Understanding The Soil-Landscape:
Implications For Manure Management

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What Is The Soil-Landscape?

The term “soil-landscape” refers to the combination of soil and landscape properties within a given geographic location. The “soil-landscape” is more than soil and it is more than landscape, it is the complex interaction of the two.

"…soil is more than farmer's dirt, or a pile of good topsoil, or engineering material; it is a body of nature that has its own internal organization and history of genesis."

- Hans Jenny, 1980

"The Soil Resource"

Processes Acting On Material Over Time Results In Form

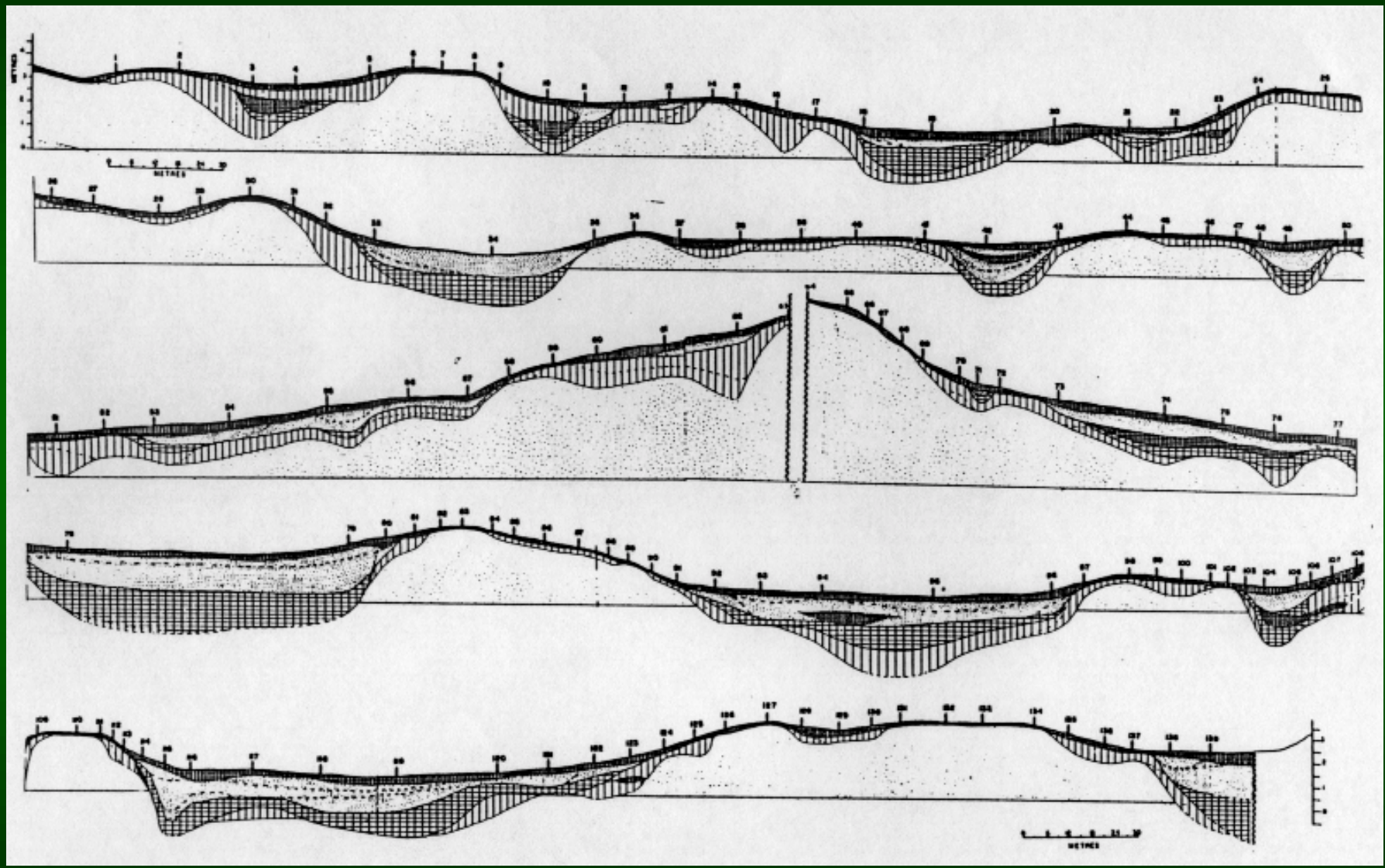
Soil Profile Types

Soil Parent Material

Processes

Processes

Processes

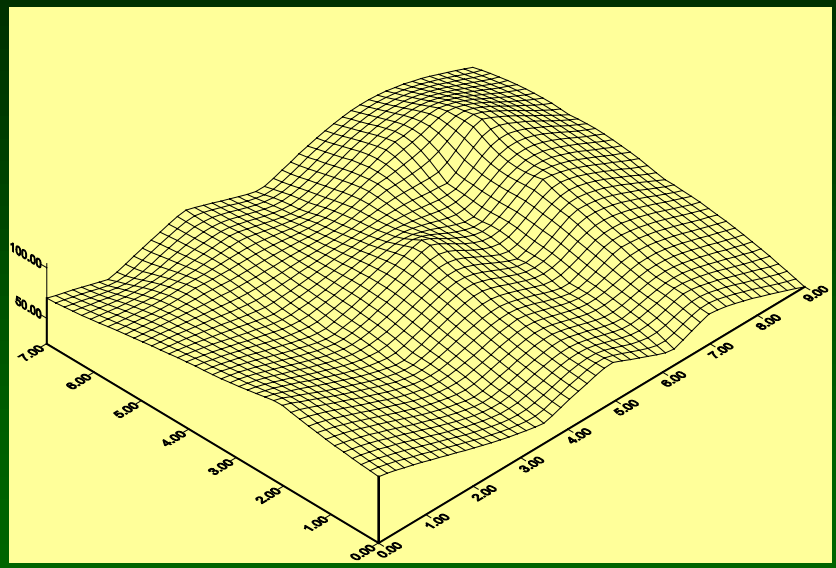


King et al. 1985

The soil profile is an historical record of environmental processes that have been and/or are active at that particular point in the landscape.

Soils are indicators of environmental process.

