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2014 North Dakota Agricultural Outlook: Representative Farms, 2014-2023

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ABSTRACT

Net farm income in North Dakota was at record levels for most representative farms in 2012. However net farm income fell for 2013 and is expected to continue to fall through 2023. Commodity prices are expected to decrease 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 low profit farm will increase slightly throughout the forecast period. Debt-to-asset ratios for the low-profit farms are expected to increase slightly.

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

HIGHLIGHTS

Net farm income in 2014 is projected to be lower than 2013 for all farms, but much higher than the 2003-2008 average. The high prices received in 2012 were not maintained in 2013 and are expected to be lower in the near future before increasing toward the last few years' averages.

Net farm income for the large-size farm is predicted to decrease from $220 thousand to $174 thousand, decrease from $89 to $62 thousand for the medium-size farm, decrease from $366 to $180 thousand for the high-profit farm and decrease from $92 to $87 thousand for the average-profit farm for the 2014- 2023 period. Net farm income for the low-profit farm is predicted to decrease from -$31 thousand in 2014 to -$33 thousand in 2023. Similarly, net farm income for small size farm may decrease slowly from the mid $40,000 in 2013 to the mid $24,000 in 2023.

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 2014, the average net farm income is expected to be $124 thousand with a standard deviation of $46 thousand. The 90% confidence interval is between $71 thousand and $212 thousand. By 2023, the average net farm income is expected to be $85 thousand with a standard deviation of $68 thousand and the 90% confidence interval is between $19 thousand and $217 thousand.

Debt-to-asset ratios for most representative farms are predicted to increase slightly except for the low profit farm throughout the forecast period. Debt-to-asset ratios are projected to increase 3% for the large-size representative farm, 3% for the medium-size representative farm, and increase 5% for the small-size representative farm by 2022. The ratios are also projected to remain constant for the high-profit representative and increase by 6% for the average-profit farm by 2023. The debt-to asset ratio for the low profit farm is projected to increase by 25%.

State average cropland values will increase 29%, from $2,129 per acre in 2013 to $2,751 per acre in 2023. Cash rents will increase 45%, from $63.43 per acre in 2013 to $92.07 per acre in 2023. Cropland values and rent are estimated solely on returns to cropland and not the recent market run-up.

Overall operating expense increased by 172% 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% during 2011 and 23% in 2012.

2014 North Dakota Agricultural Outlook:
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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 commodity prices fell which reduced net farm incomes in North Dakota.

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 2014 to 2023 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 2014-2023 period is based on the baseline projections produced by the 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 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.

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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 five major crops: wheat, barley, corn, soybeans, 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.

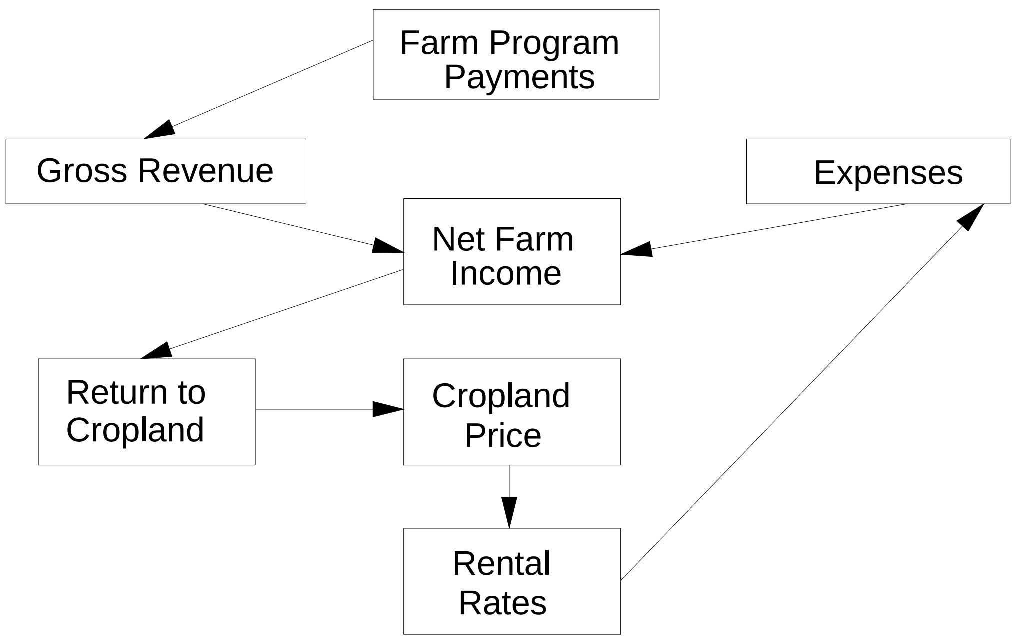
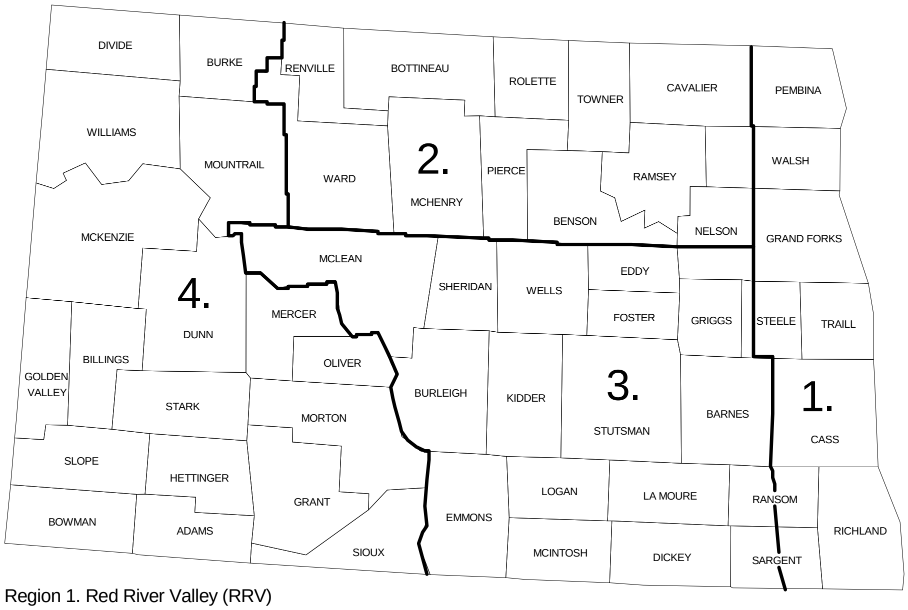


