



IPNI

INTERNATIONAL
PLANT NUTRITION
INSTITUTE



**CONGRESO PERU
Tarapoto, Nov 16 - 21**

**Dr. Luís Ignácio Prochnow
IPNI Brazil Program Director**

**SOIL FERTILITY EVALUATION
AND CONTROL WITH EMPHASIS
IN THE ION EXCHANGE RESIN**



IPNI

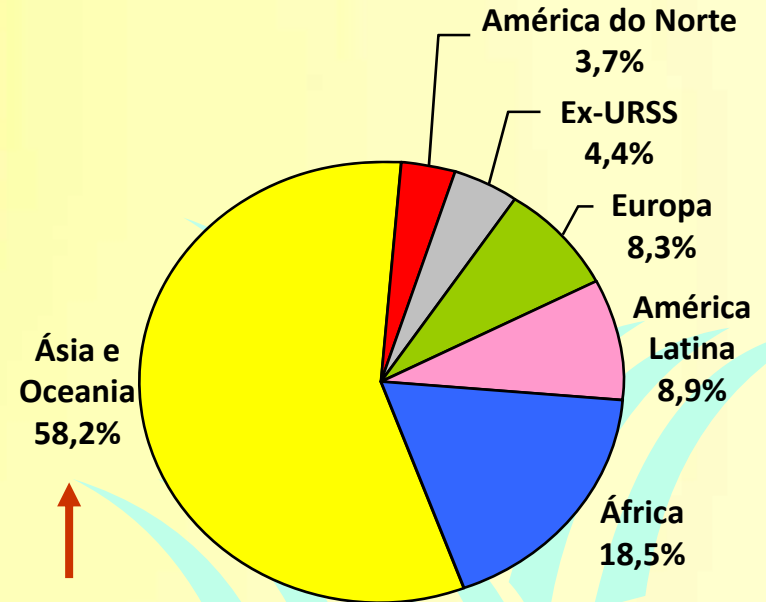
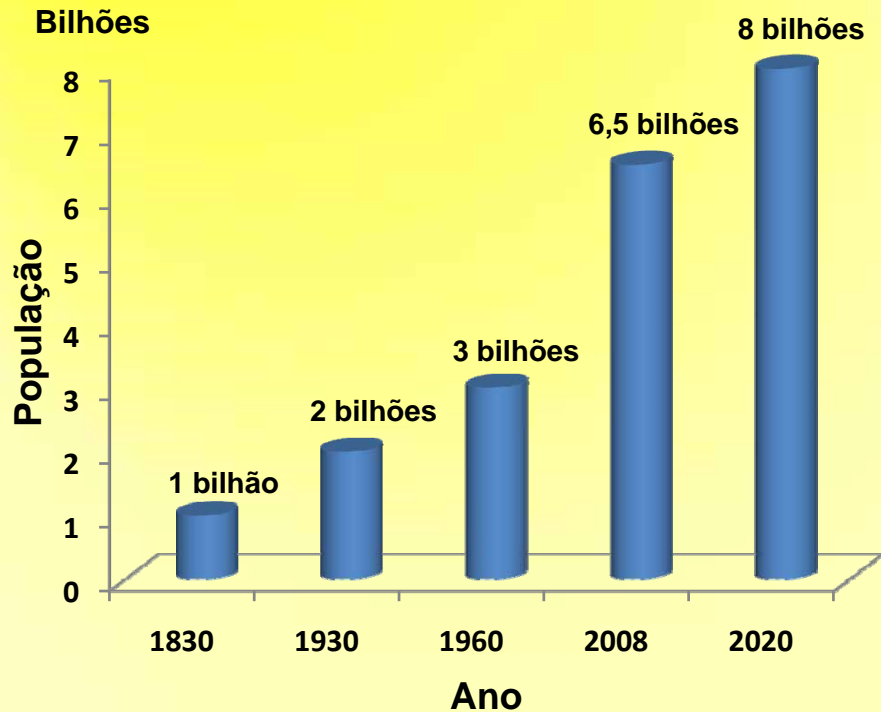


INFORMAÇÕES GERAIS

- ✓ Na medida em que a população mundial e a demanda por alimentos, combustível e fibra continuam a aumentar, existe em paralelo a necessidade crescente por conhecimento e informação baseado em ciência responsável. É nesse contexto que aparece o IPNI.

