Soil Test Laboratory Analysis and Fertilizer Recommendations

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Key Messages

- Soil test laboratories provide a critical step in management decisions of nutrients for optimum crop production, however the best analytical process can not compensate for poor sample collection and handling.
- Laboratory methods, calibrations and recommendations must be based on local (Alberta or western Canada) research.
- Soil test methods will vary among laboratories and in their ability to measure crop available nutrients.
- Calibration of soil test methods and recommendations can be influenced by soil properties (soil pH, texture, seedbed moisture), agro-climatic zones and cropping systems.
- AFFIRM will provide access to 4R Nutrient Stewardship for a range of laboratory soil test methods.

A Good Nutrient Soil Test

- Needs extensive field and laboratory research.
- Needs to provide a measure of the nutrient proportional to what a plant utilizes for a wide range of soils.
- Able to identify responsive vs non-responsive soils based on soil test critical level and/or other related properties.
- Able to predict nutrient application rate for responsive soil.
- Able to identify excessive nutrient levels.

Limits of a Nutrient Soil Test

- One-time snap-shot of nutrient levels that must be able to take the entire crop growing season into account.
- Misconception – nutrient measure equals availability; Soil analysis is an index of nutrient levels in the soil.
- Requires continuous verification, evaluation and updates.
- Field research related to management changes crops, varieties, nutrient sources, rates, time of application, placement, tillage, etc.
- Laboratory improvements: procedures, detection limits, multiple nutrient extraction

Soil Testing Recommendation Process

- **Extraction and Chemical Analysis**
  To extract "available" forms of nutrients. The values extracted this way have no absolute meaning, i.e., they are only indices and as such they must be calibrated against yield.

- **Correlation and Interpretation**
  The process whereby the "indices" derived from extraction and chemical analysis are calibrated against plant growth or nutrient uptake.

- **Fertilizer Recommendation**
  The process whereby the "calibrated indices" are applied to providing a fertilizer recommendation using crop response curves or production models.

Soil Test Calibration

- Nutrient soil test laboratory methods must be calibrated with crop yield response across many different soil types
- May use crop nutrient removal
- Often regionally specific
- Costly and time consuming

Soil Test Interpretation

Interpretation directly related to philosophy and subsequent recommendation.

Philosophies

- Sufficiency – Deficiency Correction:
  Deficient, Marginal, Adequate, Excessive, Toxic
- Replacement - Crop Removal:
  Uses target yield goals for nutrient requirements
- Build and Maintenance:
  Application of nutrients in excess of crop removal
- Base Cation Saturation Ratio (BCSR):
  Maximum yield is only achieved by creating an ideal ratio of soil calcium, magnesium and potassium.

Laboratory Soil Test Questions

- Soil test methods will vary among laboratories. What chemical extractant is used for the soil nutrient analysis? Is it appropriate for your area?
- Determination of fertilizer required for sufficiency? What is the source of the data gathered to assess how much fertilizer would be required?
- What method of supplying the fertilizers is used? Some labs consider the fertilizer is applied by broadcast application, others banding – are you broadcasting or banding?

Soil Testing Laboratory Objectives

- Maintain high analytical standards – Participate in the North American Proficiency Testing or equivalent program.
- Identify soil related problems (fertility, salinity, pH) that may be limiting yields.
- Analytical results to formulate a fertilizer recommendation.
- Timely sample turnaround.
- Agronomic and environmental limits.




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Quality Control/Quality Assurance

- The goal of the Analytical Laboratory QA/QC Program is to guarantee the generation of precise and accurate analytical data.
- Includes: Standard operating procedures (SOPs), Training, Reliable and well-maintained equipment, Traceability, Annual QC results review, QC samples.
- Soil Analytical Process Contains Errors:
  - 80% due to the soil
  - 20% due to the analytical equipment

Laboratory Analysis - Soils

- NO_3-N
- PO_4-P
- K
- SO_4-S
- pH
- Salinity (E.C.)

- Micronutrients (Cu, Zn, Mn, Fe, B, Cl)
- Organic Matter
- N Mineralization
- Soluble salts
- Cation Exchange Capacity
- Particle size (texture)

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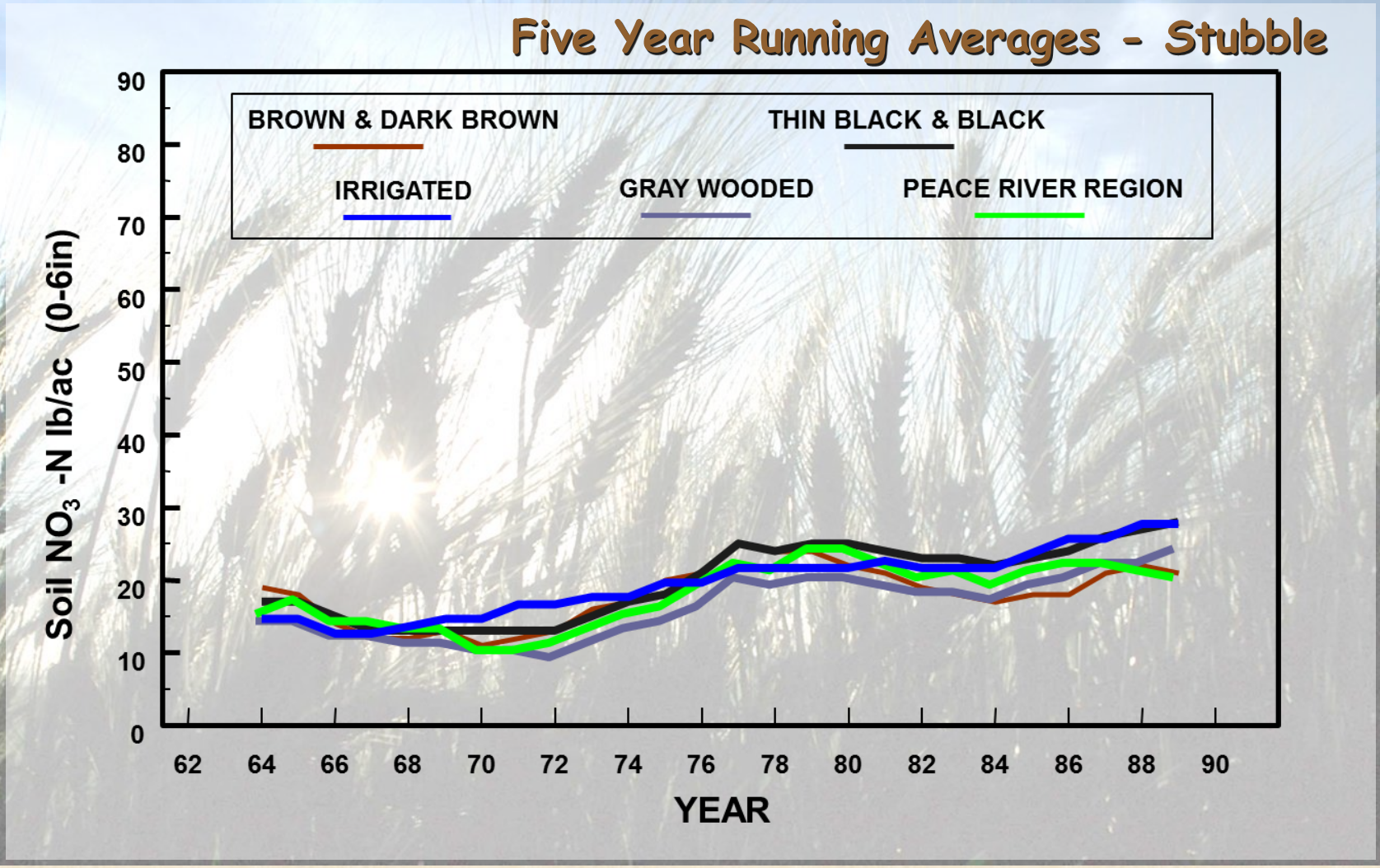
Soil Test Nitrate



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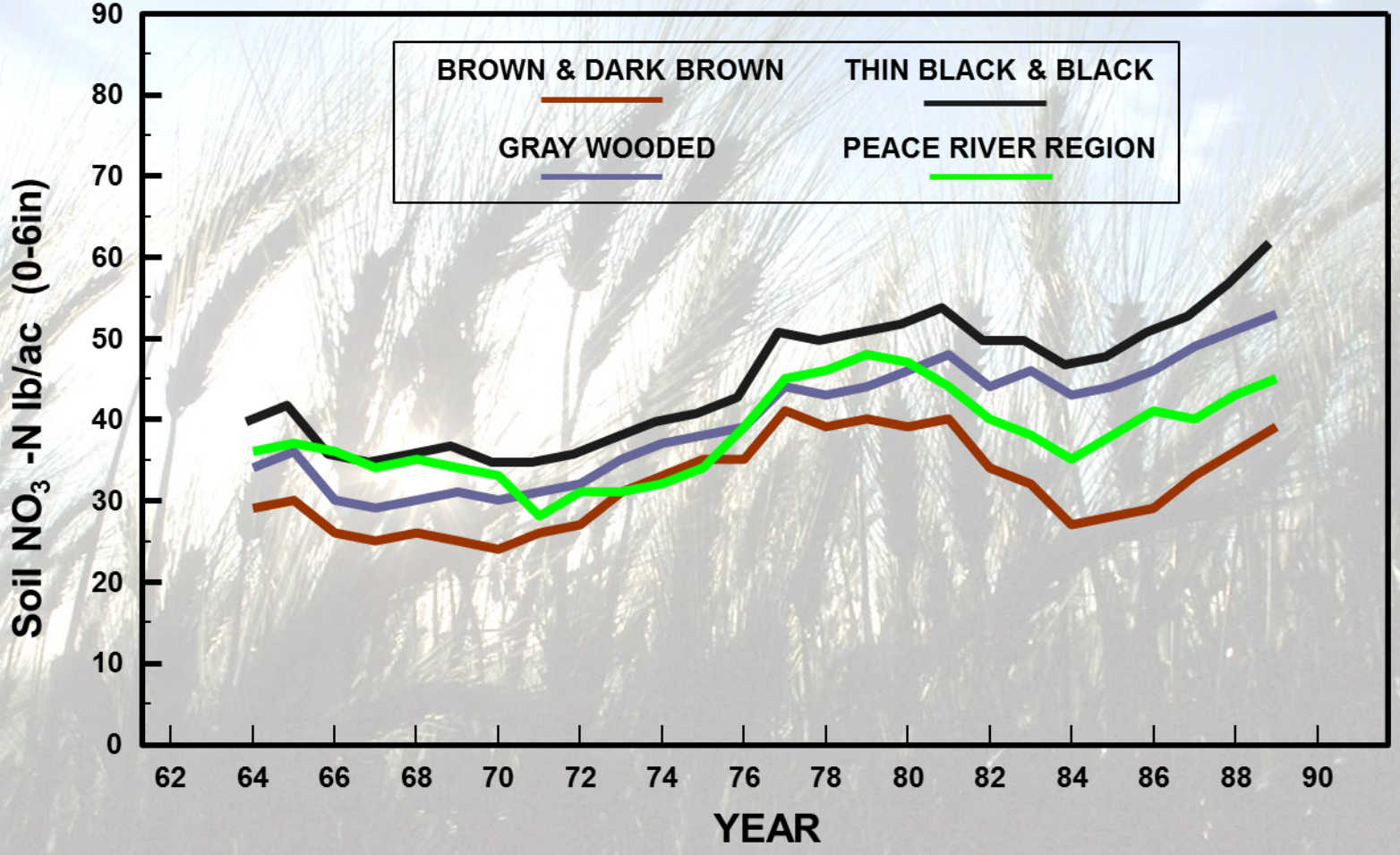
Soil Test Nitrate

Five Year Running Averages - Fallow



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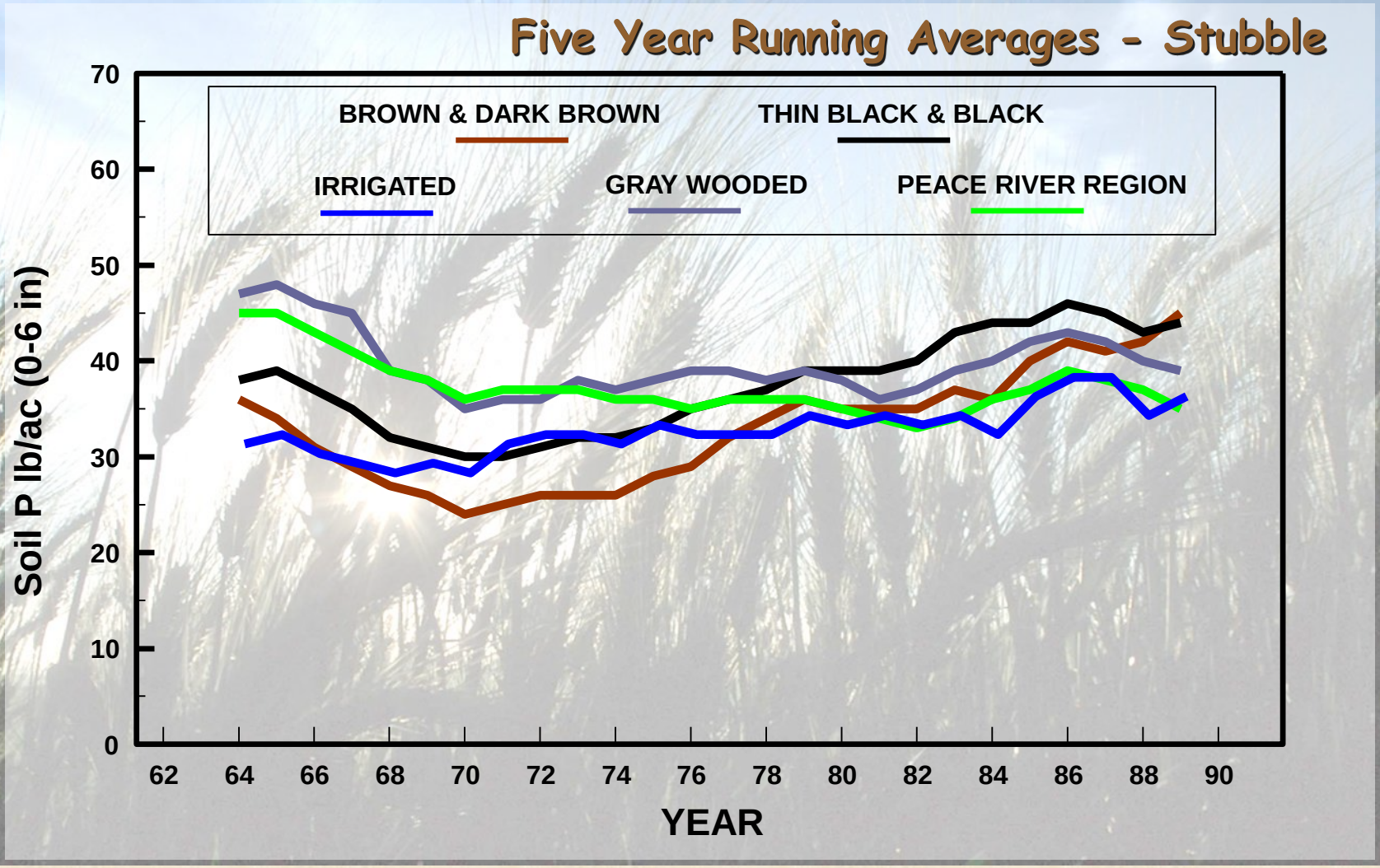
Soil Test Phosphorus



