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Factors Influencing Economic Success of North Dakota Farms

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Preface

This publication is part of a research study supported by a grant to the Agricultural Experiment Station at North Dakota State University by the Rural Rehabilitation Corporation of North Dakota. The purpose of this research study was to identify and measure the important factors influencing the economic success of moderate-sized farms in North Dakota. Description of the procedure and major findings of the analysis are contained in this report. A companion report, Agricultural Economics Report No. 224 (Wood et al. 1987), presents an analysis of farming practices related to some of the farm records factors identified in this study for east central North Dakota crop farms.

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Highlights

Factors important to the economic success of moderate-sized North Dakota farms are examined in this study. The measure of economic success is labor earnings (returns to labor and management). Results are based on farm data for 1982, 1983, and 1984. Multiple stepwise regression analysis is used to find the combination of factors derived from farm records that best explain the variation in labor earnings. Regression models predicting labor earnings are developed for crop farms by area (east central and western) and for beef and dairy farms statewide.

Results show that machinery cost control, efficiency in labor use, and crop yields are important for crop farms in both areas. Effectively using government programs in the east central area and implementing intensive cropping (less use of summer fallow) and effective marketing in the western area are identified as additional factors. However, total farm assets controlled are associated with reduced labor earnings in both areas.

Beef cow-calf ranches average negative labor earnings, and losses increased with the size of the beef cow herd. Positive influences on earnings are due to controlled overhead expenses, efficient feed conversion, intensive pasture use, and better crop yields.

The most important factor determining the economic success of dairy farmers is the value of milk production in relation to the value of feed. This is complemented by machinery cost control, effective labor use, and high crop yields.

FACTORS INFLUENCING ECONOMIC SUCCESS OF NORTH DAKOTA FARMS

Mir B. Ali and Roger Johnson*

Declining land values, low product prices, high real interest rates, and decreased export demand are causing farmers financial problems. Farmers with high debts relative to assets need a profitable farming operation just to survive. This study identifies some of the important factors associated with the economic success of moderate-sized farms in North Dakota.

Objective of the Study

The specific objective of the study is to identify and measure size, cost control, marketing, production, and labor efficiency factors associated with the economic success of crop, beef, and dairy farms.

Need for the Study

The success of the small and moderate-sized farms is important to the people of North Dakota. According to the 1982 Census of Agriculture, 83 percent of the farms in North Dakota grossed less than $100,000 annually (USDC, Bureau of the Census 1984). The economic well-being of these farms is not only important to the more than 36,000 farm families but also to the viability of rural communities. Rural and small town schools, churches, and social organizations are dependent upon keeping sufficient families in the community. The small and moderate-sized farms are also important to the success of rural businesses such as grocery stores, country elevators, and implement dealers.

Small farms are usually more dependent on nonfarm income than farm income. Off-farm income may be from employment, social security, or other transfer payments. Small farms tend to be a heterogeneous group where problems of poverty and underemployment are the appropriate focus rather than the small farm itself (Research 1971).

The focus of this project is on moderate-sized farms where the farm offers full-time or near full-time employment for at least one family member. The moderate-sized farm is basically efficient but is increasingly finding itself in economic trouble. Between 1974 and 1982 the number of farms in North Dakota above 2,000 acres increased. The number of farms below 180 acres, which are mainly part-time operators, also increased. However, the number of moderate-sized farms, 180 to 2,000 acres, decreased 17.5 percent from 37,545 to 30,992 (USDC, Bureau of the Census 1977 and 1984). Compared with large farms, moderate-sized farms are particularly disadvantaged in the areas of marketing, financing, and management. Research is needed to identify

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and quantify the factors important to the financial success of moderate-sized farms in North Dakota. This information can then serve to help guide both public and private educational and service efforts to help these farmers achieve financial success.

Background

Studies of factors associated with economic success date back to the work of George Pond (1945) and Stan Warren (1945). Farm recordkeeping systems and analytical procedures have been developed at most land grant institutions. In the last two decades private and cooperative organizations have also been offering farm recordkeeping and analysis programs (Schmidt 1962). Nearly all farm record analysis systems compare high-profit and low-profit farms on the basis of management factors, such as crop yields and size of business.

The North Dakota Extension Service developed and operated a farm recordkeeping system from 1960 through 1981. Both return to labor and management and percent return on investment were used to measure overall economic performance. Olson and Sexhus (1968) used the extension farm records data to identify eight crucial factors, other than farm size, that have an effect on profitability. They were (1) crop return per tillable acre, (2) crop expenses per tillable acre, (3) fertilizer expenses per acre of grain and cultivated crops, (4) seed expense per acre of grain and cultivated crops, (5) livestock return per $100 feed fed, (6) machinery investment per tillable acre, (7) machinery cost per tillable acre, and (8) crop returns per dollar crop expense.

