Using Soil Tests to Determine Fertilizer Rates

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Ward Laboratories

Fertilizer Recommendation Philosophies

- Deficiency Correction
- Maintenance
- Nutrient removal and balance

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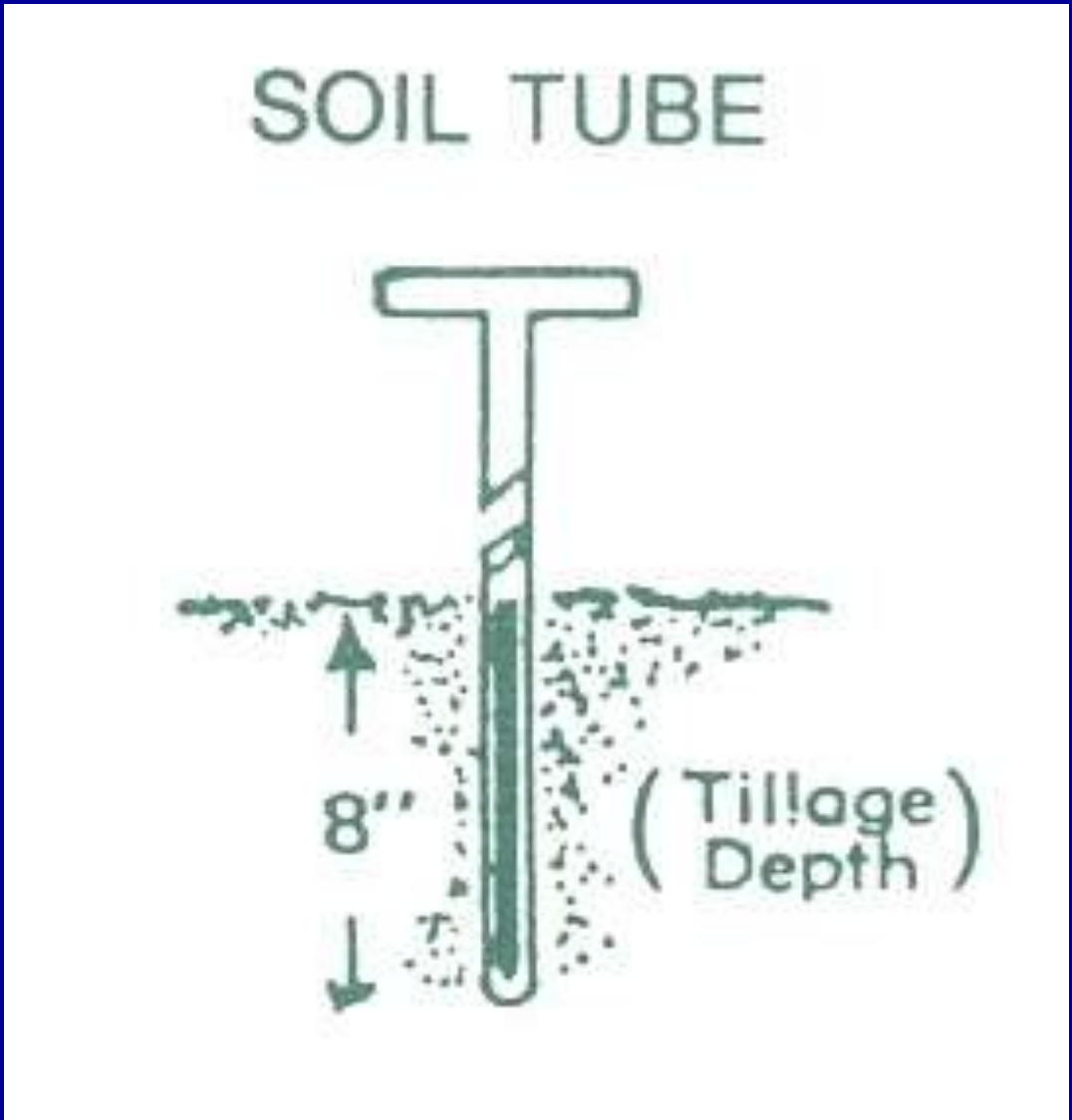
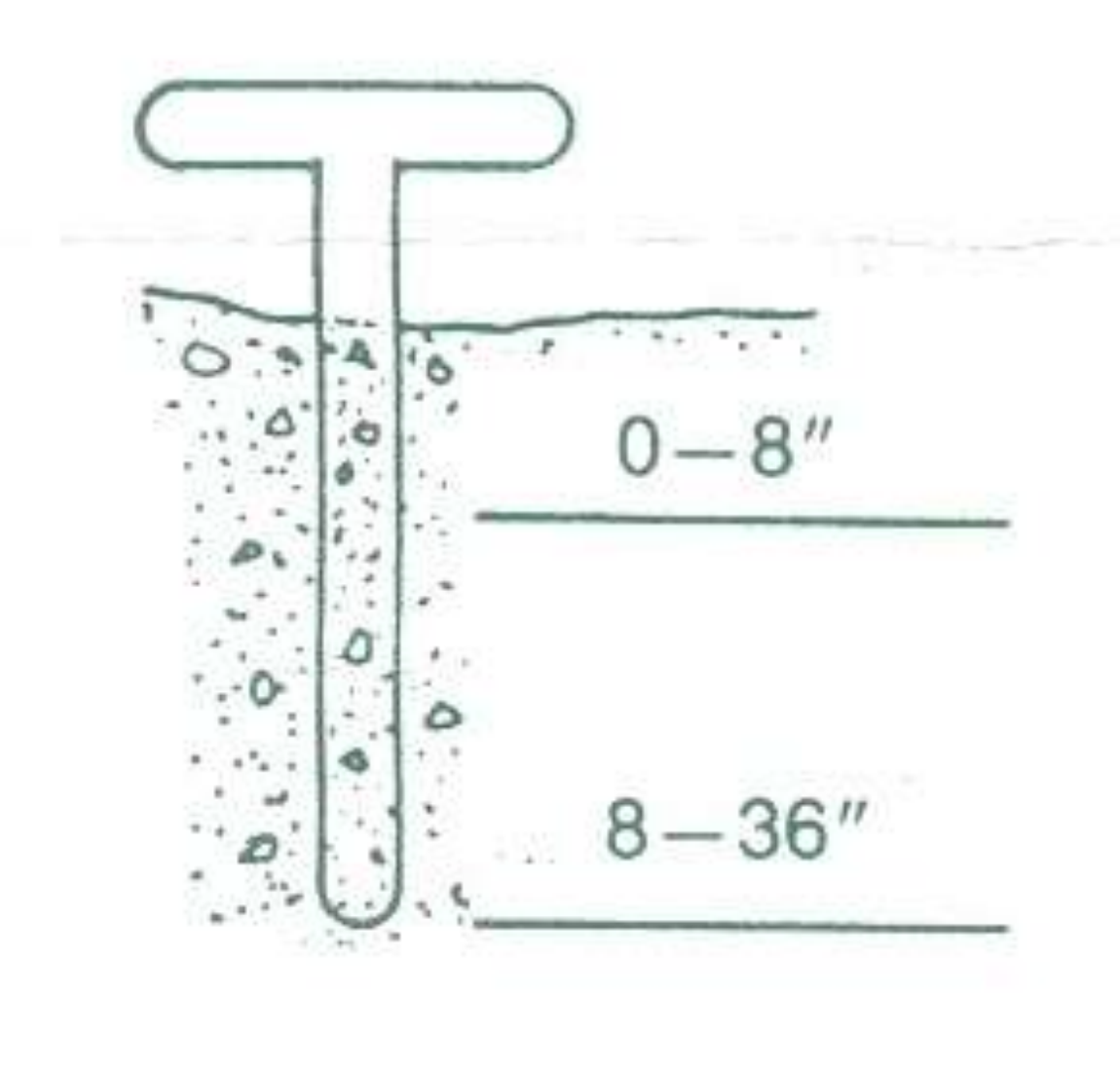
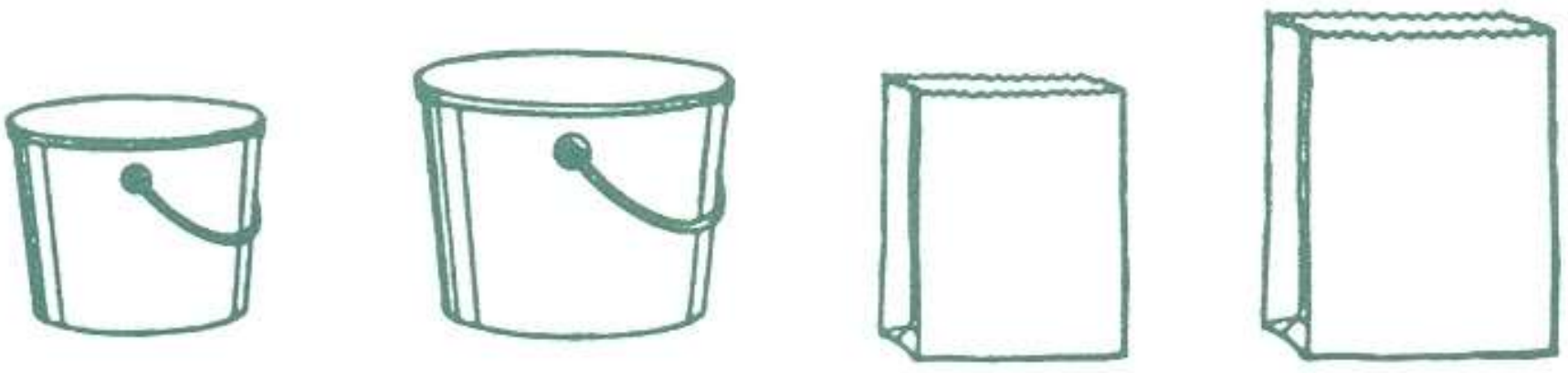
Soil Sample for Fertility



