

Cropland Cash Rental Rates in the Upper Mississippi River Basin

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Abstract

The report documents the creation of estimates for cropland cash rental rates in the Upper Mississippi River Basin in 1997. Although the basic data come from disparate sources, we employ a unifying estimation procedure based on the presumption that the cropland cash rental rate is an increasing function of corn yield potential. The rates are estimated at some 42,000 National Resources Inventory data points representing cropland in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, South Dakota, and Wisconsin.

Keywords: cropland cash rental rates, land retirement, Upper Mississippi River Basin.

CROPLAND CASH RENTAL RATES IN THE UPPER MISSISSIPPI RIVER BASIN

Introduction

This document provides a technical overview of the creation of estimates for cropland cash rental rates in the Upper Mississippi River Basin (UMRB) in 1997. The purpose of constructing the estimates is to provide the capability to model agricultural land retirement decisions following the approach of Smith (1995), who measures the opportunity cost of land retirement using cropland cash rental rates. The ultimate unit for which the rate is predicted is a “point” in the 1997 National Resources Inventory (NRI) data set (Nusser and Goebel 1997). We construct the estimates at some 42,000 NRI points representing cropland in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, South Dakota, and Wisconsin.

The basic data for construction of the estimates have been compiled from disparate sources. The analysis for which this eventually is intended is watershed based, but because of the nature of the underlying data, the estimates had to be generated using administrative boundaries such as counties and crop reporting districts. Although the fundamental concept is similar, each data source (all state-specific) requires a unique procedure because of the wide range in available spatial resolution.

In the remaining sections of the report, we first outline the general procedure and then present the details on estimation for each state separately. The report concludes with the summaries of the estimates for the UMRB.

Procedure

Under the assumption that the cropland cash rental rate is a monotonic function of corn yield potential, we estimate piecewise linear functions, which express the per acre cash rental rate as the function of the corn yield estimate, and use the functions to estimate the cash rental rate of every NRI point (USDA-NRCS 1997) in the study. The

functions, referred to as *rental rate functions*, are estimated separately for each of the states and, where possible, for sub-state geographical units (multi-county districts or counties) to better represent spatial heterogeneity in the opportunity costs and to account for possible rent differences that may exist because of non-agricultural land uses.

To estimate the corn yield potential of each NRI point, we use EPIC (Williams 1990), a physical processes simulation model, to simulate 30 years of corn-soybean rotation under normal weather conditions. The 15-year average of the predicted corn yield is used as the measure of the corn yield potential of the point.

Illinois

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship.

Moody, Hornbaker, and DeBlock (2000) provide low and high cash rents, $r_{A low}, r_{A high}, r_{B low}, r_{B high}, r_{C low}, r_{C high}$, for Class A, B, and C soils for six Illinois regions, hereafter referred to as lease survey regions (LSRs). The class of the soil can be determined by the optimum productivity index (PI) (Olson and Lang 2000) (<http://research.nres.uiuc.edu/soilproductivity/>, accessed July 2004). Soils with a PI from 133 to 147 are in Class A, from 117 to 132 are in Class B, and from 100 to 116 are in Class C.

Details on Estimation of the Rental Rate Functions. The rental rate functions are LSR-specific. The 1999 cash rents from Moody, Hornbaker, and DeBlock (2000) are deflated to 1997 dollars using the deflator 1.018 ($\$1999/\1997) computed from the data in USDA-NASS (1999). Because the rent ranges for the classes reported in Moody Hornbaker and DeBlock overlapped by as much as \$10, the upper class low rate and the adjacent lower class upper rate (e.g., the Class A low rate and Class B upper rate) were averaged to provide the piecewise linear function break points. Thus, we obtained

$$r_{BA} \equiv (r_{B high} + r_{A low})/2 \text{ and } r_{CB} \equiv (r_{C high} + r_{B low})/2 .$$

To evaluate the percentages of the soils of different classes in the LSRs, we first obtain information on the PI by soil type from Olson and Lang (2000). Next we use the STATSGO database (USDA-NRCS 2004) to allocate soil types within the LSRs. Then we calculate the percentage of agricultural land area by soil class (A, B, C, non-prime agricultural land) within each LSR (Table 1).

To assign the rental rate to each point in an LSR, we begin by rank-ordering all the points in the LSR by the corn yield potential from the lowest to the highest and assigning to the non-prime, C, B, and A land class based on the percentages of the total LSR cropland in these four categories. Thus, we obtain LSR-specific low and high corn yield potential for the non-prime, C, B, and A classes: y_{\min} and $y_{C\ low}$ for non-prime land, $y_{C\ low}$ and y_{CB} for Class C land, y_{CB} and y_{BA} for Class B land, y_{BA} and y_{\max} for Class A land (Figure 1). The endpoint cash rental rates, $r_{C\ low}$, r_{CB} , r_{BA} , and $r_{A\ high}$, are assigned to the endpoints of the C, B, and A classes, that is, to $y_{C\ low}$, y_{CB} , y_{BA} , and y_{\max} , respectively. The resulting four points are connected by linear pieces, and the left-most piece is extended leftward to cover the non-prime land (Figure 1). Thus, the rental rate functions are given by the following equations:

$$r = \begin{cases} b_{11} + b_{21}(y - y_{C\ low}) / (y_{CB} - y_{C\ low}), & \text{if } y \leq y_{CB}, \\ b_{12} + b_{22}(y - y_{CB}) / (y_{BA} - y_{CB}), & \text{if } y_{CB} < y \leq y_{BA}, \\ b_{13} + b_{23}(y - y_{BA}) / (y_{\max} - y_{BA}), & \text{if } y > y_{BA}, \end{cases}$$

where the parameters $b_{11}, b_{12}, b_{13}, b_{21}, b_{22}, b_{23}$ vary by LSR; they are reported in Table 2.

Indiana

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship.

Atkinson, Miller, and Cook (1997) provide data on cropland cash rental rates (\$139/acre, \$107/acre, and \$78/acre) together with representative corn yields (153 bu/acre, 120 bu/acre, and 89 bu/acre) for top, average, and poor quality land in the northern region of the state (the only area relevant to the UMRB region).

Details on Estimation of the Rental Rate Functions. The rental rate function passes through the three data points available and thus has two pieces. It is given by the formula

$$\begin{cases} r = -5.258 + 0.935y, & \text{if } y \leq 120, \\ r = -9.364 + 0.970y, & \text{if } y > 120. \end{cases}$$

Before applying the function for prediction, the EPIC-provided yields were scaled so that the area-weighted average yield for the northern region is within one bushel of 131.8

bu/acre, the 1997 average yield reported by USDA-NASS (1997) for this region (see Missouri section for rationale).

Iowa

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship. ISU Extension (1997) provides county-level data on cropland cash rental rates for low-, average-, and high-quality land, together with the percentages of total county cropland in these three categories.

