# Ecosystem Sustainability Framework for County Analysis
# Decision-Aid Tools for Natural Resource Analysis

This project highlights the economic and environmental health of agricultural counties within the same MLRA, using easily available data. It allows NRCS to better target workloads and programs to these areas. This method is patterned after the sustainability model used by Gomez et al., 1996.[1] The model assumes an agricultural system is sustainable if it meets the needs of the farmer, and conserves the natural resources. Indicators are selected for each of the concerns, and threshold levels of sustainability are established. The threshold for an indicator is either an average for the entire data set or another acceptable minimum value. For example, in the Gomez study the indicator organic matter had a threshold value of 1% or average of the farms in the study if greater than 1%. The individual farm values for an indicator are compared to the threshold, where meeting an indicator's threshold receives a score of one. The scores for each farm were added, then divided by the number of indicators. A score of one or higher indicates that the system is sustainable. Systems can also be compared at the indicator level for individual resource concerns.

Twenty-nine counties in Wisconsin, Minnesota, Iowa, and Illinois were examined, each having more than 60% of its area within MLRA 105. These counties were compared to the rest of the MLRA by Farmer Satisfaction, Resource Conservation, and a combination of both sets of indicators. The ratio of each county's value to the MLRA average is the index score for that indicator. 'Bad' values were inverted, so that the higher index is better for all factors. These preliminary runs include a wide range of indicators for evaluation of each indicator. A subset of these indicators will be used in later analysis.

The indicators chosen were derived from common nationally available databases: Natural Resources Inventory (NRI), Agricultural Census, National Agricultural Statistical Service (NASS) Crop Production Statistics, and the Conservation Tillage Information Center (CTIC) Tillage Survey. Eighteen indicators have been tested so far. An additional five indicators will be developed using the EPIC model with nationally available soils and climate data. At least two substitute indicators will be developed using automatic surface layer interpretation of photography. Table 1 shows the indicators and status to date. Table 2 has the index values for each county, and the averages of the indicators. The last page shows the calculation of cultivated cropland erosion, plus the margins of error. With the use of NRI data, a better test might be the average plus the margin of error.

Using the first set of 19 indicators, only one county passed all eight economic tests (Wabasha, MN), and no county passed all 11 resource conservation texts (Wabasha passed 10 of 11, but was 1% over on the total erosion index). Maps 1 and 2 show the economic and sustainability indicators to date. Jackson Co., Iowa has the poorest economic score and the second poorest environmental score. One side usage of this data might be looking at any correlation between the economic and environmental score.

Using, as Gomex does, the average index values for economics and for resource conservation, 14 counties pass the economics test, and 18 pass the resource conservation test. Extreme low levels of non-cropland erosion in some counties over-balanced the other indicators in this procedure. Only seven counties passed both the economic test, and the resource conservation test.

The next step is to drop the six indicators adding the least value, for the various reasons stated in the right two columns of Table 1. This cuts the weight of total erosion measures from six tests in eleven, to only three tests in eight. This set of 13 measures produces better results. With the smaller test, Wabasha is the only county to pass all five Economic tests, and the only county to pass all eight Resource Conservation tests. Two other Minnesota counties passed 11 of 13 tests. The other 26 counties passed between five to nine tests each.

[1] (Measuring the Sustainability of Agricultural Systems at the Farm Level; Dr. Arturo A. Gomez, David E. Swete Kelly, and Dr. J Keith Syers, Workshop on Advances in Soil Quality for Land Management; Ballarat, Australia, reprinted in Methods for Assessing Soil Quality, SSSA Special Publication Number 49, 1996)

Using the average of the indexes, 12 counties pass the overall average economic test, and 22 counties pass the resource conservation test. Seven counties pass both of the tests. Compared with using all 19 indicators, the changes were Clayton, Iowa qualifying and Monroe, WS dropping out. Clayton passed the Conservation tests when the weighting of the erosion tests was cut. Monroe Co. was borderline in both tests, and slipped below the economic threshold when its large income per farm score was eliminated. This northern county has larger farms, but less income per acre.

Many useful county insights were developed during the development of these indicators. Even with these simple indicators, soils, climate, cultural and historic development differences were seen. Many have a simple explanation, (like corn yields roughly matching an annual heat unit map. Maps and graphs were developed for all indicators, and are used in the next level of detail analysis.

