

# **SOIL EROSION AND PRODUCTIVITY**

**DICK WOLKOWSKI  
DEPARTMENT OF SOIL SCIENCE  
UW-MADISON**

# SOIL EROSION IS GLOBAL PROBLEM

- ❑ 1/3 WORLD'S ARABLE LAND LOST SINCE 1950
- ❑ MOST IN ASIA, AFRICA, S. AMERICA
  - ❑ 13-18 t/a/yr
- ❑ 30% OF US FARMLAND ABANDONED
  - ❑ EROSION
  - ❑ SALINIZATION
  - ❑ WATER-LOGGING
- ❑ 90% OF US CROPLAND LOSING SOIL FASTER THAN IT IS REPLACED
  - ❑ >1 t/a/yr

*PIMENTEL ET AL., 1995*

# SOIL EROSION

- ❑ WATER AND WIND
- ❑ LOSSES CAN BE LARGE
  - ❑ WATER 3.5 BILLION t/yr
  - ❑ WIND 1.5 BILLION t/yr
- ❑ TILLAGE TRANSLOCATION
- ❑ ENVIRONMENTAL QUALITY ISSUES
- ❑ LOSS OF PRODUCTIVITY
- ❑ WE'VE BEEN LUCKY UNTIL 2000

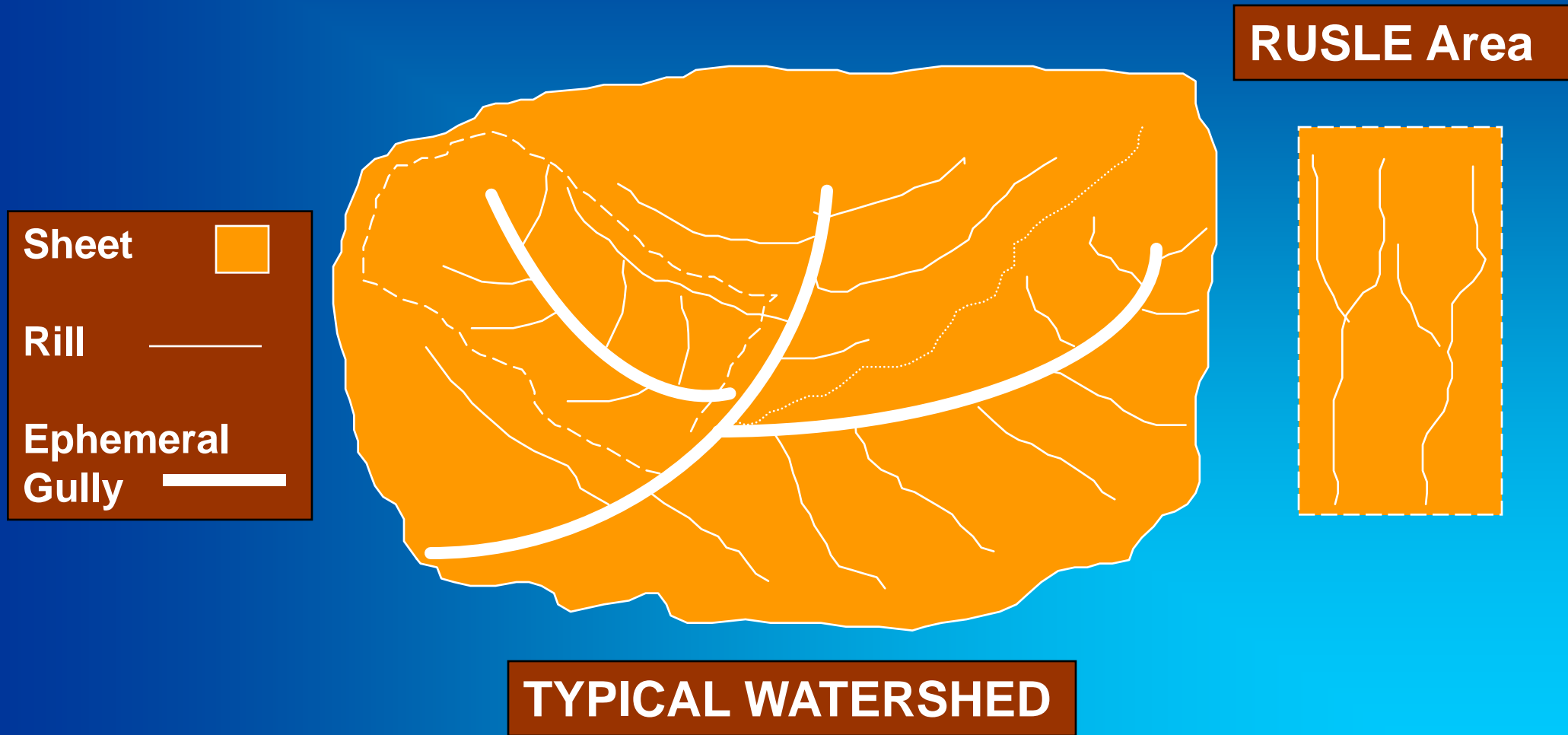
# **WATER EROSION**

- **BEGINS WITH RAINDROPS STRIKING BARE SOIL DISLODGING PARTICLES**
- **INTENSE RAINS SEAL SURFACE**
- **WHEN RAINFALL EXCEEDS INFILTRATION WATER IS STORED IN SMALL DEPRESSION**
- **ONCE DEPRESSIONS ARE FILLED, RUNOFF BEGINS**

# **WATER EROSION**

- **INITIALLY WATER FLOWS IN A DISCONTINUOUS SHEET**
- **EVENTUALLY IT CONCENTRATES INTO SMALL CHANNELS OR RILLS. THE RUNOFF NOW HAS ENERGY TO BREAK OFF PARTICLES AND CUT DEEPER**
- **THE AMOUNT OF EROSION CAUSED BY SHEET AND RILL EROSION INCREASES WITH SLOPE AND DISTANCE**
- **RILLS MAY EVENTUALLY FORM GULLIES**

# PREDICTING EROSION - RUSLE



# RUSLE - APPLICABLE CROPLAND USES

**Where shallow overland flow occurs and erosion rates are high.**

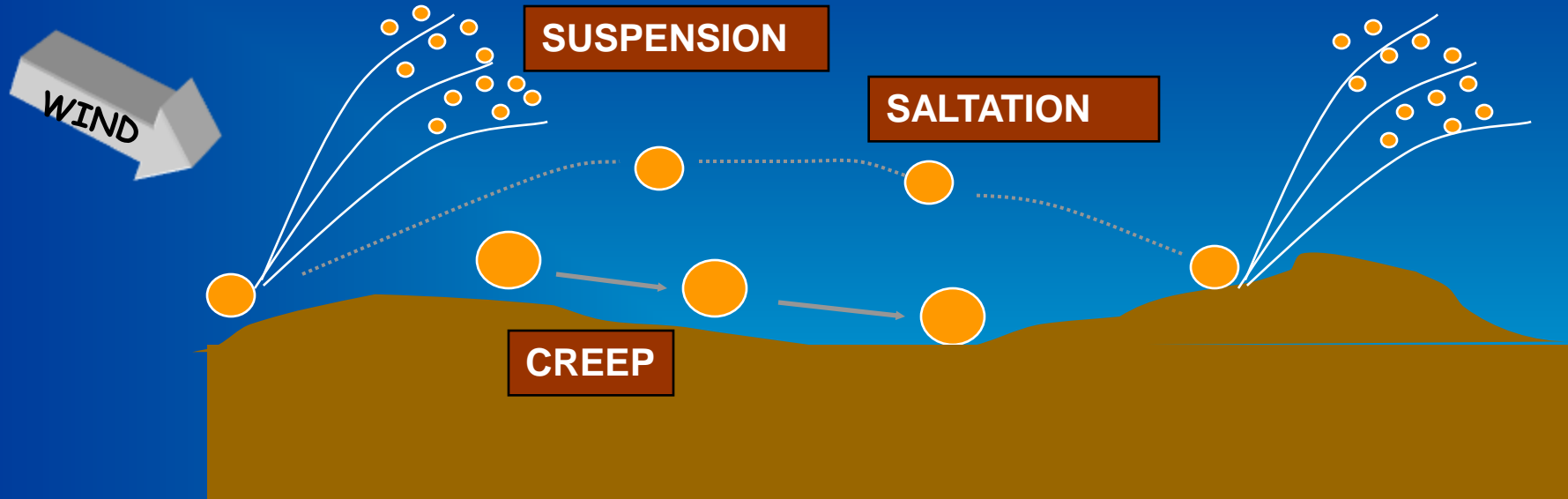
- Best: Midwest Corn, Soybean, Wheat
- Mod. Well: Conservation Tillage
- More Variable: Ridge Till, Support Practices

# RUSLE - APPLICABLE CONDITIONS

- Slope Length: 50 - 300 feet
- Slope Gradient: 3-20%
- Medium textured soils
- Rainfall predominant precipitation and exceeds 20 inches/yr



# WIND EROSION



- ☐ SALTATION DETACHES PARTICLES
- ☐ SMALLER PARTICLES SUSPENDED
- ☐ LARGER PARTICLES CREEP
- ☐ SANDY AND SILTY SOILS MOST SUSCEPTIBLE
- ☐ SOIL ACCUMULATION IN DITCHES AND FENCE ROWS

