Combining Soil and Land Use Data to Assist in Targeting Land Use Adjustment

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Introduction

There is increasing recognition of the need for land use changes based on the continued dismal economic prospects for traditionally exported cereal grains. In Saskatchewan, this adjustment is already occurring in the form of increased pulse and oilseed crops, and increased feed grains and forage for livestock. An important question is, where should this adjustment be occurring? While there are a number of important factors, the capability of the soils and landscapes is one of the most important.

Through GIS technology it is possible to combine soil and land use data to determine if land is being used for it's most appropriate use based on productive capability. This paper presents in detail one method, combining the 1: 100,000 RM based soil data with PFRA's Land Cover Data from 1994. Another method, using municipal assessment data developed by Saskatchewan Assessment Management Agency (SAMA), is discussed briefly.

Methodology

a) Combining Soil Data and Land Cover Data

PFRA's land cover data was developed from unclassified satellite imagery taken during the 1994 growing season, to assist in the verification of acres under the Western Grains Transportation Payout Program (WGTPP). This involved computer aided classification of land into various classes including annual crop land, perennial grasses, alfalfa, and shrubs. The smallest mapped area was 30 meters by 30 meters.

This land cover data can be combined or integrated with soil data, by overlaying both sets of data and then calculating the percentage of land within each soil polygon characterised by each of the land cover classes. This was done using PC-ArcInfo. This calculated data was then joined with the soils database.

Within the soils database the best measure of soil and landscape productivity is the Canada Land Inventory for Agriculture Rating (CLI), with 1 being the most productive and 7 being the least. There appears to be close to a normal distribution pattern of these soils in Saskatchewan, with very few CLI 1 or 7 soils. For each soil polygon up to 3 CLI ratings can be combined according to their estimated proportion. For example, a rating of 3(5)4(2)5(3) means that within this polygon 50% of the soils are class 3, 20% are class 4 and 30% are class 5. It is important to note, however, that this data does not indicate where in the soil polygon these different classes exist.

It has been recognised by PFRA and others that CLI 5, 6 and 7 are suitable only for perennial forages, due to severe limitations that restrict annual crop production. The types of limitations could include salinity, stones, steep slopes, coarse soil texture, poor soil structure, or poor drainage.

By comparing the percentage of CLI values with the % percentage land cover classes one can estimate to what extent land is being used for it's most appropriate use. This comparison can best be explained through several examples, starting in Table 1.

Table 1. Land Suitable for Conversion to Forage

Column ID	A	B	C	D	E
CLI Rating	Land Suited to Forage (%)	Annual Crop (%)	Alfalfa (%)	Tame and Native Grass (%)	Land Suitable for Conversion to Forage (%)
3(8)4(2)	0	60	5	35	0
4(5)5(5)	50	70	0	30	20
5(4)6(6)	100	30	10	60	30
2(10)	0	85	5	10	0
3(5)4(5)	0	85	0	15	0

In this example, the amount of land suitable for conversion to forage (E) = A – (C+D)
For this result to be true, one must assume that annual cropping utilizes all CLI 2, 3, and 4 before moving on to CLI 5 and 6. While this would often be the case, there would most likely be exceptions for most polygons. Therefore, one could probably say that the amount of land suitable for conversion to forage would be at least this amount.

This same example can be used to consider the potential for converting existing forage land on good land to annual crop production (see Table 2). In this example, the amount of land suitable for conversion to annual cropland (F) = A – (B+C). In this case alfalfa is considered as suitable for good land due to its ability to produce high quality forage. Similar to the previous example, one must assume that perennial grass utilizes all CLI 5 and 6 land before moving to CLI's 2, 3, and 4.

Table 2. Land Suitable for Conversion to Annual Crop (CLI 4 included)

Column ID	A	B	C	D	E
CLI Rating	Land Suited to Annual Cropping (%)	Annual Crop (%)	Alfalfa (%)	Tame and Native Grass (%)	Land Suitable for Conversion to Annual Cropping (%)
3(8)4(2)	100	60	5	35	35
4(5)5(5)	50	70		30	0
5(4)6(6)	0	30	10	60	0
2(10)	100	85	5	10	10
3(5)4(5)	100	85		15	15

One could argue that CLI 4 land may not be suitable for annual crop production but should remain in forage. In this case the values in columns A and E would be revised as shown in Table 3.