Details on Estimation of the Rental Rate Functions. Rental rate functions are county-specific. For each county, we begin by rank-ordering all the points by the corn yield potential from the lowest to the highest and assigning to the low-, medium-, and high-quality class based on the percentages of the total county cropland in these three categories (Figure 2). That is, the yield potential y_1 is determined as follows. Rank-order the points by corn yield potential in ascending order and choose the parcels from the beginning of the list until the area in these parcels is greater or equal to the area of low-quality land. Then y_1 is the yield potential of the last point chosen. Yield potential y_2 is chosen similarly: continue choosing parcels from the list until the area in these parcels is greater or equal to the sum of the areas of low- and medium-quality land. The midpoints of the classes, $y_{low} = \frac{1}{2}(y_{min} + y_1)$, $y_{med} = \frac{1}{2}(y_1 + y_2)$, and $y_{high} = \frac{1}{2}(y_2 + y_{max})$, are assigned the corresponding cash rental rates reported in ISU Extension, r_{low} , r_{med} , and r_{high} , respectively. The endpoints of the yield distribution in the county, y_{min} and y_{max} , are assigned rental rate values 20 percent lower than the low-quality land rental rate, $0.8r_{low}$, and 20 percent higher than the high-quality land rental rate, $1.2r_{high}$, respectively. The resulting five points (three midpoints of the corresponding classes and two endpoints) are connected by linear pieces to form the piecewise linear cash rental rate function. Since by construction the corn yield potential of any point in the county falls between y_{min} and y_{max} , the resulting function allows estimation of the cash rental rate for any point in the county. Thus, the final rental rate functions had four linear pieces given by equations

$$r = \begin{cases} b_{11} + b_{21}(y - y_{\min}) / (y_{\text{low}} - y_{\min}), & \text{if } y_{\min} \leq y < y_{\text{low}}, \\ b_{12} + b_{22}(y - y_{\text{low}}) / (y_{\text{med}} - y_{\text{low}}), & \text{if } y_{\text{low}} \leq y < y_{\text{med}}, \\ b_{13} + b_{23}(y - y_{\text{med}}) / (y_{\text{high}} - y_{\text{med}}), & \text{if } y_{\text{med}} \leq y < y_{\text{high}}, \\ b_{14} + b_{24}(y - y_{\text{high}}) / (y_{\text{max}} - y_{\text{high}}), & \text{if } y_{\text{high}} \leq y < y_{\text{max}}, \end{cases}$$

where the parameters $b_{11}, b_{21}, b_{12}, b_{22}, b_{13}, b_{23}, b_{14}, b_{24}$ vary by county; they are provided in Table 3. Table 4 provides the proportions of agricultural land in the low-, medium-, and high-quality land classes.

Michigan

The UMRB overlaps with only three Michigan counties. For the points located in Berrien County (FIPS = 26021), we used the Indiana rental rate function scaled by EPIC-predicted yields to obtain a county-average yield is of 117 bu/acre (USDA-NASS 1997). Gogebic County (FIPS = 26053) and Iron County (FIPS = 26071) in the Upper Peninsula bordering Wisconsin contain only 27 observations and were excluded from the sample.

Minnesota

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship. The University of Minnesota’s Center for Farm Financial Management makes available a Minnesota land economics dataset at <http://www.cffm.umn.edu/landeconomics/landdata/> (University of Minnesota, n.d.). This set contains 1997 soil rental rate data for the full spectrum of soil types in each county: six specific rates reported for each county, each associated with a variety of soils. In addition, the total acreage of soils associated with a particular rate is available.

Details on Estimation of the Rental Rate Functions. Rental rate functions are county specific. In each county, NRI points are ranked by corn yield potential and then assigned to a rate range based on their productivity and the proportion of total land in each rate category. Each rate range has an accompanying range of yields; the mean of the yield range is assigned the rate for that range. The resulting points provide the basis for construction of a piecewise linear yield/rate function that assigns a rate to each NRI point based on its yield potential, location (county), and soil rental rate category. The functional relation of rates to yield ranges and rates is

$$r = \begin{cases} a_1 + \frac{2(b_2 - b_1)}{3a_3 - 4a_2 + a_1} \left(y - \frac{a_2 + a_1}{2} \right), & \text{if } y \leq y_1, \\ a_2 + \frac{2(b_3 - b_2)}{3a_4 - 4a_3 + a_2} \left(y - \frac{a_3 + a_2}{2} \right), & \text{if } y_1 \leq y < y_2, \\ a_3 + \frac{2(b_4 - b_3)}{3a_5 - 4a_4 + a_3} \left(y - \frac{a_4 + a_3}{2} \right), & \text{if } y_2 \leq y < y_3, \\ a_4 + \frac{2(b_5 - b_4)}{3a_6 - 4a_5 + a_4} \left(y - \frac{a_5 + a_4}{2} \right), & \text{if } y_3 \leq y < y_4, \\ a_5 + \frac{2(b_6 - b_5)}{3a_7 - 4a_6 + a_5} \left(y - \frac{a_6 + a_5}{2} \right), & \text{if } y \geq y_4. \end{cases}$$

where

$$y_j = a_{j+1} + \frac{a_{j+2} - a_{j+1}}{2} \quad \text{for } j = 1, \dots, 4.$$

The values of the function parameters appear in Tables 5 and 6, and a graphical representation of the procedure can be found in Figure 3. Zero values for the yield range parameters simply indicate that the county has insufficient points in a particular range; this can occur because of the spacing of yields. This happens when a single observation represents a large proportion of land in the county that has one or more small rate classes. However, this is not an issue in practice, as the zero value indicates that no observations exist in that range, that is, the parameter value is not used in any calculations.

Missouri

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship. Plain and White (2003) provide estimates on how 2003 cash rental rates depend on corn yield for the whole state of Missouri. MASS (2003) provides average non-irrigated cropland cash rent per acre, by crop reporting district (CRD), for the years 1997 and 2003.

Details on Estimation of the Rental Rate Functions. Rental rate functions are CRD-specific. Plain and White (2003) provide statewide average 2003 rental rates $r_1 - r_6$ corresponding to six ranges of corn yield (<100, 100-120, 121-139, 140-149, 150-159, and >159 bu/acre). We use MASS (2003) data to deflate the six 2003 average rental rates into 1997 dollars, separately by CRD (the rates of rent growth vary from 1.13 \$2003/\$1997 for South Central CRD to 1.44 \$2003/\$1997 for North Central CRD).

To construct the CRD-specific rental rate functions, we assigned the corresponding average 1997 rental rates to the midpoints of the yield ranges (or “representative” points for the open end ranges), $(y_1, \dots, y_6) = (90, 110, 130, 145, 155, 170)$. The resulting six points were connected by linear pieces. The first and the last linear pieces were extended to the left and to the right, respectively. It turned out that the third and the fourth linear pieces had identical equations. Thus, the final rental rate functions had four linear pieces given by equations

$$\begin{cases} r = a_{01} + a_{11}y, & \text{if } y \leq 110, \\ r = a_{02} + a_{12}y, & \text{if } 110 < y \leq 130, \\ r = a_{03} + a_{13}y, & \text{if } 130 < y \leq 155, \\ r = a_{04} + a_{14}y, & \text{if } y > 155, \end{cases}$$

where the parameters $a_{ij}, i = 0, 1, j = 1, \dots, 4$, vary by CRD; they are reported in Table 7.

For each parcel in a CRD, the cash rental rates were predicted using the constructed function, and then the average rental rate was computed with the NRI expansion factors used as weights. If the predicted average rate was lower (higher) than the one reported in MASS (2003), then the EPIC-predicted corn yield was scaled up (down) to have the predicted rental rate average within one dollar of the one reported. The rationale behind this scaling is that the EPIC-predicted corn yield potential represents a long-term average yield which may differ from the 2003 realized yield.

South Dakota

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship.

SDASS (1997) reports 1997 minimum, maximum, and average cropland cash rent by county.