The University of Minnesota's system of farm record analysis has been used by Adult Vocational Agriculture instructors in North Dakota since 1971. This program combines instruction in farm management and production agriculture with a farm record analysis system. The farm records analysis presents nine measures of farm organization and efficiency (Gullickson and Holkup 1982-1984). Labor earnings is the basic measure of successful farm organization and operation. The eight factors tending to contribute to high labor earnings are (1) crop yield index, (2) gross returns per acre, (3) returns per $100 feed fed to productive livestock, (4) livestock units per 100 acres, (5) size of business-work units, (6) work units per worker, (7) power, machinery equipment, and building expenses per work unit, and (8) farm capital investment per worker.

Research is needed to determine the importance of each of the currently used factors under present North Dakota farming conditions. Also, a need exists to develop new or alternative factors that would better explain financial success of the farm business. Although important, financial management strategies such as debt structure, land acquisition methods, and interest rates paid are not covered in this study. The data available and approach used did not lend itself to the analysis of these financial factors.

Farm record analysis is useful for problem identification. Once management problems have been identified, developing a means of correcting them is the next step. Specific production, marketing, and financial

management actions or practices are needed to improve a particular farm record analysis factor. Although production and marketing recommendations have been developed through research, little empirical investigation has been made of the relation of the adoption of these practices to farmers' economic performance. A companion report, Agricultural Economics Report No. 224, presents an analysis of production, marketing, and financial management practices for a group of farmers in east central North Dakota (Wood et al. 1987).

Procedure

The farm record summaries compiled under the North Dakota Vocational Agriculture Farm Business Management Education Program were the data base. There were approximately 300 farmers completing record summaries in the program each year. Most of these farmers operated moderate-sized farms. Financial success was determined from farm record summaries for the years 1982 through 1984. Three years' records were used to reduce the variability in results due to factors affecting a single year such as weather or disease problems. Also, the effects of overstating or understating inventories are reduced in a three-year average since the inventory effect on income in one year is often cancelled the following year.

The measure of economic success used in this study was labor earnings, i.e., returns to labor and management (whole farm) per full-time operator. It is the residual after all costs except for one operator's labor and management are subtracted from gross income. This measure puts all farms on a comparable basis in that all resources used in the operation are charged the same cost whether owned, rented, or borrowed. All land was charged a cash rental rate, and all other capital used in the operation was charged 12.5 percent interest.

The factors hypothesized to contribute to labor earnings were classified into the following five groups: (1) size, (2) cost control, (3) production efficiency, (4) labor efficiency, and (5) marketing. Measures of size included total farm assets, total work units,[1] total acres, tillable acres, and number of animals. Important cost control measures were crop expenses (includes cost of seeds, chemicals, and fertilizers) per tillable acre, machinery expenses (includes cost of operating machinery plus depreciation) per tillable acre or work unit, overhead expenses (includes telephone, electricity, and general farm expenses) per tillable acre or work unit. Measures of production efficiency included crop yield index, crop intensity index,[2] percent of land tilled, sales of livestock products per

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[1]Work units represent the total work load with average efficiency accomplished in one 10-hour day.

[2]Crop intensity index reflects the intensity of cropping on a farm as compared to cropping intensity in the area (average intensity = 100). Small grains and row crops are rated as intensive land use, while summer fallow and tillable hay and pasture are rated as less intensive land use.

animal, number of animal units per 100 acres, index of returns per $100 of feed, and pasture use.[3] Labor efficiency was examined through total assets per worker, work units per worker, or tillable acres per worker. Marketing efficiency was measured by a marketing index, which compares average prices received by a farmer with the average of all farmers. Government payments received per tillable acre could also be considered partly a marketing measure.

Multiple regression analysis was used to identify and measure the influence of the above mentioned factors on labor earnings. Stepwise methods were used to select factors that best explain the variation in labor earnings. The best model was selected using the following criteria: (1) a logical relationship between labor earnings and each factor, (2) a 95 percent or higher probability of significance for each factor identified, (3) a correlation between any two factors retained in the model less than 80 percent, and (4) a maximum improvement in proportion of variation explained (adjusted R-square).

The best model was tested for multicollinearity, heteroscedasticity, and the presence of influential observations (outliers). The best model did not indicate multicollinearity or heteroscedasticity, but a total of seven observations that were found statistically influential were deleted.