One display method used by Gomez for these indicators are radar graphs. Below are the radar graphs developed for Wabasha, MN and Jackson, IA counties, the best and worst county averages in this test. This is a fast way to pinpoint items of concern for each county. The broad green (or black) line shows the sustainability goals for each item. Most goals are set at 100% of the MLRA average, so the goals appear as almost a circle. The connected points show the index for that county for each indicator. In different colors, you can even display several counties on the same radar graph.

Note how Wabasha's graph is distorted by the large 425% index value for %Other Land (non-cropland) eroding over T. Since that is a negative indicator, (less is better), the 425% is based on 1/((Wabasha's percentage of non-cropland eroding over T (1%)) / (the MLRA average (5%)). The imbalance in the NRI data for this variable was one factor in dropping it in later analysis. Note how that Wabasha does not quite qualify on Farm Tenure (96%(low average years on farm) and Total Erosion (99%(actually 101% of the MLRA USLE average since it is a negative indicator). With existing conservation measures, it has average erosion per acre on both cropland and non-cropland, but its high percentage of cropland push the total erosion per acre above the MLRA average. Both of these measures were dropped in the second cut. Wabasha has slightly greater levels of conservation tillage and applied conservation practices than the MLRA average, and those practices are doing the job.

Jackson County shows poorly on most economic and conservation measures. Being in mid-Iowa along the Mississippi, it has fewer trees, but rolling hills with 35% of the land in grass. With its warmer climate, it still has slightly higher than average yields, but low increase in yields over the last 25 years. (The northern counties had higher increases in corn yields, probably based on better short growing season varieties.) Net returns were low for all three census years (82,87,92) and 19% of farms had net losses those three years. With these factors, it also had smaller increases in land values than the neighboring counties. Its low Resource Conservation scores are due primarily to high erosion on both cropland and non-cropland. They are applying slightly higher levels of conservation (based on # of practices applied on NRI points and high levels of conservation tillage), but not enough to slow their erosion rates anywhere near the MLRA level. With their above average level of conservation tillage, additional emphasis on no-till or ridge-till practices may be effective in the county from both cultural and conservation perspectives. With the high amount of grassland and grassland erosion, emphasis on grazing practices should also be included. A case can be made to pinpoint more NRCS resources into this county to cost-effectively meet conservation goals.

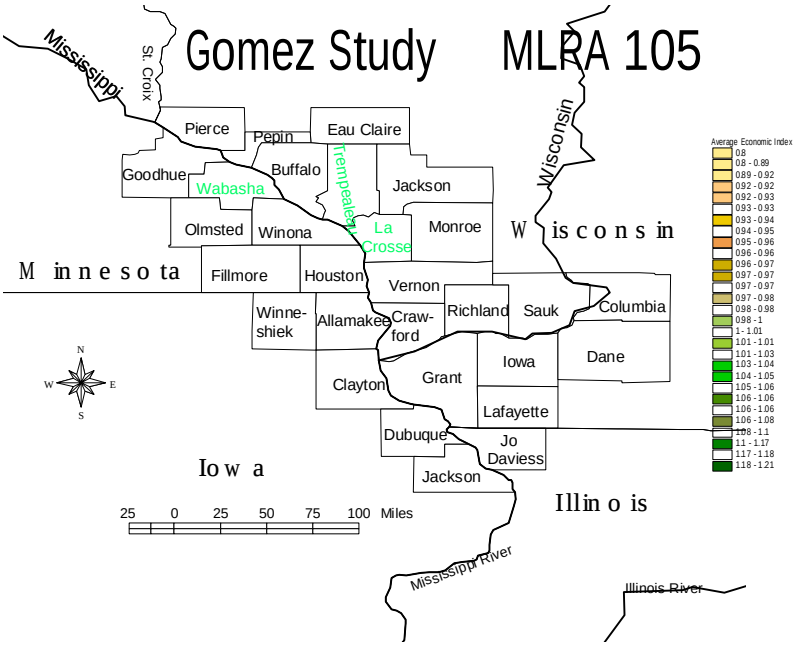
These non-EPIC indicators can be easily reproduced for other MLRAs. All indicators come from national datasets, which are already available within NRCS in INFORMAX or MS ACCESS databases. This analysis used only MS Office and a simple mapmaking tool. This analysis can be replicated at any state or regional office with their existing equipment and skills. Initial testing for the entire Mid-West region shows promise. It could be a useful tool for management to use for workload analysis or overall progress reporting.

The combining of social/economic data with natural resource data to develop joint indicators is a useful tool for conservation planning at state and regional levels. It can also be developed to provide technical guidelines on a site-specific basis to indicate when an Alternative Management System may be allowed to replace a more costly Resource Management System due to economic or social grounds. This would provide legitimate tests to support the state conservationist's decision.

