NDSU-NASS Cooperative Research Project: 'Understanding Differences in Alternative Agricultural Land Value Estimates: Evidence from North Dakota'

Final Project Report, December, 2005

Submitted to:

Roberta Pense
(USDA-NASS-RDD Chief, Geospatial Information Branch)

Submitted by:

Steve Shultz, University of Nebraska-Omaha
(formerly at North Dakota State University)

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All potential errors and/or omissions associated with this research are the sole responsibility of the principal investigator.

Steve Shultz
Associate Professor & Baright Chair of Real Estate and Land Economics
Economics Department,
University of Nebraska-Omaha

Roskens Hall 515 D
University of Nebraska-Omaha
Omaha, NE 68182-0048

Tel: (402) 554-2810
Fax: (402) 554-3747
sshultz@mail.unomaha.edu

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1) EXECUTIVE SUMMARY

This study quantified differences between North Dakota agricultural land values reported by:

1) The NASS June Agricultural Survey (JAS);
2) The North Dakota Land Value Survey (NDLVS);
3) Market sales of agricultural land.

Percentage differences in estimated land values associated with these three sources were quantified at the State, regional, county, and in some cases, the neighborhood levels of analysis. Geographic information system (GIS) based soil productivity and land use data were used in conjunction with multiple regression analysis to estimate the impact of various bio-physical and institutional factors on observed land value differences

JAS vs. NDLVS Land Value Differences in 2002 (State and county level)

Based on 2002 data, statewide JAS and NDLVS land value estimates are similar and can be considered close substitutes (JAS values were only 1.9% lower for cropland and 3.8% lower for pasture). However, at the county level, there are many cases of the JAS and NDLVS numbers differing substantially (30% of counties had crop values differing by more than 10%, while 35% of counties had pasture values differing by more than 10%).

No recognizable geo-spatial factors appear to be influencing these differences. Each of the two multiple regression models intended to quantify factors influencing differences in land value estimates between the two surveys did a poor job of explaining the variation in differences (R^2 values of 0.16 for crop values and 0.10 pasture values). However, a few of the explanatory variables in the models (the number of JAS surveys, and the percentage of wetlands in a county) had statistically significant impacts on differences. It is expected that modeling efforts could be improved by conducting analyses at the sub-county level.

JAS Land Values Versus Nearby (Comparable) Market Sales: 2001-2003

JAS estimates of cropland values based on 331 JAS segments were 9.5% higher than 331 nearby comparable market sales. In contrast, JAS estimates of pasture values were 39% lower than market sales, which resulted from the inability to distinguish between pasture and more valuable Conservation Reserve Program (CRP) land within market sale boundaries. Correspondingly, JAS estimates of mixed land sales (some combination of crop and pasture) were 3.6% higher than actual market sales. Due to the unreliability of comparing both pasture and mixed sales with the JAS (due to the inability to distinguish between pasture and CRP), all subsequent analyses focused on cropland values.

JAS crop values differed by 10% or more from nearby market values in 64% of counties yet no recognizable spatial relationships describing these differences were observed.

Multiple regression analysis intended to quantify factors influencing differences between JAS and market values for cropland did not fully explain the variation of observed differences between the JAS and market sales (the R^2 value was only 0.10). The only explanatory variable to have a statistically significant impact on differences was observed differences in spring wheat yields between JAS segments and nearby market sales, which indicated the importance of accounting for relative soil productivity measures when reporting or imputing estimates of agricultural land values.

Future modeling efforts should: better differentiate between pasture and CRP land within market sale boundaries and hence increase sample sizes substantially; experiment with alternative numbers of comparable sales; include explanatory variables that measure both the total number of market sales and the prevalence of hunting/recreation sales nearby JAS segments; include a variable that more accurately accounts for wetlands within JAS segments (in the same way that wetlands are quantified within market sale boundaries); and finally, experiment with alternative specifications associated with the dependent variable

Comparing JAS and NDLVS Land Value Estimates with All Market Sales (State/Regional/County Levels of Analysis, 2001-2004)

After the originally proposed research was completed, additional market sales data was collected. In fact, almost all publicly disclosed arms-length agricultural land sales across North Dakota between 2000 and 2004 (4,280 sales) were digitized into a GIS database.

This allowed subsequent comparisons of JAS and NDLVS survey-based land value estimates (based on 3,935 and 8,642 survey reports, respectively) with 3,243 actual market sales at the statewide, regional, and county levels of analysis over the 2001 to 2004 period. Statewide, both of the survey-based estimates were reasonably close to actual market sales (JAS estimates were 6% lower than market sales and NDLVS estimates were 9% lower). However, differences between market sales and both survey estimates varied across years and within particular regions and, especially, within individual counties. Caution is again therefore urged regarding the use of either JAS or NDLVS data for making county-specific estimates of land values for individual North Dakota counties.

Additional statistical modeling of this rich and unique dataset is warranted. In particular, the factors influencing differences between JAS and market based land values should be quantified using multiple regression modeling with different functional forms, alternative selections of comparable sales, and explanatory variables that account for both the total number of nearby market sales, and the percentage of wetlands within JAS segments.

GIS-Based Kriging to Evaluate the Accuracy of the JAS

The use of GIS based kriging to interpolate point-based land sale data statewide appears to offer several advantages over traditional county-level analyses since land characteristics and values are not homogenous across counties. Such kriged land value maps based on market sales demonstrate a great deal of variation in land values across counties that clearly would be lost if aggregated at the county level.

A kriged land value map based on year 2002 JAS segment values portrayed very similar land value estimates across the State, as did a kriged map based on almost twice as many market sales. Spatial overlays of the two maps identified distinct areas where the two sources of land value estimates differed substantially.

Further research is warranted on the accuracy and statistical validity of alternative kriging specifications and procedures to interpolate both JAS and market-based land values across the

State: Additional years (other than 2002) should be evaluated, and GIS-based research should be conducted to evaluate why differences between the JAS and market sales occur in specific locations. In the meantime, the use of kriging appears to hold great potential as a strategy for interpolating and releasing JAS land value data as it results in a great deal of sub-county specificity while maintaining the confidentiality of JAS respondents.

Conclusions

JAS agricultural land value estimates in North Dakota are similar to both the NDLVS and actual market sales statewide. However, neither the JAS nor NDLVS provide consistently accurate estimates of market values across all counties. This county level inaccuracy is likely due to land characteristics and values being heterogeneous across counties.

JAS values appear slightly higher than nearby cropland-based market sales. Further research to confirm this finding should be undertaken using larger sample sizes, alternative selection criteria for comparable sales, and additional explanatory variables that distinguish between pasture and CRP and accurately measure wetlands within JAS segments.

Kriging appears to hold great potential as a strategy for interpolating and releasing JAS land value data to the public as it provides a great deal of sub-county specificity while maintaining the confidentiality of JAS respondents. However, additional research is needed to evaluate the impact of using alternative kriging display specifications and alternative procedures to remove statistical outliers from the kriged data.

Suggested follow-up research should be conducted in North Dakota to take advantage of additional market sales and recently discovered kriging techniques. As well, this entire research project should be replicated in one or more other States which are dominated by production agriculture and which have the required GIS data and agricultural market sales available to confirm the research findings from North Dakota.

2) INTRODUCTION AND RESEARCH OBJECTIVES

The goal of this study was to quantify differences between North Dakota agricultural land value estimates based on the USDA-NASS June Agricultural Survey (JAS), a statewide, telephone-based land value survey (The North Dakota Land Value Survey or NDLVS) which is funded by the State of North Dakota but administered by the NASS North Dakota field office, and agricultural land market sales. The original research design involved collecting market sales near selected JAS survey locations, but during the study it was deemed worthwhile to digitize all 4,280 arms-length market sales in the State over the 2000 to 2004 time-period into a geographic information system (GIS) database.

In addition to quantifying the differences in land values from these three sources of land value data, multiple regression analysis was used to quantify various bio-physical and institutional factors influencing differences among the alternative sources of agricultural land value estimates.

The rationale for this research is that considerable efforts are being made both by Federal and State agencies to conduct opinion-based surveys with farm operators in order to estimate agricultural land values. These survey-based land value estimates need to be assessed for accuracy from both a spatial and temporal perspective. As well, alternative strategies to report JAS land value data to policy makers and the public at large while maintaining the anonymity of survey respondents should be evaluated since at present the JAS data is currently only released to the public at the State level of analysis.

The first comparisons were at the county level (in all 53 North Dakota counties) and involved comparing aggregated 2002 JAS crop and pasture land values (NASS 2005a), with corresponding reported county land value estimates from the North Dakota Land Value Survey

(NDLVS), a telephone survey funded by the North Dakota State Land Department and conducted by the North Dakota Field Office of NASS (NASS 2005b). Differences between the two surveys were compared spatially by mapping differences across counties. Paired, two-sided t-tests were used to evaluate observed differences between JAS and NASS land values. A multiple regression model was used to determine whether particular biophysical and survey design factors have a statistically significant influence on differences between the alternative surveys. It was hypothesized that land value differences between the two surveys would be largest in counties with relatively few surveys and heterogeneous soil productivity and land uses.

The second comparisons were conducted at a more site-specific level and covered the 2001 to 2003 time period. Reported land values on a per acre basis for specific JAS sites segments (approximately 640 acres) were compared to empirically observed land values associated with nearby (comparable) market sales in the 33 North Dakota counties that contained detailed soil survey data at the time the study was initiated. Again, differences between the two data sources were evaluated using paired t-tests and by mapping differences. Multiple regression was used to quantify factors influencing these differences. It was hypothesized that differences between the JAS opinion and market sale based land values would be greatest when the soil productivity of JAS segments and nearby market sales differed substantially, which was expected to occur most frequently in counties having relatively heterogeneous soil characteristics. It was also suspected that differences in land values would be greater when: 1) JAS segments in one or more nearby comparable sales had large quantities of wetlands within their boundaries; 2) there were relatively large distances between JAS segments and market sales; and 3) when market sales (both in the immediate vicinity of the JAS and county-wide) were relatively infrequent.

It was originally proposed to also compare JAS land value estimates with annual land value estimates made by a group of rural appraisers in the State but this was infeasible since the appraisers only report minimum and maximum land values rather than means and standard deviations.

Finally, additional analyses not included in the original research protocol were conducted and are contained in the final two sections of this report. These analyses became possible after the collection of additional market sales. In particular, during the course of the study it was considered feasible to collect and digitize all agricultural land sales in the State (rather than only the sales immediately surrounding JAS segments). This expanded data (4,280 arms-length agricultural land sales from 2000 to 2004) allows for the comparison of JAS, NDLVS, and all market-based land values at the county, regional and statewide levels from 2001 to 2004.

Similarly, the existence of a large statewide GIS database of agricultural sales allowed experimentation with GIS-based kriging techniques that interpolate point land values across areas. This allowed spatial overlays to compare statewide (kriged) land value estimates (for the year 2002) based on 767 market sales versus 376 JAS sample points. The extent and location of differences between JAS and market sale values were then quantified to evaluate the feasibility and utility of reporting JAS land value data via kriging.

3) BACKGROUND

Previous Research Comparing Opinion Versus Market Based Land Value Estimates

No previous studies were been discovered that specifically comparing the accuracy of land values from the June Agricultural Survey (JAS) or other land owner/operator land value surveys such as NDLVS. However, an article by Gertel (1995) compares actual land sales data with opinion-based land values surveys of landowners (an ERS-NASS survey) and other surveys of 'local experts' in Illinois and Maryland. As well, an article by Roka and Palmquist (1997) evaluated the use of JAS land value data for hedonic analyses of farmland attributes in the five-State Corn Belt region of Illinois, Indiana, Iowa, Missouri, and Ohio.

The Gertel study (1995) compared actual land sales with survey (opinion) based land values from alternative sources in Illinois and Maryland: 1) A ERS survey of land/owner operators (conducted by NASS); 2) a survey of County Executive Directors by the Agricultural Stabilization and Conservations Service (ASCS); and 3) ERS/NASS survey of real estate brokers and lenders conducted prior to the existence of the JAS.

In Illinois, 19,847 arms-length agricultural sale transactions from 1983 through 1991 were averaged by counties (weighted by sale size) and then aggregated to the State level (weighted by number of sales in counties). These statewide average land values were then compared to land value data from each of the three alternative surveys. Although no statistical analyses of the Illinois data were made, it was noted that both actual sales and estimates of sales by brokers/lenders were similar, and in most years were higher than survey values from either ERS/NASS (landowners) or ASCS (County Executive Directors).

The magnitude of observed differences were also not reported, but based on the land values reported in the accompanying tables, the following differences in land value data over the

1983-1991 time period can be observed: Actual sales were 9% higher than landowner estimates, 15% higher than County Director Estimates, and 2% higher than real estate broker/lender estimates. It should be noted that these land value differences varied considerably year by year. As well, it is suspected that these variations may not be consistent across counties or alternatively that the aggregation of land values at the State level of analysis masks what is occurring in individual counties.

In Maryland, 1,521 agricultural arms length sales from 1987 to 1991 in 23 counties were grouped into 17 strata and compared to land values from the 3 surveys after editing out statistical outliers associated with development sales or properties with unique amenities. Differences among land sale values and survey values were highly dependent on the region of analysis, the size of sold tracts, and nearby population densities. However, average sale values were 27% higher than landowner survey values, 19% higher than County Director estimates, and 10% lower than real estate broker/lender estimates.

From this it can be concluded that differences between actual agricultural land sales and opinion based surveys of land values appear (at least in these two states and at the Statewide level of analysis) to be smaller in agricultural areas than they are in developed areas near urban centers. As well land differences from actual sales appear smaller with 'expert' (agent/broker) surveys than with landowner surveys.

Roka and Palmquist (1997) evaluated the use of June Agricultural Survey (JAS) land value data for hedonic analyses of farmland attributes in the five-State Corn Belt region of Illinois, Indiana, Iowa, Missouri, and Ohio. Hedonic analyses involved studying market transactions in order to quantify how attributes of sold tracts impact sale prices and in this case a series of hedonic regression models were estimated with the dependent variable being agricultural land sale value (based on JAS data on a per acre basis) from 1994 to 1996, while the explanatory variables were various subsets of farm and owner/operator characteristics, obtained from both the JAS and/or the USDA Natural Resource Inventory. The specific objective was to evaluate the appropriateness of JAS data for such studies in the hope that this nationwide data set could be used in lieu of more expensive and difficult to collect data on individual market sales.