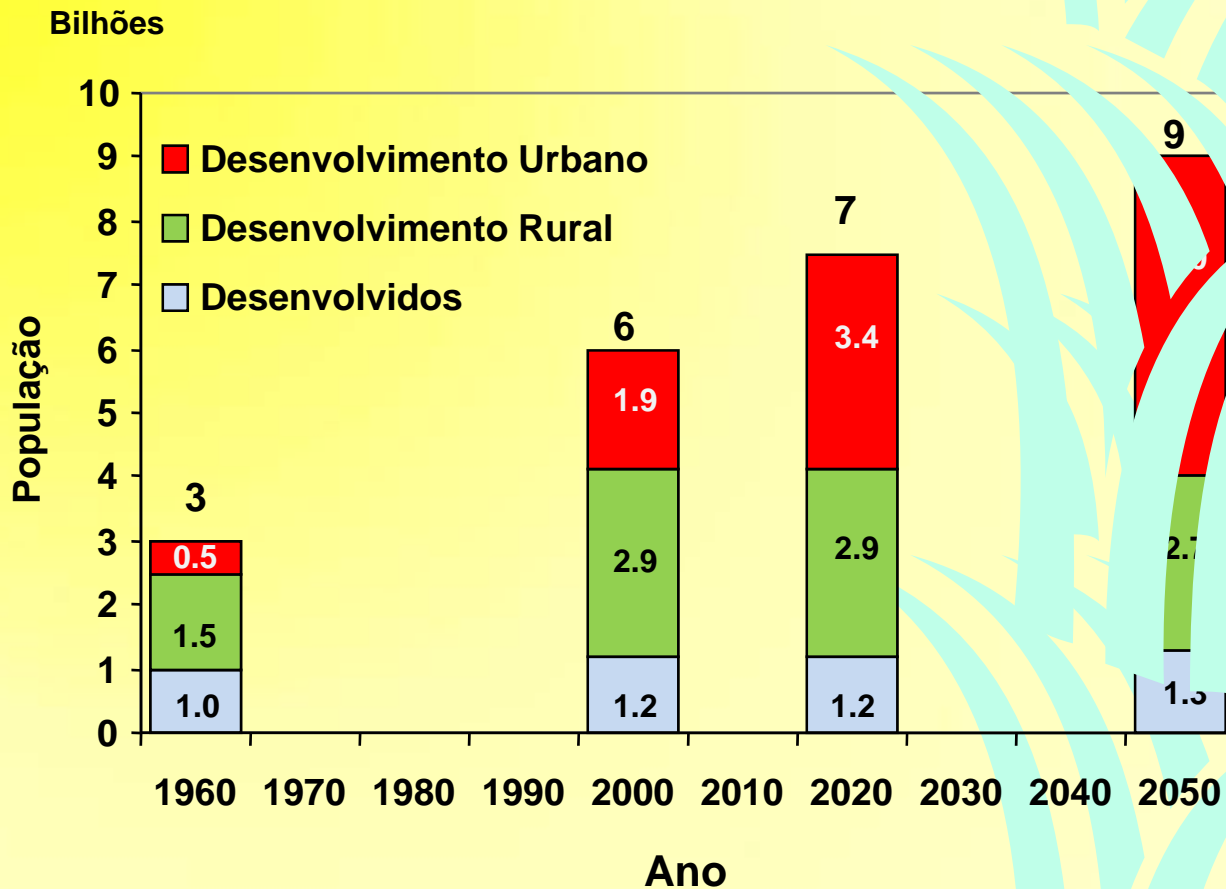


CRESCIMENTO DA POPULAÇÃO MUNDIAL

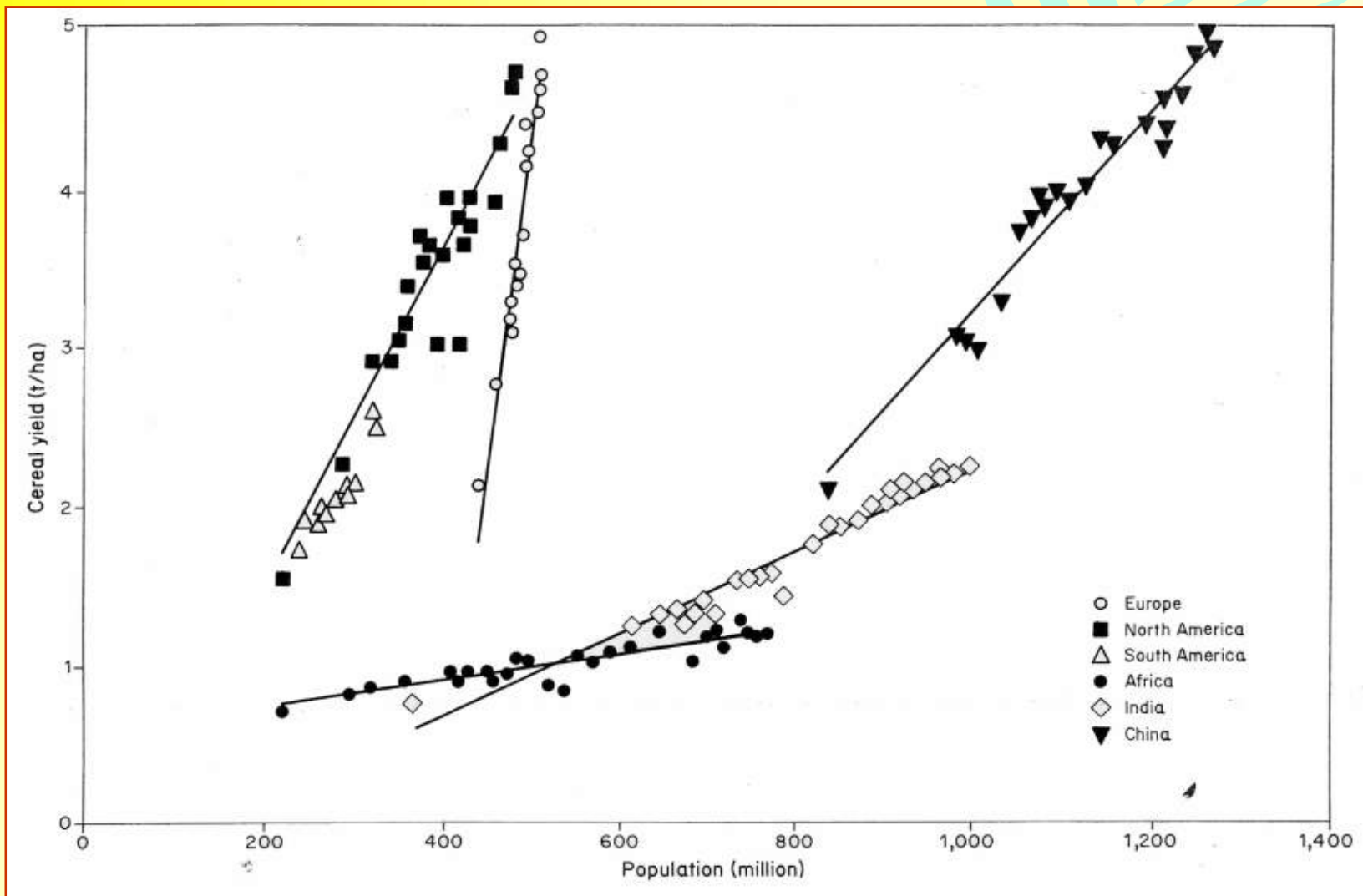


Ano de 2020: População projetada de 7.99 bilhões

CRESCIMENTO POPULACIONAL

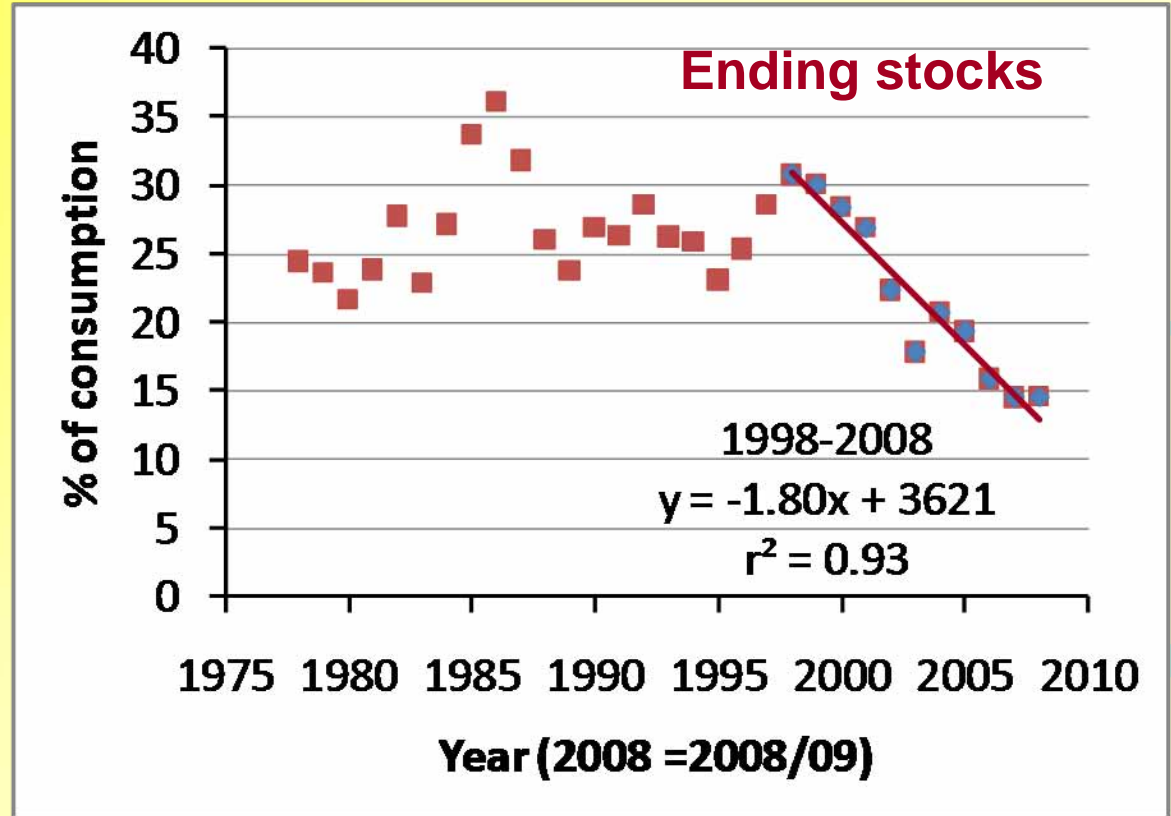
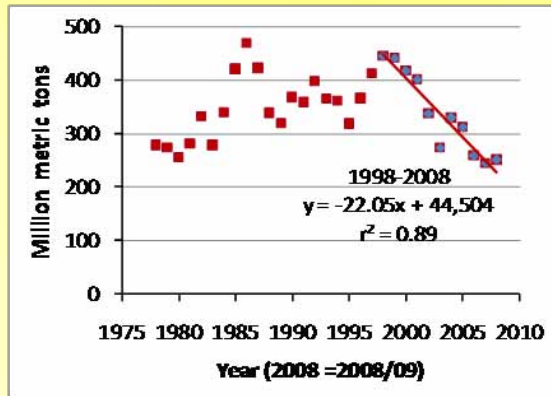
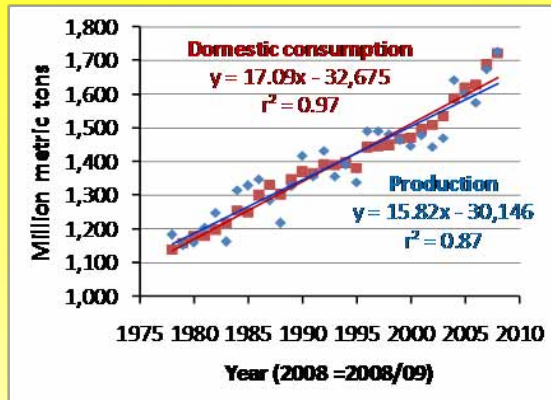


VEJA: “Megacidades, O inchaço das áreas urbanas preocupa mais que o aquecimento global”



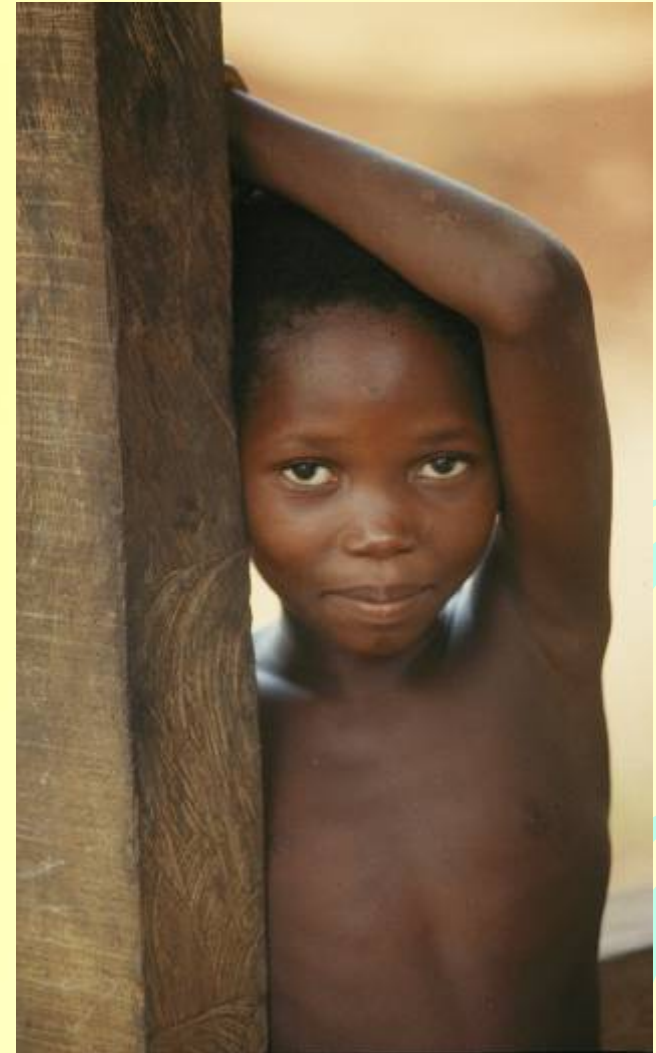
Relação entre população e produtividade média de cereais em seis regiões-chave do mundo (Evans, 2003)

World wheat plus coarse grains, 1978-2008



**“You Cannot
Build Peace
on Empty
Stomachs.”**

**John Boyd Orr
Nobel Peace Laureate
First FAO Director General**



✓ at today's level of the economic activity and today's global population of 6.5 billion people we are not sustainable with our current technologies and our current approaches in a global scale

✓ (J. Sacchs, 2007)

Estamos sobre uma lupa como nunca antes

Extracted from Fixen, 2008

- Preço e Fornecimento de Alimentos
- Uso Eficiente
- Preservação de Áreas
- Limitar
- Zonas de Hipoxia
- Emissão de GE
- Qualidade do Ar



→ “Today agricultural inputs are under the careful scrutiny of several groups: growers, general public, and governments. This has created a powerful incentive to use inputs wisely.”

INFORMAÇÕES GERAIS

✓ Na medida em que a população mundial e a demanda por alimentos, combustível e fibra continuam a aumentar, existe em paralelo a necessidade crescente por conhecimento e informação baseado em ciência responsável. É nesse contexto que aparece o IPNI.

→ ✓ O “*International Plant Nutrition Institute*” (IPNI) é uma organização nova, sem fins lucrativos, dedicada ao manejo responsável dos nutrientes das plantas – N, P, K, nutrientes secundários, e micronutrientes – para o benefício da família humana.



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[The Fertilizer Institute \(TFI\)](#)



IPNI: OBJETIVOS GERAIS

- ➔ ✓ Ajudar a definir as bases para o uso e manejo apropriado dos nutrientes das plantas, com foco especial em aspectos econômicos e ambientais
- ✓ Providenciar uma voz unificada e científica para o setor de fertilizantes mundial, sendo, independente da indústria, cientificamente acreditada e reconhecida por governos, instituições acadêmicas, NGOs, público em geral, e pela própria indústria
- ✓ Providenciar informações regionais compreensíveis no sentido de auxiliar na resolução de problemas agronômicos e ambientais
- ➔ ✓ Providenciar informação confiável quanto ao uso apropriado de fertilizantes para contrabalançar o grau crescente de desinformação quanto a utilização destes produtos
- ✓ Providenciar suporte técnico a membros e organizações da indústria que sirvam de recurso para relações públicas e atividades promocionais



IPNI: MISSÃO

- ✓ **Desenvolver e promover informações científicas sobre o manejo responsável dos nutrientes das plantas para o benefício da família humana**