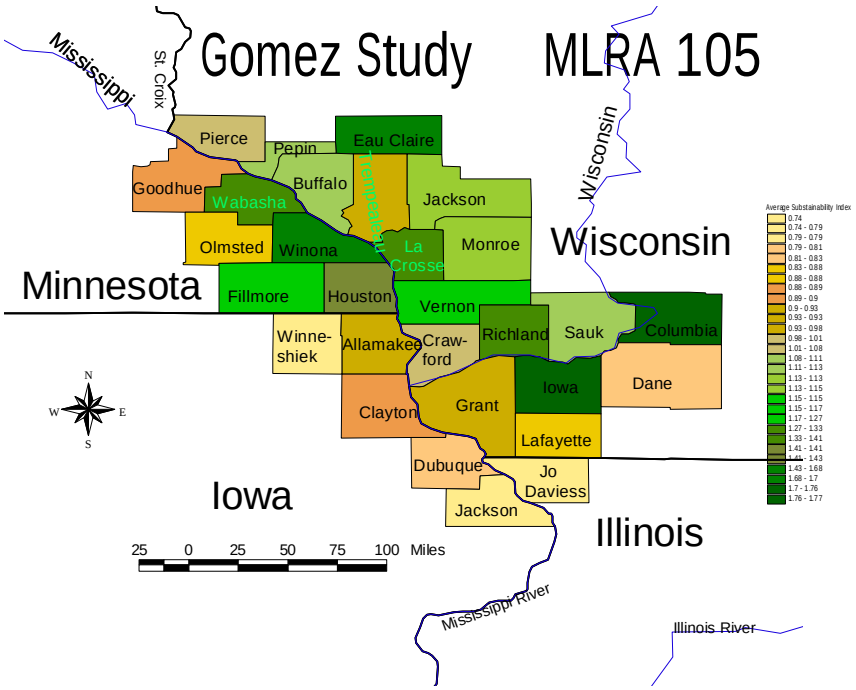
## Table 1 Table of Indicators

| Item | Test | Datasource | Ratio | Significance | Comments | Status |
|---|---|---|---|---|---|---|
| | **Economic** | | | | | |
| Yield of significant crops | County weighted avg. >MLRA Avg Yields | NASS 86-95 average | County Avg Yields(weighted by %county acreage)/MLRA avg. | Production | Significant, useful and simple. Keep | Keep |
| Yield Potential | County avg. (EPIC/NASS) production >MLRA Avg weighted by crop acres. | EPIC/NRI v. NASS | (County avg. of NASS prod./ county avg. of EPIC yields ) / MLRA ratio(weighted by %county acreage) | Management Skills | Waiting for EPIC runs | Later |
| Yield Trends | Trend Greater than MLRA average | 1972 1995 NASS Corn Yields | Slope Yield Trend / MLRA average | Productivity change | Significant, | Keep |
| Net Cash Return on farms with >10K | County avg. per farm > Mlra avg | Ag. Census, Table 12, Net Cash Return | County avg. per farm / Mlra avg | Net Farm Income | Bias toward Large Farms | Drop |
| Net Cash Return on farms with >10K, per Acre | County avg. per farm > Mlra avg | Ag. Census, Table 12, Net Cash Return | County avg. per farm / Mlra avg | Net Farm Income | Significant | Keep |
| Change in Land Value | County avg. > Mlra avg | Ag. Census, Table 12, Avg. Value/Acre,87,92 | County avg. increase/ Mlra avg increase | Change in Land Value | Significant | Keep |
| | **Risk** | | | | | |
| Farm Tenure | County avg. (% operators with <4 years on present farm > Mlra avg | Ag. Census, Table 12 Operator Characteristics, operator by years on farm | County avg. (% operators with <4 years on present farm / Mlra avg | Operator Turnover | Drop, Not useful. Ages are from 47 to 57. Note correlated | Drop |
| Yield Variance | County weighted crop yield %SD/> avg. of MLRA counties. | % Standard deviations of 69 to 95 NASS yields. | County weighted crop yield %SD / avg. of MLRA counties | Yield Risk | Inverse relationship with yields, none with profit. | Drop |
| % Farms with net losses | % Farms with net losses > Mlra avg | Ag. Census12, Net Cash Return, #farms net losses | County avg. % farms with net losses / Mlra avg. | Net Farm Income | Easy and useful | Keep |
| | **Sustainability** | | | | | |
| Acres eroding >T | County Avg. <T | NRI points | County Avg./T | Erosion | Better to only use cropland | Drop |
| Acres eroding >T, cropland | County Avg. <T | NRI points | County Avg./T | Erosion | Pinpoints com-pliance needs | Keep |
| Acres eroding >T, non-cropland | County Avg. <T | NRI points | County Avg./T | Erosion | Use total non-cropland erosion | Drop |
| Total Erosion/acre | County Avg. Erosion per acre < T | NRI points | County Average Erosion / MLRA avg. | Erosion | Better to separate | Drop |
| Total Erosion/acre, cropland | County Avg. Erosion per acre < T | NRI points | County Average Erosion / MLRA avg. | Erosion | Needed for W/Q work | Keep |
| Total Erosion/acre, non-cropland | County Avg. Erosion per acre < T | NRI points | County Average Erosion / MLRA avg. | Erosion | Pinpoints conservation needs | Keep |
| Permanent Grass | 20% or MLRA avg. | NRI X factor | % of MLRA avg. | Wildlife Habitat | All pass in this MLRA | Keep |
| Permanent Grass | 20% or MLRA avg. | NRI key photographs | % of MLRA avg. | Wildlife Habitat | Possible Substitute | Later |
| Tree cover % | 20% or MLRA avg. | NRI X factor | % of MLRA avg. | Wildlife Habitat | Significant here | Keep |
| Tree cover % | 20% or MLRA avg. | NRI key photographs | % of MLRA avg. | Wildlife Habitat | Possible Substitute | Later |
| Conservation Tillage | MLRA avg. | CTIC | % of MLRA avg. | Conservation | Shows success | Keep |
| Applied Conservation | 75% of HEL cropland | NRI Conservation App. | % cropland with conservation practices | Erosion | Little correlation / anything else | Keep |
| Crop Rotations | Avg. NRI cropland points(1 per each crop, 2 for alfalfa/grass yr) | NRI 79 - 82 Land use | County Points/MLRA Avg. | Sustainability | Good correlation with erosion | Keep |

