "rate of return on farm assets."

pact on net farm income. A 1% increase in net operating capital, on the other hand, is shown to have only a 2.2% impact on net farm income. The elasticity impacts on cashflow balances of changes in values for the respective variables are of roughly the same magnitude as the impacts on net farm income.

THE RELATIVE ECONOMICS OF PRODUCING CORN, SOYBEANS, AND ALFALFA

In none of the most profitable farm organization plans determined in this study is corn produced for sale as cash grain. Enough corn is raised to meet the feed requirements of the hog enterprise, and the maximum permitted acreages of dryland and irrigated alfalfa are raised. All the remaining cropland is in soybean production.

Corn is the dominant crop in Brookings County generally (S.D. C.L.R.S., annual), and on the irrigated farms surveyed in 1982.[1] That corn is not sufficiently atractive to be grown as a cash crop in the most profitable farm organization plans determined in this study is, therefore, somewhat at variance with actual cultivation practices. At first glance, this outcome seems surprising. However, a number of recent publications show soybeans and alfalfa to be more profitable than corn. Some examples follow.

Allen, et al. (1979) show gross margins for dryland crop in Brookings County as follows: soybeans ($67.53/acre), alfalfa ($65.56/acre), and corn ($62.09/acre).

Taylor and Shane (1983) show gross margins for dryland crops in Brookings County in 1981 as follows: soybeans ($51.45/acre), alfalfa ($121.35/acre in 1981 and $42.06/acre with 1977-79 prices), and corn ($35.01/acre). The gross margin for irrigated corn in 1981 was $120.15/acre whereas for irrigated alfalfa in 1981 it was $205.84/acre and with 1977-79 prices it was $62.52/acre.

Sogn (1984) projects dryland soybeans and alfalfa to provide more than double the gross margin that dryland corn does in eastern South Dakota for the 1984 crop year ($56.45/acre for alfalfa, $52.52/acre for soybeans and $21.70/acre for corn).

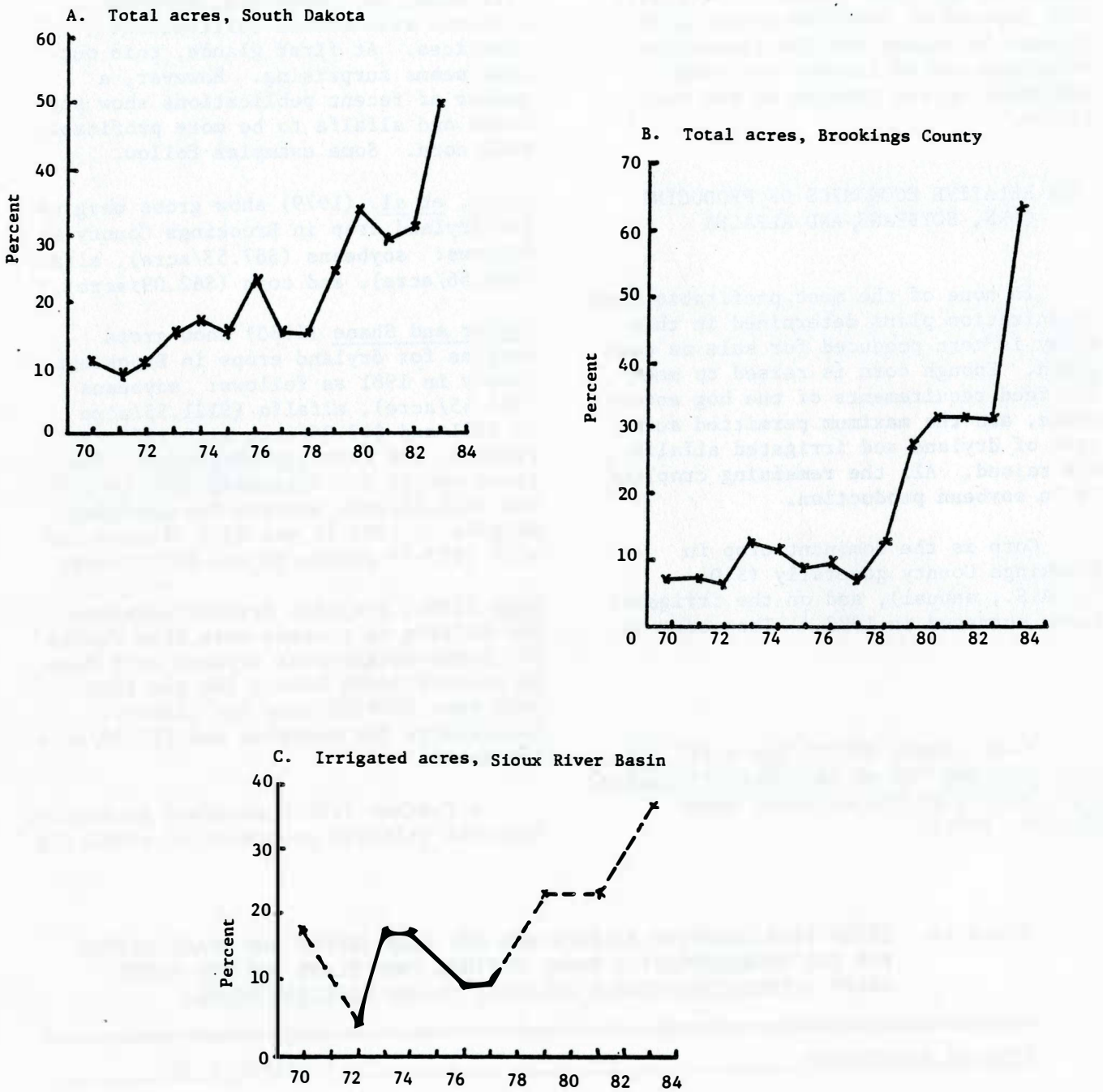
A further factor possibly detracting from the relative economics of producing