IPNI: EQUIPE CIENTÍFICA

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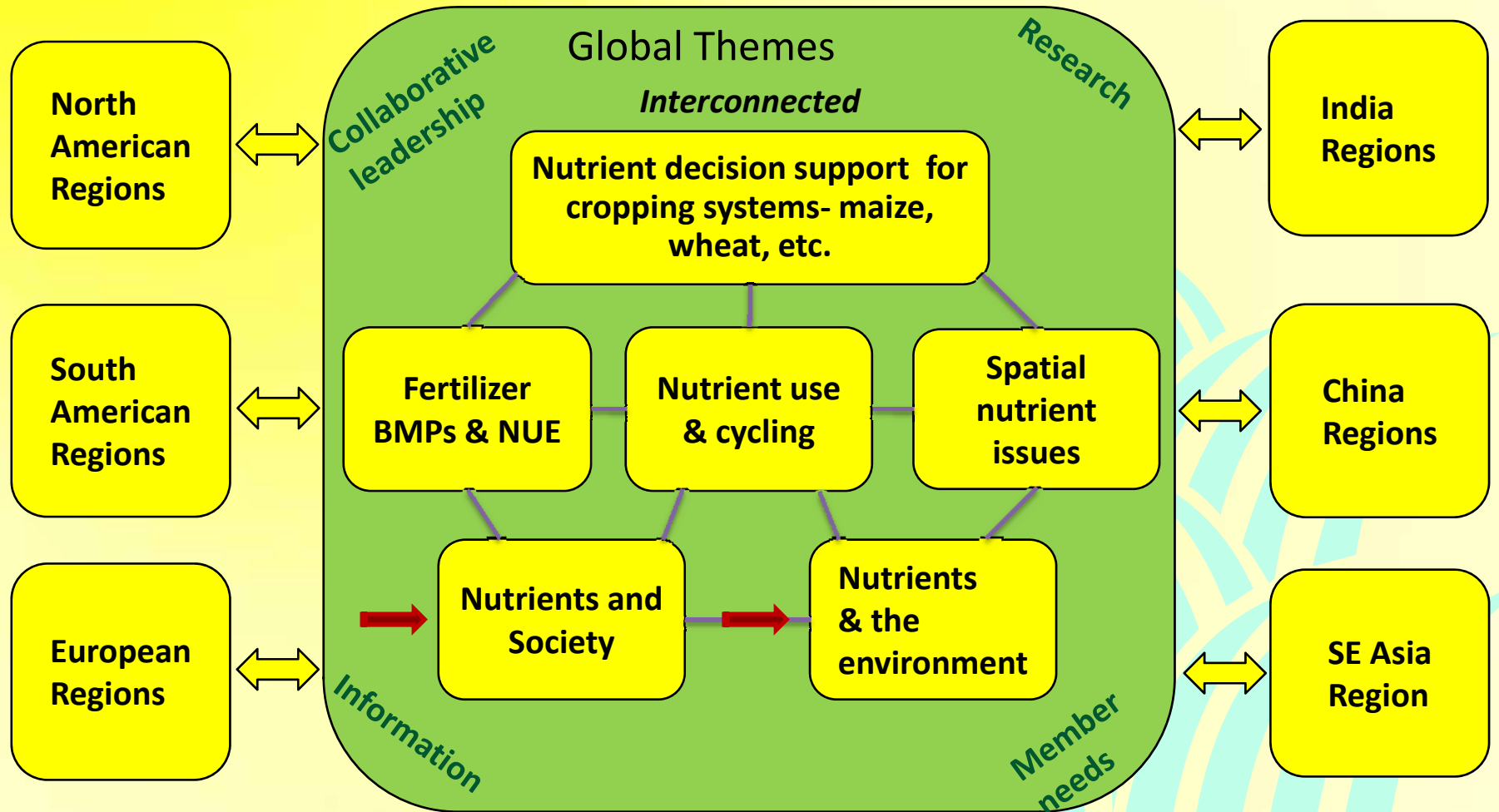


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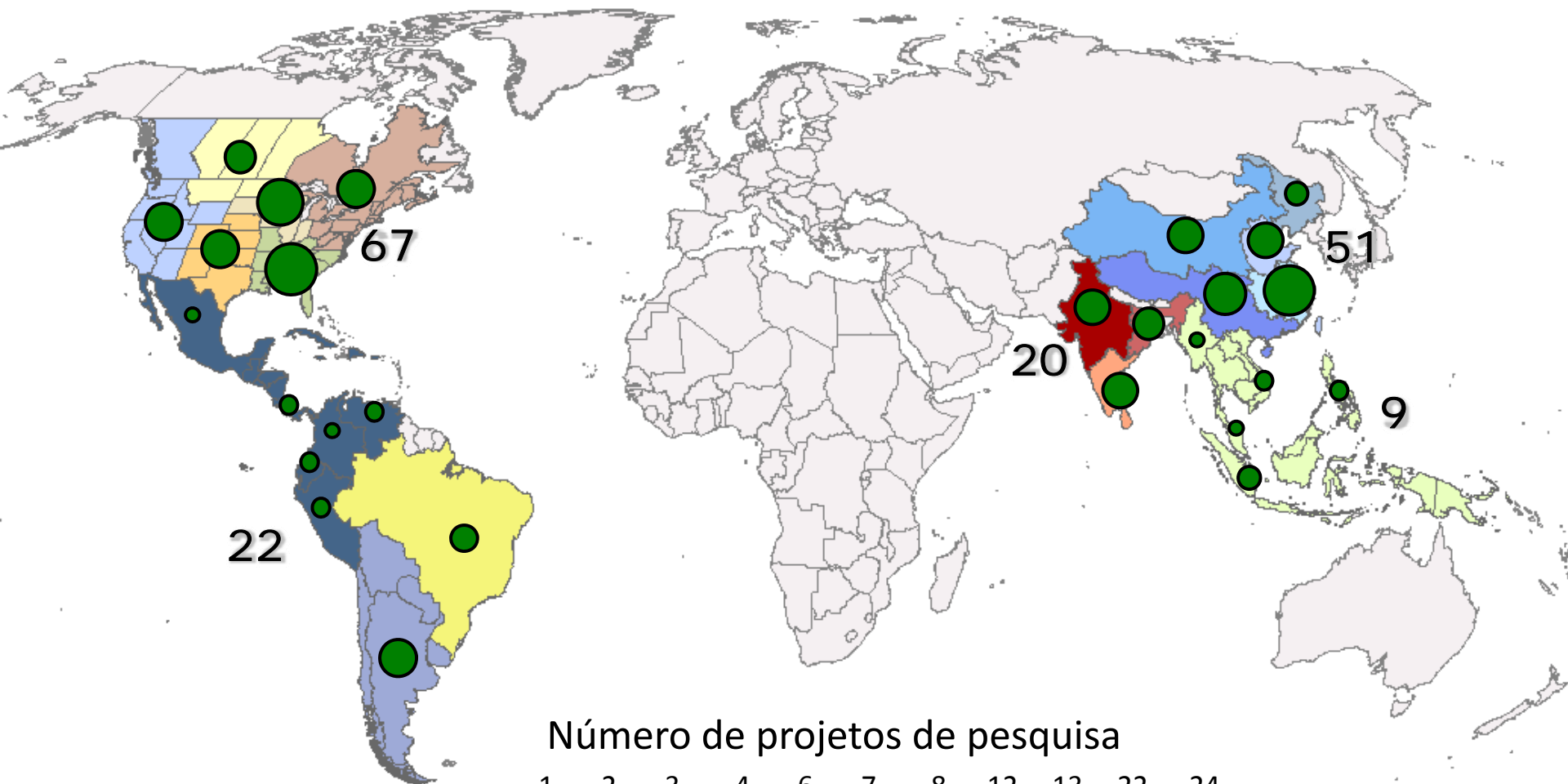
IPNI: TACTICAL PLAN



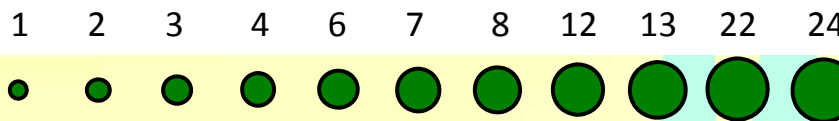
- *Regional needs influence global themes*
- *Global themes support regional programs*

Programa de Pesquisa do IPNI/FAR

169 projetos



Número de projetos de pesquisa



Todas as principais culturas

NPKS, outros

Sistemas



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→ IPNI 2008 Annual Report

The International Plant Nutrition Institute has released its 2008 Annual Report. The special 40-page document uses its theme ... "Global Science to Local impact" ... as the basis for reporting accomplishments of the past year. Our scientific staff highlighted IPNI's tactical approach using global thematic areas with local examples of how we are addressing some of the issues facing our industry.



[Read Full Story](#)

International Plant Nutrition Institute Reports on Its Efforts to Fight World Hunger

Fighting world hunger through the appropriate use of plant nutrients was a major theme of a recent Board of Directors meeting of the International Plant Nutrition Institute, held May 17 in Vienna, Austria.



[Read Full Story](#)

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**PUBLICAÇÕES –
BETTER CROPS**

BETTER CROPS
WITH PLANT FOOD



BETTER CROPS
WITH PLANT FOOD



BETTER CROPS
WITH PLANT FOOD



BETTER CROPS
WITH PLANT FOOD

2001 Number 1

For This Issue...

- 100% or More? *Assessing the Impact of Plant Food on Crop Yield and Profitability*
- Managing Crop Rotations for Profitability
- Regional Variability of Nutrient Requirements
- Land Use & more

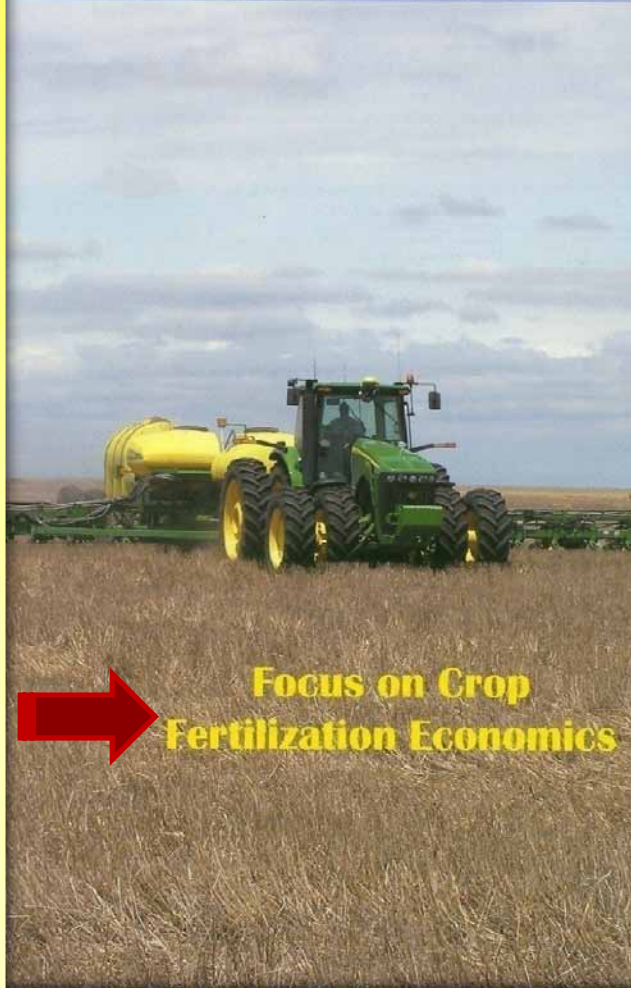
The cover features a tractor in a field, likely engaged in a farming activity like planting or harvesting. The field is green, and there are trees in the background. The sky is clear and blue. The overall scene is a typical agricultural landscape.

**PUBLICAÇÕES –
BETTER CROPS**

BETTER CROPS

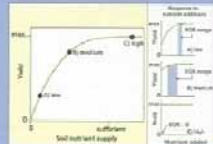
WITH PLANT FOOD

A Publication of the International Plant Nutrition Institute (IPNI) 2005 Number 3




In This Issue...


