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Profit Consistency and Management Characteristics For Successful North Dakota Farms, 1995-2000

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Abstract

Farm profitability varies widely among producers, but the reasons for those differences are not clear as it is generally not known if the same farms are in the higher profit categories every year. Characteristics of the individual producer also vary substantially. Farm size, crop yields, cost of production, debt structure, and land ownership are some of the traits which differ among farms. This study analyzed farm finance data from the North Dakota Farm and Ranch Business Management Program over the years 1996-2000 to determine if the characteristics of profitable farms were different from the characteristics of farms which were not as profitable. A secondary objective was to evaluate if farms remained in similar profit quartiles every year.

Key Words: North Dakota Farm and Ranch Business Management Program, farm characteristics, return on assets, costs, land ownership, debt structure

Highlights

Some farms in North Dakota are profitable even in times of low prices and less than ideal weather conditions while some farms are at the other end of the scale. Farm business records across the United States show similar trends.

Farm managers employ limited resources such as land, labor, and capital to their best use toward the generation of profits. They direct resource use after interpreting the goals of the farm. The success of a manager is measured by profits generated over time. Both the level and consistency of profits are important.

U.S. agriculture is rapidly changing due to the continued application of technology, uncertainty regarding future governmental support, and the freer trade environment. New management problems and opportunities arise from the changes in production agriculture**.**

Panel data consisting of 1,072 records from 222 farms over the six-year period (1995-2000) were used for the study. The farm records were sorted by year and divided into quartiles by return on assets (ROA). Farms in the high quartile had 29% more crop acreage than those in the low quartile. Their gross crop return, government payments, and other returns per acre were larger than the other quartiles. The percentage of livestock returns increased as the farms went from the high category to the low category. The percentage of owned land increased and cash rent decreased from highest to lowest quartile. All the expense ratios increased from high-quartile farms to low-quartile farms. The small grains ratio also increased. Wheat yield decreased about 23% from high- to low-quartile.

Farms tended to remain in the same ROA quartile. If farms were in the high quartile in their first year in the program, the probability that they stayed in the high quartile was 49.9%. Likewise, if farms were in the low quartile their first year, the probability that they stayed in the low quartile was 56.6%. The middle two quartile farms were not as consistent, but they were more likely to remain in the similar quartile.

Operating expense ratio is the most important factor explaining the dependent variable. Depreciation expense per acre is the next most important characteristic, followed by total crop acres and land ownership. Government return per acre, crop return per acre, the farm expansion dummy variable, and the maximum wheat yield variable are next in importance. Variables of minor importance are cash rent, livestock return, and other income per acre, which is mainly crop insurance proceeds.

Farms with high ROA were larger, had higher crop returns per acre, lower operating expense per unit of gross return, lower interest expense, and owned less land. All of the characteristics important to the profitability of a farm are highly related to its management. A number of farms are profitable even in less than ideal conditions, and those profitable farms tended to remain in the higher profit categories each year due to specific management characteristics.

Profit Consistency and Management Characteristics For Successful North Dakota Farms, 1995-2000

Richard D. Taylor, Won W. Koo, and Andrew L. Swenson*

Introduction

Since the FAIR Act was passed in 1996, commodity prices have fallen and government spending has increased substantially. The price of spring wheat fell from $4.71 in 1996 to $2.85 in 2000, and North Dakota net farm income dropped from $1,119 million in 1996 to $417 million in 1999, before increasing to $749 million in 2000. Government spending in North Dakota increased from $353 million in 1996 to $1,170 million in 2000 (North Dakota Agricultural Statistics Service). In addition, U.S. agricultural exports decreased in recent years. Exports were $56 billion in 1995 and fell to $51 billion in 2000 (U.S. Department of Agriculture). These factors, combined with growing supplies, have lowered the prices of most commodities, which in turn have lowered net farm incomes and increased government spending on agriculture.

Regardless of aggregate farm income, North Dakota farm profitability varies widely among farms each year, according to the Farm and Ranch Business Management Education Program records. Table 1 shows the total average net farm income, as well as the average net farm income for the five highest profit and the five lowest profit farms in the program, reported for the years 1995 to 2000. In 2000, net farm income averaged $59,587 and varied between $345,598 and -$47,682.