# WIND EROSION



*MITCHELL, SD (2000)*

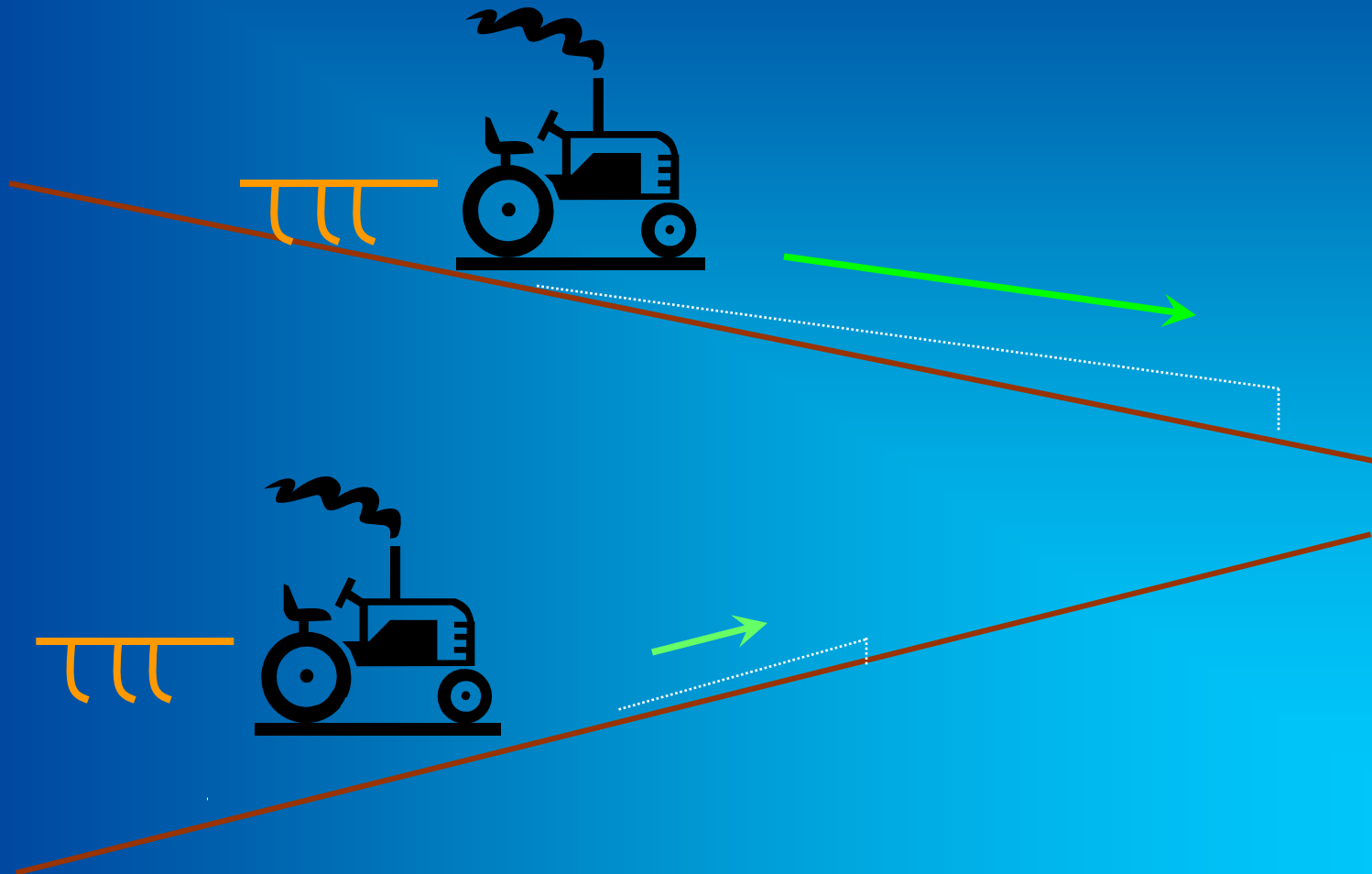
# EROSION EFFECTS ON PRODUCTIVITY

- ❑ SHALLOW ROOTING ZONE
- ❑ LOWER AVAILABLE WATER
- ❑ LOSS OF NUTRIENTS AND O.M.
- ❑ FARMING THE SUBSOIL
  - ❑ POORER TILTH
  - ❑ GREATER PENETRATION RESISTANCE
- ❑ INCREASED HYDRAULIC COND.
  - ❑ “STRONGER” AGGREGATES
- ❑ CAN A SOIL BE “REHABILITATED”

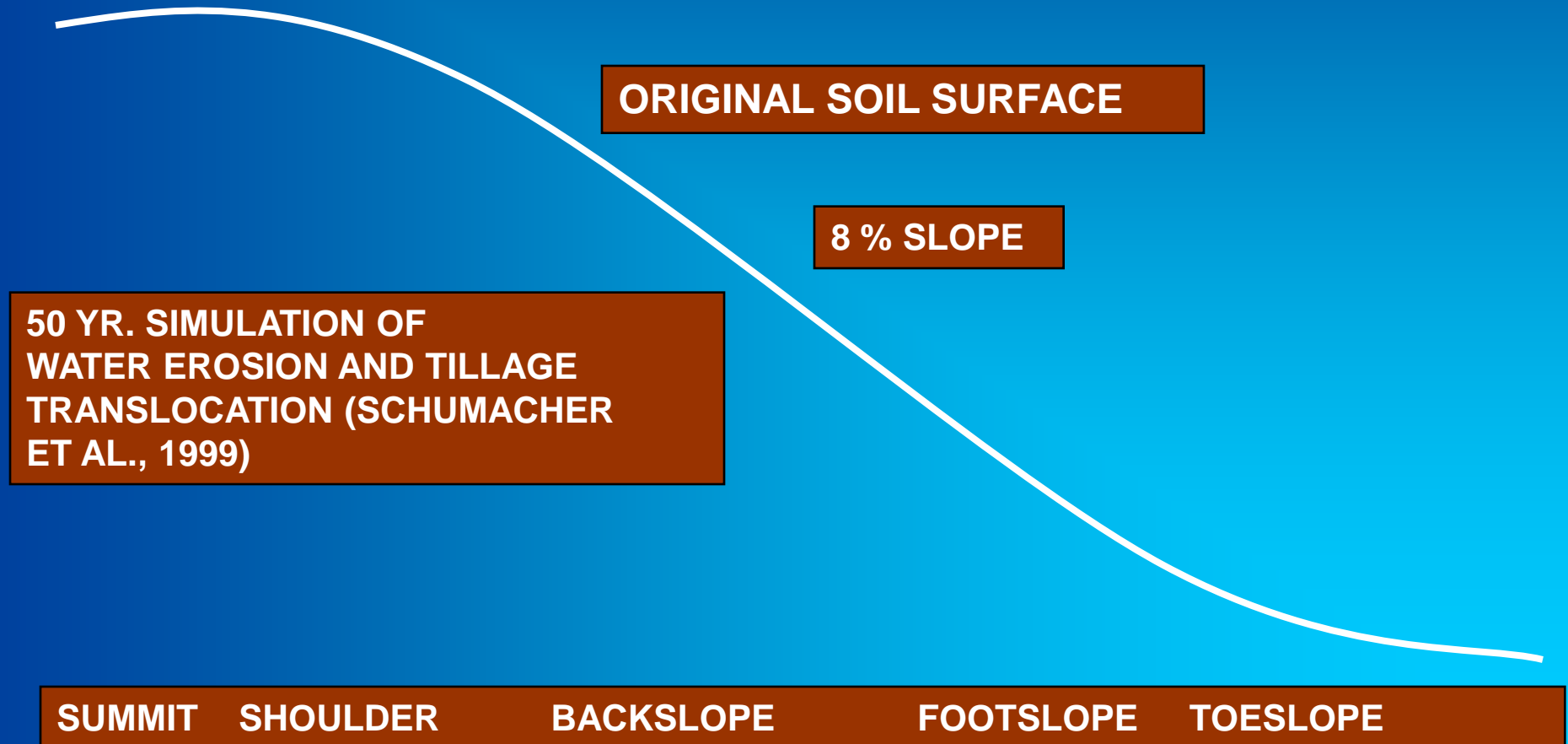
# TILLAGE TRANSLOCATION

- ❑ NET DOWNHILL MOVEMENT BY TILLAGE
- ❑ RESULTS IN SMOOTHING OF SURFACE
- ❑ WATER EROSION INCREASES RELIEF INTENSITY
- ❑ BOUNDARIES STOP MOVEMENT
- ❑ NOT ACCOUNTED FOR BY RUSLE
- ❑ INCREASES SOIL VARIABILITY