Top and Subsoil Sampling



Clean Buckets and Sample Bags



Top Soil 8”

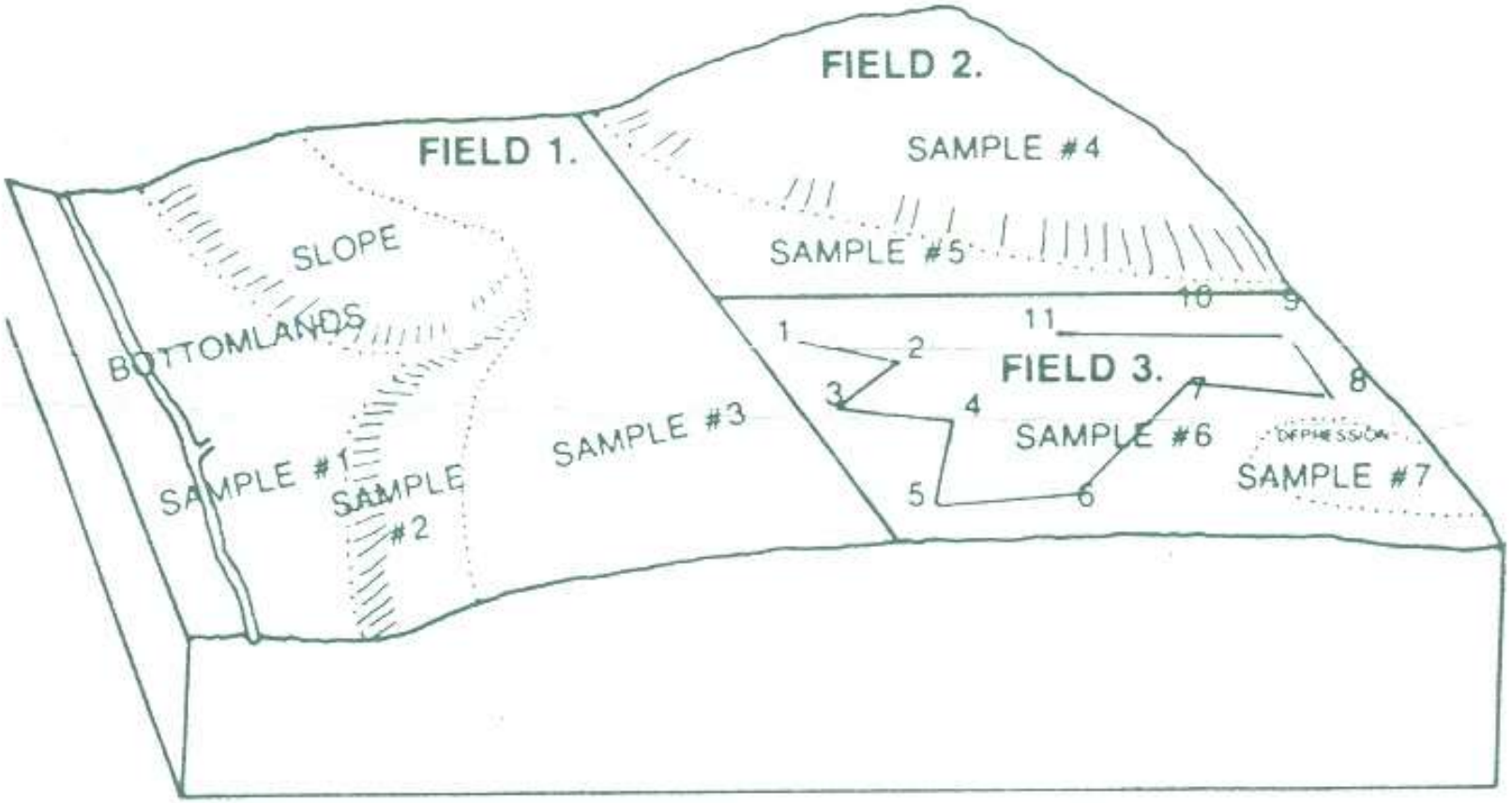
Sub Soil 8-36”