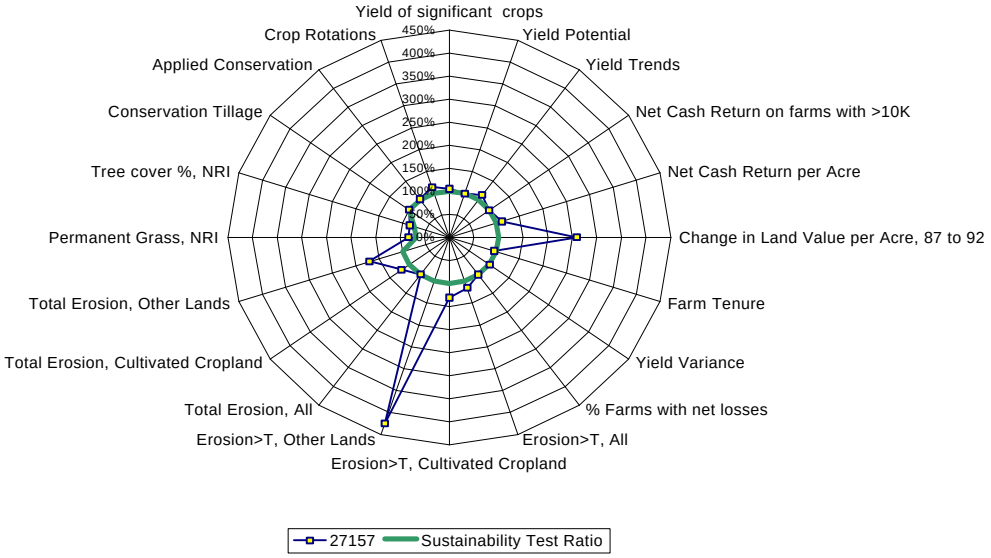
**Prior to the EPIC related Indexes, the Average Economic Indexes:**