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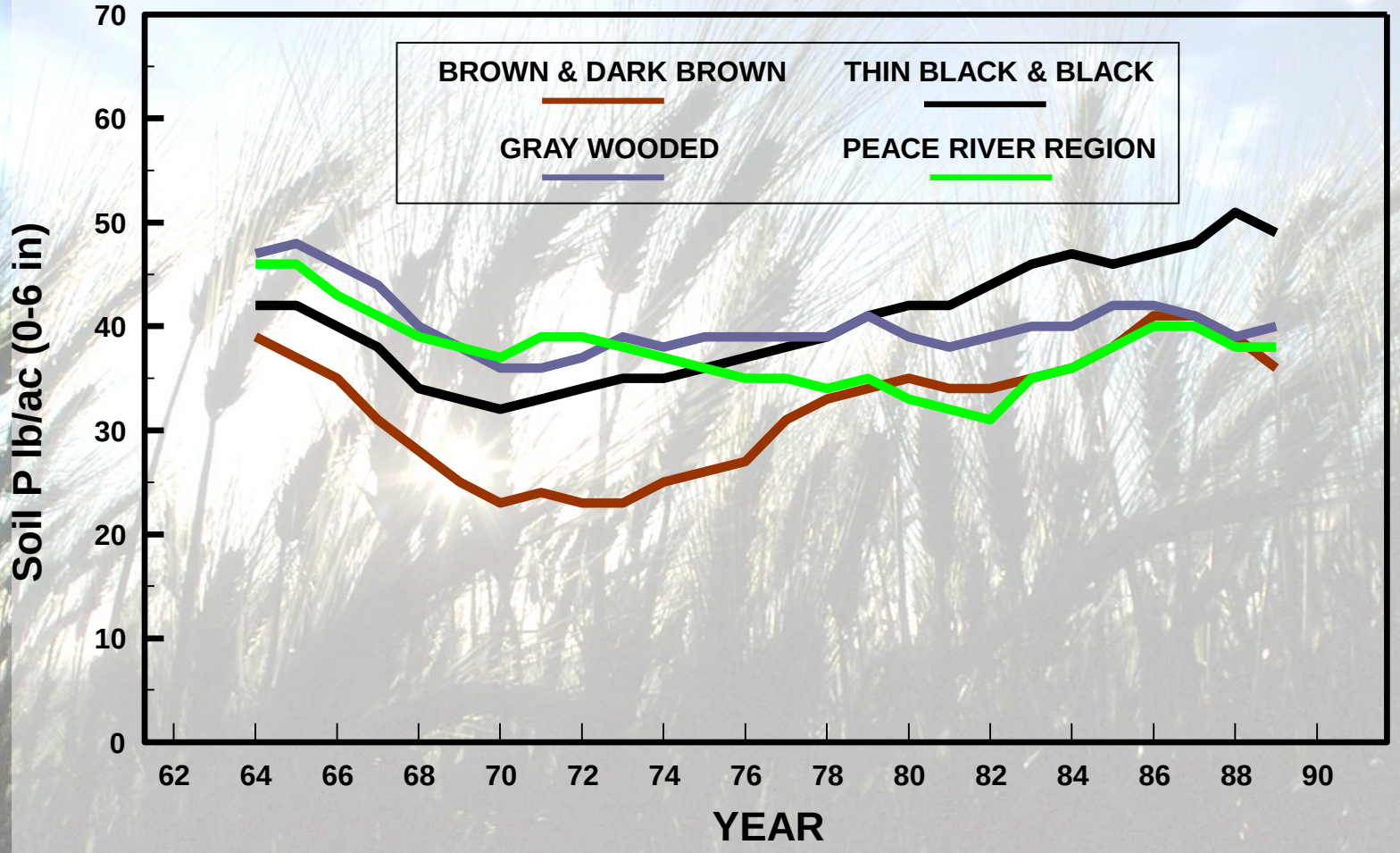

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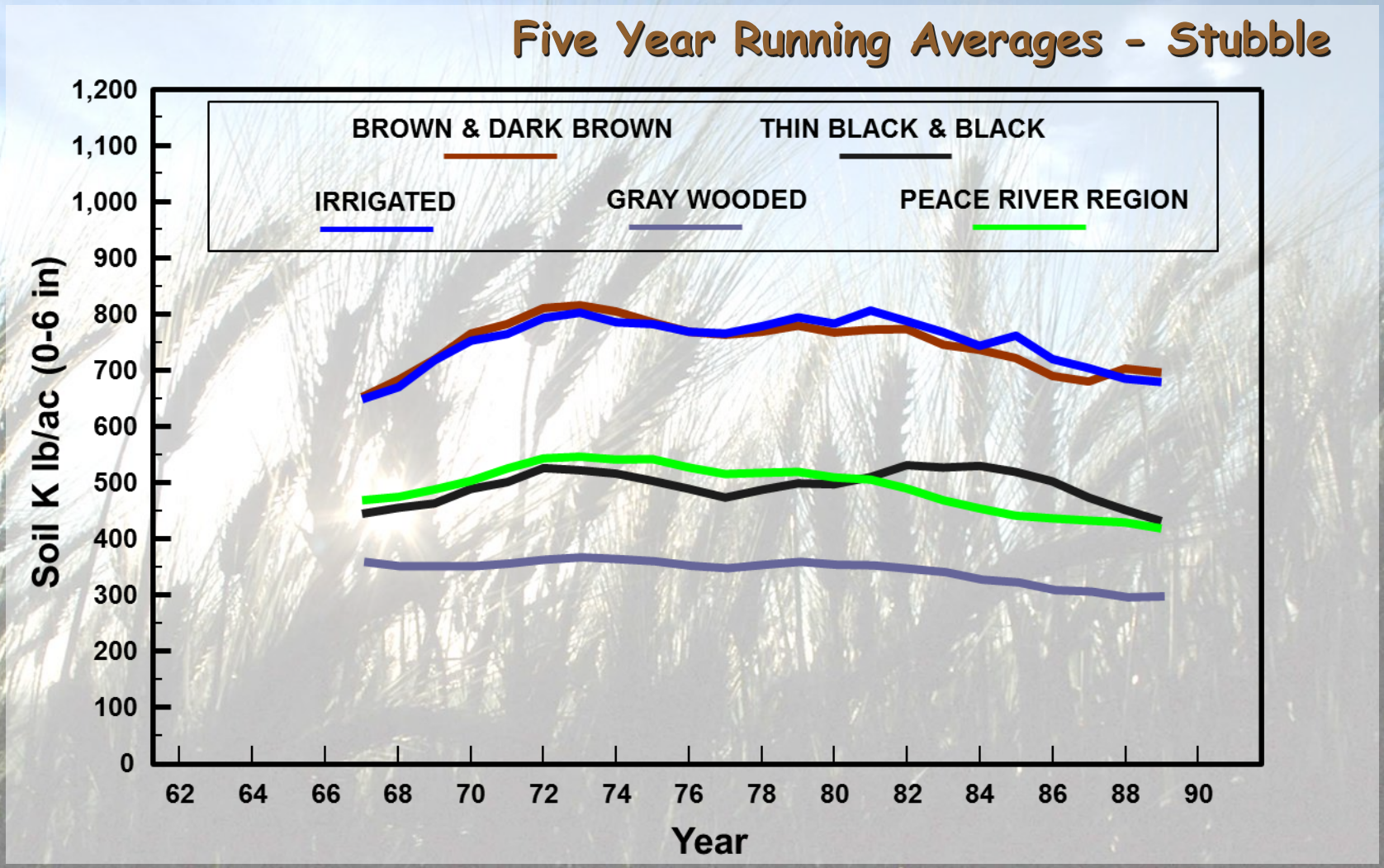
Soil Test Potassium



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Soil Test Potassium

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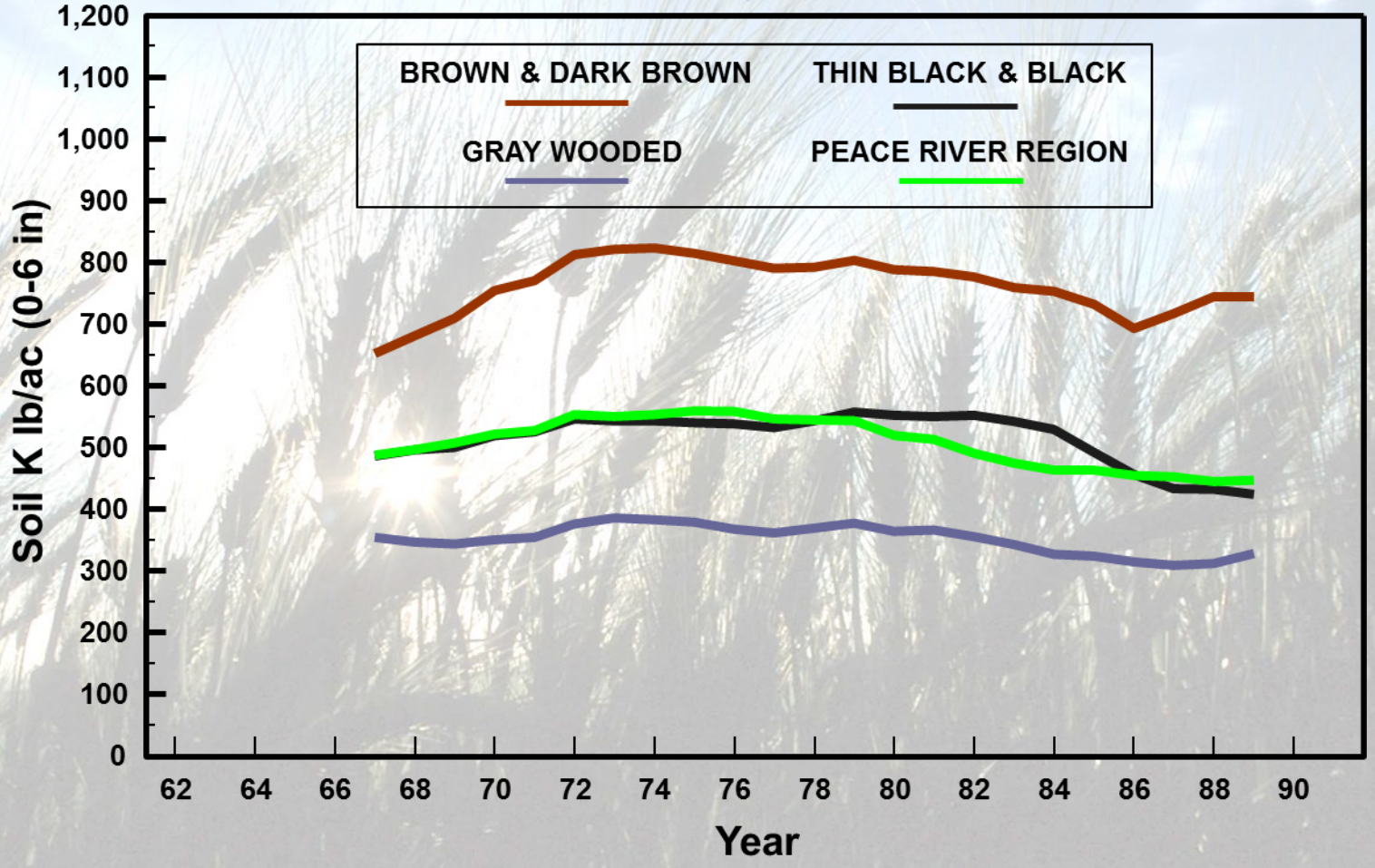

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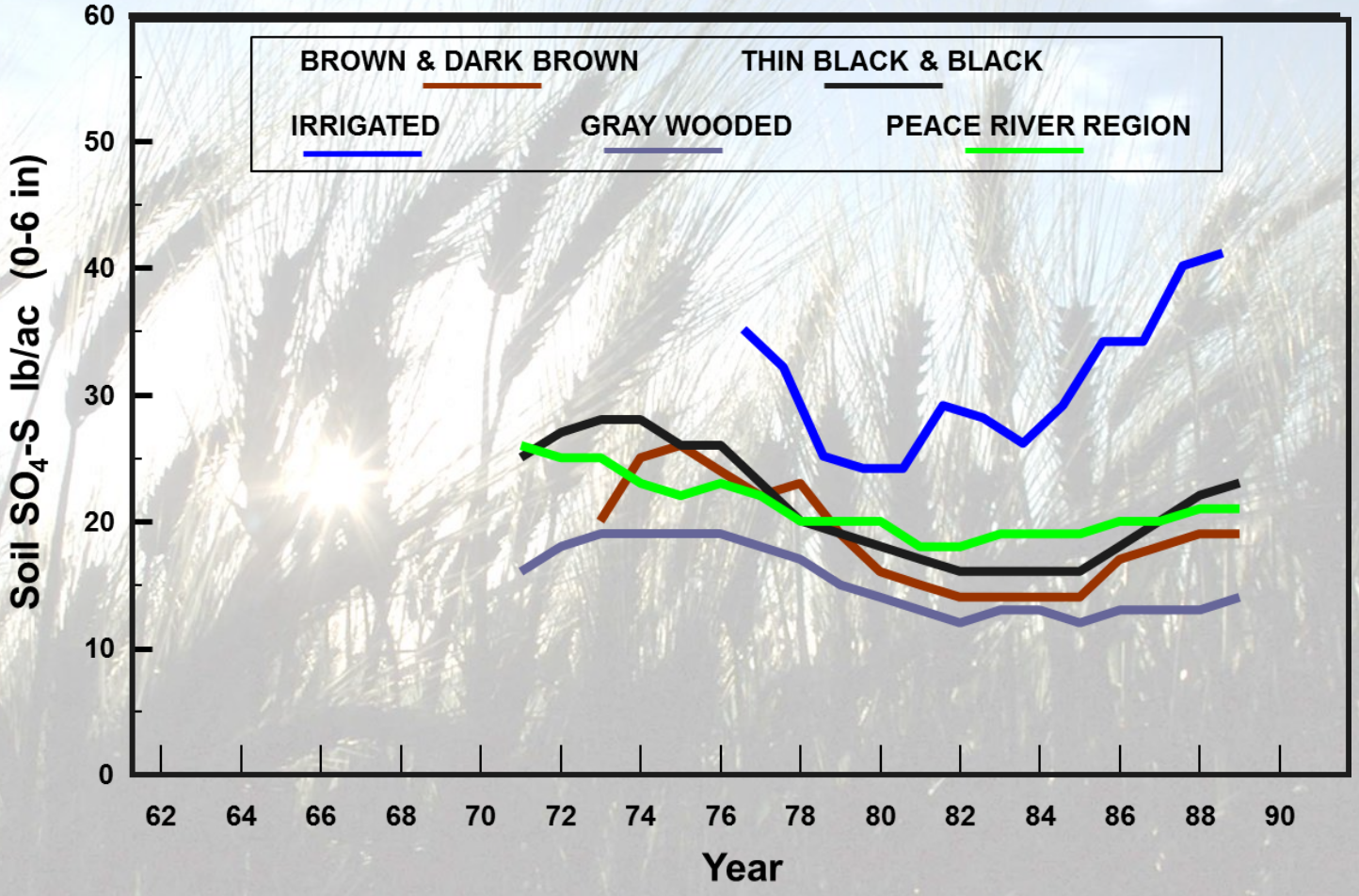
Soil Test Sulfate

Five Year Running Averages - Stubble



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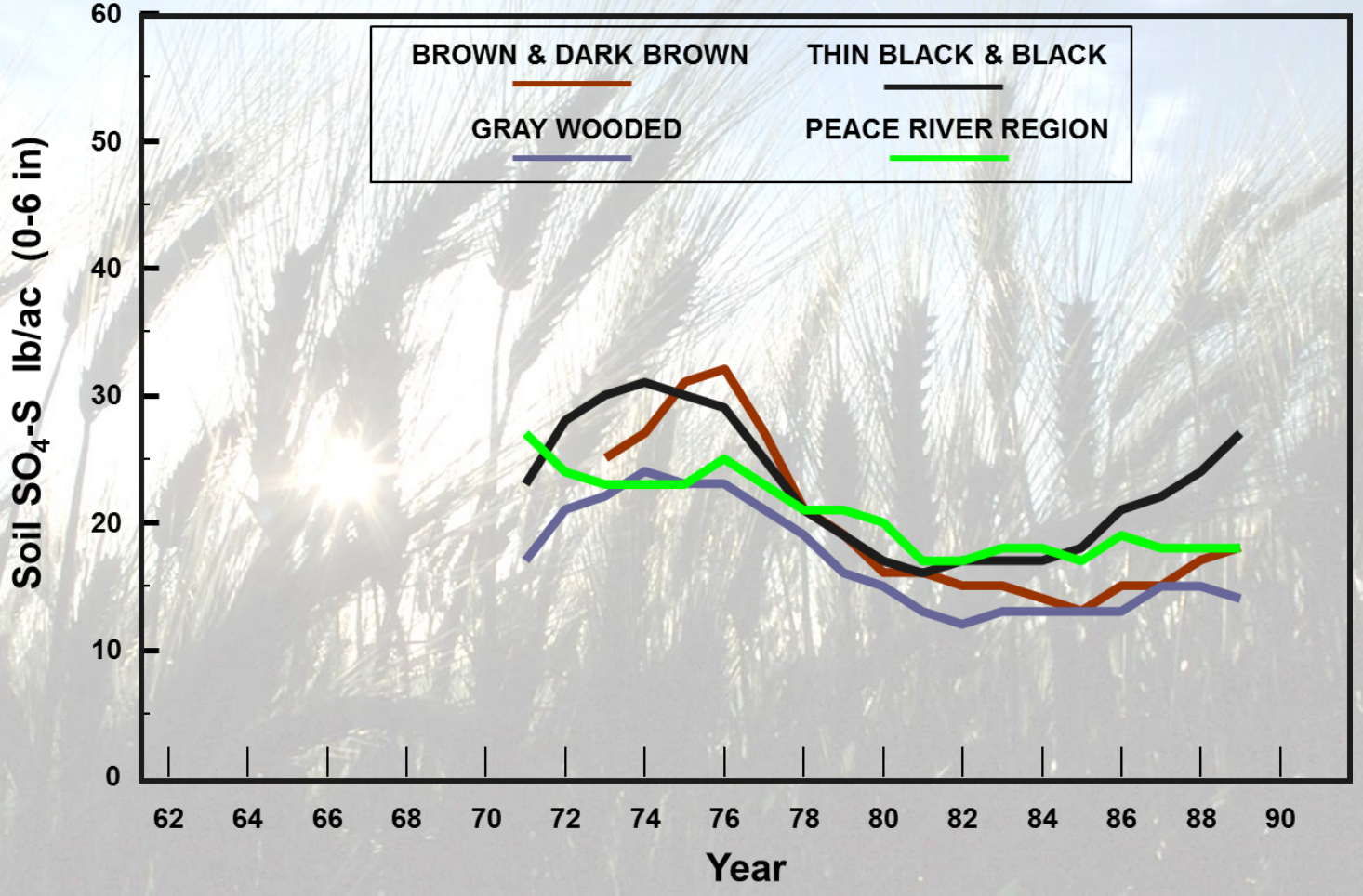