Top Soil Bag

Subsoil Bag

USE PLASTIC PAILS

Field & Zone Sampling



Zone Sampling

- Similar Soil Type
  - Similar Slope
  - Similar Soil Color
  - Same Soil Management
- Sample by Yield Map

Grid Sampling

- New technology using GPS, etc
- Point sampling usually every 2.5 acre
- Measures variability within the field
- Variable rate apply phosphate, potash, zinc and lime

Grid Sampling

– 1 2 3 4 5 6 7 8

– 9 10 11 12 13 14 15 16

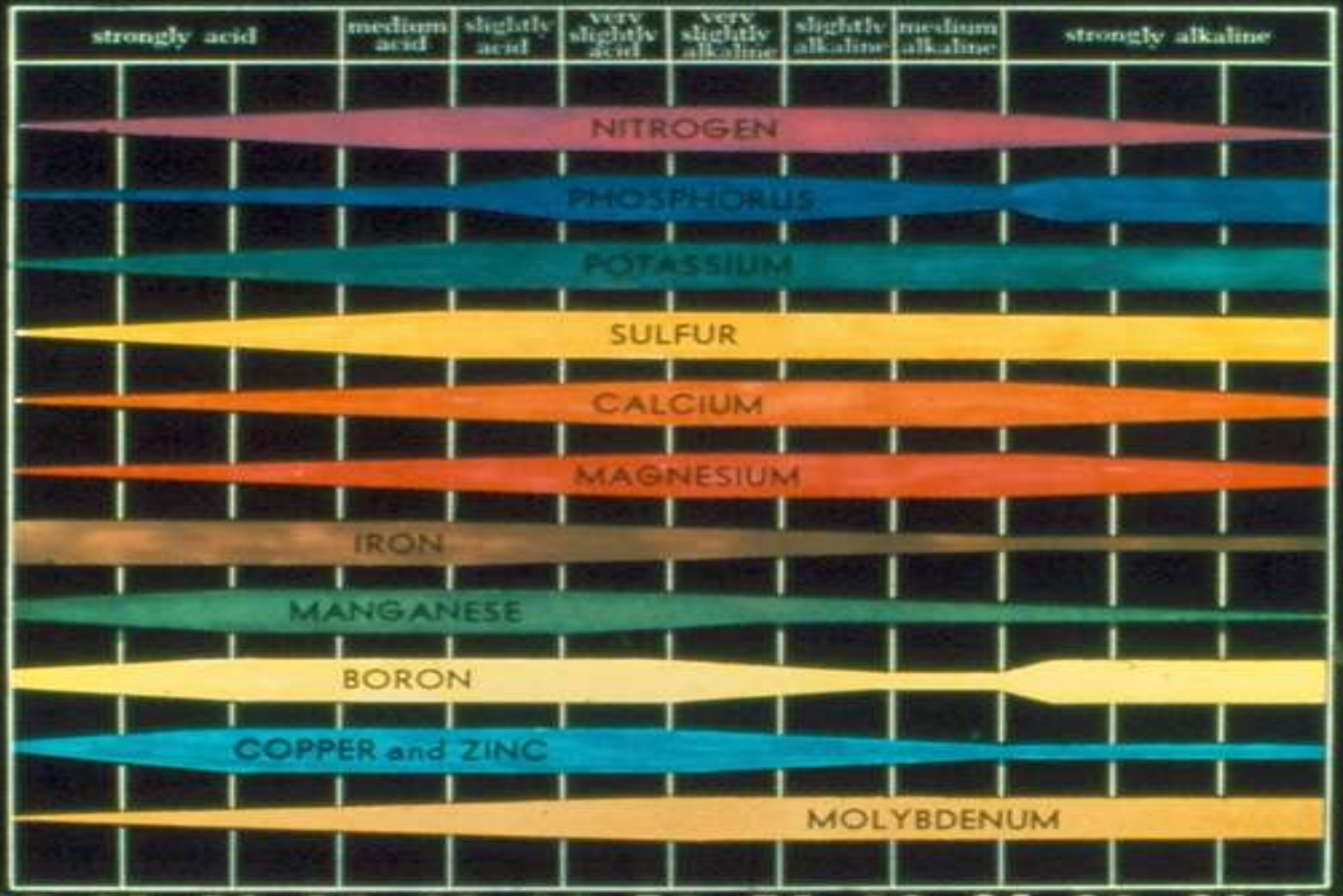
– 17 18 19 20 21 22 23 24

– 25 26 27 28 29 30 31 32

Soil pH (1:1)