It is important to note that in the model specifications for 1994 and 1995 the authors included a variable 'SOLD': a binary measure of whether JAS respondents had actually sold property in the previous year. In 1994 and 1995, 1.4% of JAS respondents had actually sold property. In 1996, this market experience question was dropped from the JAS.

Based on the fact that the 'SOLD' variable did not have a statistically significant impact on sale prices (in 1994 and 1995) the authors find "some evidence that the land value opinion given in the JAS match market opinions" with the caveat that imputed JAS values may have an impact on this match. A second indication of the reliability of the JAS land value data is that the estimated hedonic coefficients (marginal prices of land characteristics) were consistent (stable) across years. The fact that the best estimated model only explained one third of the variation in land values was attributed to the lack of detailed explanatory variables and in particular a lack of soil productivity data specific to JAS tracts, rather than the quality of JAS land value data itself.

Available Agricultural Land Value Data in North Dakota

Opinion based land valuation studies are generally conducted through surveys of farm operators and/or absentee landowners by asking them to estimate land values in their area. They generally assume that these respondents are aware of market transactions and are able to estimate the value of land they own or rent. In North Dakota there are two opinion based land value surveys administered each year to farm operators: The June Agricultural Survey (JAS) and the North Dakota Land Values Survey (NDLVS).

The June Agricultural Survey (JAS) is funded and administered by the National Agricultural Statistics Service (NASS). It is a national effort that involves annually surveying all farm activity within approximately 10,000 segments across the country, each segment measuring roughly one square mile. Segment samples are on average 640 acres or 1 square mile in size, and are selected from the major land use stratums across the contiguous 48 States with the goal of capturing all types of agricultural activities. All farmers operating within the selected segments are interviewed in-person and asked to describe very specific agricultural practices within the segments that they operate.

Collected JAS data includes: ownership details, crop acreage and practices, livestock inventories, management activities and input costs, gross agricultural sales, and both land values and cash rents. More specifically in relation to land values, the JAS asks operators what they believe the market value is of their land inside the segment boundaries as well as the value and cash rental amounts for cropland, pasture, grazing and grassland acres. The JAS also asks operators questions about the entire farm they own or operate. In North Dakota there are approximately 420 segments surveyed by the JAS each year, representing a random sample of land uses throughout the State. However the data is only reported to the public at the State level of aggregation in large part because there are often not enough sample points to accurately represent data within particular counties, and also in order to maintain the confidentially of all data provided by individual farm operators (NASS, 2005b).

In contrast, the NDLVS is telephone survey of farm operators that is conducted in January or early February of each year by the North Dakota Field Office of NASS. It is funded by the North Dakota State Land Department, which requires agricultural land value data in each county of the State in order to assess the validity of sale prices and rents of land they control. However, the land value data is also published on-line and in the corresponding annual North Dakota Agricultural Statistics Handbook by NASS, and is widely reported on and used as source of land value data.

Approximately 3,800 farm operators provide land value data to the survey and, both land values and cash rental values are collected for non-irrigated crop, pasture, and hay. For each county, the number of collected responses is reported along with minimum, maximum, most frequent (modal), and average values.

North Dakota allows sellers and/or buyers of land to maintain the confidentiality of real estate transactions considerations (prices). However, in most counties of the State anecdotal evidence suggests that more than 70% of the agricultural land sales are not specified to be confidential and are hence available from public deed records in County courthouses. An exception to this trend is apparently occurring in some of the counties in the southwestern corner of the State.

For disclosed land sales to be used for appraisals or other valuation studies it is important that they be verified as being arms-length sales (not between family members), not including substantial buildings or equipment, and involving cash or cash equivalent transactions. Although North Dakota taxes agricultural land based on its productive value, the Office of the State Tax commissioner in collaboration with county tax directors, regularly verify and compile all arms-length and land only agricultural land sales in the State as part of an 'assessment ratio study' (they compare sale values with assessed taxable values). Normally this data is not released to the public, but all publicly disclosed agricultural market sales from the State and individual counties were provided for the purposes of this NASS study. However, in order for this data to be useful it is necessary to determine whether individual sales were for crop or pasture land. This required the digitizing of sale parcels into a geographic information system (GIS) database and spatially overlying the sales with land use data associated with the year of the sale.

Another potential source of agricultural market sales are rural appraisers who regularly collect, verify, and utilize agricultural sales for appraisal purposes. In many States, appraisers are regularly surveyed by other appraisers (the case in North Dakota) or by University researchers (as done in South Dakota and Nebraska) to obtain regular and consistent estimates of changing agricultural land values. However, such appraiser surveys often (as in North Dakota) only report ranges of land values, and in cases where means and standard deviations are actually reported they are almost always aggregated at county or regional levels of analysis.

4. JAS VERSUS NDLVS LAND VALUES AT THE COUNTY LEVEL OF ANALYSIS

Mean county level JAS based crop and pasture land values for the year 2002 were compared with corresponding NDLVS based crop and pasture land values. JAS values from individual operators were then averaged across counties by crop and pasture dominated segments and only in counties with at least three operator surveys per segment in order to maintain the confidentiality of JAS respondents and because of the limited statistical confidence associated with very small sample sizes.

Collected Data: 1) JAS

Data consisting of 1,189 JAS survey interviews of farm operators within 420 segments were utilized. Cropland value data was reported in 914 interviews within all 53 counties while pastureland values were available from only in 39 counties (275 interviews). All interviews within individual segments were aggregated (averaged).

County level cropland values ranged from \$191 to \$973 per acre (rental values ranged from \$17 to \$57 per acre), while pastureland values ranged from \$100 to \$303 per acre, and \$4 to \$15 for rental values (Tables 4.1 and 4.2). Crop and pastureland values (for counties having at least three survey respondents and at least two JAS sites) generally increase from west to east across North Dakota which is expected as soil productivity in the State follow this same geographic pattern (Figures 4.1 and 4.2).

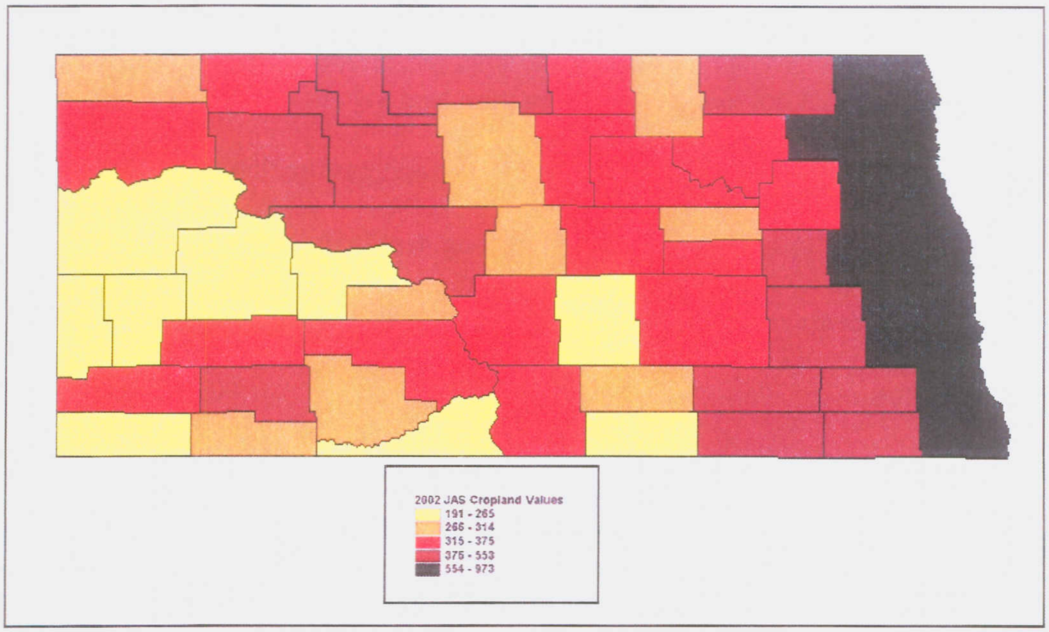

Figure 4.1. JAS Crop Values (County Level, 2002)

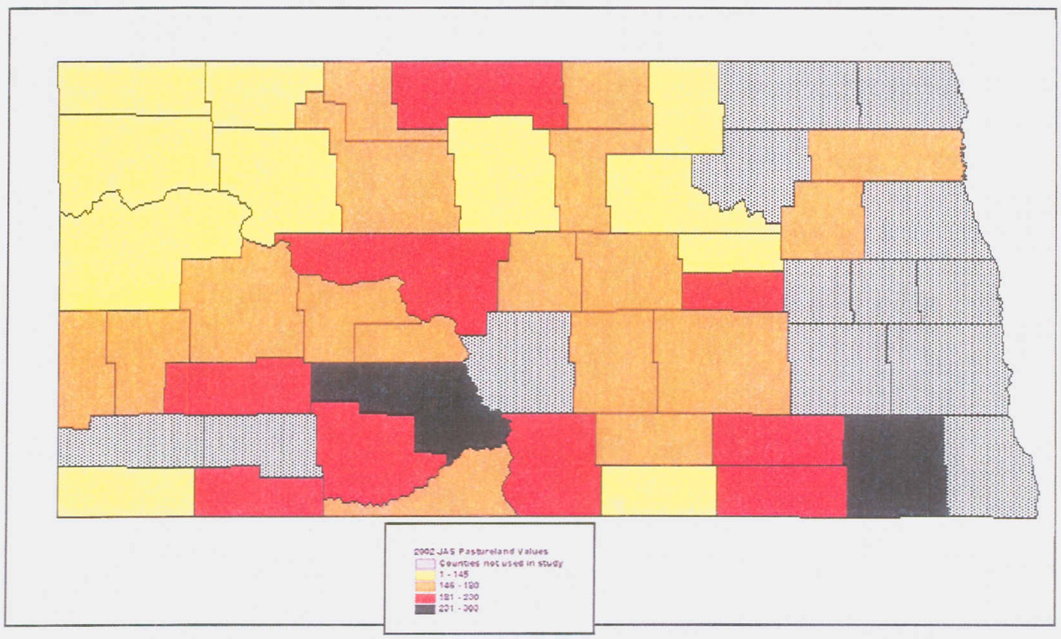

Figure 4.2. JAS Pasture values (County Level, 2002)

Collected Data: 2) NDLVS

Crop and pasture land values based on the North Dakota Land Value Survey (NDLVS) is already aggregated and reported at the county level of analysis. In 2002, an average of 35 NDLVS cropland survey reports per county was obtained, with a range of 21 to 57 reports per county. Cropland reports were more frequent than pasture reports (which averaged 27 reports per county) and as expected were also more frequently reported than JAS surveys (on average 17 reports per county for crop values and 7 reports for pasture values)

NDLVS crop values ranged from $217 to $1034 per acre (rental values ranged from $20 to $64 per acre), while county pastureland values ranged from $126 to $276 per acre (rental values ranged from $7 to $18 per acre). As was the case with JAS based values, these NDLVS crop and pasture values generally increase from west to east (Figures 4.3 and 4.4).

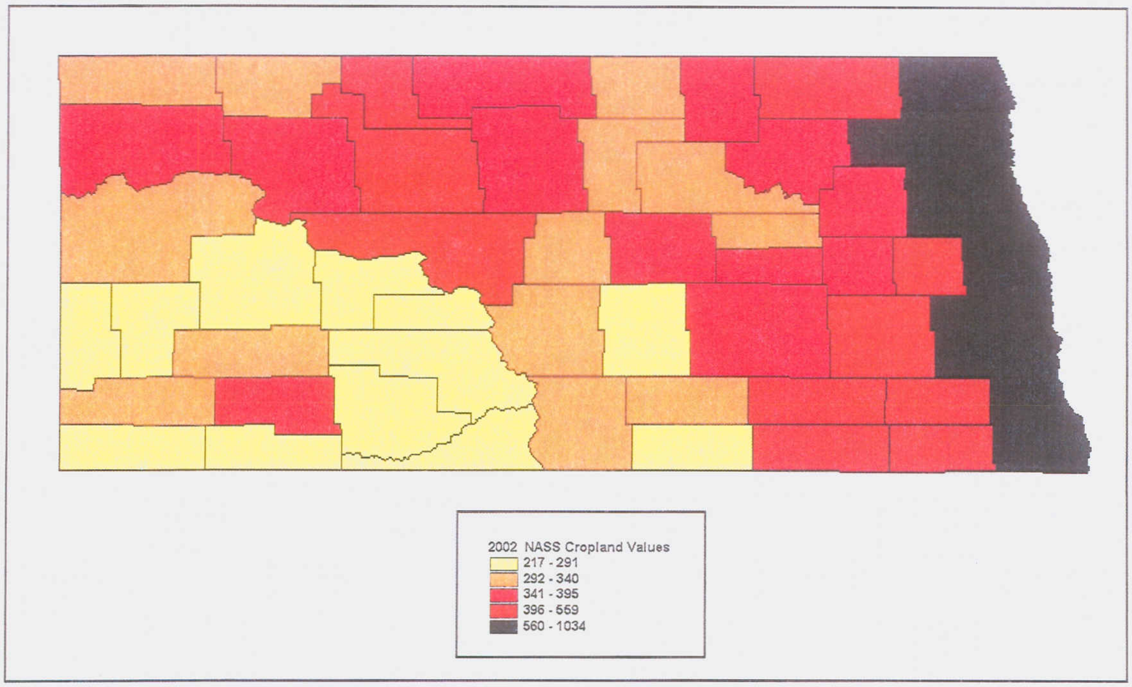

Figure 4.3. NDLVS Crop Values (2002)