Details on Estimation of the Rental Rate Functions. Only six counties have cropland acreage within the UMRB (FIPS = 46011, 46029, 46039, 46051, 46091, 46109). The rental rate functions are county-specific; each of them consists of two linear pieces. The minimum of the predicted crop yield potential, y_{\min} , was assigned the minimum of the cash rent reported, r_{\min} , and the maximum crop yield potential, y_{\max} , was assigned the maximum cash rent reported, r_{\max} . The median crop yield potential, y_{med} , was initially

assigned the average rental rate in the county, r_{avg} . If the predicted average county rate was lower (higher) than the one reported, the assignment of the median yield potential was adjusted upward (downward) so that the predicted county-average rental rate was within one bushel of that reported in SDASS (1997). More specifically, the rental rate functions have the form

$$\begin{cases} r = r_{\min} + (y - y_{\min})(a - r_{\min}) / (y_{\text{med}} - y_{\min}), & \text{if } y \leq y_{\text{med}}, \\ r = a + (y - y_{\text{med}})(r_{\max} - a) / (y_{\max} - y_{\text{med}}), & \text{if } y > y_{\text{med}}, \end{cases}$$

where the parameter a is chosen so that the predicted area-weighted average rental rate is equal to r_{avg} which is reported in SDASS (1997). The county-specific data used in estimation is provided in Table 8.

Wisconsin

Source of Cash Rental Rate Data and Productivity—Rental Rate Relationship.

WASS (2001) provides average 2001 cropland rental rates by CRD.

Details on Estimation of the Rental Rate Functions. The WASS (2001) rental rates are deflated to 1997 dollars using the deflator 1.2 (\$2001/\$1997) computed from the data in USDA-NASS (1999, 2004). Since no information on the productivity–rental rate relationship was found for the state, we utilized the rental rate functions estimated for neighboring states in prediction. Specifically, we used the functions estimated for Illinois for the southern part of the state, Southwest, South Central, and Southeast CRDs, and the functions estimated for Minnesota for the rest of the state. In particular, the rental rate function estimated for the Northwest LSR of Illinois was used for estimation of the cash rental rates in the Illinois Southwest and South Central CRDs. The rental rate function estimated for the Northeast LSR of Illinois was used for estimation of the rental rates in the Illinois Southeast CRD. The predictions were then calibrated to match the available CRD-average rental rates.

Summary

A regional summary of the results can be seen in Tables 9 and 10 as well as in Figures 5 and 6. Figure 5 shows average rental rates by eight-digit Hydrologic Unit Code (HUC); this is the scale at which the eventual analysis is to be done. Figure 6 shows

average rental rates by county. Note in Figure 6 that, thanks to the use of NRI-point-specific characteristics in the creation of the data, there is a smooth transition across state lines despite the differences in source information.

Tables

TABLE 1. Illinois: Proportions of agricultural land in various land classes

Region	East Central	Northeast	Northwest	South	South Central	West Central
Percent Class A	0.452	0.223	0.339	0.003	0.085	0.346
Percent Class B	0.343	0.403	0.310	0.166	0.222	0.108
Percent Class C	0.175	0.361	0.335	0.505	0.475	0.526
Percent non-prime	0.030	0.013	0.016	0.325	0.218	0.020

TABLE 2. Illinois: Rental rate function parameters

LSR	b_{11}	b_{21}	b_{12}	b_{22}	b_{13}	b_{23}
Northwest	78.6	40.8	119.4	23.1	142.4	30.5
Northeast	72.7	32.9	105.6	22.6	128.2	42.7
West Central	91.4	24.6	115.9	26.5	142.4	38.3
East Central	83.5	32.4	115.9	26.5	142.4	38.3
South Central	88.4	35.9	124.3	30.5	154.7	31.9
South	44.2	17.7	61.9	11.3	73.2	17.2

TABLE 3. Iowa: Rental rate function parameters

County FIPS	b_{11}	b_{21}	b_{12}	b_{22}	b_{13}	b_{23}	b_{14}	b_{24}
19001	61.231	15.308	76.538	19.533	96.071	24.107	120.179	24.036
19003	72.000	18.000	90.000	21.000	111.000	11.000	122.000	24.400
19005	72.727	18.182	90.909	18.409	109.318	20.000	129.318	25.864
19007	49.000	12.250	61.250	15.194	76.444	20.778	97.222	19.444
19009	76.000	19.000	95.000	25.714	120.714	20.714	141.429	28.286
19011	82.737	20.684	103.421	26.579	130.000	20.643	150.643	30.129
19013	87.455	21.864	109.318	30.000	139.318	23.818	163.136	32.627
19015	75.886	18.971	94.857	23.310	118.167	22.521	140.688	28.138
19017	77.257	19.314	96.571	24.276	120.848	23.152	144.000	28.800
19019	85.000	21.250	106.250	18.750	125.000	25.818	150.818	30.164
19021	82.444	20.611	103.056	26.736	129.792	24.792	154.583	30.917
19023	81.000	20.250	101.250	26.500	127.750	23.750	151.500	30.300
19025	83.273	20.818	104.091	21.992	126.083	26.644	152.727	30.545
19027	91.700	22.925	114.625	19.063	133.688	16.938	150.625	30.125
19029	71.500	17.875	89.375	30.938	120.313	22.813	143.125	28.625

TABLE 3. Continued

County FIPS	b_{11}	b_{21}	b_{12}	b_{22}	b_{13}	b_{23}	b_{14}	b_{24}
19031	86.190	21.548	107.738	27.914	135.652	24.802	160.455	32.091
19033	81.723	20.431	102.154	20.692	122.846	10.615	133.462	26.692
19035	74.833	18.708	93.542	24.167	117.708	20.625	138.333	27.667
19037	72.308	18.077	90.385	20.865	111.250	18.558	129.808	25.962
19039	51.429	12.857	64.286	21.786	86.071	18.929	105.000	21.000
19041	75.857	18.964	94.821	26.250	121.071	22.857	143.929	28.786
19043	76.500	19.125	95.625	28.264	123.889	26.411	150.300	30.060
19045	89.077	22.269	111.346	27.692	139.038	32.390	171.429	34.286
19047	79.600	19.900	99.500	24.500	124.000	24.000	148.000	29.600
19049	75.867	18.967	94.833	18.000	112.833	17.323	130.156	26.031
19051	54.857	13.714	68.571	13.571	82.143	18.214	100.357	20.071
19053	51.429	12.857	64.286	21.786	86.071	18.929	105.000	21.000
19055	81.581	20.395	101.976	24.387	126.364	25.114	151.477	30.295
19057	77.333	19.333	96.667	28.750	125.417	29.583	155.000	31.000
19059	69.714	17.429	87.143	19.732	106.875	15.982	122.857	24.571
19061	77.556	19.389	96.944	26.667	123.611	30.278	153.889	30.778
19063	78.400	19.600	98.000	17.000	115.000	20.000	135.000	27.000
19065	80.000	20.000	100.000	22.692	122.692	24.441	147.133	29.427
19067	72.571	18.143	90.714	26.429	117.143	28.571	145.714	29.143
19069	79.418	19.855	99.273	20.686	119.958	25.269	145.227	29.045
19071	67.429	16.857	84.286	20.071	104.357	22.786	127.143	25.429
19073	86.333	21.583	107.917	19.583	127.500	16.042	143.542	28.708
19075	93.733	23.433	117.167	25.000	142.167	21.833	164.000	32.800
19077	75.500	18.875	94.375	19.847	114.222	21.611	135.833	27.167
19079	80.571	20.143	100.714	25.223	125.938	18.646	144.583	28.917
19081	80.800	20.200	101.000	28.250	129.250	21.750	151.000	30.200
19083	81.664	20.416	102.080	21.759	123.839	21.732	145.571	29.114
19085	75.257	18.814	94.071	23.500	117.571	28.857	146.429	29.286
19087	70.400	17.600	88.000	28.300	116.300	27.000	143.300	28.660
19089	64.615	16.154	80.769	19.846	100.615	14.615	115.231	23.046
19091	85.500	21.375	106.875	20.268	127.143	18.482	145.625	29.125
19093	78.667	19.667	98.333	26.667	125.000	35.500	160.500	32.100
19095	79.000	19.750	98.750	20.000	118.750	18.125	136.875	27.375
19097	77.556	19.389	96.944	26.667	123.611	30.278	153.889	30.778
19099	82.873	20.718	103.591	22.045	125.636	21.818	147.455	29.491
19101	76.622	19.156	95.778	19.167	114.944	24.222	139.167	27.833
19103	74.286	18.571	92.857	25.893	118.750	27.750	146.500	29.300
19105	78.857	19.714	98.571	28.214	126.786	24.643	151.429	30.286
19107	78.857	19.714	98.571	20.714	119.286	24.643	143.929	28.786
19109	87.077	21.769	108.846	20.154	129.000	13.857	142.857	28.571
19111	70.400	17.600	88.000	28.300	116.300	27.000	143.300	28.660
19113	76.966	19.241	96.207	23.849	120.056	22.319	142.375	28.475
19115	73.333	18.333	91.667	30.833	122.500	25.556	148.056	29.611
19117	49.000	12.250	61.250	15.194	76.444	20.778	97.222	19.444

