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MARGINAL AGRICULTURAL LAND CLASSIFICATION: A NEW APPROACH

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It has long been held by conservationists that a balanced soil protection program should include marginal cropland retirement and application of erosion control practices. It was not, however, until passage of the RIM (Reinvest in Minnesota) bill in 1986 that sufficient funds were available in Minnesota to implement a major, state-funded land retirement program (Korczak and Gran, 1986). Historically, funding had been limited in Minnesota to the application of erosion control practices. During debate of the RIM bill, it was established that 2.5 million acres of marginal cropland should be retired through a conservation reserve for a minimum of ten years for the benefit of erosion control, water quality improvement and wildlife habitat enhancement. These specific objectives, the limited acreage goal and other factors discussed by Roloff, et al. (1987) in a companion paper, suggested the need for an innovative approach to classifying marginal cropland.

National Resources Inventory data (USDA, 1984) illustrates that the USDA Land Capability Classification (LCC) system is too broad to be used solely for RIM Conservation Reserve. As an example, if classes III and IV e, w and s soils were combined with classes VI through VIII, the acreage would total over 6.8 million acres of cropland. Using the LCC to arrive at the 2.5 million acre goal would, therefore, preclude some subclasses and eliminate certain areas of the state. For example, (s) soils of outwash plains and glacial beach ridges located in central, west-central and northwest Minnesota, respectively, would be omitted if an (e) weighted priority were adopted. These areas, if omitted, would severely restrict development of a comprehensive resource protection program. Consequently, a search began for a new way of identifying marginal cropland. Methods under development at the University of Minnesota Departments of Agricultural and Applied Economics and Soil Science were chosen for further review.

Soil productivity (PI) and resistivity indices (RI) as described by Roloff, et al. (1987) were selected for classifying marginal cropland for RIM Conservation Reserve. Runge et al. (1986) and Taff and Runge (1986) suggest that these PI and RI indices portray a strategy for directing soil conservation and other farm program funds. Land parcels (or soil classes) can be characterized as falling into one of four quadrants, according to each parcel's position along PI and RI gradients. If breakpoints are assumed at 50 percent of the PI and RI populations, the diagram consists of four more or less equally sized subsets (Figure 1). Upper left might be thought of as having a high risk (nonresistant to erosion) landscape with productive soils (NRP lands). Upper right comprises a low risk (resistant to erosion) landscape with productive soils (RP lands). Lower left comprises a high risk landscape with nonproductive soils (NRNP lands). Lower right comprises a low risk landscape with nonproductive soils (RNP lands). The relationship of these categories to soil conservation and farm program policy is as follows:

NRP lands: These areas should be set-aside from crop production because of erosion risk, which would also maximize foregone crop production.

RP lands: Production should be encouraged because the land is productive and poses low risks to erosion. Public expenditure for erosion control practices is, therefore, minimized.

NRNP lands: These areas should be enrolled in the Federal Conservation Reserve Program or RIM Conservation Reserve because an erosion risk is present and the land is inherently unproductive, thus minimizing its usefulness for set-aside or crop production.

RNP lands: Program participation should be discouraged because the land poses few erosion risks and is not productive for set-aside purposes.

The size of the respective quadrant can be adjusted based on program funding or acreage goals. For example, if limited funds were available for long-term cropland retirement, a 25 percent breakpoint could be used (Figure 2). This narrows the zone of nonproductive/nonresistant lands, focusing attention on more critical areas. Additional lands would then be available for other categories. A 25 percent criterion was adopted for water erosion and ten percent for wind erosion. A smaller criterion was used for wind erosion to achieve partity between water and wind erosion acreages (Roloff et al., 1987). These breakpoints apportioned Minnesota's 23 million cropland acres as follows: NRP 4.67M, RP 11.5M, NRNP 2.3M, and RNP 4.6M. National Resources Inventory (NRI) and Soils - 5 data which included soil information and environmental factors from the erosion equations were used to generate the data necessary to establish the PI and RI quadrants and associated soils and acreages (Roloff et al., 1987).