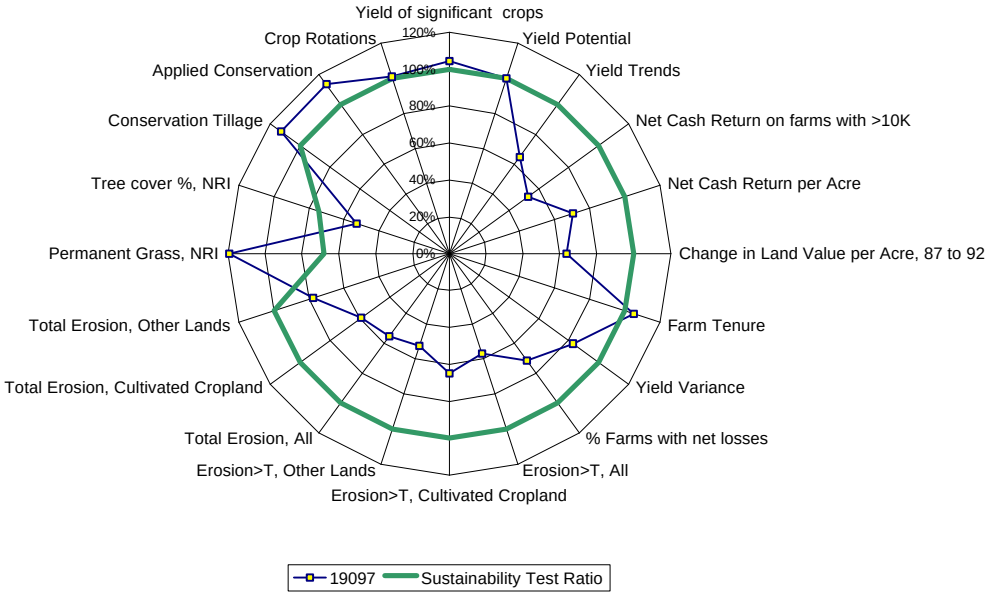

**Prior to the EPIC related Indexes, the Average Sustainability Indexes:**



**Sustainability Tests for MLRA105.**
**Counties listed by FIPS code.**
**Wabasha Co. Minnesota**




**Sustainability Tests for MLRA105.**
**Counties listed by FIPS code.**
**Jackson Co. Iowa**



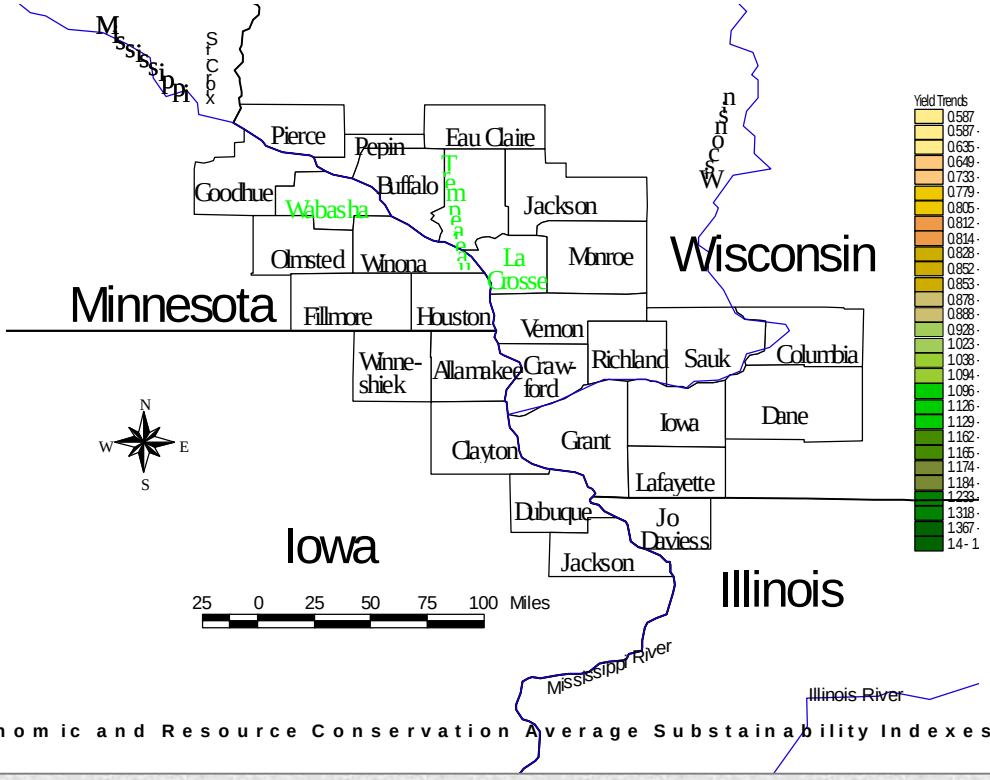
## Yield Trends

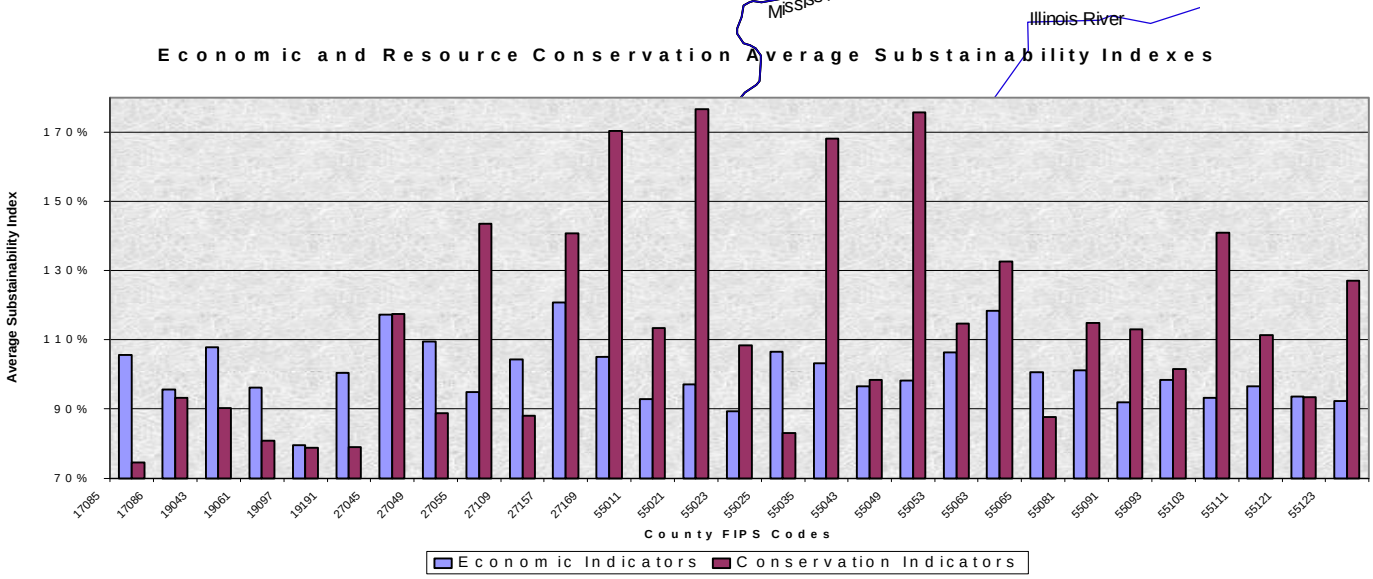
The trend of corn yields was calculated from the regressions on 1972 to 1995 corn yields for each county.

This yield trend variable seems valuable. All the most Northern counties have large yield increases, perhaps due to better short growing season corn varieties. Why Columbia and Dane counties in the east have large yield increases is more of a puzzle.

All counties have similar resources, access to the same improving technology, and a primary dependence on corn as their main cash crop. Weather variations should cancel out over the 23 years of data. The main factors are management and technology improvements over time, balance against changes in the resources base. Yield Trends seem to be a determining factor for long-term increases in county land prices.

Why are there both low yields, and low yield increases in the area from Houston to Richland Counties?