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Soil Test Calibration Research

Field trials - Variables:

- Crops, varieties, fertilizer products, time of application, fertilizer placement, tillage
- Regions - soil types, climate, soil moisture, irrigation
- Soil samples

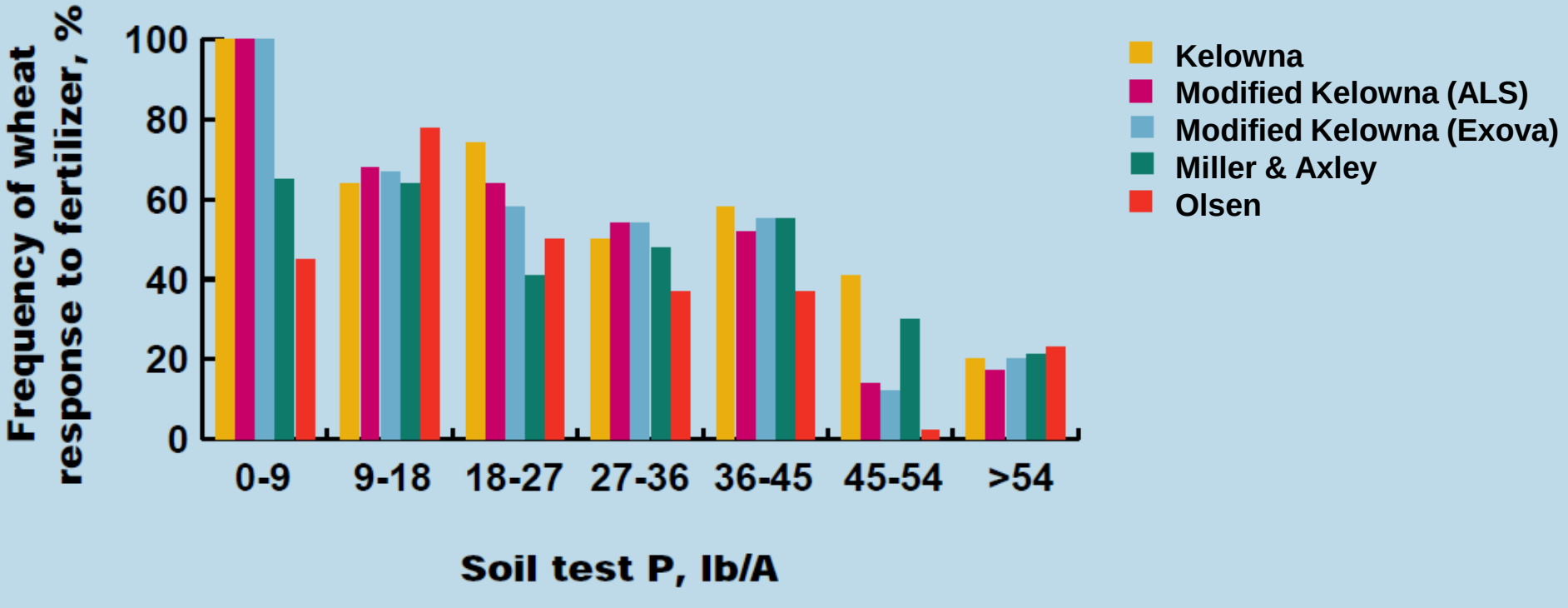
Laboratory soil test methods - Chemistry:

- Chemical extraction solutions
  - Acids, bases, neutral salts
  - Anion and cation displacement

Correlation - How good is the relationship:

- Crop response – Fertilizer rate relationship
- Soil test - Crop response relationship
- Soil test – Fertilizer rate relationship
- Linear, Non-linear, Spline, etc
- As the soil test increases, the recommended fertilizer rate decreases

Soil test P calibration trials in Alberta



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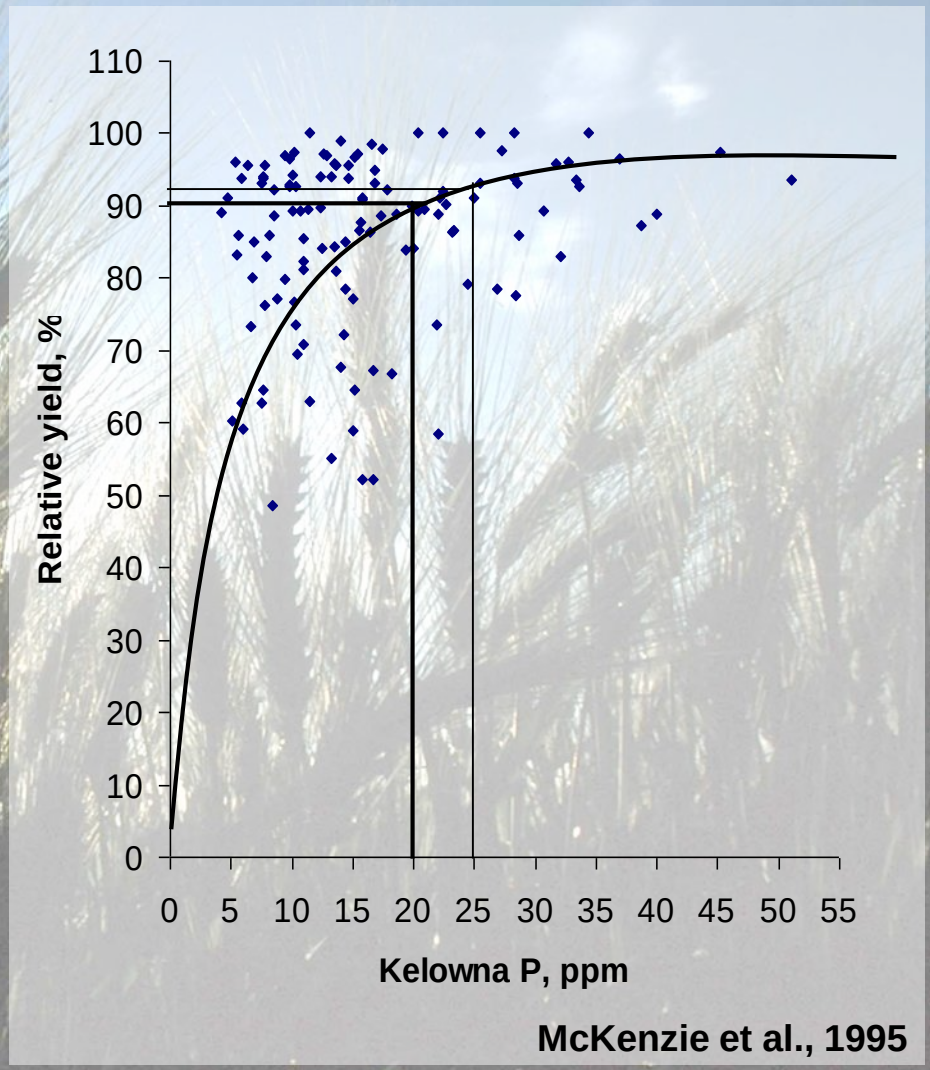
Sufficiency Soil Test P Level for Canola

- Calibration curve indicates which soil test levels tend to limit yields.
- The results of this calibration data set from Alberta show a critical level (sufficiency) of 20 to 25 ppm (40 to 50 lb/ac) P.
- This is the level of soil test P above which minimal response to applied P can be expected.



McKenzie et al., 1995

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Phosphorus Soil Tests

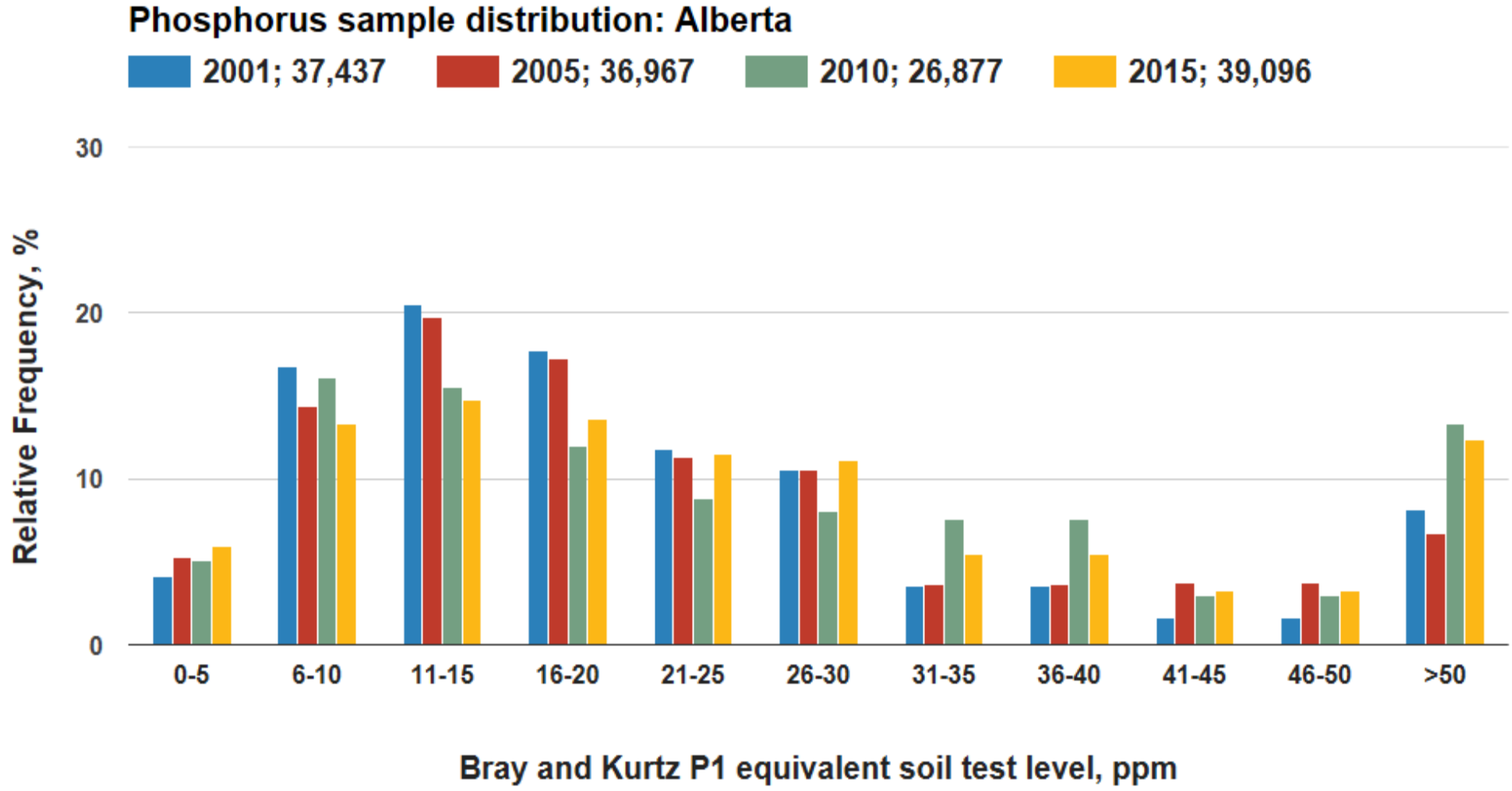
Calibrated in Western Canada Field Studies

- Miller Axley
- Olsen (bicarbonate)
- Kelowna
- Modified Kelowna (Exova, ALS)

Not Calibrated in Western Canada Field Studies

- Bray I (weak), Bray II (strong)
- Mehlich-1, Mehlich-2, Mehlich-3
- Morgan
- Many others

IPNI Soil Test Summary



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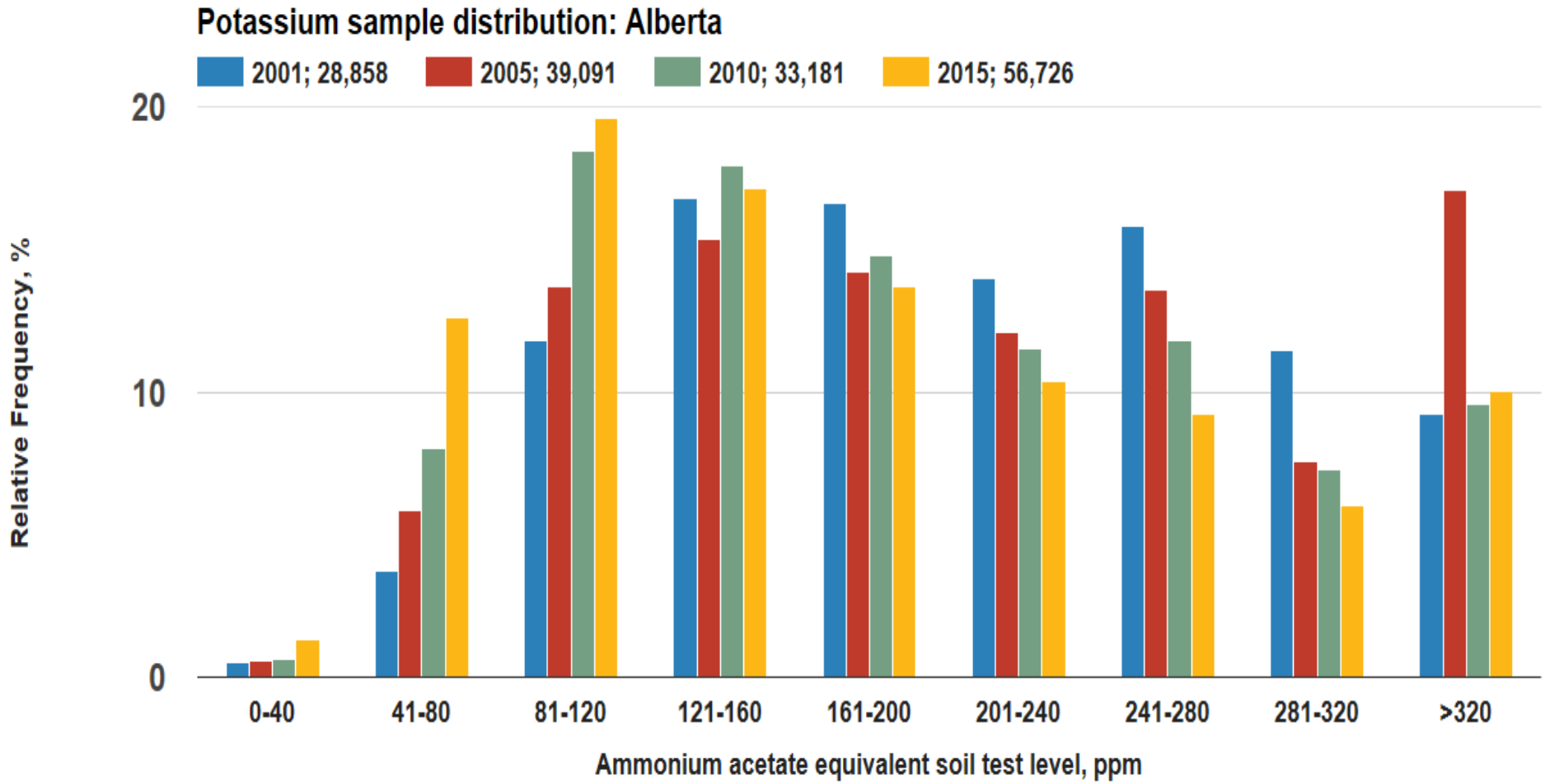