[1] Corn covers 35% of the total dryland area and 77% of the total irrigated area cropped on the surveyed farms (Taylor, 1984a).

TABLE 10. TENTH YEAR CASHFLOW BALANCE AND NET FARM INCOME ARC ELASTICITIES FOR THE REPRESENTATIVE FARM, OPTIMAL FARM PLANS FOR THE THREE BASIC ALTERNATIVE MODELS RELATIVE TO THE BASELINE MODEL.

Type of elasticity	Elasticity (%)
Cashflow balance elasticity with respect to:	
Net operating capital	2.81
Interest rate	5.00
Crop prices	6.46
Net farm income elasticity with respect to:	
Net operating capital	2.15
Interest rate	4.93
Crop prices	6.65

FIGURE 4. SOYBEANS AS A PERCENT OF CORN GRAIN, HARVESTED ACRES, 1970-1983.



Sources: Panels A and B: S.D.C.L.R.S. (annual)

Panel C: D.W.N.R. (annual)

Note: In Panel C, dotted lines span across years for which data are missing.

corn is the labor requirement which, in the budgets used in this study, is 30% or more greater for corn than for soybeans or alfalfa.

Recent trends in crop acreages reflect a growing popularity of soybeans relative to corn. For South Dakota during the early 1970's, the total acreage of soybeans was less than 20% of that for corn for grain. In recent years, 30% or more has been common (Figure 4A). For Brookings County, the increase in the relative popularity of soybeans has been even more striking. In the early 1970's, roughly 10% as many acres of soybeans as corn for grain were grown. In the 1980's, the percentage has exceeded 30 (Figure 4B). The ratio of irrigated soybeans to irrigated corn grain in the Sioux River Basin -- of which Brookings County is a part -- has also trended up during the past 15 years (Figure 4C).

LIMITATIONS TO THE STUDY

Some limitations arise in this study because of structural features in the analytical model used to determine the economic impacts of credit and commodity prices on farm firm growth. Other limitations arise because only a few of the possible values for certain key variables were examined.

The most important limitations in the study of which we are aware are indicated below. Further research focused on one or more of these areas should provide additional useful insights on the influence of various factors on the prospects for farm firm growth.

Commodity prices are fixed in the model used in this study at either one level or another throughout the 10 year production period. Further, the two levels examined differ by the same percentage for each crop involved. Designing the model so as to reflect (a) differing degrees of variability over time in the prices of different commodities and/or (b) differences in the relative prices of the different commodities studied would broaden the applicability of study results.

The model used in this study involves maximizing net farm income. Farm organizational plans that generate maximum net farm income may not also provide maximum rates of return on investment or maximize increases in net worth. Since each of these decision criteria has a certain validity, it would be worthwhile to determine whether (and, if so, in what ways) the use of the different criteria would give rise to contrasting results.

A factor critically influencing the outcomes in this study is the amount of September - October hired labor that was assumed available for use on the farm. With an expanded labor supply, the limits to farm firm growth realized in this study's analysis would perhaps be released.

The coefficients in the model reflect before-tax dollars. No provision is made for the possible appreciation (or depreciation) over time in the value of land. Providing appropriate attention to these two features -- while challenging -- could also enable the model to more fully reflect the conditions facing real-world decision makers.