TABLE 3. Continued

County FIPS	b_{11}	b_{21}	b_{12}	b_{22}	b_{13}	b_{23}	b_{14}	b_{24}
19119	71.692	17.923	89.615	21.808	111.423	22.154	133.577	26.715
19121	61.455	15.364	76.818	24.396	101.214	24.940	126.154	25.231
19123	72.000	18.000	90.000	33.571	123.571	30.000	153.571	30.714
19125	64.444	16.111	80.556	29.444	110.000	23.889	133.889	26.778
19127	80.700	20.175	100.875	21.125	122.000	23.625	145.625	29.125
19129	67.333	16.833	84.167	18.750	102.917	17.083	120.000	24.000
19131	75.111	18.778	93.889	22.222	116.111	22.778	138.889	27.778
19133	68.233	17.058	85.292	24.708	110.000	29.583	139.583	27.917
19135	49.000	12.250	61.250	15.194	76.444	20.778	97.222	19.444
19137	67.333	16.833	84.167	18.750	102.917	17.083	120.000	24.000
19139	70.556	17.639	88.194	28.591	116.786	32.242	149.028	29.806
19141	81.714	20.429	102.143	19.635	121.778	20.097	141.875	28.375
19143	72.471	18.118	90.588	19.265	109.853	21.618	131.471	26.294
19145	59.333	14.833	74.167	22.500	96.667	18.333	115.000	23.000
19147	80.889	20.222	101.111	19.589	120.700	14.500	135.200	27.040
19149	70.429	17.607	88.036	16.611	104.647	15.753	120.400	24.080
19151	85.333	21.333	106.667	21.167	127.833	19.667	147.500	29.500
19153	77.433	19.358	96.792	22.583	119.375	17.917	137.292	27.458
19155	73.143	18.286	91.429	21.000	112.429	22.571	135.000	27.000
19157	80.686	20.171	100.857	22.071	122.929	23.905	146.833	29.367
19159	53.000	13.250	66.250	15.417	81.667	22.500	104.167	20.833
19161	82.293	20.573	102.867	25.383	128.250	20.868	149.118	29.824
19163	88.571	22.143	110.714	30.536	141.250	28.592	169.842	33.968
19165	73.200	18.300	91.500	17.500	109.000	20.000	129.000	25.800
19167	82.000	20.500	102.500	24.000	126.500	15.643	142.143	28.429
19169	81.569	20.392	101.962	22.427	124.389	16.433	140.821	28.164
19171	83.556	20.889	104.444	25.101	129.545	22.121	151.667	30.333
19173	52.800	13.200	66.000	21.000	87.000	26.000	113.000	22.600
19175	73.714	18.429	92.143	21.857	114.000	21.000	135.000	27.000
19177	54.000	13.500	67.500	22.000	89.500	28.625	118.125	23.625
19179	76.622	19.156	95.778	19.167	114.944	24.222	139.167	27.833
19181	61.455	15.364	76.818	24.396	101.214	24.940	126.154	25.231
19183	83.714	20.929	104.643	21.786	126.429	23.571	150.000	30.000
19185	51.333	12.833	64.167	15.083	79.250	18.750	98.000	19.600
19187	82.000	20.500	102.500	20.556	123.056	19.313	142.368	28.474
19189	76.571	19.143	95.714	20.348	116.063	26.080	142.143	28.429
19191	76.000	19.000	95.000	22.857	117.857	23.571	141.429	28.286
19193	65.000	16.250	81.250	24.750	106.000	30.250	136.250	27.250
19195	72.646	18.162	90.808	19.346	110.154	17.668	127.821	25.564
19197	84.941	21.235	106.176	21.046	127.222	19.861	147.083	29.417

TABLE 4. Iowa: Proportions of agricultural land in various land quality classes

County FIPS	High Quality	Medium Quality	Low Quality
19001	0.23	0.43	0.34
19003	0.20	0.42	0.38
19005	0.24	0.52	0.24
19007	0.21	0.48	0.31
19009	0.27	0.42	0.31
19011	0.35	0.43	0.22
19013	0.39	0.40	0.21
19015	0.45	0.35	0.20
19017	0.54	0.28	0.18
19019	0.30	0.50	0.20
19021	0.40	0.40	0.20

TABLE 5. Minnesota: Rental rate function parameters, yield cutoff points

County FIPS	a_1	a_2	a_3	a_4	a_5	a_6	a_7
27001	4.34	5.14	6.47	7.42	7.45	8.35	10.14
27003	3.32	6.88	7.05	8.31	8.42	9.04	9.71
27005	3.99	6.23	6.63	6.76	6.92	6.97	9.23
27007	3.82	7.65	7.66	7.89	8.09	8.25	11.66
27009	4.47	5.51	6.55	6.56	6.74	7.36	9.22
27011	3.31	4.65	4.77	5.29	5.75	6.28	6.87
27013	4.77	6.85	7.24	7.76	8.48	9.28	11.31
27015	2.75	5.59	6.05	6.58	6.86	7.01	9.36
27017	3.26	5.75	6.2	7.2	8.13	8.71	9.27
27019	3.47	6.22	6.72	7.1	7.54	7.56	10.32
27021	4.43	5.07	6.13	7.11	7.41	8.81	8.81
27023	4.06	4.58	4.79	5.66	7.12	7.82	9.15
27025	3.53	6.96	7.22	8.06	8.22	8.66	11.45
27029	4.13	5.42	6.14	6.23	6.56	7.44	8.34
27033	1.64	4.48	4.77	4.96	5.22	6.62	7.2
27035	3.26	5.2	5.33	5.41	6.77	7.05	8.16
27037	2.81	5.15	5.32	5.48	6.34	7.35	9.85
27039	4.11	5.5	5.95	6.68	8.08	8.64	9.52
27041	3.95	5.04	5.73	5.85	5.88	5.97	7.76
27043	5.68	7.88	8.09	9.51	10.17	10.7	11.94
27045	3.37	7.67	7.82	8.49	9.42	9.82	11.32
27047	3.89	6.14	6.75	7.55	8.72	9.58	12.94
27049	2.98	6.28	6.5	7.27	8.34	9.47	10.24
27051	3.36	5.02	5.34	5.62	6.01	6.48	7.14
27053	4.17	5.36	6.22	6.63	6.97	8.34	9.18
27055	4.55	8.11	8.44	8.9	10.27	11.38	11.38
27057	3.87	4.25	5.31	5.93	7.06	8.3	8.8
27059	2.97	6.82	6.83	6.89	7.24	8.35	10.17