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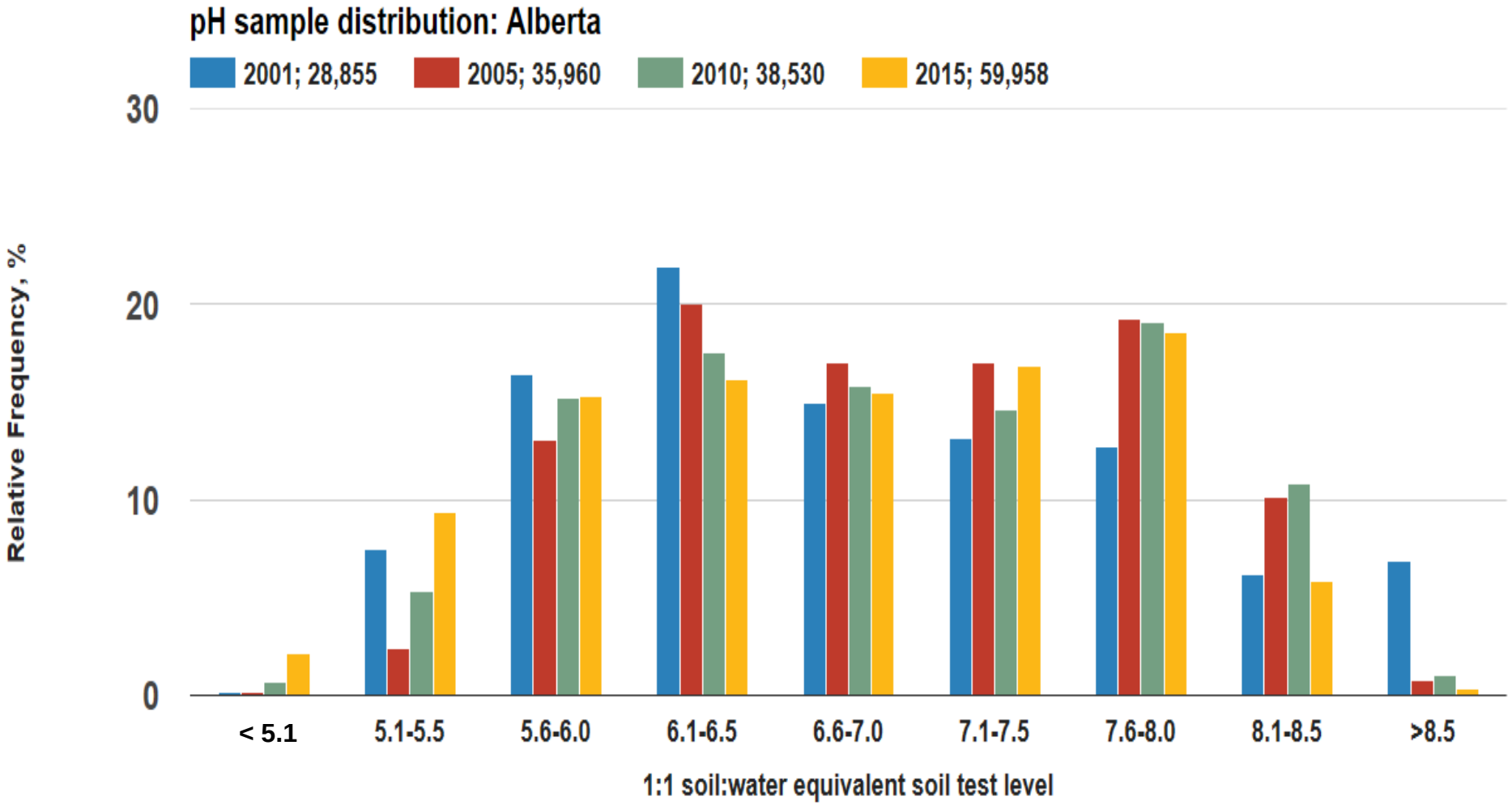

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Today's Laboratory Challenge

The challenge today in the selection of a soil extractant is to select ones that accommodates several factors:

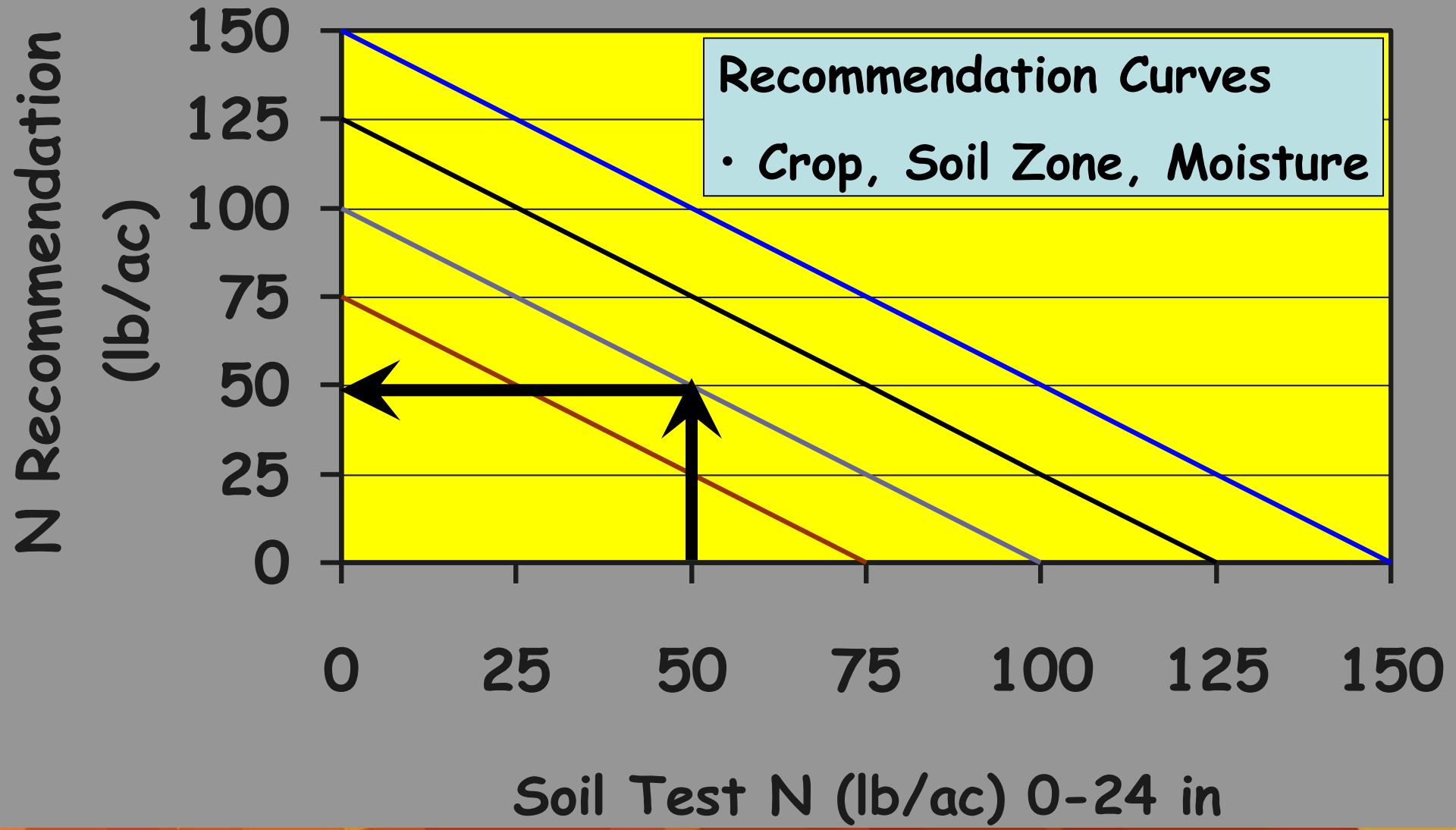
- multielement in order to take full advantage of multielement analyzers, such as the ICP,
- suitable for a range of soil characteristics, such as pH, texture, organic matter content, etc.,
- have an established significant relationship between elemental level and crop response.

Nutrient Recommendations

Factors Influencing Recommendations

- Soil Nutrient Level
- Crop
- Agro-Climatic Zone
- Growing Season Precipitation
- Soil Texture
- Soil Moisture
- Soil Organic Matter
- Soil pH
- Soil Salinity

Nitrogen Fertilizer Recommendation



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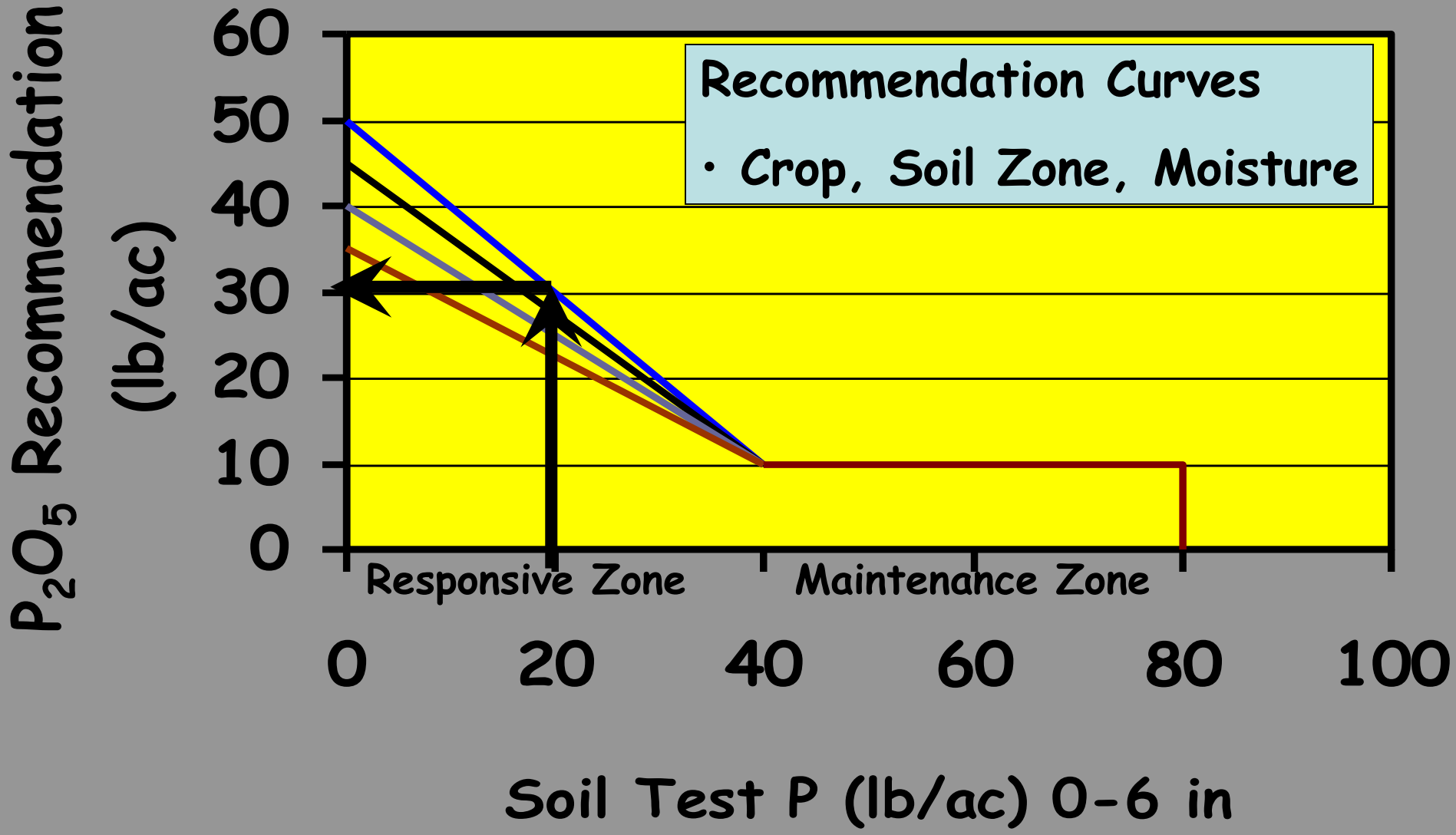
Phosphate Fertilizer Recommendation



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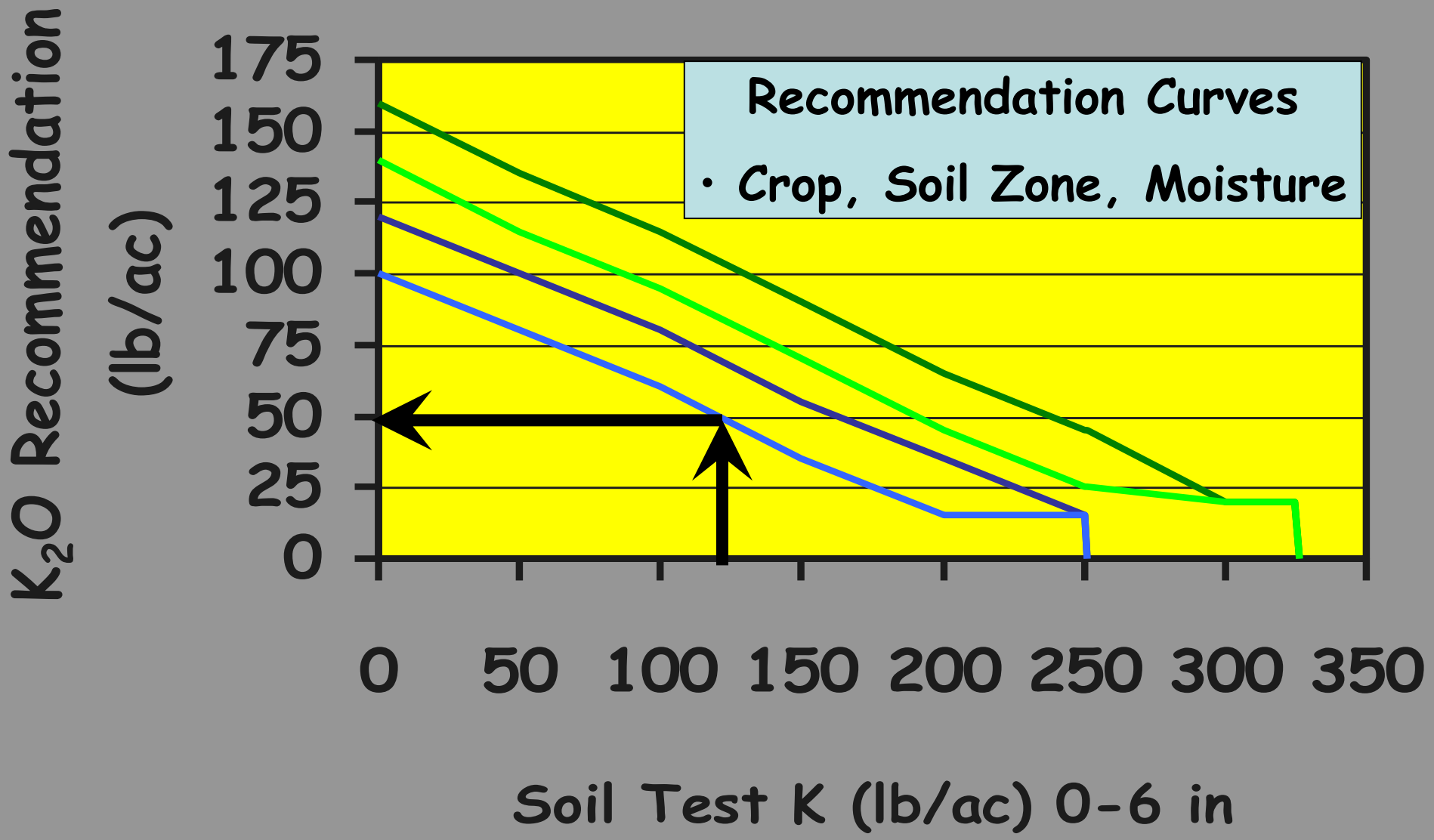
Potash Fertilizer Recommendation