Figures 1 and 2 suggest abrupt boundaries between the quadrants. In theory, this is conceivable; in the actual case, it is not possible. This is due to the characteristics of soil properties and landscape features. They occupy a continuum, with individual differences often subtle in nature

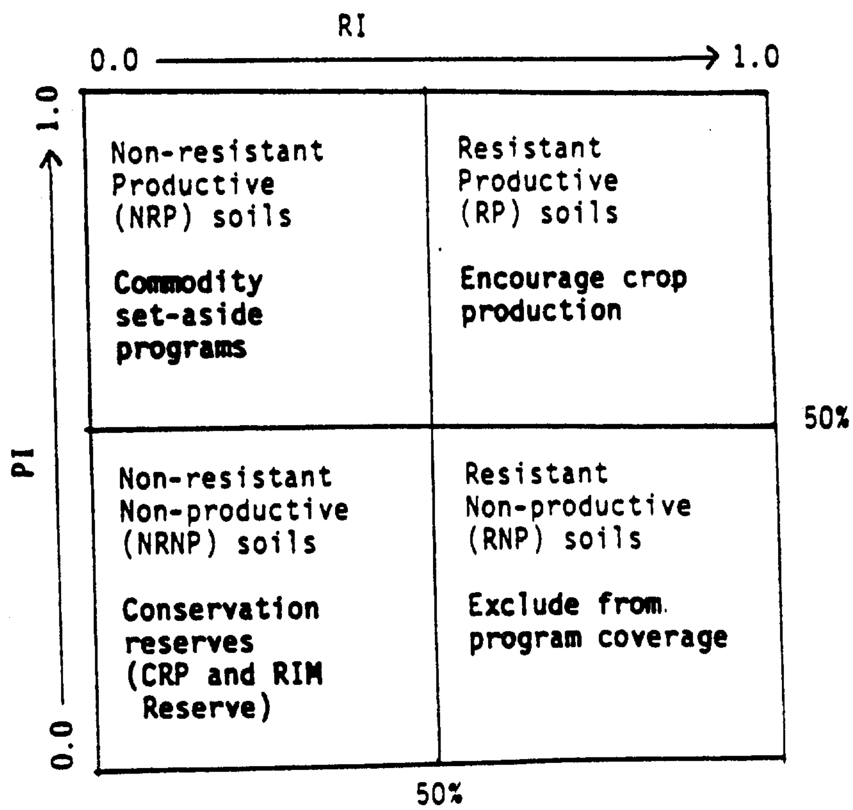

Fig. 1. Lands associated with soil conservation and farm programs

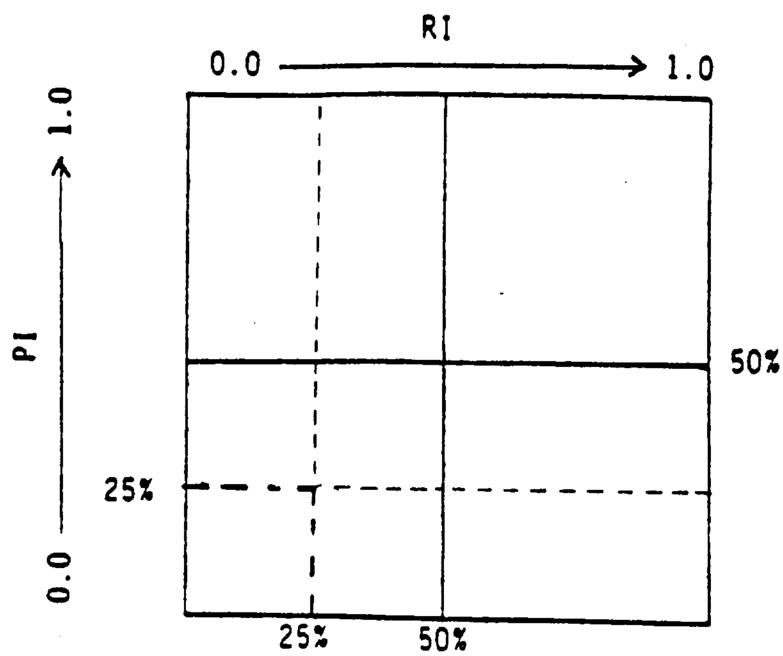

Fig. 2. Illustration of a 25 percent criterion

and subjectively delineated on maps. National Resources Inventory sampling frequency and the spatial variability of soils also introduces error. For example, if NRI points were located in a cropland field with short unsheltered distances, even an unproductive fine sand might be indicated as having an RI approaching 1.0, or being resistant to erosion. Conversely, the same soil at locations with longer unsheltered distances may be indicated as nonresistant to erosion, and therefore, eligible. The RI concept is, therefore, more "accurate" if used on a multicounty or state basis. Limitations of the PI concept must also be considered. As developed, PI correlates best with established yields of deep rooted crops grown on well drained mineral soils with slopes of six percent or less. Organic soils, eroded soils and the effects of slope and potentially decreased infiltration on crop production must also be considered.