APPENDIX

TABLE A.1: DRYLAND CROP BUDGETS, AVERAGE PROJECTED PRICES.

	Corn	Oats	Soybeans	Alfalfa	Corn silage
			(dollars per acre)		
Receipts	162.15	76.72	155.48	112.50	n/a
Variable costs					
Seed	10.80	8.65	12.50	3.00	10.80
Fertilizer	28.50	15.00	8.10	9.45	28.50
Herbicides	7.60	2.00	8.35	0	7.60
Insecticides	7.00	1.10	0.50	1.60	7.00
Crop Insurance	3.00	2.25	2.00	0	0
Storage & drying	13.50	2.70	4.40	0	0
Overheads	4.50	4.50	4.50	4.50	4.58
Fuel & lubricants	13.60	10.85	11.45	8.50	10.16
Machinery Repair	7.30	5.05	5.85	9.50	9.82
Total variable costs	95.80	52.10	57.65	36.55	78.46
Gross margins	66.35	24.62	97.83	75.95	n/a

Source: Variable costs are based on Aanderud and Allen (1982).

TABLE A.2: IRRIGATED CROP BUDGETS, AVERAGE PROJECTED PRICES.[a]

	Corn		Alfalfa		Soybeans	
	L.P.	H.P.	L.P.	H.P.	L.P.	H.P.
			(dollars per acre)			
Receipts	305.50	305.50	202.50	202.50	239.20	239.20
Variable costs						
Seed	16.43	16.43	7.92	7.92	15.00	15.00
Fertilizer	49.92	49.92	27.45	27.45	19.38	19.38
Herbicides & fertilizer	16.93	16.93	0	0	10.75	10.75
Crop Insurance	1.95	1.95	0	0	7.03	7.03
Overhead	9.05	9.05	4.74	4.74	6.02	6.02
Fuel & lubrication	11.08	11.08	9.15	9.15	10.11	10.11
Machinery repairs	8.45	8.45	9.84	9.84	8.31	8.31
Grain storage & drying	26.09	26.09	0	0	1.07	1.07
Irrigation cost	26.45	38.24	25.32	36.62	23.24	33.65
Total variable costs	166.35	178.14	84.42	95.72	100.91	111.32
Gross margins	139.15	127.36	118.08	106.78	138.29	127.88

Source: Adapted from Taylor and Shane (1983).

[a]L.P. and H.P. refer to a low and a high pressure center pivot, respectively.

TABLE A.3: RECEIPTS, VARIABLE COSTS, AND GROSS MARGINS FOR THE CROP BUDGETS USED IN THE STUDY, ASSUMING A 30% INCREASE IN COMMODITY PRICES.

	Dryland crops			
	Corn	Oats	Soybeans	Alfalfa
	(dollars per acre)			
Receipts	210.45	99.68	202.02	146.25
Variable costs	95.80	52.10	57.65	36.55
Gross margins	114.65	47.58	144.37	109.70

	Irrigated crops[a]					
	Corn		Soybeans		Alfalfa	
	H.P.	L.P.	H.P.	L.P.	H.P.	L.P.
Receipts	396.50	396.50	310.80	310.80	263.20	263.20
Variable costs	178.14	166.35	111.32	100.91	95.72	84.42
Gross margins	218.36	230.15	199.48	209.89	167.48	174.78

Source: The dryland variable costs are based on the budgets of Aanderud and Allen (1982). The irrigated variable costs are adapted from Taylor and Shane (1983).

[a]L.P. and H.P. refer to a low and a high pressure center pivot, respectively.

TABLE A.4: LABOR HOURS REQUIRED PER ACRE PER BI-MONTHLY PERIOD FOR IRRIGATED AND DRYLAND CROP ACTIVITIES IN THE STUDY.

	Dryland crops				
Months	Corn	Oats	Alfalfa	Soybeans	Corn silage
May-June	0.76	0.60	0.65	0.59	0.76
Jul.-Aug.	0.20	0.99	0.45	0.16	0.20
Sept.-Oct.	1.47	0.25	0	1.14	2.00
Total hours of labor required	2.43	1.84	1.10	1.89	2.96

	Irrigated crops		
Month	Corn	Soybeans	Alfalfa
Mar.-Apr.	0	0	.06
May-June	1.32	1.02	1.35
Jul.-Aug.	0.40	0.32	1.39
Sept.-Oct.	1.78	1.38	0
Nov.-Dec.	0.35	0	0
Total hours of labor required	3.85	2.72	2.80

Source: Allen (1982).