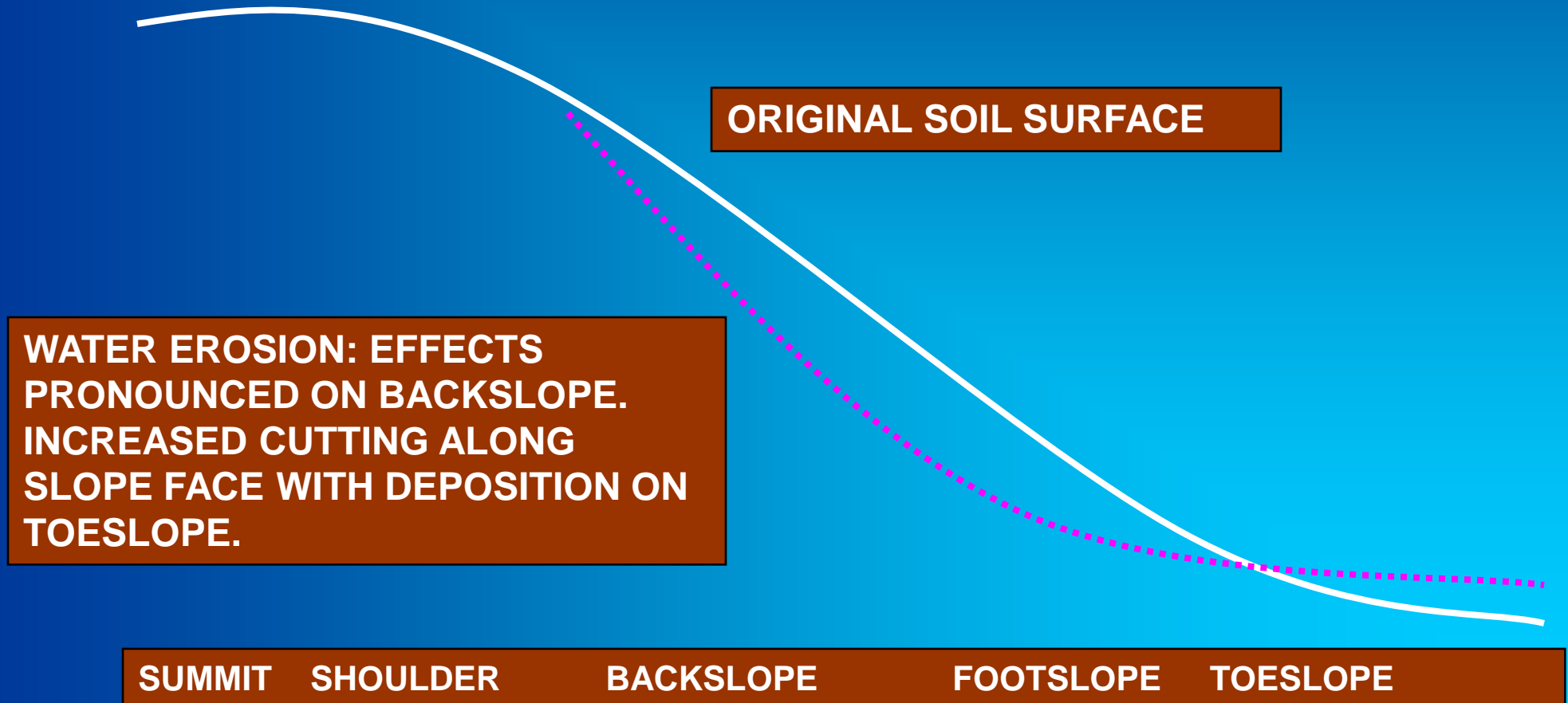
# MECHANISM OF TILLAGE TRANSLOCATION



# COMPARING WATER EROSION AND TILLAGE TRANSLOCATION

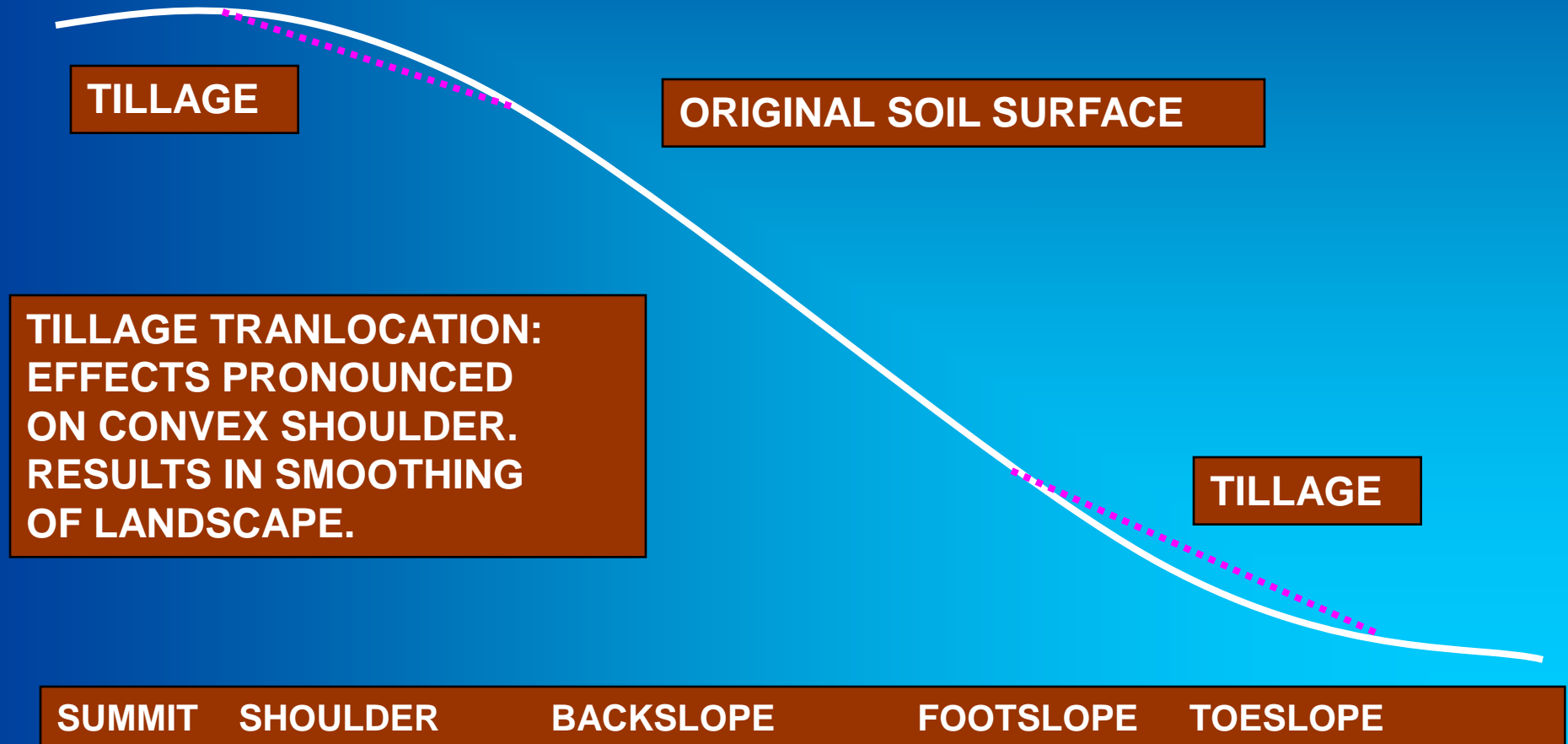


# COMPARING WATER EROSION AND TILLAGE TRANSLOCATION





# COMPARING WATER EROSION AND TILLAGE TRANSLOCATION





# TILLAGE TRANSLOCATION EFFECT ON SOIL PRODUCTIVITY INDEX

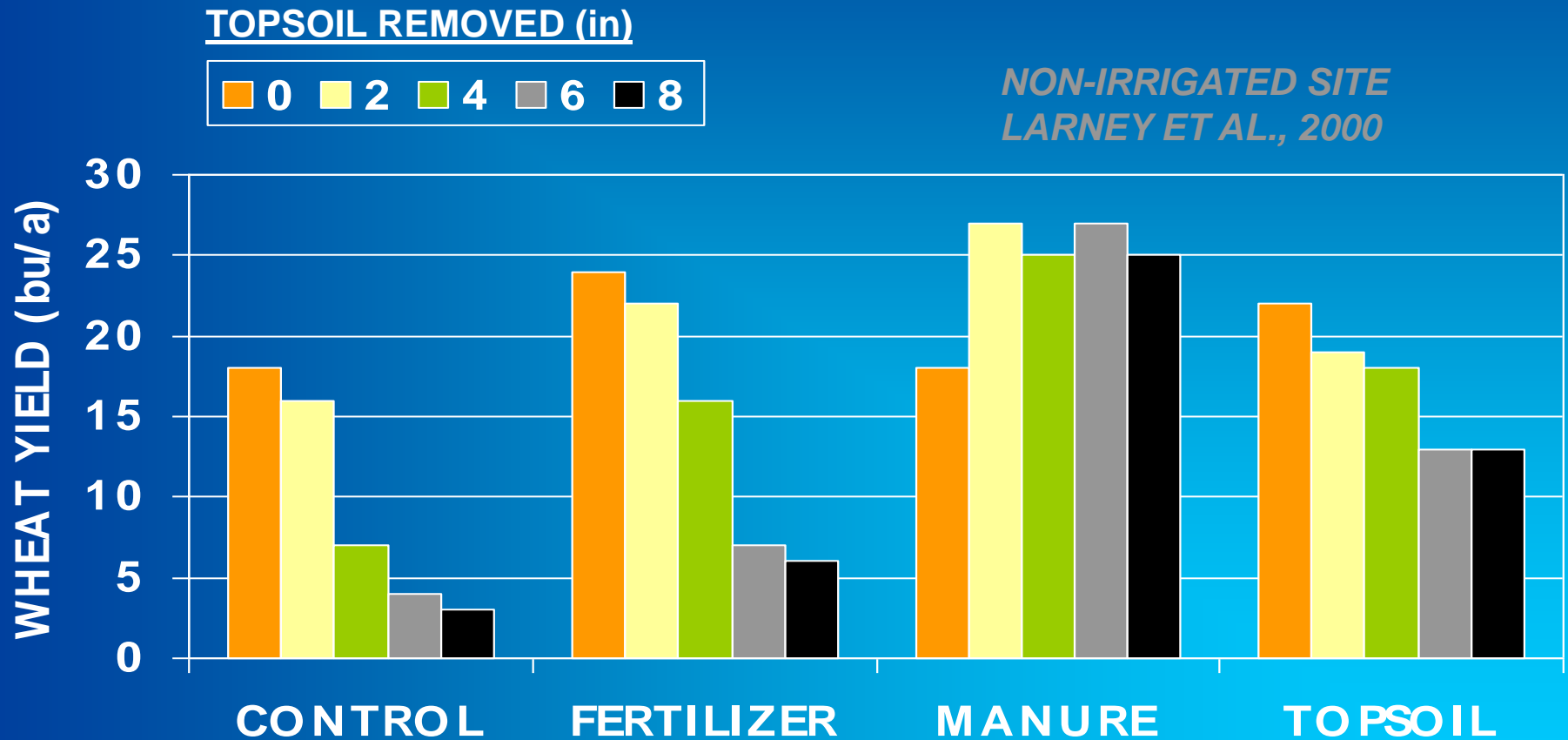
EROSION PROCESS	SOIL PRODUCTIVITY INDEX							
	SUMMIT		SHOULDER		BACKSLOPE		FOOTSLOPE	
DISTANCE (m)	10	20	30	40	50	60	70	80
TILLAGE TRANS.	0.87	0.72	0.67	0.70	0.86	0.86	0.92	0.91
WATER	0.87	0.73	0.72	0.66	0.81	0.78	0.94	0.94
TILLAGE TRANS. +WATER EROSION	0.87	0.70	0.64	0.64	0.80	0.81	0.95	0.95

