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2017 North Dakota Agricultural Outlook: Representative Farms, 2017-2026

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ABSTRACT

Net farm income in North Dakota was at record levels for most representative farms in 2012. However, by 2016 net farm income fell 65% from 2012 levels. Net farm income is expected to continue to fall through 2026, although at a much slower rate. Commodity prices are expected to increase slowly from current levels. Commodity yields are projected to increase at historical trend-line rates and production expenses are expected to return to normal growth rates. Debt-to-asset ratios for all farms except for the high profit farms will increase slightly throughout the forecast period. Debt-to-asset ratios for the high profit farms are expected to decrease slightly.

Keywords: net farm income, debt-to-asset ratios, cropland prices, land rental rates, farm operating expenses, capitalization rate, risk.

HIGHLIGHTS

Net farm income for the large-size farm is predicted to decrease from $202 thousand to $152 thousand, fall from $85 thousand to $62 thousand for the medium-size farm, decrease from $234 to $180 thousand for the high-profit farm and decrease from $68 to $56 thousand for the average-profit farm for the 2017-2026 period. Net farm income for the low-profit farm is predicted to decrease from -$40 thousand in 2017 to -$53 thousand in 2026. Similarly, net farm income for small size farm may decrease slowly from $32 thousand in 2017 to $22 thousand in 2026.

Risk analysis indicates the possibility of a wide variation in net farm income for the representative farms. A large variation in historical yields and prices results in a wide distribution of forecasted incomes. In 2017, the average net farm income is expected to be $68 thousand with a standard deviation of $72 thousand. The 90% confidence interval is between $-31 thousand and $200 thousand. By 2026, the average net farm income is expected to be $56 thousand with a standard deviation of $91 thousand and the 90% confidence interval is between $-72 thousand and $221 thousand.

Debt-to-asset ratios for most representative farms are predicted to increase except for the high profit farm throughout the forecast period. Debt-to-asset ratios are projected to remain constant for the large-size representative farm, increase 7% for the medium-size representative farm, and increase 8% for the small-size representative farm by 2026. The ratios are projected to fall 11% for the high-profit representative and increase by 7% for the average-profit farm by 2026. The debt-to asset ratio for the low profit farm is projected to increase by 9%.

State average cropland values will decrease 9.3%, from $2,106 per acre in 2017 to $1,910 per acre in 2026. Cash rents will decrease 9.2%, from $67.34 per acre in 2017 to $61.12 per acre in 2026. Cropland values and rent are estimated solely on returns to cropland and not the recent market run-up.

Overall operating expense increased by 162% since 2004 because of higher fertilizer, fuel, chemicals, and land costs. Operating expense for 2009 was 7% lower than in 2008 and operating expenses fell another 14% in 2010 before increasing 28% in 2011, 23% in 2012 and 10% in 2013. Expenses fell 5% in 2014 and 16.6% in 2015 before increasing by 9.0% in 2016.

2017 North Dakota Agricultural Outlook: Representative Farms, 2017-2026

Richard D. Taylor*

INTRODUCTION

North Dakota is a major agricultural area with a distinctive climate and crop mix. The state is uniquely situated in terms of marketing and logistics within the United States because it shares a border with Canada, which is the United States' largest trading partner. Changes in government policies through recent farm bills and the Uruguay Round Agreement (URA) have affected the region's economy. Commodity prices increased significantly, starting in 2007 with global demand and changes in Federal policy towards renewable energy, which increased corn based ethanol production. In late 2010 and 2011, there was an increase in commodity prices which increased incomes in North Dakota to near record levels. Further price increases due to the drought in the central portion of the United States increased net farm income to record levels in 2012. In 2013, 2014 and 2015 commodity prices fell, which reduced net farm incomes in North Dakota. However, operating expenses fell in 2015, which help increase net farm incomes in 2015. Expenses increased in 2016 but a large crop supported farm incomes.

The main objective of this analysis is to evaluate changes in net farm income and debt-to-asset ratios for different size and profit categories of representative farms. Net farm income includes returns to capital, management, and labor. The representative farms are developed from the North Dakota Farm and Ranch Business Management Education Program farm records and are projected over the 2017 to 2026 period under the Agriculture Act of 2014, the URA, and the North American Free Trade Agreement (NAFTA). Secondary objectives are to evaluate the reaction of cropland prices and cash rental rates to farm income estimates over the same time horizon. In addition, this analysis includes risk, stemming from unknown future yields and prices.

The North Dakota agricultural outlook for the 2017-2026 period is based on the baseline projections produced by USDA and the North Dakota Global Policy Simulation Models.

U.S. agriculture has been influenced by major changes in agricultural and trade policies. Trade agreements, such as Canadian-U.S. Trade Agreement, NAFTA, and the URA, have liberalized agricultural trade and will continue to do so for the next decade.

Development of an Empirical Model

Major crops produced in North Dakota are hard red spring wheat, durum wheat, barley (malting and feed), corn, soybeans, and minor oilseeds, including sunflower and canola. In addition, the region produces dry edible beans, flax, field peas, sugarbeets, and potatoes. The agricultural sector provides between 8% and 15% of the state economy. The average farm size, as defined by USDA, in North Dakota is 1,238 acres including pasture. About 43% of total

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farms in North Dakota have a farm size less than 1,000 crop acres. In addition, small farms (less than 200 acres) account for 26% of total farms in North Dakota but only 3% of total farmland.

The North Dakota Representative Farm Model is a stochastic simulation model designed to analyze the impact of policy changes on farm income. The model projects average net farm incomes, debt-to-asset ratios, cash rents, and cropland prices for representative farms producing six major crops: wheat, barley, corn, soybeans, canola and sunflowers. The model is linked to the USDA projections and North Dakota econometric simulation models, and it uses the prices of the crops generated from these models (Figure 1). The base model assumes an average trend yield based on historical data and average predicted prices received by farmers based on the historical relationships between USDA prices and North Dakota prices. In addition, macro policies and assumptions, trade policies, and agricultural policies are incorporated into the model directly or indirectly, with assumptions made by the USDA in its price series. For the outlook, agricultural and macroeconomic policies are assumed to remain constant.