Farm Data

Farm record summaries for the years 1982, 1983, and 1984 were obtained from the North Dakota Vocational Agriculture Program (Gullickson and Holkup). Farm records were screened to remove variation due to error in accounting, dramatic change in farm size, and any data inconsistencies. The criteria used to select farm records were as follows:

1. Records for the farm must be complete for each of the three years.
2. Total acres in the farm must be greater than 300 acres, and year-to-year acreage change must be less than 35 percent (positive or negative).
3. Custom work or miscellaneous income must be less than 25 percent of total farm income.
4. The difference between cash-in and cash-out must be less than 10 percent of cash-in.
5. Net worth reliability must have a less than $7,000 error.
6. Inconsistency in land inventory must be less than $4,000.

Farms were classified as east central crop, western crop, beef, and dairy farms. Crop farms were divided into east central and western areas because of differences in cropping patterns and land use intensity (Figure 1).

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[3]Pasture use is a measure of pasture intensity expressed in terms of animal units grazed per 100 acres of nontillable hay and pasture. Animal units were calculated by multiplying number of beef cows by one and grass-fed feeder cattle by 0.65 to get total animal units utilizing pasture.

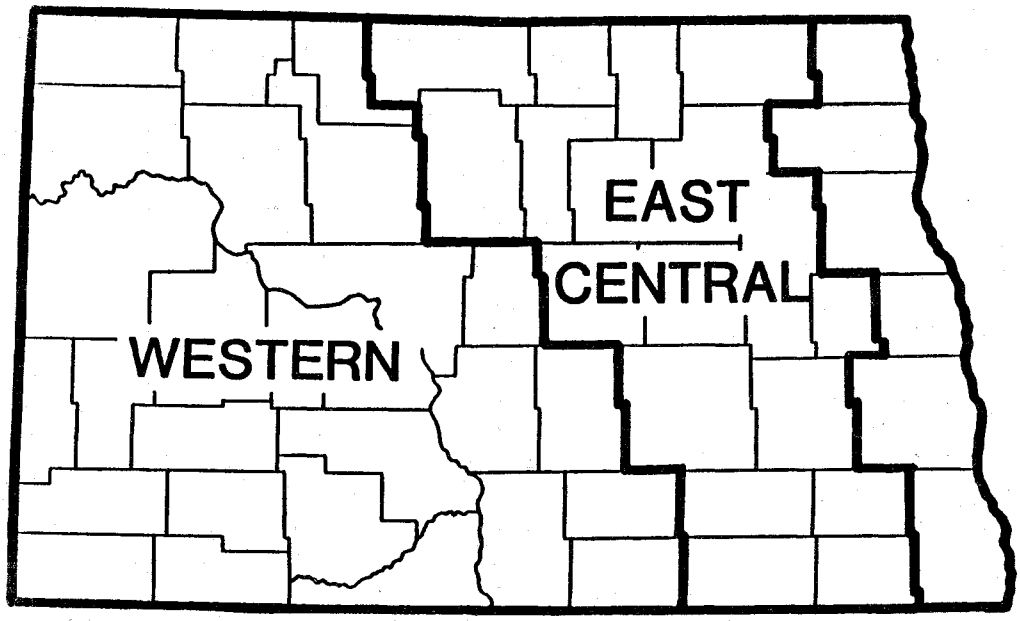

Figure 1. East Central and Western Areas of North Dakota

Beef and dairy farms were studied on a statewide basis. Crop farms in the east central area were those with crop sales greater than 80 percent of cash receipts; 35 crop farms met the selection criteria in the east central area. Crop farms in the western area were those with crop sales greater than 70 percent of cash receipts; 29 farms were used in the western area. For a farm to be classified as a beef farm, at least 50 percent of its cash income must have been from the beef enterprise; 27 beef farms were used. The dairy farm classification included operations in which at least 60 percent of the cash income was from the dairy operation; 26 dairy farms were used.

Selected characteristics of crop farms by area are given in Table 1. The average characteristics are shown for the low and high 25 percent of farms classified by level of labor earnings. These characteristics were averaged over the three-year period (1982 to 1984).

Average crop farms in the east central area operated nearly 8 quarters of land of which 80 percent is tillable. Major crops produced were wheat, barley, and sunflower. Crop farms in the western area were larger in acreage and more specialized in wheat with one-third or more of the tillable land summer fallowed. Although returns to labor and management (labor earnings) were negative for the average crop farms in the east central area, operators' net income was positive ($15,000). Average labor earnings and net income were higher for the western crop farms.