Figure 1. Structure of the North Dakota Representative Farm Model

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.



Region 1. Red River Valley (RRV)
Region 2. North Central (NC)
Region 3. South Central (SC)
Region 4. Western (West)

Figure 2. North Dakota Farm and Ranch Business Management Regions

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 1,851 acres of cropland and 917 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 all farms 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 33% of farm profitability for each production region. The low-profit representative farm is an average of farms in the bottom 33% of farm profitability in each production region. Average farm sizes are 2,955 cropland acres for the high-profit farms, 1,851 cropland acres for the average-profit farms, and 1,179 cropland acres for the low-profit farms. In addition, the high, average, and low profit farms had 596 acres, 889 acres, and 476 acres of pasture, respectively.

Table 1. Characteristics of Representative North Dakota Farms, 2013

	Size			Profit		
	Large	Medium	Small	High	Average	Low
Number of Farms	162	161	162	162	161	162
Total Cropland (ac)	3,582	1,478	494	2,955	1,354	1,179
Spring Wheat (ac)	938	383	78	703	273	128
Durum Wheat (ac)	99	41	15	15	28	69
Barley (ac)	138	51	22	125	41	24
Corn (ac)	456	172	56	253	109	55
Sunflower (ac)	130	89	24	149	49	16
Soybeans (ac)	739	393	92	511	213	114
Preventive Plant	54	51	51	34	44	66

The farms are also divided into large, medium and small size farms. The large representative farm is the average of the largest 33% of farms in cropland acres for each producing region. The small representative farm is an average of the smallest 33% of the farms for each producing region. Average farm sizes are 3,582 cropland acres for the large-size farms, 1,478 cropland acres for the medium-size farms, and 494 cropland acres for the small-size farms (Table 1). In addition, the large, medium, and small-size farms had 899 acres, 683 acres, and 672 acres of pasture, respectively. The size farms include only farms enrolled in the Farm business Management Education program of North Dakota.

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 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 is 1.34 and in 2013 that ratio was 1.22. Figure 4 shows the average crop acres of the farms. In 1994, the average size was 1,262 acres. In 2013, the average size was 1,851 acres. This is an increase of 50% over the 14-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 2013 were $76.31. Operating expenses have increased 440% since 1994 and 109% since 2005.

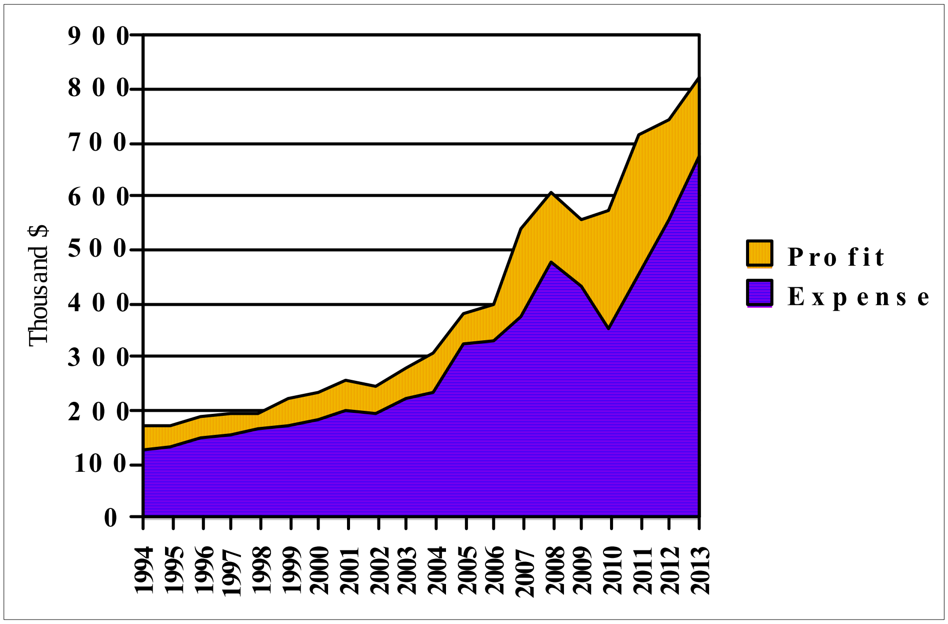


Figure 3. Average Expense and Profit for Farms Excluding the Red River Valley in the North Dakota Farm and Ranch Business Management Program