Hydrologic Variability Within The Soil-Landscape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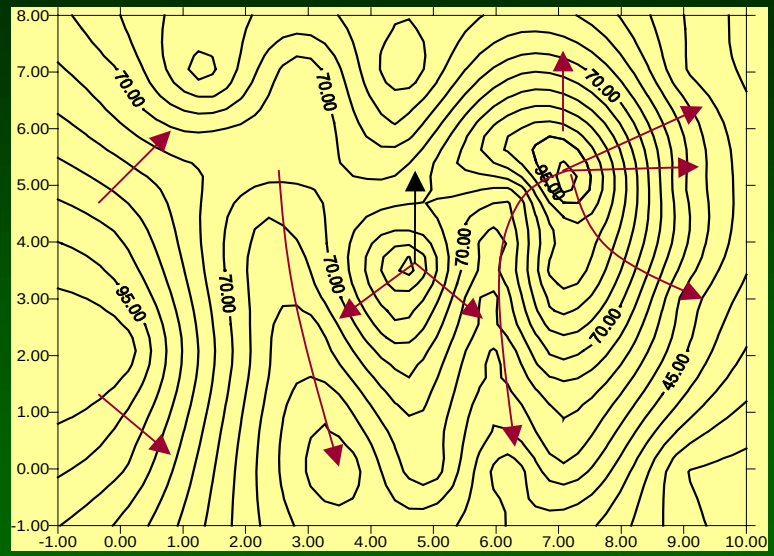
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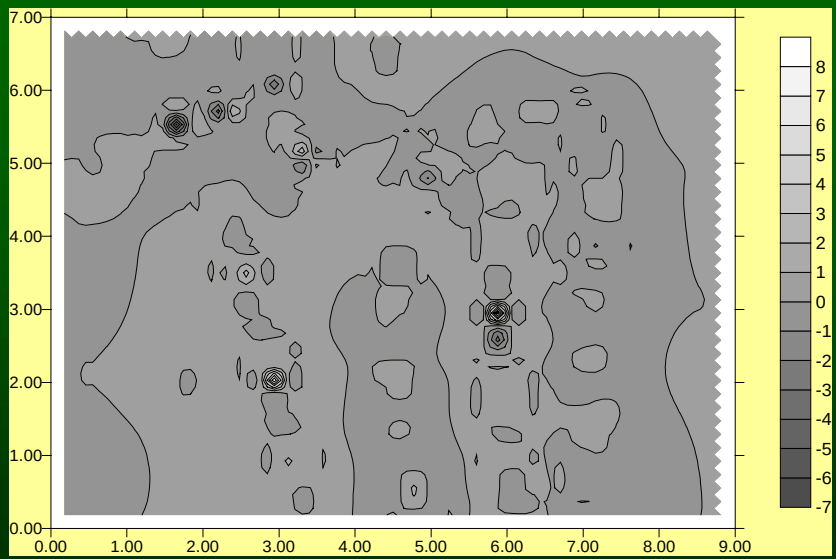
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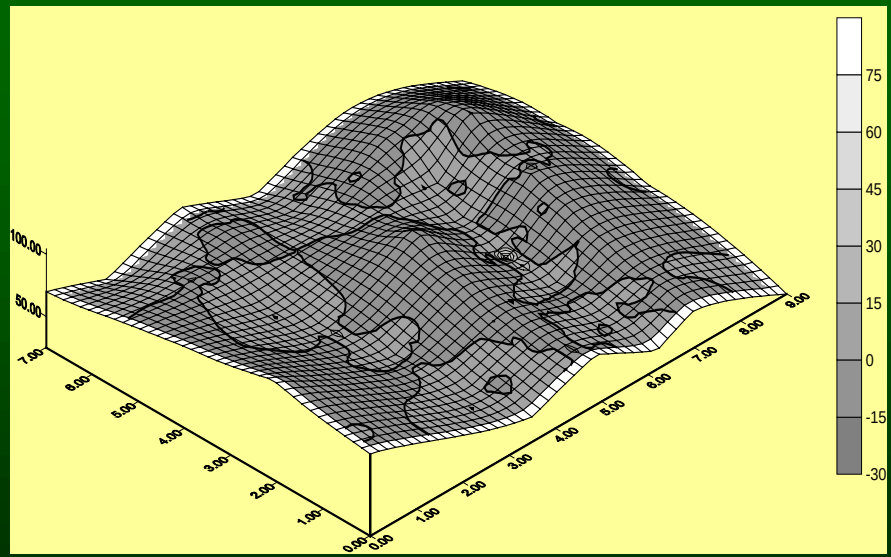
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Key to understanding environmental process variability is WATER.