*SCHUMACHER ET AL., 1999*

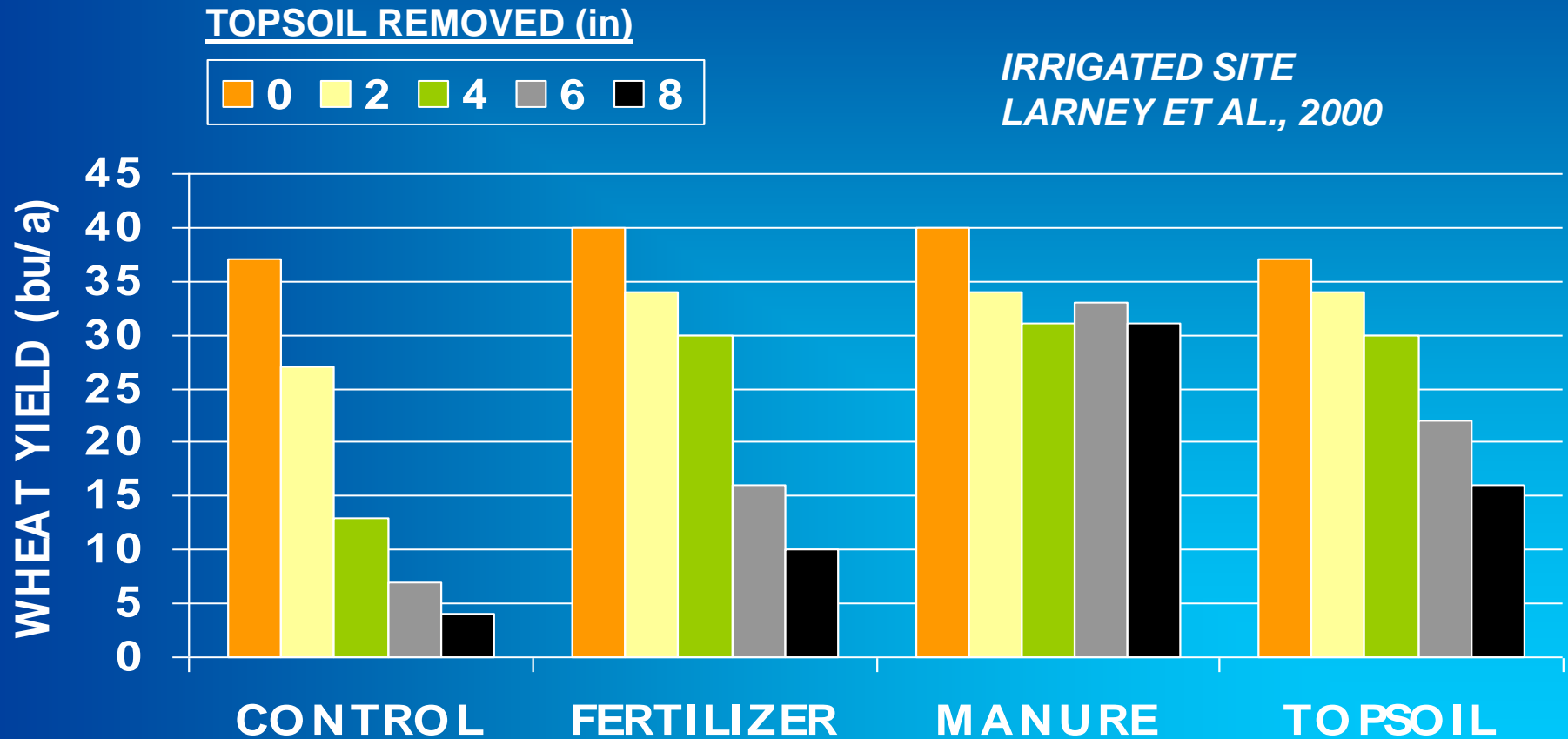
# SOIL LOSS AND PRODUCTIVITY

- ❑ WESTERN CANADA
- ❑ WHEAT
- ❑ REMOVED 0, 2, 4, 6, 8 TOPSOIL
- ❑ REPLACE NOTHING, N&P, 30 t/a MANURE, AND 2" TOPSOIL
- ❑ IRRIGATED AND NON-IRRIGATED
- ❑ LARNEY ET AL., 2000

# TOPSOIL LOSS AND PRODUCTIVITY



# TOPSOIL LOSS AND PRODUCTIVITY





# EROSION CLASS EFFECT ON AVAILABLE WATER AND CORN GROWTH

EROSION CLASS	AVAIL. WATER	SILKING ET	MAX. HEIGHT	GRAIN YIELD
	in/ 3 ft	in/day		bu/a
SLIGHT	7.8	0.17	91	146
MODERATE	7.4	0.15	86	136
SEVERE	6.9	0.14	81	137

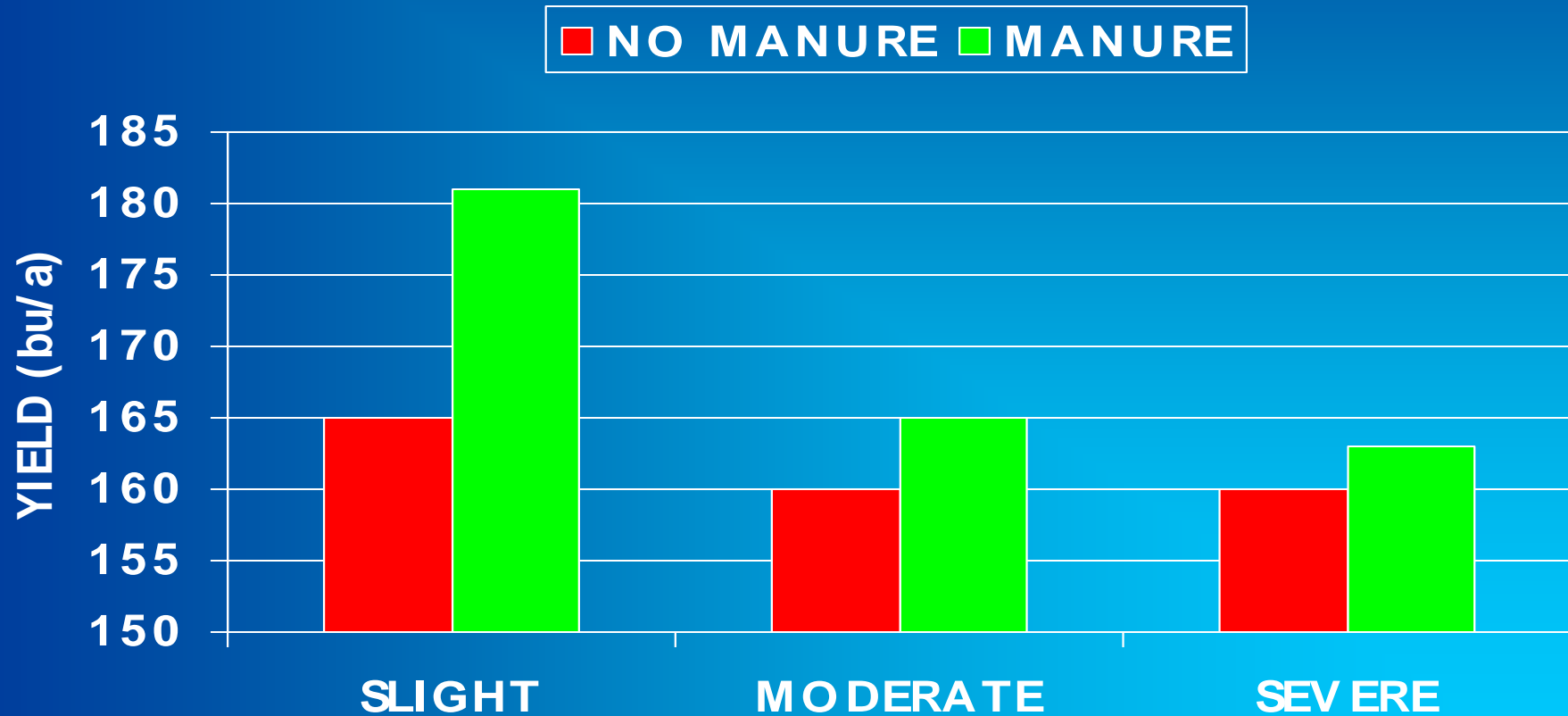
ANDRASKI AND LOWERY, 1992 (LANCASTER, WIS.)