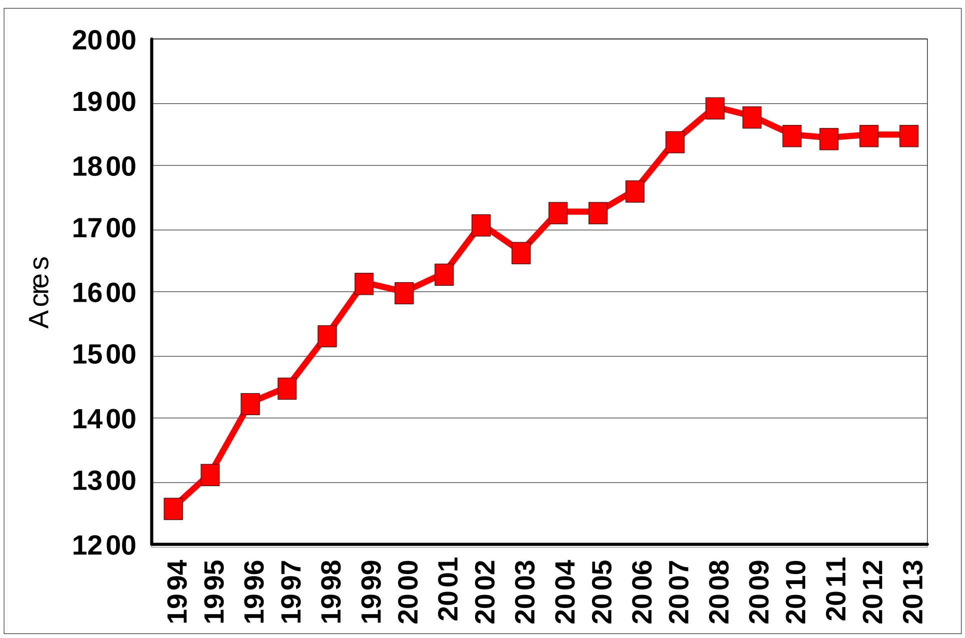


Figure 4. Average Cropland Acres for Farms in the North Dakota Farm and Ranch Business Management Program

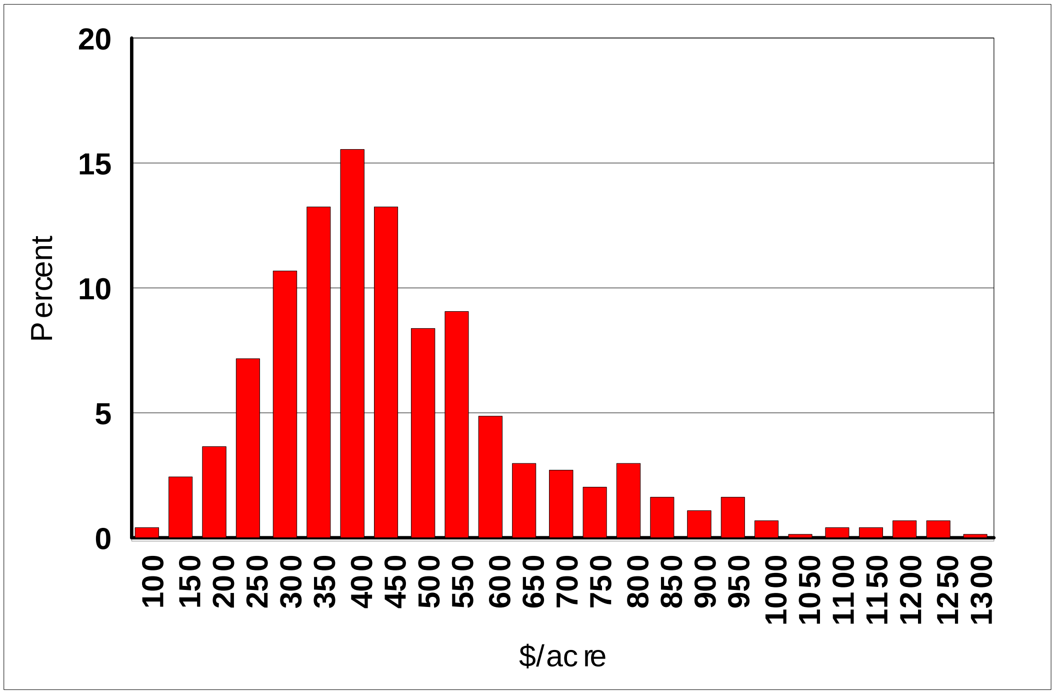


Figure 5. Distribution of Per Acre Gross Returns For Cropland for 2013

Figure 5 shows the distribution of per acre gross returns for all farms within the Farm and Ranch Business Management program for 2013. The majority of the returns are $300 to $450 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 2013 is $428 per acre, an increase of 6% from 2012. Table 2 shows the average per acre gross cash returns to cropland and net farm income for 2000 to 2013. 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 as commodity price fell from the record levels in 2012.