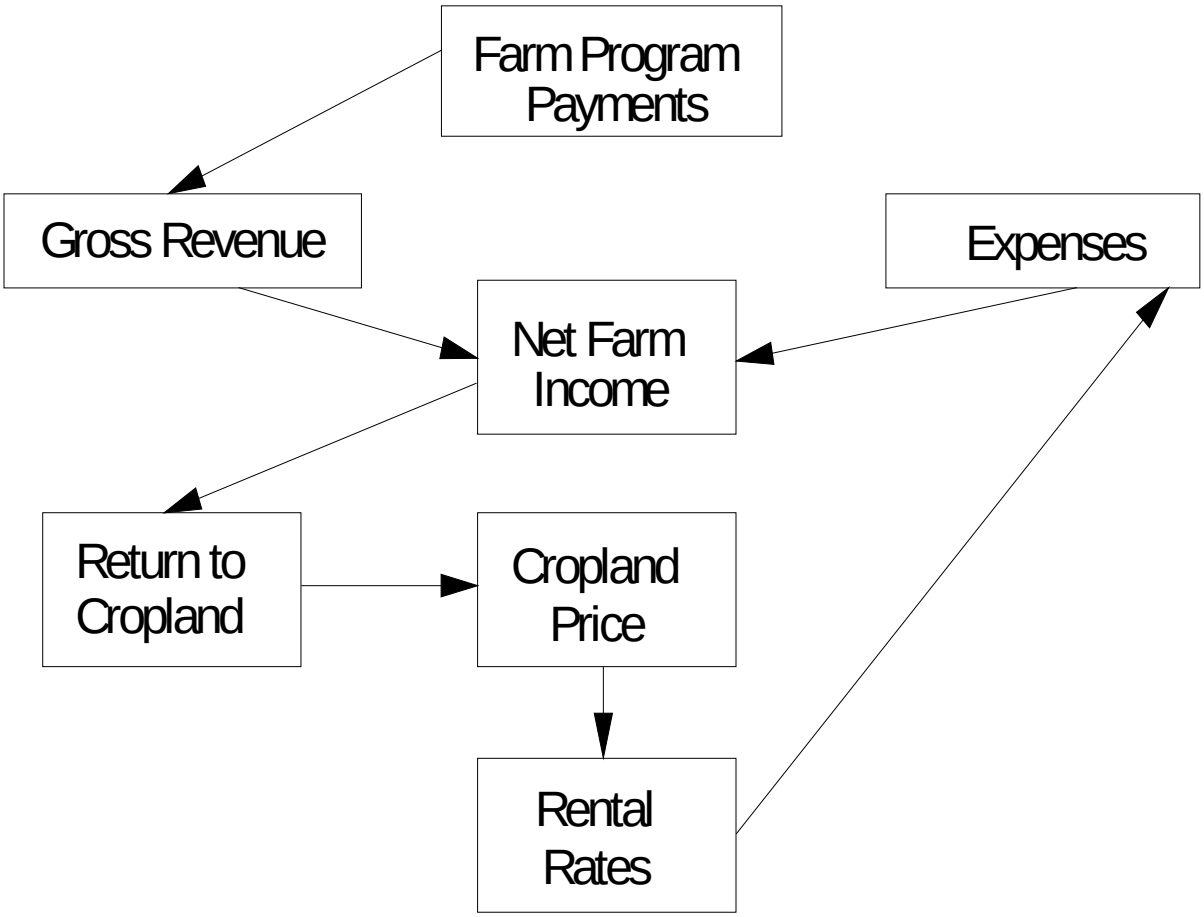


Figure 1. Structure of the North Dakota Representative Farm Model

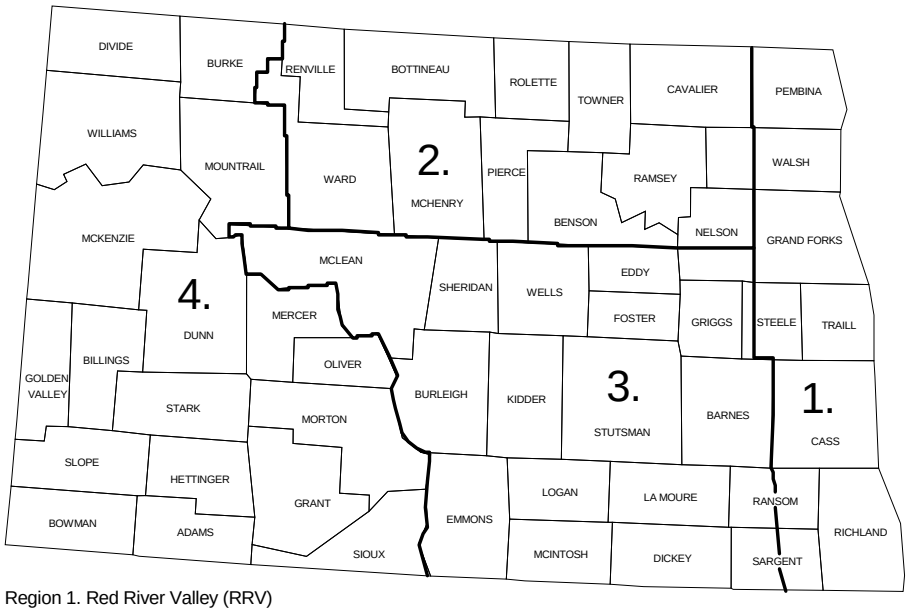


Figure 2. North Dakota Farm and Ranch Business Management Regions

Alternative farm policies affect net farm income for the representative farms. Changes in return to cropland, given the market-determined capitalization rate, result in changes in land prices. Changes in return to cropland affect cash rental rates that farmers are willing to pay on land used to produce crops. Changes in land price and cash rental rates, in turn, affect net farm income through adjustments in farm expenses. These changes affect the debt-to-asset ratios of the representative farms.

The North Dakota Representative Farm

The model has 24 representative farms: six farms in each of the four regions of North Dakota. These regions are the Red River Valley (RRV), North Central (NC), South Central (SC), and Western (West) (Figure 2). The farms in each region are representative of the average, high, and low-profit farms; and small, medium, and large-size farms enrolled in the North Dakota Farm and Ranch Business Management Education Program.

The representative farms average 1,879 acres of cropland and 536 acres of pasture. The farms are about 84% larger than the state average reported by the North Dakota Agricultural Statistics Service. A reason for this difference is that the state average includes all farms with $1,000 or more in agricultural production; therefore, hobby farms, farms operated as part of combined larger farms, semi-retired farms, and commercial farms are all included, while the farms used in this study mainly represent commercial farms.

The average profit representative farm is an average of the middle 50% of farms based on profitability in the Farm and Ranch Business Management Records System of North Dakota and

the RRV of Minnesota in each production region. The high-profit representative farm is an average of farms in the top 25% of farm profitability for each production region. The low-profit representative farm is an average of farms in the bottom 25% of farm profitability in each production region. Average farm sizes are 3,821 cropland acres for the high-profit farms, 1,879 cropland acres for the average-profit farms, and 1,304 cropland acres for the low-profit farms. In addition, the high, average, and low profit farms had 496 acres, 789 acres, and 276 acres of pasture, respectively.

Table 1. Characteristics of Representative North Dakota Farms, 2016

	Size			Profit		
	Large	Medium	Small	High	Average	Low
Number of Farms	161	160	161	125	375	125
Total Cropland (ac)	3677	1390	416	3,821	1,879	1,304
Spring Wheat(ac)t	1047	311	91	731	261	286
Durum Wheat (ac)	216	26	7	108	25	22
Barley (ac)	218	52	18	157	35	33
Corn (ac)	770	279	100	466	170	170
Sunflower (ac)	202	57	11	108	25	76
Soybean (ac)	1235	456	172	872	364	342

Figure 3 shows the historical average farm expense and profit for farms in the North Dakota Farm and Ranch Management Program located in the NC, SC, and West regions of the state during the past 10 years, excluding the RRV. In 1994, the farms averaged $171,713 gross income with a profit of $46,289. In 2011, the farms averaged $715,874 gross return with a profit of $260,485. In 2013, average gross returns were $823,861 and net farm income decreased to $146,805. In 2014 saw net farm income fall again to $75,177 while expenses dropped 2.6%. Expenses fell 16.6% between 2014 and 2015 in spite of lower gross returns, net farm income increased in 2015. In 1994, the farms generated $1.37 gross output for every $1 in inputs; by 2006, that had fallen to $1.22 gross output for every $1 in inputs. In 2009, that ratio was 1.18 and in 2010 that ratio was 1.62. In 2012 the ratio was 1.34, 1.22 in 2013 and 1.11 in 2014. The ratio increased to 1.21 in 2015 and 2016. Figure 4 shows the average crop acres of the farms. In 1994, the average size was 1,262 acres. In 2016, the average size was 1,879 acres. This is an increase of 52% over the 16-year period. Net return per acre fell from $36.67 per acre in 1994 to $33.20 per acre in 2005 before increasing to $88.97 in 2007 and then falling to $45.83 in 2009 before increasing to $101.24 in 2012. Per acre returns in 2016 were $67.28. Operating expenses have increased 348% since 1994 and 87% since 2005, but have fallen 12.8% since 2013.

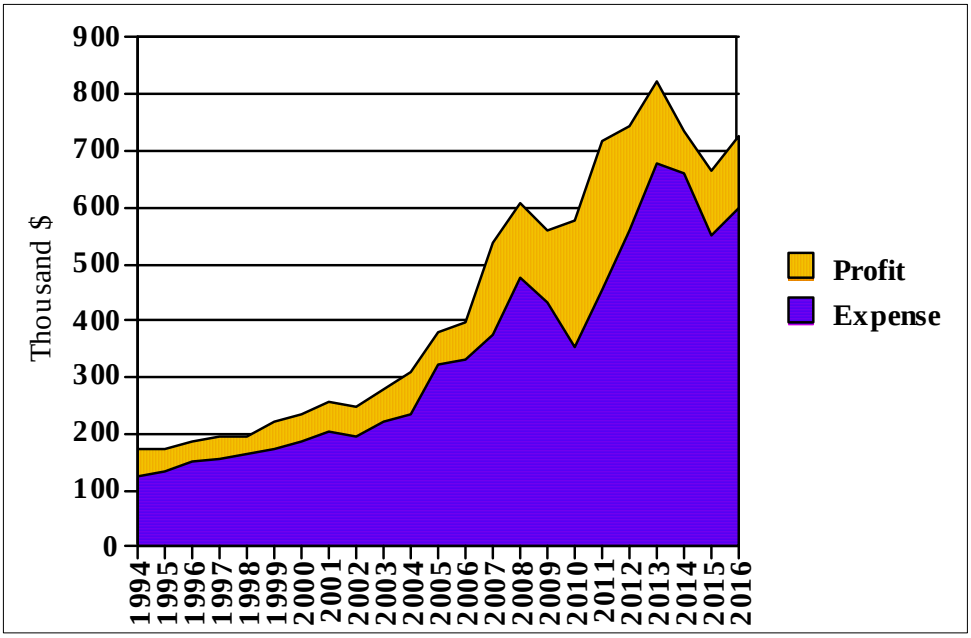


Figure 3. Average Expense and Profit for Farms Excluding the Red River Valley in the North Dakota Farm and Ranch Business Management Program