Principles of Allocating Funds across Nutrients




Nutrient Management within a Wheat-Maize Rotation



Corn Fertilizer Decisions in a High-Priced Market



Also:
Balanced Fertility Still Pays in Irrigated Corn
...and much more



IPNI
www.ipni.net

 **Focus on Crop Fertilization Economics**





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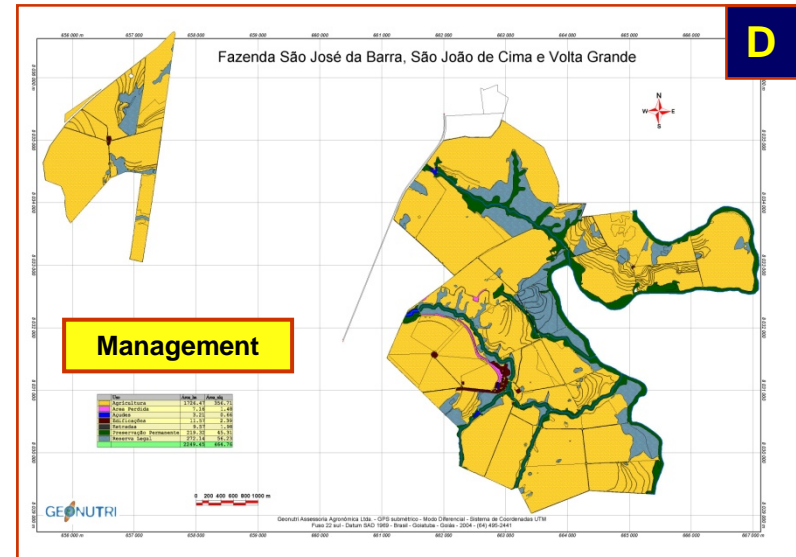
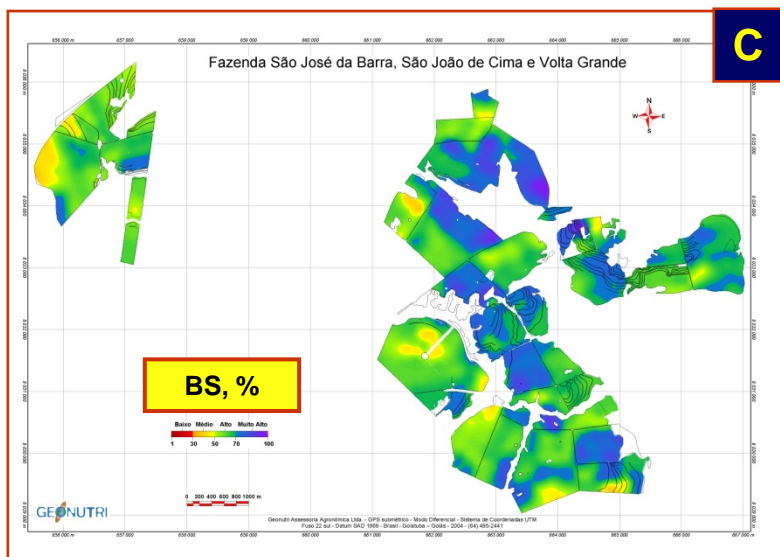
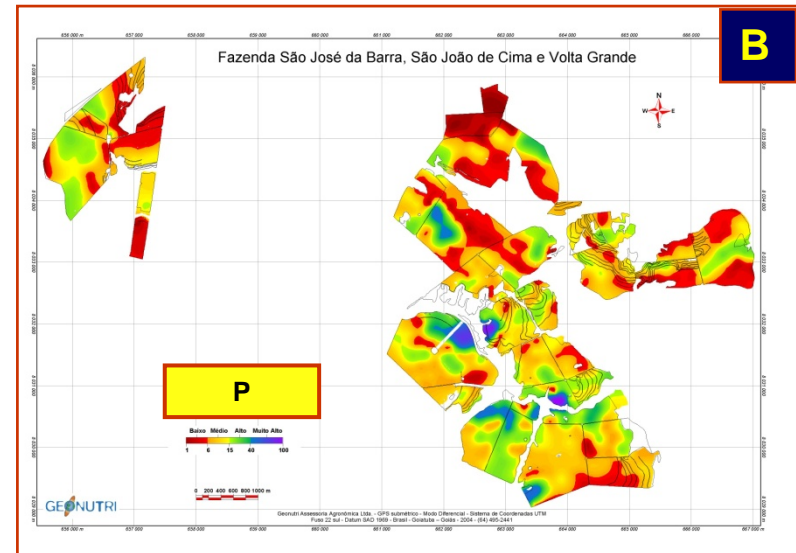
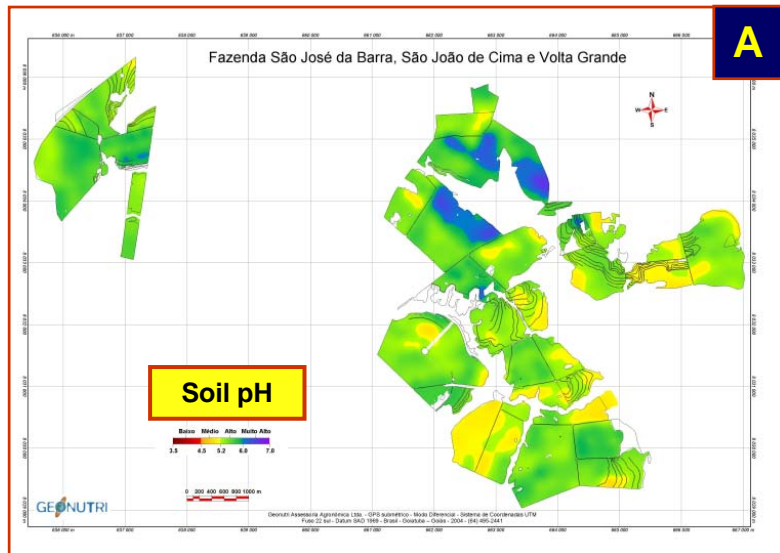
**SOIL FERTILITY EVALUATION
AND CONTROL WITH EMPHASIS
IN THE ION EXCHANGE RESIN**



**A GOOD PROGRAM UNDER AGRICULTURE
NUTRIENT MANAGEMENT SHOULD INITIALLY,
AND ABOVE ALL, HAVE AN EFFICIENT METHOD
TO PROPERLY EVALUATE THE SOIL
BIOAVAILABILITY OF PLANT NUTRIENTS**



Spatial distribution of pH CaCl_2 0.01 mol L⁻¹ (A). P (B). base saturation (C). and soil management recommendation (D) in farms São José da Barra. São João de Cima e Volta Grande (Sparovek & Cooper, 2003)



EXERCISE 1

THE DETERMINATION OF P IN A SOIL SAMPLE, USING METHODOLOGY “A”, REVEALED AN AMOUNT OF 4 MG DM⁻³ (VERY LOW). THE FERTILIZER RECOMENDATION TO MAIZE IN THIS CASE WOULD BE 100 KG HA⁻¹ OF P₂O₅. AN EXPERIMENT UNDER THIS FIELD SITE SHOWED THAT THE CROP DID NOT RESPOND TO P (7.5 T HA⁻¹). MAKE COMMENTS REGARDING THE EFFECTIVENESS OF METHODOLOGY “A”.

SEVERAL METHODS TO EVALUATE SOIL NUTRIENT BIOAVAILABILITY

ADVANTAGES OF SOIL CHEMICAL ANALYSIS

- ✓ ANTICIPATES CHEMICAL MANAGEMENT
- ✓ RELIABLE WHEN PROPERLY ADJUSTED
- ✓ EASILY USED ON ROUTINE BASIS
- ✓ GENERALLY NOT EXPENSIVE



Rate of P_2O_5 application considering regular farmer practice versus when utilizing soil chemical analysis.

Area	Soil P ⁽¹⁾	Rate of P_2O_5		P_2O_5 balance
		Applied by farmer	Required ⁽²⁾	
	mg dm ⁻³	----- kg ha ⁻¹ -----		
A	3	60	90	- 30
B	12	60	60	0
C	28	60	30	+ 30

⁽¹⁾ Soil P (mg dm⁻³): 0 – 6 = very low, 7 – 15 = low, 16 – 40 = medium, 41 – 80 = high, > 80 = very high.

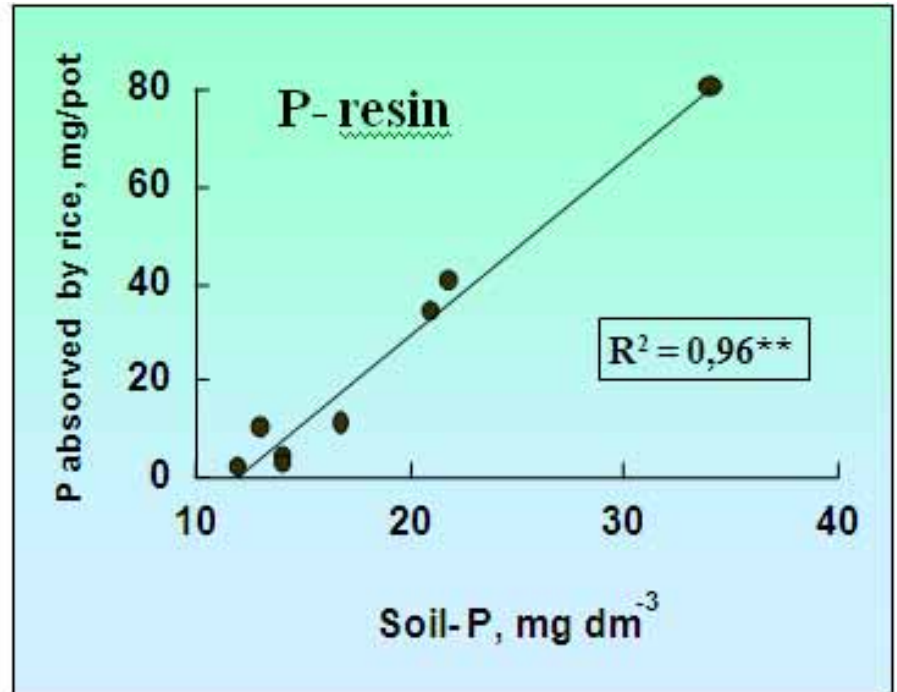
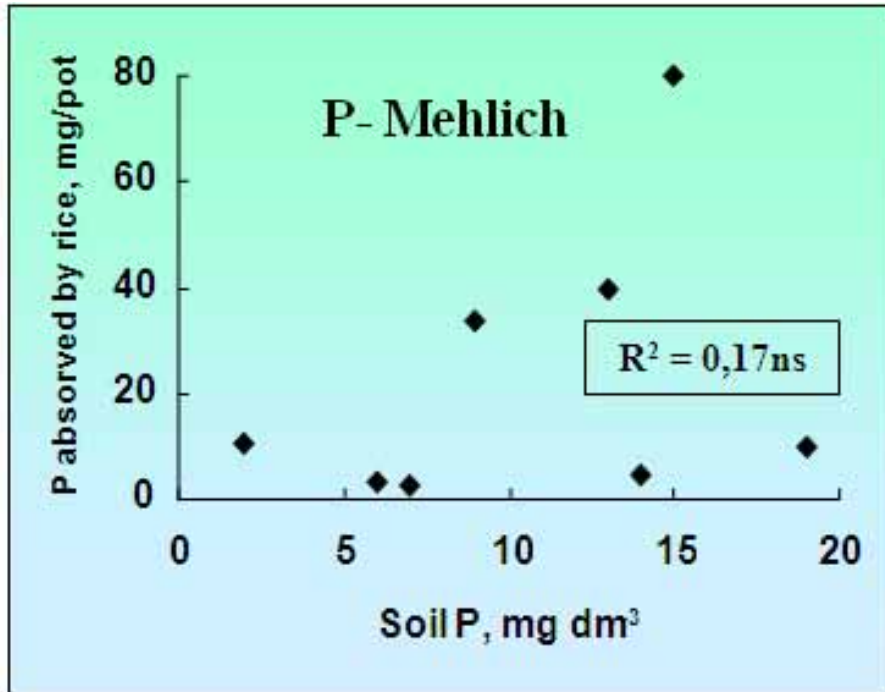
⁽²⁾ According to maize calibration and response curve studies by the resin method to evaluate the bioavailable pool of P in the soil.