Table 3. Land Suitable for Conversion to Annual Crop (CLI 4 excluded)

Column ID	A	B	C	D	E
CLI Rating	Land Suited to Annual Cropping (%)	Annual Crop (%)	Alfalfa (%)	Tame and Native Grass (%)	Land Suitable for Conversion to Annual Cropping (%)
3(8)4(2)	80	60	5	35	15
4(5)5(5)	0	70		30	0
5(4)6(6)	0	30	10	60	0
2(10)	100	85	5	10	10
3(5)4(5)	50	85		15	0

Some mapped results of these analyses are shown in Appendix I.

b) Municipal Assessment Data

Agricultural land in Saskatchewan is assessed approximately once every ten years by SAMA. This information not only provides information to rural munipalities (RM's) for calculating appropriate property taxes, but also provides useful land use and productivity information.

Table 4 shows a typical example of the relevant information available for one quarter section.

Table 4. Municipal Assessment Data (partial example)

Parcel #	Acres	Land Use	Final Rating
1	70	Annual Cropland	35
2	20	Annual Cropland	25
3	40	Hayland	25
4	30	Native Pasture	19

Much more information is available than is presented here. For example, each of the four parcels indicated above are rated for various factors such as soil texture, stones, salinity, slope steepness, and soil organic matter. These factors are all considered in reaching the final rating. There has been some work to relate final rating values to CLI values. Some have suggested that a final rating of 27 is close to the transition between CLI 4 and 5. (PFRA used this information to help evaluate applications to the Permanent Cover Program between 1989 and 1992.) Therefore, one could suggest, based on the arguments given earlier, that parcel #2 should be converted to perennial forage.

Comparison and Limitations of Methods

It is obvious that municipal assessment data provides more detailed soil productivity information (at the quarter section level) than the CLI values from the soils database. This is especially true for areas represented by very large soil polygons. There is much less difference in detail for the land use information. The end result, however, is that the municipal assessment data provides a more detailed and accurate method to identify recommended areas for increasing annual cropland or forage land.

However, a major concern at this time is that municipal assessment data is not readily available from SAMA in a digital format. The soils data is available for most of the agricultural areas in Saskatchewan. While PFRA's land cover data is available for all agricultural areas, it is already 6 years old, and becoming out of date. A land cover map could be developed from recent satellite imagery, but this is a fairly costly process.

An alternative method would be to use the municipal assessment soil productivity data with a recent land cover map. This would provide better land use information since the municipal land use data is updated only once every 10 years or so.