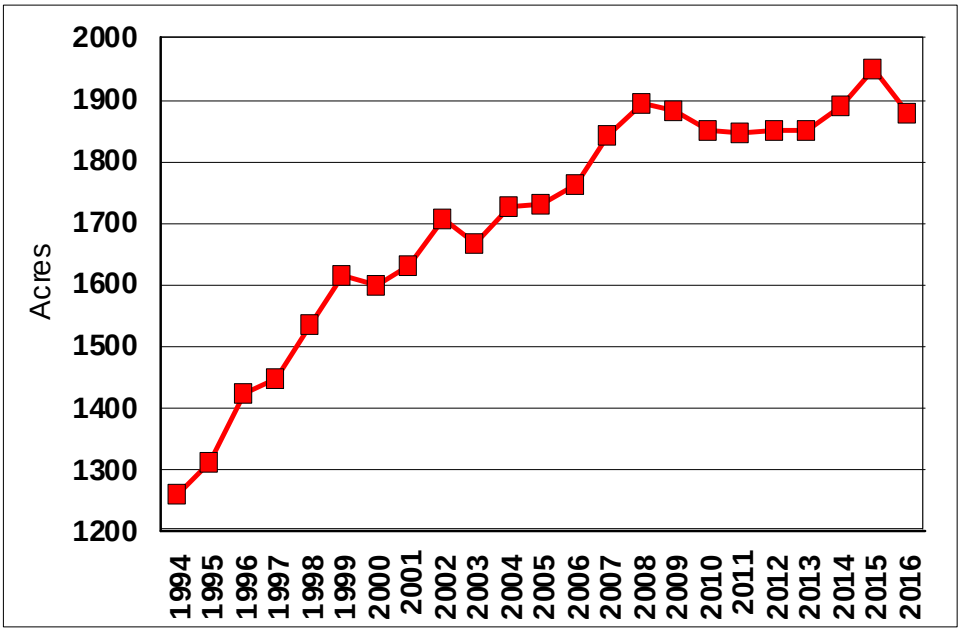


Figure 4. Average Cropland Acres for Farms in the North Dakota Farm and Ranch Business Management Program

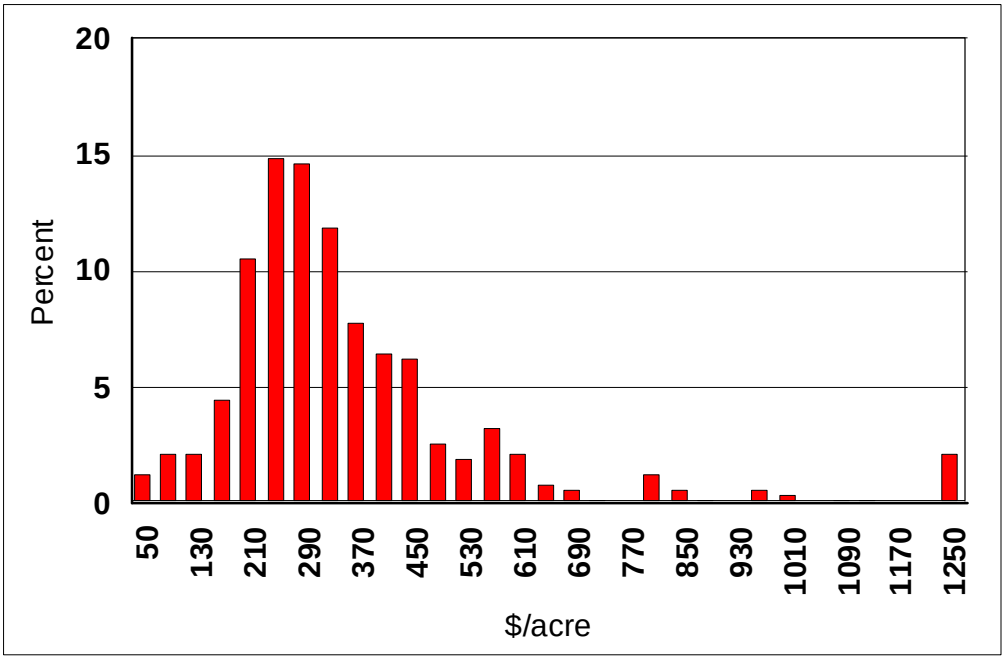


Figure 5. Distribution of Per Acre Gross Returns For Cropland for 2016

Figure 5 shows the distribution of per acre gross returns for all farms within the Farm and Ranch Business Management program for 2016. The majority of the returns are $210 to $410 per acre. Many of the farms in the lower distribution are farms in the West region where livestock is the major enterprise and farms in the upper distribution are RRV farms with sugarbeets. The average gross return for 2016 is $386 per acre, a decrease of 13% from 2014. Table 2 shows the average per acre gross cash returns to cropland and net farm income for 2000 to 2016. Per acre gross returns increased from $147 in 2000 to $226 in 2006 while net farm income stayed in the $47,000-$75,000 range for those years. In 2007, net farm income increased to about $163,900 because of higher commodity prices. There are numerous factors involved in net farm income other than crop returns. Returns to livestock are a major factor in the western portion of the state along with government payments and proceeds from crop insurance. Expenses have also increased substantially during the past several years which put downward pressure on net farm income, however expenses decreased in 2009 and 2010. In 2011 gross returns increased 32% above 2010 levels and increased an additional 17% above 2011 in 2012. Net farm income fell in 2013 to $136,123 and continued to fall in 2014 to $75,117. In 2015, gross returns fell by $46 per acre while net farm incomes increased. Per acre expenses were 16.6% lower in 2015 than in 2014. In 2016 gross returns increased by 12.3% over 2015, however expenses also increased by 13%.

Table 2. Average Per Acre Gross Cash Returns and Net Farm Income For Farms in the North Dakota Farm and Ranch Business Management Program

	Per Acre Gross Returns	Net Farm Income*
	Dollars per acre	Dollars
2000	147	47,900
2001	158	54,800
2002	145	51,600
2003	168	58,200
2004	178	74,900
2005	220	57,500
2006	226	68,200
2007	292	163,900
2008	321	131,400
2009	298	126,500
2010	311	220,600
2011	388	205,500
2012	403	364,798
2013	428	136,123
2014	388	75,117
2015	342	116,818
2016	386	126,427

*Before inventory adjustments

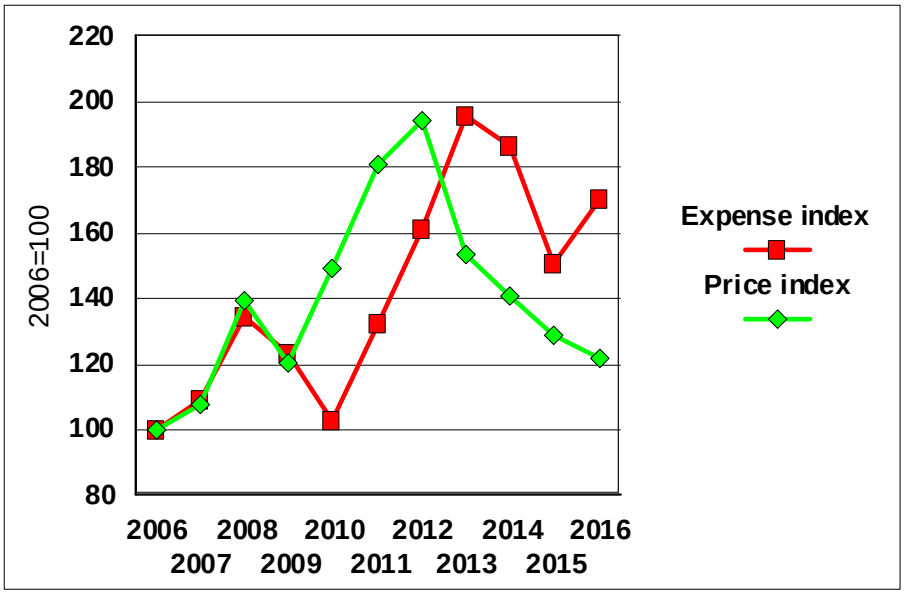


Figure 6. A Weighted Average North Dakota Commodity Price Index and An Expense Index

A commodity price index and an expense index were created to show the relationship between recent commodity price changes and North Dakota farm expense. The commodity index is the weighted average of crop production, wheat, corn and soybeans times average prices received by farmers normalized to 2006=100. The expense index is the total per acre expense from the representative farms normalized to 2006=100. Figure 6 shows that between 2006 and 2009 farm expenses and commodity prices followed similar paths. Beginning in 2010 through 2012, commodity prices increased much faster than expenses. During 2013 and 2014 expenses increased faster than prices but in 2015 that trend changed. In 2016 expenses increased, which lowered potential net farm income increases.