# CAN MANURE REHABILITATE AN ERODED SOIL?

EROSION CLASS	MANURE	ORG. CARBON	BULK DENSITY	HYDRAULIC COND.
		%	g/cc	cm/sec
SLIGHT	NO	1.4	1.32	0.0003
	YES	2.1	1.15	0.0007
MODERATE	NO	1.6	1.32	0.0010
	YES	2.3	1.21	0.0019
SEVERE	NO	1.8	1.30	0.0009
	YES	2.5	1.20	0.0025

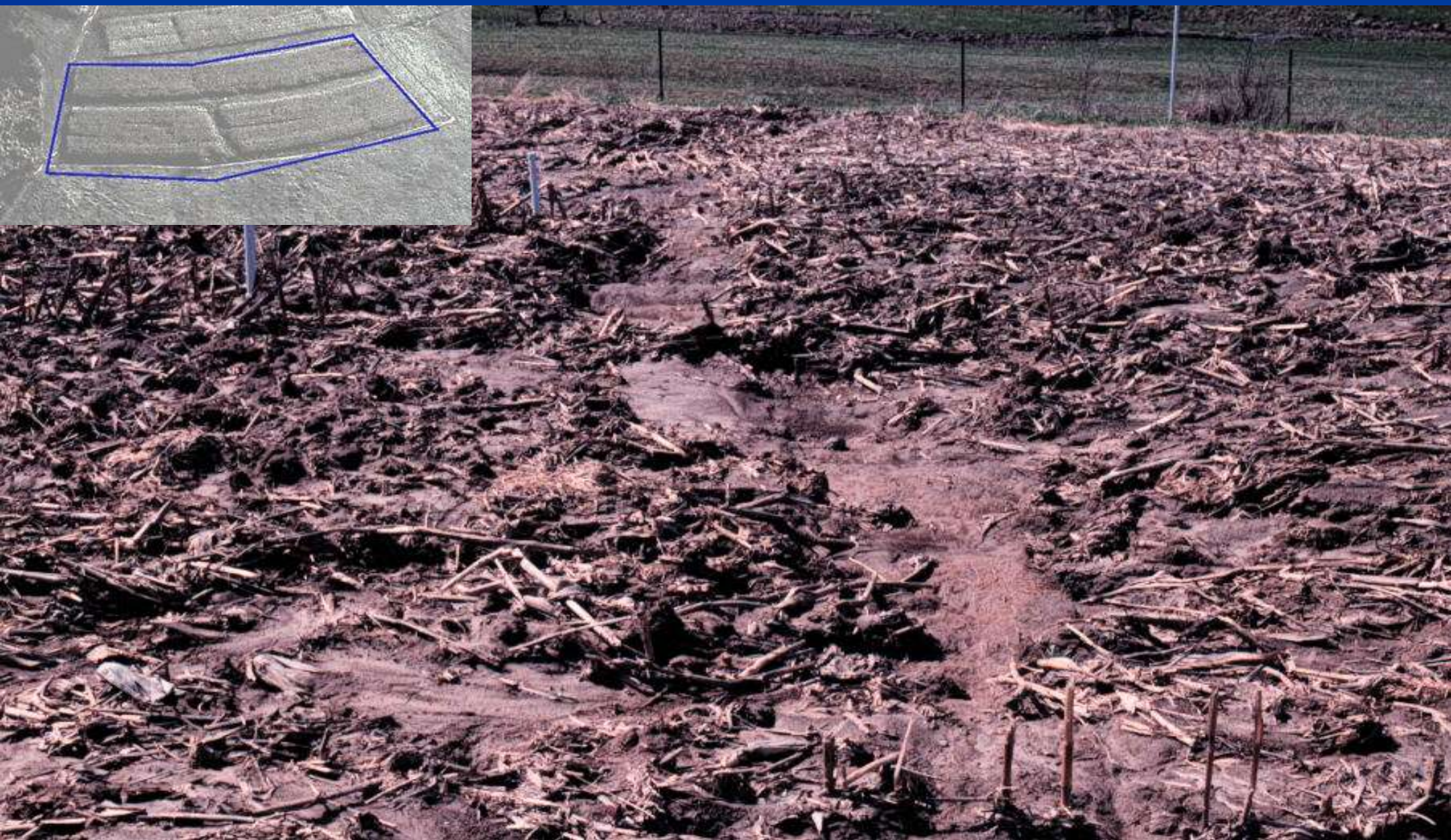
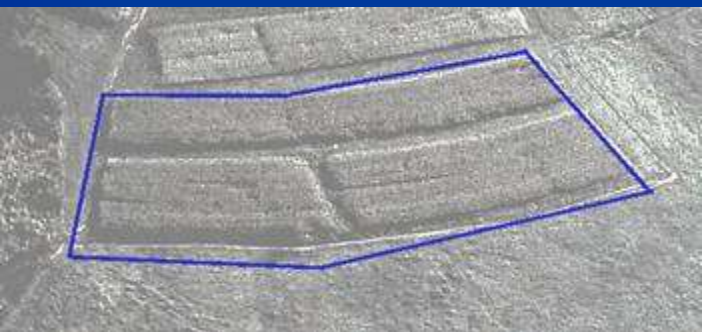
*ARRIAGA, 2000 (LANCASTER, WIS.)*

