



Unidades de Gestão Diferenciada - UGD

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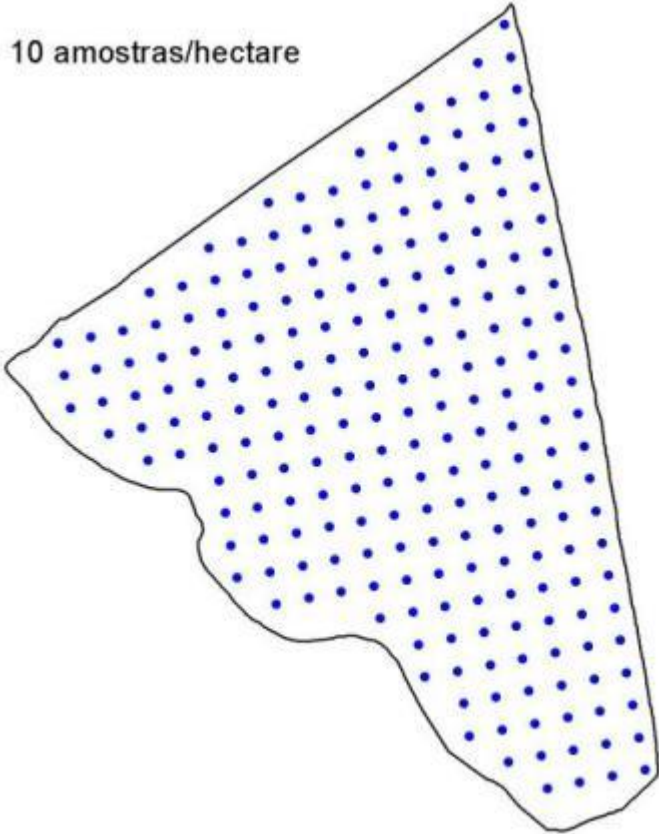


Objetivo

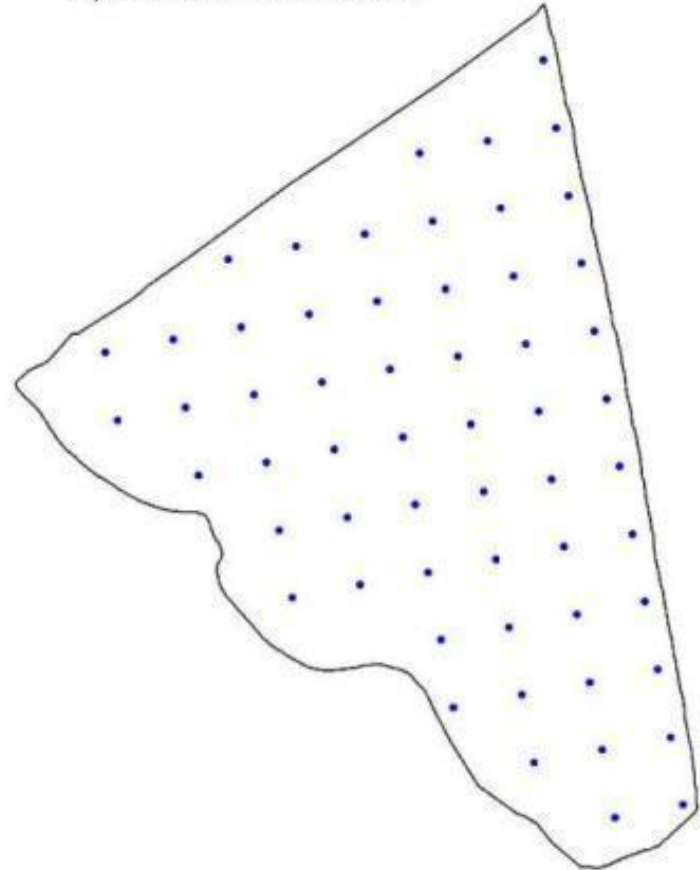
Trabalhar o conceito de unidades de gestão diferenciada como uma abordagem para a gestão da variabilidade espacial e temporal das lavouras