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

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

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

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 including direct payments,
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 2013 are used to estimate price equations. The price equations were used to estimate cash prices received by North Dakota farmers for the 2014-2023 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 2013. 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:

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

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 2013. 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 fall to the upper $5.00 range for wheat and lower $4.00 range for corn.

Table 3. North Dakota Baseline Price Estimates

	Spring Wheat	Durum Wheat	Malting Barley	Sunflower	Soybeans	Corn	Canola
	------------$/bu-------------------			-$/cwt-	-------$/bu-------		-$/cwt-
2013	7.51	8.26	6.02	24.40	13.02	5.86	23.10
2014	5.97	7.02	5.13	20.78	10.16	4.35	19.25
2015	5.76	6.73	5.09	20.69	10.14	4.30	19.16
2016	5.70	6.65	5.08	20.40	10.05	4.28	18.87
2017	5.69	6.63	5.07	20.40	10.05	4.28	18.87
2018	5.66	6.58	5.06	20.62	10.12	4.26	19.09
2019	5.63	6.55	5.05	20.80	10.17	4.25	19.27
2020	5.62	6.53	5.02	20.85	10.19	4.22	19.32
2021	5.60	6.50	4.99	21.02	10.24	4.20	19.49
2022	5.60	6.50	4.99	20.90	10.20	4.18	19.37
2023	5.57	6.47	4.96	20.88	10.19	4.15	19.34

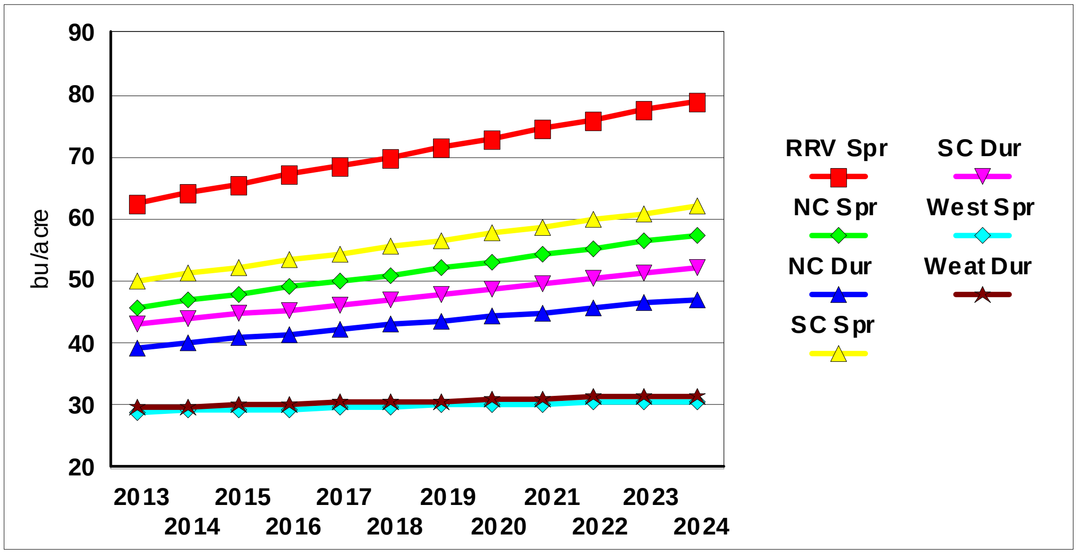


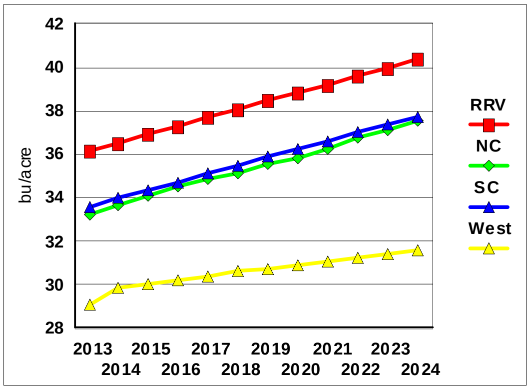
Figure 6. North Dakota Estimated Wheat Yields Used in the Representative Farm Model

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:

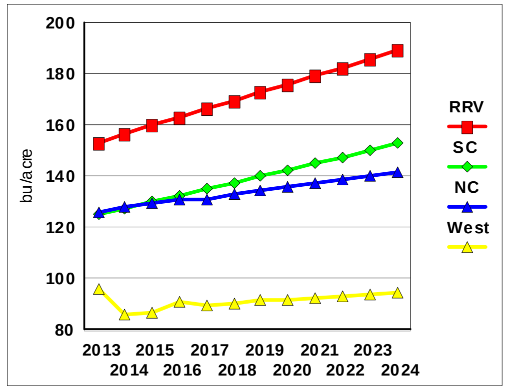
$$y_{it} = b_0 + b_1 \text{ trend} + b_2 \, y_{it-1} + D_t + e_{it} \qquad (6)$$

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 2013. The estimated equations are used to predict crop yields in each region. Figure 6 shows the estimated spring and durum wheat yields. The yields show a slight upward trend throughout the forecast period. Figure 7 shows the estimated yields for corn and soybeans. Corn and soybean yields are also expected to increase over the forecast period.