Although initially introduced here as a source of error, the fact that soils occupy a continuum on the landscape and exhibit spatial variability demonstrates a strength: flexible adjustments to PI and RI are possible.

For these reasons, local knowledge of soils and landscapes must be reflected in a revision process. Soil and water conservation districts (SWCDs) are provided an opportunity to develop a list of soil map units based on a proposed NRNP soils list developed by the Minnesota Department of Agriculture (MDA) in cooperation with the University of Minnesota Department of Soil Science and Soil Conservation Service (Roloff et al., 1987). Tables 1 and 2 are examples of a proposed NRNP soil list. The county name is located in the upper left corner. Soil series as matched to NRI cropland sampling points are listed in the left column. Figures for RI and PI are listed in columns 2 and 4, respectively. The fifth column lists

Table 1. Non-resistant (to water erosion) and non-productive soil series

DAKOTA

Series*	RI (water)	LS	PI	NRNPL % of Cropland	Cropland (100 Acres)
Estherville	0.769	0.099	0.452	84.6	233
Kanaranzi	0.525	0.071	0.651	100.0	44
Hubbard	0.635	0.361	0.373	100.0	39
Hawick	0.542	0.167	0.432	100.0	39
Kingsley	0.844	0.657	0.636	82.6	46
Dickinson	0.844	0.145	0.599	29.5	61
Burkhardt	0.000	0.099	0.372	100.0	13
Copaston	0.000	0.071	0.527	100.0	12
Plainfield	0.859	0.508	0.360	100.0	12
Sparta	0.924	0.369	0.457	30.8	39
County	0.696	0.070	0.758	---	2,090

* Twenty-four additional series were recorded by the NRI but are not listed here because they do not contain NRNP lands.

Table 2. Non-resistant (to wind erosion) and non-productive soil series

DAKOTA

Series*	RI(wind)	L (Ft.)	PI	NRNPL % of Cropland	Cropland (100 Acres)
Estherville	0.563	510	0.542	89.7	233
Hubbard	0.633	28	0.373	100.0	39
Hawick	0.739	1,368	0.432	64.1	39
Burkhardt	0.608	510	0.372	100.0	13
County	0.800	---	0.759	---	2,077

*Series not listed are not included in the wind erosion data pool or do not contain NRNP land.

the percentage of eligible, or NRNP, land that is associated with the total cropland acres of a particular soil (column 6). Column 3, "LS" and "L" relate to the RI concept. The LS value the criticdal value for a mapping unit to be considered eligible. Unsheltered distance (L) may also be interpreted in this manner. The NRNPL percentage reflects the number of NRI sampling points that equalled or exceeded the critical LS value. Although map unit data was entered on NRI recording forms, it cannot be retrieved. This leaves series as the interpretive unit. Landscape values, particularly LS, are thus useful in determining which map units of a given series are eligible. The numbers at the bottom of columns 2 and 4 refer to county RI and PI figures. They are weighted by the percent each series comprises of the total county cropland. The fifth column is the amount of eligible acreage. In Table 1, 44,000 acres are eligible. The RIM Conservation Reserve rule provides that at least 50 percent of a proposed parcel must contain eligible map units. Consequently, 44,000 acres could conceivably generate 88,000 acres of enrolled lands. The number at the bottom right is the NRI total cropland figure. In Table 1, there are 209,000 acres. Due to NRI sampling frequency, many soil series are missing from Tables 1 and 2. Yet, the limited number equals total cropland acreage. This is explained by a term called "expansion factor." Based on the number of times a soil occurred on cropland points, its acreage was expanded proportionally. Consequently, a partial list of soil series equals total cropland acreage. With comparative ease, a knowledgeable person using tables similar to 1 and 2 can develop a complete list of eligible map units. Soil and water conservation districts are encouraged to solicit outside opinion in developing a list of eligible map units. To maintain consistency between countries and insure that acreage targets are not exceeded, the MDA approves all local lists. Appendix 1 is an example of an approved county list prepared by local SWCD personnel using Tables 1 and 2 and a published soil survey.