TABLE 1. AVERAGE FARM CHARACTERISTICS OF CROP FARMS CLASSIFIED BY LEVEL OF LABOR EARNINGS, 1982 TO 1984

Item	Level of Labor Earnings		
	Low 25%	All Farms	High 25%
East central area (n=33)			
Labor earnings[a]	$-21,568	$- 2,208	$ 14,518
Cash receipts	$157,410	$102,172	$ 87,078
Cash operating expenses	$ 78,734	$ 48,514	$ 40,312
Operator's net income[b]	$ 18,761	$ 14,908	$ 20,395
Total acres	2,170	1,264	902
Tillable acres	1,605	1,010	786
Western area (n=29)			
Labor earnings[a]	$-14,794	$ 3,720	$ 27,475
Cash receipts	$102,300	$110,531	$134,917
Cash operating expenses	$ 50,963	$ 51,352	$ 54,080
Operator's net income[b]	$ 18,868	$ 22,192	$ 35,490
Total acres	1,732	1,654	1,599
Tillable acres	1,198	1,256	1,410

[a]Return to labor and management (whole farm) per full-time operator.
[b]Return to operator farm equity and unpaid family labor.

Average characteristics of beef and dairy farms are given in Table 2. Beef farms operated 15 quarters of land of which one-third was tillable. Dairy farms were the smallest in both total and crop acreage. On the average, the beef farm had 165 beef cows, and the dairy farm had 65 dairy cows. Average labor earnings for both livestock farms were negative, but losses were substantially larger for beef farmers. High-income beef farms had a smaller herd and lower operating expenses than low-income beef farms. High- and low-income dairy farms were similar in their herd size and cash operating expenses. However, the high-income group had a larger sales volume (cash receipts) than the low-income dairy farms.

Results

The model that best explained labor earning differences for crop farms in east central and western areas and beef and dairy farms statewide are discussed in this section. Also, the average, minimum, and maximum values of the variables that are retained in the best model are tabulated. These values not only indicate the magnitude of variation but also are useful in the interpretation of regression results. The expansion of regression results beyond the range of data would be questionable.

TABLE 2. AVERAGE FARM CHARACTERISTICS OF BEEF AND DAIRY FARMS CLASSIFIED BY LEVEL OF LABOR EARNINGS, 1982 TO 1984

Item	Level of Labor Earnings		
	Low 25%	All Farms	High 25%
Beef farms (n=27)			
Labor earnings[a]	$-51,652	$-26,186	$ 12,260
Cash receipts	$125,728	$ 96,254	$128,768
Cash operating expenses	$ 88,828	$ 61,416	$ 64,788
Operator's net income[b]	$ -9,086	$ 7,614	$ 31,790
Total acres	3,292	2,437	1,293
Tillable acres	1,067	803	772
Animal units	329	223	117
Dairy farms (n=26)			
Labor earnings[a]	$-31,668	$ -6,937	$ 12,260
Cash receipts	$ 93,698	$104,930	$128,768
Cash operating expenses	$ 68,413	$ 60,018	$ 64,788
Operator's net income[b]	$ -6,967	$ 12,510	$ 31,790
Total acres	1,197	1,169	1,293
Tillable acres	571	647	772
Animal units[c]	115	101	117

[a]Return to labor and management (whole farm) per full-time operator.
[b]Return to operator farm equity and unpaid family labor.
[c]Livestock population computed by assigning unit values to different livestock classes.

East Central Crop Farms

The model selected for crop farms in the east central area had five variables. This model explains 76 percent of the variation in labor earnings. Table 3 shows the range of values for selected variables in the model.

The sequence of variables entered in the model by the stepwise method is the order presented in Table 4. The first variable entered was total assets and the last variable was tillable acres per worker.

The adjusted R-square indicates the cumulative percent of the variation in labor earnings explained as each variable is added. For example, total assets explain 33 percent, and machinery costs per tillable acre explain an additional 25 percent of the variation in labor earnings. Together they explain 58 percent of the variation in a two-variable model. R-squares are corrected for degrees of freedom to eliminate the effects of the number of variables (adjusted R-squares).

TABLE 3. AVERAGE, MINIMUM, AND MAXIMUM VALUES FOR SELECTED FACTORS, CROP FARMS IN EAST CENTRAL NORTH DAKOTA, 1982 TO 1984

Factor	Minimum	Average	Maximum
Labor earnings	$-36,869	$ -2,208	$ 24,525
Total assets	$200,890	$597,095	$2,090,197
Machinery costs per tillable acre	$ 19.87	$ 34.10	$ 52.50
Gov't payments per tillable acre	$ 0.20	$ 10.26	$ 22.90
Tillable acres per worker	298	749	1,622
Crop yield index	54.9	96.1	118.0

TABLE 4. FACTORS DETERMINING LABOR EARNINGS FOR CROP FARMS IN EAST CENTRAL NORTH DAKOTA, 1982 TO 1984

Regression Variable	Predicted Influence	Adjusted R-square	Partial R-square
Total assets	(-)	.33	.53
Machinery costs per tillable acre	(-)	.58	.49
Crop yield index	(+)	.66	.34
Gov't payments per tillable acre	(+)	.74	.29
Tillable acres per worker	(+)	.76	.19

The partial R-square for each variable is also shown in Table 4. This statistic helps in identifying the relative importance (ranking) of variables retained in the model. It gives the contribution of one variable while holding the other variables in the model constant. The most influential variable was total assets followed by machinery costs per tillable acre; of somewhat lesser influence were crop yield index, government payments per tillable acre, and tillable acres per worker.