PROPERLY ADJUSTED TO LOCAL CONDITIONS

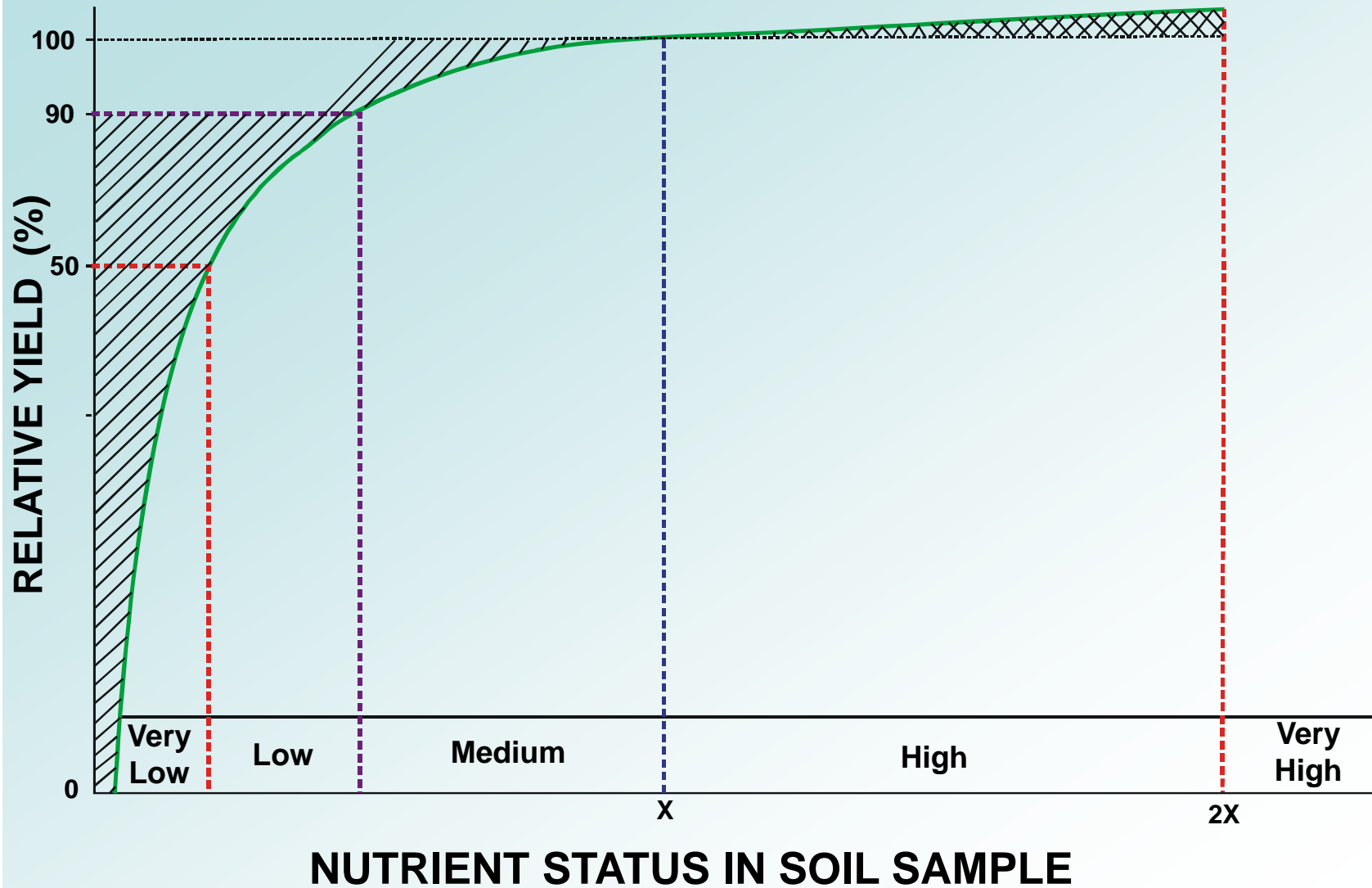
- ✓ CORRELATION (WHAT METHODOLOGY?)
- ✓ CALIBRATION (NUMBERS VERSUS PLANT REQUIREMENTS)
- ✓ RESPONSE CURVES (WHAT TO ADD?)