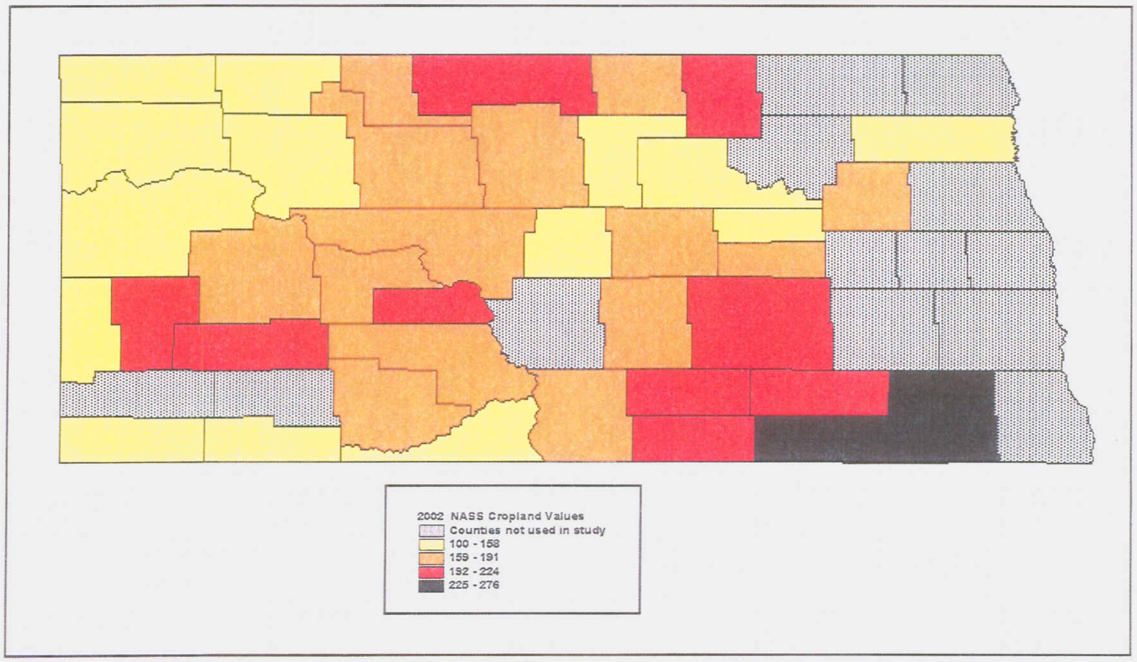

Figure 4.4. NDLVS Pasture Values (2002)

Differences Between JAS and NDLVS Data

Differences between JAS and NDLVS land values were calculated on a percentage basis and used NDLVS values as the basis in the following equation:

$$\text{Percentage Difference (JAS vs. NDLVS)} = \frac{JAS - NDLVS}{NDLVS}$$

Using the formula, a JAS land value estimate larger than a NDLVS value would result in a positive percentage difference between estimates. JAS land value estimates smaller than NDLVS estimates for the county would result in a negative percentage difference between estimates. Difference maps were broken down into three categories based on the percentage difference in each county. Counties with JAS cropland estimates 5% or more than NDLVS cropland estimates were considered positive. Counties with JAS cropland estimates 5% or less than NDLVS county estimates were considered negative. All counties with JAS county level estimates of between 5% less and 5% more than NDLVS county level estimates were considered to have no difference.

T-tests were conducted at the 95 percent confidence interval to evaluate whether the observed differences between alternative land value estimates were statistically different from each other. Specifically, each county was treated as an observation except in situations where the county had insufficient sample sizes. The null hypothesis is that there is no difference between estimates. The two-sided T-test utilized was:

$$T = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

The following hypothesis test was then conducted: Ho: $\mu_{NDLVS} = \mu_{JAS}$; Ha: $\mu_{NDLVS} \neq \mu_{JAS}$

Land value differences were also summarized and mapped by placing counties in categories of land value differences greater than plus or minus 5%

Percentage differences between year 2002 county level JAS and NDLVS crop and pastureland value estimates on a percentage basis are summarized in Table 4.1 and displayed in Figures 4.5 and 4.6. Overall (across all 53 counties for cropland and 39 counties with pastureland estimates) only minor differences were noted: JAS based cropland values were on average 1.9% lower than NDLVS cropland values and JAS pastureland values were on average 3.8% lower than NDLVS pastureland values (Table 4.1). Neither of the differences was found to be significant using a 2-sided t-test at the 95% confidence level (the t-statistics were 1.25 for cropland difference and 1.30 for pastureland differences). These results are a little surprising considering the fact that there are many fewer JAS surveys conducted than NDLVS surveys. Similarly, the standard deviations of JAS and NDLVS values are of similar magnitude ($170 and $176 respectively for crop and $40 and $32 respectively for pasture).

However, there are many cases of particular counties where larger differences between average land values were noted: County cropland differences ranged from –20% to 31% while pastureland differences ranged from –37% to 64%. 30% of counties had JAS-NDLVS cropland differences of at least 10% while 45% of counties had JAS-NDLVS pastureland differences of at least 10%. These differences (shown in Figure 4.5), do not appear to be part of a recognizable geo-spatial pattern except for the concentration of negative differences in the extreme west-central part of the State.

Table 4.1. County Level JAS Versus NDLVS Land Values (Statewide, 2002)

	JAS Crop	NDLVS Crop	JAS Pasture	NDLVS Pasture
Observations (surveys)	914	1804	275	1046
Mean Observation Per County	17	34	7	27
Mean Value ($/acre)	$402	$410	$174	$181
Standard Deviation	$170	$176	$40	$32
Difference	-$8 (-1.9%)*		-$7 (-3.8%)*	
Std. Dev. of Differences	47%		32%	
Range of Differences	-20% to 31%		-37% to 64%	
Percentage of Counties with Differences > +5%	23%**		28%***	
Percentage of Counties with Differences > -5%	28%**		54%***	
Percentage of Counties with Differences > +10%	11%**		15%***	
Percentage of Counties with Differences > -10%	19%**		30%***	

* Statistically different using a 2-sided t-test at the 95% confidence level.
** Percentages based on all 53 North Dakota counties
*** Percentage based on 39 North Dakota counties with pastureland values for both JAS and NDLV data

Differences were not calculated for 14 (mostly eastern) counties without pastureland. Similar to crop values, differences were spread randomly throughout the State. However, differences in the west central part of the State, like cropland differences, have JAS pastureland values lower than NDLVS pastureland values. From Figure 4.6 it can also be observed that JAS values are typically less than NDLVS pastureland values throughout the State.

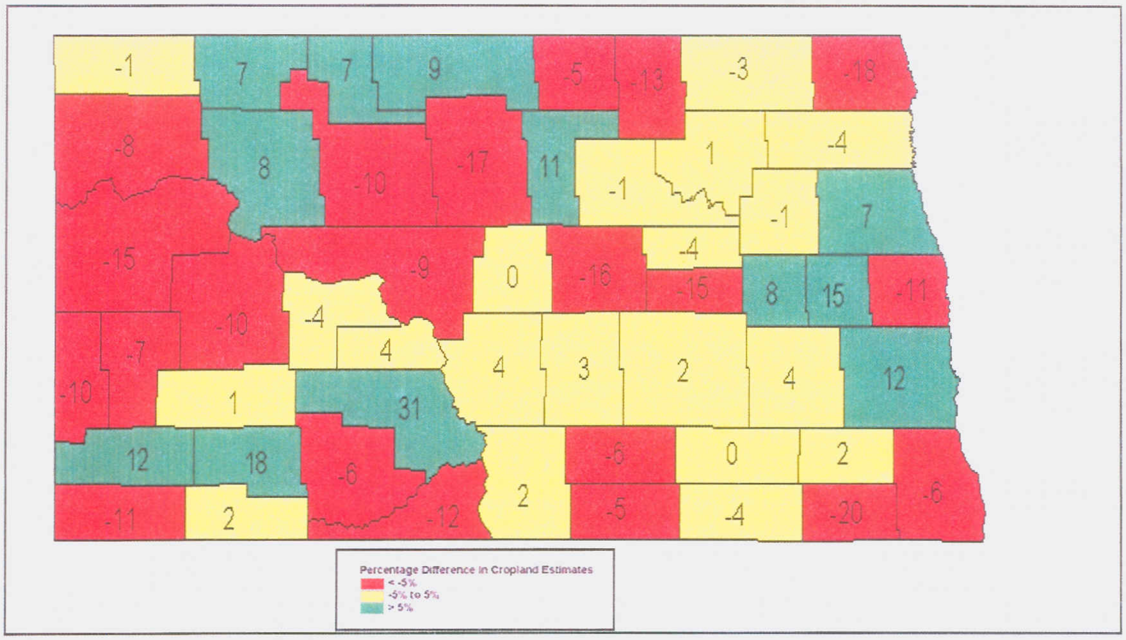

Figure 4.5. Differences Between County JAS and NDLVS Crop Values (2002)

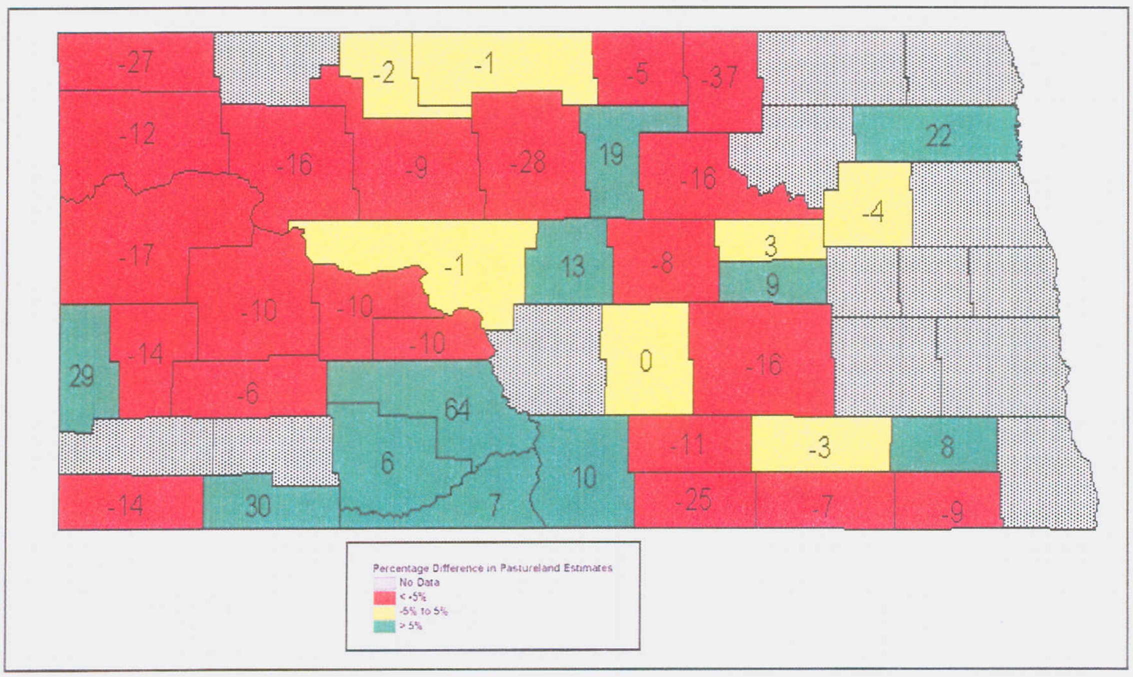

Figure 4.6. Differences Between County JAS and NDLVS Pasture Values (2002)

Percentage differences between year 2002 county level JAS and NDLVS crop and pasture land rent estimates on a percentage basis are summarized in Table 4.2. Overall differences (in 50 counties for cropland and 38 counties for pastureland) were greater than corresponding market value differences. JAS cropland rents were 4.7% less than NDLVS rents while JAS pastureland rents were 9.4% less than NDLVS rents estimates and both of these differences were statistically significant based on a paired t-test at the 95% confidence interval (the t-statistics were –2.26 for crop and –3.97 for pasture differences).

Cropland rent differences in individual counties ranged from –31% to 29% while pastureland rent differences ranged from –45% to 22%. Similarly, 6 counties (12%) had JAS cropland rent differences 5% or greater than NDLVS cropland rent while 27 counties (54%) had JAS cropland rent differences –5% or greater than NDLVS cropland rent. Analysis of pastureland rent differences shows 7 counties (18%) had JAS rent values 5% or greater than NDLVS rent values while 24 counties (63%) had JAS pastureland rent values –5% or less than NDLVS pastureland rent (Figures 4.7 and 4.8).

Table 4.2. JAS and NDLVS County Level Comparisons of Rental Values.

	JAS Crop Rent	NDLVS Crop Rent	JAS Pasture Rent	NDLVS Pasture Rent
Observations (surveys)	631	1731	239	986
Mean Observations Per County	12	34	6	26
Mean Value ($/acre)	31	32	10	11
Standard Deviation	11.85	10.34	2.78	2.37
Difference	-1.14 (-4.7%)*		-1.01 (-9.4%)*	
Std. Dev. of Differences	3.56		1.57	
Range of Differences	-31% to 29%		-45% to 22%	
Percentage of Counties with Differences > +5%	12%**		18%***	
Percentage of Counties with Differences > -5%	54%**		63%***	
Percentage of Counties with Differences > +10%	6%**		11%***	
Percentage of Counties with Differences > -10%	24%**		45%***	

* Statistically different using a 2-sided t-test at the 95% confidence level.