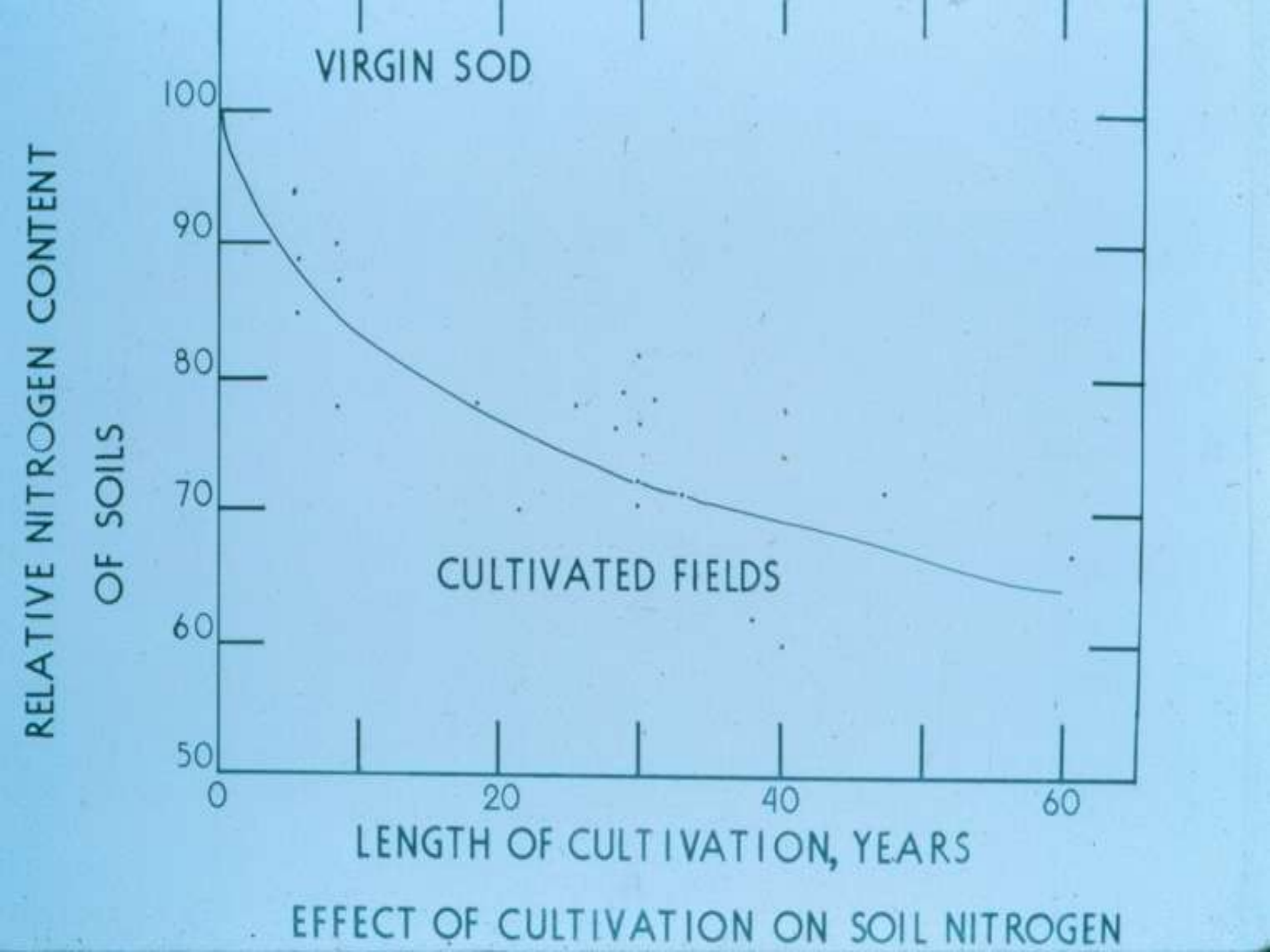
Acid	Neutral	Basic
4.0	7.0	8.5
Strongly acid	pH 4.0 to 5.2	
Moderately acid	pH 5.3 to 5.7	
Slightly acid	pH 5.8 to 6.2	
Neutral	pH 6.3 to 7.2	
Slightly alkaline	pH 7.3 to 7.7	
Strongly alkaline	pH 7.8 to 8.3	

