Indian Head Precision Farming Research Project, summary of objectives and preliminary survey data.

A. Moulin[1], G. Lafond[2], J. Boersch[3], B. McConkey[4], R. Zentner[4], L. Kozak[5], G. Padbury[5], R. Palmer[6], P. Bullock[7], G. Weiterman[8], and J. Squires[9]

[1]AAFC, Brandon, MB, R7A 5Y3, [2]AAFC, Indian Head, SK, S0G 2K0, [3]IHARF, Indian Head, SK, S0G 2K0, [4]AAFC, Swift Current, SK, S9H 3X3, [5]AAFC, Saskatoon, SK, S7N 0W0, [6]University of Regina, Regina, S4S 0A2, [7]Noetix Research Incorporated, Winnipeg, MB, R3K 1R2, [8]Sask Water, Outlook, SK, S0L 2N0, [9]PFRA, Weyburn, S4H 0W3

Introduction

A partnership of farmers, scientists, industry and government was formed to evaluate precision farming concepts on a farm size scale in an unbiased, practical and environmentally responsible manner. Variable-rate fertiliser management systems can improve efficiency of fertilizer use and environmental sustainability. Adoption of this technology has been hampered due to the difficulty of classifying fields into management units, the high cost of sampling soils on a grid basis, and the variability of soil and plant properties in the landscape. Technology for variable rate fertilizer systems is available, but there is little information available related to yield response in glacio-lacustrine soils. In order to accomplish this objective, a study was located on a 307-acre site located near Indian Head, Saskatchewan.

Previous research (Moulin et al 1994) showed crop yield and soil erosion were related to a multivariate factor composed of relative elevation and surface curvature. Variability of crop yield in a glacial-till landscape was attributed to the effect of relative elevation and surface curvature on overland flow of water and related soil properties.

Subsequent research (Beckie et al 1997) evaluated variable rate fertilizer management in a field classified according to slope position, organic matter and residual soil test nitrogen. The highest efficiency of fertilizer use was found when nitrogen fertilizer was variably applied to land classified according to topography.

In current research, Dr. L Fuller and Larry Durant (1998) of the University of Manitoba have identified a relationship between microtopography and soil fertility in glacio-lacustrine soils in the Red River valley. Crop response to fertilizer was significantly related to surface curvature as it affects distribution of water at the surface.

Objectives

The overall objective of the project is to study cost effective ways of assigning management units relative to grid sampling, and evaluating the economic merits of precision farming. The objectives will be addressed in a wide range of research activities:

1. Soil variability related to surface curvature and landscape position.

2. Crop yield related to soil variability and variable management.

3. Remote sensing, soils information and digital elevation maps for landscape classification and variable management.

4. Economic return of precision farming.

5. Control systems for field equipment.

Experimental Design and Field Activities

In spring 1998, soil properties and elevation were surveyed at the site. Eight cropping blocks were established in a cereal-oilseed-cereal-pulse rotation (Figure 1), and yields recorded with a yield monitor. In fall 1998, soils were sampled to 90 cm in a one-acre grid survey (308 sites) to determine the variability of soil properties at the site. Nitrate-N, sulphate-S, P, K, pH and conductivity will be measured. Additional deep coring was conducted to characterize distribution of soil nitrates. Soil conductivity was mapped with an EM38 to determine the distribution of salinity. Yield data were collected with a yield monitor. Infra-red, black and white, and satellite images were also obtained for the site.

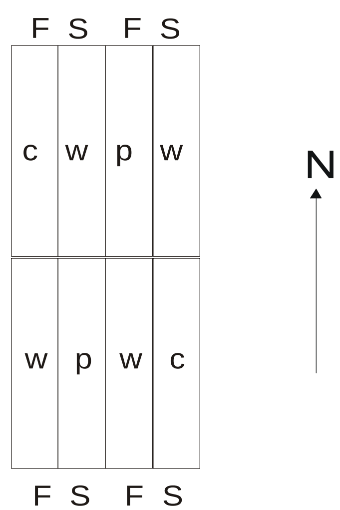

Figure 1. Crop blocks for 1998. w-wheat, c-canola, p-peas; Previous management in 1997, F-fallow, S-cereal stubble

Results

Soil variability related to surface curvature and landscape position.