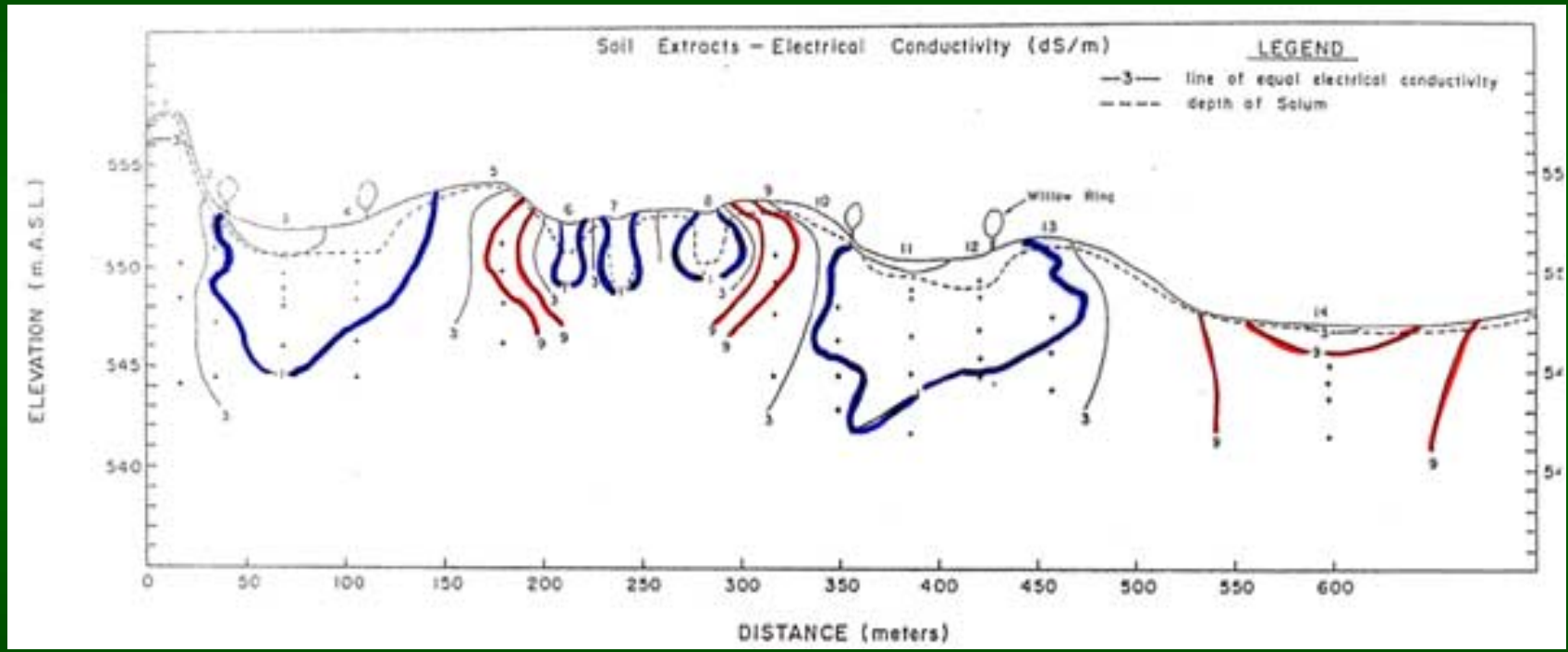
Landscape morphology is instrumental in precipitation partitioning:

- Slope gradient, length, curvature:
  - localized soil moisture regimes and hydraulic gradients.
  - Hydrologic divergence, transmission and convergence.

RESULT:

Variable leaching regimes across a landscape.