The regression coefficients for the variables in the best model are given in the following equation (t-values are in parentheses):

$$Y_1 = \underset{}{-\ 8{,}185} \underset{(-.69)}{-\ 0.030X_1} \underset{(-5.52)}{+\ 15.70X_2} \underset{(1.87)}{-\ 897.20X_3} \underset{(-5.09)}{+\ 794.95X_4} \underset{(3.30)}{+\ 359.66X_5} \underset{(3.36)}{}$$

where

Y_1 = Labor earnings per full-time operator
X_1 = Total assets
X_2 = Tillable acres per worker
X_3 = Machinery costs (includes costs of operating machinery, depreciation, and interest on machinery investment) per tillable acre
X_4 = Government payments per tillable acre
X_5 = Crop yield index (measures the yield level for all crops produced expressed as a percentage of the average)

Total assets have a negative influence on labor earnings. The regression coefficient indicates that for every increase of $100 in total assets, labor earnings will be decreased by $3.00 or 3 percent. Cash rent was 6.5 percent of land value, and nonland assets were charged 12.5 percent, giving a 7.7 percent weighted average charge on all assets. The net marginal rate of return to assets, therefore, was 4.7 percent (7.7 minus 3.0).

Although below opportunity cost, rate of return to assets were constant with farm size measured in assets controlled. However, a larger farm can contribute indirectly to higher labor earnings. Larger farms have more potential to lower machinery costs per acre and can more easily achieve high tillable acres per worker.

The number of tillable acres per worker, a measure of labor efficiency, has a positive influence on labor earnings. It says, in other words, that labor earnings will increase by $15.70 for each additional tillable acre farmed without additional labor.

Machinery costs per tillable acre have a negative influence on labor earnings. An increase in machinery costs per tillable acre results in lower labor earnings. However, the decrease in labor earnings is less than the total increase in machinery costs. For example, a one dollar per acre decrease in machinery costs on a 1,000-acre farm would increase labor earnings by $897. In other words, each dollar a farmer can reduce machinery costs will be rewarded by an increase in labor earnings of about $.90. Implicit in these figures are constant yields and labor efficiency. An increase in machinery costs could contribute to earnings if more timely work sufficiently increased crop yields and/or larger machinery increased the tillable acres each worker handled.

The government payments per tillable acre measure the degree of use of government programs as well as program crop base acres and proven yields. If government payments are increased by one dollar per acre, total government payments will be increased to $1,000 (assumes 1,000 average tillable acres). However, net labor earnings are actually increased by $795. The difference

($205) reflects the cost involved in program participation, such as required acreage diversion in the wheat and feed grain programs and grain storage costs of the farmer-owned reserve program.

The crop yield index, a measure of cropping efficiency, has a positive influence on labor earnings. For example, average wheat yield in the area is 35 bushels per acre. A one percent increase in yield represents 0.35 bushels per acre. Assuming wheat sells at $3 a bushel, the gross income from a one percent yield increase on 1,000 tillable acres would be $1,050 (.35 X $3.00 X 1,000). However, labor earnings are actually increased by $360. The difference ($640) represents the cost associated with improving yields.

Western Crop Farms

The model developed for crop farms in the western area was a six-variable model. This model explains 73 percent of the variation in labor earnings. Table 5 shows the magnitude of the variation in the values of these variables. The sequence of variables entered in the model along with their contributions in explaining labor earnings differences are given in Table 6. The first variable entered was machinery expenses per tillable acre followed by the crop yield index, the crop intensity index, the marketing index, tillable acres per worker, and total assets. Based on partial R-squares, the most influential variable was crop yield index, and other variables were of nearly equal importance in predicting labor earnings. The predicted influence was positive for all the variables with the exception of machinery expenses per tillable acre and total assets.