Soybean



Corn

Figure 7. 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:

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

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 2013. 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:

$$S_{jit} = A_{jit} / \sum_{j=1}^{i} A_{jit} \tag{8}$$

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 2% 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 3% per year increases between 2014 and 2024.

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 strong through 2023.

Agricultural Outlook for the Representative Farms, 2014-2023

The North Dakota Representative Farm Model was used to estimate net farm income, debt-to-asset ratios, land prices, and rental rates for 2014-2023. 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, and 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. Weather conditions and other factors affecting production practices are normal.

6. 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 $174 thousand in 2023 (Figure 8). Net farm income, for the medium-size farm, decreases from $85 thousand in 2013 to $62 thousand in 2023. Net farm income for the small-size farm was $49 thousand for 2013 and will decrease to $24 thousand in 2023. The decrease in net farm income is due mainly to decreasing commodity prices and increases in farm expenses. State average net farm income over the 10-year period is $197 thousand for the large-size farm, $74 thousand for the medium-size farm, and $34 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--					
2013	227,738	84,765	48,896	365,932	92,597	-31,266
2014	220,244	88,933	42,495	252,022	123,988	34,779
2015	208,352	82,409	38,529	228,730	110,467	6,944
2016	202,285	79,644	35,915	217,034	105,985	-682
2017	197,239	74,230	33,483	208,361	103,592	-5,397
2018	191,683	71,682	30,978	207,441	101,745	-9,873
2019	186,778	68,446	29,336	199,058	98,891	-16,493
2020	181,562	66,121	27,265	193,062	96,504	-22,552
2021	178,681	64,635	25,946	185,564	93,351	-26,756
2022	175,916	63,090	25,288	181,111	90,531	-30,943
2023	174,387	62,057	24,164	179,861	87,015	-33,222

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. Except for corn and soybeans, producers have little additional price risk as the reference prices under the PLC are near current and future prices.

Net farm income for the high-profit farm was $366 thousand for 2013 and is expected to decrease to $180 thousand in 2023 (Figure 8). Net farm income for the average-profit farm was $93 thousand in 2013 and is projected to fall to $87 thousand in 2023. The low-profit farm had a net farm income of -$31 thousand in 2013 and will slowly decrease to -$33 thousand by 2023. The low-profit farm may not have the financial resiliency to survive without outside income. State average net farm income over the 2014-2023 period is $224 thousand for the high-profit farm, $102 thousand for the average-profit farm, and -$10 thousand for the low-profit farm.