Table 1. Range of Net Farm Income for North Dakota Farms Enrolled in the Farm and Ranch Business Management Education Program

Year	Average	Average of Five Highest	Average of Five Lowest
	----------dollars----------		
1995	35,776	236,174	-71,772
1996	45,042	306,088	-37,028
1997	20,238	219,538	-81,786
1998	28,452	248,850	-51,197
1999	57,611	304,285	-46,017
2000	59,587	345,598	-47,682

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Table 2 shows the total average return to assets and the return to assets for the five highest profit and the five lowest profit farms in the program, reported for the years 1995 to 2000. The average return to assets was the highest in 1996 at 8.38% and the lowest in 1997 at 1.71%. The average return to assets for the most profitable farms ranged from 48.86% in 1996 to 21.10% in 1997 while the return to assets for the least profitable farms ranged from -22.02% in 1997 to -7.92% in 2000.

Table 2. Range of Return to Assets for North Dakota Farms Enrolled in the Farm and Ranch Business Management Education Program

Year	Average	Average of Five Highest	Average of Five Lowest
		----------percent----------	
1995	7.01	26.22	-17.36
1996	8.38	48.86	-18.18
1997	1.71	21.10	-22.02
1998	4.84	32.64	-19.56
1999	7.93	32.08	-17.42
2000	7.87	25.58	-7.92

These tables indicate that some farms in the state apparently are profitable even in times of low prices and less than ideal weather conditions while some farms are at the other end of the scale. Farm business records across the United States show similar trends. Each year the top 25% of farms are very profitable, while the bottom 25% show little or no profit (Edwards and Kay). The question is, are the same farms in the higher profit categories year after year and, if they are, what characteristics do those farms have which can be identified as being important to their success? The objective of this study is to estimate or identify characteristics of successful North Dakota farms and farm managers.

Farm Management

Farm managers employ limited resources such as land, labor, and capital to their best use toward the generation of profits. Managers control activities relating to the organization and operation of a farm for the attainment of specific ends. They direct resource use after interpreting the goals of the farm. The goals may vary depending upon the nature of the farm. The success of a manager is measured by profits generated over time. Both the level and consistency of profits are important.

U.S. agriculture is rapidly changing due to the continued application of technology, uncertainty regarding future governmental support, and the freer trade environment. New management problems and opportunities arise from the changes in production agriculture: more mechanization, continued adoption of new technologies, growth in capital investments per

worker and in the large amount of borrowed capital, increased farm size, new marketing techniques, and increased risks.

Figure 1 shows a typical cost curve for agriculture (Hallam). It is an L-shaped curve where per unit costs decrease rapidly at first, as size increases, and then level off. The point at which unit costs cease to fall is undetermined, but with the changing nature of agriculture the cost curve continually shifts to the right. That shift pressures producers to expand their operation in order to maintain their operating efficiency.

The manager's role is to organize inputs in such a way as to move down and to the right on the cost curve. According to Schnitkey, high profit farms in Illinois were larger, owned less land, had higher corn yields, and carried lower per acre costs than low profit farms. Lattz also found differences between high profit and low profit farms in Illinois. About 36% of those differences in returns were identified as a result of higher gross returns while 64% were due to lower costs. The decisions that a manager makes when viewing new information determine, for a large part, the level of success that the operation experiences. The manager's decisions affect both the level of production and the costs associated with that production.