# CORN YIELD ON A MANURED, ERODED SOIL (12 YEAR AVG.)



*ARRIAGA, 2000 (LANCASTER, WIS.)*





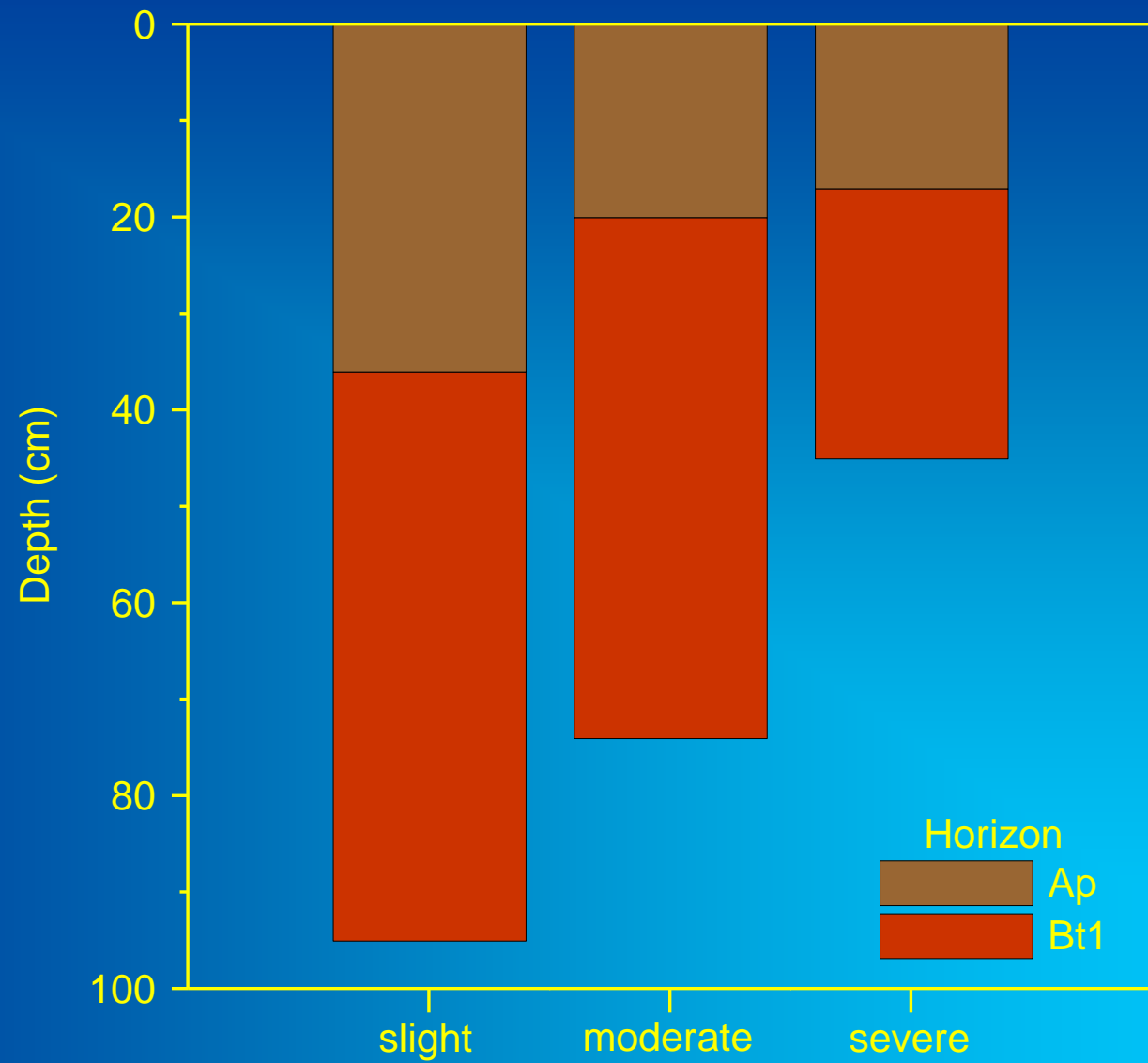


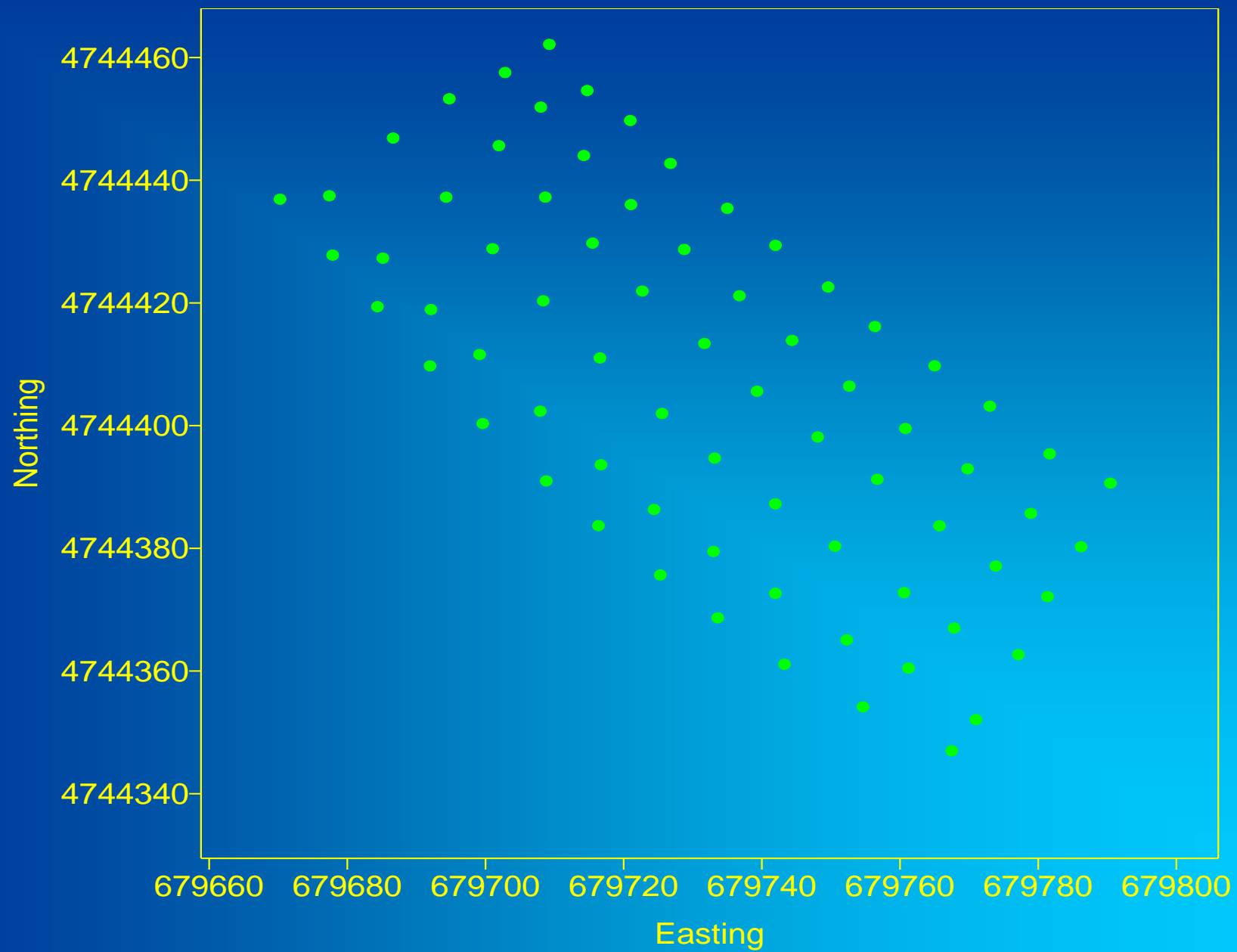