The PI and RI concepts are the basis for defining marginal agricultural lands in the adopted RIM Conservation Reserve rules. Marginal Agricultural land is defined in the rule as "land with cropland soils that are inherently unproductive for agricultrual crop production and subject to significant potential soil productivity loss from erosion." The PI portion of this definition is referenced in the rule as inherently unproductive, which means that "the soil properties of available water capacity, bulk density and pH in the uppermost 100 centimeters of a soil, are present in such a manner that an unfavorable rooting environment exists." Significant potential soil productivity loss refers to the RI concept. This is defined in the rule as a loss which "may occur in a short time unless management measures are initiated to control soil erosion. The method of calculation combines the rating of a soil as a rooting environment with landscape characteristics that represent erosion potential."

A review of land deemed eligible by these definitions reveals some erosive (e), droughty (s), and wet (w) soils. Wet soils require special consideration. As they relate to PI and RI, wet soils are not marginal because of excess water. Those that are marginal have a poor rooting environment in terms of bulk density or pH. Furthermore, undrained wet soils have probably not been cropped consistently enough to qualify for the RIM Conservation Reserve Program which requires that enrolled lands must have been cropped for two out of five years during the period of 1981 to

1985. In addition, the parcel must be currently physically possible to crop. Relating eligible soils to proposed parcels is easy in counties with published soil surveys. In addition, digitized soil survey information systems being produced by the University of Minnesota Soil Science Department include soltware to visually illustrate eligible map units and compute acreages of parcels. At locations where detailed soils information is not available, a soil scientist must classify the soils of proposed parcels to at least the family level of taxonomy. With this information, eligibility of proposed parcels can be determined by comparing the soil(s) to those on an area map unit legend. Although this discussion has focused on the soil component of marginal lands, it must be emphasized that many other factors have a bearing on parcel selection. Fisheries, wildlife, and water quality considerations must be included in parcel selection decisions made at the local level. To alleviate concerns that the inherent inaccuracy of NRI data when used at a subcounty level may result in unfair allocations to SWCDs, RIM Conservation Reserve funding was not based solely on eligible soil acreage. Other factors such as the extent of lakes, streams or wildlife management areas were also considered.

In summary, the marginal land classification system developed for the RIM Conservation Reserve Program has the following advantages over LCC and rate of soil loss methods:

- The extent of eligible soils can be adjusted based on acreage goals, and in so doing, most types of soils, landscapes and geographic areas can be accommodated; but the method always separates the least resistant and least productive lands whichever criterion is used.
- Soil loss calculations are unnecessary; and

- Because eligible soil map units are available, time for advance determination of eligible areas is minimized.

There are also disadvantages:

- New methods represent a departure from time-honored procedures;
- The PI and RI method might be viewed as too complicated and therefore, dismissed for lack of understanding;
- Inherent characteristics of NRI data may create interpretation problems, particularly in those counties with a small cropland base; and,
- Some will argue that too much reliance has been placed on the accuracy of the SCS-Soils-5 data base.

The disadvantages are manageable if local users are given an opportunity to revise the proposed NRNP soil lists based on their knowledge of the landscape and soil. As mentioned earlier, this opportunity is available.

This approach to classifying cropland creates opportunities to further implement soil productivity and vulnerability concepts. Wildlife habitat programs could, for example, be developed for soils in the resistant, nonproductive category by focusing on sites with desirable features such as poor drainage. Larson et al. (1984) discussed the utility of productivity and vulnerability indices in targeting state and local soil conservation efforts. A number of applications are possible: A redefinition of "T" values, establishment of planning horizons based on a local consensus concerning allowable soil productivity losses, and incorporation of off-site concerns into the decision-making process. A recent report from Ohio (USDA, 1985) demonstrates the local demand for additional methods to promote and quantify the effect of soil erosion on productivity.

Landowner interest in the RIM Conservation Reserve has been enthusiastic despite a strong showing for the Federal Conservation Reserve Program. Over 2,100 landowners offered nearly 60,000 acres for RIM Reserve with requests in excess of 25 million dollars. The entire 1986 RIM Conservation Reserve allocation of 9.4 million dollars was allocated. In turn, 914 easements will be conveyed covering 22,000 acres. Over 100 easements are permanent; the balance are 10 years in duration.