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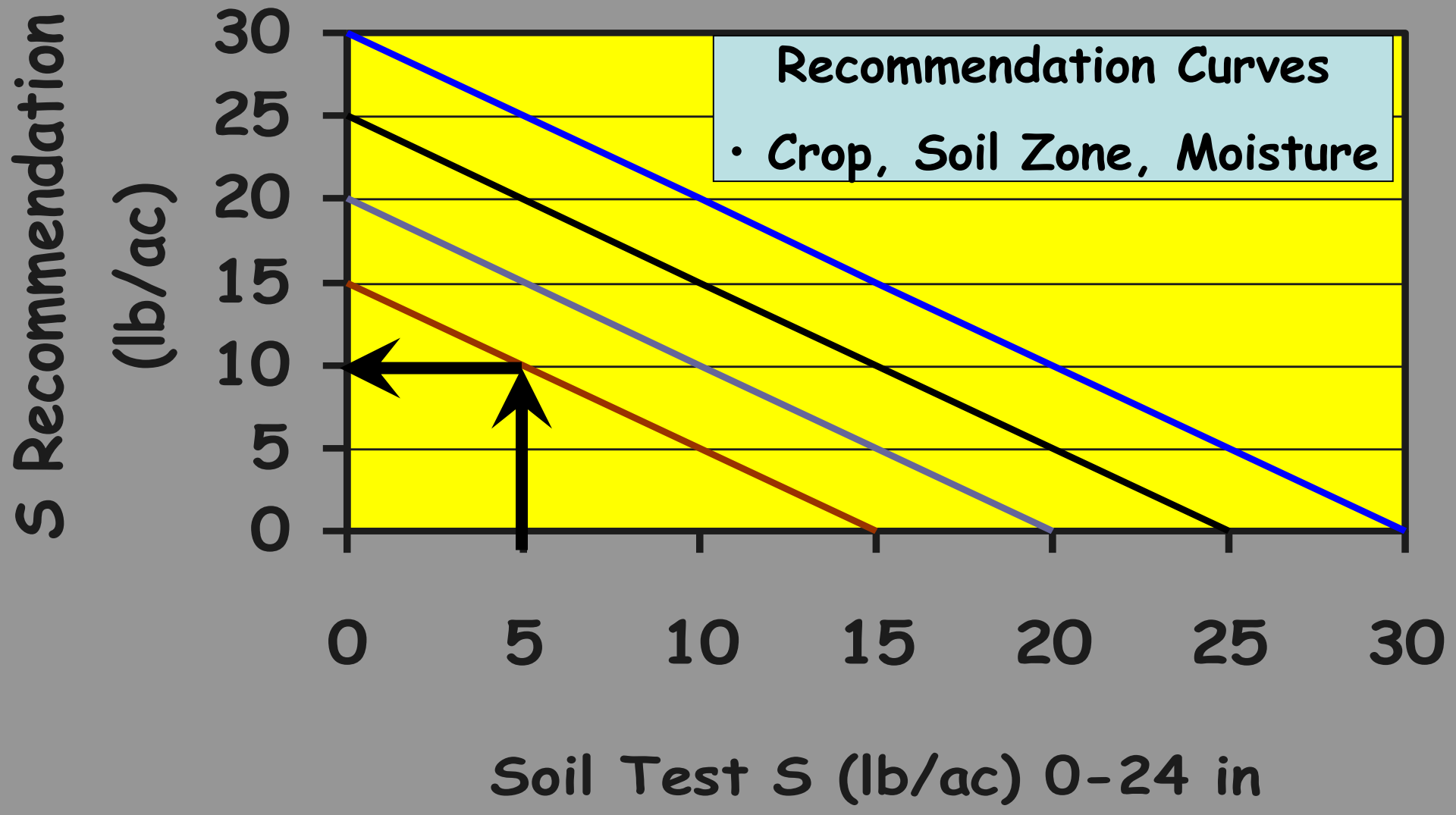
Sulfur Fertilizer Recommendation



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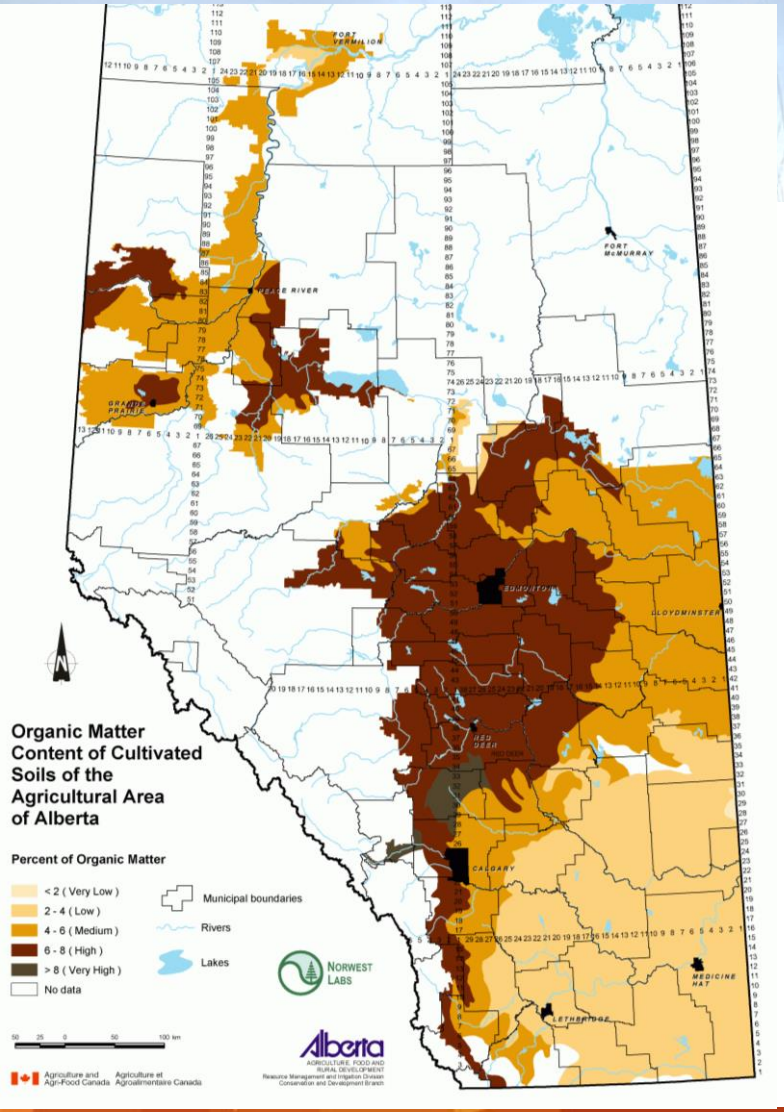
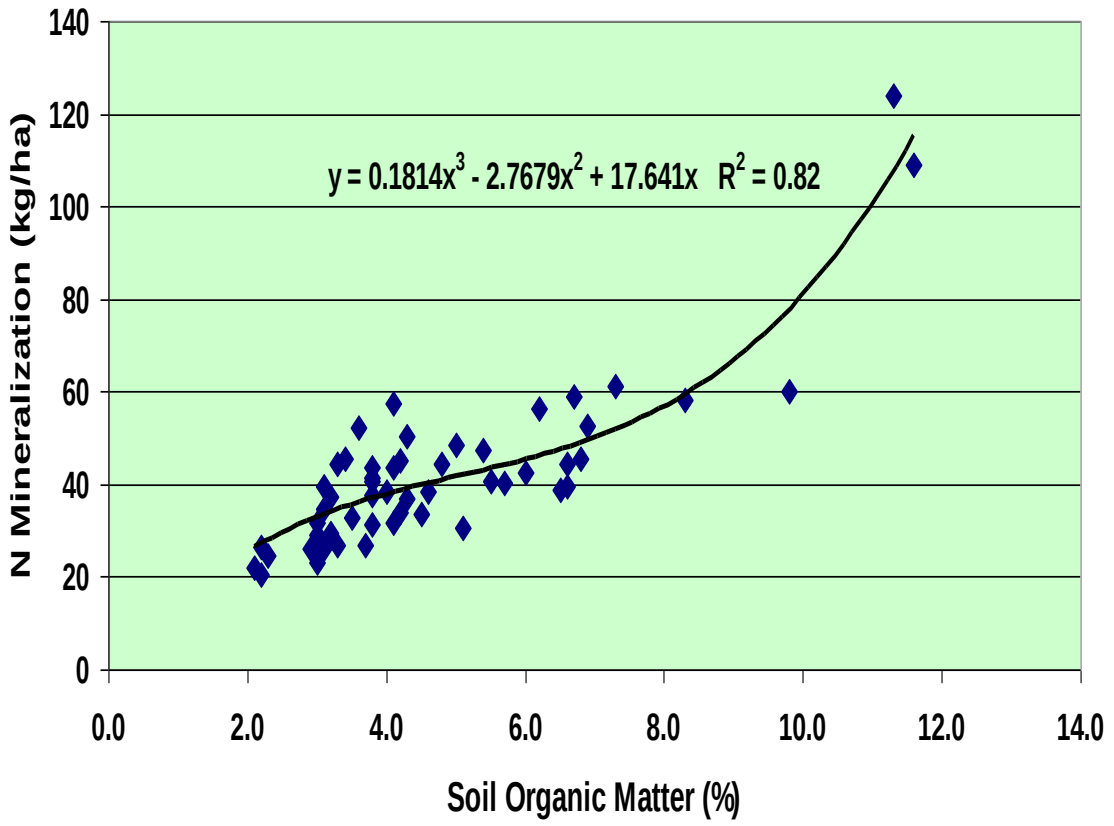
Micro Nutrients Interpretation

Micro Nutrient Critical Levels (ppm)						
	Boron 0-6"	Copper 0-6"	Iron 0-6"	Manganese 0-6"	Zinc 0-6"	Chloride 0-24"
Deficient	<0.35	<0.2	<2.0	<1.0	<0.5	<15
Marginal	0.35-0.5	0.5-1.0	2.0-4.0		0.5-1.0	16-30
Adequate	0.5-3.5	>1.0	>4.0	>1.0	>1.0	>30
Excessive	>3.5					

Soil Organic Matter & Soil Nitrogen Mineralization





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Moisture

- Spring plant available soil moisture (PAW)
- Growing season precipitation (GSP)
  - Probabilities by soil zone
- Total Avail Moisture (TAM) = PAW + GSP

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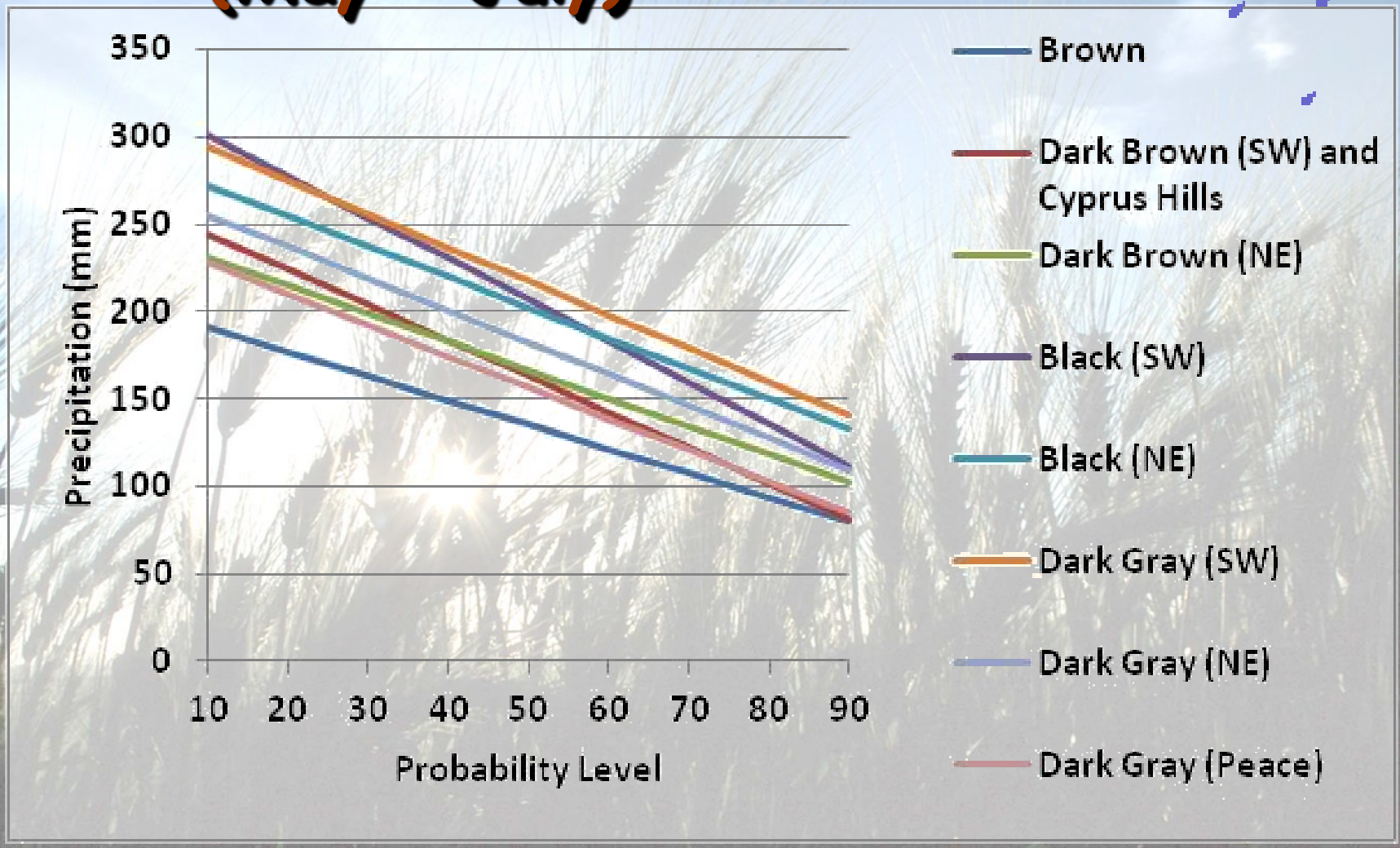
Precipitation Probabilities (May - July)



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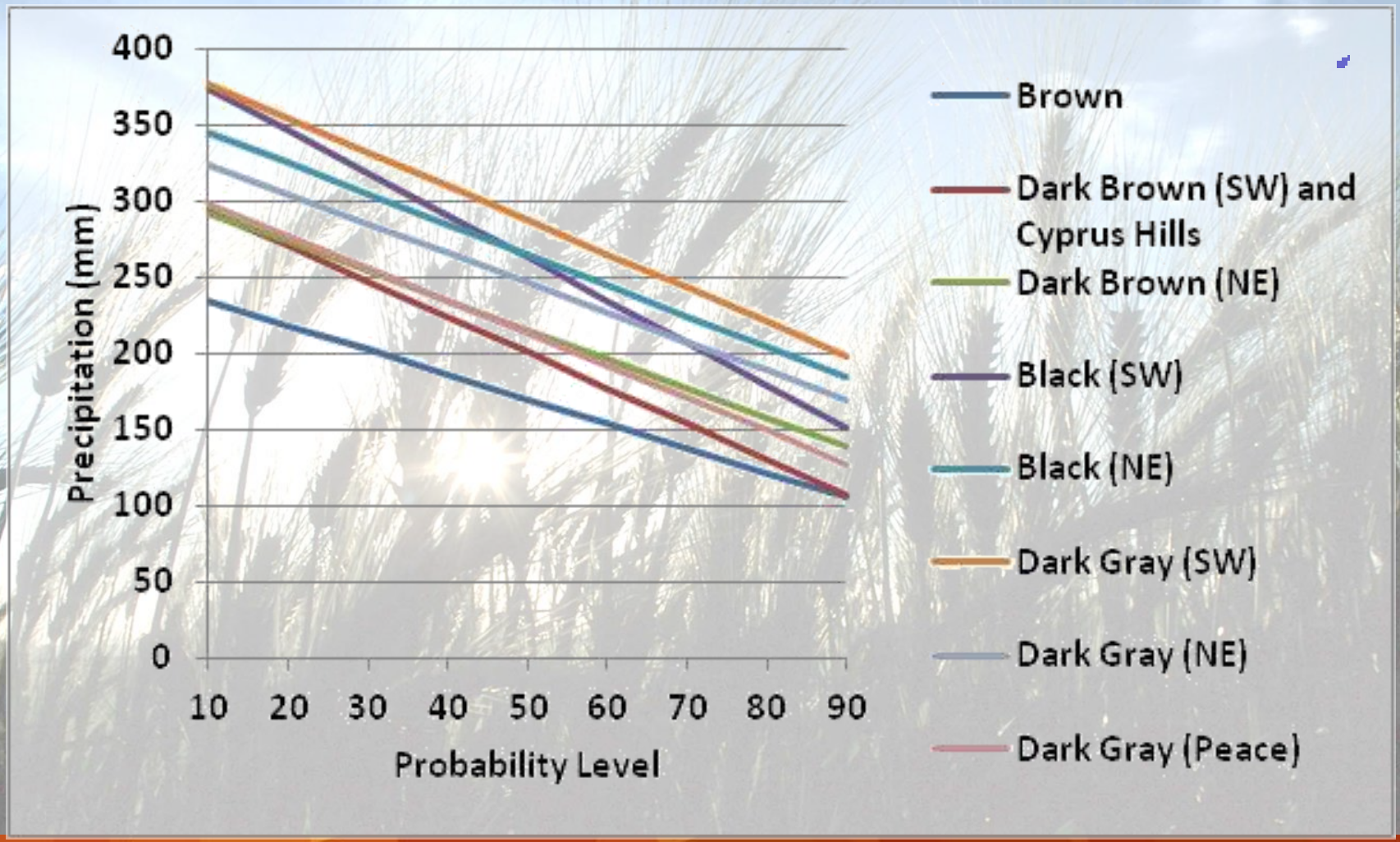
Precipitation Probabilities (May - August)