HOW SOIL pH AFFECTS AVAILABILITY OF PLANT NUTRIENTS



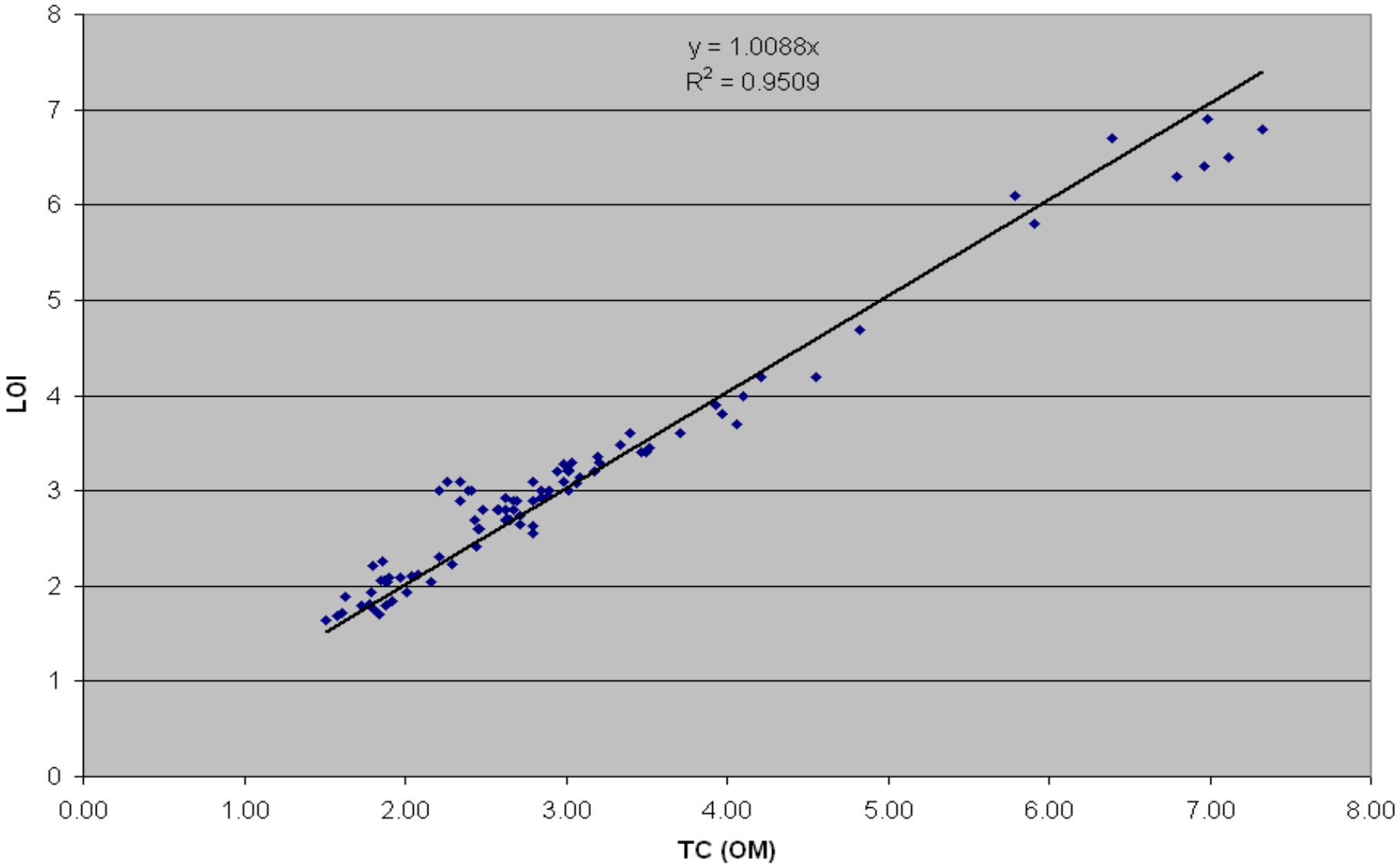
EC (soluble salts) mS/cm

- **Soluble Salts mS/cm (mmho/cm)**
- 0-1.5 No crop hazard
- 1.6-3.0 Yield reduction on sensitive crops
- 3.1-5.5 Moderate yield reduction
- 5.6+ Severe yield reduction

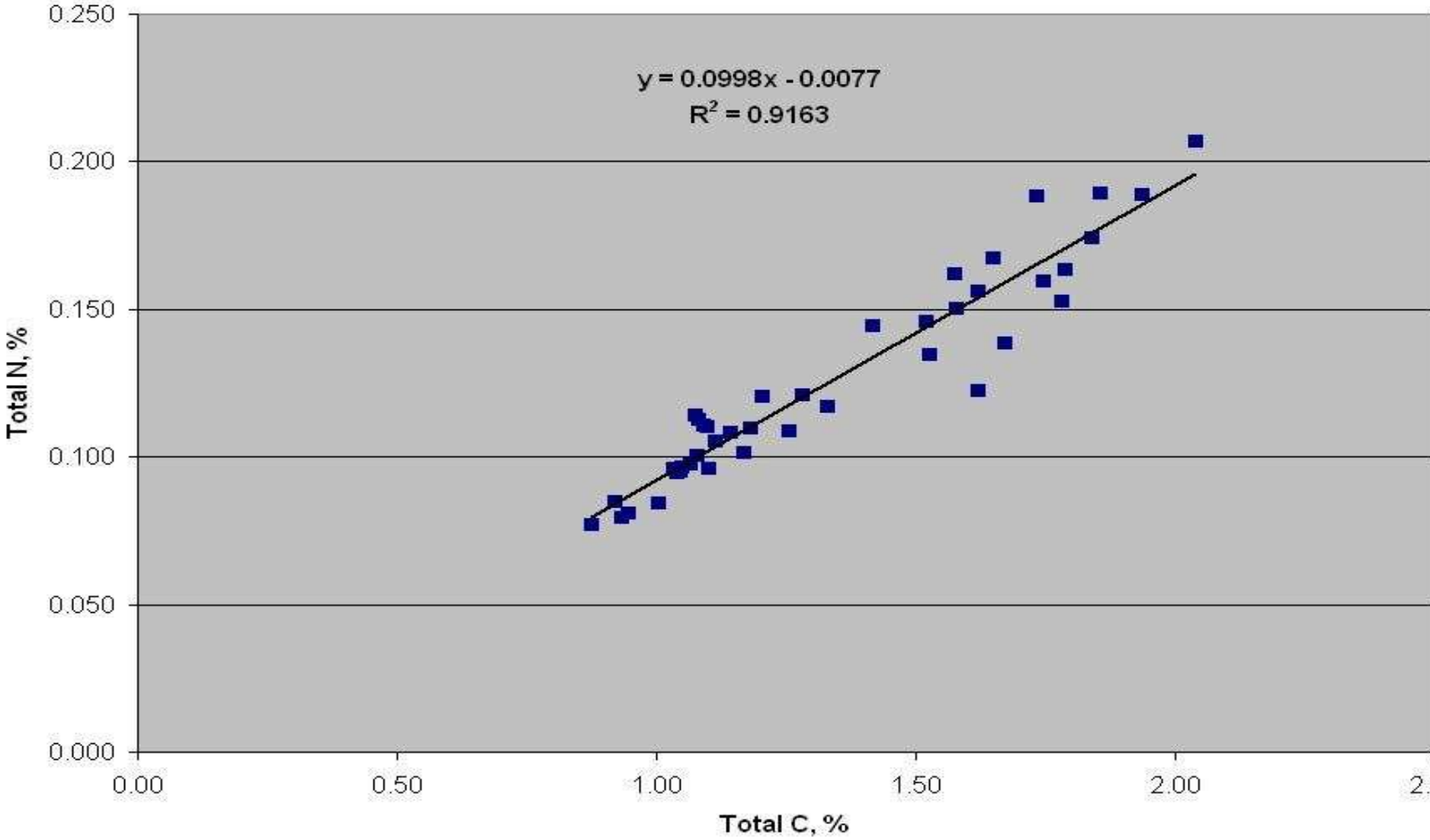


EFFECT OF CULTIVATION ON SOIL NITROGEN

Organic Matter vs Total Carbon



Total N vs Total Carbon



Nitrogen Recommendation

N lbs/A = (yield * N req.) minus

lbs of NO_3-N in 24 or 36” minus

Legume credit minus

Manure credit minus

Irrigation water credit

Nitrogen Requirement

- Corn 1.2 lbs N/Bu
- Wheat 2.4 lbs N/Bu
- Milo 1.1 lbs N/Bu
- Grass 40 lbs N/Ton
- Millet 1.7 lbs N/Bu