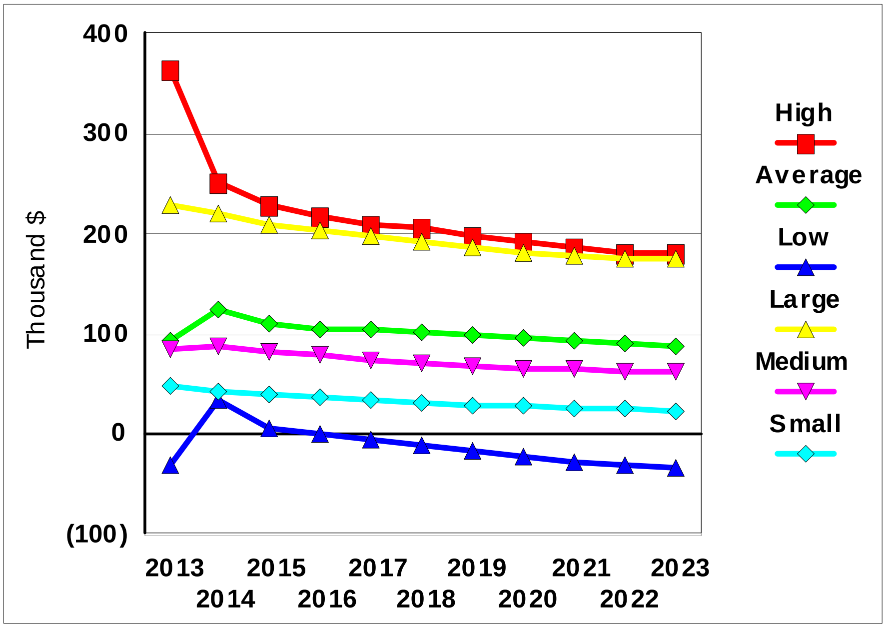


Figure 8. Net Farm Income for Size and Profit North Dakota Representative Farms

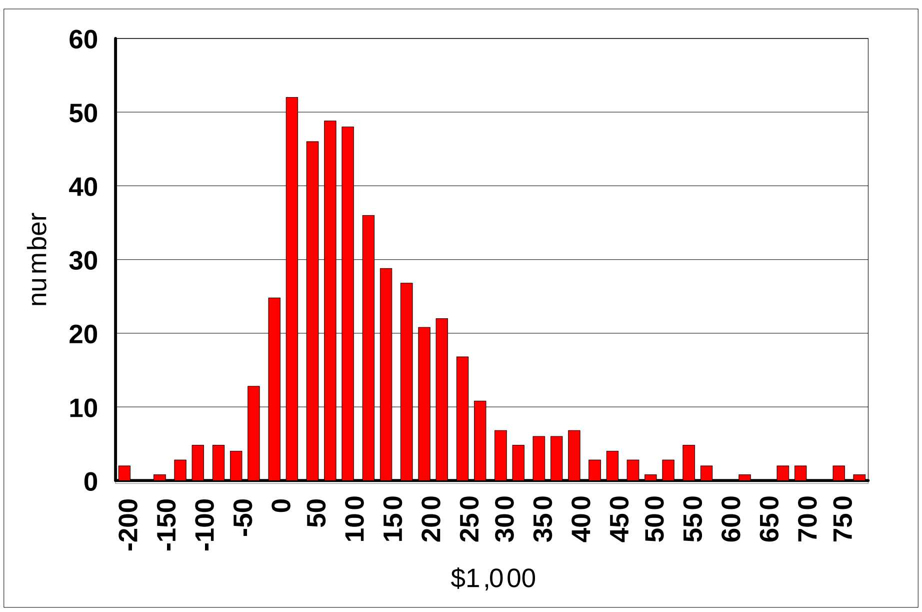


Figure 9. Number of Farms in Each Income Category, 2013

Figure 9 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 $25 thousand to $200 thousand range for net farm income with a long tail extending out to over $750 thousand.

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.

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 37% of net farm income in 2014 and almost 80% of average incomes in 2023. The large standard deviation makes long range planning difficult as future incomes are expected to have large fluctuations.

The 90% confidence interval means that the mean or average net farm income will be between the lower and upper bounds at 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--				
2014	123,987	46,426	337,312	69,810	70,722 to 211,786
2018	101,745	59,931	355,299	43,898	44,073 to 218,966
2023	87,014	68,260	415,351	19,026	19,194 to 216,973

Debt-to-asset Ratios for North Dakota Representative Farms

Debt-to-asset ratios for all representative farms increase slightly throughout the forecast period, except for the low profit farm which increases by 25% (Table 6 and Figures 10-11). 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 2014 is projected to be 0.377 and slowly increases to 0.389 by 2023. This indicates a slight decrease in financial health. The medium size farm debt-to-asset ratio is 0.417 in 2014 and increases slowly to 0.428 by 2023. The small farm's debt-to-asset increases from 0.489 in 2014 to 0.512 in 2023. The debt-to-asset ratio increases from 0.318 in 2014 to 0.320 in 2023 for the high profit farms and 0.443 in 2014 to 0.468 in 2023 for the average profit farm. The debt-to-asset ratio for the low profit farm increases from 0.548 in 2014 to 0.685 in 2023. 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 2013, low profit farms averaged over $38,000 in off farm income and small size farms averaged nearly $40,000.

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

	Size			Profit		
	Large	Medium	Small	High	Average	Low
2014	0.377	0.417	0.489	0.318	0.443	0.548
2015	0.378	0.418	0.492	0.318	0.446	0.563
2016	0.380	0.419	0.494	0.318	0.449	0.578
2017	0.381	0.421	0.497	0.319	0.451	0.594
2018	0.382	0.422	0.499	0.319	0.454	0.609
2019	0.384	0.423	0.502	0.319	0.457	0.624
2020	0.385	0.424	0.504	0.319	0.460	0.639
2021	0.386	0.426	0.507	0.320	0.462	0.655
2022	0.388	0.427	0.509	0.320	0.465	0.670
2023	0.389	0.428	0.512	0.320	0.468	0.685
Average	0.383	0.422	0.501	0.319	0.456	0.616

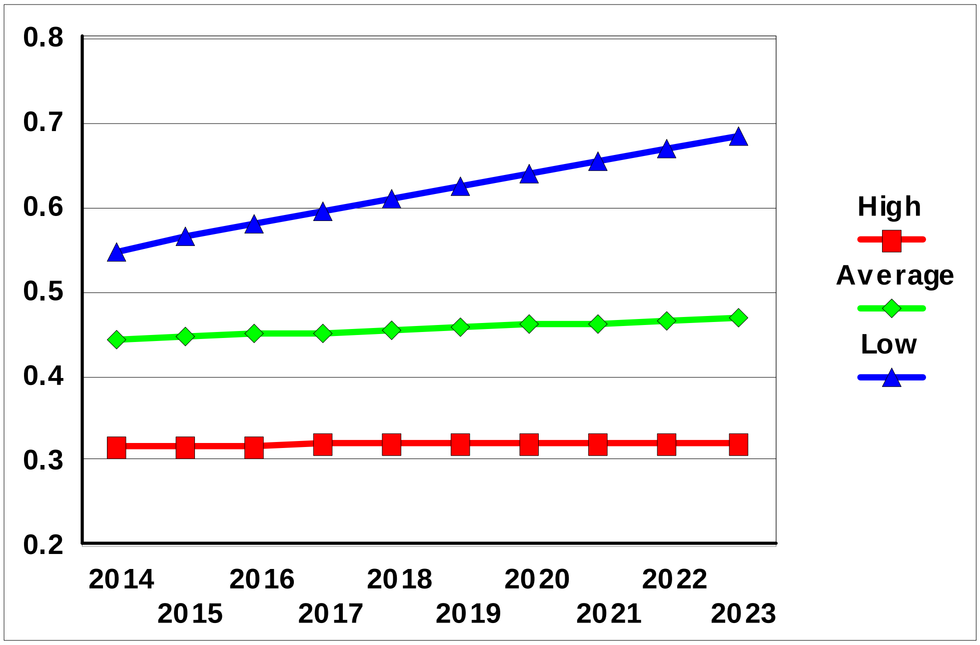


Figure 10. Debt-to-asset Ratio for North Dakota Representative Farms by Profit Category