| | | Sustainability Test Ratio | JO DAVIESS | ALLAMAKEE | CLAYTON | DUBUQUE | JACKSON | WINNESHIEK | FILLMORE | GOODHUE | HOUSTON | OLMSTED | WABASHA | WINONA | BUFFALO | COLUMBIA | CRAWFORD | DANE | EAU CLAIRE | GRANT | IOWA | JACKSON | LA CROSSE | LAFAYETTE | MONROE | PEPIN | PIERCE | RICHLAND | SAUK | TREMPEALEAU | VERNON | Keep or Drop |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 17085 | 17086 | 19043 | 19061 | 19097 | 19191 | 27045 | 27049 | 27055 | 27109 | 27157 | 27169 | 55011 | 55021 | 55023 | 55025 | 55035 | 55043 | 55049 | 55053 | 55063 | 55065 | 55081 | 55091 | 55093 | 55103 | 55111 | 55121 | 55123 | |
| | Item | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Profitability | Yield of significant crops | 100% | 100% | 110% | 117% | 115% | 105% | 112% | 101% | 105% | 103% | 99% | 105% | 105% | 94% | 102% | 95% | 102% | 90% | 103% | 96% | 89% | 97% | 101% | 92% | 93% | 95% | 93% | 96% | 93% | 96% | Keep |
| | Yield Trends | 100% | 81% | 81% | 80% | 73% | 65% | 102% | 93% | 113% | 78% | 116% | 113% | 110% | 117% | 144% | 63% | 137% | 118% | 83% | 85% | 140% | 89% | 104% | 85% | 123% | 132% | 88% | 109% | 117% | 59% | Keep |
| | Net Cash Return on farms with > | 100% | 89% | 100% | 120% | 118% | 53% | 98% | 84% | 103% | 95% | 79% | 100% | 117% | 111% | 83% | 74% | 152% | 90% | 112% | 114% | 140% | 100% | 130% | 107% | 82% | 83% | 85% | 99% | 93% | 88% | Drop |
| | Net Cash Return per Acre | 100% | 85% | 86% | 120% | 86% | 70% | 169% | 160% | 101% | 77% | 102% | 113% | 90% | 104% | 52% | 114% | 76% | 102% | 125% | 120% | 75% | 80% | 85% | 81% | 97% | 93% | 116% | 100% | 109% | 112% | Keep |
| | Change in Land Value per Acre, | 100% | 195% | 92% | 131% | 88% | 64% | 33% | 230% | 172% | 105% | 181% | 259% | 114% | 10% | 102% | 35% | 106% | 105% | 38% | 57% | 84% | 258% | 81% | 110% | 52% | 72% | 23% | 61% | 21% | 20% | Keep |
| Risk | Farm Tenure | 100% | 101% | 105% | 96% | 96% | 105% | 96% | 101% | 101% | 105% | 105% | 96% | 101% | 101% | 101% | 101% | 105% | 86% | 96% | 101% | 101% | 110% | 96% | 101% | 91% | 105% | 101% | 105% | 96% | 96% | Drop |
| | Yield Variance | 100% | 91% | 95% | 95% | 85% | 83% | 96% | 97% | 98% | 104% | 87% | 102% | 92% | 110% | 118% | 106% | 93% | 102% | 105% | 95% | 111% | 119% | 88% | 103% | 105% | 101% | 108% | 111% | 102% | 109% | Inversed,Drop |
| | % Farms with net losses | 100% | 108% | 90% | 110% | 103% | 71% | 97% | 89% | 92% | 86% | 70% | 100% | 115% | 91% | 73% | 116% | 87% | 135% | 108% | 115% | 118% | 114% | 121% | 130% | 86% | 102% | 127% | 87% | 111% | 149% | Inversed,Keep |
| Sustainability | Erosion>T, All | 100% | 55% | 88% | 69% | 52% | 57% | 67% | 104% | 62% | 187% | 60% | 116% | 218% | 171% | 115% | 128% | 80% | 252% | 98% | 281% | 200% | 178% | 57% | 162% | 135% | 109% | 218% | 139% | 92% | 145% | Inversed,Drop |
| | Erosion>T, Cultivated Cropland | 100% | 61% | 78% | 77% | 65% | 65% | 96% | 136% | 92% | 229% | 78% | 131% | 189% | 123% | 119% | 61% | 107% | 216% | 88% | 210% | 98% | 97% | 71% | 93% | 134% | 112% | 147% | 137% | 117% | 94% | Inversed,Keep |
| | Erosion>T, Other Lands | 100% | 56% | 94% | 113% | 104% | 53% | 53% | 259% | 115% | 92% | 164% | 425% | 323% | 116% | 605% | 97% | 75% | 120% | 88% | 187% | 118% | 253% | 81% | 105% | 99% | 61% | 117% | 96% | 39% | 173% | Inversed,Drop |
| | Total Erosion, All | 100% | 63% | 80% | 62% | 57% | 56% | 73% | 100% | 62% | 178% | 66% | 99% | 197% | 105% | 128% | 135% | 101% | 319% | 103% | 293% | 121% | 162% | 67% | 166% | 90% | 112% | 216% | 136% | 86% | 166% | Inversed,Drop |