Structure of the Representative Farm Model

The model consists of four components: net farm income, debt-to-asset ratio, land price, and cash rent. This section discusses the definition of each component and the formulas used to calculate them.

Net Farm Income

Net farm income is calculated by subtracting total crop and livestock expenses from total farm income. Crop and livestock expenses consist of direct costs that include seed, fertilizer, fuel, repairs, feed, supplies, feeder livestock purchases, and hired labor; and indirect costs that include machinery depreciation, overhead such as insurance and licenses, land taxes, and land rent or interest on real estate debt. Total farm income is the sum of cash receipts from crop and livestock enterprises, government payments, CRP payments, custom work, patronage dividends, insurance income, and miscellaneous income. Net farm income is calculated as

$$NFI = \sum_{j=1}^{n} Y_j P_j A_j + \sum_{h=1}^{m} P_h L_h + \sum_{j=1}^{n} S_j A_j + I^o - \sum_{h=1}^{m} EX_h^L - \sum_{j=1}^{n} EX_j^C \quad (1)$$

where

Y_j	=	yield per acre for crop j,
P_j	=	price of crop j,
A_j	=	planted acres of crop j,
P_h	=	price of livestock h,
L_h	=	number of livestock h sold,
S_j	=	government subsidies for crop j per acre,
I^o	=	other farm income,
EX^C_j	=	total expenses in producing crop j,
EX^L_h	=	total expenses in producing livestock h.

Inventory changes, accounts receivable, accounts payable, and prepaid expenses and supplies are assumed to be constant from year to year. Cash receipts are based on predicted cash prices and yields in North Dakota. Cash prices received by farmers are based on national price projection made by USDA, adjusted to North Dakota. The adjustments are estimated from North Dakota price equations, which are calculated on the basis of the historical relationships between North Dakota prices and U.S. export prices of the commodities. Annual data from 1974 to 2016 are used to estimate price equations. The price equations were used to estimate cash prices received by North Dakota farmers for the 2017-2026 period. USDA prices are used as exogenous variables in the price estimates.

Regional North Dakota yield trend equations were estimated from historical yield data reported by the North Dakota Agricultural Statistics Service from 1974 to 2016. The estimated equations were used to forecast crop yield trends for future years. A dummy variable was used to compensate for two drought years: 1980 and 1988.

Debt-to-asset Ratio

The debt-to-asset ratio is calculated by dividing total outstanding farm debt by total farm assets. Total debt includes debt on land, intermediate debt, and short-term debt. Total assets include price of farmland times acres of farmland owned and the depreciated value of farm equipment and supplies, livestock, and liquid assets. Annual payments that are made by producers equal depreciation to maintain the current value of machinery. The value of farm equipment, supplies, and livestock is assumed to be constant over the forecast period.

Cropland Prices and Cash Rent

Land prices for representative farms are estimated on the basis of the implicit discount rate the farms have previously used and the expected return on land. Therefore, land prices are defined as the amount that farms can afford to pay for farmland. They are not prevailing market prices. Financial data from average representative farms for each region are used to calculate a dollar return to land. To do this, all production expenses for the crops, including depreciation,

land taxes, a labor charge for unpaid family labor, net return from a livestock enterprise, and a management fee equivalent to that charged by bank trust departments for management of share-rented farms, are subtracted from gross farm income. To the remaining balance, interest on real estate debt is added back because the return to land is not affected by ownership of the land. This figure is used as the return allocated to cropland.

The average return allocated to each acre of cropland per year is divided by the average cropland price to determine the long-run capitalization rate used by farmers, as follows:

$$R_g = \frac{M_g}{PL_g} \tag{2}$$

where

R_g = long-run capitalization rate in region g,
M_g = average net return allocated to cropland in region g,
PL_g = average observed price of cropland in region g.

For the forecast years, this capitalization rate is applied to the estimated average income per acre allocated to cropland to determine cropland value for land utilized to produce wheat, corn, soybeans, barley, and sunflowers. The average net return is an n-year weighted moving average of annual per acre income. Calculation of cropland prices is summarized as

$$PL_{gt} = \frac{1}{R_g} \sum_{t=t-n}^{t} W_t \, M_{tg} + T_r \tag{3}$$

where

PL_{gt} = cropland price in region g in time t,
W_t = weighting factor for year t,
M_{tg} = net return allocated to cropland in region g and year t,
T_r = trend.

The price of cropland calculated in Equation 3 can be defined as the amount farmers are willing to pay for the cropland to produce wheat, barley, corn, soybeans, and sunflowers.

Cash Rent

Cash rent for cropland is calculated by multiplying a k-year moving average of the estimated price of cropland by the long-run capitalization rate, plus taxes on land. Calculation of cash rent is summarized by

$$CR_{gt} = \sum_{t=t-k}^{t} PL_{gt} \, R_g + TX_t \tag{4}$$

CR_{gt} = cropland cash rent in region g in time t,
PL_{gt} = estimated price of cropland in region g and year t,
TX_t = taxes on land in time t,
R_g = long-run capitalization rate in region g.

The cash rent is defined as the amount farmers are willing to pay for the rented cropland to produce wheat, barley, corn, soybeans, and sunflowers.

Data Used for the Representative Farm

The commodity prices for crops are obtained from the USDA Long-term Projections and ND Global Wheat Policy simulation models. The national average farm prices are converted to the prices received by North Dakota representative farms by regressing the average farm price of each crop produced in North Dakota against the national average farm price of the same crop. The price equation used for this study is specified in a dynamic framework on the basis of Nerlove's partial adjustment hypothesis, as follows:

$$P_{it} = a_0 + a_1 P_t + a_2 P_{it-1} + e_{it} \quad (5)$$

where P_{it} = average farm price of a crop in region i in time t,
P_t = national average farm price of a crop in time t.

The price equation is estimated for each crop produced in North Dakota using the time series data from 1975 to 2016. The estimated equations are used to predict average prices received by farmers in each region from the national average prices found in the USDA and ND simulation models. Table 3 shows the projected North Dakota prices based on USDA's estimates. USDA estimates that crop prices will increase to the upper $5.00 range for wheat and mid $3.00 range for corn.

Table 3. North Dakota Baseline Price Estimates

	Spring Wheat	Durum Wheat	Malting Barley	Sunflower	Soybeans	Corn	Canola
	----------$/bu----------			-$/cwt-	-------$/bu-------		-$/cwt-
2016	4.59	6.17	4.54	18.93	8.72	3.22	16.34
2017	5.10	6.05	4.89	20.20	9.18	3.44	17.60
2018	5.43	6.44	5.02	20.46	9.40	3.59	17.86
2019	5.61	6.65	5.01	20.52	9.45	3.58	17.93
2020	5.64	6.69	4.97	20.41	9.35	3.54	17.81
2021	5.64	6.69	4.96	20.20	9.18	3.53	17.60
2022	5.59	6.63	4.97	20.16	9.15	3.54	17.56
2023	5.60	6.64	4.96	20.20	9.18	3.53	17.60
2024	5.58	6.61	4.96	20.14	9.13	3.53	17.54
2025	5.56	6.60	4.96	20.20	9.18	3.52	17.60
2026	5.51	6.54	4.93	20.07	9.06	3.49	17.47