** Percentages based on all 50 North Dakota counties

*** Percentage based on 38 North Dakota counties with pastureland rent values for both JAS and NDLVS data

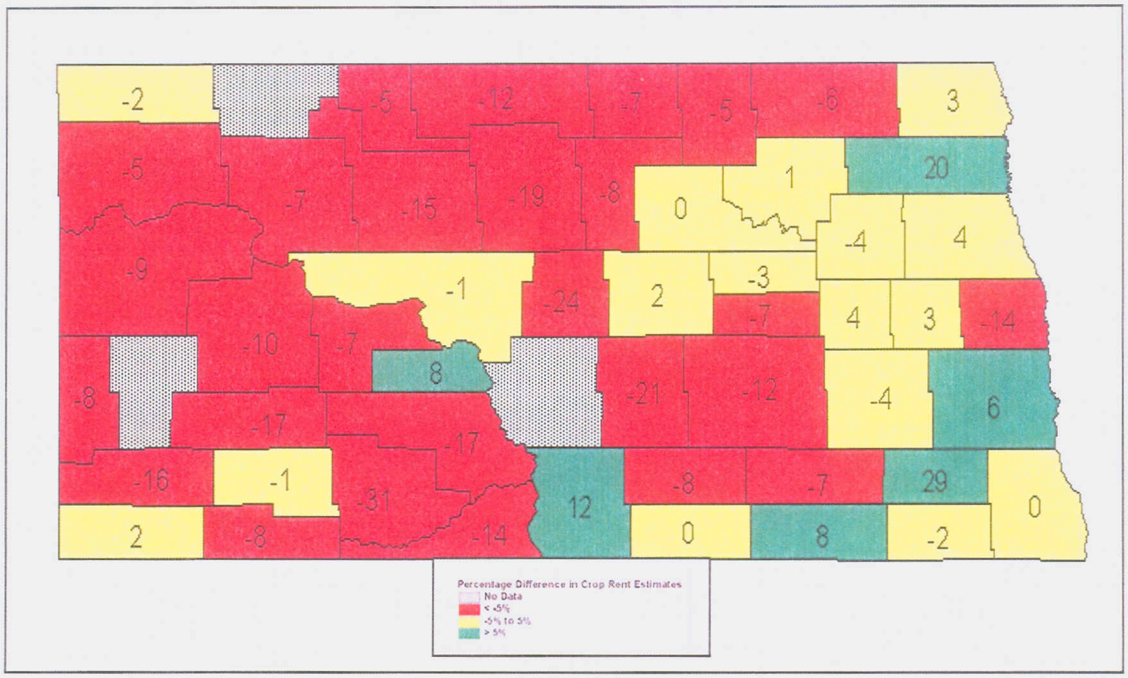

Figure 4.7. JAS-NDLVS County Level Crop Rental Differences (2002)

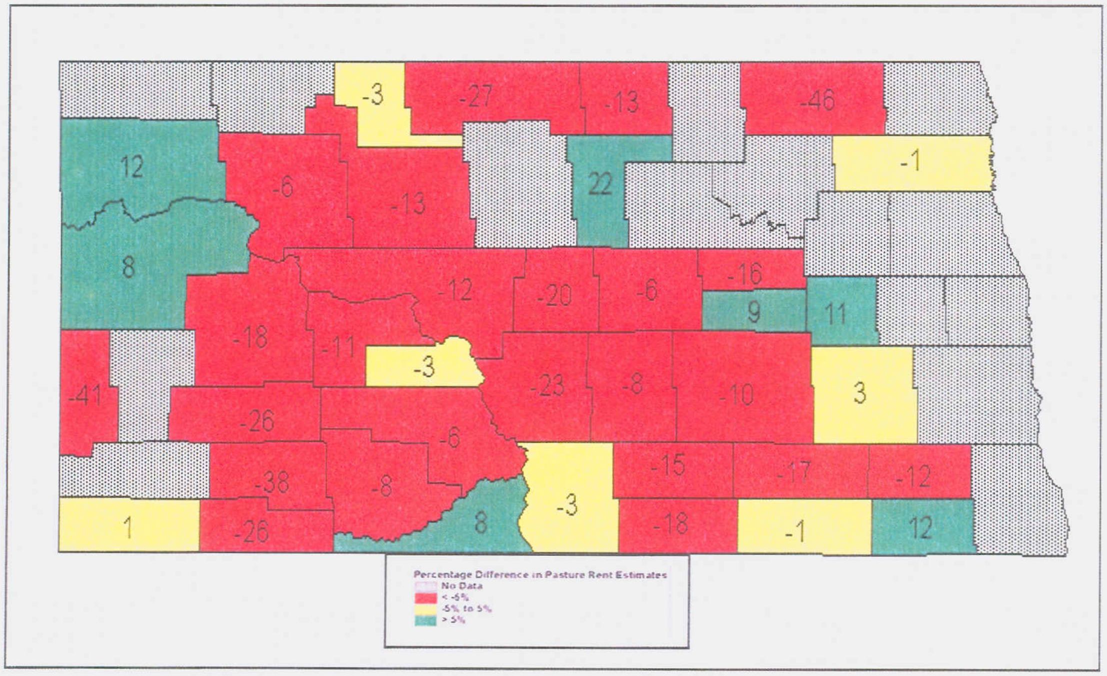

Figure 4.8. JAS-NDLVS County Level Pasture Rental Differences (2002)

Factors Influencing Differences between JAS and NDLVS Land Values

Two multiple regression models were estimated to quantify factors that might be influencing observed differences and hence the reliability of the alternative surveys at the county level. It was hypothesized that differences in reported land values of the two surveys would be largest in counties with relatively few JAS surveys, highly heterogeneous soil productivity, low percentages of cropland (or alternatively mixed land uses), and high percentages of wetlands. Separate models were estimated for crop and pastureland values (n=53 and 39 respectively).

The dependent and explanatory variables in these models are summarized in Tables 4.3 and 4.4 (cropland and pastureland models respectively). The dependent variable in each model represents the absolute difference between JAS and NDLVS land values (positive and negative differences are not differentiated in order to simplify the interpretation of the explanatory variables. The number of JAS reports in the county was expected to reduce differences because average JAS values based on larger sample sizes are expected to reduce the likelihood that any single JAS value is statistical outlier. The percentage of cropland in a county was expected to reduce differences in the cropland model but increase differences for the pastureland model since high amounts of cropland was assumed to be a proxy for similar (homogenous) land uses across particular counties. Conversely the percentage of wetlands in the county (semi-permanent and permanent wetlands from the National Wetland Inventory) was expected to increase differences because wetlands negatively impact land values and it is likely that they would exist within the lands evaluated by each of the survey respondents. Finally, the standard deviation of spring wheat yields across counties (estimated at the township level of analysis by 1969 NDSU statewide study) was hypothesized to increase differences as it is considered a proxy for heterogeneity in productivity.

Table 4.3. Variables Used to Model The Factors Influencing County Level Differences Between JAS and NDLVS Crop Values (n=53)

Variable	Mean	Standard Deviation	Minimum	Maximum
1) Explanatory Variable (Difference JAS & NDLVS)*	8%	6%	0%	30%
2) Explanatory Variables				
# JAS Reports	17	11%	3%	42%
Cropland (%)	60%	18%	18%	94%
Wet Wetlands (%)	5.9%	4.5%	0%	15%
Standard Deviation of 1969 NDSU Soil Productivity (bushels/acre)	7.9	2.8	2.1	16.5

Table 4.4. Variables Used to Model The Factors Influencing County Level Differences Between JAS and NDLVS Pasture Values (n= 39)

Variable	Mean	Standard Deviation	Minimum	Maximum
1) Explanatory Variable (Difference JAS & NDLV)*	15%	12%	0%	63%
2) Explanatory Variables				
# JAS Reports	6%	5%	1%	18%
Cropland (%)	58%	17%	18%	88%
Wetlands (%)	6%	4.7%	0%	13%
Standard Deviation of 1969 NDSU Soil Productivity (bushels/acre)	8.2	2.8	2.9	16.6

The regression model results are shown in Table 4.5. The results are disappointing for both the crop and pasture value specifications, as the explanatory variables jointly do not accurately predict the variation in absolute differences between the JAS and the NDLV (R^2 values are 0.16 and 0.10 respectively).

With the crop value model the number of JAS reports in the county is statistically significant at the 90% confidence level and its coefficient has the correct sign (increased reports decrease differences). However the only other statistically significant variable is wetlands (significant at the 95% confidence level) but the direction of its coefficient is the reverse of what was hypothesized: increasing quantities of wetlands decrease differences.

With the pasture value model the only statistically significant explanatory variable is the percentage of wetlands in the county and again it has an unexpected negative sign on its coefficient

Table 4.5. Results: Factors Influencing County Level JAS-NDLVS Crop and Pasture Values (2002)

1) Crop Value model	Coefficient	Standard Error	P-Value
(n = 53, R^2 = 0.16)			
# JAS Reports	-0.00141	0.000838	**0.098**
Cropland (%)	0.065273	0.050434	0.202
Wetlands (%)	-0.46962	0.191386	**0.018**
Standard Deviation of 1969 NDSU Soil Productivity	0.000735	0.003058	0.811
Constant	0.087532	0.03499	0.016
2) Pasture Value model	Coefficient	Standard Error	P-Value
(n = 39, R^2 = (0.10)			
# JAS Reports	-0.00445	0.003883	0.259
Cropland (%)	0.046452	0.116031	0.691
Wetlands (%)	-0.83185	0.431048	**0.061**
Standard Deviation of 1969 NDSU Soil Productivity	0.0017	0.006534	0.796
Constant	0.188322	0.083099	0.029

The low level of explained variation in these regression models indicates that there are likely omitted variables that would help explain differences between the JAS and the NDLVS. In particular, it is hypothesized that the number of NDLVS responses in a county could also be an influencing factor. Another variable that is suspected as being relevant is the existence and quantity of nearby hunting/recreation sales in a county, which may be falsely influencing NDLVS respondents' perceptions of land values.

Another strategy, which is expected to improve efforts to model the factors influencing the differences between JAS and NDLVS values, would be to increase the sample size of the analyses by including multiple years of analysis. Finally some additional research is warranted regarding alternative specifications of the multiple regression models. The models estimated in this present study treated both the dependent and explanatory variables measuring differences as absolute values (i.e. negative values were represented as positive). It is possible that relationships between negative and positive differences and the explanatory variables may exist and more complex model specifications may be needed to quantify these relationships

Summary and Discussion

Based on data from 2002, statewide estimates of either crop or pasture land values (or for rental values) the JAS and the NDLVS generate similar results (JAS were 1.9% lower that NDLVS crop values and 3.8% lower than pasture values) and these two data sources can be considered very close substitutes.

However, for county specific estimates there are many cases where the JAS and NDLVS numbers differ substantially (30% of counties had crop values that differed by more than 10% versus 35% of counties with pasture values differing by more than 10%). No recognizable spatial factors appear to be underlying these cases of large differences. Two multiple regression models intended to quantify factors influencing differences between the two surveys had overall poor explanatory results (R^2 values of 0.16 for crop values and 0.10 pasture values), yet it was determined that a few variables did have statistically significant impacts on differences (the number of JAS responses and the percentage of wetlands in a county for crop value differences, and the percentage of wetlands in a county for pasture value differences).

Future modeling efforts should use larger sample sizes (multiple years of analysis), include a variable representing the number of NDLV surveys in a county, account for the prevalence of hunting/recreation sales within counties, and experiment with alternative specifications associated with the dependent variable (i.e. avoid absolute values for representing differences between the two surveys).

5) COMPARING JAS LAND VALUE ESTIMATES AND SELECTED MARKET SALES

Comparisons between JAS segment level land values for crop and pasture land with nearby (comparable) market sales were made over the 2001 to 2003 time period because not enough market sales were found in proximity to year 2002 JAS sites. Each JAS survey segment was classified by the survey year and its pre-dominant land use (cropland, pasture or mixed land uses). Nearby market sales from the database of publicly disclosed arms length sales occurring within a year of the sale date, and containing the same type of land, were utilized for comparisons. At least two, and in most cases three nearby comparable sales were obtained for each JAS segment and some comparable sales were used for multiple JAS sites.

These JAS-market sale comparisons were only made in 33 counties across the State for which detailed SSURGO GIS based soils data existed in order to conduct evaluations of the impact of soil productivity heterogeneity on observed valuation differences. SSURGO is a product of the Natural Resource Conservation Service (NRCS) and from this database it was possible to extract both spring wheat yields (a good general indicator of cropland productivity in North Dakota) as well as forage yields to measure pastureland productivity. The counties where SSURGO soils data existed are shown in Figure 5.1 and include: Barnes, Burke, Burleigh, Cass, Cavalier, Dickey, Divide, Emmons, Golden Valley, Grand Forks, Grant, Griggs, Kidder, Lamoure, Logan, McIntosh, Morton, Pembina, Ramsey, Ransom, Renville, Rolette, Sargent, Sheridan, Sioux, Stark, Steele, Stutsman, Towner, Traill, Walsh, Wells, and Williams.

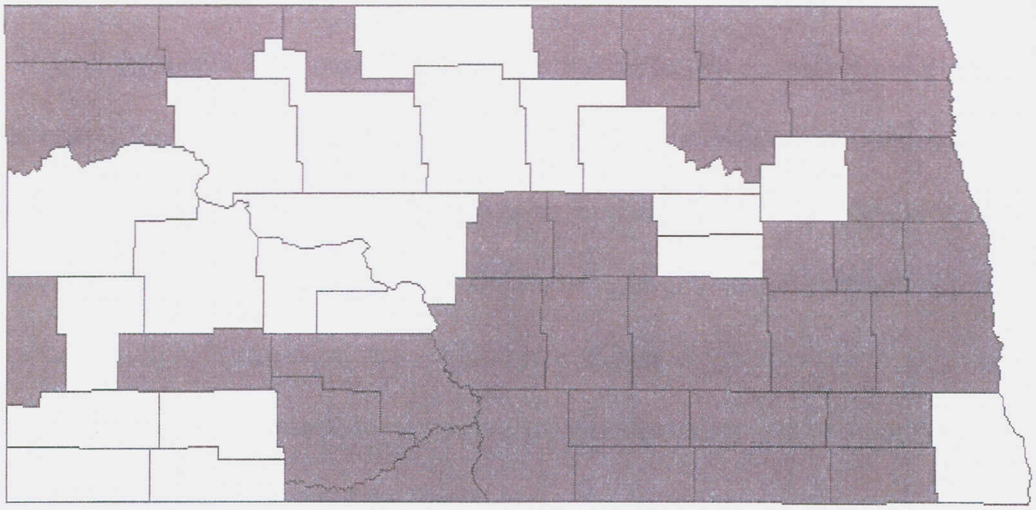

Figure 5.1. North Dakota Counties where JAS and Market Values Were Compared

Collected Data: 1) JAS Data

A total of 533 JAS survey segment sites were assembled containing data on land values and rental values throughout the State covering the 2001 to 2003 time period. The number of sites within the study counties varied from year to year with a high of 198 sites in 2002 and a low of 150 in 2003 (Table 5.1). On average each county used in the study contained 9 unique sites (the same JAS sites may be surveyed in consecutive years) with a range of 3 to 17 unique sites per county. The JAS sites used in this study are spread randomly across the 33 counties with 37% of the JAS sites containing both crop and pasture activities and 63% containing only cropland (primarily in the eastern half of North Dakota).