TABLE A.5: BEEF COW UNIT, CREEP FED CALVES SOLD IN OCTOBER, REPLACEMENTS FIRST CALVE AS 2 YEAR OLDS, 92% CALF CROP, 16% REPLACEMENTS RAISED, ONE BULL PER 25 COWS.

Receipts	Unit	Quantity	Weight	Price	Value
Steer calf	Cwt.	0.46	4.25	60.18	117.65
Heifer calf	Cwt.	0.28	3.75	58.57	61.49
Heifer	Cwt.	0.02	6.00	51.59	6.15
Cull cows	Cwt.	0.15	10.00	34.65	51.97
Total receipts					237.26

Variable costs	Unit	Rate per unit	Price	Value[a]
Corn	Bu.	2.0	0	Tr.
Oats	Bu.	4.0	0	Tr.
Alfalfa hay	T.	0.4	0	Tr.
Prairie hay	T.	1.4	0	Tr.
Native pasture	AUM	8.0	9.50	76.00
Cattle supplement	Cwt.	1.6	10.95	17.52
Salt & minerals	Lbs.	56.6	0.33	18.70
Veterinary & medical supplies	Hd.	n/a	7.00	7.00
Hauling & marketing	Hd.	n/a	6.00	6.00
Machine & equipment repair	n/a	n/a	n/a	0.96
Total variable costs				126.18
Gross margin				111.08

Source: Allen and Aanderud (1982).

[a]Corn, oats, alfalfa hay, and prairie hay are transferred in.

TABLE A.6: FULL FED STEER CALF, LIBERAL ROUGHAGE, GAIN 650 LBS. IN 11 MONTHS ON FEED, DEATH LOSS 2%.

Receipts	Unit	Quantity	Weight	Price	Value
Fat steer choice	Cwt.	0.98	10.75	52.64	554.56

Operating expenses	Unit	Rate per unit	Price	Value[a]
Steer calf	Cwt.	4.25	0	Tr.
Corn	Bu.	48.00	0	Tr.
Oats	Bu.	10.00	0	Tr.
Alfalfa hay	T.	0.9	0	Tr.
Prairie hay	T.	0.4	0	Tr.
Cattle supplement	Cwt.	2.25	10.95	24.64
Salt & minerals	Lbs.	30.00	.33	9.90
Veterinary & medical supplies	Hd.	1.00	5.00	5.00
Hauling & marketing	Hd.	2.25	6.00	13.50
Fuel, oil & lubrication	n/a	n/a	n/a	1.26
Machinery & equipment repair	n/a	n/a	n/a	1.94
Total variable costs				56.24
Gross margin				498.32

Source: Allen and Aanderud (1982).

[a]4.25 cwt. steer, corn, oats, alfalfa hay, and prairie hay are transferred in.

TABLE A.7: FULL FED HEIFER CALF, LIBERAL ROUGHAGE, GAIN 550 LB. IN 9.5 MONTHS ON FEED, DEATH LOSS 2%.

Receipts	Unit	Quantity	Weight	Price	Value
Fat heifer choice	Cwt.	0.98	9.25	52.10	472.28

Variable cost	Unit	Rate per unit	Price	Value[a]
Heifer	Cwt.	3.75	0	Tr.
Corn	Bu.	40.00	0	Tr.
Oats	Bu.	8.00	0	Tr.
Alfalfa hay	T.	0.80	0	Tr.
Prairie hay	T.	0.20	0	Tr.
Cattle supplement	Cwt.	2.00	10.95	21.90
Salt & minerals	Lbs.	25.00	0.33	8.25
Veterinary & medical	Hd.	1.00	5.00	5.00
Hauling & marketing	Hd.	2.00	6.00	12.00
Fuel, oil & lubrication	n/a	n/a	n/a	1.26
Machinery & equipment repair	n/a	n/a	n/a	1.94
Total variable costs				50.35
Gross margin				421.93

Source: Allen and Aanderud (1982).

[a]3.75 cwt. heifer, corn, oats, alfalfa hay, and prairie hay are transferred in.

TABLE A.8: SOW AND TWO LITTERS, RAISING AND FINISHING BUTCHER HOGS, 15 PIGS SOLD PER SOW. JANUARY AND JULY FARROWING. ONE SAVED FOR REPLACEMENT FROM JANUARY LITTER. MARKET 2.25 CWT. BUTCHER HOG.