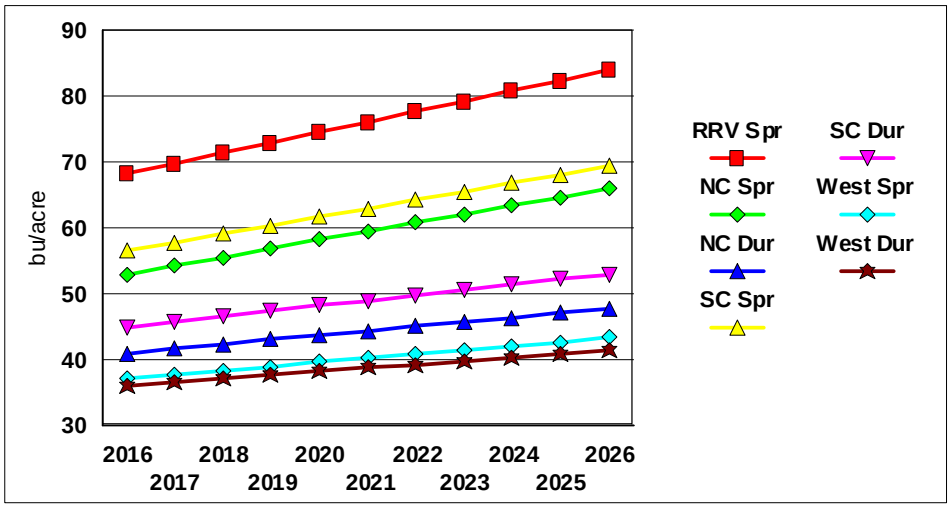


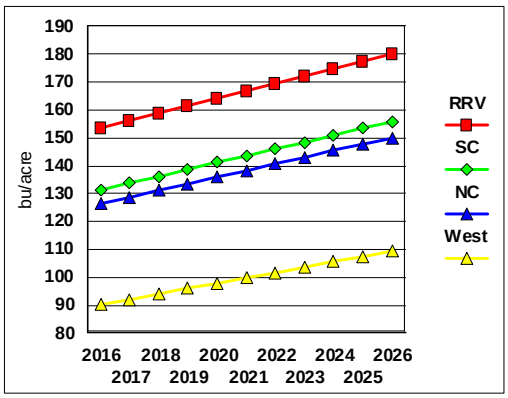
Figure 7. North Dakota Estimated Wheat Yields Used in the Representative Farm Model

Crop yields in each region also are predicted using the estimated yield equations for crops produced in each region. The yield equation for each crop in each region is specified in the same dynamic framework as that in the price equation, as follows:

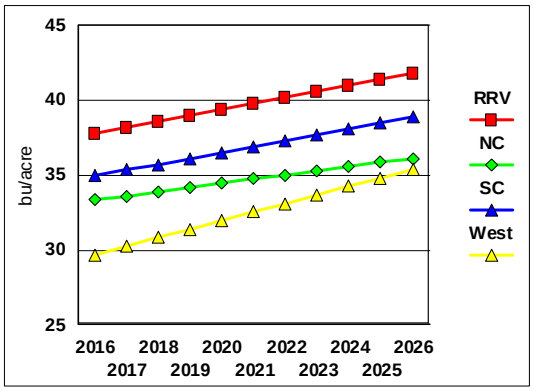
$$y_{it} = b_0 + b_1 \text{ trend} + b_2 y_{it-1} + D_t + e_{it} \qquad (6)$$

where y_{it} represents yield of a crop in region i in time t, and e_{it} is a random error term. A dummy variable (D) was used to compensate for two drought years: 1980 and 1988. The trend variable is included to capture changes in production technology.

This equation is estimated for each crop in each region using time series data from 1974 to 2016. The estimated equations are used to predict crop yields in each region. Figure 7 shows the estimated spring and durum wheat yields. The yields show a slight upward trend throughout the forecast period. Figure 8 shows the estimated yields for corn and soybeans. Corn and soybean yields are also expected to increase over the forecast period.



Corn



Soybeans

Figure 8. North Dakota Estimated Row-crop Yields Used in the Representative Farm Model

Crop mix changes over time as a function of prices of the crops produced in each region. A dynamic acreage equation for each crop is specified on the basis of Nerlove's partial adjustment hypothesis, as follows:

$$A_{jit} = C_o + \sum_{j=1}^{n} C_j \; P_{jit} + C_{n+1} \, A_{jit-1} + C_{n+2} \, G_{jt} + e_{jit} \qquad (7)$$

where A_{jit} = the total acres of the jth crop in region i in time t,
P_{jit} = the price of the jth crop in region i in time t,
G_{jt} = government policy variables applied to the jth crop in time t,
e_{jit} = a random error term
C = regression coefficient.

The equations are estimated using time series data from 1976 to 2016. The estimated equations are used to predict the total acres of each crop produced in each region. The predicted

prices from Equation 5 are used in the acreage equations. The jth crop share in region i in time t is then calculated as follows:

$$S_{jit} = A_{jit} / \sum_{j=1}^{i} A_{jit} \quad (8)$$

where S_{jit} is an acreage share of the jth crop in region i in time t.

The estimated share of a crop is applied to calculate the total acres of the crop produced in the region by multiplying the total acres in the region by the share.

Other data needed for the model are obtained from the North Dakota Farm and Ranch Business Management Association.

Farm size has been increasing about 1.0% per year. The size increase has been similar for all profit and size categories of farms. However, that increase has stopped during the past 5 years. During the forecast period, the representative farms are allowed to increase 1% in size per year. With the increased size, expenses are allowed to increase about 1% above the expected rate of inflation to account for the additional acreage. Expenses have increased substantially in recent years. Since 2006, production expenses increased 109% during the previous 7 years, which is a 11% average increase per year. Expenses are assumed to return to 2% per year increases between 2017 and 2026.

In the previous reports, livestock income was assumed to remain constant throughout the forecast period. The model was adapted to allow returns from livestock to follow USDA's projections for cow-calf prices in the future. USDA projects the cattle market will remain weak through 2026.

All risk federal crop insurance is assumed to be carried by all representative farms at the 80% level. Each representative farm is also assumed to be enrolled in the Agricultural Risk Coverage option of the 2014 farm bill.

Agricultural Outlook for the Representative Farms, 2017-2026

The North Dakota Representative Farm Model was used to estimate net farm income, debt-to-asset ratios, land prices, and rental rates for 2017-2026. Additional assumptions in this study are:

1. Net farm income from the production of other crops, including potatoes and dry beans, remains constant during the period.

2. The farm equipment stock remains constant, indicating that depreciation allowances are invested back into farm equipment.

3. Inventory changes, accounts receivable, accounts payable, prepaid expenses and supplies are constant from year to year.

4. The U.S. farm program and macroeconomic policies remain the same during the forecasting period.

5. The 2018 Farm bill will be similar to the 2014 Farm bill.

6. Weather conditions and other factors affecting production practices are normal.

7. Family living expense is taken out of net farm income.

Net Income for North Dakota Representative Farms

Table 4 presents net farm income for farms by size and profitability. Average net income for North Dakota representative farms varies, depending upon the size of farm and its profitability. The net income for the large-size farm is expected to fall to $152 thousand in 2026 (Figure 8). Net farm income, for the medium-size farm, decreases from $85 thousand in 2017 to $62 thousand in 2026. Net farm income for the small-size farm was $32 thousand for 2017 and will decrease to $22 thousand in 2026. The decrease in net farm income is due mainly to increasing expenses. State average net farm income over the 10-year period is $184 thousand for the large-size farm, $74 thousand for the medium-size farm, and $28 thousand for the small-size farm. This implies that most large and medium size farms in North Dakota will have enough income under the current farm bill and international price conditions, although the small-size farm may need off-farm income to supplement family living.

Table 4. State Average Net Farm Income for Different Size and Profit Representative Farms

	Size			Profit		
	Large	Medium	Small	High	Average	Low
	----------dollars----------					
2016	237,584	89,422	32,464	367,326	80,372	-41,904
2017	202,307	84,555	32,296	233,640	67,865	-40.265
2018	196,764	78,852	31,477	221,295	66,215	-39,596
2019	189,930	75,365	30,112	213,114	64,634	-43,890
2020	184,612	73,939	29,455	205,046	62,742	-44,488
2021	176,285	71,310	28,593	200,570	60,882	-47,816
2022	170,735	69,529	27,244	193,731	59,598	-49,290
2023	163,923	67,201	25,497	186,429	58,663	-49,925
2024	160,309	65,334	23,602	184,784	58,002	-52,120
2025	154,858	63,039	22,410	182,121	56,859	-52,300
2026	151,724	62,011	21,856	179,951	55,507	-52,610

Future crop production in the United States and around the world is predicted to be consistent with annual trend line increases, while demand is predicted to increase slowly.

Net farm income for the high-profit farm was $367 thousand for 2016 and is expected to decrease to $180 thousand in 2026 (Figure 9). Net farm income for the average-profit farm was $80 thousand in 2016 and is projected to fall to $56 thousand in 2026. The low-profit farm had a net farm income of -$42 thousand in 2016 and will slowly decrease to -$53 thousand by 2026.