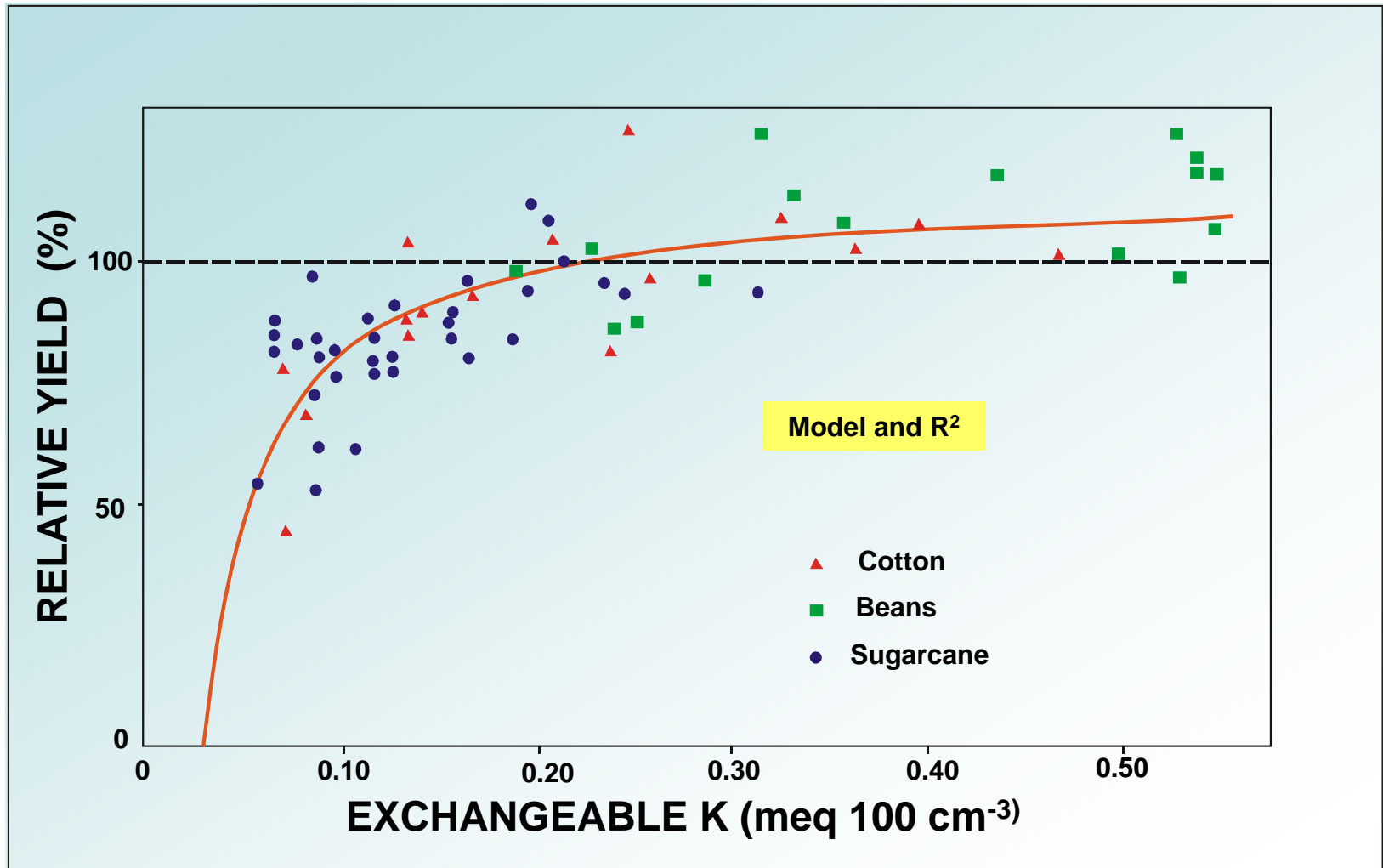
CORRELATION STUDIES



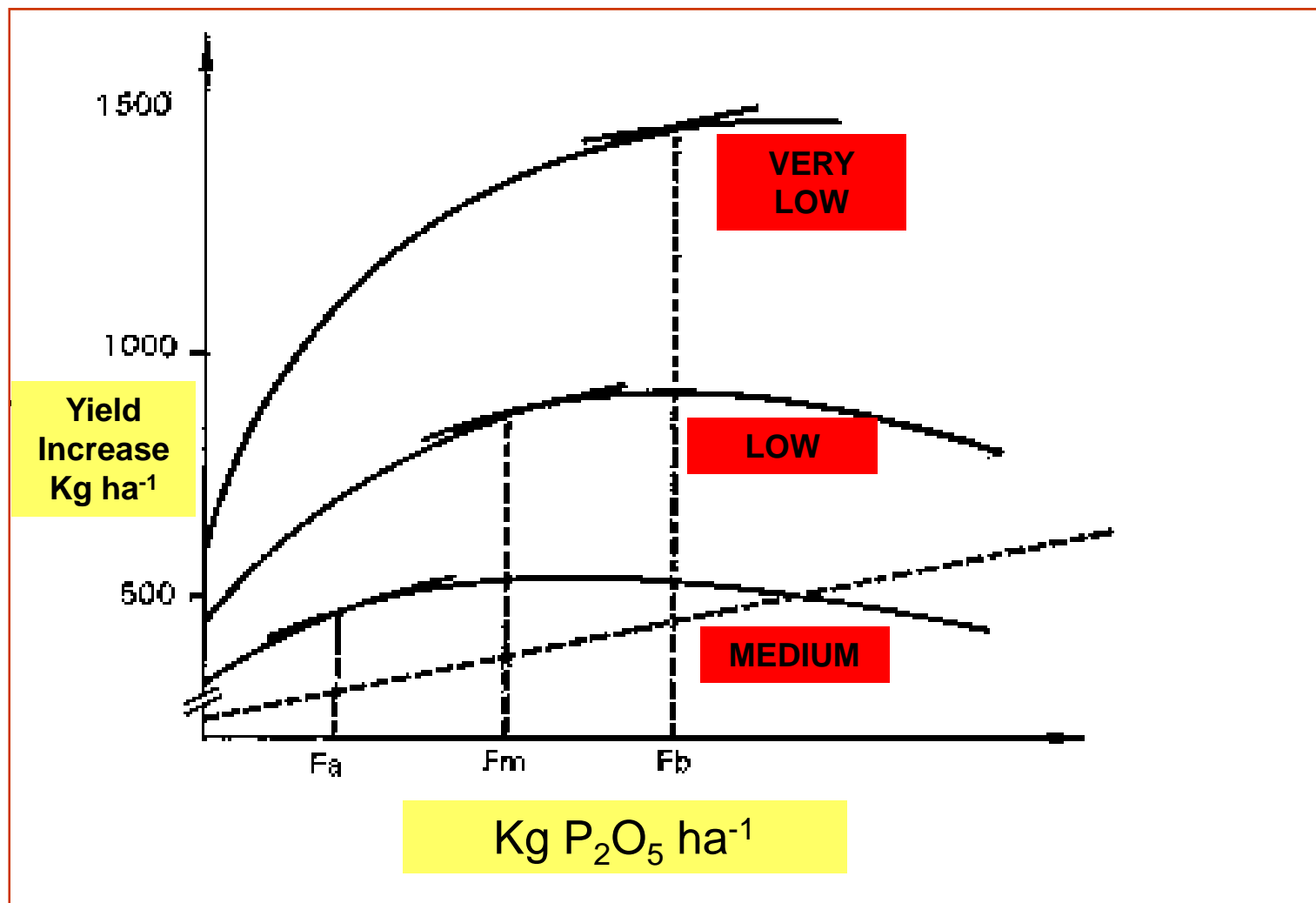
CALIBRATION STUDIES



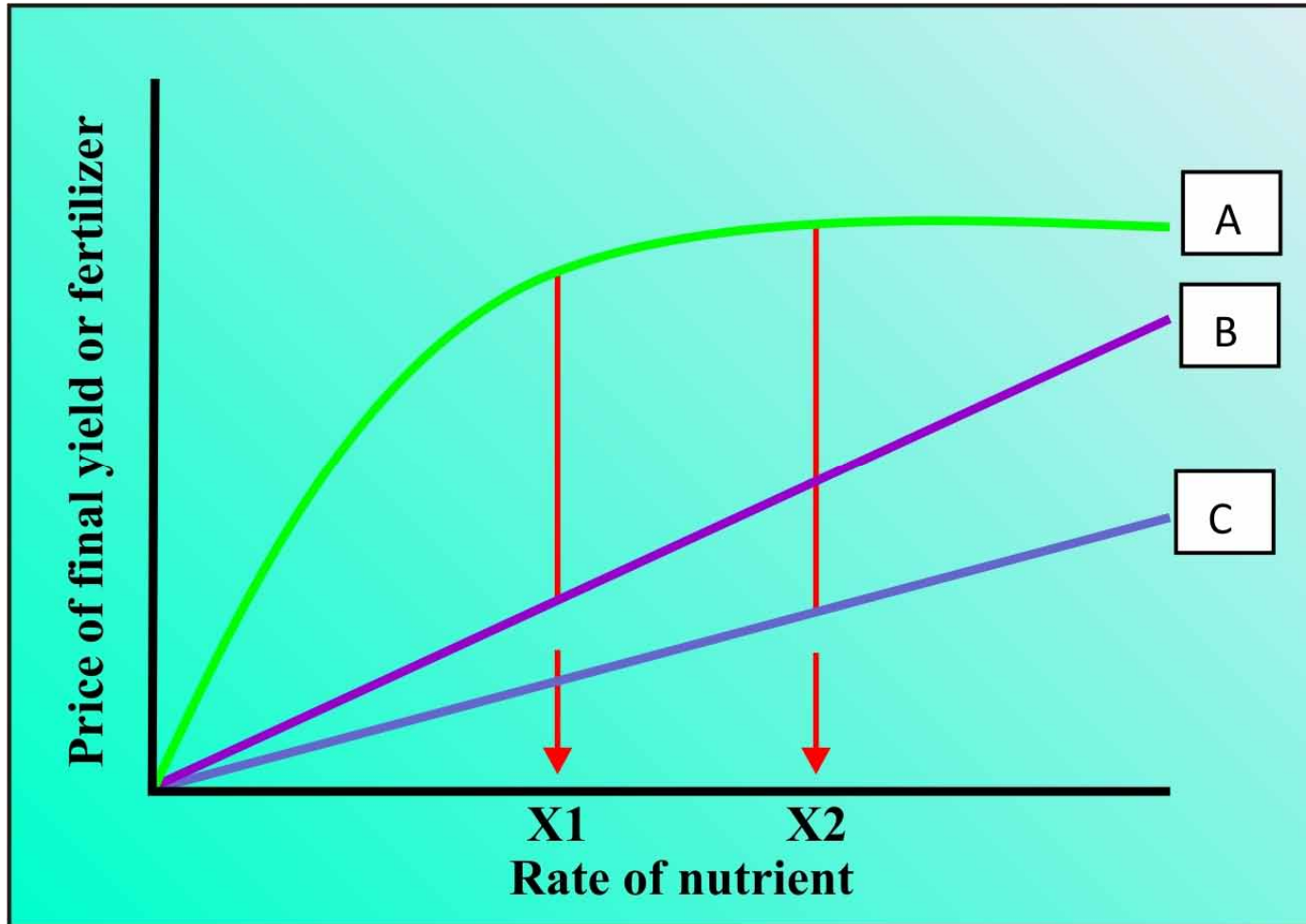
CALIBRATION STUDIES



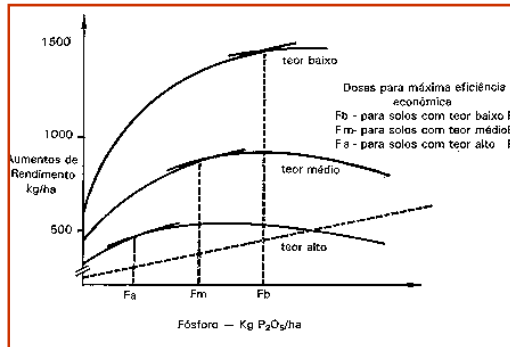
RESPONSE CURVE STUDIES



RESPONSE CURVE STUDIES



A = YIELD RESPONSE, B AND C = FERTILIZER



RECOMENDATION CHART

Adubação mineral de plantio: Aplicar de acordo com a análise de solo e a produtividade esperada, conforme a seguinte tabela:

YIELD	Nitro- gênio	P resina, mg/dm ³				K ⁺ trocável, mmol _c /dm ³			
		0-6	7-15	16-40	>40	0-0,7	0,8-1,5	1,6-3,0	>3,0
t/ha	N, kg/ha	P ₂ O ₅ , kg/ha				K ₂ O, kg/ha ⁽²⁾			
2- 4	10	60	40	30	20	50	40	30	0
4- 6	20	80	60	40	30	50	50	40	20
6- 8	30	90	70	50	30	50	50	50	30
8-10	30	⁽¹⁾	90	60	40	50	50	50	40
10-12	30	⁽¹⁾	100	70	50	50	50	50	50

⁽¹⁾ É improvável a obtenção de alta produtividade de milho em solos com teores muito baixos de P, independentemente da dose de adubo empregada. ⁽²⁾ Para evitar excesso de sais, no sulco de plantio, a adubação potássica para doses maiores que 50 kg/ha de K₂O está parcelada, prevendo-se a aplicação em cobertura.

Maize – Rajj et al, 1996



PROCEDURE HAS TO BE SPECIFIC FOR

- ✓ **METHODOLOGY**
- ✓ **AREA/REGION AND SOILS CONSIDERED**
- ✓ **CULTIVATION SYSTEM**
- ✓ **SOIL DEPTH SAMPLING**



IMPORTANT ISSUES

- ✓ PROPER SOIL SAMPLING
- ✓ USE OF RELIABLE LAB
- ✓ PRECISION AND ACCURACY
- ✓ CAREFULL INTERPRETATION
- ✓ CAREFULL RECOMMENDATION
- ✓ CAREFULL APPLICATION

Correct result = 10

Precise: 9, 10, 8, 9

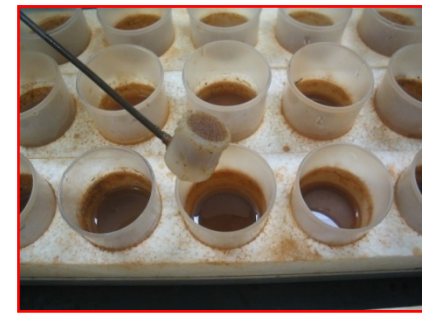
Accurate: around 10

Precise but inaccurate: 22, 23, 21

Accurate (AV), not precise: 7, 13, 6, 14



THE ION EXCHANGE RESIN METHOD



- ✓ H-C ARTIFICIAL PHYSICAL PRODUCT
- ✓ HIGH EXCHANGE CAPACITY
- ✓ BIO-CHEMICAL-PHYSICAL METHOD
- ✓ RESIN WITH CEC OR AEC
- ✓ MIXTURE OF TWO (EX.: P, CA, MG AND K)

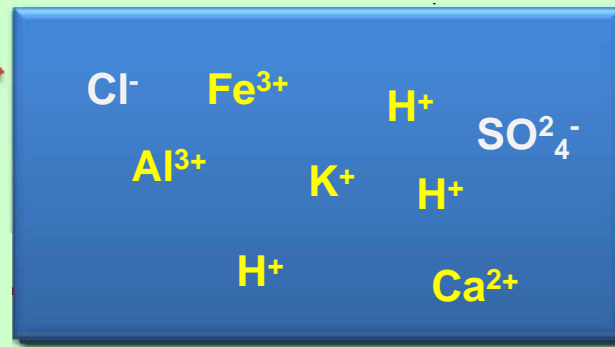
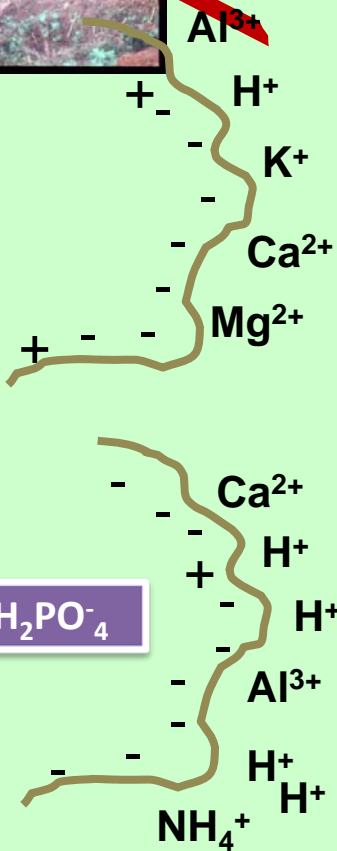
ASPECTOS BÁSICOS DE QUÍMICA DO SOLO:

Fase Sólida

Fase Solução



Formação de P – Ca, Fe e/ou Al



CONSEQÜÊNCIAS:

⇓ [P] na solução

Transporte até superfície da raiz por difusão

⇓ Disponibilidade de P às plantas

SOLO	FASE SÓLIDA
De forma simples	ORGÂNICA INORGÂNICA
	POROS
	AR ÁGUA
	ORGANISMOS
	MACRO MICRO

CARGAS:
Constantes
Variáveis (principalmente pH)

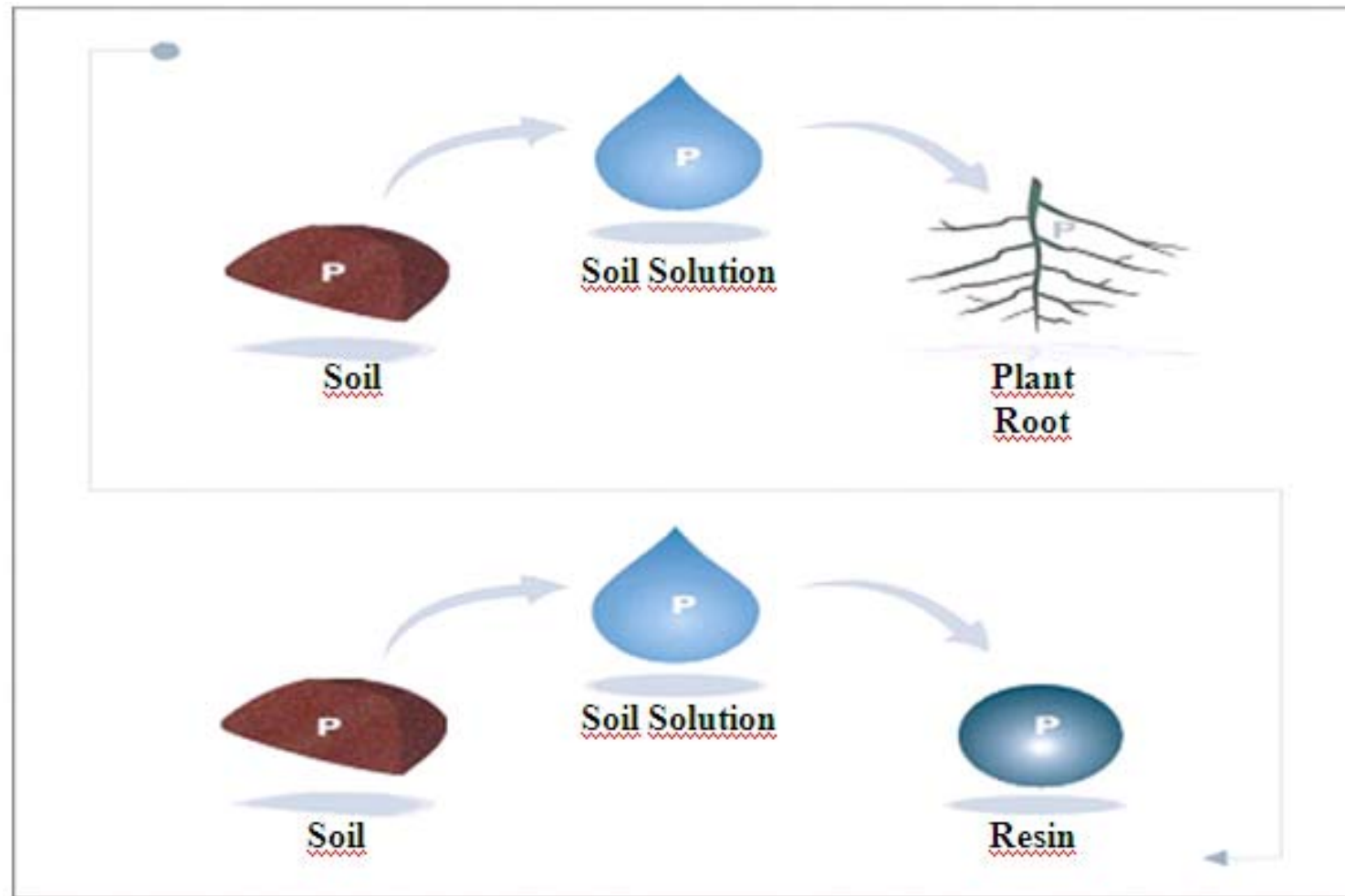
PCZ ou PESN:
pH onde -S = +S
Efeito de profundidade

ADSORÇÃO:
Ligação iônica = Pratic/te todos os cátions
Ligação covalente = H+

Equação de Kerr
 $(K^+) = K_{ex} [K^+]$
 $(Na^+) [Na^+]$

$SB = K + Ca + Mg (+Na)$
 $CTC\ pH\ 7,0 = SB + (H+Al)$
 $V\% = \frac{SB \times 100}{CTC\ pH\ 7,0}$





THE ION EXCHANGE RESIN METHOD



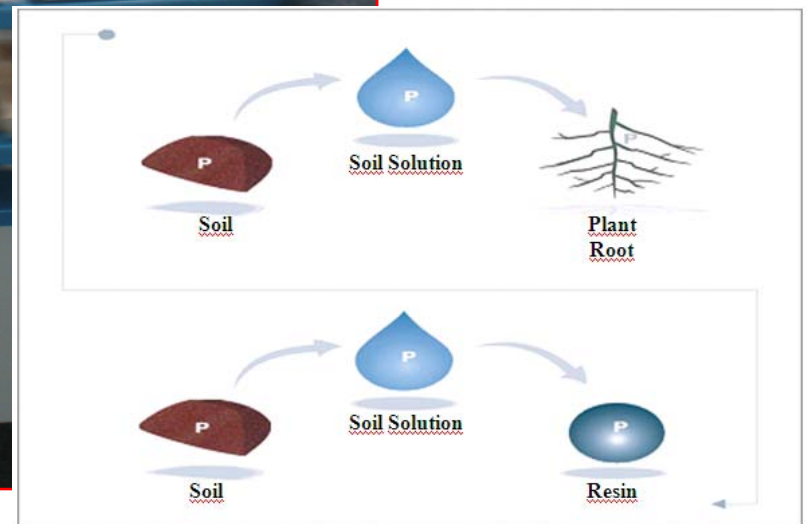
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- ✓ HIGH EXCHANGE CAPACITY
- ✓ BIO-CHEMICAL-PHYSICAL METHOD
- ✓ RESIN WITH CEC OR AEC
- ✓ MIXTURE OF TWO (EX.: P, CA, MG AND K)



SOIL SAMPLE AND RESIN



16 H SHAKING



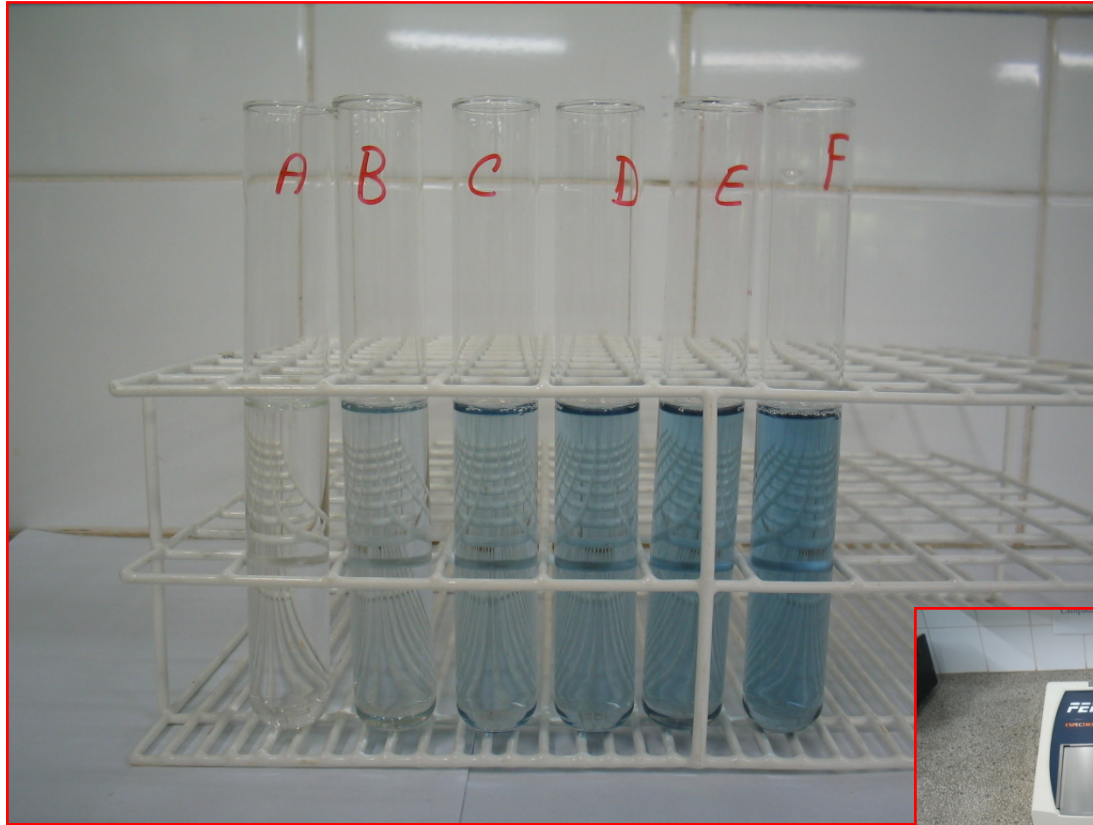
SEPARATION



1 H SHAKING



P QUANTIFICATION



NON LABILE P - LABILE P → SOLUTION P → PLANT

SOIL CHEMICAL ANALYSIS RESULT

Resultado de análise química de terra de rotina

Amostra	pH	M.O. g dm ⁻³	P mg dm ⁻³	K	Ca	Mg	Al	mmol _c dm ⁻³				
								H+Al	S	SB	CTC	V%
A(0-20)	5,4	20	7	1,0	36	14	0	25	2	51	76,0	67
A (20-40)	4,4	14	4	0,7	23	6	12	42	3	29,7	71,7	41
B (0-20)	5,3	28	42	4,4	48	16	0	35	12	68,4	103,4	66



ADVANTAGES IER

- ✓ ACCURACY IN EVALUATING SOIL NUTRIENT BIOAVAILABILITY
- ✓ MULTI NUTRIENT EXTRACTION/EVALUATION (P, CA, MG, K)
- ✓ NEW POSSIBLE ELEMENTS (EX.: S)
- ✓ LOW COST
- ✓ AMPLIFIED RANGE FOR NUTRIENT INTERPRETATION (SUFFICIENCY LEVELS)
- ✓ P EVALUATION IN SOILS RECEIVING PR



EFFECTIVENESS OF P SOIL EXTRACTORS (70 SCIENTIFIC PAPERS)

METHOD	COEFFICIENT OF DETERMINATION (%)		
	ACID	ALCALINE/NEUTRAL pH	NOT SPECIFIED
Resin	84	83	69
Olsen	47	52	58
Mehlich 1	56	39	41
Bray 1	53	25	48

Source: Adapted from SILVA e RAIJ (1999).