Densidade amostral

10 amostras/hectare

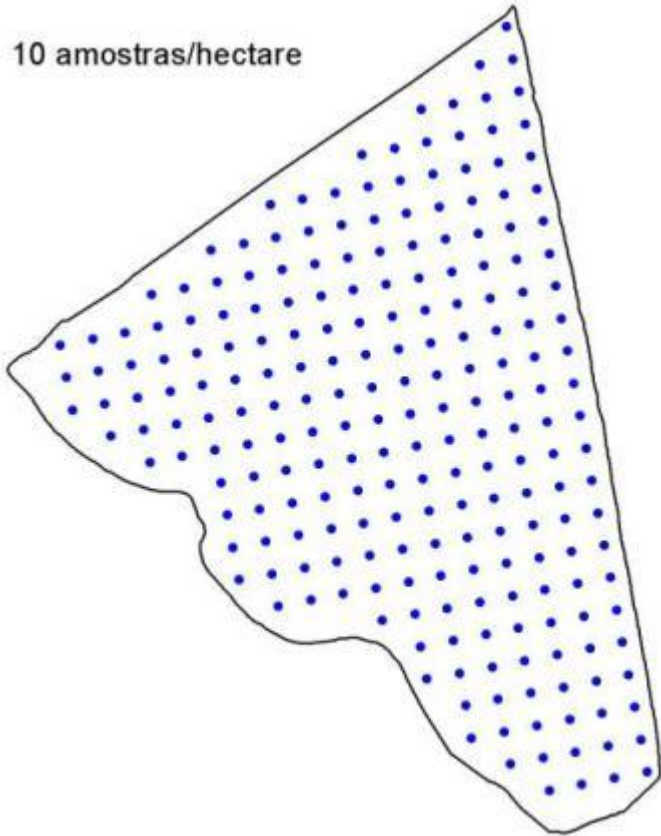


2,5 amostras/hectare

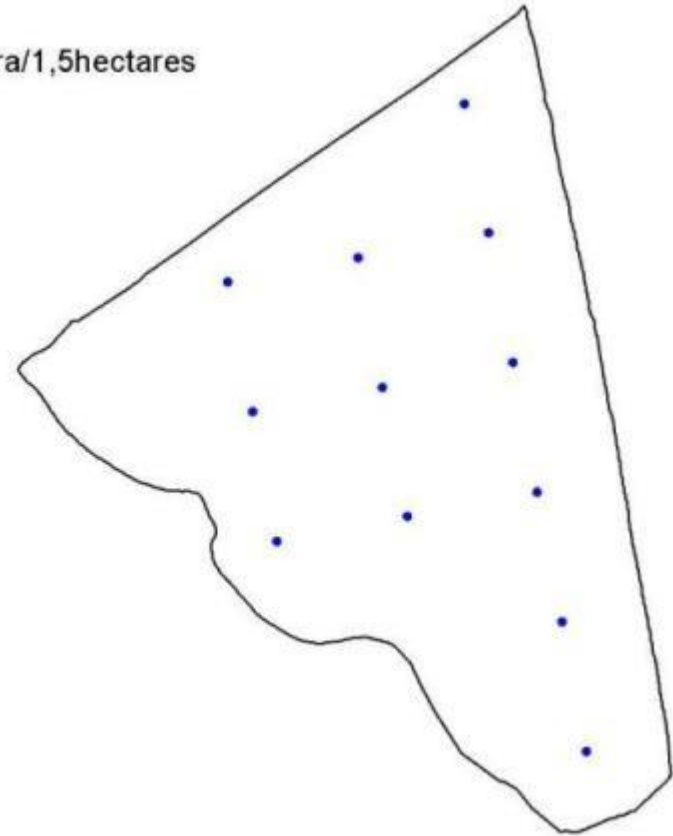


Densidade amostral