The low-profit farm may not have the financial resiliency to survive without outside income. State average net farm income over the 2017-2026 period is $200 thousand for the high-profit farm, $61 thousand for the average-profit farm, and -$47 thousand for the low-profit farm.

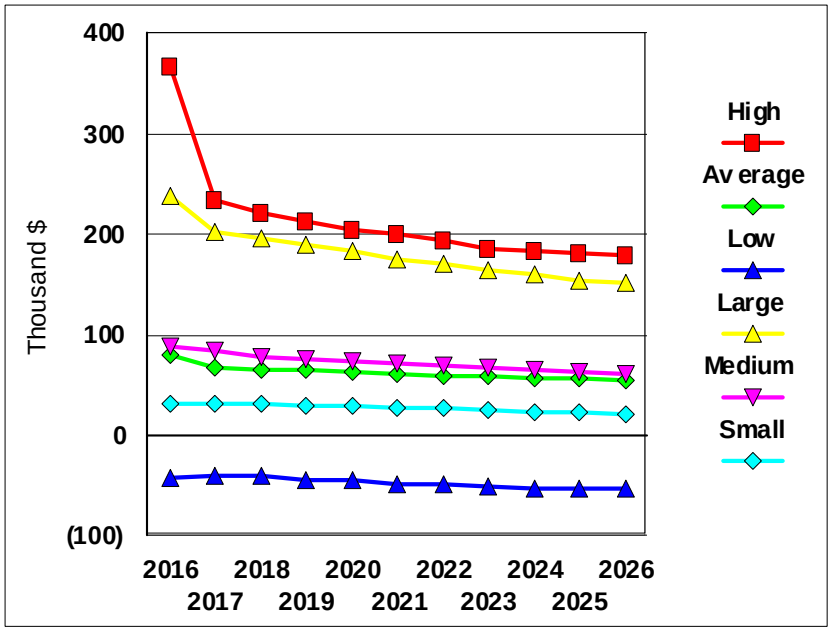


Figure 9. Net Farm Income for Size and Profit North Dakota Representative Farms

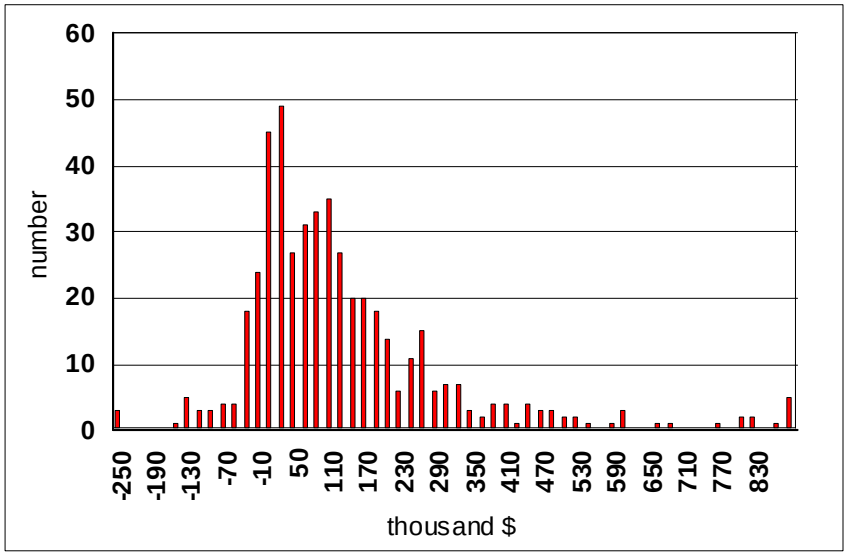


Figure 10. Number of Farms in Each Income Category, 2017

Figure 10 shows the distribution at each income level for the average profit farms in the North Dakota Farm and Ranch Business Management Education. A majority of the producers are in the $-30 thousand to $170 thousand range for net farm income with a long tail extending out to over $800 thousand. Last year the distribution was centered around -$10 thousand with the majority of producers between -$20 thousand and $20 thousand range.

Risk Simulation

A range of net farm incomes are estimated under risk as future yields and prices are unknown. The amount of risk is based on the standard deviation and means of each unknown yield and price. The variation in price was assumed to follow a lognormal distribution and the variation in yield was assumed to follow a truncated normal distribution. Most commodity prices follow a lognormal distribution. The yields are truncated at zero because of the large standard deviation. Yields of some crops under @RISK will fall below zero, which is unrealistic. The yields of the various crops are correlated with each other based on historical patterns. The correlations between different small grains are typically greater than correlations between small grains and row crops, likewise, the correlations between different row crops are greater than correlations between row crops and small grains. Typical correlations between spring wheat, durum wheat and barley are between 0.85 and 0.95 within a region and 0.71 and 0.88 between regions. The correlation between row crops, corn, soybeans, sunflowers and canola is between 0.75 to 0.83 within a region and 0.60 and 0.79 between regions. The correlation between small grains and row crops is small and assumed to be zero. It was determined that there was very little correlation between North Dakota yields and national prices, except for sunflowers, canola and durum wheat. The model is iterated 3000 times, which allows output distributions to converge within acceptable criteria. The mean yields are allowed to increase throughout the time period and standard deviations are assumed to remain constant.

Figure 11 shows the distribution for spring wheat prices in North Dakota for 2017. The mean is $5.43 per bushel and the standard deviation is $1.40 per bushel. The 90% confidence interval is between $3.46 per bushel and $7.99 per bushel. This indicates that we are confident that the true spring wheat price for 2017 will be between those two values. Figure 12 shows the distribution for spring wheat yields in the North Central region for 2017. The mean is 53.9 bushel pre acre and the standard deviation is 6.25 bushel per acre. The 90% confidence interval is between 43.0 bushels per acre and 63.9 bushels per acre.

Table 5 shows the forecasted net farm income, standard deviation, maximum and minimum level, and the 90% confidence interval for the average profit representative farms. The standard deviations, an indication of variation, are large for the state, averaging 106% of net farm income in 2017 and almost 165% of average incomes in 2026. The large standard deviation makes long range planning difficult as future incomes are expected to have large fluctuations.