TABLE 5. Continued

County FIPS	a_1	a_2	a_3	a_4	a_5	a_6	a_7
27061	3.26	6.67	0	6.79	6.99	7.29	9.22
27063	3.55	4.66	5.5	6.51	7.74	8.15	8.64
27065	2.67	5.58	6.53	6.98	7.03	7.46	9.85
27067	2.68	4.95	5.21	5.61	6.14	7.45	9.79
27073	2.19	3.54	3.88	4.37	4.39	5.27	7.58
27079	4.33	5.99	6.22	6.54	7.08	7.54	10.84
27081	1.76	1.9	2.89	3.07	4.48	5.11	6.25
27083	2.82	3.94	4.25	4.65	5.6	6.41	7.55
27085	5.08	5.75	5.92	6.14	6.66	6.85	8.81
27091	4.61	5.78	6.59	9.03	9.48	9.79	11.65
27093	3.63	5.93	5.99	6.39	6.73	7.19	9.56
27095	2.82	6.64	6.82	7.18	7.57	8.34	10.78
27097	3.44	6.14	6.5	6.72	7.11	7.13	8.81
27099	5.21	7.8	8.72	9.43	10.02	10.78	11.73
27101	2.24	4.15	4.81	4.89	5.29	5.36	7.16
27103	4.68	6.68	6.79	7.41	7.99	8.47	10.66
27105	3.5	4.37	5.58	6.08	6.92	7.8	9.13
27109	2.62	5.28	5.81	6.37	7.39	8.24	9.32
27111	2.38	3.85	4.25	4.6	5.04	5.39	7.45
27115	2.94	6.44	6.98	7.95	8.16	8.61	10.34
27117	2.32	2.55	2.68	3.06	4.66	6.11	6.96
27121	3.45	4.75	5.6	5.84	5.99	6.3	7.61
27127	2.96	4.59	4.8	4.93	6.54	6.66	8.07
27129	4.43	6.02	6.16	6.72	7.42	7.77	9.42
27131	3.59	6.9	7.49	7.82	8.67	8.91	11.48
27137	5.65	6.91	0	0	7.59	8.53	11.31
27139	4.18	6.97	7.66	8.27	8.72	8.92	10.91
27141	2.96	5.22	5.25	8.72	9.34	9.36	9.55
27143	4.03	6.04	6.11	6.76	7.17	7.31	9.31
27145	2.61	5.39	5.57	5.91	5.98	6.05	10.62
27147	1.85	5.51	6.54	0	7.34	7.74	10.19
27149	3.22	4.64	5.14	5.85	6.44	6.67	7.98
27151	3.02	3.57	4.06	5.27	5.58	6.46	7.15
27153	3.19	5.35	5.65	5.65	5.74	5.78	9.46
27155	3.51	4.05	4.22	4.94	6.27	6.51	6.77
27157	3	6.99	7.24	7.95	8.2	9.3	9.62
27159	2.52	4.92	5.15	0	5.33	5.41	9.46
27161	5.4	6.66	6.91	6.97	7.29	8.14	10.56
27163	3.16	4.55	4.75	5.18	5.84	6.62	9.13
27165	3.88	6.39	8.85	9.4	9.73	10.44	11.39
27169	3.09	6.65	7.27	7.53	7.83	10.09	11.04
27171	4.39	5.98	7.8	8.42	9.37	9.41	11.23
27173	2	3.35	3.77	4.08	4.85	5.08	6.09

TABLE 6. Minnesota: Rental rate function parameters

County FIPS	b_1	b_2	b_3	b_4	b_5	b_6
27001	16	18	20	22	24	26
27003	25	28	31	34	37	40
27005	36	40	45	49	54	58
27007	25	28	31	34	37	40
27009	25	28	31	34	37	40
27011	44	49	54	60	65	70
27013	76	86	95	105	114	124
27015	68	79	89	100	110	121
27017	12	14	15	17	18	20
27019	73	82	91	100	109	118
27021	13	17	20	23	25	27
27023	68	76	85	93	102	110
27025	28	32	35	39	42	46
27029	23	26	29	32	35	38
27033	68	77	86	94	103	112
27035	13	17	20	23	25	27
27037	55	64	72	81	89	98
27039	69	77	86	94	103	111
27041	36	40	45	49	54	58
27043	82	92	102	112	122	133
27045	64	72	80	88	96	104
27047	73	82	91	100	109	118
27049	76	86	95	105	114	124
27051	51	58	65	71	78	85
27053	41	46	51	56	61	66
27055	75	85	95	105	115	125
27057	26	30	33	37	40	44
27059	26	30	33	37	40	44
27061	15	17	19	21	23	25
27063	71	81	90	100	109	119
27065	20	22	25	27	30	32
27067	60	68	75	83	90	98
27073	58	65	72	75	80	87
27079	73	80	82	92	102	112
27081	48	54	60	66	72	78
27083	63	70	78	86	94	102
27085	73	82	91	100	109	118
27091	80	90	100	110	120	130
27093	55	61	68	74	81	87
27095	17	19	21	23	25	27
27097	25	28	30	33	36	39
27099	69	78	87	95	104	113
27101	66	75	83	91	95	99
27103	76	86	95	105	114	124

TABLE 6. Continued

County FIPS	b_1	b_2	b_3	b_4	b_5	b_6
27105	63	70	78	86	94	102
27109	56	64	72	80	88	96
27111	26	30	33	34	37	38
27115	20	23	26	28	31	34
27117	53	59	66	72	79	86
27121	45	51	57	63	69	75
27127	68	76	85	93	102	110
27129	73	82	91	100	109	118
27131	74	84	93	103	112	122
27137	14	16	18	20	22	24
27139	73	82	91	100	109	118
27141	20	22	25	27	30	32
27143	76	86	95	105	114	123
27145	44	50	55	61	66	72
27147	71	80	86	89	98	107
27149	57	64	71	78	85	92
27151	65	73	81	89	97	105
27153	23	26	29	32	35	38
27155	48	54	60	66	72	78
27157	70	79	89	96	105	114
27159	23	26	29	32	35	38
27161	76	86	95	105	114	124
27163	41	46	51	56	61	66
27165	90	101	108	119	130	134
27169	63	73	81	91	99	109
27171	48	54	60	66	72	78
27173	60	68	75	83	90	98

TABLE 7. Missouri: Rental rate function parameters

Crop Reporting District	a_{01}	a_{11}	a_{02}	a_{12}	a_{03}	a_{13}	a_{04}	a_{14}
Northwest	32.625	0.145	-3.262	0.471	39.150	0.145	-5.800	0.435
North Central	31.200	0.139	-3.120	0.451	37.440	0.139	-5.547	0.416
Northeast	36.118	0.161	-3.612	0.522	43.342	0.161	-6.421	0.482
West Central	36.316	0.161	-3.632	0.525	43.579	0.161	-6.456	0.484
Central	36.610	0.163	-3.661	0.529	43.932	0.163	-6.508	0.488
East Central	38.571	0.171	-3.857	0.557	46.286	0.171	-6.857	0.514
Southwest	39.255	0.174	-3.926	0.567	47.106	0.174	-6.979	0.523
South Central	40.000	0.178	-4.000	0.578	48.000	0.178	-7.111	0.533
Southeast	39.107	0.174	-3.911	0.565	46.929	0.174	-6.952	0.521

TABLE 8. South Dakota: Data for rental rate function estimation

County name	FIPS	Min rent, r_{\min}	Max rent, r_{\max}	Average rent, r_{avg}
Brookings	46011	28	85	49.5
Codington	46029	25	55	39.8
Deuel	46039	30	70	50.2
Grant	46051	20	67	48.6
Marshall	46091	25	60	38.6
Roberts	46109	20	75	48.5

Source: SDASS 1997.