Spatial Variability of Leaching Regime



Miller et al. 1985

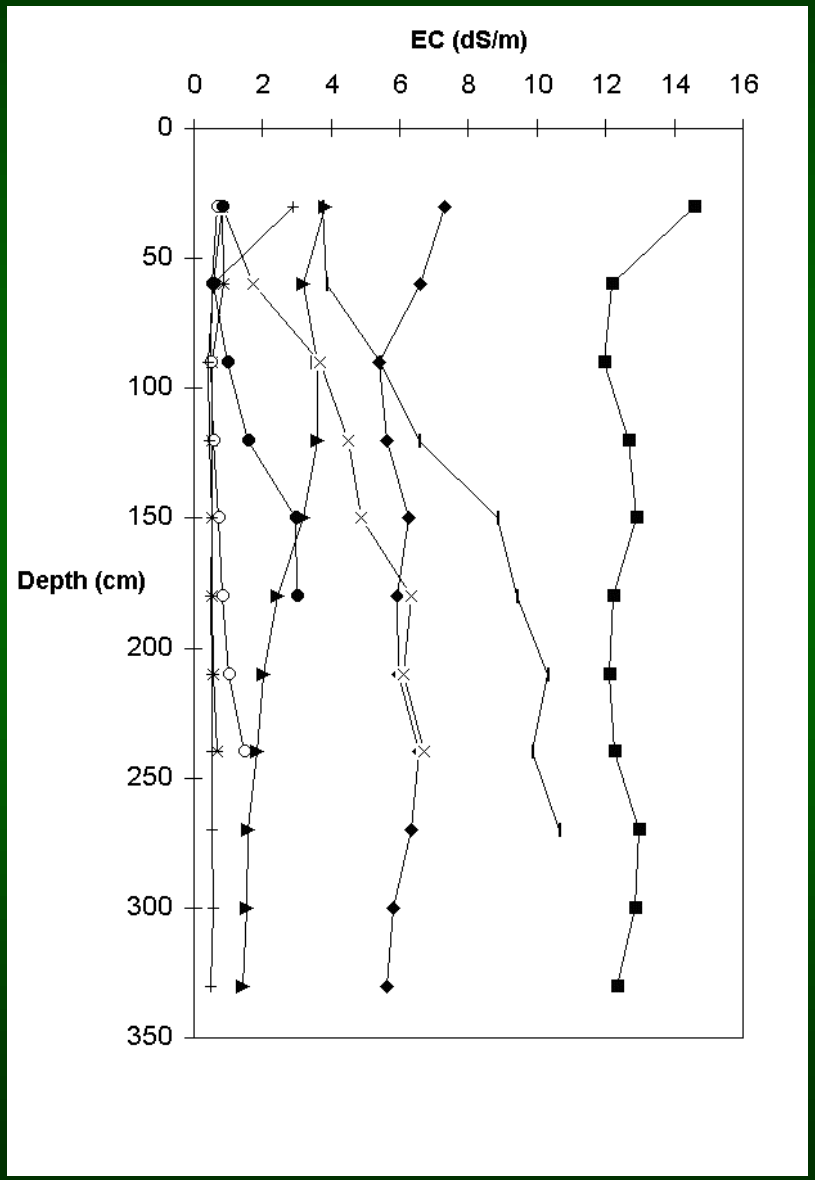
Implications For Land Management:

- Agricultural land management has traditionally operated at a different scale than that at which environmental processes are expressed.