Nitrogen Rate (Corn 200 bu/A)

- 200 X 1.2 = 240 lbs of N Required
- 240 – Soil Nitrate (30) = 210
- 210 – Past Soybean Crop (40) = 170
- 170 – Manure Credit or Irrigation Water

Nitrate Soil Test Ratings

- End of Growing Season < 5 ppm NO3-N average for 0-36 inches
  - Potential movement below root zone if higher than 5 ppm
- Iowa Pre-Sidedress Nitrate Test
  - 0-12 inches at 4 to 5 leaf stage <25 ppm NO3-N

Phosphorus Soil Test
Mehlich P-3 or Bray P-1

Soil test ppm P	Rating	% Sufficiency
0-5	Very Low	25-50
6-12	Low	45-80
13-25	Medium	70-95
26-50	High	90-100
51+	Very High	100

Phosphorus Recommendations

Soil test ppm P	Rating	lbs P_2O_5/A
0-5	Very Low	60-140
6-12	Low	35-75
13-25	Medium	20-45
26-50	High	0-30
51+	Very High	None

Potassium Soil Test, Ammonium Acetate Extractable

Soil Test ppm K	Rating	% Sufficiency
0-40	Very Low	20-50
41-80	Low	45-80
81-120	Medium	70-95
121-200	High	90-100
201+	Very High	100

Potassium Recommendations

Soil Test ppm K	Rating	lbs K2O
0-40	Very Low	90-200
41-80	Low	50-120
81-120	Medium	25-60
121-200	High	0-35
201+	Very High	None

Sulfur Soil Test, Ca-P Extractable

Soil Test ppm S	Rating
0-4	Very Low
5-7	Low
8-11	Medium
12-15	High
16+	Very High

Sulfur Requirement

Crop	Yield Unit	LBS of S
Corn	Bushel	0.18-0.26
Soybean	Bushel	0.20-0.29
Wheat	Bushel	0.28-0.35
Alfalfa	Ton	4.7 – 6.3
Grass	Ton	2.2 – 3.6

Sulfur Recommendation Example

Wheat 80 bu/A Yield Goal

Sulfur Requirement is .28 to .35 lb S/bu

Total S Required is 22 to 28 lbs/A

Sulfate Soil Test is 8 ppm S

8 ppm X .3 X 8 inches = 19 lbs S/A

Recommendation is 3 to 9 lbs S/A

Zinc Soil Test, DTPA Extractable

Soil Test ppm Zn	Rating
0-0.25	Very Low
0.26-0.50	Low
0.51-.75	Medium
0.76-1.00	High
1.01+	Very High

Zinc Recommendations

Soil Test ppm Zn	Corrective Rate lb Zn/A
0-0.25	3-12
0.26-0.50	1-7
0.51-.75	0-6
0.76-1.00	0-3
1.01+	None

*Annual rate: Divide Corrective Rate by 6.

Manganese Soil Test, DTPA Extractable

Soil Test Value	Rating
0-0.5	Very Low
0.6-1.0	Low
1.1-1.5	Medium
1.6-4.0	High
4.1+	Very High

Manganese Recommendations

- Foliar Treatment if deficiency is diagnosed with Plant Analysis
  - Manganese 0.5 to 1.0 lb Mn/A in 20 gallon water/A
  - Possible soil treatment of 25 to 50 lbs of manganese sulfate per acre.

Copper Soil Test, DTPA Extractable

Soil Test Value	Rating
0-0.10	Very Low
0.11-0.20	Low
0.21-0.30	Medium
0.31-0.60	High
0.61+	Very High

Copper Recommendations

- Low copper soil test and long term no-till
- 3 lbs of Cu per acre as copper sulfate or
- 1 lb of Cu per acre as copper chelate

Soil Chloride, 24 inch Sample

Rating	Soil Test
Very Low	0-2 ppm Cl
Low	3-4 ppm Cl
Medium	5-6 ppm Cl
High	7-8 ppm Cl
Very High	9+ ppm Cl

From SDSU

Chloride Recommendations

- Cl Rec. =45 – (7.2 * Cl ppm in 24 inches)

  – or

- Cl Rec. = 45 – (Cl ppm * Top Soil Depth in inches * 0.3) – (Cl ppm * Subsoil Depth in inches * 0.3)

Chloride Recommendation

Soil Test, ppm Cl	lbs of Cl/A
< 4 ppm Cl	20 lbs/A
4 – 6 ppm Cl	10 lbs/A

KSU based on average Cl in 0 - 24 inch soil root zone.

Wheat Responses to Chloride

	Wheat yields, bu/A			
Cl rate, lb/A	Yr. 1	Yr. 2	Yr. 3	Yr. 4*
0	37	55	62	77
30	45	61	66	--
60	--	61	69	80
90	--	61	67	--
Soil test Cl:	--	low	low	med-high

*Average of six varieties

Kansas

Crop Nutrient Removal, lbs/Bu

Nutrient	Corn	130 bu/A
Nitrogen, N	0.75	98
Phosphorus, P2O5	0.32	42
Potassium, K2O	0.23	30
Sulfur, S	0.09	12
Zinc, Zn	0.001	0.13
Manganese, Mn	0.0006	0.08
Copper, Cu	0.0004	0.05

Crop Nutrient Removal, lbs/Bu

Nutrient	Milo	130 bu/A
Nitrogen, N	0.81	105
Phosphorus, P_2O_5	0.35	46
Potassium, K_2O	0.25	33
Sulfur, S	0.10	13
Zinc, Zn	0.001	0.13
Manganese, Mn	0.0008	0.10
Copper, Cu	0.0003	0.04

Crop Nutrient Removal, lbs/Bu

Nutrient		Wheat	80bu/A
Nitrogen	N	1.20	96
Phosphorus	P2O5	0.52	42
Potassium	K2O	0.26	21
Sulfur	S	0.12	10
Zinc	Zn	0.003	0.24
Manganese	Mn	0.0002	0.02
Copper	Cu	0.0007	0.06

Crop Nutrient Removal, lbs/bu

	Soybeans	60 bu/A
Nitrogen, N	3.70	222
Phosphorus, P_2O_5	0.77	46
Potassium, K_2O	1.40	84
Sulfur, S	0.37	22
Zinc, Zn	0.002	0.12
Manganese, Mn	0.001	0.06
Copper, Cu	0.001	0.06