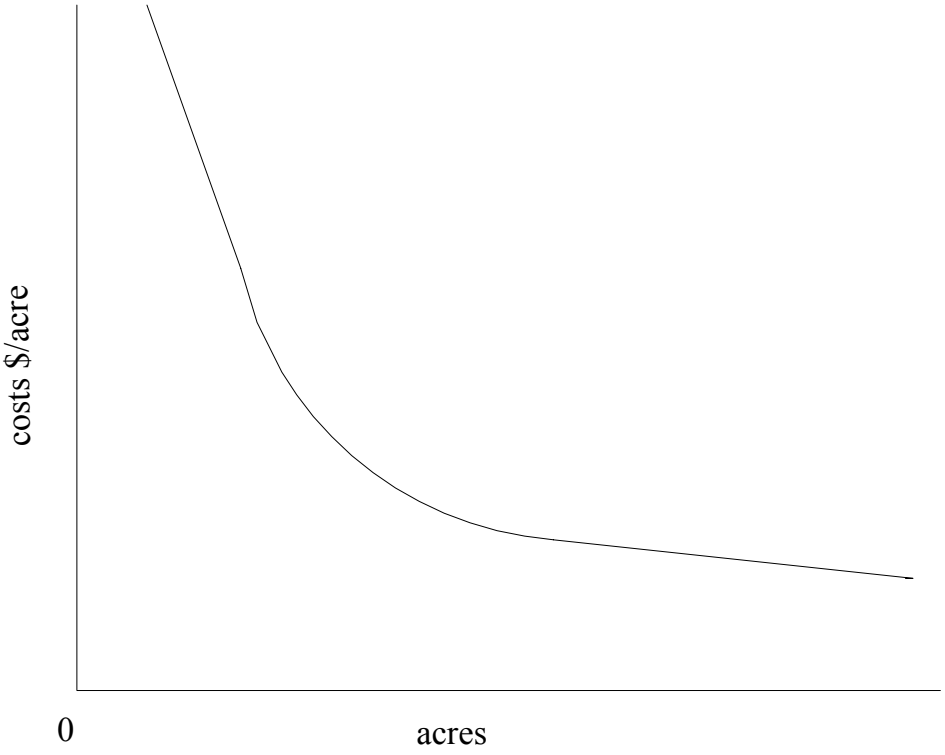

Figure 1. Long Run Agricultural Cost Curve

The farm manager's decisions can be divided into four categories: input, output, diversification, and risk (Lall, Norman, and Langemeier). Input decisions cover activities that relate to production: fertility, tillage practices, labor, and capital use. Output decisions relate to the question of how much to produce and the relationship with buyers of outputs. Diversification decisions are directed towards crop mix and the introduction of other enterprises, such as livestock. Risk decisions are related to crop insurance coverage, debt exposure, and government payments. Government payments are included because they reduce the risk that farmers face.

Characteristics of North Dakota Farms

Table 3 shows North Dakota net farm income trends over the six years of the study. The farms in the study are more profitable than the average farm as recorded for the state by NASS. NASS data include all farms in North Dakota while this study examines just a small sample from the state. Each year some of the farms in this study had negative net farm income. The number varies from 31.8% in 1997 to 9.3% in 2000. However, some farms show substantial profit each year. About 3.6% of farms in 1997 had more than $100,000 in net farm income, and in 2000 that number increased to 25.5%.

Except for 1997, the average farm's return on assets (ROA) is above 4%. In 1996, the ROA is 8.4%, and in 1999 the annual ROA is 7.9%. The mean ROA on the average farm for the six-year period is 6.29%. When government subsidies are removed, the picture changes substantially. The six-year average for ROA is 0.96%, and the ROA is negative during the last four years of the time period.

Farm income and profitability vary widely both during an individual year and also between years. The next question is whether the same farms are in the higher profit categories each year.

Table 3. Characteristics of North Dakota Farms Enrolled at Least Four out of Six Years in the North Dakota Farm and Ranch Business Management Education Program

	1995	1996	1997	1998	1999	2000
NASS Average NFI ($)	11,609	34,907	5,133	25,051	13,676	24,724
Study Average NFI ($)	48,188	54,879	19,947	39,719	60,307	63,983
Number with Loss	25	22	62	42	18	15
Number with Profit	155	161	133	145	150	146
Number over $100,000	27	28	7	24	36	41
Return on Assets	7.01	8.38	1.71	4.84	7.93	7.87
Return on Assets Without Government Payments	5.59	6.25	-0.55	-0.70	-1.35	-3.50

Method

According to Lull, Norman, and Langemeirer, net farm income (I) can be specified as a function of four decision activities and a group of family and farm characteristics represented as Input (IP), Output (OP), Diversification (D), Risk (R), and Family (F) as follows:

$$I_i = f(IP_i, OP_i, D_i, R_i, F_i), \qquad i=1,2,.....N \tag{1}$$

where i is an index for an individual farm.

Whereas Lull, Norman, and Langemeirer measure income for business success, Kay and Edwards state that net farm income is not an accurate measure of farm profitability. Profitability is concerned with size of the profit relative to the size of the business, or to the value of the resources used to produce the profit. A business can show a profit, but the net gain may be small relative to total size of that business. A more accurate measure of profitability is ROA. ROA is measured in percent and is calculated by dividing total return to assets by average farm asset value. ROA is substituted into Equation 1 for net farm income because many positive management characteristics may be overshadowed by farm size. Thus, Equation 1 is rewritten as

$$ROA_i = f(IP_i, OP_i, D_i, R_i, F_i), \qquad i=1,2,.....N. \tag{2}$$

Input decisions (IP_i) related to production were identified as a size variable, total crop acres (TC_i). Production efficiency of the manager was represented by two calculated variables: operating expense less depreciation and interest divided by gross revenue ($OXEP_i$) and total depreciation and capital adjustments divided by gross revenue (DEP_i). Two dummy variables were included to indicate whether the farm was expanding (D_{1i}) or decreasing in size (D_{2i}). If a farm increased 3% in total crop acres per year, D_{1i} was equal to one, otherwise it was zero; and if a farm decreased 3% in size each year, D_{2i} was equal to one, otherwise it was zero.
Thus, input decisions (IP) are a function of these variables:

$$IP = g_1(TC_i, OEXP_i, DEP_i\ D_{1i}, D_{2i}). \tag{3}$$

The sign on the estimated coefficient for total crop acres (TC_i) should be positive because the larger producers operate on a lower cost portion of the long run average cost curve (see Figure 1). The operating expense ratio ($OEXP_i$) and deprecation variable (DEP_i) should be negative because producers who spend less money on resources per dollar of output are more efficient. The dummy variable representing change in farm size should be positive for expanding farms (D_{1i}) and negative for farms deceasing in size (D_{2i}), because farms with higher incomes may be more efficient and have the resources to expand. Farms with lower income may be experiencing inefficiency and reducing size in order to limit cash outlay.

Output decisions (OP) are related to the question of how much to produce, the methods/success in marketing products, and skill in forecasting prices, and are represented by crop return per acre (R_i), maximum wheat yield (Y_i), and all other crop related revenue per acre (OR_i). Thus, output decisions are specified as:

$$OP_i = g_2 (R_i, Y_i, OR_i). \tag{4}$$

Crop returns (R_i) and other crop related income (OR_i) should be directly related to profits. More gross returns should lead to higher profits. The yield variable should also be directly related to profits; higher yields result in higher returns so long as the marginal cost of wheat production is less than the marginal revenue of wheat production.

Diversification decisions are directed towards enterprise choice: a crop mix variable, represented as the percentage of acres planted to small grains (CM_i), and a diversification variable, characterized as the percentage of total gross revenue due to livestock production, ($LVST_i$). Diversification decisions are specified by

$$D_i = g_3(CM_i, LVST_i). \tag{5}$$

The sign on the small grain mix should be negative because row crops typically provide higher returns than small grains. The livestock variable should be positive because livestock adds to income and may stabilize it, although livestock is typically raised in the western part of the state where returns may be less than in the rest of the state.

Risk decisions can be identified as debt exposure (INT_i) and government payments (GS_i) and are specified as

$$R_i = g_4(INT_i, GS_i). \tag{6}$$

Total interest cost divided by gross revenue should be negatively related to profits for the same reason as the other expense variables. Government payments should be positively related to profits because higher government payments should provide higher incomes.

Family and farm characteristics are specified by

$$F_i = g_5(OWNL_i, RENT_i, FEXP_i, NF_i, FL_i, DY_1, DY_2). \tag{7}$$

Land use is estimated by two variables: percent of land owned ($OWNL_i$) and percent of land cash rented ($RENT_i$). The signs on land use variables are not clear. If owning land is more profitable than share cropping, the sign should be positive. Likewise, if cash renting land is more profitable than share cropping, it should also be positive. The number of years of manager/operator experience ($FEXP_i$) should be positively related to profits, and nonfarm income (NF_i) should be negatively related to profits. Nonfarm income is typically higher for farms with lower profits for two reasons: 1) the operator needs additional income for family living, and 2) the operator and family have available time for outside work. Family living expense (FL_i) was included for informational purposes. Two dummy variables were included to indicate the number of years that the farm was included in the record-keeping program. DY_1 is equal to one if the farm was in the program for all six years and zero otherwise. DY_2 is equal to one if the farm was in the program five out of the six years and zero otherwise. The two dummy variables should have a positive sign if better long term record-keeping is a benefit to the operation.

In addition, two other sets of dummy variables for location within the state and for the year of the farm record were developed. Regional dummy variables are DL_1 for the Red River Valley, DL_2 for the North Central region of North Dakota, and DL_3 for the South Central region of the state. A description of the various regions of the state can be found in Taylor, Koo, and Swenson. Dummy variables for years are D95 for 1995, D96 for 1996, D97 for 1997, D98 for 1998, and D99 for 1999.