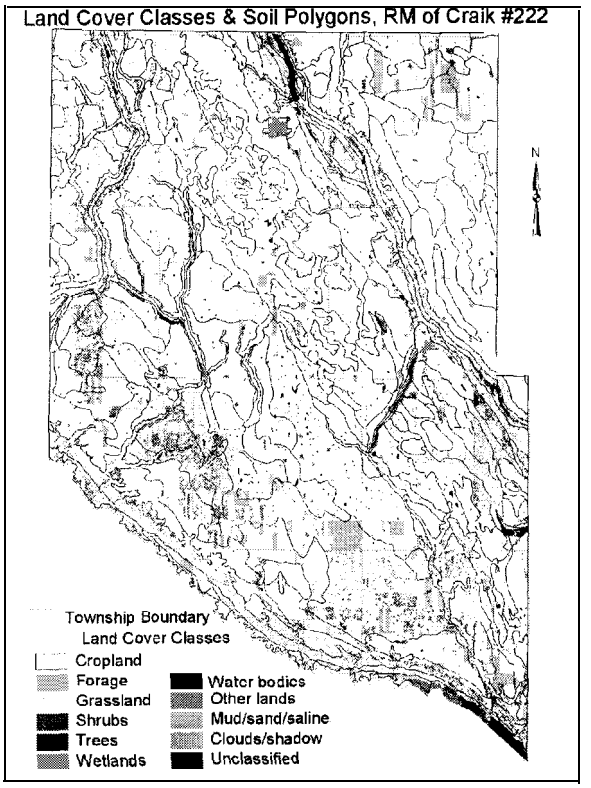
Application of Information

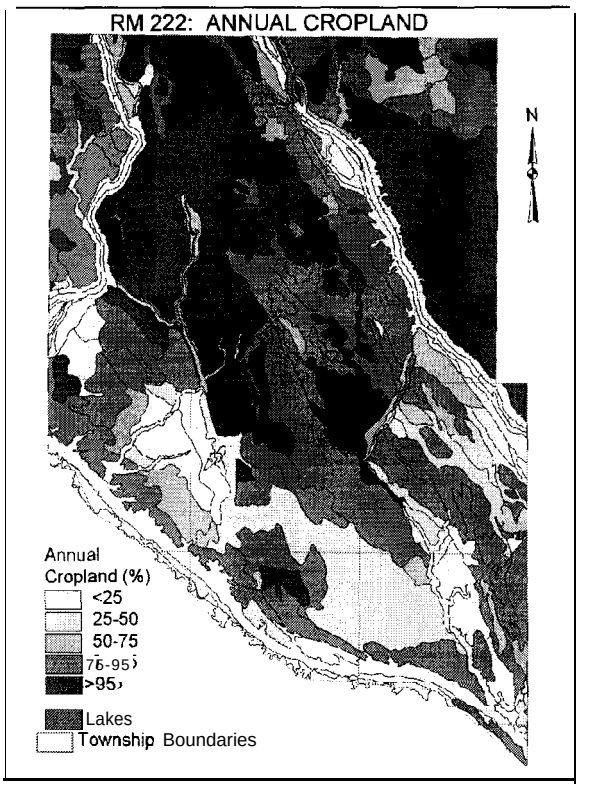
Relating land use and soil productivity information to determine recommendations for land use change can be done at various scales. The methods discussed in this paper are at a fairly detailed scale. At a much broader or general scale, PFRA has done a similar type analysis using the Soil Landscapes of Canada and the Agriculture Census Data. Information at this scale is useful to organizations with a large geographic mandate (like PFRA) in targeting future programs and activities. At the more detailed scale the information becomes more useful to local organizations and community groups. Following are a list of examples of how this information could be used:

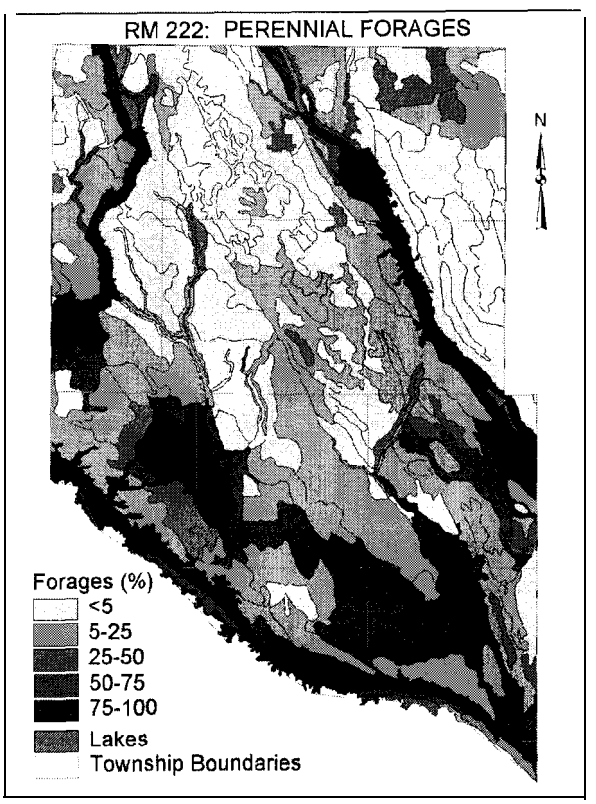
-assist in locating an intensive livestock operation that requires increased production of forages or feed grains.
-assist in locating a value added crop processing facility (eg. pulse splitter, oilseed crusher) that requires increased production of pulse or oilseed crops.
-assist an RM in establishing programs such as tax incentives where land use adjustment is recommended from an environmental point of view.
-assist a Regional Economic Development Authority (REDA) in identifying economic development opportunities that require an adjustment in land use.