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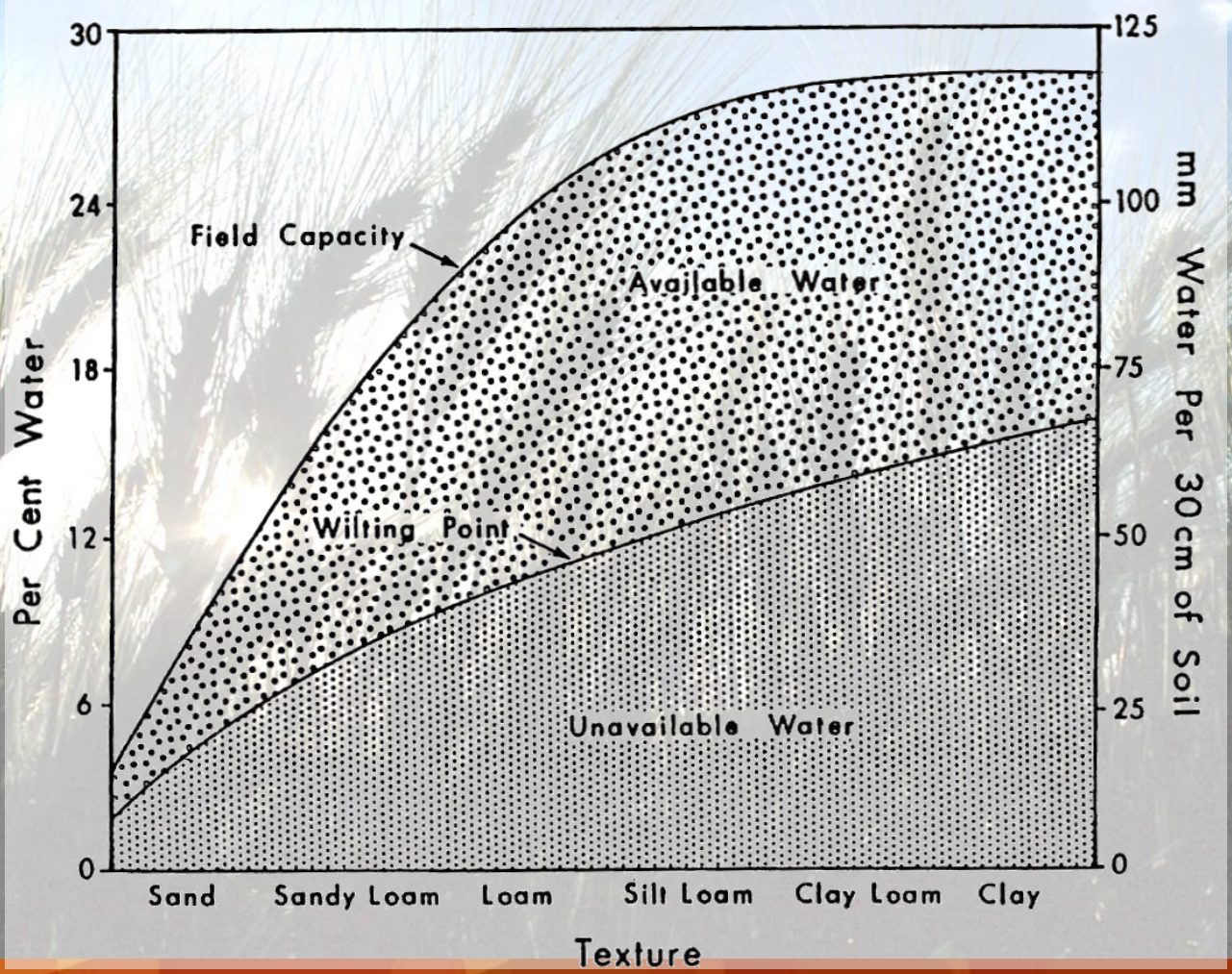
Estimating Plant Available Soil Moisture



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Estimating Plant Available Soil Moisture

Soil Texture		PAW cm/m	Depth of Moist Soil (cm)		
			Dry	Medium	Wet
Very Coarse	FS, LS	7 – 8	30 - 60	60 - 120	120 +
Coarse	SL, FSL	10 – 14	30 - 50	50 - 100	100 +
Medium	L, SiL, CL	15 – 18	15 - 30	30 - 60	60 +
Fine & Very Fine	SiCL, SiC, C	16 - 19	15 - 30	30 - 60	60 +

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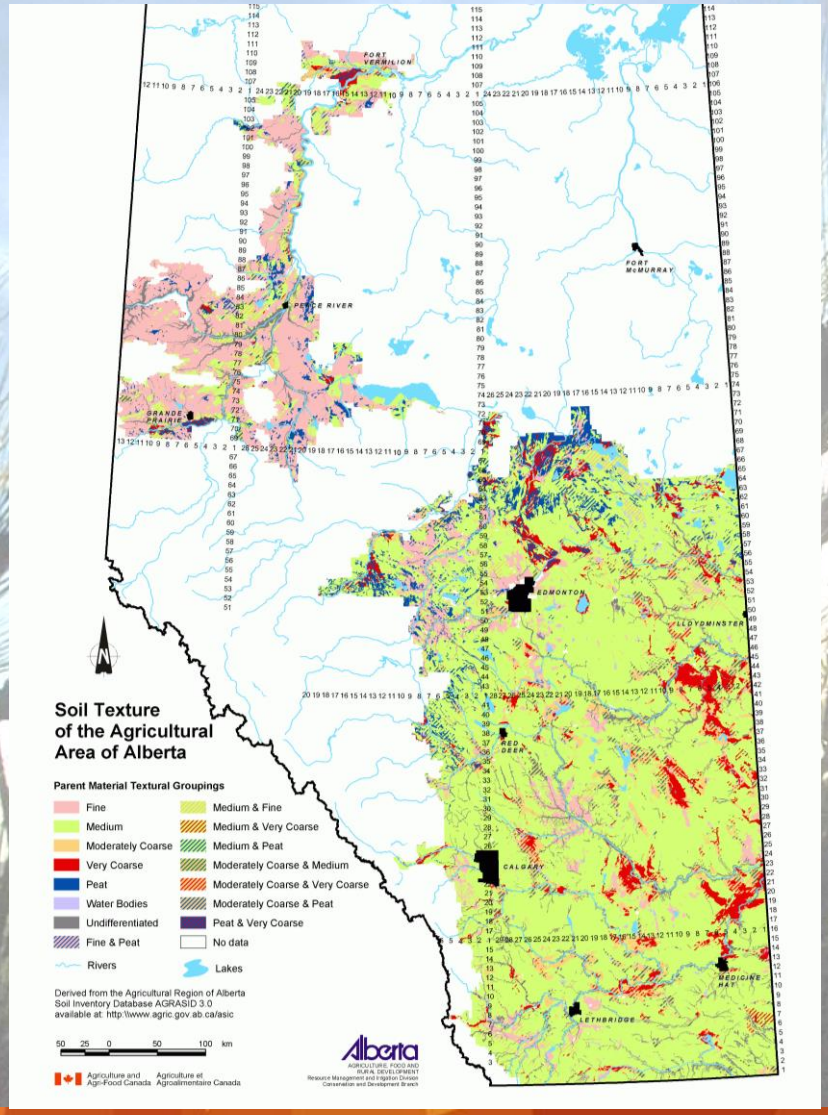
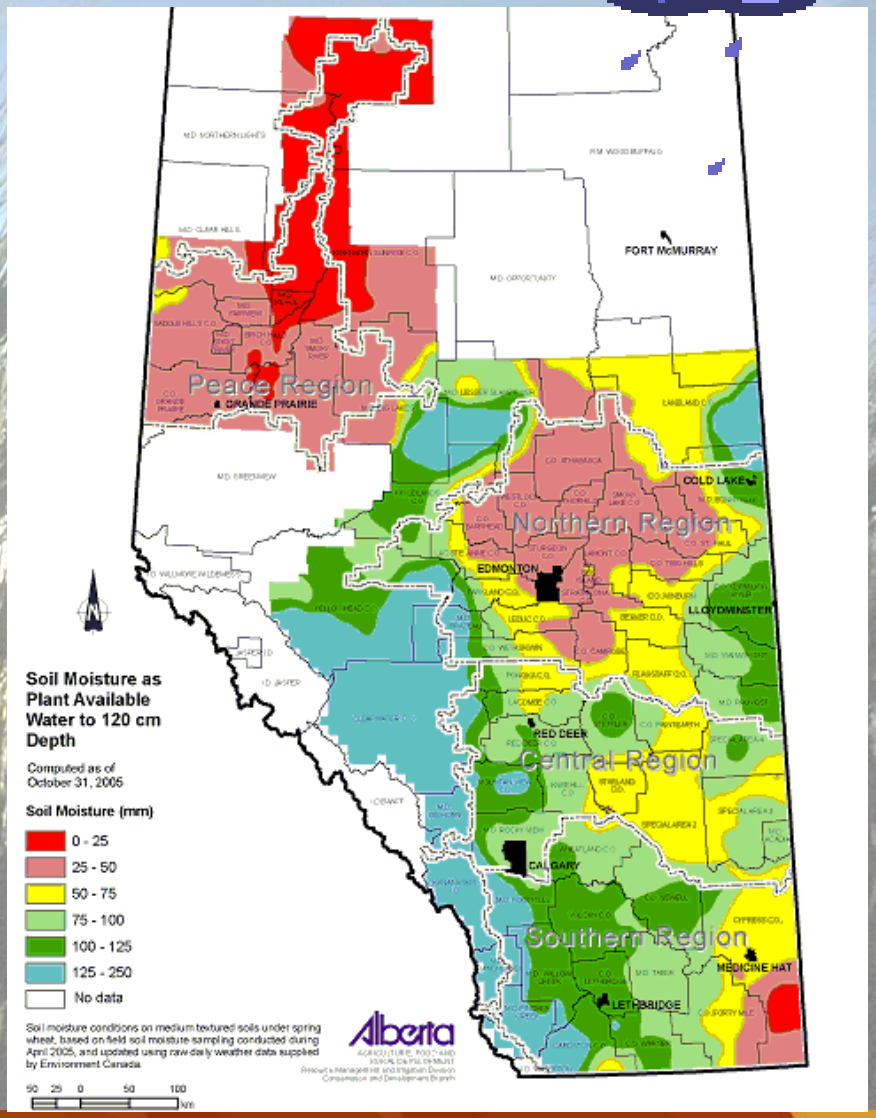
Soil Texture & Soil Moisture





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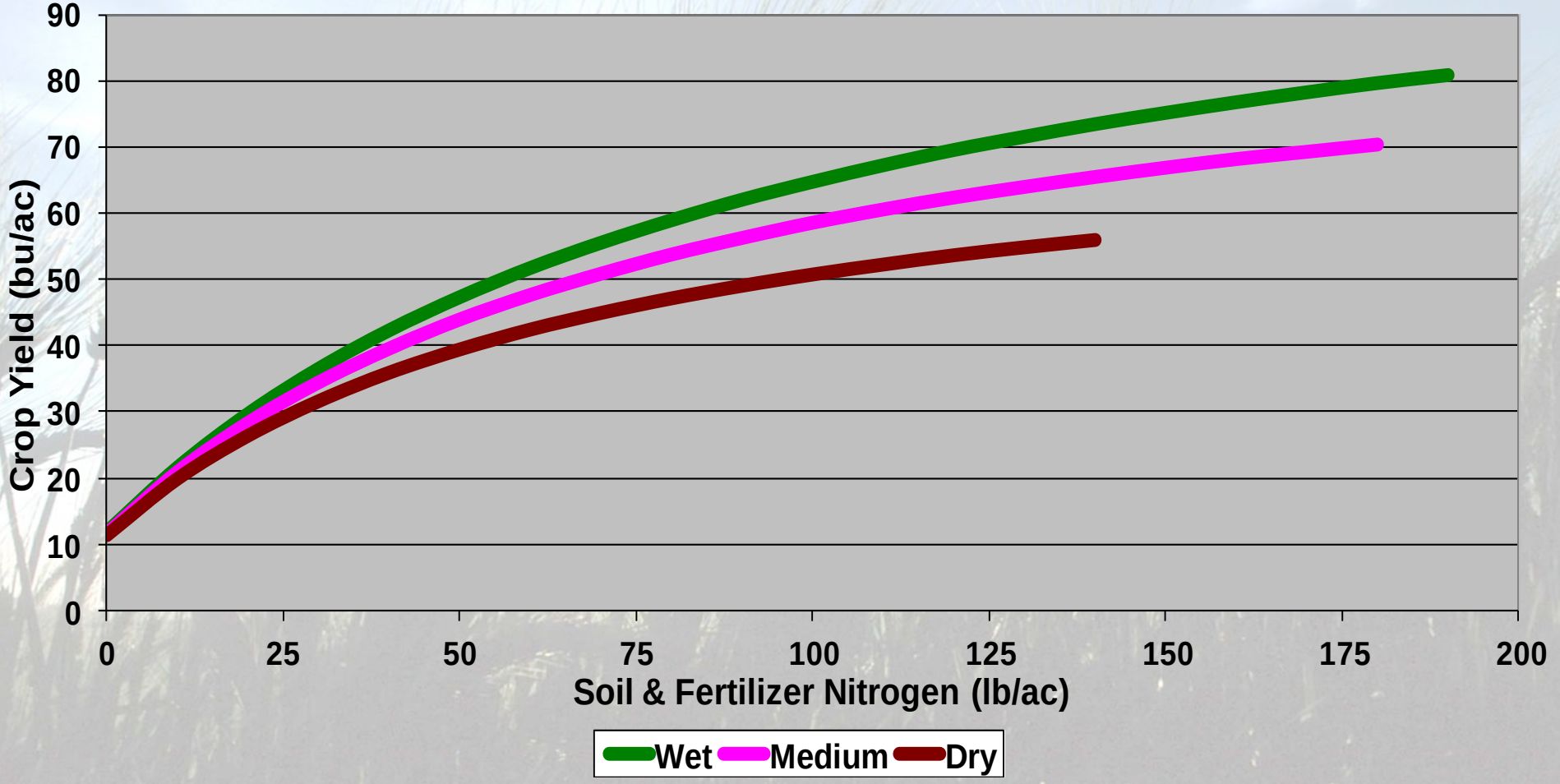
Crop Response to Nitrogen & Moisture