The regression coefficients of the variables in the model are given in the following equation (t-values are in parentheses):

$$\begin{array}{l} Y = \underset{(-4.77)}{-\ 393{,}422} + \underset{(4.51)}{489.32X_1} - \underset{(-3.20)}{797.35X_2} + \underset{(-3.46)}{2{,}387X_3} \\ \qquad + \underset{(3.21)}{1{,}165X_4} + \underset{(3.01)}{24.64X_5} - \underset{(-2.84)}{0.0234X_6} \end{array}$$

where

Y_1 = Labor earnings per full-time operator
X_1 = Crop yield index
X_2 = Machinery expenses (includes operating costs and depreciation) per tillable acre
X_3 = Crop intensity index (measures crop selection and summer fallow use on a farm as compared to the area average)
X_4 = Marketing index (measures prices received for crops by a farmer as compared to the area average)
X_5 = Tillable acres per worker
X_6 = Total assets

The crop yield index has a positive influence on labor earnings. A one percent increase in yield will increase labor earnings by $489. The average wheat yield in the area is about 25 bushels per acre. A one percent

TABLE 5. AVERAGE, MINIMUM, AND MAXIMUM VALUES FOR SELECTED FACTORS, CROP FARMS IN WESTERN NORTH DAKOTA, 1982 TO 1984

Factor	Minimum	Average	Maximum
Labor earnings	$-23,596	$ 3,720	$ 40,355
Total assets	$228,921	$594,768	$1,652,940
Machinery expenses per tillable acre	$ 12.00	$ 25.20	$ 58.25
Crop yield index	67.7	106.6	149.5
Crop intensity index	94.3	100.0	105.7
Marketing index	91.5	100.0	113.4
Tillable acres per worker	343	921	1,576

TABLE 6. FACTORS DETERMINING LABOR EARNINGS FOR CROP FARMS IN WESTERN NORTH DAKOTA, 1982 TO 1984

Regression Variable	Predicted Influence	Adjusted R-square	Partial R-square
Machinery expenses per tillable acre	(-)	.17	.35
Crop yield index	(+)	.46	.48
Crop intensity index	(+)	.55	.32
Marketing index	(+)	.63	.32
Tillable acres per worker	(+)	.64	.29
Total assets	(-)	.73	.27

increase in yield means an increase of .25 bushels per acre. Assuming 1,250-tillable acre farm, gross income will increase by $937 (if wheat sells at $3 a bushel). The difference, $448 ($937 - $489), represents the costs associated with yield-improving practices.

The regression coefficient for machinery expenses per tillable acre has a negative influence on labor earnings. However, the actual decrease in labor earnings is lower than the total increase in machinery expenses. For example, if machinery expenses increase by one dollar per tillable acre, total expenses would increase to $1,250 (assumes 1,250 tillable acres), and labor earnings would decrease by $797, which is $453 less than the total increase in machinery expenses. Crop yield, crop intensity, and tillable acres per worker could be influenced by machinery expenses. A possible change in any of these variables must be considered when taking action to reduce machinery expenses per acre.

The regression coefficient for the crop intensity index shows a positive influence on labor earnings. The crop intensity index measures the intensity of cropping on a farm as compared to the average cropping intensity in the area (average intensity = 100). Small grains and row crops are rated as intensive land use while summer fallow and tillable hay and pasture are rated as less intensive land use. An index above 100 reflects more intensive cropping or less use of fallow on the farm as compared to average cropping practices in the area. The historic use of summer fallow may have been justified as a way to maintain income in dry years. Currently, cropping pattern changes are limited by government program provisions.

The marketing index, a measure of marketing performance, has a positive influence on labor earnings. An index of 100 is given for the average prices received in the area (weighted by the quantity sold). A one percent increase in the marketing index will result in an increase of $1,165 in labor earnings. The marketing index could be increased by using improved marketing strategies such as better market timing including forward contracting and selling higher quality grain.

The regression coefficient for tillable acres per worker indicates that labor earnings will increase by $24.64 if an additional acre was tilled without additional labor.

Total assets influence the labor earnings negatively. The results show that for every $100 increase in assets, labor earnings will decrease by $2.34. Weighted interest charged on total assets was 8.2 percent. The marginal net rate of return to assets, therefore, was 5.9 percent (8.2 - 2.34), which is higher than that of east central crop farms.

Beef Farms

The best model for a beef farm (basically a cow-calf operation) had 5 variables. The model explains 83 percent of the variation in labor earnings. The variables in the model were (1) number of animal units, (2) index of return per $100 of feed, (3) pasture use, (4) crop yield index, and (5) overhead expenses per work unit. Table 7 shows magnitude of variation for the variables retained in the model. The sequence of variables entered into the model by stepwise method, their predicted influences, and adjusted R-squares are shown in Table 8. The first variable entered was number of animal units and the last variable was overhead expenses per work unit. The number of animal units is the most influential variable, with lesser important variables ranked as follows: index of return per $100 of feed, crop yield index, pasture use, and overhead expenses per work unit (refer to partial R-squares in Table 8).