Table 5.1. JAS Segment Sites Assembled for the Study By Year

Year	Total Sites	Average Sites Per County	Range of Sites Per County	Sites With Crop Activity Only	Sites With Both Crop and Pasture Activity
2001	185	5.6	2 - 13	115	70
2002	198	6	2 - 13	122	76
2003	150	4.5	2 - 12	98	52
All	533	16.15	5 - 38	335	198
Unique sites*	318	9.63	3 - 17	-	-

* not used in preceding or subsequent years

From 2001-2003 JAS average cropland values in the 33 study counties increased from $455 to $489 per acre (3.7% per year) and average pastureland values decreased from $218 to $214 per acre, which corresponds to an average annual decrease of .9% per year (Table 5.2). The corresponding standard deviations in both crop and pasture values vary across years in no apparent patterns

Table 5.2. JAS Land Value Data From Assembled Sites ($/acre)

Year	Mean Crop Values	Std. Dev. Crop Values	Mean Pasture Values	Std. Dev. Pasture Values
2001	455	280	218	282
2002	466	225	205	108
2003	489	260	214	136
All Years	469	255	212	191

Collected Data: 2) Comparable Market Sales

A minimum of 2 and a maximum of 3 comparable (market) sales were collected for each JAS survey data site. A total of 566 market sales were collected throughout the 33 counties with SSURGO soils data from 2001- 2003. The locations of market sales were digitized into a GIS database based on legal descriptions and acreage associated with the sale, in conjunction with the following GIS based data: 1) Common land units (CLU's) of the USDA Farm Service Agency, which are mapped landowner parcels in each county (and which are currently available in about half of all North Dakota counties); and 2) public land survey records (townships, range, sections, and quarters).

Once sale parcels were digitized they were spatially overlaid with the NASS cropland data layer (for the corresponding year) and the percentage of the parcel associated with crops, pasture, and wetlands was calculated. Conservation Reserve Program (CRP) acreage could not be distinguished from pasture using either the NASS CDL or USDA-NAIP color air photos. This is problematic because CRP land is usually valued closer to cropland rather than less valuable pastureland which means that all subsequent pasture and mixed land analyses of market sales are suspect.

Distances from each JAS segment to the nearest 3 market sales were calculated using a GIS procedure (the 'Near' command) and kept (associated with) a particular JAS site if the sale was within 30 miles and it had land uses similar to the segment (classified as either cropland, pastureland, or mixed sale parcel). Market sale prices and other characteristics were represented on a per acre basis and combined (averaged) with other nearby sales and hence treated as a single observation for comparisons with associated (nearby) JAS sites.

Market based comparable cropland sales ranged from $81 to $2,013 per acre, while pastureland sales values ranged from $78 to $660 per acre (Table 5.3 and Figure 5.2). Market sale average cropland values increased from $465 per acre to $656 per acre from 2001 to 2003. Comparable cropland market sale values increased 20% per year while pasture values increased 8.5% per year from 2001 to 2003.

Table 5.3. Market Sale Values ($/acre)

Year	Mean Crop Values	Std. Dev. Crop Values	Mean Pasture Values	Std. Dev. Pasture Values	Mean Mix Values	Std. Dev. Mix Values
2001	465	274	255	106	323	193
2002	506	259	237	95	337	151
2003	656	370	298	145	428	300
All	549	319	262	117	363	228

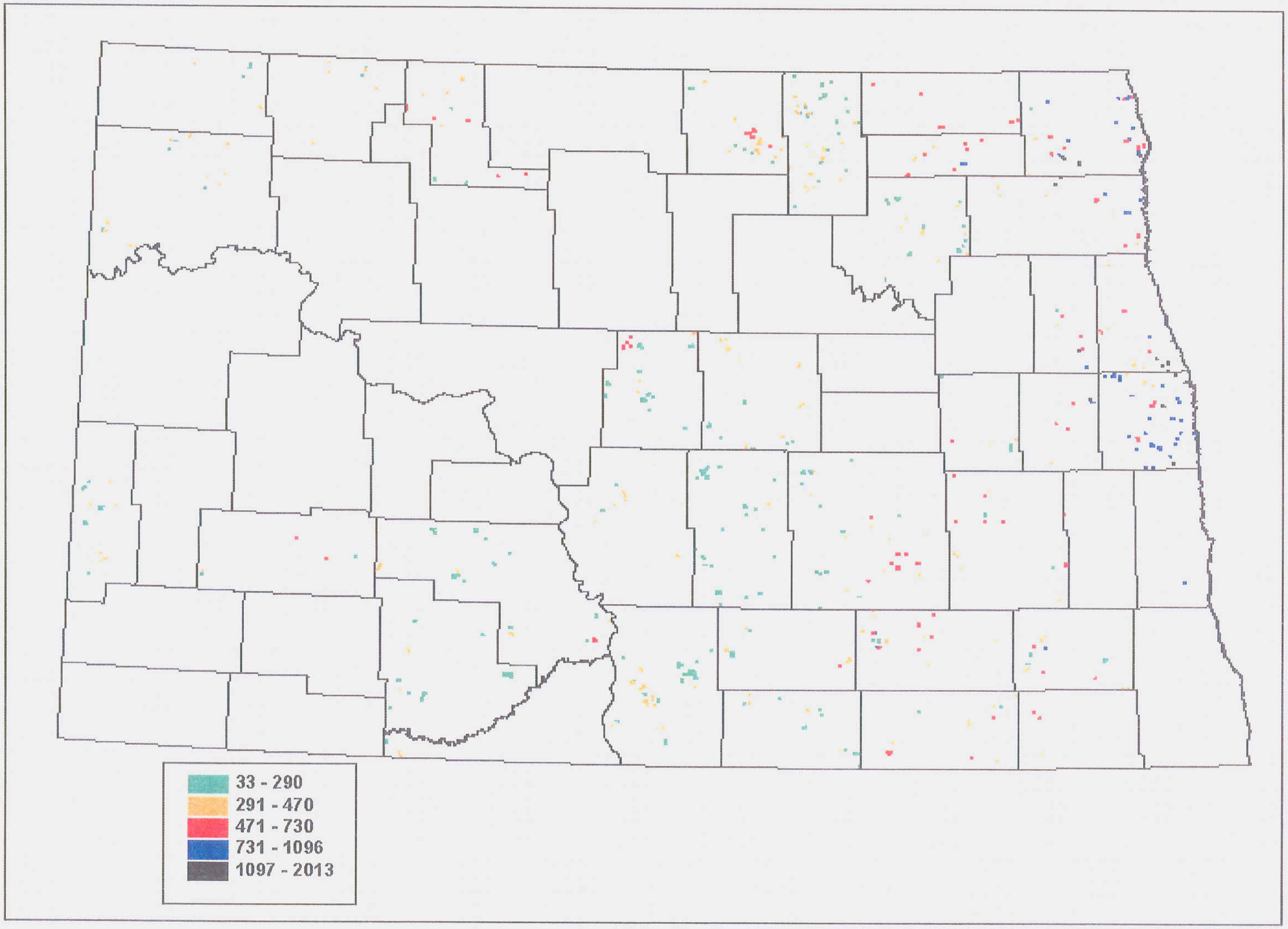

Figure 5.2. Comparable Sale Values ($/acre) Near JAS Survey Sites in 33 Counties (2001-2003)

Characteristics of JAS Segments and Comparable Market Sales.

Only 527 of the 533 JAS segments were used for comparisons as it was not possible to locate comparable sales for six JAS sites. Most (63%) of the 527 JAS segments used in the analysis were comprised entirely of cropland with less than 1% for pastureland (only two JAS sites), and 37% for mixed land uses (combined crop and pastureland). Land use typologies of the comparable market sales were similar: 65% were cropland, 1% pastureland and 34% were of mixed land uses (Table 5.4).

Most (82%) of the JAS sites had three corresponding market sales and the remainder had at least two. The average distance from JAS sites to market sales was 13 miles (for cropland sales), 11 miles (pastureland), and 14 miles (mixed land uses). Reported JAS land values and market sales (both on a per acre basis) were highest amongst cropland sites followed by mixed land uses and then pastureland.

Mean sale parcel sizes were larger among mixed and pasture sales than cropland only sales. Both spring wheat yields and pasture productivity based on the NRCS were similar for JAS segments and nearby market sales. For sale parcels, SSURGO polygons were spatially overlaid and the average yields were estimated using database management operations while yields for JAS sites were the SSURGO values nearest to the JAS centroids. The percentage of wetlands within JAS segments was almost twice as high as nearby market sales. This is likely due to JAS wetland classifications being based on operator reports of wasteland (wetland acreage per se was not specified in the JAS questionnaire), while wetlands within market sale boundaries were based on the National Wetland Inventory (NWI).

Table 5.4. Characteristics of JAS Segments and Market Sale Parcels (2001-2003)

	JAS Segments	Market Sales
1) Cropland		
Observations	331	969
% JAS Observations with 3 Market Sales*	90%	
Mean & Std. Dev. Land Values ($/Acre)	$529 ($255)	$483 ($232)
Mean Sale Parcel Size (Acres)		240
Mean Spring Wheat Yield (Bu/Acre)	37	36
Wetlands (%)**	6%	3.8%
Mean Distance: Segments to Sales (miles)	13	
2) Pastureland		
Observations	2	6
% JAS Observations with 3 Market Sales*	100%	
Mean & Std. Dev. Land Values ($/Acre)	$260 ($85)	$429 ($116)
Mean Range Productivity (Pounds Forage/Acre)	3394	3,214
Mean Sale Parcel Size (Acres)		262
Wetlands (%)**	7.4%	21%
Mean Distance: Segments to Sales (miles)	11	
3) Mixed Land (Crop and Pasture)		
Observations	194	524
% JAS Observations with 3 Market Sales*	67%	
Mean & Std. Dev Land Value ($/Acre)	$318 ($212)	$330 ($134)
Mean Sale Parcel Size (Acres)		380
Mean Spring Wheat Yield (Bu/Acre)	28	30
Wetlands (%)**	5.2%	3.8%
Mean Distance: Segments to Sales (miles)	14	

* The minimum number or market sales per JAS site are 2.

** Waste is used as a proxy for wetlands in the JAS segments

Differences Between Site-Specific JAS Values and Nearby Market Sales

Percentage Difference between JAS and market values were calculated on a per acre basis by: $\frac{JASValue - Mkt.Value}{Mkt.Value}$

As shown in table 5.5 mean JAS values were 9.5% higher than market sale values for cropland, but lower for both pastureland (-39%) and mixed land uses (-3.6%). The cropland differences were statistically significant but mixed sale differences were not, while the statistical significance associated with pastureland sales was not evaluated due to their relatively small sample size. However, the high differences associated with pasture land may be due to the fact that while JAS surveys accurately account for the existence of pastureland nearby market sales assumed to be pastureland are very likely to include CRP which is valued more closely with cropland.

Table 5.5. Differences Between JAS segments and Nearby Comparable Sales

	Paired Comparisons (n)	**Mean Observed Difference (JAS vs. Sales)**	**T-Statistic**
Cropland	331	+ 9.5 %	4.35 *
Pastureland	2	- 39.3%	Not tested
Mixed Land Uses	194	+ 3.6%	- 0.77

* Statistically significant at the 99% confidence level

The magnitude of differences between JAS and market sales are further evaluated in Table 5.6 and Figure 5.3, which contrasts differences at the county level across the State. From this it can be seen that differences between JAS and market sale values are not constant across all counties in the State.

Table 5.6. County Level Differences Between JAS and Market Values (n=33)

	All Comparisons	Cropland Comparisons	Mixed Land Use Comparisons
Percentage of Counties with Differences > +5%	58%	67%	39%
Percentage of Counties with Differences > -5%	18%	6%	42%
Percentage of Counties with Differences > +10%	52%	61%	21%
Percentage of Counties with Differences > -10%	9%	3%	27%

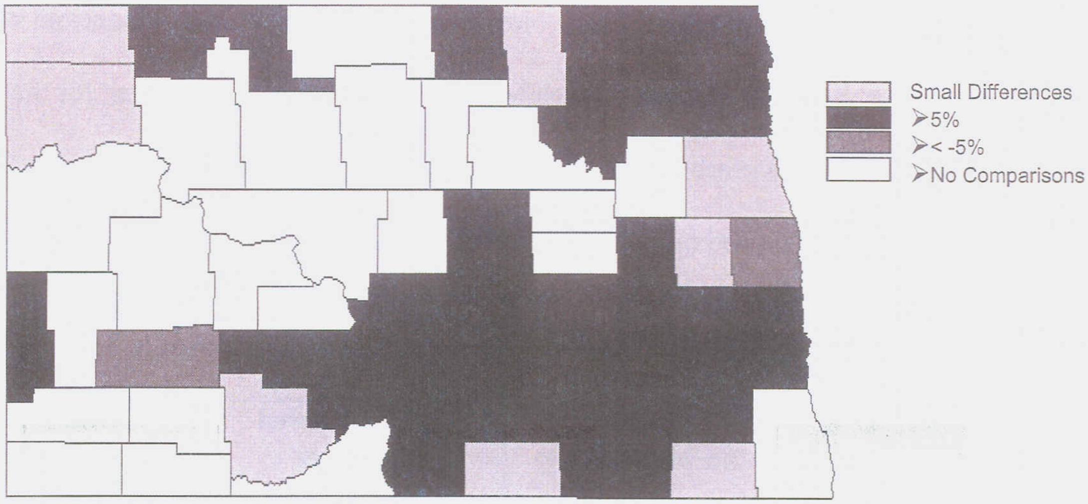

Figure 5.3 Counties with JAS-Market Sale Cropland Differences Greater than 5%

Factors Influencing Differences Between JAS and Market Sale Values

It is important to try and understand what factors may be influencing observed differences between JAS land value estimates and market sales in order to potentially modify the survey design. Four approaches are used to evaluate the factors influencing differences between JAS and market sales: First differences are compared by year (2001 to 2003), and then the number of comparable sales used in comparisons (two versus three). Thirdly, the correlation coefficients between differences and a variety of JAS and market sale characteristics are calculated. Finally, a multiple regression model is estimated to quantify the impact that these various factors have on differences associated with cropland values.