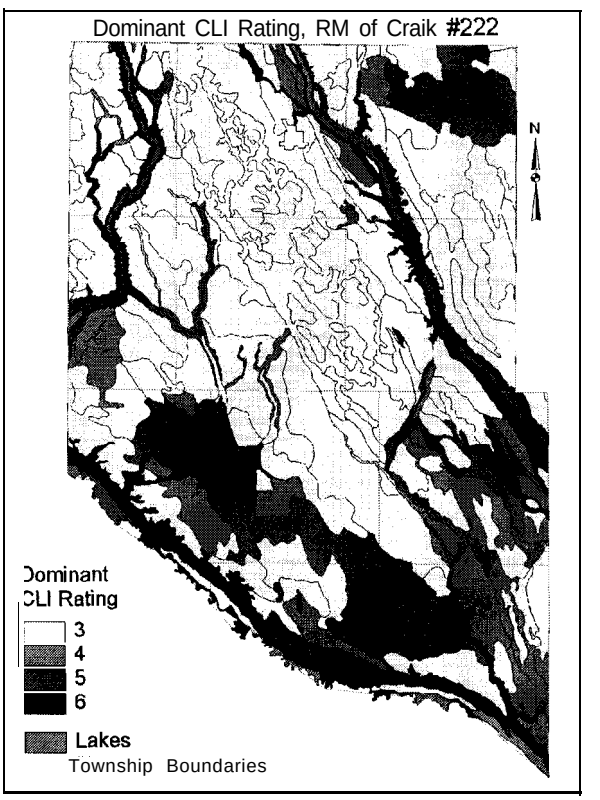
Finally, it could be debatable if this information would be useful at the farm level. One could say that most traditional family farm operators already know the productive capability of their land and have targeted their land uses most appropriately. However, there is a growing number of farmers that are considering massive changes in the their operation because of the dismal outlook for selling cereal grains. This information could be useful in determining to what extent they could diversify into other annual crops, or increased livestock. Also, with the trend to larger and more corporate owned farms, this information may be more useful for farm managers that are not as familiar with their land.

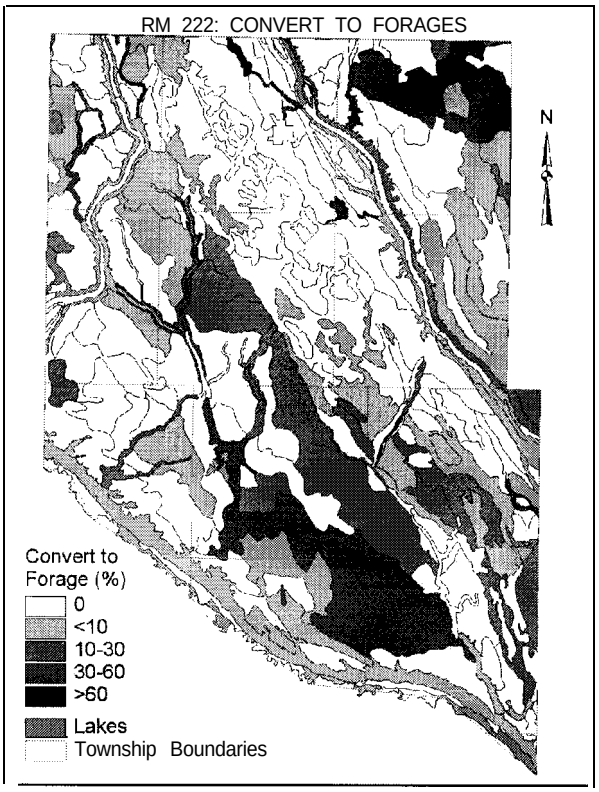
Appendix 1. Example Maps from RM of Craik No. 222