- Agricultural land management is superimposed over variable landscape-controlled processes.
- Environmental concerns arise where management scale differs from process scale (i.e. uniform management of a variable and complex resource)

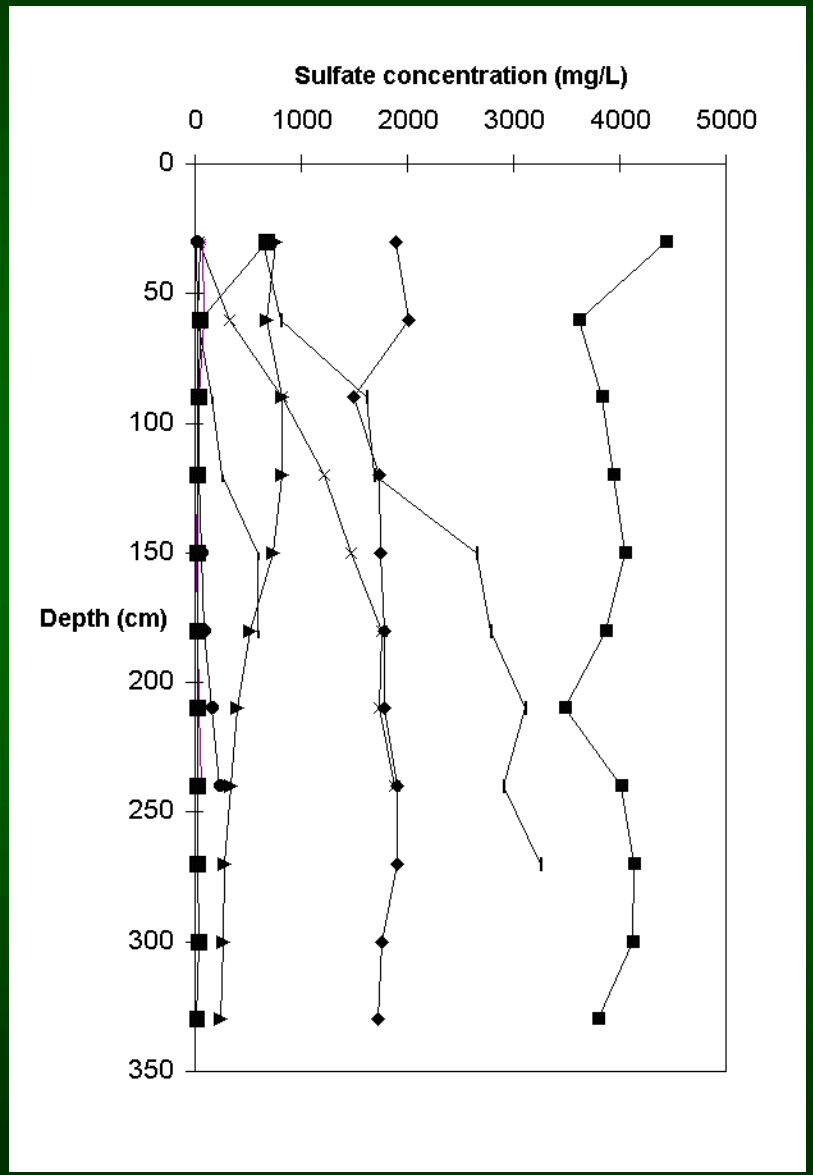
Need indicators of hydrologic variability in the landscape:

a) spatial variability of solute profiles

E.C. (dS/m)



Soluble Sulfate (mg/L)



b) spatial variability of soil profile morphology

Sample Points With Low EC To Depth

- Soil profile development:
  - lixiviation
  - decarbonation
  - pervection
- Deep soil profiles (1.2 to 2.0 m)
- Strongly leached, acidic, non-saline.

Sample Points With High EC to Depth

- Soil profile development:
  - lixiviation absent
  - carbonates present throughout profile
  - no pervection
- Shallow soil profiles (< 30cm)
- Non-leached, alkaline, saline.

“Intermediate Sample Points”

- Soil profile development:
  - lixiviation active to a point
  - carbonate-free solum
  - pervection weak if present
- Soil profile depth ranges from 30 to 75 cm
- Weakly leached, neutral pH, non-saline solum but saline subsoil may be present.

Leaching potential is not uniform across the soil-landscape.

The spatial variation in soil profile development (morphology) provides an indication of long-term hydrologic conditions across the soil-landscape.

Nutrient Use Efficiency Within The Landscape

Crop response to applied nutrient is influenced by various landscape-controlled parameters:

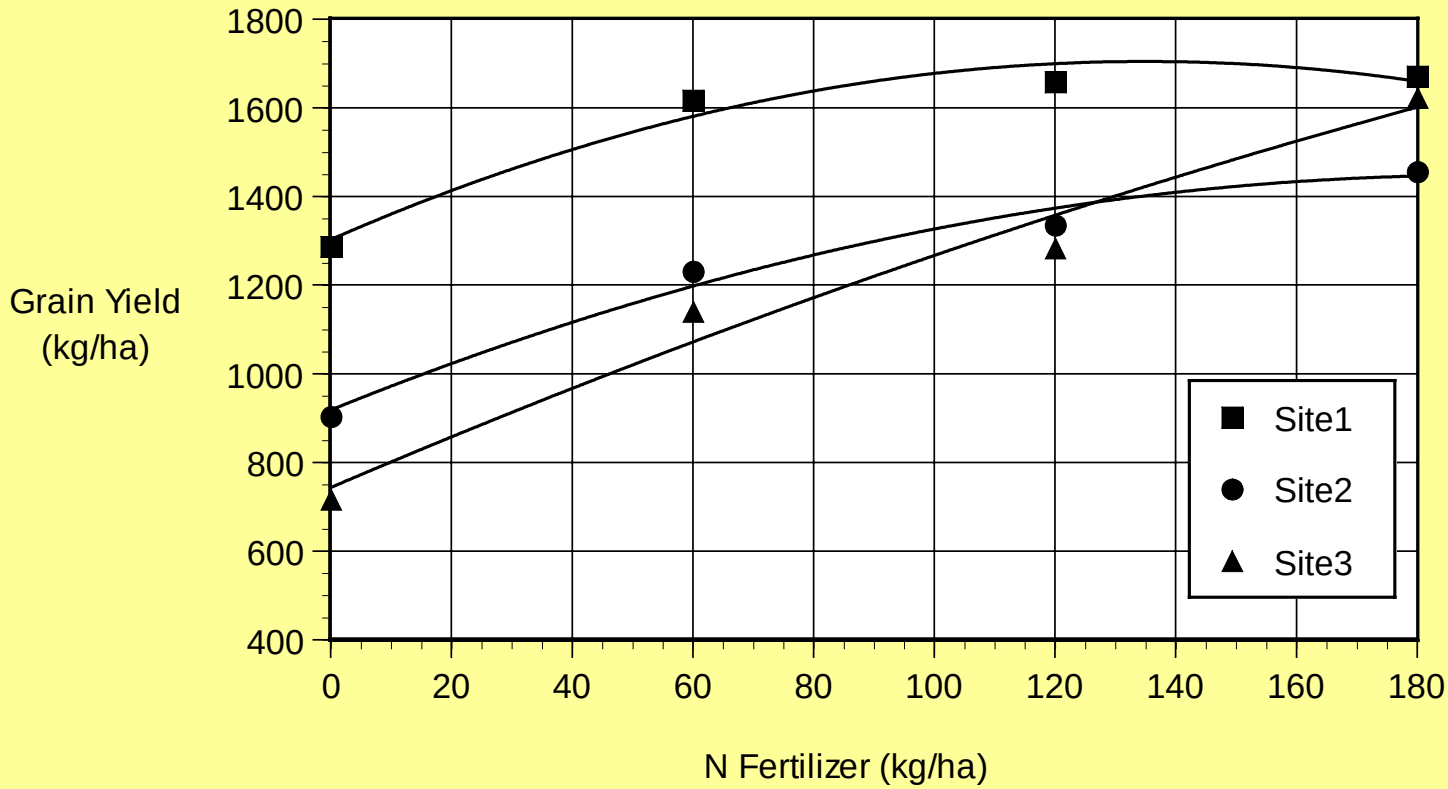
- soil moisture
  - surface and sub-surface supply
- root zone salinity
- oxygen diffusion rate and rooting volume
- N supply (denitrification, mineralization…)
- disease
- weed ecology and patch dynamics

Wheat Response to Fertilizer N - 1996

Site 1: Yield = -2.20E-2*N^2 + 5.95*N + 1.30E+3 (r^2 = 0.97)

Site 2: Yield = -1.43E-2*N^2 + 5.52*N + 9.15E+2 (r^2 = 0.98)

Site 3: Yield = -5.85E-3*N^2 + 5.82*N + 7.41E+2 (r^2 = 0.97)