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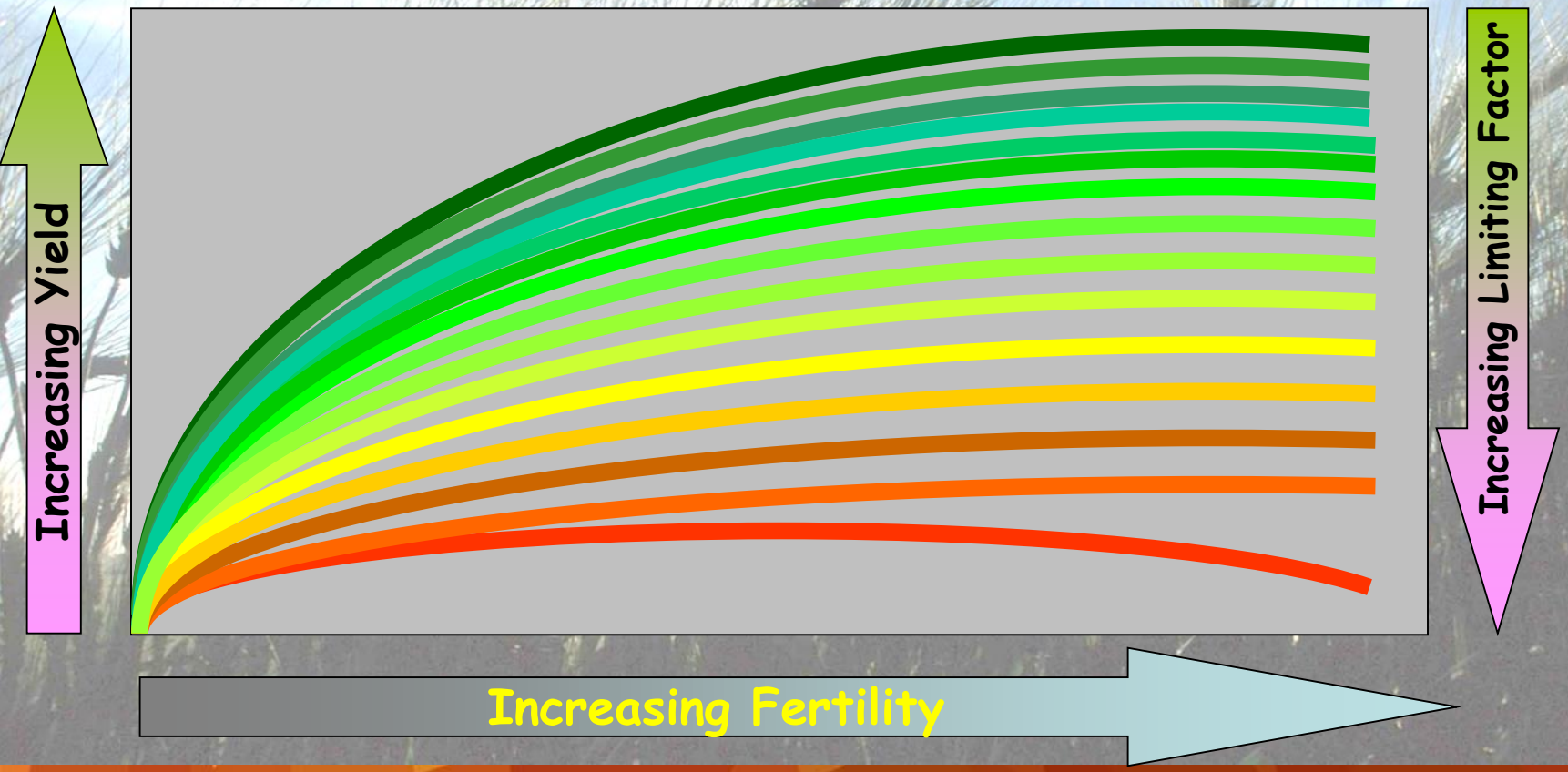
Crop Response Curves



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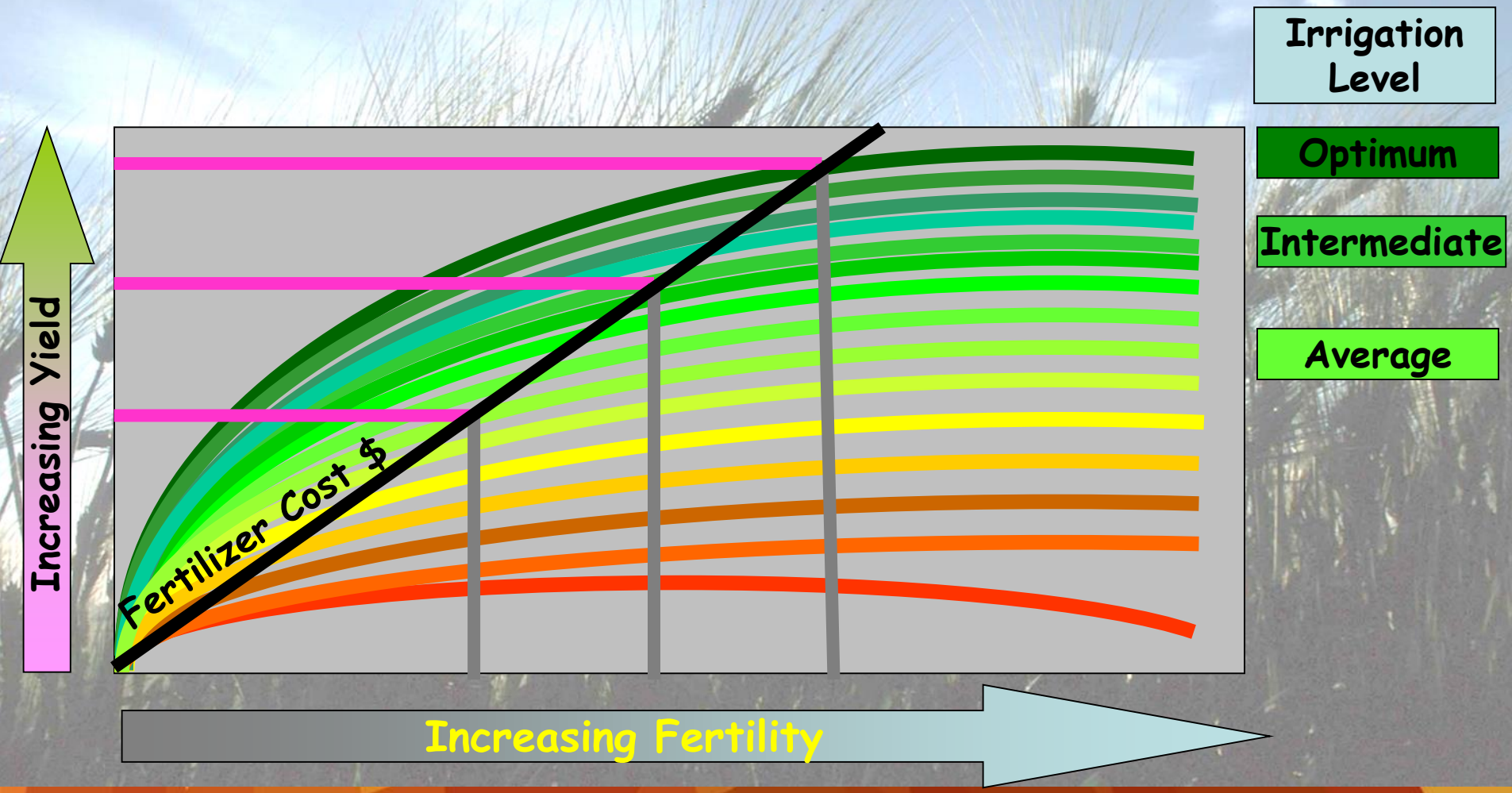
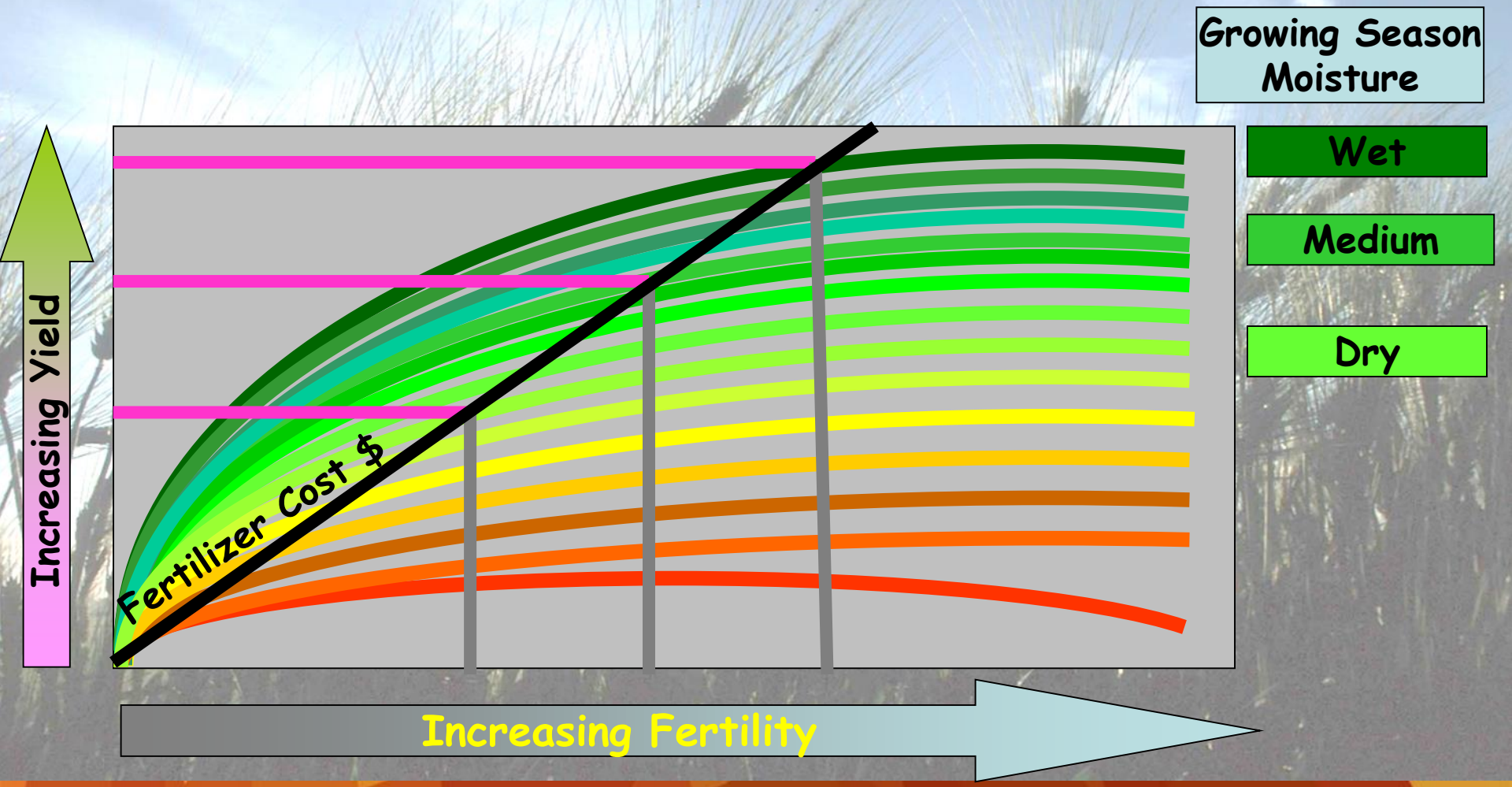
Irrigation


Irrigation Level
Optimum
Intermediate
Average
Increasing Yield
Fertilizer Cost $
Increasing Fertility

Growing Season Moisture



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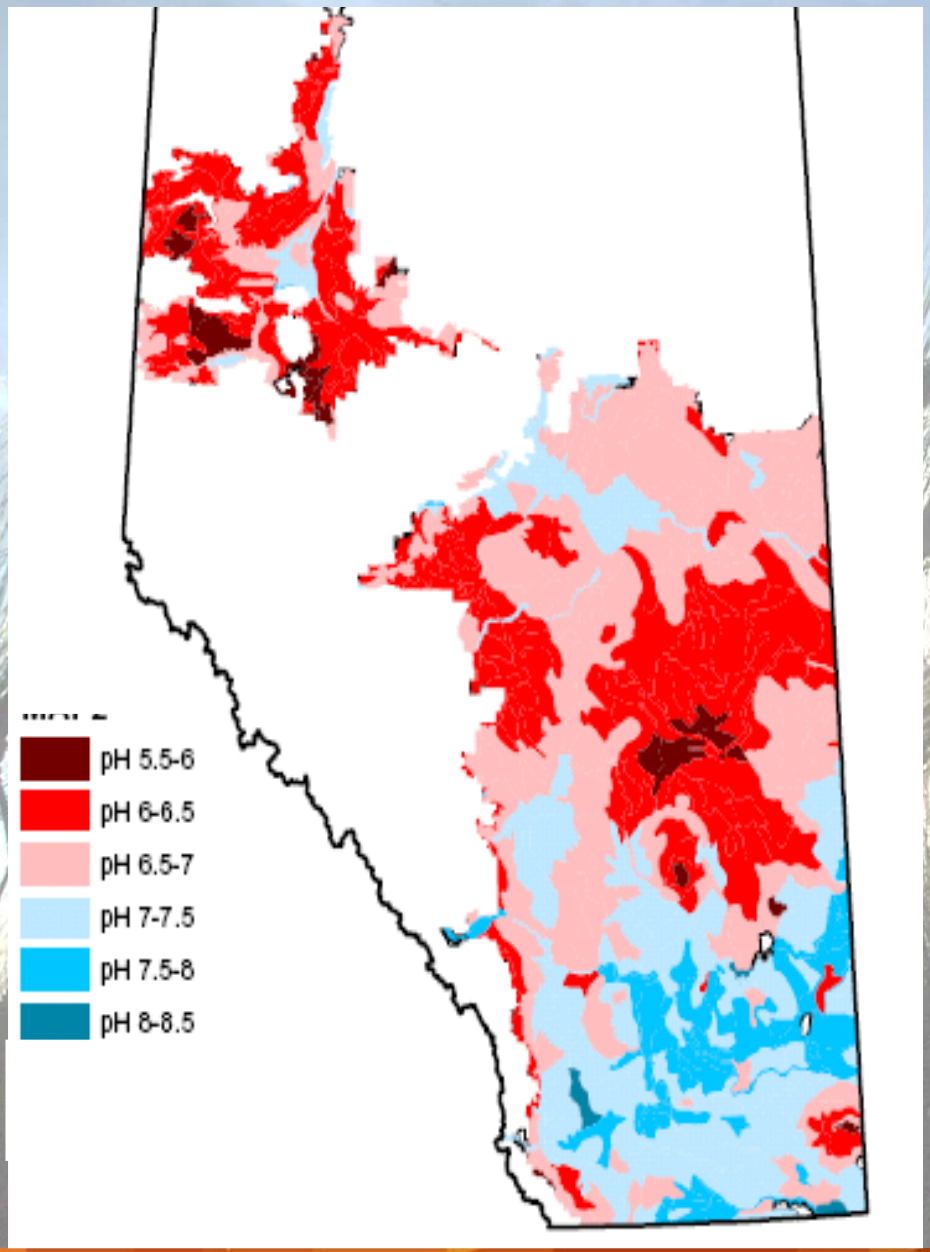
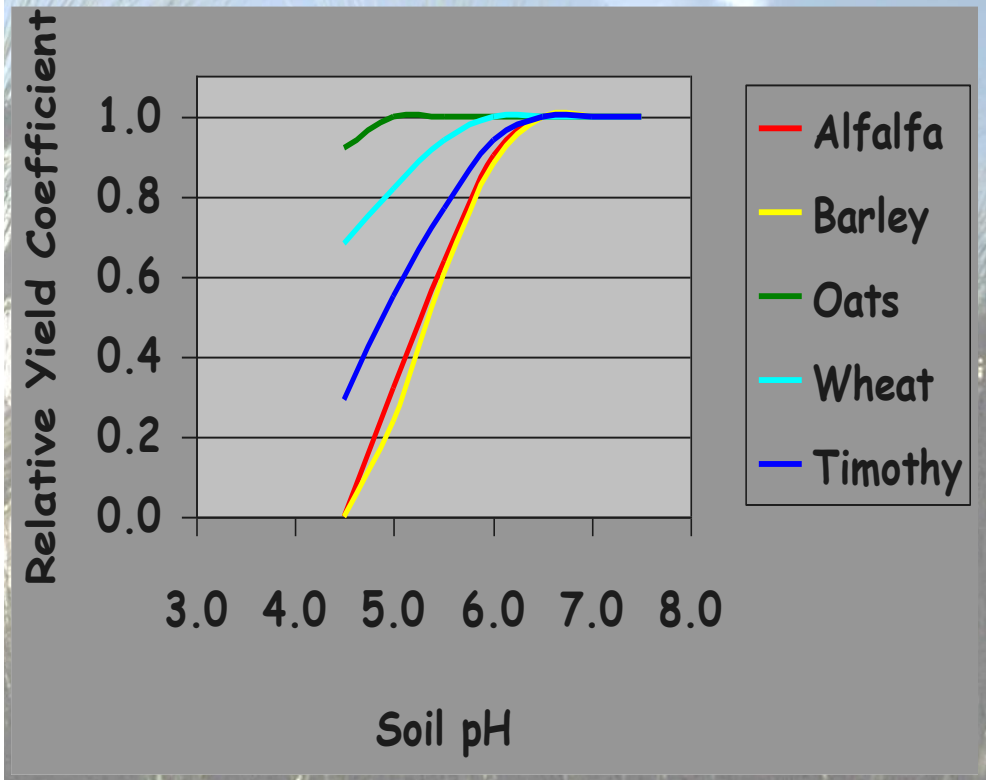
Soil pH