Nutrient Recommendations Assuming Low Soil Tests

Nutrient		Calculation for Amount/A
• Nitrogen	N	Removal times 1.2
• Phosphorus	P_2O_5	Crop Removal Rate
• Potassium	K_2O	Ditto
• Sulfur	S	Ditto
• Zinc	Zn	Ditto
• Manganese	Mn	Ditto
• Copper	Cu	Ditto

Nutrient Recommendations Assuming Low Soil Tests

Nutrient		Wheat, 80 bu/A	
		Removal	Recommended
• Nitrogen	N	96	115
• Phosphorus	P2O5	42	42
• Potassium	K2O	21	21
• Sulfur	S	10	10
• Zinc	Zn	0.2	0.2
• Manganese	Mn	0.02	0.02
• Copper	Cu	0.06	0.06

Nutrient Recommendations Assuming Low Soil Tests

Nutrient		Corn, 130 bu/A	
		Removal	Recommended
• Nitrogen	N	98	118
• Phosphorus	P2O5	42	42
• Potassium	K2O	30	30
• Sulfur	S	12	12
• Zinc	Zn	0.13	0.13
• Manganese	Mn	0.08	0.08
• Copper	Cu	0.05	0.05

Nutrient Recommendations Assuming Medium Soil Tests

Nutrient		Calculation for Amount/A
• Nitrogen	N	Removal times 1.2
• Phosphorus	P2O5	½ of Crop Removal
• Potassium	K2O	Ditto
• Sulfur	S	Ditto
• Zinc	Zn	Ditto
• Manganese	Mn	Ditto
• Copper	Cu	Ditto

Nutrient Recommendations Assuming Medium Soil Tests

Nutrient		Corn, 130 bu/A	
		Removal	Recommended
• Nitrogen	N	98	118
• Phosphorus	P2O5	42	24
• Potassium	K2O	30	15
• Sulfur	S	12	6
• Zinc	Zn	0.13	0.07
• Manganese	Mn	0.08	0.04
• Copper	Cu	0.05	0.03

Nutrient Recommendations Assuming Medium Soil Tests

Nutrient		Wheat, 80 bu/A	
		Removal	Recommended
• Nitrogen	N	96	115
• Phosphorus	P2O5	42	21
• Potassium	K2O	21	11
• Sulfur	S	10	5
• Zinc	Zn	0.2	0.1
• Manganese	Mn	0.02	0.01
• Copper	Cu	0.06	0.03

Soil Test Ratings
V Low and Low

- Phosphorus, P 12 ppm
- Potassium, K 80 ppm
- Sulfate, S 7 ppm
- Magnesium, Mg 20 ppm
- Zinc, Zn 0.50 ppm
- Manganese, Mn 1.0 ppm
- Copper, Cu 0.20 ppm
- Boron, B 0.25 ppm
- Chloride, Cl 4 ppm

WARD Laboratories, Inc.

Ag Testing - Consulting

Account No. : 90013

Plant Analysis Report

WARD, RAYMOND & JOLENE
FARM ACCOUNT
2545 E 92ND ST
KEARNEY NE 68847

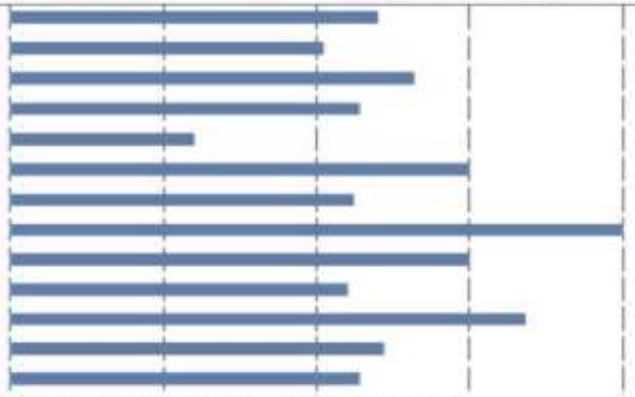
Invoice No. : 1046303
Date Received : 03/05/2008
Date Reported : 03/06/2008

Lab Number : 1044

Results For : GOODSON RANCH LP
Location : NORTH B GOOD
Sample ID : WINTER WHEAT

Plant Type : Wheat
Stage : FEEKES4

	Result Dry Basis	Sufficiency Levels (Deficient / Low / Sufficient / High)
Nitrogen ,% N	4.59	
Phosphorus, % P	0.41	
Potassium, % K	3.02	
Calcium, % Ca	0.44	
Magnesium, % Mg	0.13	
Sulfur, % S	0.35	
Zinc, ppm Zn	32	
Iron, ppm Fe	615	
Manganese, ppm Mn	101	
Copper, ppm Cu	6.0	
Boron, ppm B	14	
Chloride, % Cl	0.73	
Molybdenum, ppm Mo	1.38	



This sample is low in Magnesium. I am not sure if foliar will help. Epsom salts is magnesium sulfate. Apply 2 to 4 lbs of espsom salts per acre as a trial.

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Account No. : 90013

Plant Analysis Report

WARD, RAYMOND & JOLENE
FARM ACCOUNT
2545 E 92ND ST
KEARNEY NE 68847

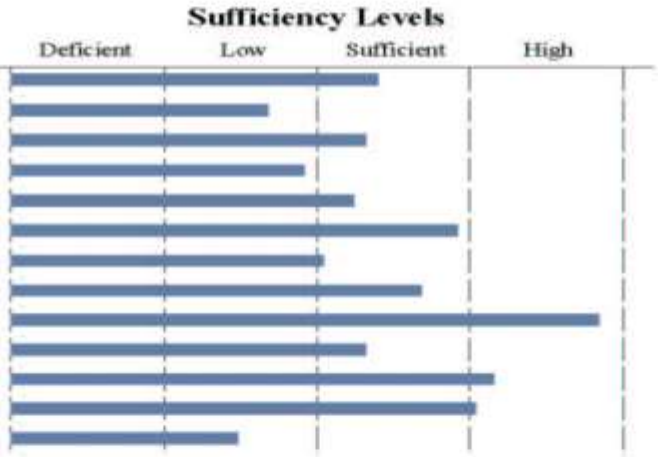
Invoice No. : 1046303
Date Received : 03/05/2008
Date Reported : 03/06/2008

Lab Number : 1048

Results For : JOHN GOODKNIGHT
Location : 20 WEST
Sample ID : WHEAT

Plant Type : Wheat
Stage : FEEKES4

	Result Dry Basis
Nitrogen ,% N	4.60
Phosphorus, % P	0.37
Potassium, % K	2.64
Calcium, % Ca	0.33
Magnesium, % Mg	0.22
Sulfur, % S	0.33
Zinc, ppm Zn	21
Iron, ppm Fe	212
Manganese, ppm Mn	182
Copper, ppm Cu	6.6
Boron, ppm B	12
Chloride, % Cl	1.03
Molybdenum, ppm Mo	0.13



This sample is low in Molybdenum. Use a foliar.