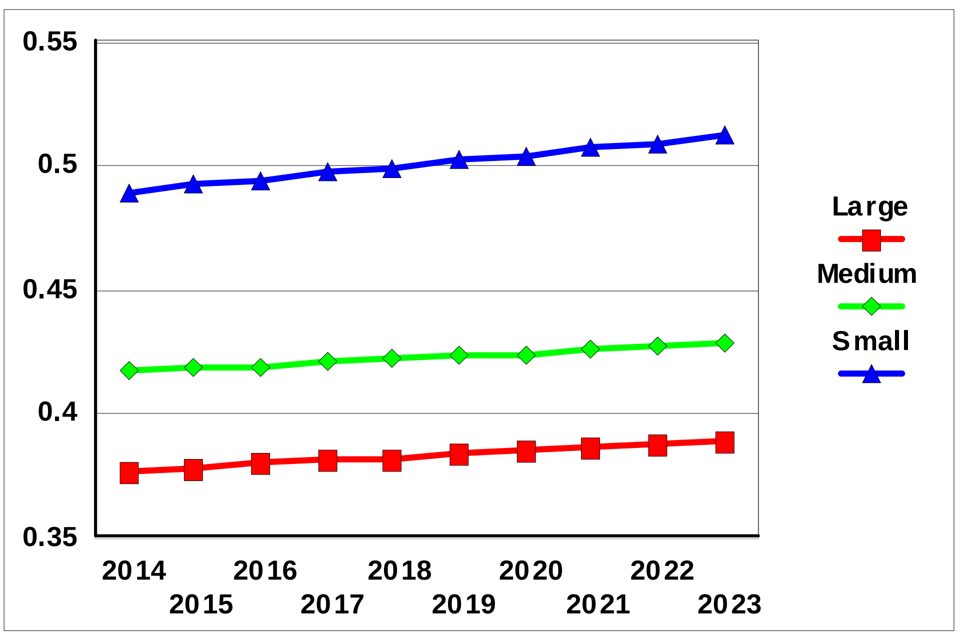


Figure 11. Debt-to-asset Ratio for North Dakota Representative Farms by Size Category

Farm Land Value and Cash Rents

Table 7 presents land values for representative farms in North Dakota. Land values have increased substantially in recent years. The 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 2013. The estimates are released in early spring each year. Cropland values depend on return-to-land. Land values in the RRV are expected to increase from $3,158 per acre in 2013 to $4,081 per acre in 2023 (Figure 12). Land values in the other regions are also expected to increase but slower than they have in the past. Most yearly increases are between 3% and 5%. For example, land in the NC region is estimated to increase about 5% per year from a value of $1,824 per acre in 2013 to $2,357 per acre in 2023. Land in the SC region is expected to increase in value about 3% per year from $2,363 in 2013 to $3,054 in 2023. Land in the West is expected to increase about 3% per year between 2012 and 2023. Cash rents follow land prices which increases operating expenses.

Cash rents for the average-profit farms will increase slightly faster than land values because cast rents have fallen behind land values during the past 5 or 6 years (Table 8). Rents typically lag land values when values rise and then lag when land values go down. 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--------------------------------				
2013	3,158	1,824	2,363	1,171	2,129
2014	3,284	1,897	2,458	1,218	2,214
2015	3,399	1,963	2,544	1,260	2,292
2016	3,501	2,022	2,620	1,298	2,360
2017	3,589	2,073	2,685	1,331	2,419
2018	3,679	2,125	2,752	1,364	2,480
2019	3,770	2,178	2,821	1,398	2,542
2020	3,846	2,221	2,878	1,426	2,593
2021	3,923	2,266	2,935	1,455	2,645
2022	4,001	2,311	2,994	1,484	2,697
2023	4,081	2,357	3,054	1,513	2,751
2014-23 ave	3,707	2,141	2,774	1,375	2,499