TABLE 9. Average rental rates by state

State	Average Rental Rate
Illinois	115.0964385
Indiana	128.1830088
Iowa	123.4889401
Michigan	81.80714286
Minnesota	84.87055572
Missouri	60.53107564
South Dakota	49.92083333
Wisconsin	80.87981283

TABLE 10. Average rental rates by four-digit watershed

Four-digit HUC	Average Rental Rate
0701	52.45
0702	89.42
0703	37.49
0704	83.73
0705	41.52
0706	122.61
0707	74.69
0708	125.48
0709	121.08
0710	112.51
0711	67.80
0712	116.72
0713	128.32
0714	78.20

Figures

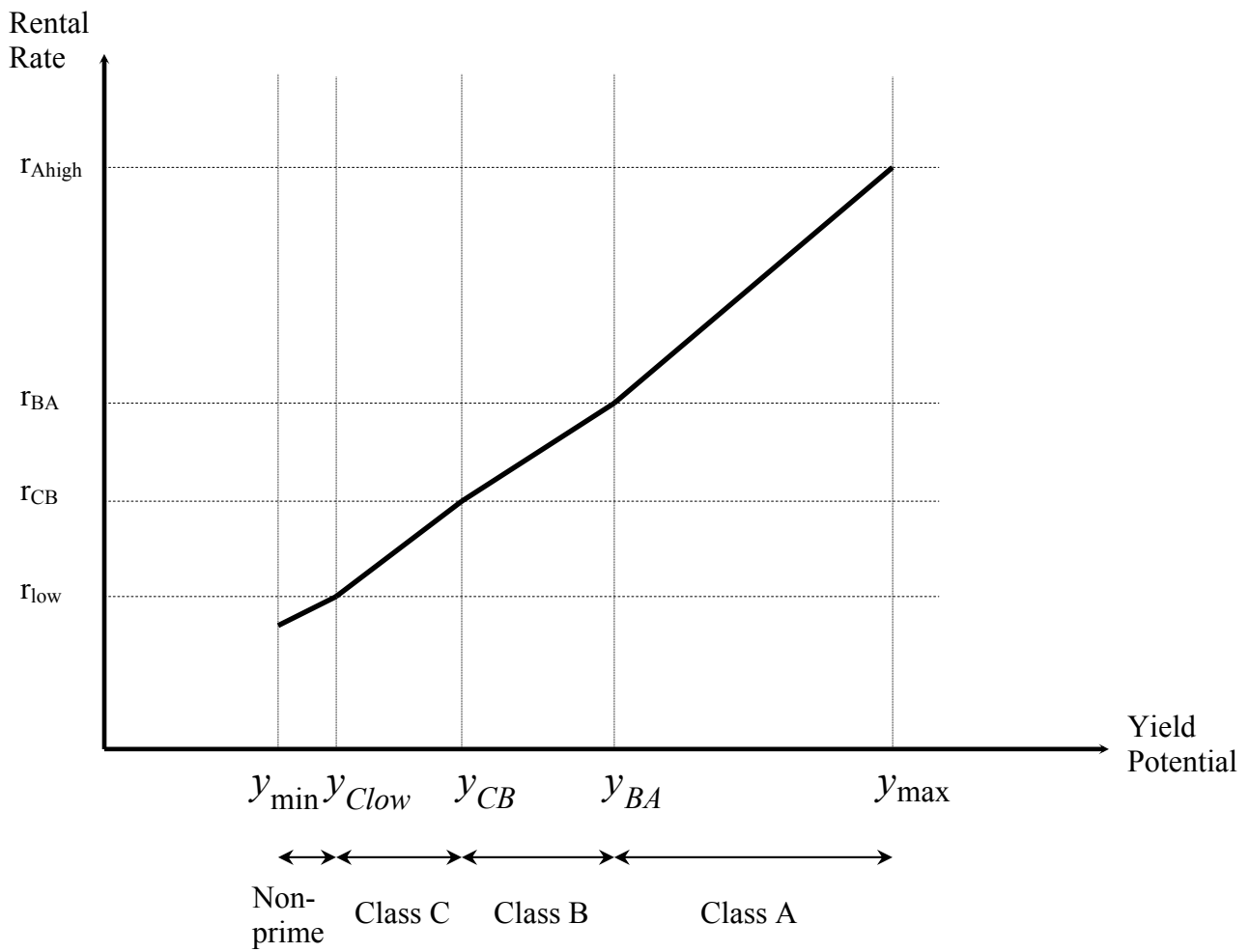


FIGURE 1. Illinois: Estimation of cash rental rate function

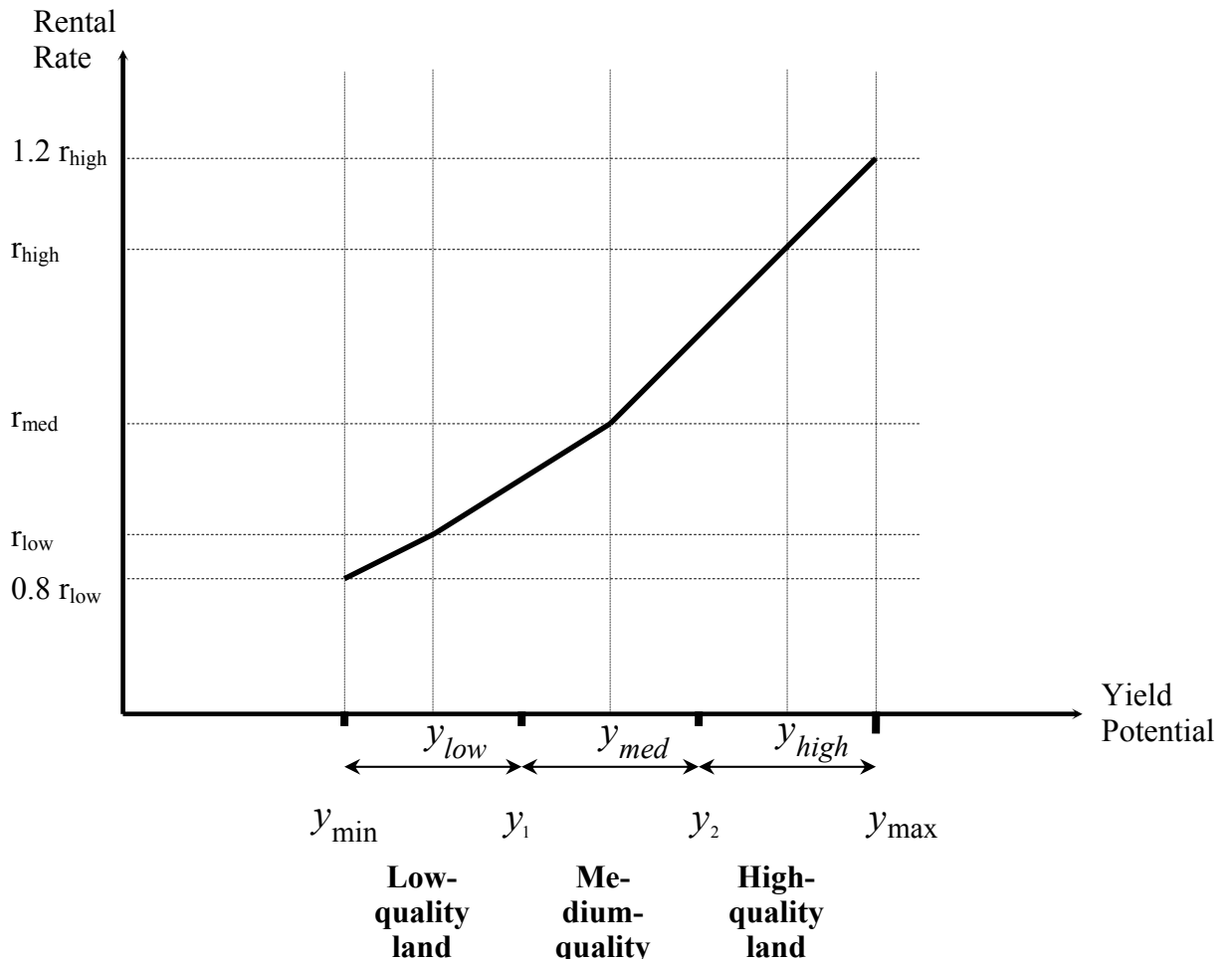


FIGURE 2. Iowa: Estimation of cash rental rate function

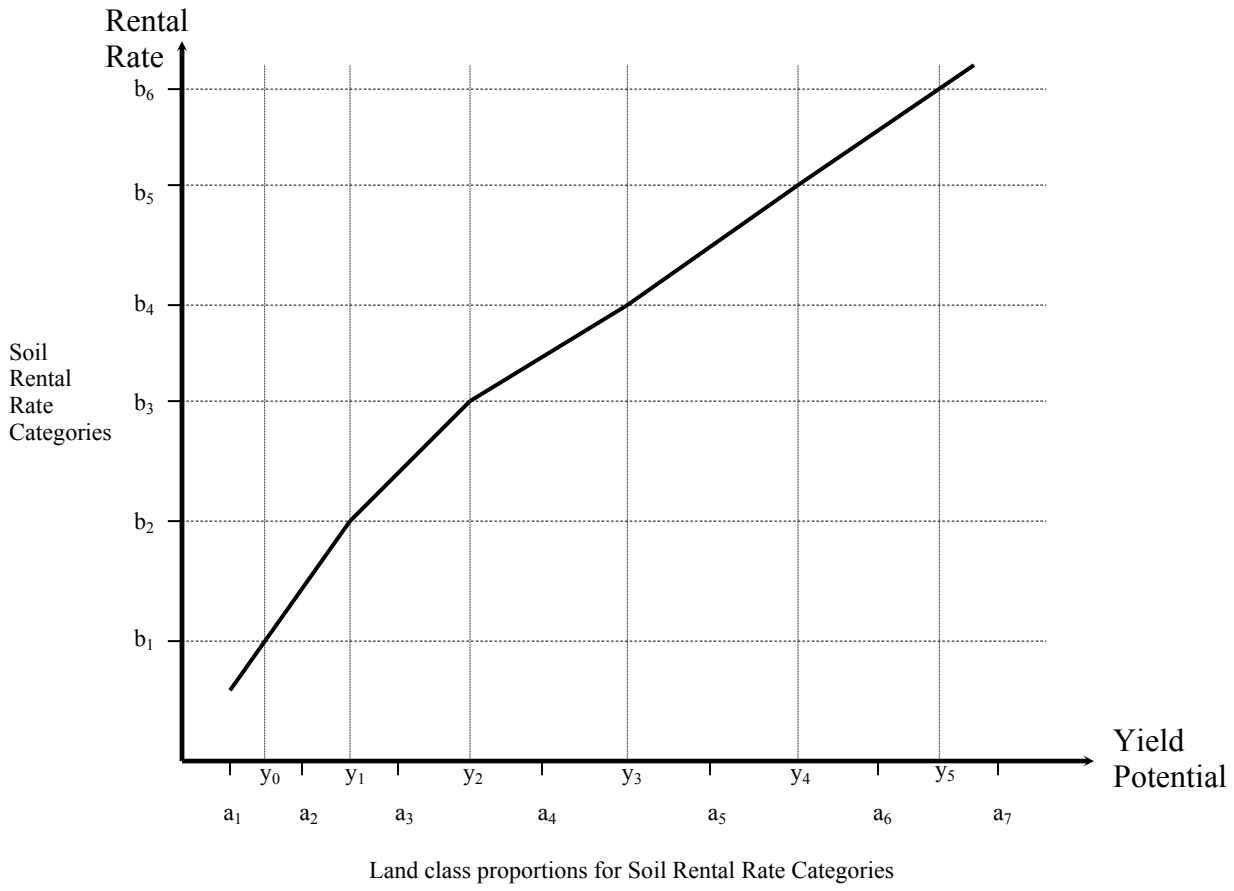