Soil survey

The landscapes are relatively level to very gently undulating and occasionally inclined. A large part of the field tends to slope or drain towards a shallow draw running across the field from the west to the north east. The slopes tend to be a little steeper and more dissected immediately adjacent to the draw in the north-eastern corner of the field.

Most of the soils at the IHARF research farm belong to the Indian Head soil association which is defined as a group of Chernozemic Black soils developed on uniform clayey lacustrine deposits. In some cases these soils are relatively shallow (less than one metre thick) and are underlain by loamy or clayey water-modified glacial till. These soils are simply referred to as shallow Indian Head soils underlain by glacial till. Where the glacial till becomes extremely shallow or outcrops at the surface the soils formed in these parent materials are referred to as either Edgeley or Oxbow soils. The soils belonging to the Edgeley soil association are dominantly Chernozemic Black soils formed in a mixture of loamy to clayey, water-modified glacial till while Oxbow soils are Chernozemic Black soils developed on loamy glacial till.

The area immediately east and south east of the farmstead consists primarily of water modified glacial till and glacial till. The south western and south eastern edges of the research farm and the area immediately north of the farmstead consists of primarily a mixture of clayey deposits and shallow clayey deposits underlain by glacial till. The lower lying area in the middle of the half section, extending from the western edge of the research farm to the eastern edge of the research farm was made up of predominantly clayey materials. This area represents approximately one quarter of the field. Very few shallow Indian Head soils were encountered at the site. The northern third of the research farm was primarily a mixture of clayey and shallow clayey deposits, however, glacial till was encountered at the surface in some areas. There were also some saline soils encountered along the draw in eastern portions of this area.

The soil profiles were predominantly Rego Blacks, with a significant amount of Orthic Blacks (approximately 20%) scattered throughout the landscape. There were also a few Calcareous profiles but these accounted for less than 10% of the landscape. The surface horizons (Ap) were usually less than 20 cm thick and frequently in the order of 10 cm, common for clayey textured soils with limited profile development. However, a significant number of relatively thick surfaces were present, from 20 to 30 cm and greater. Some of these surfaces seemed to occur fairly randomly throughout the field whereas others tended to follow old field boundaries (running in a north south direction) where surface materials evidently accumulated from erosion and/or was built up as a result of using disk type implements.

Soil grid sampling

Observations made during the spring survey were confirmed by analyses from grid sampling at the site. Analysis of horizontal surface curvature and predicted overland flow indicates most of the water moves toward the draw at the centre of the field and the presence of long shallow channels (Figure 2). Depth to primary and secondary carbonates varied considerably throughout the field (Figure 3) and appeared to reflect a combination of erosion and tillage. Thick deposits of non-carbonated soils were observed at the west and east boundaries of the field, in addition to several locations in the middle of the field. The latter locations may represent the effects of previous fence lines or tillage management. Results of the salinity survey are not yet available.

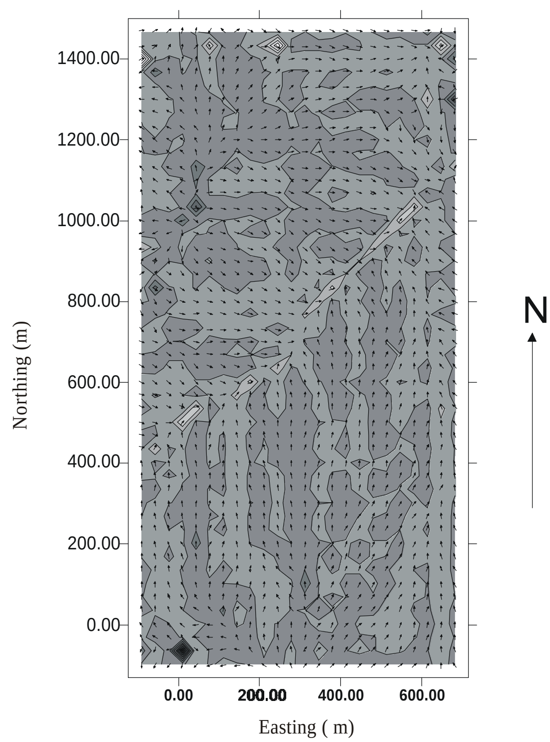

Figure 2. Horizontal curvature and direction of overland flow. Convergence Dark, Divergence Light, Arrow represent direction of slope