Differences between JAS and market values by year are summarized in Table 5.7. Sharp variations across years occur but a pattern is not apparent except than differences are noticeably smaller in 2003 than in the other years. Similarly, differences between JAS and market values by the number of comparable sales used (two versus three) appear small Table 5.8.

Table 5.7 Differences Between JAS and Market Sale Values by Year

	All Comparisons	Cropland Comparisons	Mixed Land Use Comparisons
All years (2001-2003)	11%	9.5%	4%
2001	13%	12%	14%
2002	18%	28%	1%
2003	- 0.3%	6%	- 11%

Table 5.8. JAS-Market Sale Differences and Number of Market Sales

	2 Comparables	3 Comparables
Cropland	8%	9.5%
Mixed Sales	-3%	4%

Correlation coefficients provide a preliminary indication of what factors may be influencing differences between JAS and market values. They are summarized in Table 5.9 for the variables hypothesized to be affecting land values, namely soil productivity, wetlands, parcel size and distances between JAS sites and sales, and region where the comparison occurred (6 geographic regions across the State). It appears that only the mean spring wheat yield of sale parcels appear to have moderate relationship with observed JAS-market sale crop land value differences.

Table 5.9. Correlation Coefficients to Explain JAS-Market Sale Differences

	Observed Differences		
	All Land Uses	**Cropland**	**Mixed Land Uses**
1) Comparison Characteristics			
Number of Comparable Sales	0.08	0.06	0.05
Year	-0.09	-0.05	-0.13
Region	-0.02	-0.03	0.07
Mean Distance (JAS-Mkt. Sales)	-0.01	-0.01	0.01
2) JAS Segment Characteristics			
Mean Spring Wheat Yield	0.15	0.15	0.09
% Waste (wetlands)	-0.03	-0.11	0.03
3) Market Sale Characteristics			
Mean Spring Wheat Yield	-0.08	**-0.25**	- 0.04
% Wetlands	0.07	0.05	10
Mean Parcel Size	-0.07	0.06	-0.07

A multiple regression model was fit where the dependent variable is the absolute difference between JAS and market values (on a per acre basis) and the dependent variables included: parcel size of market sales, distance from market sale to JAS segment, and the absolute differences in both wetlands and soil productivity (spring wheat yield) between JAS sites and market segments. The model was estimated only with cropland sales due to the infrequency of pasture sales and the difficulties in differentiating between pasture and CRP within market sale parcels.

As the average size of nearby market sale parcels increased, differences between JAS and market sale values were expected to decrease because larger parcel sizes sales would more closely correspond to the characteristics of JAS segments (640 acres), and because it would be likely that JAS respondents would have been aware of such sales which may have in influence their self-reported values. As distances between JAS sites and comparable sales decrease, differences in land values were expected to decrease since land parcels in close proximity are expected to share similar characteristics and again, because such nearby sales are likely to have been taken account of when JAS respondents estimated their own land values. Finally, differences in the percentage of both wetlands and spring wheat yields between JAS and nearby sale sites were both expected to increase differences between JAS and market sale values since the bio-physical characteristics of JAS sites and market sales would be less similar. The descriptive statistics of the explanatory variable and each of the explanatory variables used in this multiple regression model are summarized in Table 5.10

Table 5.10. Descriptive Statistics: Regression Model to Explain JAS-Market Sale Differences (Cropland, n = 331)

Variable	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable				
Absolute Difference Between JAS & Sales	**31%**	31%	0%	200%
Explanatory Variables				
Market Sale Parcel Size (acres)	240	128	76	991
Distance (miles)	13	5.6	2.4	28
Absolute Difference in the Percentage of Wetlands	6.2	6.5	0	44.1
Absolute Difference in Spring Wheat Yields (bushels/acre)	5	4.6	0	27

The results of the multiple regression model are summarized in Table 5.11. The variables considered jointly do not do a very good job in explaining the absolute differences between JAS and market sale cropland values as the R^2 value is only 0.10 and only the spring wheat variable has statistically significant impact on the absolute JAS-market sale differences (at the 99% confidence level).

Table 5.11. Regression Results to Explain Cropland JAS and Market Sale Differences (n = 331, R^2 = .10)

Variable	Coefficient	Std. Error	P-Value
Size Market Sales (acres)	-0.0000939	0.00	0.47
Distance JAS & Sales (miles)	0.0017997	0.00	0.55
Absolute Differences in Wetland Percentages	0.3869307	0.25	0.12
Absolute Differences in Spring Wheat Yields	0.0196343	0.00	**0.00***
Constant	0.1869372	0.05	0.00

* Statistically significant at the .01 level

The small amount of explained variation in this regression model indicates that it is likely that there are omitted variables that would help explain differences. In particular it is hypothesized that the number of total market sales in an area surrounding a JAS site would influence land value differences because it is likely that JAS respondents will have an easier time determining the value for their land with many nearby (comparable) sales as reference points. Unfortunately, at the time of this analysis, it was not possible to include this variable, as all of the market sales were not digitized. Another variable that may be relevant is the existence and quantity of nearby hunting/recreation sales, which may be falsely influencing landowner's perceptions of land values. The word 'falsely' is used because preliminary analyses of a companion study has found that hunting/recreation sale values do not differ substantially from purely agricultural sales, which is counter to conventional wisdom among the agricultural producers in North Dakota. One final variable that may be relevant in modeling differences between JAS and market sales is whether either JAS or comparable sales were purchased as part of the expansion of nearby or adjacent farm operation since anecdotal evidence from around the State suggests that such buyers sometimes will pay premium prices for land.

Another strategy, which is expected to improve efforts to model the factors influencing the differences between JAS and market sales, would be to increase the sample size of the analyses by including pasture only and mixed (cropland and pasture) sales. This would only be possible if the Farm Service Agency supplied researchers with a GIS coverage of CRP land in the State. This would increase the sample size by approximately 60%. Similarly, the percentage of wetlands within JAS segments should be calculated using the same GIS techniques used to quantify wetland within market sale boundaries to avoid the potential errors in defining wetlands within JAS segments.

Finally some additional research is warranted regarding alternative specifications of the multiple regression model. The model estimated in this present study treated both the dependent and explanatory variables measuring differences as absolute values (i.e. negative values were represented as positive). It is possible that relationships between negative and positive differences and the explanatory variables may exist and more complex model specifications may be needed to quantify these relationships

Summary and Discussion

JAS estimates of cropland values based on 331 JAS segments over the 2001 to 2003 time period were 9.5% higher than nearby comparable market sales (either 2 or 3 comparable sales were associated with each JAS segment). In contrast, based on two observations JAS estimates of pasture values were 39.3% lower than market sales, which are assumed to be due to the fact that pasture acreage associated with many market sales is actually Conservation Reserve Program (CRP) acreage. Correspondingly JAS estimates of mixed land sales (some combination of crop and pasture) were 3.6% higher than actual market sales based on 194 observations. The difference crop sales was and statistically significant while differences for mixed sales were not, and pasture differences were not tested due to the low number of comparisons (n=2). Due to the unreliability of comparing pasture and mixed sales with the JAS all subsequent analyses focused on cropland values.

Notably, 64% of the counties in North Dakota had JAS crop values that differed by 10% or more than market values. No particular spatial relationships describing these differences based on counties boundaries could be recognized.

Sharp variations in JAS-market sale differences occur across years (2001 to 2003) yet no recognizable pattern is observed. The only characteristic of JAS and market sales strongly correlated with JAS-market value differences are spring wheat yields.

Finally, as with the case of the previous county level JAS-NDLVS comparisons, a multiple regression model intended to quantify factors influencing JAS-market sale crop value differences had overall poor explanatory results with an R^2 values of only 0.10, and only one explanatory variable having a statistically significant impact on differences (differences in spring wheat yields between JAS segments and nearby market sales).

Future modeling efforts should:

1) Account for the difference between pasture and CRP within market sales and hence increase sample sizes substantially.

2) Experiment with alternative numbers of comparable sales using GIS buffering techniques.

3) Include explanatory variables that measure both the total number of market sales and the prevalence of hunting/recreation sales surrounding around JAS segments.

4) Account for wetlands within JAS segments the same way that they are quantified within market sale boundaries.

5) Experiment with alternative specifications associated with the dependent variable (i.e. avoid absolute values for representing differences between the two surveys).

6) COMPARING JAS, NDLVS, AND ALL MARKET BASED SALES (BY COUNTY, REGION AND STATEWIDE: 2001-2004)

Why This Additional Research Was Conducted

During the course of the study it became feasible to collect and digitize into a GIS database the location of all publicly available agricultural land sales in the State rather than only a limited number of the sales found in proximity to JAS segments. This was due in part due to fact the Common Land Unit (CLU) GIS data from the FSA became available for all North Dakota counties which made digitizing sales much easier and more accurate. In addition, soil yield data from the NRCS SSURGO database became available for all counties, and county tax directors provided all of their 2000 to 2004 agricultural sales data.

This resulting expanded data of 4,280 arms-length agricultural land sales from 2000 to 2004 allowed for the comparison of JAS, NDLVS, and all market based land values at the county, regional and statewide levels of analysis and over a time span. However since the JAS data in our possession at the time of the analysis was from 2001 to 2004 the analysis only focused on this 3-year time span and 3,243 sales.

Summary Statistics for All Market Sales (2000-2004)

A total of 4,280 arms length agricultural land sales across the State from 2000 to 2004 were digitized into a GIS and classified by dominant land uses, wetlands and soil productivity. These sales are not a complete population of all sales in the State because North Dakota is a non-disclosure State meaning that buyers or sellers have the right not to disclose the sale price of transactions for public dissemination. Rates of non-disclosure across the State are not monitored or estimated but anecdotal evidence suggest that they are more common in the western part of the State. Informal discussions with county tax directors who work with both disclosed and non-disclosed sales data also indicated that there are not recognizable differences in land sale values associated with disclosure.

2004 land sale values averaged $431/acre for all land versus $529/acre for cropland and $272/acre for pasture land (Table 6.1). However since the GIS analyses were not able to always distinguish between CRP and pasture, our estimates of pasture land values are likely exaggerated somewhat. Over the 2000-2004 time period, values have on average increased 7% a year and risen most sharply southeastern part of the State (11%) and most slowly in the South Red River Valley (1%) and the Northwest (0%).

The centroid location of all these sales and their values on a per acre basis are shown in Figure 6.1. From this it can be seen that a general trend of declining land values from east to west across the State is present (a direct relationship with declining soil productivity in a western direction). However, there are numerous exceptions to this trend: that is, there are high land sale values (denoted by red) in areas of the State dominated by with relatively low (blue) values. As well it can be clearly seen that land values are not consistently homogenous within individual counties.

Table 6.1. Agricultural Land Values and Changes Based on 4,280 Market Sales

	2004 Values ($/Acre)			Average Annual Increase (All, 2000-2004)
	All Land	Crop	Pasture	
Statewide	431	529	272	7%
North Red River Valley	739	783	498	7%
South Red River Valley	863	886	699	1%
Northeast	360	396	268	7%
Southeast	385	455	271	11%
Northwest	327	414	233	0%
Southwest	286	332	253	8%

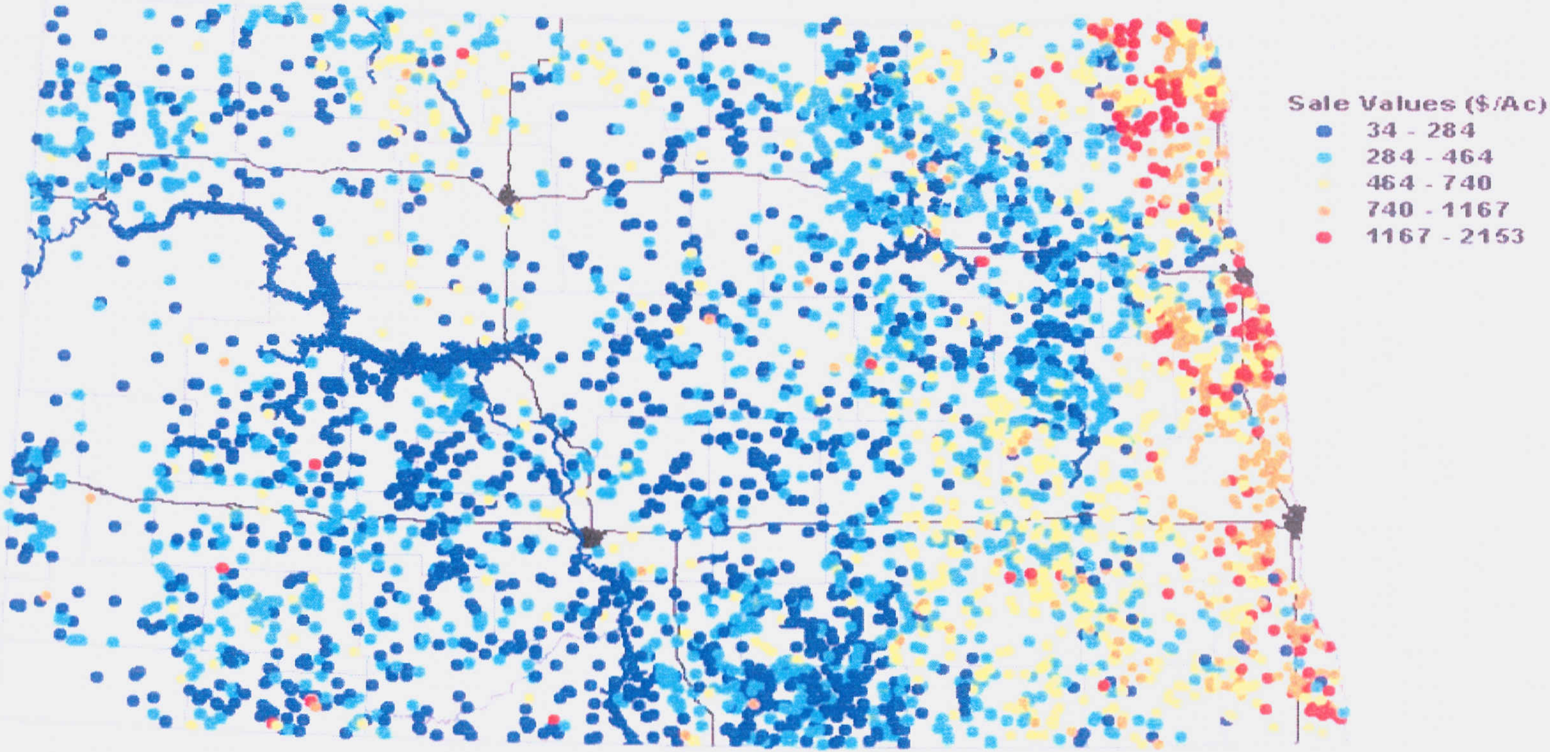

Figure 6.1. Centroids of 4,280 Agricultural Land Sales in North Dakota (2000-2004)

Differences Between JAS, NDLV, and all Market Sales (2001-2004)

The question of how survey estimates of land values based on both the JAS and the NDLVS differ from actual market sales at the statewide, regional and county levels of analysis provide an indication of the accuracy and usefulness of these survey estimates. Again this analysis focuses on the 2001 to 2004 time period for which we had the necessary JAS data.