Receipts	Unit	Quantity	Weight	Price	Value
Slaughter hogs	Cwt.	8.	2.25	43.	774.00
Slaughter hogs	Cwt.	7.	2.25	43.	677.25
Aged sow	Cwt.	1.	4.41	36.	158.76
					1610.01

Variable costs	Unit	Rate per unit	Price	Value[a]
Corn	Bu.	184.0	0	Tr.
Oats	Bu.	30.0	0	Tr.
Pig creep ration	Cwt.	5.8	15.70	91.06
Alfalfa hay	T.	0.4	0	Tr.
Legume pasture	AUM	2.0	15.00	30.00
Hog supplement	Cwt.	16.5	17.00	280.50
Salt & minerals	Lbs.	170.0	0.33	56.10
Veterinary & medical	n/a	2.0	40.00	80.00
Hauling & marketing	n/a	7.0	6.00	42.00
Machinery & equipment repair	n/a	n/a	n/a	15.15
Total variable costs				594.81
Gross margins				1015.20

Source: Allen and Aanderud (1982).

[a]Corn, oats, and alfalfa hay are transferred in.

TABLE A.9: TEN PURCHASED FEEDER PIGS, FINISHED FOR FEBRUARY AND MARCH MARKETING, FALL PIGS IN DRYLOT, 0.4 TO 2.25 CWT.

Receipts	Unit	Quantity	Weight	Price	Value
Slaughter hogs	Cwt.	9.85	2.25	43.	952.98

Variable costs	Unit	Rate per unit	Price	Value[a]
Feeder pig 40 lb.	Hd.	10.00	28.00	280.00
Corn	Bu.	105.00	0	Tr.
Alfalfa hay	T.	0.20	0	Tr.
Hog supplement	Cwt.	9.50	17.00	161.50
Salt & minerals	Lbs.	80.00	0.33	26.40
Veterinary & medical	Hd.	10.00	3.00	30.00
Hauling & marketing	Hd.	5.25	6.00	31.50
Machinery & equipment repair	n/a	n/a	n/a	9.50
Total variable costs				538.90
Gross margins				414.08

Source: Allen and Aanderud (1982).

[a]Corn and alfalfa hay are transferred in.

TABLE A.10: DAIRY COW, 12,500 LBS MANUFACTURING MILK SOLD PER COW, REPLACEMENTS PURCHASED.

Receipts	Unit	Quantity	Weight	Price	Value
Manufacturing milk	Cwt.	125.00		12.00	1,500.00
Dairy calves	Hd.	0.92	1.	100.00	92.00
Cull cows	Cwt.	0.25	11.	34.65	95.28
					1,687.28

Variable costs	Units	Rate per unit	Price	Value[a]
Dairy replacement heifer	Hd.	0.21	1,200.00	252.00
Corn	Bu.	45.00	0	Tr.
Oats	Bu.	50.00	0	Tr.
Corn silage	T.	2.8	0	Tr.
Alfalfa hay	T.	2.00	0	Tr.
Prairie hay	T.	0.25	0	Tr.
Pasture	AUM.	4.00	10.00	40.00
Cattle supplement	Cwt.	4.00	10.95	43.80
Salt & minerals	Lbs.	60.00	0.33	19.80
Veterinary & medical	Hd.	1.75	5.86	10.25
Hauling milk	Cwt.	100.00	0.30	30.00
Dairy testing	Hd.	1.00	15.00	15.00
Hauling & marketing	Hd.	1.07	6.00	6.42
Fuel, oil & lubrication	n/a	n/a	n/a	0.32
Machinery & equipment repair	n/a	n/a	n/a	2.85
Total variable costs				420.44
Gross margin				1,266.84

Source: Allen and Aanderud (1982).

[a]Corn, oats, corn silage, alfalfa hay and prairie hay are transferred in.

TABLE A.11: BI-MONTHLY LABOR REQUIREMENTS OF THE LIVESTOCK ENTERPRISES.

Month	Beef cow unit	Fed steer	Fed heifer
Jan. - Feb.	1.27	0.4	0.4
Mar. - Apr.	2.37	0.4	0.4
May. - Jun.	0.95	0.4	0.4
Jul. - Aug.	0.23	0.4	0.2
Sep. - Oct.	0.52	0.2	0.1
Nov. - Dec.	1.27	0.4	0.4
Total hours of labor required	6.61	2.2	1.9

Month	Hog farrowing and finish	Feeder pigs	Dairy cows
Jan. - Feb.	7	2	10
Mar. - Apr.	4	0	10
May. - Jun.	4	0	10
Jul. - Aug.	5	0	10
Sep. - Oct.	4	2	10
Nov. - Dec.	4	2	10
Total hours of labor required	28	6	60

Source: Allen and Aanderud (1982).

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