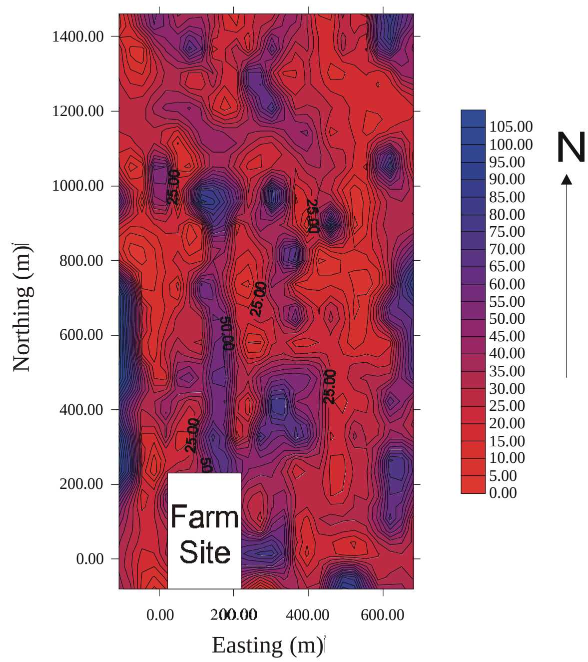

Figure 3. Depth to carbonates (cm).

Crop yield related to soil variability.

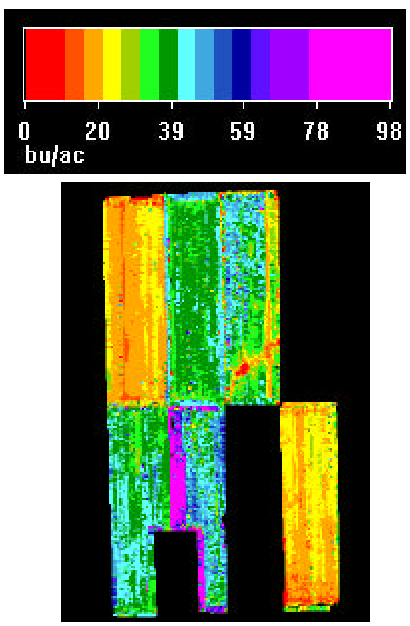

Figure 4. Crop yield (bu/ac).

Crop yield varied considerably in the field (Figure 4). Two plots were not mapped due to loss of global positioning signal.

Remote sensing, soils information and digital elevation maps for landscape classification and variable management.

Satellite imagery (Figure 5) indicates significant variability across the field. Variability of imagery was attributed to excess moisture and competition from weeds. Correlation’s between satellite imagery, soil properties and crop yield will be assessed when soil analyses are complete.

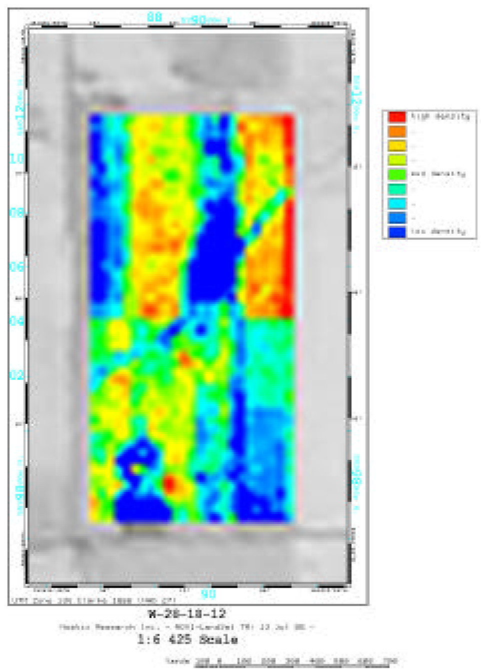

Figure 5. Satellite image of field.

Economic return of precision farming.

The economic return of precision farming will be determined from data from the study. All costs related to GPS technology, variable rate application, fertilizer, fuel, pesticide and other inputs will be used in this calculation.

Control systems for field equipment.

Control and global positioning systems for field scale equipment will be evaluated in farm operations at the site. Potential applications of the technology include remote control of sprayers and other farm equipment.

Conclusions

Spatial variability of glacio-lacustrine soils varied in terms of depth to carbonates and surface curvature. Variability was observed in crop yield and remote sensing images. Future research will determine if management units can be assigned to this variability based on remote sensing or other images, and the economics of variable management will be assessed.

Acknowledgements

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