| | Total Erosion, Cultivated Croplar | 100% | 71% | 69% | 72% | 74% | 59% | 109% | 137% | 92% | 180% | 88% | 120% | 182% | 62% | 143% | 59% | 130% | 227% | 104% | 241% | 112% | 97% | 85% | 98% | 74% | 123% | 132% | 131% | 88% | 129% | Inversed,Keep |
| | Total Erosion, Other Lands | 100% | 70% | 110% | 89% | 98% | 78% | 54% | 167% | 154% | 129% | 130% | 170% | 236% | 127% | 271% | 135% | 120% | 201% | 77% | 185% | 50% | 173% | 87% | 113% | 137% | 64% | 145% | 108% | 49% | 128% | Inversed,Keep |
| | Permanent Grass, NRI | 68% | 101% | 112% | 84% | 100% | 119% | 98% | 68% | 72% | 79% | 69% | 84% | 89% | 93% | 106% | 96% | 81% | 108% | 127% | 133% | 86% | 71% | 132% | 104% | 97% | 132% | 110% | 103% | 116% | 126% | Keep |
| | Tree cover %, NRI | 74% | 73% | 93% | 71% | 38% | 53% | 41% | 55% | 50% | 159% | 29% | 84% | 125% | 183% | 68% | 184% | 34% | 141% | 91% | 91% | 216% | 173% | 34% | 164% | 124% | 81% | 160% | 110% | 108% | 132% | Keep |
| | Conservation Tillage | 100% | 87% | 88% | 131% | 101% | 113% | 86% | 89% | 90% | 127% | 129% | 102% | 110% | 83% | 195% | 95% | 31% | 120% | 98% | 44% | 86% | 69% | 164% | 58% | 126% | 114% | 85% | 62% | 137% | 89% | Keep |
| | Applied Conservation | 100% | 104% | 112% | 130% | 111% | 113% | 90% | 89% | 85% | 121% | 50% | 102% | 121% | 81% | 101% | 96% | 60% | 35% | 96% | 126% | 68% | 88% | 83% | 91% | 129% | 105% | 120% | 107% | 97% | 115% | Keep |
| | Crop Rotations | 100% | 78% | 103% | 96% | 91% | 101% | 102% | 89% | 103% | 97% | 105% | 115% | 83% | 103% | 91% | 106% | 93% | 110% | 114% | 141% | 104% | 97% | 102% | 108% | 99% | 104% | 101% | 96% | 97% | 100% | Keep |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | **First 18 Indicators** | | 17085 | 19005 | 19043 | 19061 | 19097 | 19191 | 27045 | 27049 | 27055 | 27109 | 27157 | 27169 | 55011 | 55021 | 55023 | 55025 | 55035 | 55043 | 55049 | 55053 | 55063 | 55065 | 55081 | 55091 | 55093 | 55103 | 55111 | 55121 | 55123 | |
| | Average Economic Substainabi | 100% | 106% | 95% | 109% | 96% | 77% | 100% | 119% | 111% | 94% | 105% | 123% | 106% | 92% | 97% | 88% | 107% | 104% | 96% | 98% | 107% | 121% | 101% | 101% | 91% | 98% | 92% | 96% | 93% | 91% | |
| | Average Resource Conservatior | 95% | 74% | 93% | 90% | 81% | 79% | 79% | 117% | 89% | 143% | 88% | 141% | 170% | 113% | 177% | 108% | 83% | 168% | 98% | 176% | 115% | 133% | 88% | 115% | 113% | 101% | 141% | 111% | 93% | 127% | |
| | Total Average Substainability Index | | 90% | 94% | 100% | 88% | 78% | 90% | 118% | 100% | 119% | 96% | 132% | 138% | 103% | 137% | 98% | 95% | 136% | 97% | 137% | 111% | 127% | 94% | 108% | 102% | 100% | 117% | 104% | 93% | 109% | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | **First Cut to 13 Good Indicators** | | 17085 | 19005 | 19043 | 19061 | 19097 | 19191 | 27045 | 27049 | 27055 | 27109 | 27157 | 27169 | 55011 | 55021 | 55023 | 55025 | 55035 | 55043 | 55049 | 55053 | 55063 | 55065 | 55081 | 55091 | 55093 | 55103 | 55111 | 55121 | 55123 | |
| | Average Economic Substainabi | 100% | 114% | 92% | 112% | 93% | 75% | 103% | 135% | 117% | 90% | 114% | 138% | 107% | 83% | 95% | 85% | 101% | 110% | 91% | 95% | 101% | 127% | 98% | 100% | 90% | 99% | 89% | 91% | 90% | 87% | |
| | Average Resource Conservatior | 93% | 81% | 96% | 94% | 85% | 88% | 84% | 104% | 92% | 140% | 85% | 114% | 142% | 107% | 137% | 104% | 82% | 145% | 99% | 146% | 103% | 108% | 95% | 104% | 115% | 104% | 125% | 107% | 101% | 114% | |
| | Total Average Substainability Index | | 84% | 89% | 94% | 81% | 78% | 112% | 117% | 101% | 119% | 98% | 111% | 116% | 111% | 107% | 89% | 104% | 125% | 99% | 122% | 105% | 99% | 89% | 93% | 110% | 109% | 112% | 113% | 108% | 94% | |