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EFFECTIVENESS OF THE PRE TREATMENT OF THE RESIN

SOIL	COTTON (Kg ha ⁻¹)		RESIN-HCl		RESIN-NaCl		RESIN-NaHCO ₃	
	NO P	WITH P	pH (mg dm ⁻³)	P	pH (mg dm ⁻³)	P	pH (mg dm ⁻³)	P
1	3.678	3.673	3.37	3	5.58	5	6.78	36
2	2.058	2.244	3.34	2	5.29	1	6.79	12

Source: RAJ et al. (1986).



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EFFECTIVENESS OF DIFFERENT P METHODOLIGIES

Evaluation of P bioavailability	TSP Before Seeding (STANDARD)		Fertilizers Applied 75 Prior to Seeding					
			TSP		Low Reactive PR		Calcined AI-P	
	Valor	Index	Value	Index	Value	Index	Value	Index
P uptake by soybean (mg pot ⁻¹)	4.26	100	2.25	53	1.13	27	1.72	40
P resin (mg dm ⁻³)	12.7	100	7.9	62	1.70	11	4.9	39
P Bray 1 (mg dm ⁻³)	37.9	100	39.6	104	7.90	21	39.4	104
P Mehlich 1 (mg dm ⁻³)	27.9	100	24.6	88	42.8	153	15.0	54

Source: Raij & Quaggio, 1999



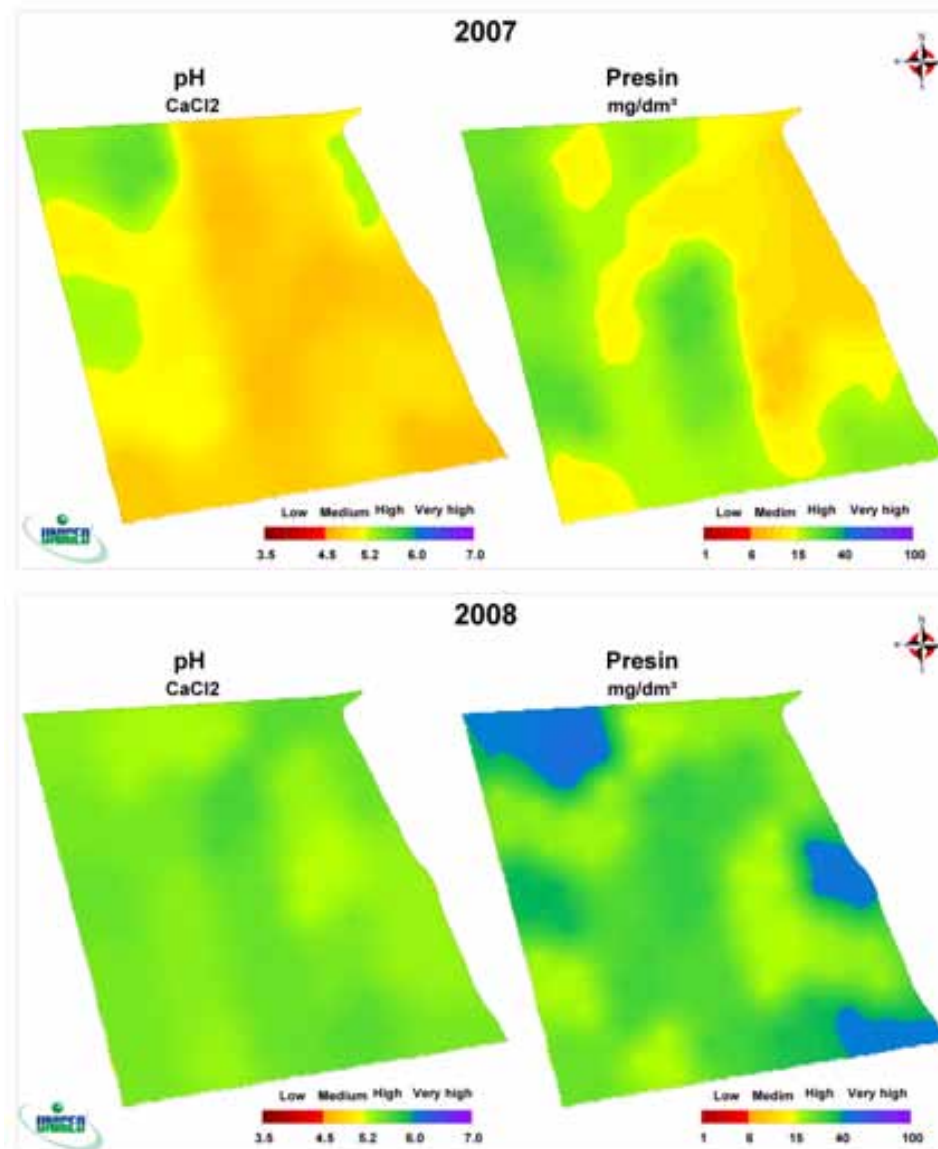
IPNI INTERNATIONAL PLANT NUTRITION INSTITUTE

EFFECT OF SOIL PH IN THE AMOUNT OF P IN PLANT LEAF AND SOIL P BY DIFFERENT METHODOLOGIES

Crop and Location	pH CaCl ₂	Leaf P (g Kg ⁻¹)	Soil P (mg dm ⁻³)			
			Mehlich 1	Bray 1	Olsen	Resina
Beans Pariqüera-Açu	3.8 d *	2.44 b	17 a	20 a	41 a	33 b
	4.2 c	3.21 a	18 a	21 a	33 b	36 ab
	4.7 b	3.25 a	18 a	20 a	26 c	38 ab
	5.1 a	3.26 a	19 a	18 a	19 d	43 a
	5.2 a	3.25 a	20 a	19 a	21 d	43 a
Sunflower Mococa	4.3 c	2.79 c	12 b	24 a	17 a	22 b
	4.6 c	3.27 b	12 b	22 a	17 a	26 ab
	5.3 b	3.81 a	16 a	25 a	16 a	33 ab
	5.5 ab	3.87 a	15 a	20 a	12 a	35 a
	5.7 a	3.80 a	16 a	20 a	12 a	37 a
Soybean Mococa	4.3 a	1.85 c	6 a	15 a	10 a	13 c
	4.8 d	2.06 bc	7 a	16 a	11 a	16 c
	5.5 c	2.44 ab	5 a	13 a	7 a	17 bc
	6.1 b	2.26 a	7 a	17 a	8 a	22 ab
	6.4 a	2.55 a	7 a	15 a	8 a	27 a
Soybean Ribeirão Preto	4.5 d	2.35 b	9 a	20 a	18 a	16 c
	4.9 c	2.69 ab	8 a	22 a	15 ab	19 bc
	6.1 b	2.88 a	8 a	20 a	13 ab	23 b
	6.6 a	2.85 a	10 a	24 a	12 b	34 a

Source: RAIJ e QUAGGIO (1990).





Images of precision agriculture showing pH in CaCl₂ and P_{resin} before (2007) and after liming (2008)

FINAL REMARKS



**A GOOD PROGRAM UNDER AGRICULTURE
NUTRIENT MANAGEMENT SHOULD INITIALLY, AND
ABOVE ALL, HAVE AN EFFICIENT METHOD TO
PROPERLY EVALUATE THE SOIL BIOAVAILABILITY
OF PLANT NUTRIENTS**

**WE SHOULD NOT MAKE OURSELVES
CONFORTABLE. NEW AND BETTER POSSIBILITIES
MAY EXIST.**

**TEST THE EFFECTIVENESS OF CURRENT
METHODS UNDER SITE FIELD CONDITIONS**

**HOW ARE THE METHODS FOR SOIL ANALYSIS
EVALUATING THE BIOAVAILABILITY OF
NUTRIENTS IN YOUR REGION ?**





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INTERNATIONAL
PLANT NUTRITION
INSTITUTE



**CONGRESO PERU
Tarapoto, Nov 16 - 21**

**Dr. Luís Ignácio Prochnow
IPNI Brazil Program Director**



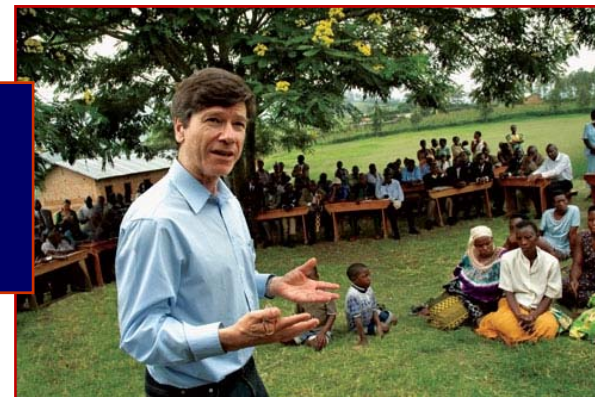
**PRODUCTION AND AGRONOMIC
EFFECTIVENESS OF P FERTILIZERS
TO IMPROVE THE USE OF
PHOSPHATE ROCKS**



IPNI



Dr. JEFFREY SACCHS
Columbia University



- **Times Magazine**: Dr. Jeffrey Sachs é uma das 100 pessoas mais influentes no mundo.
- Líder do “*United Nations Millenium Project*”.
- Palestra no XVIII Congresso Mundial de Ciência do Solo, Philadelphia, Julho 2007:
“A Ciência do Solo e o Desafio por Crescimento Sustentável”.



....

**WE NEED YOU. WE NEED TO PICK UP YOUR BRAINS.
BECAUSE SOIL SCIENCE IS REALLY AT THE CENTER
OF SO MANY OF THE GREAT CHALLENGES THIS
WORLD FACES RIGHT NOW**

....

FILOSOFIA, POESIA



Denes GÁBOR/Hungria

Prêmio Nobel 1973 - Holografia

**“THE FUTURE CAN NOT BE PREDICTED.
THE FUTURE CAN ONLY BE INVENTED.”**



Extraído de Magen, H. (2008)

The future

“One thing is sure: The Earth is more cultivated and developed now than ever before; there is more farming, but fewer forests, swamps are drying up and cities springing up on an unprecedented scale. We

hav **“THE FUTURE CAN NOT BE PREDICTED.
THE FUTURE CAN ONLY BE INVENTED.”** soon Nature will no longer be able to satisfy our needs. It will come to pass

that disease, hunger, flood and war will reduce the excessively large numbers of the human species”.

Quintus Septimus Tertullianus, 200 BC

(by D. G. Johnson, Univ. of Chicago, 22 August 1998)



**SUCCESS TO YOU ALL,
SUCCESS TO AGRICULTURE,
AND THANK YOU VERY MUCH
FOR YOUR KIND ATTENTION**



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