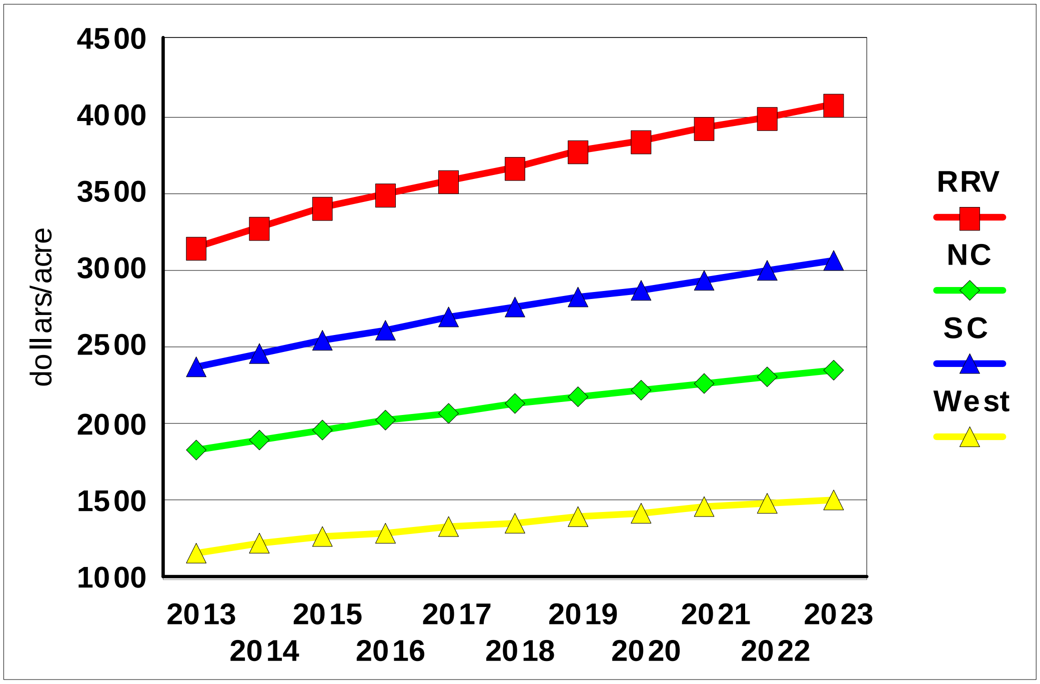


Figure 12. Average Value of Cropland for North Dakota Average-Profit Representative Farms

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

	RRV	NC	SC	West	State
	-------------------------$/acre----------------------------				
2013	90.51	51.93	74.53	36.88	63.46
2014	95.94	55.05	79.00	39.09	67.27
2015	101.22	58.07	83.35	41.24	70.97
2016	106.28	60.98	87.51	43.31	74.52
2017	111.06	63.72	91.45	45.25	77.87
2018	115.50	66.27	95.11	47.06	80.99
2019	119.55	68.59	98.44	48.71	83.82
2020	123.13	70.65	101.39	50.17	86.34
2021	126.21	72.41	103.93	51.43	88.49
2022	128.73	73.86	106.01	52.46	90.26
2023	131.31	75.34	108.13	53.50	92.07
2014-2023 ave	115.89	66.49	95.43	47.22	81.26

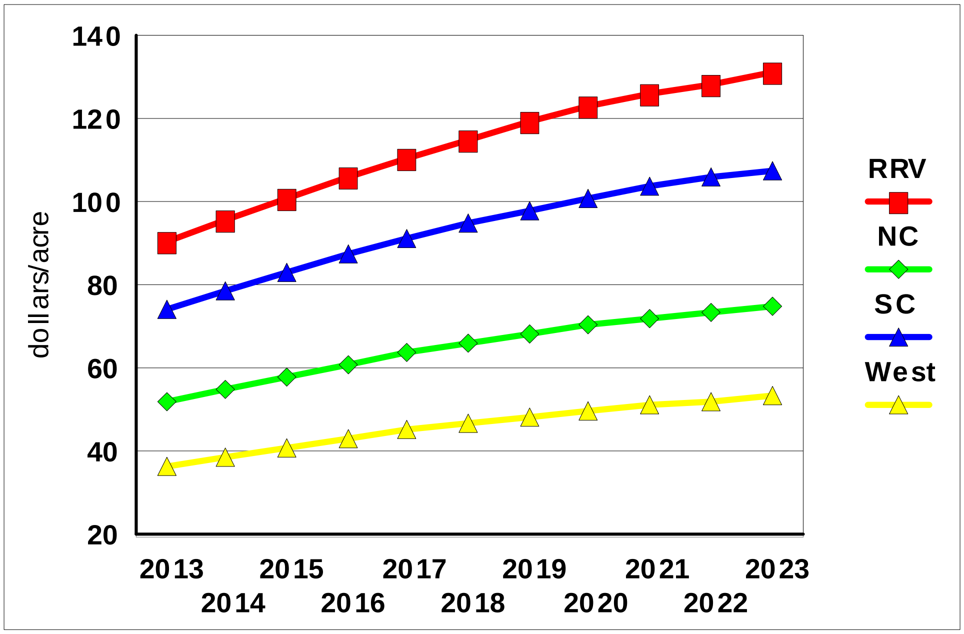


Figure 13. Average Cash Rent of Cropland for North Dakota Average-Profit Representative Farms

CONCLUDING REMARKS

Net farm income in 2023 is predicted to be lower than in 2013 for most farms. For example, net farm income for the average profit farm was $93 thousand in 2013 and is predicted to be $87 thousand in 2023, net farm income for the large size farm was $228 thousand in 2013 and is projected to decrease to $174 thousand in 2023. The decreases in net farm income for the 2014-2023 period is due mainly to expected increases in production expenses and gradual decreases in commodity prices. Production expenses increased 440% since 1994 and 109% since 2005, however they fell 16% in 2010 but increased 28% in 2011, 22% in 2012 and 17% in 2013. It was assumed the expenses for 2014 will increase 3% above 2013 levels and continue increasing at the 2% level. 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. Future projected prices are expected to continue to fall for the next 3 to 4 years before leveling out late in the forecast period.

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

Land values are predicted to increase during the forecast period because they are based on return to land. Projected land values would increase over 29% for the projection period. Historically, recent North Dakota land prices have increased from $490 per acre in 2004 to $2,129 per acre in 2013. Cash rent levels follow patterns similar to land values. Current increases in market land values and cash rents are not reflected in the model as the model uses current returns to land and not future expected returns.

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