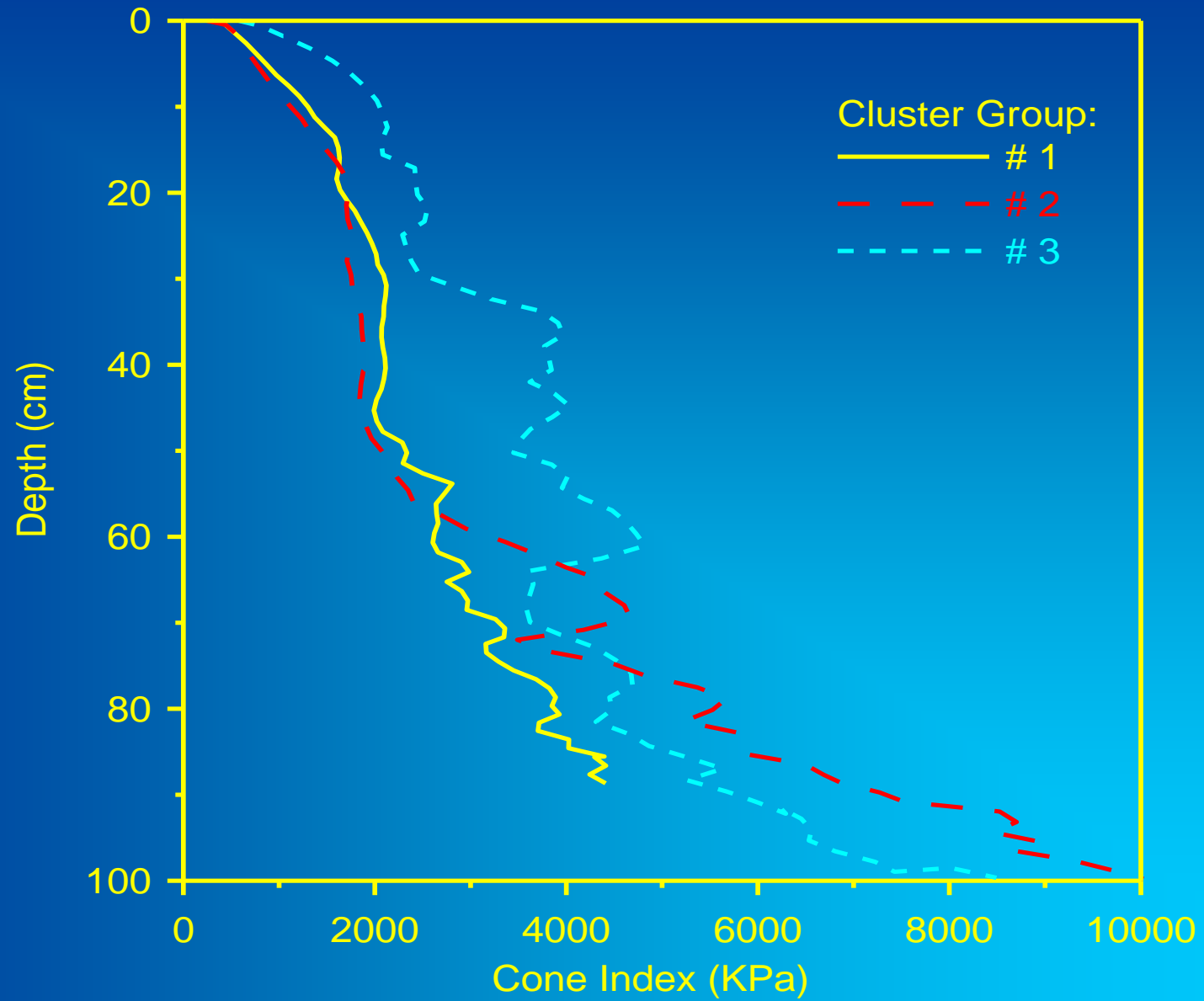


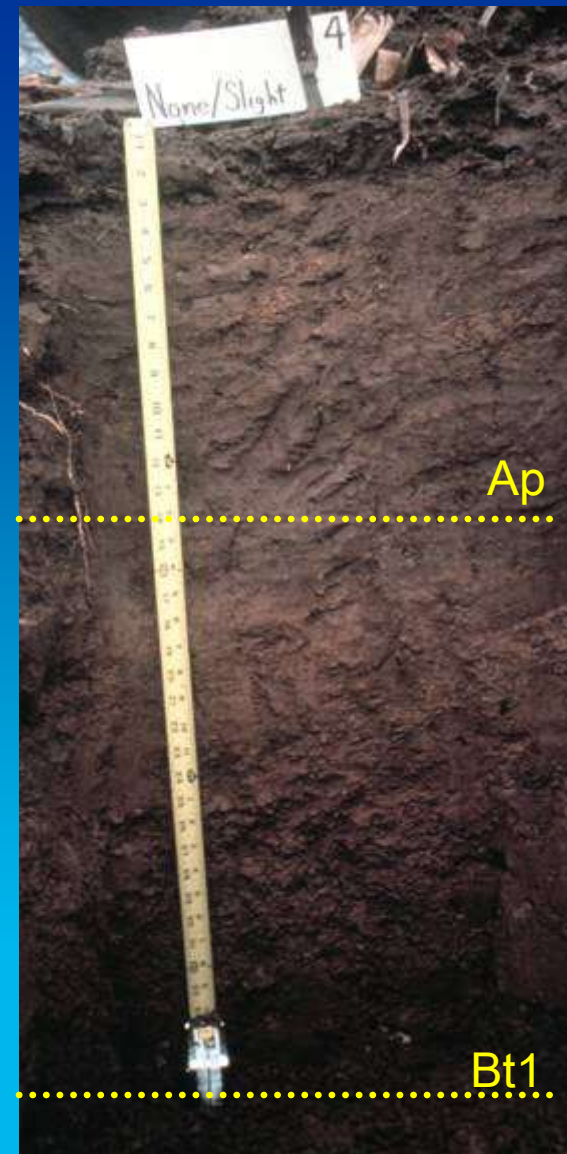
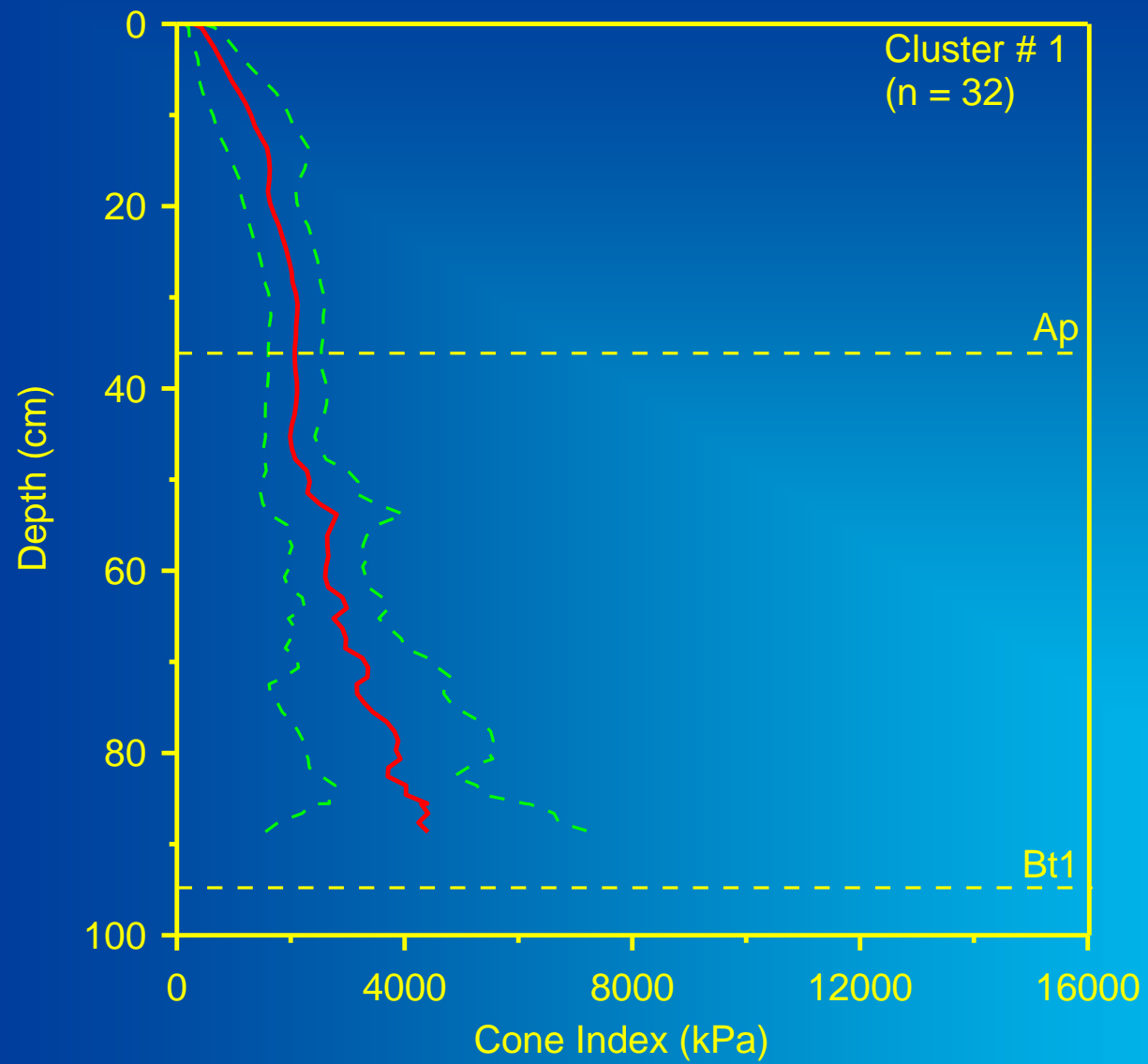


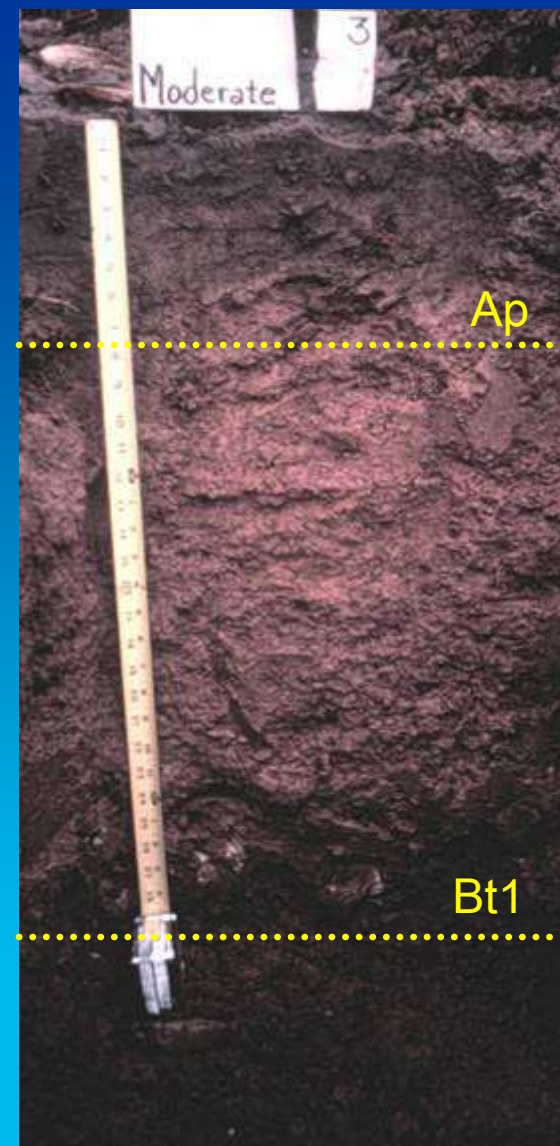
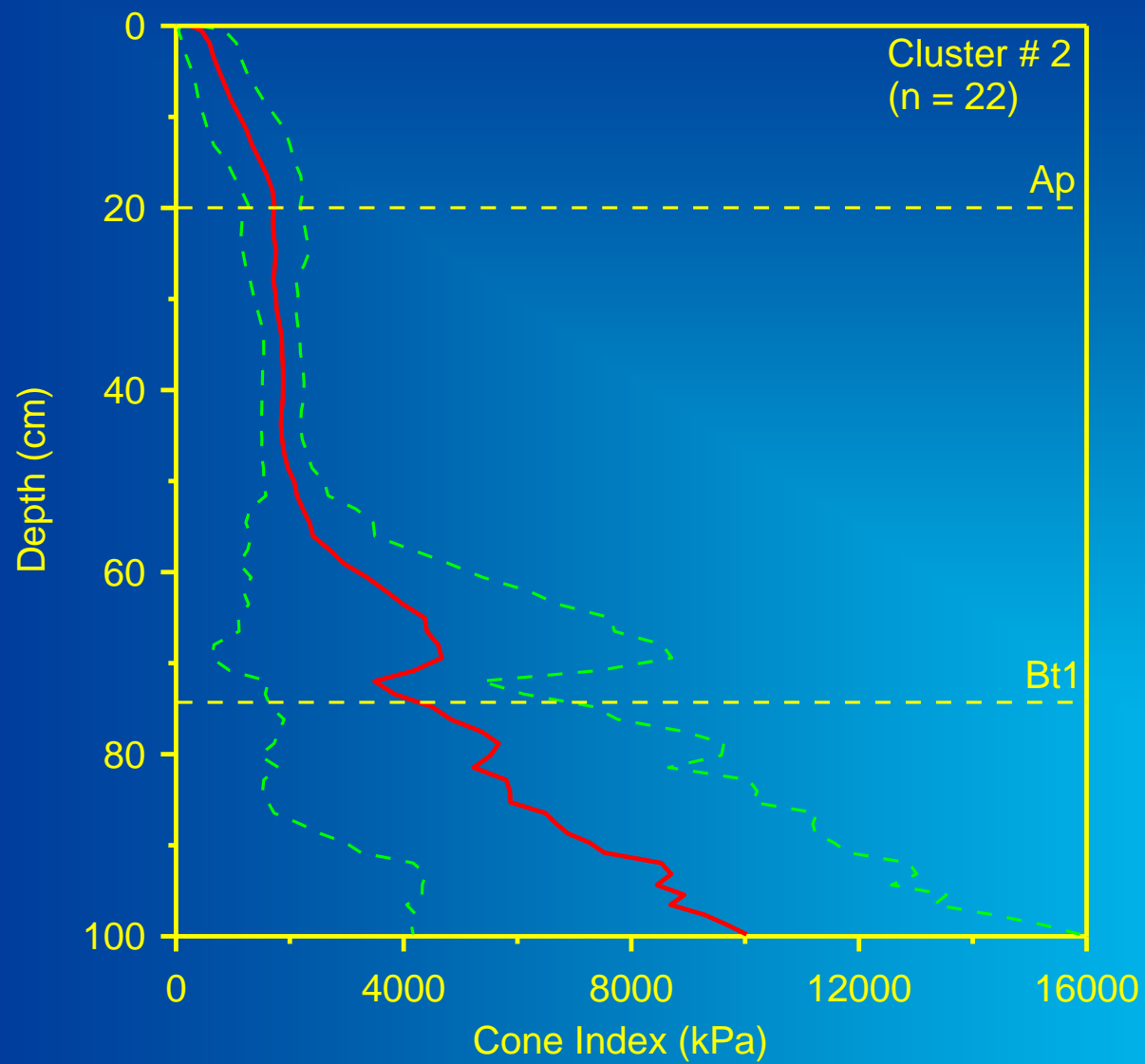