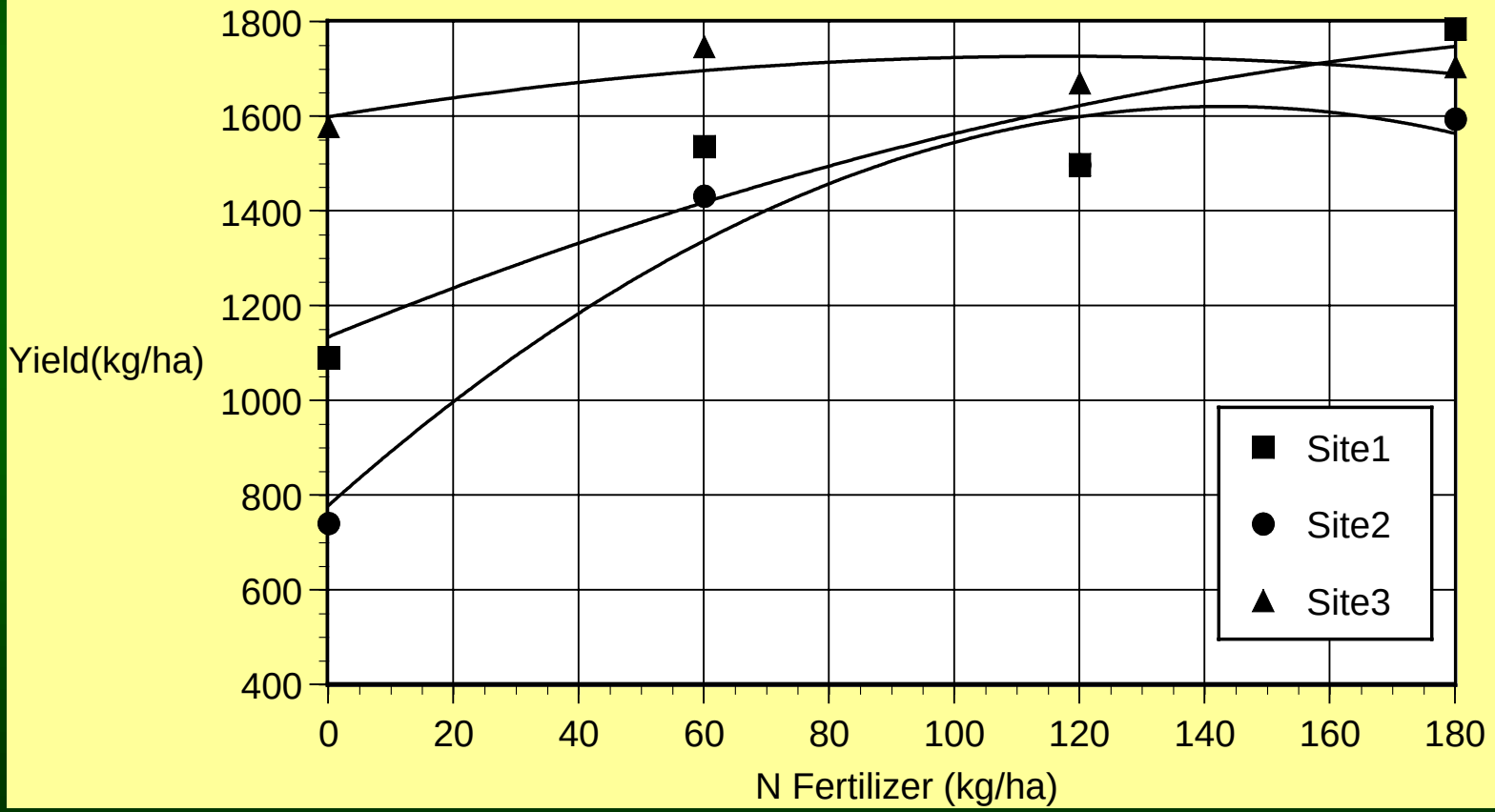


Canola Response to Fertilizer N - 1996

Site 1: Yield = -1.10E-2*N^2 + 5.39*N + 1.13E+3 (r^2 = 0.87)

Site 2: Yield = -4.12E-2*N^2 + 1.18E+1*N + 7.73E+2 (r^2 = 0.95)

Site 3: Yield = -9.34E-3*N^2 + 2.18*N + 1.59E+3 (r^2 = 0.59)



Significant variation in crop nutrient use occurs across the landscape. This has implications for rate of nutrient addition in subsequent years.

Summary

1. Leaching potential is not uniform across the soil-landscape.

- Nutrient utilization by a growing crop is not uniform across the soil-landscape.

Implications for Manure Management:

1. A single application rate across a variable soil-landscape is not consistent with sustainable manure nutrient management.

2. Manure management needs to take into account soil-landscape variability (i.e. benchmark sampling and monitoring)

Closing Remarks

- Within-field variability has not been sufficiently addressed within the last 50 years of agricultural land management.

- Soil and landscape parameters vary spatially across the field and influence a variety of land management issues.

- Research priorities must begin to focus upon development of agricultural practices and management systems that reflect underlying process and resource variability.

- There is a need to understand the effect of soil-landscape variability on production efficiency if an environmentally sustainable agriculture is to be achieved.