In comparison to the 3,243 actual agricultural land sales over the 2001 to 2003 time period (on average 811 per year) a relatively high number of JAS surveys were obtained (n= 3,935 or 985 per year across the approximately 420 JAS segments), and a very high number of NDLV surveys were conducted with completed land value opinions (8,642 or 2,160 per year).

At least on a statewide basis land value estimated based on each of the two surveys were reasonably close to actual market sales: JAS estimates were 6% lower than market sales and NDLVS estimates were 9% lower (Table 6.2). However, differences between the two surveys and market values were not constant over time. In some years such as 2001, JAS is 6% higher than market values and in others it is 2% lower (Table 6.3). Similarly, the NDLVS ranges from 1% higher than market sales in 2001 to 6% lower in 2004. The observed temporal relationships appear to be that both land value surveys have started to underestimate actual market sales in recent years.

Table 6.2. Agricultural Land Value Estimates from the Alternative Sources ($/Acre, 4 Year Average: 2001-2004)

Source	All Land	Difference From Market Values
Market Sales (n = 3,243)	$430	
JAS (n = 3,935*)	$406	- 6%
NDLV (n= 8,642)	$392	- 9%

* About 80% of JAS sites are revisited each year and the number of reports associated with segments varies

Table 6.3. Differences in Land Values from Alternative Sources Over Time ($/Acre)

Source	2001	2002	2003	2004	Average Annual Change (2001-04)
Market Sales	361	375	420	459	7%
JAS (Vs Mkt. Sales)	384 (+6%)	384 (+2%)	406 (-3%)	449 (-2%)	4%
NDLVS (Vs Mkt. Sales)	365 (+1%)	377 (+1%)	395 (-6%)	432 (-6%)	5%

Differences between the two land value surveys and actual market sales also do not appear constant across the distinct regions of the State: Both JAS and NDLVS numbers underestimate actual market sales most sharply in the southwest part of the State, while the JAS overestimate market sales mostly in the Southern Red River Valley and the northeastern part of the State (Table 6.4).

Table 6.4. Regional Differences in Land Values from Alternative Sources Over Time ($/Acre, 4 Year Average: 2001-2004)

	Market Sales	JAS	NDLV
Statewide	$430	$406 (-6%)	$392 (-9%)
North Red River Valley	$732	$751 (3%)	$725 (-4%)
South Red River Valley	$879	$933 (6%)	$936 (0%)
Northeast	$355	$374 (5%)	$368 (-2%)
Southeast	$398	$386 (-3%)	$382 (-1%)
Northwest	$328	$347 (6%)	$334 (-4%)
Southwest	$303	$276 (-9%)	$245 (-11%)

Similarly, as can be seen from Table 6.5, there are extreme variations on how the JAS and NDLV surveys differ from actual market sales in different counties throughout the State. In fact in some counties differences between the JAS and market sales vary by as much as 44%, and almost 30% of counties have differences that exceed 20%. It appears that differences between the NDLVS estimates and market sales are not quite as extreme as with the JAS but again large differences in particular counties do exist (18% of counties have Market Sale-NDLVS differences that exceed 20%).

Table 6.5. Differences Between Land Value Survey Estimates and Market Sale Values Across North Dakota Counties (2001-2004)

	JAS Versus Market Sales	NDLVS Versus Market Sales
Range of Differences	-27% to +44%	-35% to +33%
Percentage of Counties with Differences > +10%	20%	9%
Percentage of Counties with Differences > -10%	22%	6%
Percentage of Counties with Differences > +20%	12%	10%
Percentage of Counties with Differences > -20%	8%	8%

There do not appear to be any particular geo-spatial patterns associated with counties having high differences between market sales and the two surveys other than counties with the highest differences appear to be banded together around the Missouri River in the Southwestern part of the State (Figures 6.2 and 6.3). Still there are adjacent counties to those with high differences without major differences and differences among these counties appear to haphazardly be either positive or negative. Finally counties with high difference appear on other parts of the States and while the county level specificity of extreme differences among the JAS and the NDLVS are similar, they are not identical

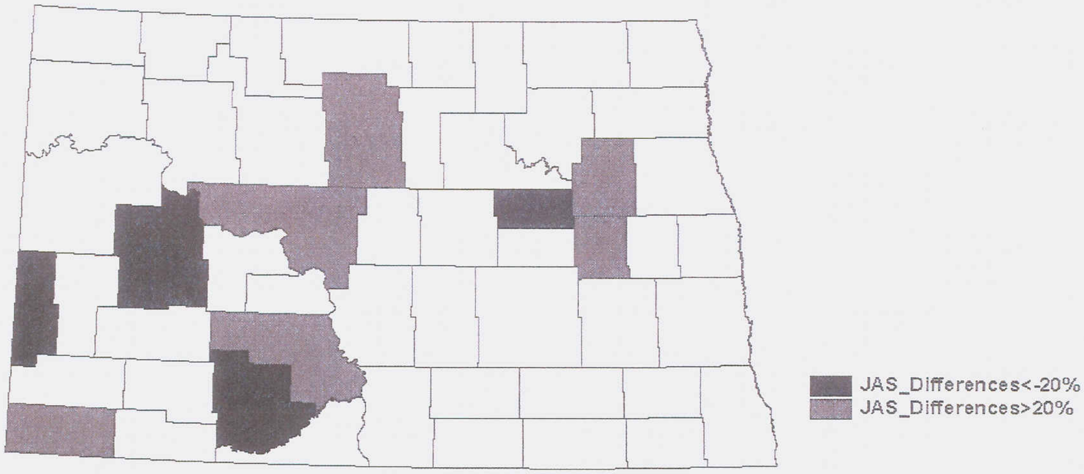

Figure 6.2. North Dakota Counties with Large Differences Between JAS Estimates and Market Sales (2001-2004)

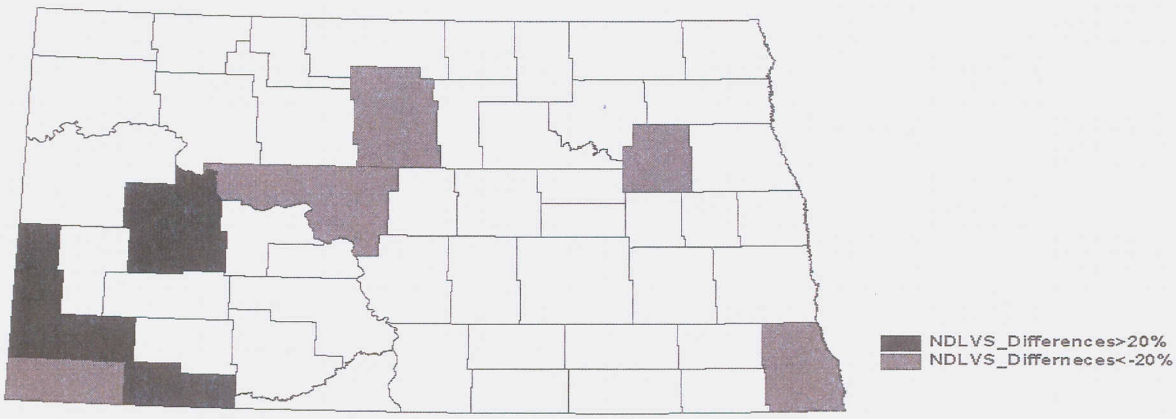

Figure 6.3. North Dakota Counties with Large Differences between NDLVS Estimates and Market Sales (2001-2004)

Summary and Discussion

In comparison to the 3,243 actual agricultural land sales over the 2001 to 2003 time period (on average 811 per year) a relatively high number of land value surveys were conducted with the JAS (n= 3,935 or 985 per year), and a very high number of NDLV surveys were conducted (8,642 or 2,160 per year). On a statewide basis over a 4-year time period the surveys were reasonably close to actual market sales: JAS estimates were 6% lower than market sales and NDLVS estimates were 9% lower. However differences between market sales and both surveys vary across years and within particular regions and individual counties. Therefore particular caution is urged in relying on either the NDLVS or the JAS for making county specific estimates of land values in individual North Dakota counties.

Continued research with this rich and unique dataset is warranted. This could include multiple regression analysis at the county level to determine which county level factors influence differences between market sales and each of the two land value surveys. Such an analysis would however require the assumption that county level characteristics (numbers of sales, surveys, cropping patterns and the homogeneity of land productivity) are constant across counties. A more powerful analysis would therefore involve comparing segment specific JAS value estimates to nearby comparable sales across multiple years.

7) KRIGING TO ANALYZE JAS AND MARKET BASED LAND VALUES

Why This Additional Research Was Conducted

The previous county level analyses comparing actual market sales with JAS survey estimates of agricultural land values are limited because they rely on the assumptions that land value and the characteristics that influence land values are constant or homogenous within counties, and that county wide average values (single point estimates) accurately reflect the conditions throughout individual counties. Kriging is an option for making and comparing land value estimates across a continuous landscape. Reported here are some early experiments with the approach.

Background on Kriging

Kriging is a GIS based technique to interpolate (spatially estimate) point data to a continuous (raster) surface by assuming that the distance and/or direction between sample points shows a spatial correlation that can be used to help describe the surface. The technique involves fitting a mathematical function to a specified number of points to determine the output value for each location. Traditionally the technique has been used mostly in the natural sciences when a spatially correlated distance of directional bias in the data is present (Chou, 1997).

An advantage to the kriging technique is that once point values have been interpolated across a continuous surface, these values can be spatially compared to data from other years or sources. For example, one can easily identify site-specific areas of changing land use values by overlaying kriged values from different years or to compare land values from different sources (for example those based on market values versus JAS surveys).

A caveat to the kriging technique is that interpolated values, and in particular how they are visually represented is highly dependent on the particular kriging technique chosen and the mathematical functions used for fitting the points (Isaaks and Srivastava, 1989). Ideally one should perform exploratory statistical analyses of data before choosing these kriging parameters. At this stage in this research project, kriging has been based simply on using the default calculation option in Arc-GIS, Spatial analyst software. Another potential limitation with the technique is that it is limited by the number and distribution of available data points and in particular may under or over estimate land values if survey points with particularly high or low survey values have not been collected.

Kriged raster datasets can be displayed in many different ways. The most common involves the use of stretch symbology where values are colored according to a band of graduated colors i.e. (Light to Dark or Red to Blue). Depending on how the data is distributed one might choose to display it based on the standard deviations or to equalize the colors. When using the standard deviations approach to stretching all values within any given standard deviation are assigned the same values. This tends to exaggerate highs and lows. In a sense the data is simplified. In contrast, if the histogram equalize function is used the data is displayed according to its exact value (i.e. $5 < 6 < 7$ etc.). This tends to be a more conservative approach, which will in turn display a wider range of color intensity.

Kriging Based Estimates of Market Values (2000-2004)

Kriging was applied to the 4,280 market sale points collected over the 2000 to 2004 time-period. The resulting map (Figure 7.1) portrays the widely known east to west value gradient present in North Dakota, but it also demonstrates that estimated land value are almost never homogenous within counties.

Kriged land value estimates specific to the year 2000 were contrasted to those from 2004 through a spatial overlay to identify site-specific areas of the State with particularly high or low rates of land value change during this 5-year period (Figure 7.2). Again these areas of change do not follow county boundaries. In many cases it has been possible for agricultural experts in the State to offer logical explanations for previously undetected regions of rapidly increasing or decreasing land values. For example a large swath of land in the southwest part of the State with high rates of land value increase has been attribute to landowners there switching from spring wheat to corn and soybean production. Some other nearby areas northeast of there, as well as in the far northeastern part of the State have seen increased land values due to irrigated potato production. Finally several areas of the western part of the State with rapidly increasing land values have been associated with many hunting and recreation related sales.