TABLE 7. AVERAGE, MINIMUM, AND MAXIMUM VALUES FOR SELECTED FACTORS, BEEF FARMS IN NORTH DAKOTA, 1982 TO 1984

Factor	Minimum	Average	Maximum
Labor earnings	$-124,043	$-26,186	$ 2,941
Index of return per $100 of feed	70.00	105.40	156.00
Overhead expenses per work unit	$ 0.80	$ 2.10	$ 7.45
Number of animal units	52.9	223.2	925.7
Pasture use intensity[a]	3.8	13.2	33.9
Crop yield index	46.6	102.7	150.4

[a]Animal units grazed per 100 acres of nontillable hay and pasture. An animal unit was one beef cow and .65 grass-fed feeder calf.

TABLE 8. IMPORTANT FACTORS DETERMINING LABOR EARNINGS OF BEEF FARMS IN NORTH DAKOTA, 1982 TO 1984

Regression Variable	Predicted Influence	Adjusted R-square	Partial R-square
Number of animal units	(-)	.61	.84
Index of return per $100 of feed	(+)	.67	.47
Pasture use	(+)	.74	.29
Crop yield index	(+)	.79	.36
Overhead expenses per work unit	(-)	.83	.25

The regression coefficients for variables retained in the best model are as follows (t-values are in parentheses):

$$Y_1 = \underset{}{-69{,}343} \underset{(-4.90)}{- 1{,}064X_1} \underset{(-2.62)}{+ 260.45X_2} \underset{(3.41)}{+ 403.97X_3} \underset{(4.46)}{- 125.00X_4} \underset{(-10.71)}{+ 806.17X_5} \underset{(2.93)}{}$$

where

Y_1 = Labor earnings per full-time operator
X_1 = Overhead expenses (includes telephone, electricity, and general farm expenses) per work unit
X_2 = Crop yield index
X_3 = Index of return per $100 of feed (measures the general level of feed efficiency of all livestock expressed as a percentage of the average)
X_4 = Number of animal units (measures livestock population by assigning unit values to various livestock classes)
X_5 = Pasture use (measures animal units grazed per 100 acres of nontillable hay and pasture)

Overhead expenses per work unit have a negative influence on labor earnings. This is a measure of expense control which includes telephone, electricity, and general farm expenses divided by total work units. Work units are a better size measure than total acres for livestock farms. A work unit represents the total work load with average efficiency accomplished by a worker in one 10-hour day. Work unit values are assigned to each class of livestock, each crop, and other tasks utilizing farm labor. If overhead expenses are increased by one dollar per work unit, a total increase in overhead expenses will be $585 (the average work units on the beef farm equal 585). This will decrease the labor earnings by $1,064. In other words, the decrease in labor earnings will be almost twice the total increase in overhead expenses. A possible explanation is that high overhead expenses may be indicative of a lack of cost control in other farm business expenses.

As expected, measures of production and feed efficiency have beneficial influence on labor earnings. The efficiency measures identified were crop yield index and index of return per $100 of feed. A one percent increase in these variables increases the labor earnings by $260 and $404, respectively.

The number of animal units measures the livestock population by assigning unit values to various livestock classes. For example, the value of 0.8 is assigned to adult and 0.3 to other beef breeding animals. Beef feeders were assigned the value of 1.0. The regression coefficient for animal units indicates that an additional animal unit is associated with an additional loss of $125 in labor earnings. In other words, since the beef enterprise was unprofitable, a large herd lost more than a small herd. However, these figures do not imply diseconomies of size in beef production but rather a constant size return relationship.

Pasture use is a measure of pasture intensity expressed in terms of animal units grazed per 100 acres of nontillable hay and pasture. Animal units grazed are calculated by multiplying the number of beef cows by one and the number of grass-fed feeder calves by 0.65. The results show that an increase of pasture intensity by one animal unit per 100 acres will result in an increase of $806 in labor earnings.

The average beef farm had 1,600 acres of nontillable hay and pasture land (excludes farmstead and wasteland) and 211 animal units of beef cows and grass-fed feeder calves for 13.2 animal units per 100 nontillable acres. This was equivalent to 7.6 nontillable hay and pasture acres per animal unit. One way to increase animal units per acre would be to reduce the acres of nontillable hay and pasture land through sale or rental-out while maintaining herd size. A 114-acre reduction to 1,486 acres of nontillable hay and pasture would increase animal units per 100 nontillable acres by one to 14.2. Labor earnings would increase $806 or $7.07 per nontillable acre, a reduction which is slightly less than the rental rate charged for this type of land. The alternative of increasing the herd size by 16 to raise the animal units per 100 acres by one for the average size ranch would actually reduce labor earnings about $1,200, since the $125 loss per additional animal unit would have to be deducted from the $806 gain from increased pasture use intensity [806-(16)(125) = -$1,194].