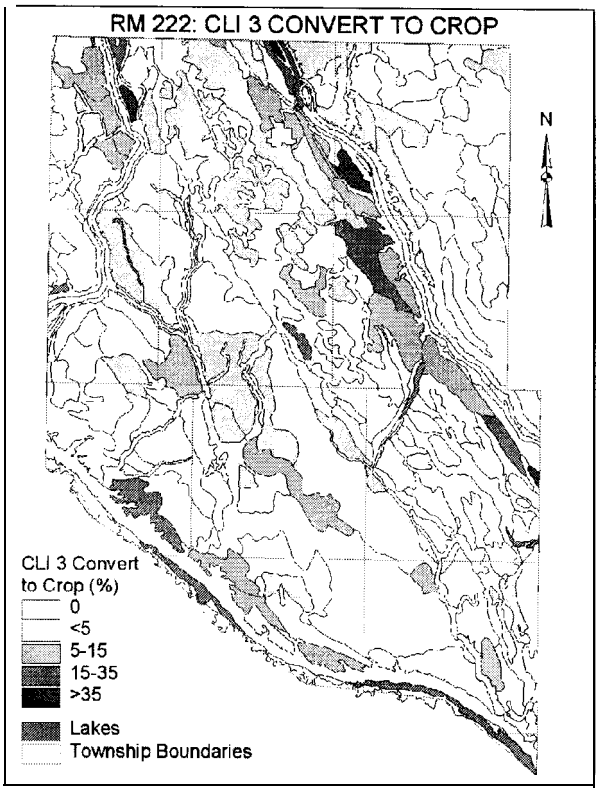


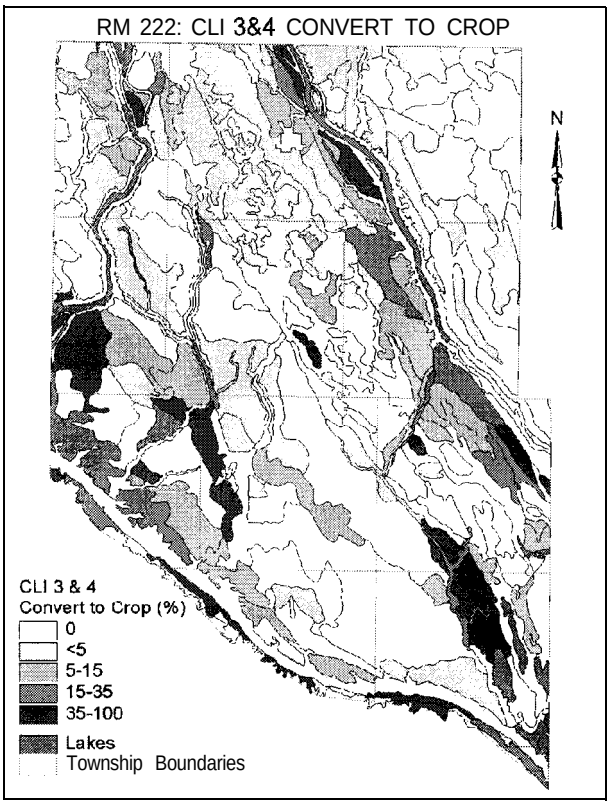







RM 222: CONVERT TO FORAGES
N
Convert to
Forage (%)
0
<10
10-30
30-60
>60
Lakes
Township Boundaries


RM 222: CLI 3 CONVERT TO CROP
N
CLI 3 Convert
to Crop (%)
0
<5
5-15
15-35
>35
Lakes
Township Boundaries


RM 222: CLI 3&4 CONVERT TO CROP
N
CLI 3 & 4
Convert to Crop (%)
0
<5
5-15
15-35
35-100
Lakes
Township Boundaries