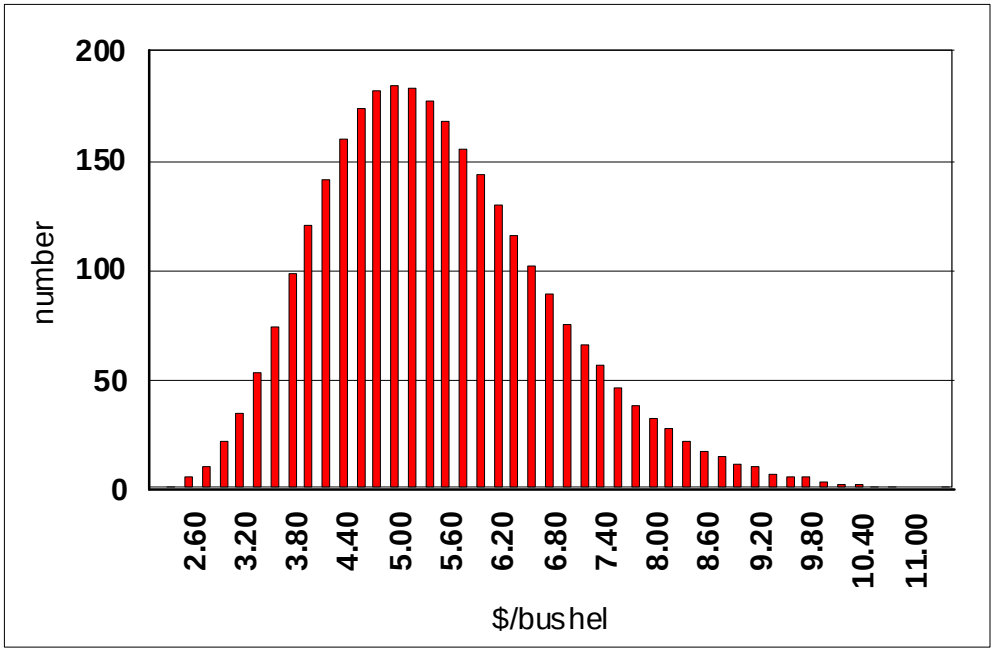


Figure 11. Distribution of Spring Wheat Prices

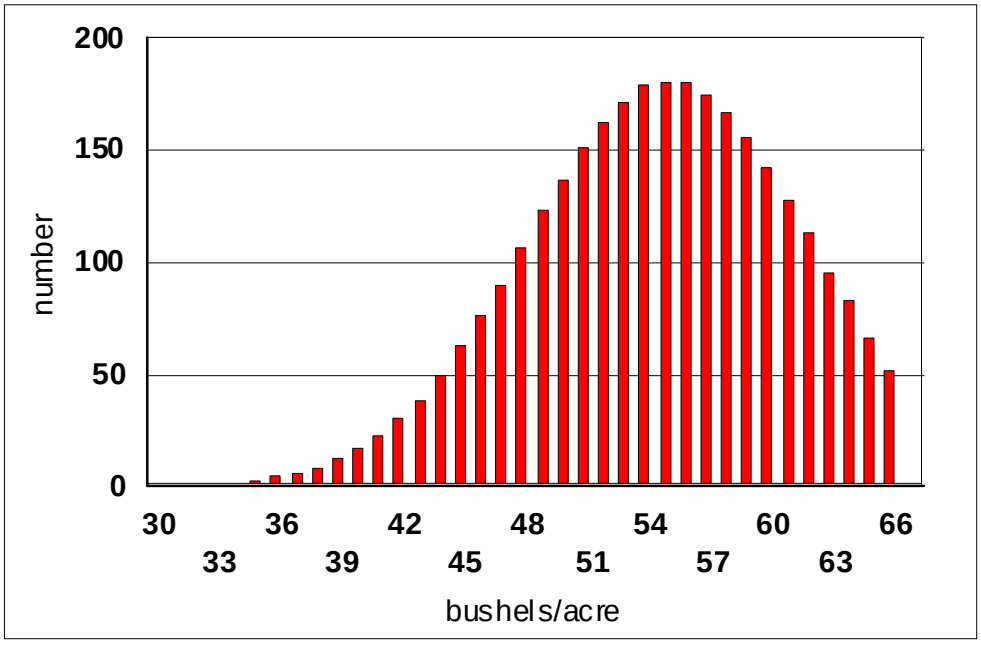


Figure 12. Distribution of Spring Wheat Yields for the North Central Region

The 90% confidence interval means that the mean or average net farm income will be between the lower and upper bounds 90% of the time (90 times out of 100). The extreme width of the confidence interval indicates that net farm income within the state is subject to wide variation and is very difficult to predict.

Table 5. Results of the Simulation for the Average Profit Representative Farm Model, Net Farm Income

	Mean	Std Deviation	Maximum	Minimum	90% Confidence Interval
	----------dollars----------				
2017	67,865	72,203	520,711	-94,834	-30,890 to 200,483
2020	62,742	78,982	495,601	-96,840	-45,218 to 208,671
2026	55,507	91,178	524,708	-141,017	-71,637 to 220,784

Debt-to-asset Ratios for North Dakota Representative Farms

Debt-to-asset ratios for all representative farms except for the high profit should increase throughout the forecast period (Table 6 and Figures 11-12). The debt-to asset ratio is total debts, long, intermediate and short term, divided by total assets. The debt-to-asset ratio is one of the financial measures used to estimate the financial health of a business. The debt-to-asset ratio for the large size farm in 2017 is projected to be 0.40 and remain near that level through 2026. The medium size farm debt-to-asset ratio is 0.42 in 2017 and increases slowly to 0.45 by 2026. The small farm's debt-to-asset increases from 0.48 in 2017 to 0.52 in 2026. The debt-to-asset ratio decreases from 0.36 in 2017 to 0.32 in 2026 for the high profit farms and increases from 0.43 in 2017 to 0.46 in 2026 for the average profit farm. The debt-to-asset ratio for the low profit farm increases from 0.56 in 2017 to 0.60 in 2026. The low income levels for both the small size and the low profit farms require income from outside sources for the family to continue farming. In 2016, low profit farms averaged over $41,000 in off-farm income and small size farms averaged nearly $44,000.

Table 6. State Average Debt-to-asset Ratios for Different Size and Profit Representative Farms

	Size			Profit		
	Large	Medium	Small	High	Average	Low
2016	0.40	0.42	0.49	0.37	0.43	0.54
2017	0.40	0.42	0.48	0.36	0.43	0.55
2018	0.39	0.42	0.48	0.36	0.43	0.55
2019	0.39	0.42	0.48	0.35	0.43	0.56
2020	0.39	0.42	0.48	0.35	0.44	0.56
2021	0.39	0.42	0.49	0.34	0.44	0.57
2022	0.39	0.42	0.49	0.34	0.44	0.57
2023	0.39	0.43	0.50	0.33	0.45	0.58
2024	0.40	0.43	0.51	0.33	0.45	0.59
2025	0.40	0.44	0.51	0.32	0.45	0.59
2026	0.40	0.45	0.52	0.32	0.46	0.60
Average	0.39	0.43	0.50	0.34	0.44	0.57

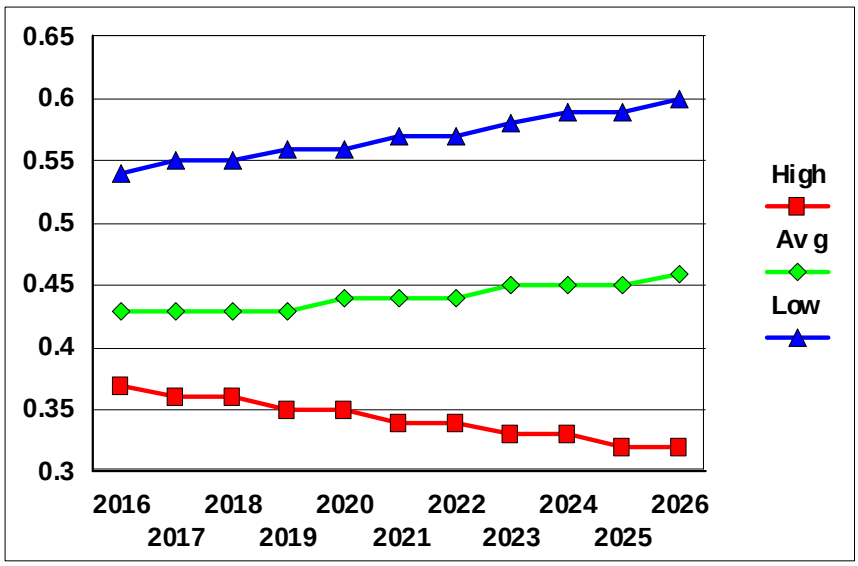


Figure 11. Debt-to-asset Ratio for North Dakota Representative Farms by Profit Category

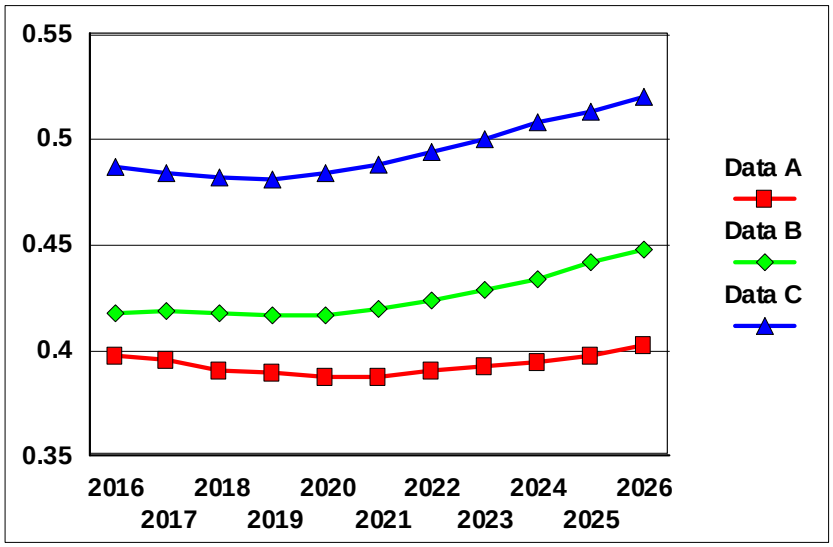


Figure 12. Debt-to-asset Ratio for North Dakota Representative Farms by Size Category

Farm Land Value and Cash Rents

Table 7 presents estimated land values for representative farms in North Dakota. Land values have increased substantially in recent years. The historical weighted average cropland value in North Dakota was $490 per acre in 2004 increasing to $842 per acre in 2007 and increased further to $985 per acre in 2008. Cropland values were $1,028 in 2009, $1,169 in 2010, $1,414 in 2011 and increased to $2,124 in 2013. Cropland values did not change very much between 2012 and 2014, however in 2016 average North Dakota land values were $1896 per acre. The estimates are released in early spring each year. Cropland values in the model

depend on return-to-land. Future land values in the RRV are expected to decrease from $3,496 per acre in 2016 to $3,096 per acre in 2026 (Figure 12). Land values in the other regions are also expected to decrease. Most yearly decreases are about 1.5%. For example, land in the NC region is estimated to decrease about 11% from a value of $1,671 per acre in 2016 to $1,487 per acre in 2026. Land in the SC region is expected to decrease in value about 16% from $2,204 in 2016 to $1,849 in 2026. Land in the West is expected to decrease about 6% between 2016 and 2026. Cash rents follow land prices, which will decrease operating expenses.