Assuming a linear relationship between the dependent and independent variables, the model is specified by combining Equations 2 through 7 and adding the additional variables as follows:

$$ROA_i = \alpha_0 + \alpha_1 TC_i + \alpha_2 OEXP_i + \alpha_3 DEP_i + \alpha_4 R_i + \alpha_5 Y_i + \alpha_6 OR_i + \alpha_7 CM_i + \alpha_8 LVST_i + \alpha_9 INT_i + \alpha_{10} GS_i + \alpha_{11} OWNL_i + \alpha_{12} RENT_i + \alpha_{13} FEXP_i + \alpha_{14} NF_i + \alpha_{15} NL_i + \alpha_{16} D_{1i} + \alpha_{17} D_{2i} + \alpha_{18} DY_{1i} + \alpha_{19} DY_{2i} + \alpha_{20} DL_{1i} + \alpha_{21} DL_{2i} + \alpha_{22} DL_{3i} + \alpha_{23} D95_i + \alpha_{24} D96_i + \alpha_{25} D97_i + \alpha_{26} D98_i + \alpha_{27} D99_i + \epsilon_i. \quad (8)$$

Data

The data for this study are from the North Dakota Farm Business Management Education Program from 1995-2000. Every year, new farms enroll in the program while others leave the program. Also, detailed farm records may not be completed by the submission deadline for every year a farm is enrolled in the program. A total of 3,334 farm records were available for the six-year period. Table 4 shows the distribution of farms by the number of years for which records were available for the study. Farm records from farms which were enrolled in the program for at least four years were separated and used for the analysis.

Table 4. Number of Years that Farms were Enrolled and Submitted Records, Farm and Ranch Business Management Education Program, 1995-2000

Number of Years	Number of Farms
1	250
2	153
3	85
4	51
5	73
6	106

About 222 farms were in the program and submitted records for at least four out of the six years. Farms with less than four years of records were omitted from the study because these data would not show consistency of profits. Farms in the Red River Valley that raised sugarbeets were also removed from the study because these farms were not typical of farms in that region or within the state. Panel data consisting of 1,072 records from the 222 farms over the six-year period were used for the study.

Table 5 shows the average values for each of the independent variables evaluated in the study. Total crop acres per farm increased 23.3%, from 1,621 acres to 1,999 acres, during the time period. The average farm size in North Dakota, according to the North Dakota Agricultural Statistics Service (NDASS), increased from 1,228 acres to 1,300 acres during the same time period. This indicates that the farms in the Farm and Ranch Business Management Education Program are larger than the average of farms across the state. The mix of crops between small grains and row crops also changed during the time period for the farms in the study. In 1995, about 71% of the total crop acres were planted to small grains. By 2000, the percentage of small grains had fallen to 65%. The level of livestock returns as a proportion of total returns fell until 1999. Crop yields varied during the time period, mainly due to weather conditions. The highest average wheat yield was about 35 bushels per acre in 2000, and the lowest was 26 bushels per acre in 1997.

Gross return for crops fell 37%, from $97.39 per acre in 1995 to $61.16 per acre in 2000, indicating that for the most part, prices have decreased. On the other hand, government payments increased 462%, from $7.43 per acre in 1995 to $41.79 per acre in 2000. Other crop revenue increased 104%, from $9.11 per acre in 1995 to $18.54 per acre in 1999, before falling to $16.22 in 2000. Most of these increases were due to crop insurance payments. Total crop revenue, the sum of all three indicators, increased about 5%, from $113.93 per acre in 1995 to $119.17 per acre in 2000.

The ownership of land changed slightly during the time period. Land ownership fell from about 36% in 1995 to about 32% in 2000, while cash rented land increased from about 43% in 1995 to 51% in 2000.

The ratio of operating expense less deprecation and interest to gross returns varied during the time period. In 1995, 66 cents of each $1 of gross returns was spent for production. That increased to about 75 cents in 1997 and then fell to 64-65 cents in 1999 and 2000. Depreciation and capital adjustments varied throughout the time period, but dropped from 7% in 1995 to 6% in 2000.

The interest ratio followed a similar trend, as did crop expense and deprecation ratios. In 1995, the interest ratio was 8%; it increased to 10% in 1997, before falling to 8% in 2000.

Years of farming experience increased from almost 19 years in 1995 to just more than 22 years in 2000. Farming experience should have increased by more than 4 years, but several of the farm records in later years were apparently reported by younger operators with much less farming experience. Nonfarm income increased from $12,607 in 1995 to $20,249 in 1999, before falling to $18,822 in 2000. Family living expense increased from $37,888 in 1995 to $43,604 in 2000.