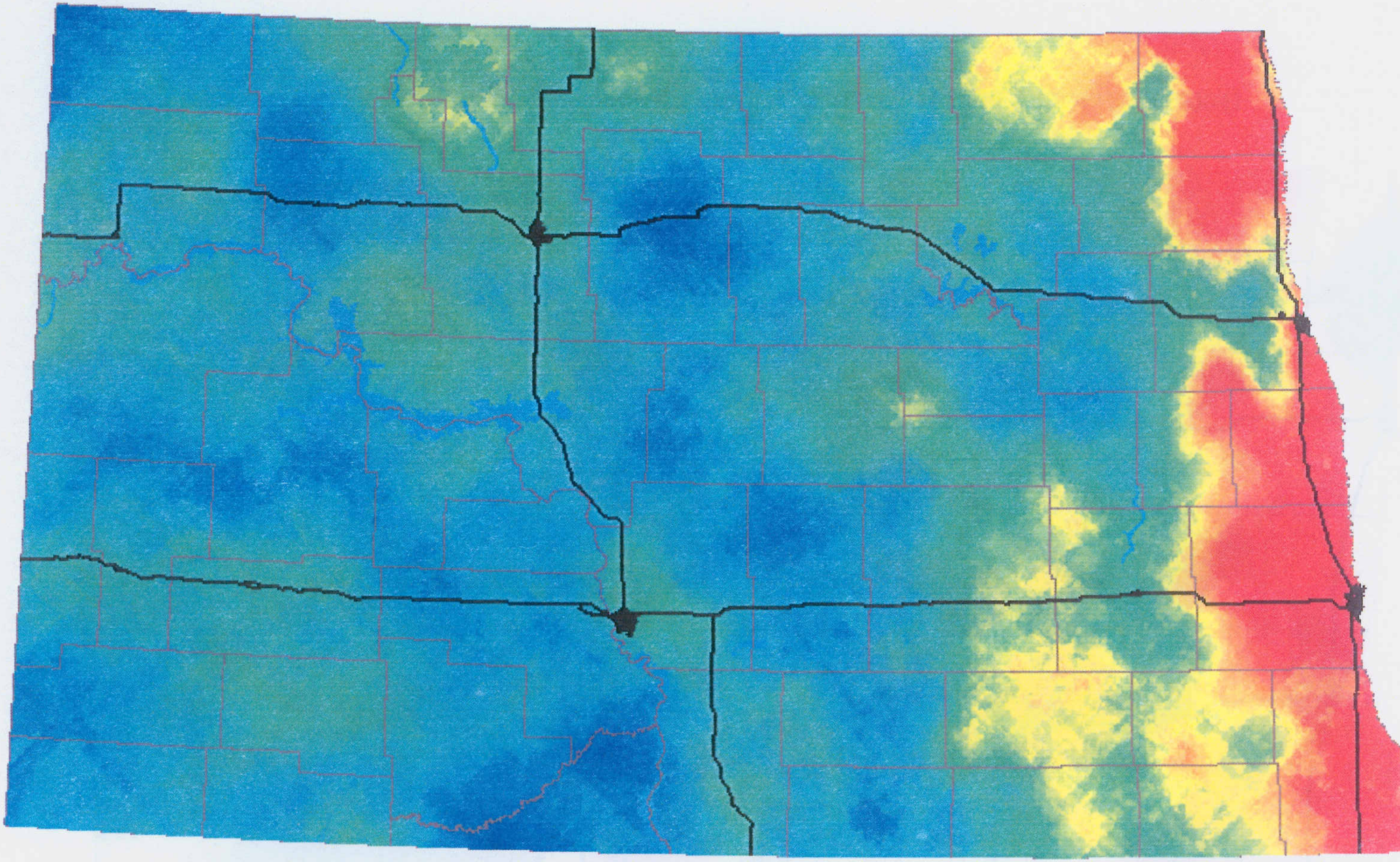

Figure 7.1. Kriging Based Estimates of Agricultural Land Values Based on 4,280 Market Sales (2000-2004)

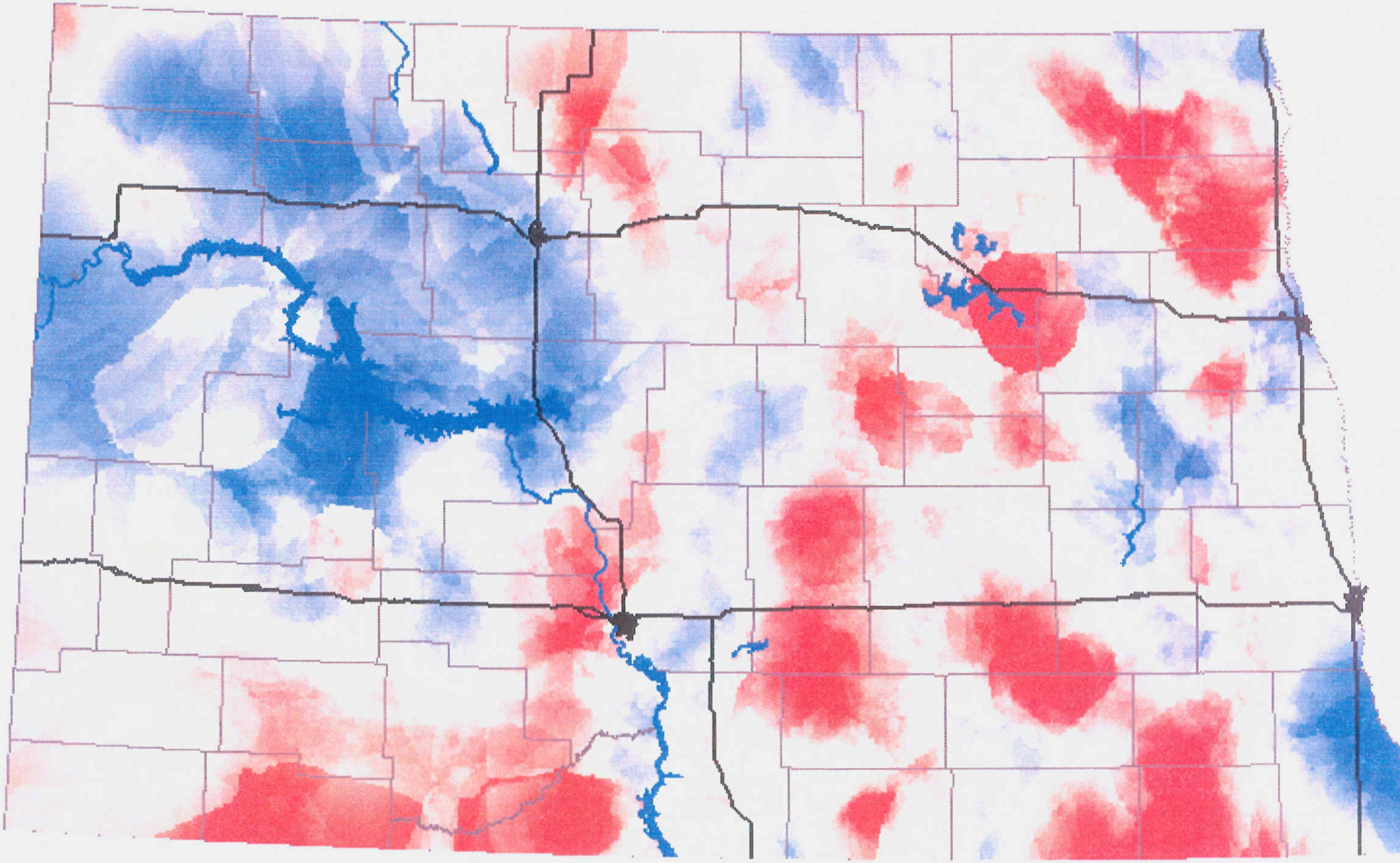

Figure 7.2. Kriging Based Estimates of Changing Agricultural Land Values (2000-2004)

Using Kriging to Compare Market Sales and JAS Land Value Estimates

Kriging based estimates of market sales in the year 2002 (776 sales) shown in Figure 7.3 were spatially overlaid with a kriged map based on year 2002 JAS sales shown in Figure 7.4 (376 sites). Despite the much larger sample size, each of the two maps appear (at least visually) to estimate land values across the State in a relatively similar pattern. The areas where the land values from the two maps do not coincide appear in the overlay map shown in Figure 7.5 as dark red (indicating that JAS values are higher than market based values) and in dark blue (indicating JAS values are less than market sales).

The above kriging analysis was conducted using the default 'standard deviation' criteria for stretching and display (which is intended to highlight or even exaggerate extremes). In contrast Figure 7.4 was based on an 'equalized histogram' stretching procedure and the differences between the JAS and market sales appear less pronounced.

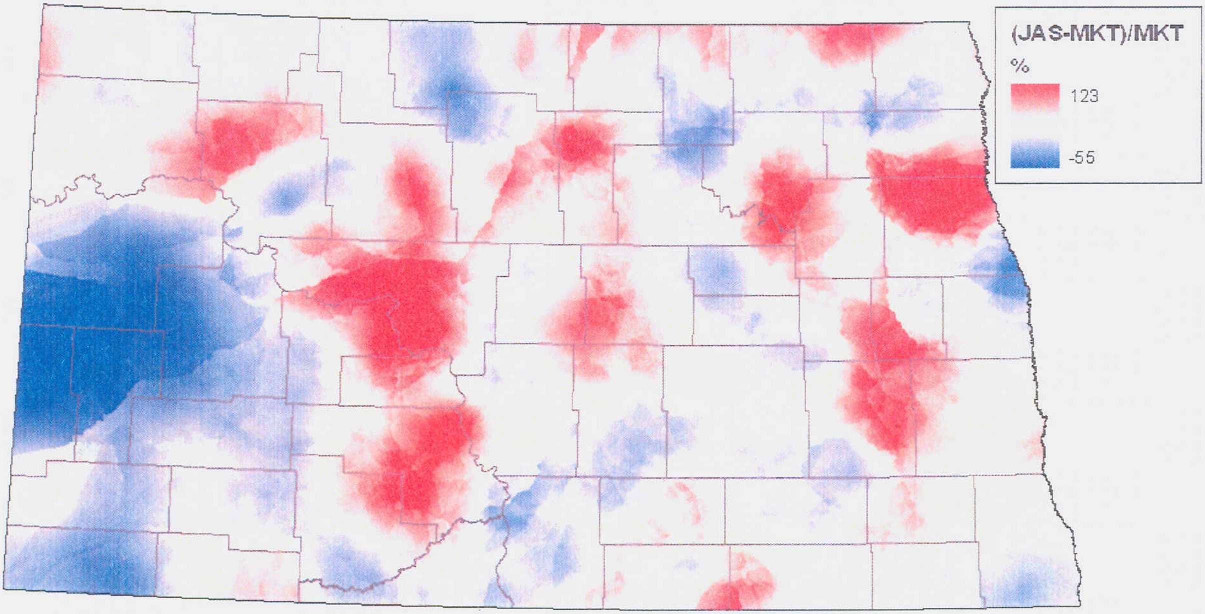

Figure 7.5 Differences Between 2003 JAS and Market Sale Values (Based on Standard Deviation Kriging)

Summary and Discussion

The use of GIS based kriging to interpolate point based land sale data across a continuous surface appears to hold much advantage over traditional county level analyses as it appears that land characteristics and land values are not homogenous across counties. The kriged land value maps presented visually demonstrate the high degree of variation in land values across counties that clearly would have been lost if represented at the county level of analysis. Kriged land value maps can also be spatially overlaid with one another as demonstrated by the map of changing land values across the State based on land sales from 2000 to 2004.

Somewhat surprisingly, a kriged land value map based on year 2002 JAS segment values displayed very similar land value estimates across the State as did a kriged map based on almost twice as many market sales. Spatial overlays of the two maps did identify distinct areas of the State where the land value estimates based on the two data sources did differ substantially but for the most part they were not extensive areas.

Further research is warranted regarding the impact of using alternative kriging display specifications and alternative procedures to compare kriged base estimates of JAS versus market sale values. As well, when a methodologically sound approach to identifying areas where JAS and market based values differ, GIS based research should be conducted to evaluate why this is occurring in these particular areas. In the meantime, the use of kriging appears to hold great potential as a strategy for interpolating and releasing JAS land value data as it provides a provides sub-county specificity while maintaining the confidentiality of JAS respondents.

8) CONCLUSIONS

The JAS generates agricultural land values that are similar to both the alternative NDLVS and actual market sales at the statewide level in North Dakota. The JAS does not appear to consistently make accurate estimates of market sale values in all counties of the State, although it was never intended for this purpose. The NDLVS, which is intended to capture county level land values, also does not appear to be accurate across all counties in the State which is likely a result of the fact that land characteristics and values are not homogenous across county boundaries as was shown by kriging analyses that interpolated market sales across the State.

Multiple regression analyses to quantify factors influencing differences between the JAS and market sales at both the county and site-specific (JAS segment) level of analyses were only partially successful: There were some indications that homogeneity with respect to wetlands, land uses and soil productivity influence such differences, but the accuracy of the analyses were limited due to omitted variables and small sample sizes (due to the inability to separate pasture from CRP). Future efforts that utilize a larger sample size (either distinguishing CRP from pasture or utilizing the recently created statewide database of market sales) along with the use of more complex buffering techniques to more carefully select nearby 'comparable' sales are expected to increase the accuracy of efforts to model the factors influencing differences between the JAS and market sale values.

Another promising approach at gaining a better understanding of the factors influencing differences between the JAS and market sale values is through kriging and spatial analyses and in particular, quantifying the characteristics of land where such differences occur. However, before this research is conducted, refinements to the methodologies need to be made. This will likely involve exploratory analyses of the statistical distribution of both JAS and market sale values across various years. It is expected that such research can be conducted with the existing 2001-2004 JAS and market sales data that has already been collected in North Dakota. However it may also be prudent to begin the effort to replicate this research in another State particularly one with has publicly disclosed agricultural land sales data, soil productivity, common land unit, and the NASS cropland layer data.

It would also be advantageous if this research is continued in other States which, like North Dakota, are dominated by production agriculture and are not subject to a great deal of urban sprawl which can interfere with agricultural land valuation modeling efforts. Other criteria for selecting States include the availability of GIS-based data for soils (NRCS-SSURGO), common land units (FSA), and land uses (the NASS cropland data layer) as well publicly available market sale data.

In the meantime, policy makers should be cautious regarding the use and interpretation of JAS (or NDLVS) data below the State or regional levels of analysis. At the same time NASS should consider the use of kriged map as an approach for releasing JAS land value data to the general public as an alternative to the current policy of releasing only a single statewide land value estimates. This GIS based approach has the potential to provide reasonably accurate site-specific agricultural land value estimates in many parts of the country where such data is clearly not available while maintaining the confidentiality of individual JAS respondents.

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