The marginal land classification system discussed in these two papers has been well received by landowners. Many commented favorably on the benefit of knowing the eligibility of a parcel at the time of enrollment. Others appreciated the opportunity to enroll marginal cropland that had been previously protected from erosion. This point provided considerable flexibility for local officials to link public and private parcels for the maximum benefit of wildlife.

In conclusion, the results to date suggest that this land classification system has been successful because:

- Local input is accommodated;
- The scope of eligibility can be changed depending on acreage or budget constraints; and,
- It has the flexibility to allow RIM Conservation Reserve to complement federal farm policy.

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APPENDIX

Appendix 1. **Eligible Soil Map Units for RIM Reserve: Acreage and Proportionate Extent**

Map Symbol	Soil Name	Acres	Percent
7A	Hubbard loamy sand, 0 to 1 percent slopes	755	0.2
7B	Hubbard loamy sand, 1 to 6 percent slopes	2,090	0.6
7C	Hubbard loamy sand, 6 to 12 percent slopes	936	0.3
7D	Hubbard loamy sand, 12 to 18 percent slopes	608	0.2
8A	Sparta loamy fine sand, 0 to 1 percent slopes	1,545	0.4
8B	Sparta loamy fine sand, 1 to 6 percent slopes	1,690	0.5
12C	Emmert very gravelly sandy loam, 3 to 15 percent slopes	320	0.1
27B	Dickinson sandy loam, 2 to 6 percent slopes	4,193	1.1
39C	Wadena loam, 6 to 12 percent slopes	1,350	0.4
39C2	Wadena loam, 6 to 12 percent slopes, eroded	397	0.1
39D	Wadena loam, 12 to 18 percent slopes	283	0.1
41A	Estherville sandy loam, 0 to 2 percent slopes	3,941	1.1
41B	Estherville sandy loam, 2 to 6 percent slopes	6,764	1.8
42C	Salida gravelly coarse sandy loam, 2 to 12 percent slopes	496	0.1
81B	Boone loamy fine sand, 2 to 6 percent slopes	988	0.3
81C	Boone loamy fine sand, 6 to 12 percent slopes	1,482	0.4
81E	Boone loamy fine sand, 12 to 40 percent slopes	618	0.2

100A	Copaston loam, 0 to 2 percent slopes	608	0.2
100B	Copaston loam, 2 to 6 percent slopes	1,643	0.4
100C	Copaston loam, 6 to 12 percent slopes	1,413	0.4
106C2	Lester loam, 6 to 12 percent slopes, eroded	886	0.2
106D2	Lester loam, 12 to 18 percent slopes, eroded	967	0.3
151C	Burkhardt sandy loam, 6 to 12 percent slopes	1,760	0.5
151D	Burkhardt sandy loam, 12 to 18 percent slopes	833	0.2
155B	Chetek sandy loam, 3 to 8 percent slopes	660	0.2
155C	Chetek sandy loam, 8 to 15 percent slopes	1,445	0.4
155E	Chetek sandy loam, 15 to 25 percent slopes	502	0.1
173F	Frontenac loam, 25 to 40 percent slopes	651	0.2
177A	Gotham loamy fine sand, 0 to 2 percent slopes	601	0.2
177B	Gotham loamy fine sand, 2 to 6 percent slopes	553	0.2
177C	Gotham loamy fine sand, 6 to 12 percent slopes	318	0.1
189	Auburndale silt loam	938	0.3
251D	Marlean loam, 12 to 18 percent slopes	674	0.2
251E	Marlean loam, 18 to 25 percent slopes	444	0.1
279C	Otterholt silt loam, 6 to 15 percent slopes	404	0.1
283A	Plainfield loamy sand, 0 to 2 percent slopes	486	0.1
283B	Plainfield loamy sand, 2 to 6 percent slopes	1,536	0.4
283D	Plainfield loamy sand, 6 to 18 percent slopes	321	0.1
299C	Rockton loam, 6 to 12 percent slopes	1,218	0.3
317	Oshawa silty clay loam	407	0.1
318	Mayer loam, swales	990	0.3
342C	Kingsley sandy loam, 8 to 15 percent slopes	6,884	1.9
342E	Kingsley sandy loam, 15 to 25 percent slopes	2,618	0.7
342F	Kingsley sandy loam, 25 to 40 percent slopes	727	0.2