Table 5. Average Values for Independent Variables Used in the Study, by Year

		1995	1996	1997	1998	1999	2000
Input							
Total Crop	(acres)	1621.09	1692.20	1763.62	1811.68	1931.26	1999.35
Oexp	(%)	65.90	65.14	74.87	71.36	64.01	65.07
Dep	(%)	7.29	6.72	7.29	6.51	7.48	6.30
Output							
Crop	($)	97.39	91.17	88.46	80.24	65.20	61.16
Other	($)	9.11	10.26	11.36	10.02	18.54	16.22
Max Y	(bu)	30.17	34.47	25.82	31.40	29.89	34.97
Diversification							
Smallg	(%)	71.19	74.27	68.54	60.91	63.87	64.53
Lvst	(%)	11.82	10.18	11.35	10.90	10.63	15.26
Risk							
Int	(%)	8.42	8.78	10.03	9.69	8.74	7.75
Govt	($)	7.43	10.73	9.75	18.69	32.49	41.79
Family and Farm							
YrsFarm	(years)	18.97	19.11	19.69	21.06	21.80	22.34
Owned	(%)	36.39	35.40	33.44	33.23	33.91	32.38
Cash	(%)	43.13	46.75	48.10	49.27	50.18	50.98
Nonfinc	($)	12,608	12,868	13,731	16,015	20,249	18,822
Fmly Liv	($)	37,888	37,977	39,909	40,269	40,118	43,604

The farm records were sorted by year and divided into quartiles by ROA. Table 6 outlines the characteristics of North Dakota farms grouped by ROA quartiles. Farms in the high quartile had 29% more crop acreage than those in the low quartile. Their gross crop return, government payments, and other returns per acre were larger than the other quartiles. The percentage of livestock returns increased as the farms went from the high category to the low category. The percentage of owned land increased and cash rent decreased from highest to lowest quartile.

All the expense ratios increased from high-quartile farms to low-quartile farms. The small grains ratio also increased. Wheat yield decreased about 23% from high- to low-quartile.

Table 6. Characteristics of North Dakota Farms by Return on Assets Quartiles, 1995-2000

		High	Med-High	Med-Low	Low
Crop Acres	(acre)	2082.19	1955.00	1683.50	1468.43
Crop return/acre	($)	93.50	84.04	76.31	67.15
Government/acre	($)	22.10	19.33	18.72	17.81
Other return/acre	($)	14.63	13.63	10.98	10.43
Livestock return	(%)	5.50	4.61	7.53	8.64
Owned land	(%)	24.77	36.92	41.72	36.50
Cash rent land	(%)	54.44	46.38	45.22	47.81
Years farming	(years)	18.55	20.73	21.79	20.92
Operating exp	(%)	57.50	62.79	68.00	83.85
Depreciation exp	(%)	4.68	5.97	7.67	9.54
Interest exp	(%)	6.00	8.53	9.95	11.41
Small grain ratio	(%)	66.34	68.33	68.14	69.56
Wheat yield	(bu)	34.80	31.65	30.07	26.87
Nonfarm income	($)	10,945	15,368	18,117	18,112
Fmly Liv	($)	48,825	42,075	36,789	31,881

Table 7 shows the consistency of farms within the ROA quartiles. The study determined which ROA quartile a farm was in during the first year of its participation in the record-keeping program. If farms were in the high quartile in their first year, the probability that they stayed in the high quartile was 49.9%, and the likelihood that they stayed in the high or the med-high quartile was 74.3%. Likewise, if farms were in the low quartile their first year, the probability that they stayed in the low quartile was 56.6%, and the likelihood that they stayed in the low or mid-low quartiles was 77.7%. The middle two quartile farms were not as consistent, but they were more likely to remain in the same quartile as the first year. A χ^2 test was conducted to confirm this consistency. Based on the results of the test, all farms, regardless of ROA quartile the first year, were more likely to remain in the same or similar quartile for the remaining years.

Table 7. Probability of Return on Assets Achieved During 1995-2000, on Average, and Chi Square Tests, for Farms in Various Return on Assets Groups, North Dakota Farm Business Management Education Program

First year of participation	-----Profit Groups, later years-----					
	High	Med-High	Med-Low	Low	X^2	$X^2_{critical}$
	------annual probability (%)------					
High Profit	49.9	24.4	16.9	7.8	18.87	7.80
Med-High Profit	23.0	43.4	18.5	14.7	8.68	7.80
Med-Low Profit	17.1	18.5	43.5	20.9	7.82	7.80
Low Profit	10.1	13.7	21.1	56.6	22.19	7.80