FIGURE 3. Minnesota: Estimation of cash rental rate function

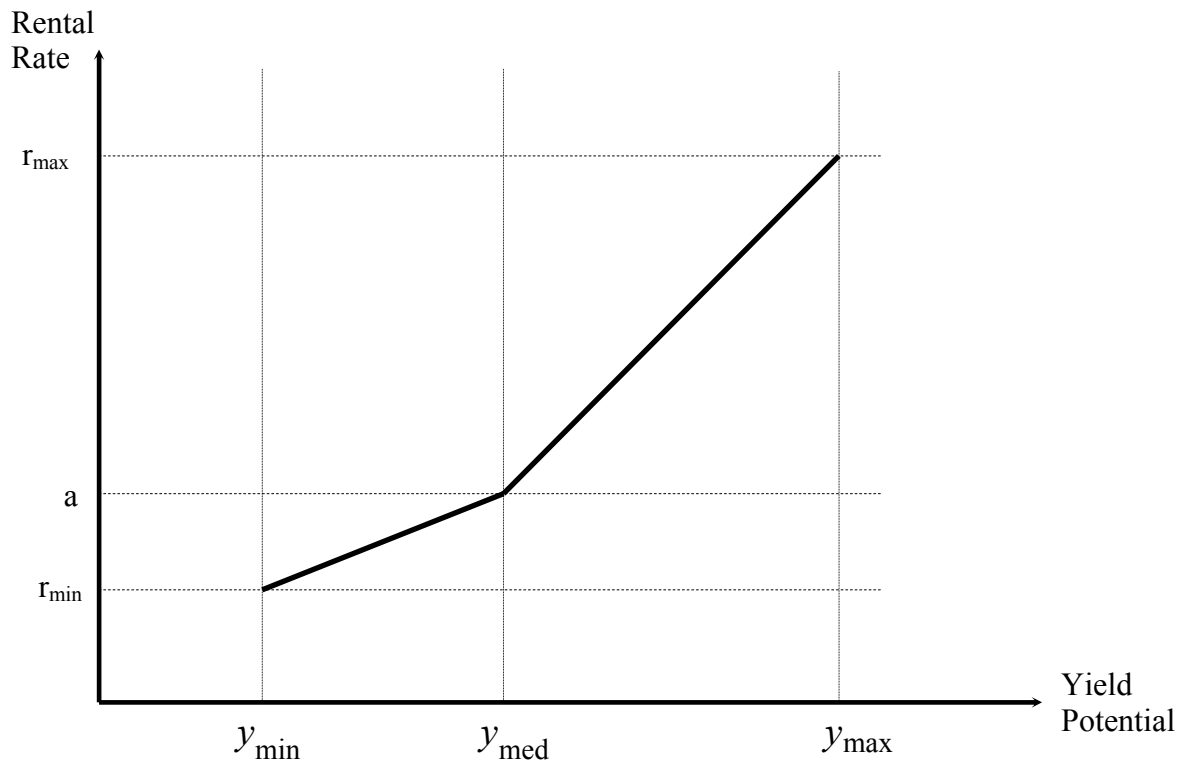


FIGURE 4. South Dakota: Estimation of cash rental rate function

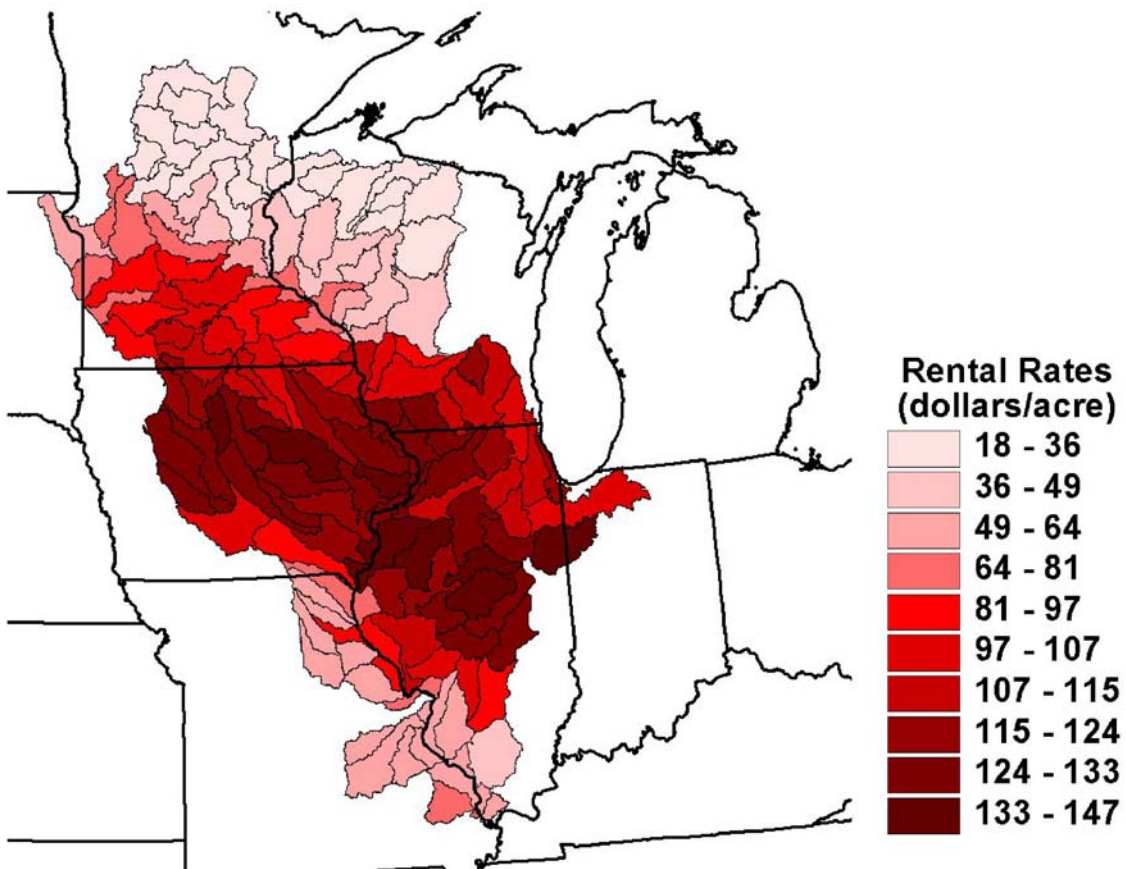


FIGURE 5. Rental rates by eight-digit watershed

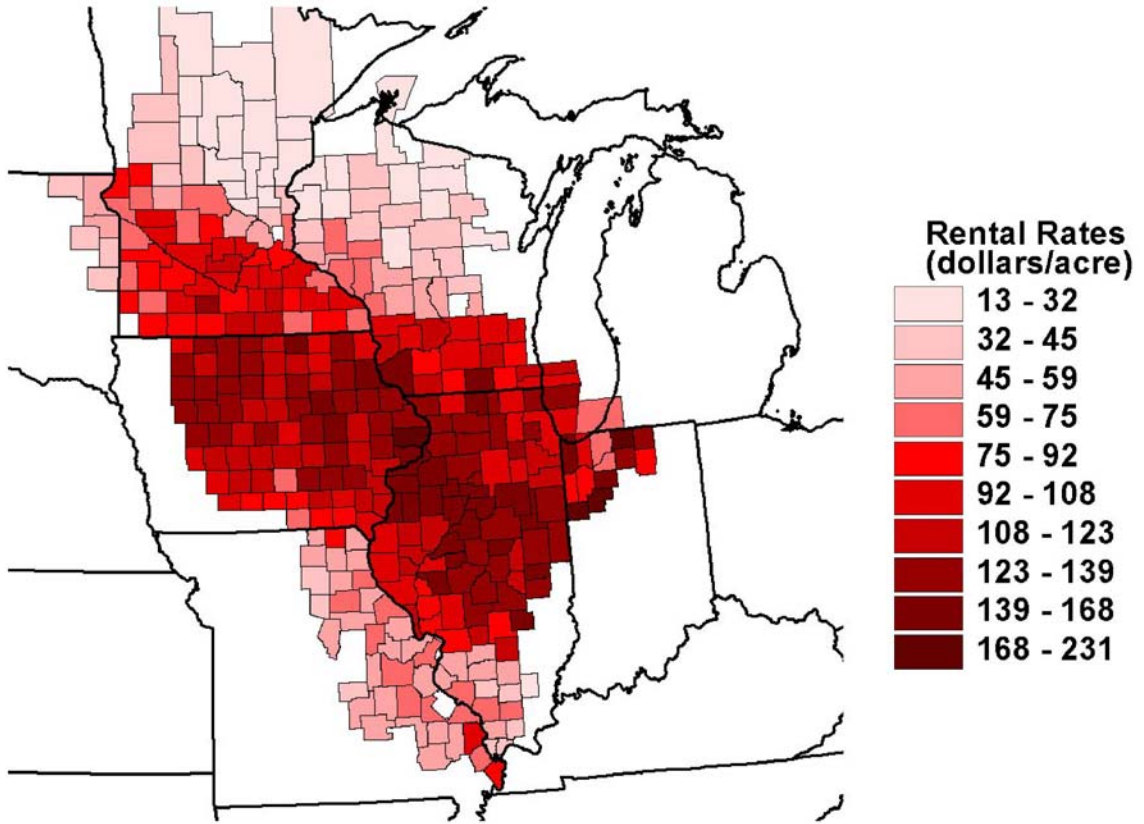


FIGURE 6. Rental rates by county

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