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Plant Analysis Report

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2545 E 92ND ST
KEARNEY NE 68847

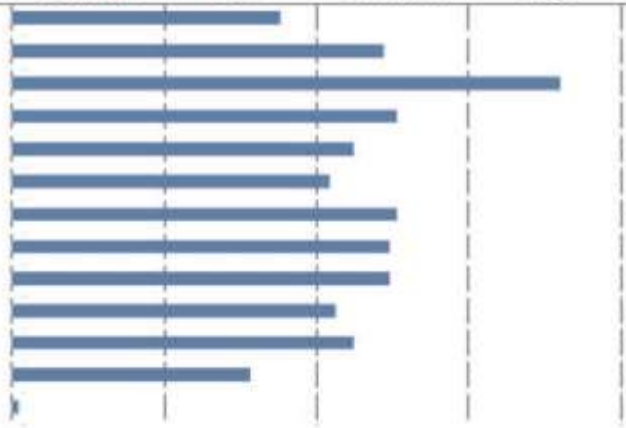
Invoice No. : 1017510
Date Received : 07/09/2007
Date Reported : 07/10/2007

Lab Number : 927

Results For : RAY WARD
Location :
Sample ID : HOME

Plant Type : Soybean
Stage : Flower

	Result Dry Basis	Sufficiency Levels (Deficient / Low / Sufficient / High)
Nitrogen ,% N	4.07	
Phosphorus, % P	0.37	
Potassium, % K	3.53	
Calcium, % Ca	1.04	
Magnesium, % Mg	0.39	
Sulfur, % S	0.19	
Zinc, ppm Zn	35	
Iron, ppm Fe	171	
Manganese, ppm Mn	86	
Copper, ppm Cu	9.0	
Boron, ppm B	31	
Chloride, % Cl	0.04	
Molybdenum, ppm Mo	0.01	



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Plant Analysis Report

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FARM ACCOUNT
2545 E 92ND ST
KEARNEY NE 68847

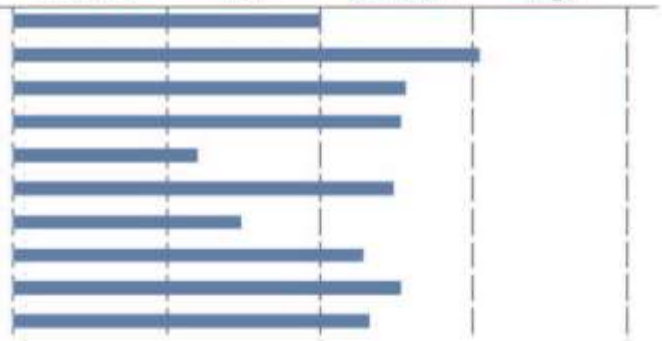
Invoice No. : 1034433
Date Received : 06/30/2008
Date Reported : 07/01/2008

Lab Number : 1734

Results For : RAY WARD
Location : N OF B
Sample ID : CORN

Plant Type : Corn
Stage : 10-14 L

	Result Dry Basis	Sufficiency Levels
Nitrogen ,% N	3.00	
Phosphorus, % P	0.39	
Potassium, % K	2.66	
Calcium, % Ca	0.34	
Magnesium, % Mg	0.11	
Sulfur, % S	0.20	
Zinc, ppm Zn	16	
Iron, ppm Fe	111	
Manganese, ppm Mn	100	
Copper, ppm Cu	9.2	



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Plant Analysis Report

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2545 E 92ND ST
KEARNEY NE 68847

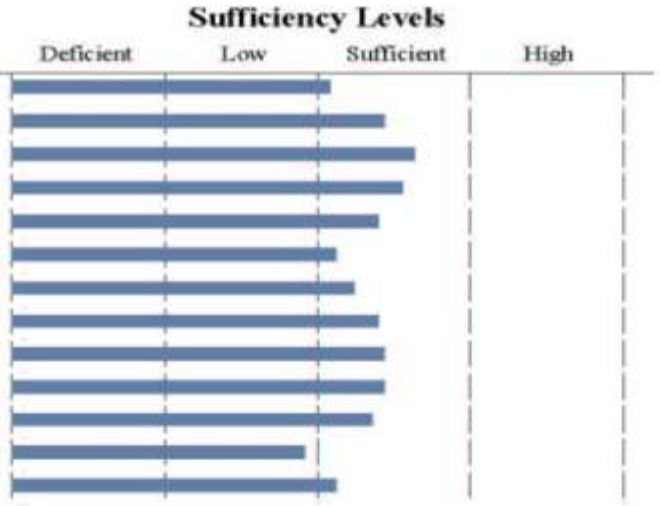
Invoice No. : 1017510
Date Received : 07/09/2007
Date Reported : 07/10/2007

Lab Number : 925

Results For : RAY WARD
Location :
Sample ID : HOME

Plant Type : Corn
Stage : Tassel

	Result Dry Basis
Nitrogen ,% N	2.78
Phosphorus, % P	0.29
Potassium, % K	2.39
Calcium, % Ca	0.56
Magnesium, % Mg	0.22
Sulfur, % S	0.15
Zinc, ppm Zn	28
Iron, ppm Fe	134
Manganese, ppm Mn	76
Copper, ppm Cu	11.3
Boron, ppm B	12
Chloride, % Cl	0.10
Molybdenum, ppm Mo	0.72



Sulfur in Wheat

Sulfur Deficiency - Corn


Zinc deficiency

Zinc Deficiency Wheat

Zinc Deficiency Wheat

Copper Deficiency Wheat