Results

Table 8 shows the estimated coefficients, t-values, standard deviations, and standardized coefficients for the independent variables from the estimated equation (8). The standardized coefficients were calculated as follows:

$$B_j^* = B_j(Sx_j/Sy) \qquad j=2,3,4,.....,k. \qquad (9)$$

where B_j^* represents the standardized coefficients, B_j is the estimated coefficients of the independent variables, Sx_j is the standard deviation of the corresponding independent variables, and Sy is the standard deviation of the dependent variable. The standardized coefficients describe the relative importance of the independent variables in a multiple regression model. A standardized coefficient of 0.5 means that a 1 standard deviation change in the independent variable will lead to a 0.5 standard deviation change in the dependent variable. Most independent variables are significant at the 95% level and most signs are as expected. Operating expense ratio is the most important factor explaining the dependent variable. A standardized coefficient of 0.68 means that a 1 standard deviation increase in the operating expense ratio will decrease return to assets by 6.4%. Depreciation expense per acre is the next most important characteristic, followed by total crop acres and land ownership. Government return per acre, crop return per acre, the farm expansion dummy variable, and the maximum wheat yield variable are next in importance. Variables which are not important include the percentage of small grains in the operation and the dummy variable for farms which are decreasing in size. Variables of minor importance are cash rent, livestock return, and other income per acre, which is mainly crop insurance proceeds. Farming experience has a negative affect on ROA. The reason may be that older farmers own more land thereby increasing their asset base which lowers ROA.

Some of the dummy variables are significant, indicating that factors such as the number of years in the record-keeping program and whether the farm is expanding are important to ROA. Location was not important as all estimated coefficients are insignificant.

Table 8. Ordinary Least Square Estimates of Estimated Coefficients, t-values, Standard Deviations, and Standardized Coefficients for the Independent Variables

Variable	Coefficient	t-value	Std. Dev.	Std. Coefficient
Constant	**30.93**	**5.870**		
Input				
Totcrop	**0.001**	**7.329**	931.000	14.082
Oexp	**-0.414**	**-34.630**	15.399	68.010
Dep	**-0.330**	**-14.640**	7.562	27.338
Dexp	**1.612**	**4.497**	0.495	8.523
Ddec	-0.243	-0.396	0.300	0.780
Output				
Max Y	**0.074**	**3.099**	9.538	7.571
Crop	**0.014**	**2.535**	46.744	6.967
Other	**0.027**	**2.484**	15.794	5.349
Diversification				
Smallg	-1.517	-1.603	0.221	0.358
Lvst	**-0.255**	**-2.597**	2.069	5.636
Risk				
Int	**-0.097**	**-3.179**	6.330	6.545
Govt	**0.063**	**3.215**	15.725	10.591
Family and Farm				
Yrsfarm	**-0.051**	**-2.237**	8.121	4.436
Nonfinc	-0.000	-1.331	17472.0	2.420
Owned	**-3.937**	**-4.366**	0.274	11.521
Cash	1.244	1.494	0.305	4.055
Fmly living	**0.000**	**2.232**	9.364	4.625
Others				
Dy1	**-1.505**	**-3.250**	0.500	8.034
Dy2	**-1.224**	**-2.481**	0.464	6.066
D11	-1.180	-1.413	0.309	3.894
D12	-0.158	-0.303	0.472	0.797
D13	0.663	1.166	0.481	3.200
D95	**2.899**	**3.134**	0.369	11.424
D96	**2.949**	**3.390**	0.378	11.903
D97	1.118	1.267	0.388	4.632
D98	1.458	1.955	0.380	5.916
D99	1.106	1.778	0.364	4.300
R^2	0.692			
Degree of freedom	1032			

Bold values are significant at the 95% level

The independent variables were separated into a production group and an expense group to estimate which class was more important, at mean levels, for the explanation of the dependent variable, ROA (Table 9). The production variables included total crop acres (Totcrop), crop return per acre (crop), government payments per acre (govt), other payments per acre (other), livestock ratio (lvst), percentage of land owned (owned), percentage of land cash rented (cash), small grains ratio (smallg), and maximum wheat yield (max). The expense variables included operating expense ratio (opexp), depreciation expense per acre (depre), and interest expense per acre (int). The means of the production variables were increased by 10% and the cost variables were decreased by 10% for this analysis. At mean levels of the independent variable, ROA was estimated at 6.176%. When the production variable means were increased 10%, ROA increased to 7.2%, which was a 17.2% increase compared to ROA at mean levels. When the expense variable means were decreased 10%, ROA increased to 9.3%, which was a 50.6% increase compared to ROA at mean levels. This indicates that the dependent variable was more sensitive to changes in the expense variables than to production variables, which implies that the expense variables are more important to the value of the dependent variable than the production variables.