Cash rents for the average-profit farms will decrease slightly slower than land values because cast rents typically lag behind land values both on the way up as well as on the way down (Table 8). Cash rents also differ between regions; the highest are in the RRV, and the lowest are in the West (Figure 13).

Table 7. North Dakota Land Prices for Average-Profit Representative Farms

	RRV	NC	SC	West	State
	----------$/acre----------				
2016	3,496	1,671	2,204	1,283	2,164
2017	3,411	1,631	2,124	1,258	2,106
2018	3,336	1,596	2,054	1,238	2,056
2019	3,271	1,566	1,994	1,223	2,014
2020	3,216	1,541	1,944	1,213	1,979
2021	3,171	1,521	1,904	1,208	1,951
2022	3,136	1,506	1,874	1,203	1,930
2023	3,111	1,496	1,854	1,198	1,915
2024	3,096	1,491	1,844	1,198	1,907
2025	3,091	1,486	1,841	1,203	1,906
2026	3,096	1,487	1,849	1,208	1,910
2017-26 ave	3,185	1,528	1,922	1,215	1,962

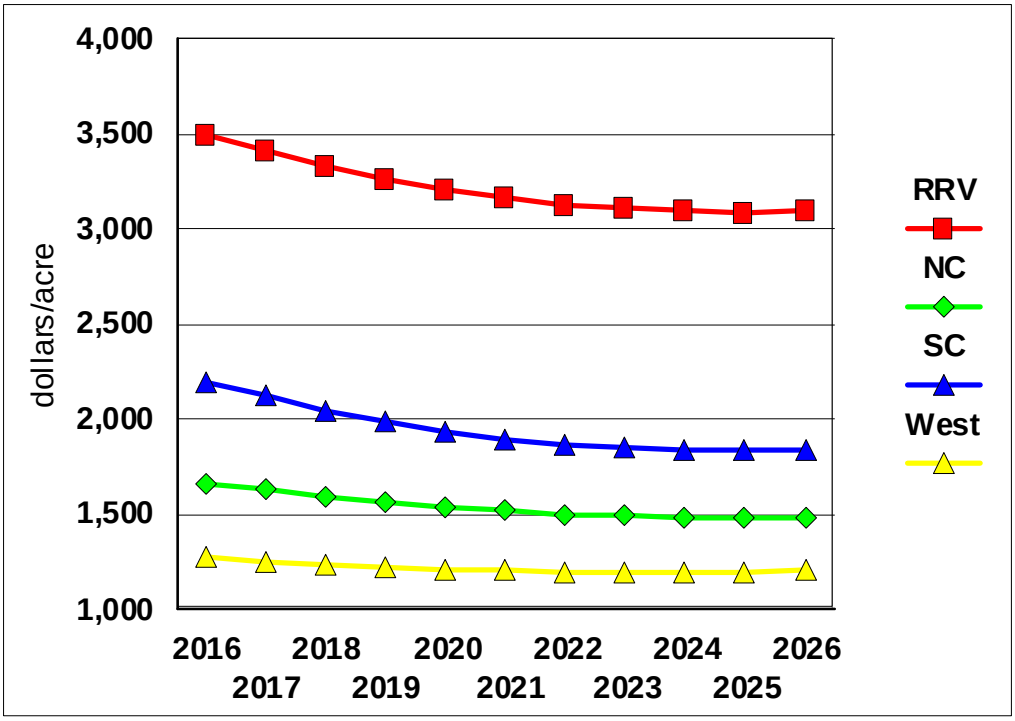


Figure 13. Average Value of Cropland for North Dakota Average-Profit Representative Farms

Table 8. North Dakota Cash Rent for Average-Profit Representative Farms

	RRV	NC	SC	West	State
	----------$/acre----------				
2016	105.94	57.62	68.88	44.24	69.17
2017	103.36	56.24	66.38	43.38	67.34
2018	101.09	55.03	64.19	42.69	65.75
2019	99.12	54.00	62.31	42.17	64.40
2020	97.45	53.14	60.75	41.83	63.29
2021	96.09	52.45	59.50	41.66	62.42
2022	95.03	51.93	58.56	41.48	61.75
2023	94.27	51.59	57.94	41.31	61.28
2024	93.82	51.41	57.63	41.31	61.04
2025	93.67	51.24	57.63	41.48	61.00
2026	93.82	51.24	57.78	41.66	61.12
2017-2026 ave	96.77	52.83	60.27	41.90	62.94

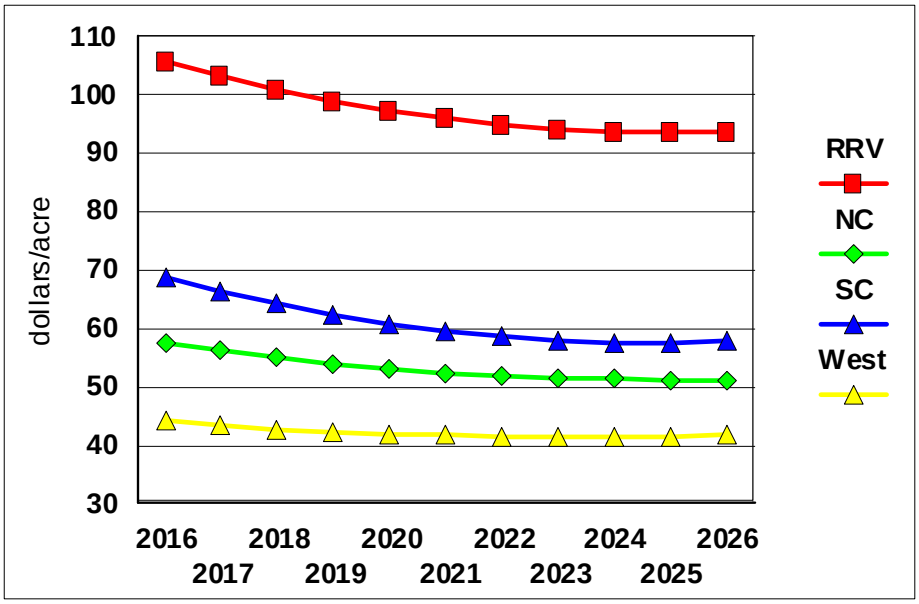


Figure 14. Average Cash Rent of Cropland for North Dakota Average-Profit Representative Farms

CONCLUDING REMARKS

Net farm income in 2026 is predicted to be lower than in 2016 for all farms. For example, net farm income for the average profit farm was $80 thousand in 2016 and is predicted to be $56 thousand in 2026, net farm income for the high profit farm was $367 thousand in 2016 and is projected to decrease to $180 thousand in 2026. The decreases in net farm income for the 2016-2026 period is due mainly to expected increases in production expenses and level commodity prices. Production expenses increased 351% since 1994 and 186% since 2005, however they fell 16% in 2010 but increased 28% in 2011, 22% in 2012 and 17% in 2013. Farm expenses decreased 5% in 2014 and 16.6% in 2015, however expenses increased 12% during 2016. It was assumed the expenses for 2017 will increase 2% above 2016 levels and continue increasing at the 2% level. If producers can continue to reduce expenses the income situation will be substantially different. Crop production in the United States and around the world is assumed to be normal with annual trend-line increases.

Most commodity prices fell between 14% and 18% between 2012 and 2013 and fell between 13% and 30% in 2014. For 2016 commodity prices changed between a 1% for canola and a 12% decrease for spring wheat. Future projected prices are expected to increase slowly over the next 7 years before falling during the last 2 or 3 years.

Debt-to-asset ratios are predicted to increase slowly, except for the high profit farms, throughout the forecast period.

Land values are predicted to decrease slowly during the forecast period because they are based on return to land. Projected land values would decrease between 6% and 16% for the

projection period. Historically, recent North Dakota land prices have increased from $490 per acre in 2004 to $2,164 per acre in 2015. Cash rent levels follow patterns similar to land values.

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