408	Faxon silty clay loam	676	0.2
409B	Etter fine sandy loam, 2 to 6 percent slopes	5,477	1.5
409C	Etter fine sandy loam, 6 to 12 percent slopes	1,671	0.5
411C	Waukegan silt loam, 6 to 12 percent slopes	459	0.1
415A	Kanaranzi loam, 0 to 2 percent slopes	3,072	0.8
415B	Kanaranzi loam, 2 to 6 percent slopes	4,895	1.3
415C	Kanaranzi loam, 6 to 12 percent slopes	733	0.2
454B	Mahtomedi loamy sand, 3 to 8 percent slopes	403	0.1
454C	Mahtomedi loamy sand, 8 to 15 percent slopes	1,099	0.3
454E	Mahtomedi loamy sand, 15 to 25 percent slopes	1,152	0.3
465	Kalmarville sandy loam, frequently flooded	1,393	0.4
495	Zumbro fine sandy loam	807	0.2
522	Boots muck	288	0.1
539	Palms muck	2,616	0.7
540	Seelyeville muck	2,903	0.8
545	Rondeau muck	423	0.1
611C	Hawick coarse sandy loam, 6 to 12 percent slopes	7,605	2.1
611D	Hawick coarse sandy loam, 12 to 18 percent slopes	1,941	0.5
611E	Hawick loamy sand, 18 to 25 percent slopes	1,242	0.3
611F	Hawick loamy sand, 25 to 50 percent slopes	1,287	0.3
858C	Urban land-Chetek complex, 1 to 15 percent slopes	3,202	0.9
861C	Urban land-Kingsley complex, 3 to 15 percent slopes	4,339	1.2
861E	Urban land-Kingsley complex, 15 to 25 percent slopes	377	0.1
865B	Urban land-Hubbard complex, 0 to 6 percent slopes	939	0.3
880F	Brodale-Rock outcrop complex, 18 to 45 percent slopes	716	0.2
888C	Kingsley-Lester complex, 6 to 12 percent slopes	1,042	0.3
888D	Kingsley-Lester complex, 12 to 18 percent slopes	331	0.1

889B	Wadena-Hawick complex, 2 to 6 percent slopes	204	0.1
889C	Wadena-Hawick complex, 6 to 12 percent slopes	215	0.1
889D	Wadena-Hawick complex, 12 to 18 percent slopes	195	0.1
895B	Kingsley-Mahtomedi-Spencer complex, 3 to 8 percent slopes	3,354	0.9
895C	Kingsley-Mahtomedi-Spencer complex, 8 to 15 percent slopes	5,474	1.5
896E	Kingsley-Mahtomedi complex, 15 to 25 percent slopes	4,552	1.2
896F	Kingsley-Mahtomedi complex, 25 to 40 percent slopes	1,150	0.3
963C2	Timula-Bold silt loams, 6 to 12 percent slopes, eroded	1,034	0.3
963D2	Timula-Bold silt loams, 12 to 18 percent slopes, eroded	1,266	0.3
963E2	Timula-Bold silt loams, 18 to 25 percent slopes, eroded	923	0.3
1013	Pits, quarry	241	0.1
1027	Udorthents, wet	1,735	0.5
1029	Pits, gravel	1,565	0.4
1039	Urban land	1,811	0.5
1055	Aquolls and Histosols, ponded	1,550	0.4
1072	Udorthents, moderately shallow	389	0.1
1815	Zumbro loamy fine sand	1,104	0.3
1824	Quam silt loam, ponded	980	0.3
1825C	Seelyeville muck, sloping	193	0.1
1827	Waukegan silt loam, bedrock substratum, 6 to 12 percent slopes	271	0.1
1848B	Sparta loamy sand, bedrock substratum, 2 to 8 percent slopes	1,324	0.4
1898F	Etter-Brodale complex, 25 to 60 percent slopes	1,555	0.4
	TOTAL	139,723	37.9

NOTES:

- -- The acreage total includes all land uses. Eligible cropland acreage is considerably smaller.
- -- Eligibility of complexes (e.g., Kingsley-Lester complex) is determined as follows: If any member of the complex is eligible, the entire complex is eligible.
- -- Undifferentiated groups (e.g., Udorthents, wet) are eligible because soil properties and landscape position are usually indicative of marginal agricultural land. Moreover, PI and RI concepts do not apply to these and other soils lacking specific chemical and physical properties.
- -- A cropping history and other factors (1) are necessary <u>in addition</u> to an eligible map unit before a site is eligible for enrollment.