Table 9. Sensitivity of the Dependent Variable to a 10% Increase in Production Variables and a 10% Decrease in Expense Variables at Mean Levels

	Estimated	Value			Change*		
	Coefficient	Means	Prod+10%	Cost-10%	Mean	Prod+10%	Cost-10%
Production Variables							
Totcrop	0.001	1798.21	1978.03		2.55	2.80	2.55
Crop	0.014	80.29	88.31		1.12	1.23	1.12
Govt	0.063	19.50	21.45		1.23	1.35	1.23
Other	0.03	12.42	13.66		0.34	0.38	0.34
Lvst	0.26	0.66	0.72		0.17	0.18	0.17
Owned	-3.94	0.34	0.31		-1.35	-1.22	-1.35
Cash	1.25	0.48	0.53		0.60	0.66	0.60
Smallg	-1.52	0.68	0.61		-1.03	-0.92	-1.03
Max	0.07	30.86	33.94		2.30	2.52	2.29
Expense Variables							
Opexp	-0.41	67.99		61.19	-28.12	-28.12	-25.31
Depre	-0.33	6.96		6.26	-2.29	-2.29	-2.07
Int	-0.10	8.97		8.07	-0.87	-0.87	-0.78
Other Variables					31.54	31.54	31.54
ROA					6.18	7.24	9.31
% change						17.29	50.65

*Calculated by multiplying the estimated coefficients by the corresponding means.

The usefulness of the four sets of dummy variables for location, accounting year, years in the program, and size change was tested using the log-likelihood ratio test. The log-likelihood ratio is calculated by

$$\chi_m^2 \sim -2[L(\beta_R)-L(\beta_{UR})]$$

where m is the number of restrictions, χ_m^2 is the calculated χ^2, $L(\beta_R)$ is the log-likelihood of the restricted model, and $L(\beta_{UR})$ is the log-likelihood of the unrestricted model. Table 10 shows the results of the likelihood ratio tests: all four sets of dummy variables are significant in the model.

Table 10. Likelihood Ratio Test Results for the Unrestricted and Restricted Models

Dummy Variable	Log-likelihood Value		X_m^2	Number of Restrictions, m	$X^2_{critical}$
	Unrestricted	Restricted			
Location	-4209.55	-4219.59	20.06	3	0.035
Accounting	-4209.55	-4215.40	11.69	2	0.102
Year	-4209.55	-4216.27	13.44	5	1.150
Size Change	-4209.55	-4223.71	28.31	2	0.102

Summary

U.S. and North Dakota agriculture have been plagued with low commodity prices since 1996. Net farm incomes and ROA in North Dakota would have been negative without large government subsidies. However, there is great variation in farm profitability. Some farms in the state continue to be profitable even in times of low prices and less than ideal weather conditions. The question was, are the same farms in the higher ROA categories year after year and, if they are, what characteristics do those farms have that can be identified as being important to their success?

Farm managers employ limited resources such as land, labor, and capital to their best use toward the generation of profits. The success of a manager is measured by ROA over time. The farm manager's decisions can be divided into four categories: input, output, diversification, and risk.

Records from the farms enrolled in the Farm and Ranch Business Management Education Program for at least four years were separated and used for the analysis. These records were chosen because farms enrolled in the program for less than four years would not have enough data to show consistency. ROA was used as the dependent variable because size of the farm could be an over-bearing aspect of net farm income.

Farms in the high ROA quartile were 29% larger than ones in the low ROA quartile. Their gross crop return, government payments, and other returns per acre were larger than those

for farms in the other quartiles. All the expense ratios increased from high-quartile farms to low-quartile farms. Wheat yield decreased about 23% from the high- to low-quartile farms.

Farms tended to remain in the same quartile during the six-year study period. High profit farms were most likely to remain in the high quartile, just as low profit farms were likely to remain in the low quartile.

Most independent variables are significant at the 95% level, and most signs are as expected. Operating expense ratio is the most important variable explaining the dependent variable. Depreciation expense per acre is the next most important characteristic, followed by total crop acres and owned land. Government return per acre, interest expense ratio, and yield are next in importance. The expense variables were more important than production related variables; which implies that ROA is more sensitive to changes in expenses than to changes in production.

Farms with high ROA had lower operating expense per unit of gross return, lower interest expense, and owned less land. They were larger and had higher crop returns per acre. All of the characteristics important to the profitability of a farm are highly related to its management. A number of farms are profitable even in less than ideal conditions, and those profitable farms tended to remain in the higher profit categories each year due to specific management characteristics.

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