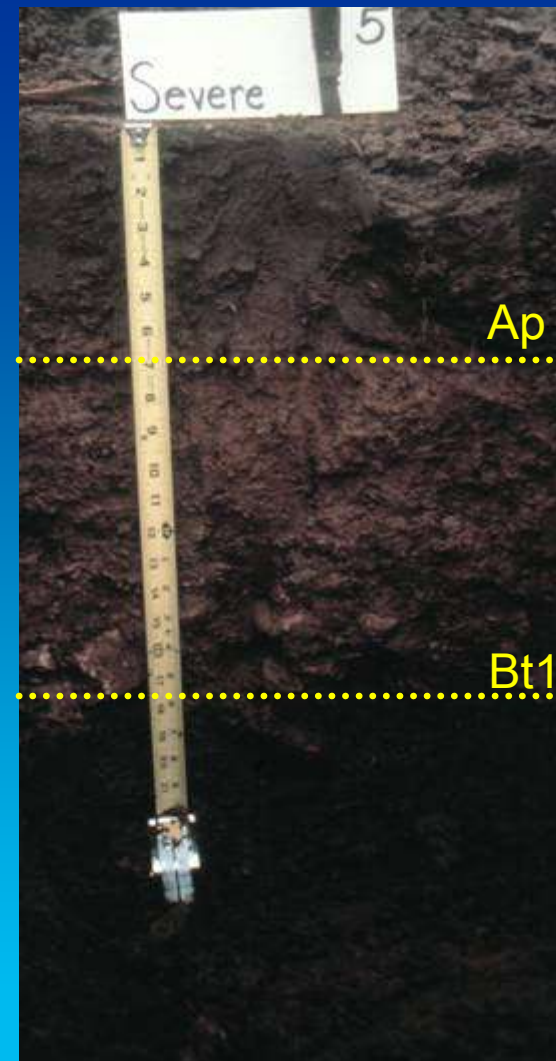
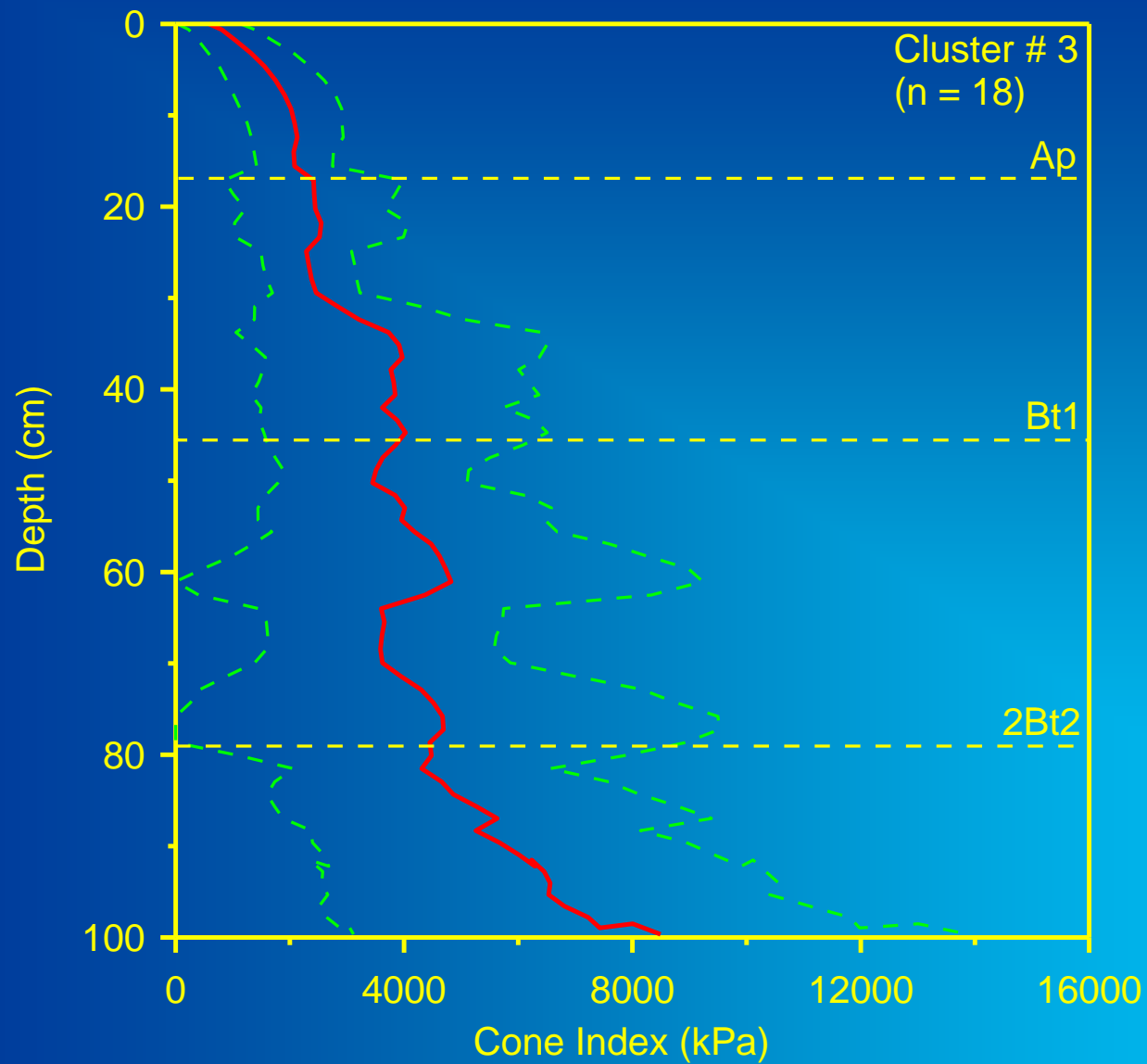


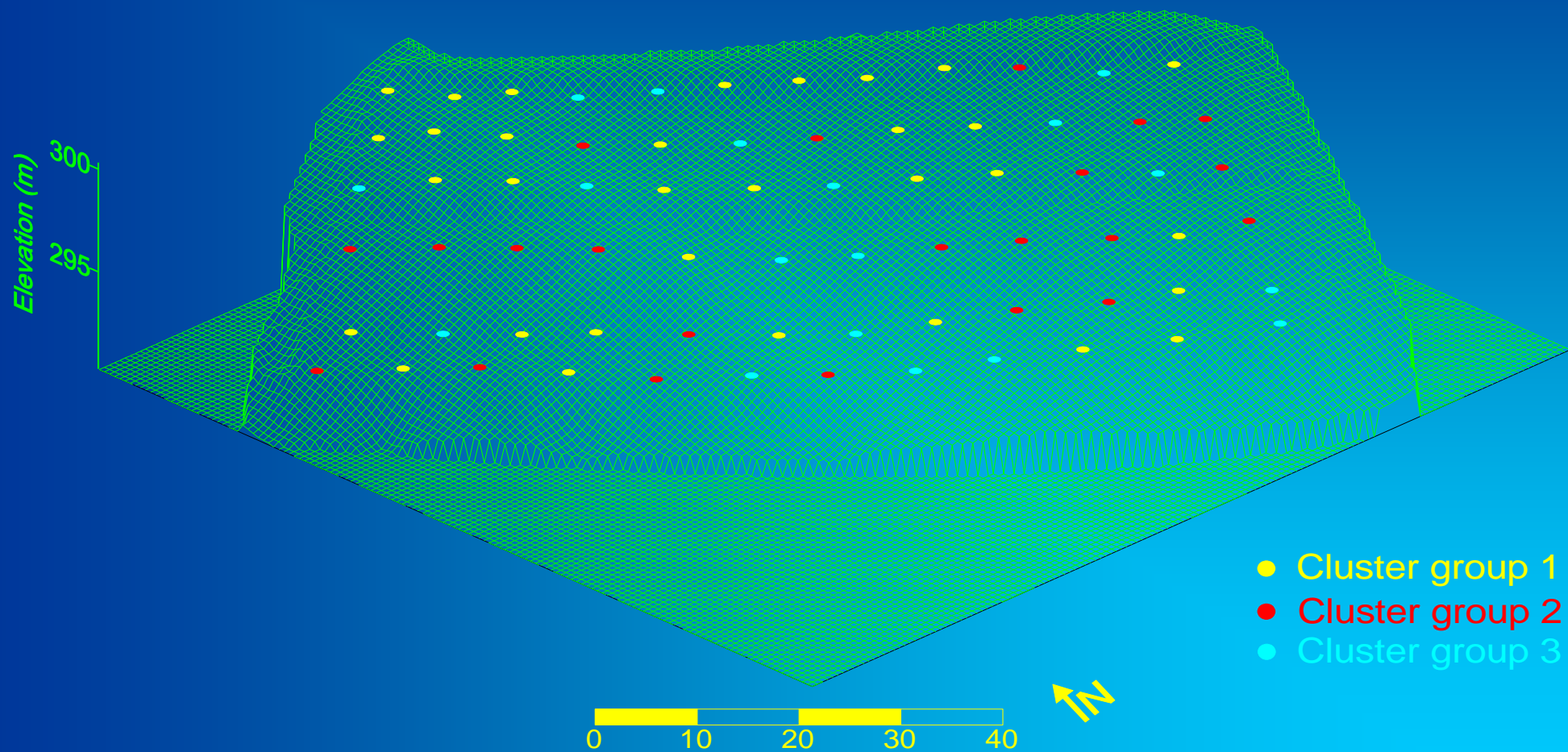












# SUMMARY

- ❑ SOIL EROSION IS A SERIOUS PROBLEM
  - ❑ ENVIRONMENTAL
  - ❑ PRODUCTIVITY
- ❑ CONSERVATION PLANNING MUST BE AN INTEGRAL PART OF ALL OPERATIONS
- ❑ REDUCED EROSION FROM INCREASED RESIDUE AND CONSERVATION PRACTICES
- ❑ PRODUCTIVITY LOSS IS COMPLEX
- ❑ POTENTIAL TO QUICKLY RESTORE PRODUCTIVITY IS LIMITED