Dairy Farms

A 4-variable model was developed for dairy farms, which explains 68 percent of the variation in labor earnings. Table 9 shows the range in values for the selected variables. The sequence of variables entered into the model is given in Table 10. The variables ranked in order of their relative importance (partial R-squares) were index of return per $100 of feed, crop yield index, machinery expenses per work unit, and work units per worker.

Regression coefficients for the selected variables in the best model influencing labor earnings of dairy farms are given in the following equation (t-values are in parentheses):

$$Y_1 = \underset{(-5.09)}{-\ 68{,}649} + \underset{(5.64)}{534.46X_1} + \underset{(2.18)}{22.07X_2} \underset{(-3.51)}{-\ 1{,}036.56X_3} + \underset{(3.67)}{346.41X_4}$$

where

Y_1 = Labor earnings
X_1 = Index of return per $100 of feed
X_2 = Work units per worker (measures the total work load accomplished with average efficiency in one 10-hour day divided by number of workers on the farm)
X_3 = Machinery expenses per work unit
X_4 = Crop yield index

The regression coefficients for the index of return per $100 of feed and for the crop yield index have positive influence on labor earnings. An increase in labor earnings due to one percent increase in these variables will be $534 and $346, respectively.

Machinery expenses per work unit, a measure of cost control, has a negative influence on the labor earnings. If machinery expenses increase by one dollar per work unit, the total increase in expenses will be $750 (assumes 750 average total work units). This will decrease the labor earnings by $1,036. Apparently other cost control measures are associated with this variable. In contrast to the crop farms, total machinery expenses were divided by work units instead of tillable acres. This is because (1) work units are a better size measure for farms with both crops and livestock and (2) costs of owning and operating equipment for the dairy herd are also included.

Work units per worker have a positive influence on the labor earnings of dairy farms. One dairy cow equals seven work units. The results show that labor earnings will be increased by $154 (7 x 22) for each additional cow handled without additional labor.

In contrast to the crop and beef farms, labor earnings did not decrease with farm size. However, the average dairy farm had negative returns to labor and management and earned less than opportunity cost for land and other assets controlled. These losses did not increase with total assets controlled which indicates the existence of size economies for the dairy farms. The size economies are in addition to those arising from lower machinery expenses and increased labor efficienty facilitated by larger farm size.

TABLE 9. AVERAGE, MINIMUM, AND MAXIMUM VALUES FOR SELECTED FACTORS, DAIRY FARMS IN NORTH DAKOTA, 1982-1984

Factor	Minimum	Average	Maximum
Labor earnings	$-62,430	$ -6,937	$ 2,941
Index of return per $100 of feed	52.40	104.70	151.10
Machinery expenses per work unit	$ 20.15	$ 36.00	$ 48.50
Work units per worker	196.8	461.8	1,027.6
Crop yield index	56.4	94.8	133.1

TABLE 10. IMPORTANT FACTORS INFLUENCING LABOR EARNINGS OF DAIRY FARMS IN NORTH DAKOTA, 1982 TO 1984

Regression Variable	Predicted Influence	Adjusted R-square	Partial R-square
Index of return per $100 of feed	(+)	.35	.60
Crop yield index	(+)	.50	.39
Machinery expenses per work unit	(-)	.67	.37
Work units per worker	(+)	.68	.18

Summary

Regression analysis was used to identify the factors influencing labor earnings of crop, beef, and dairy farms. Crop farms were studied in the east central and western areas, and beef and dairy farms were studied on a statewide basis.

Results indicate that cost control measures, labor efficiency, and high crop yields were important for the labor earnings of crop farms. This was complemented by effective use of government programs in the east central area and by intensive cropping and obtaining above-average prices in the western area. However, total assets controlled were detrimental to labor earnings.

Herd size was the most important factor associated with negative labor earnings of beef ranches. Positive influences were cost control measures, efficient feed conversion, pasture utilization, and high crop yields. Feeding efficiency was the most important factor predicting labor earnings of dairy operations. This indicates that high milk production relative to the value of

feed used is critical to the economic success of dairy farms. Dairy herd productivity was complemented by machinery cost control, labor efficiency, and better crop yields on tillable land.

These results give farmers, farm advisers, and credit agencies information about the relative importance of variables influencing labor earnings over a three-year period (1982 to 1984). It should be emphasized that the importance of factors identified in this analysis may change over time depending on government farm policies and economic conditions in agriculture. Therefore, care should be taken in using the regression model for projection purposes.

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