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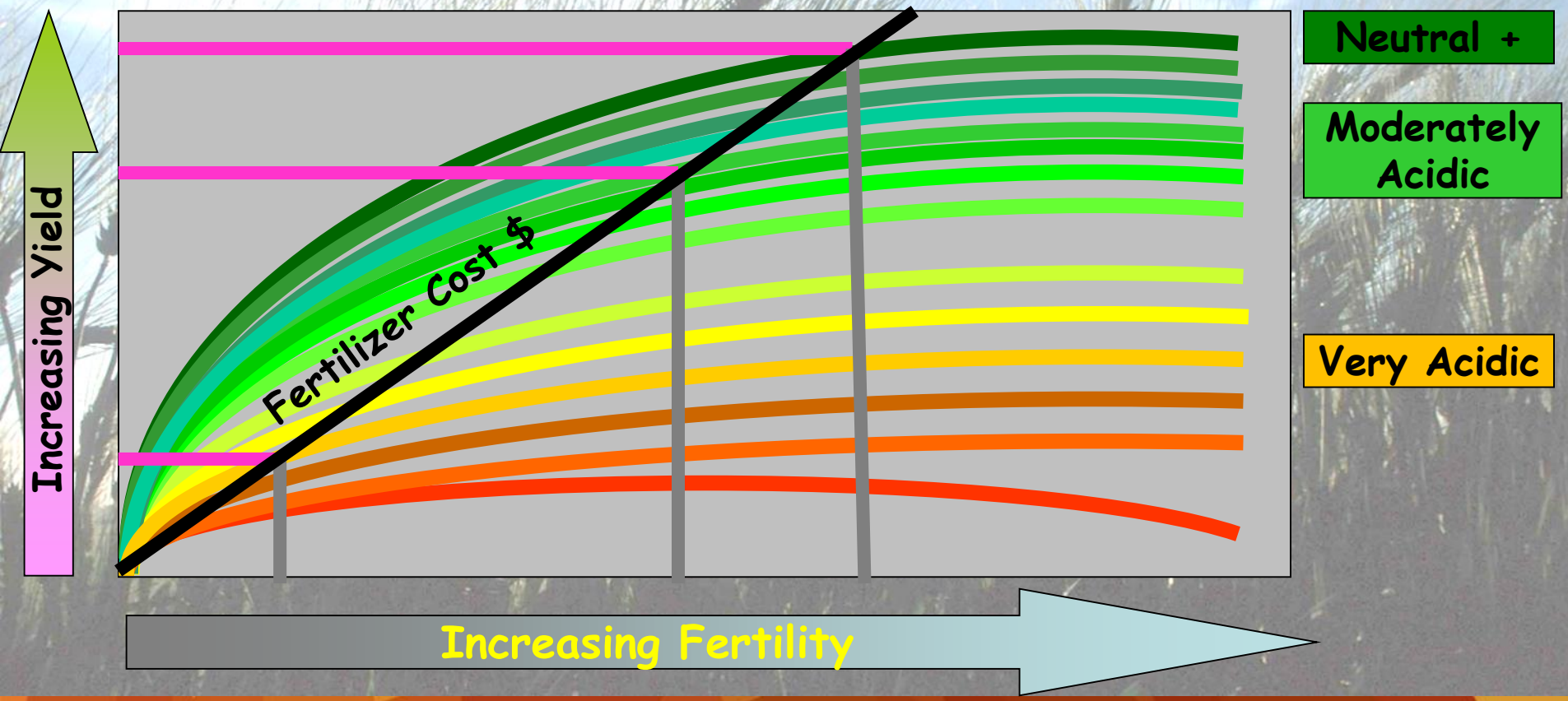

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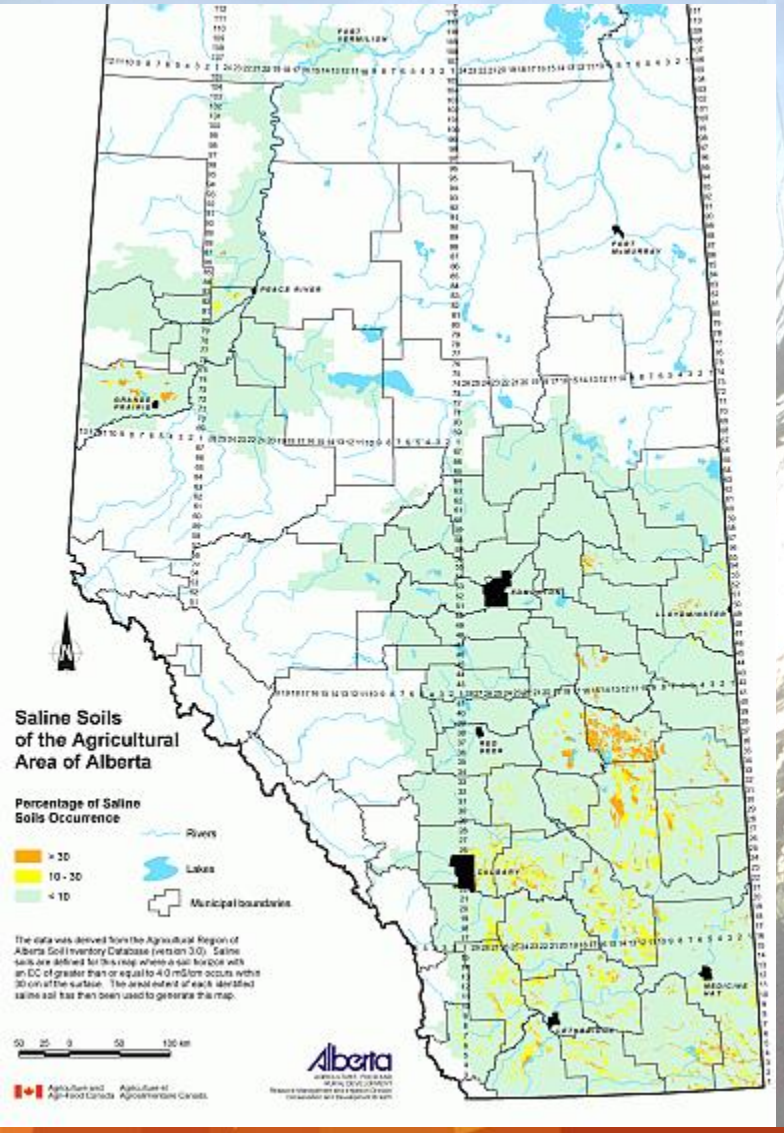
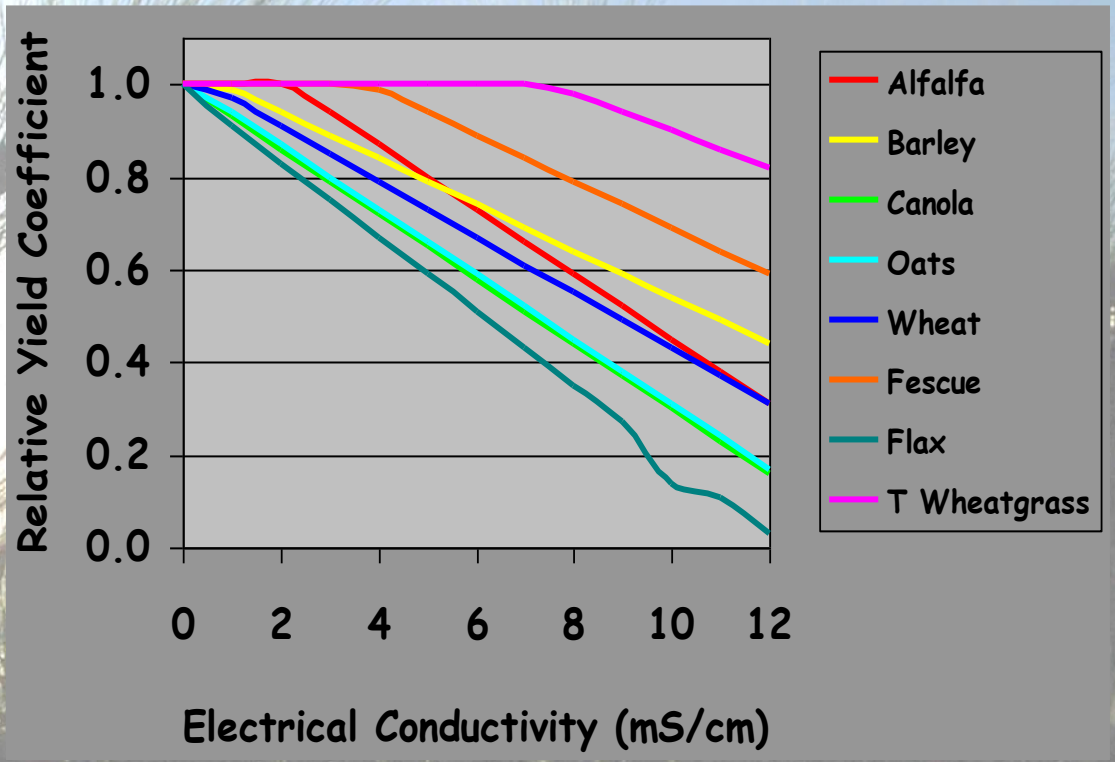
Soil Salinity





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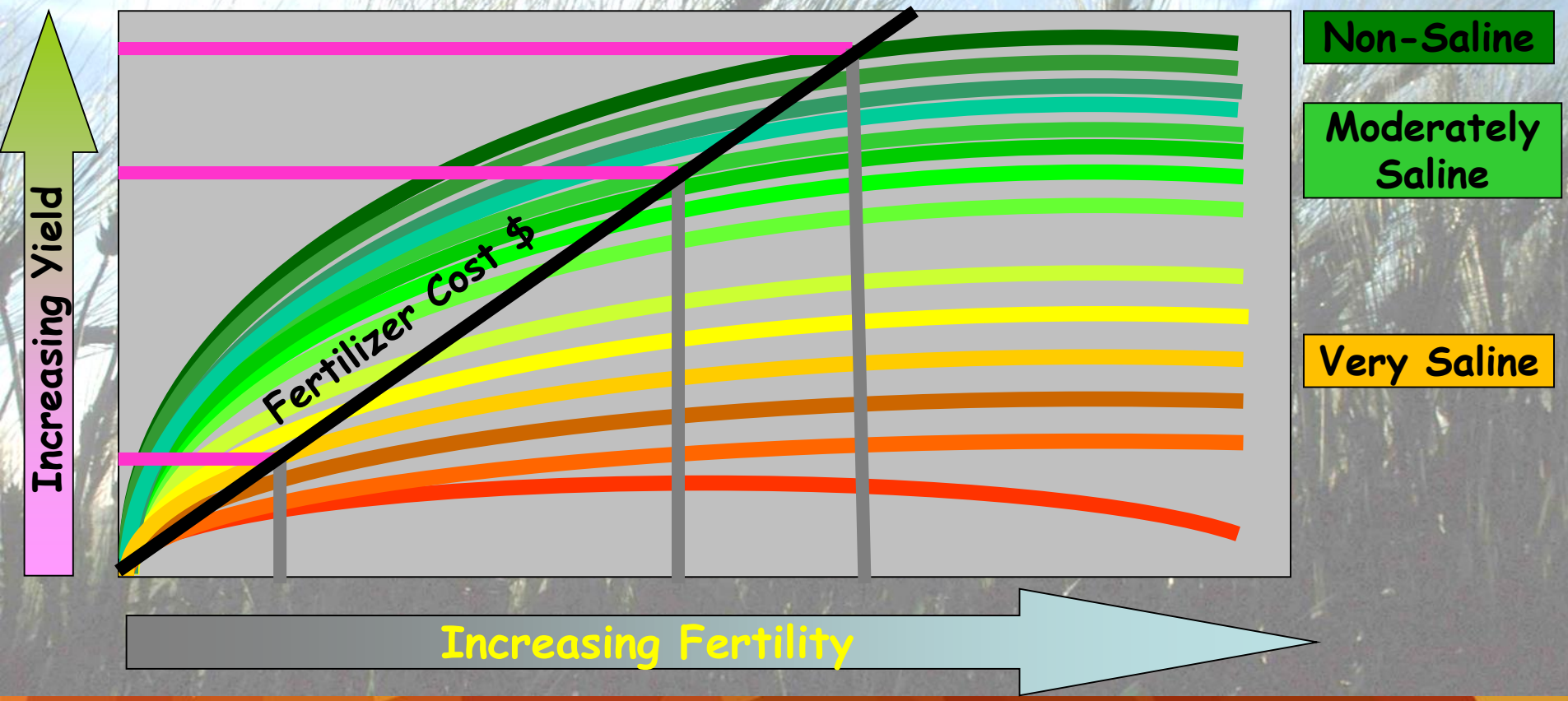

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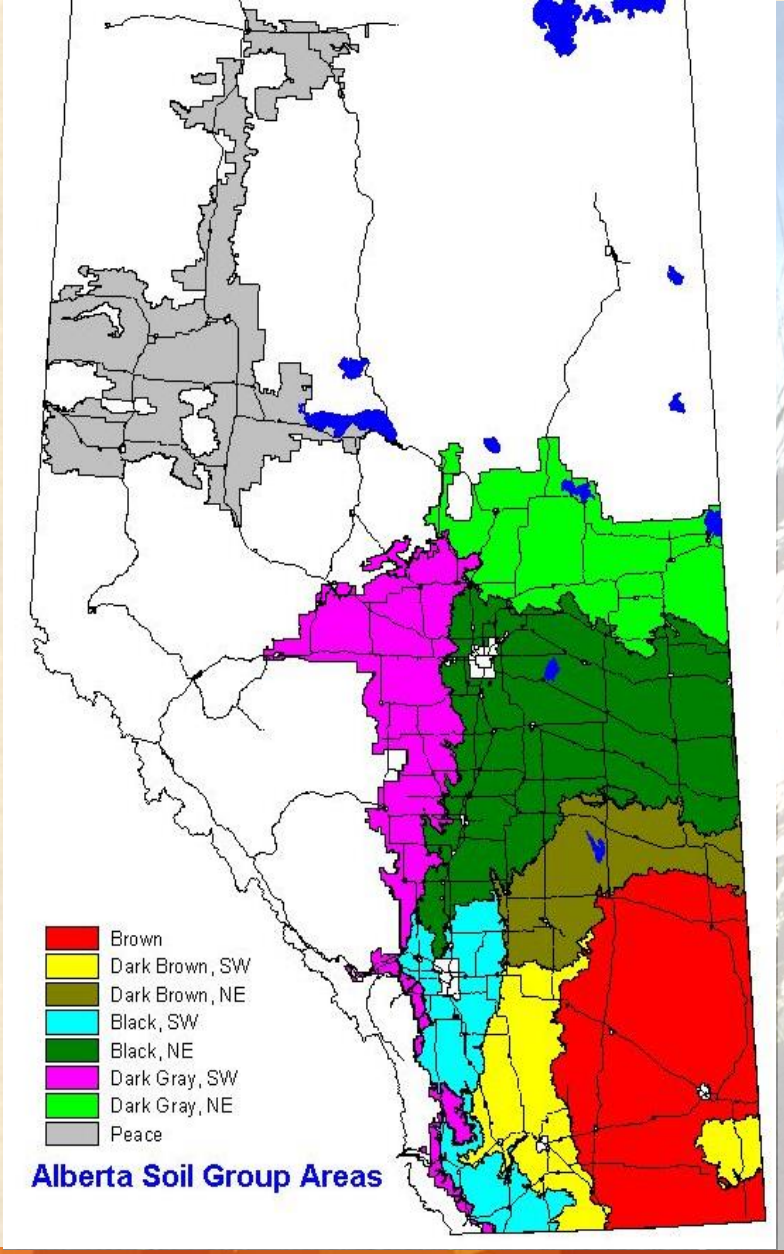
Agro-Climatic Zones



Zones reflect differences

- Soils
- Climate
  (pptn, temp, growing season)
- Crop management
- Yield potential
- Nutrient availability
- Nutrient requirements

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Alberta Farm Fertilizer Information and Recommendation Manager (AFFIRM)

- Fertilizer recommendations based soil test calibrations from Alberta research.
- Able to utilize soil test results from several different laboratories.
- Access to current nutrient management knowledge based on Alberta research.
- Nitrogen fertilizer-crop response model that incorporates soil test and fertilizer nitrogen with spring moisture conditions and growing season precipitation.
- Balanced nutrient economic analysis model.
- Nitrogen mineralization estimates to improve fertilizer nitrogen recommendations for crop production.
- Field and whole farm optimization for nutrient management.

AFFIRM Enhancements

- Update Laboratories and Soil Test Calibrations
- New fertilizer products research
  - Enhanced Efficiency Fertilizers
    ESN (coated urea) and other fertilizer products
- 4R Nutrient Stewardship
  - Product, Rate, Time, Placement
- Incorporate nutrients from manure sources
- Linkage to AB Climate Information Services and AB Soil Information Viewer

Your Responsibility

- Need to collect and handle the best representative sample.
- Use a reputable laboratory.
- Surface and subsurface samples.
- Provide field management information.
- Be aware of the soil test methods that the laboratory uses.
- Is the laboratory using research data, soil test calibrations and recommendations appropriate for your region?
- Does the laboratory have a QA/QC program?
- Be careful when switching laboratories.
- Unusual soil test results need to checked. Reanalyze or resample?

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Thank You

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