10 amostras/hectare

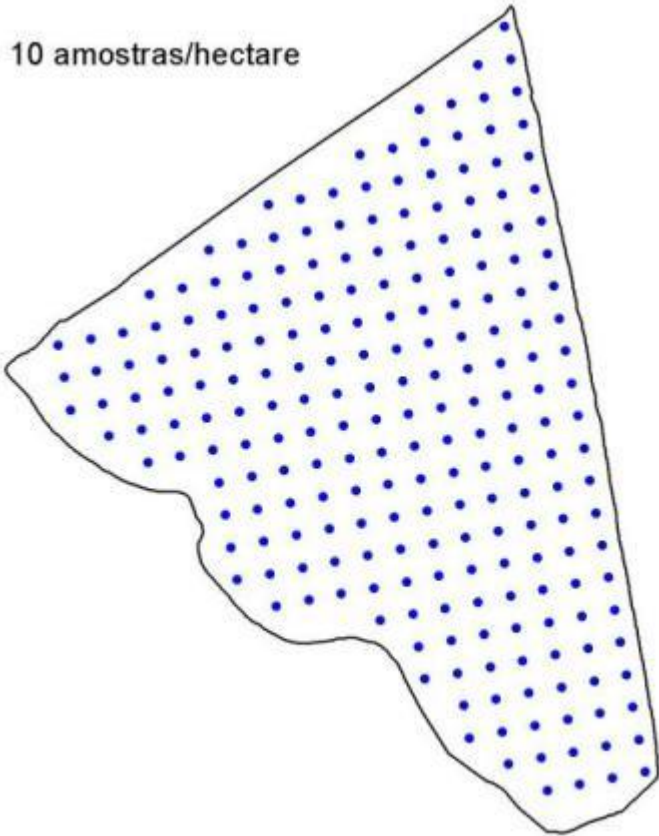


1 amostra/1,5hectares

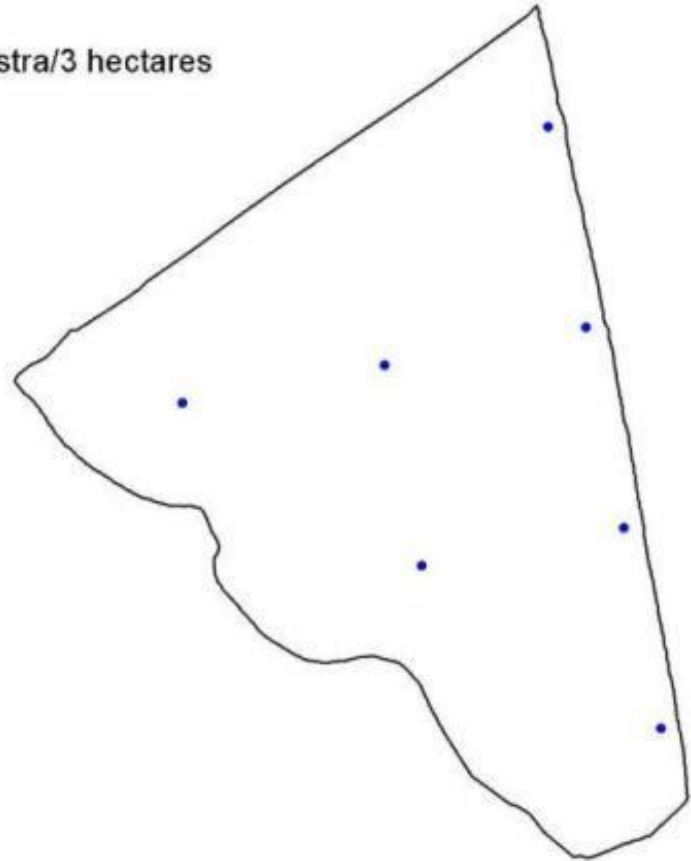


Densidade amostral

10 amostras/hectare



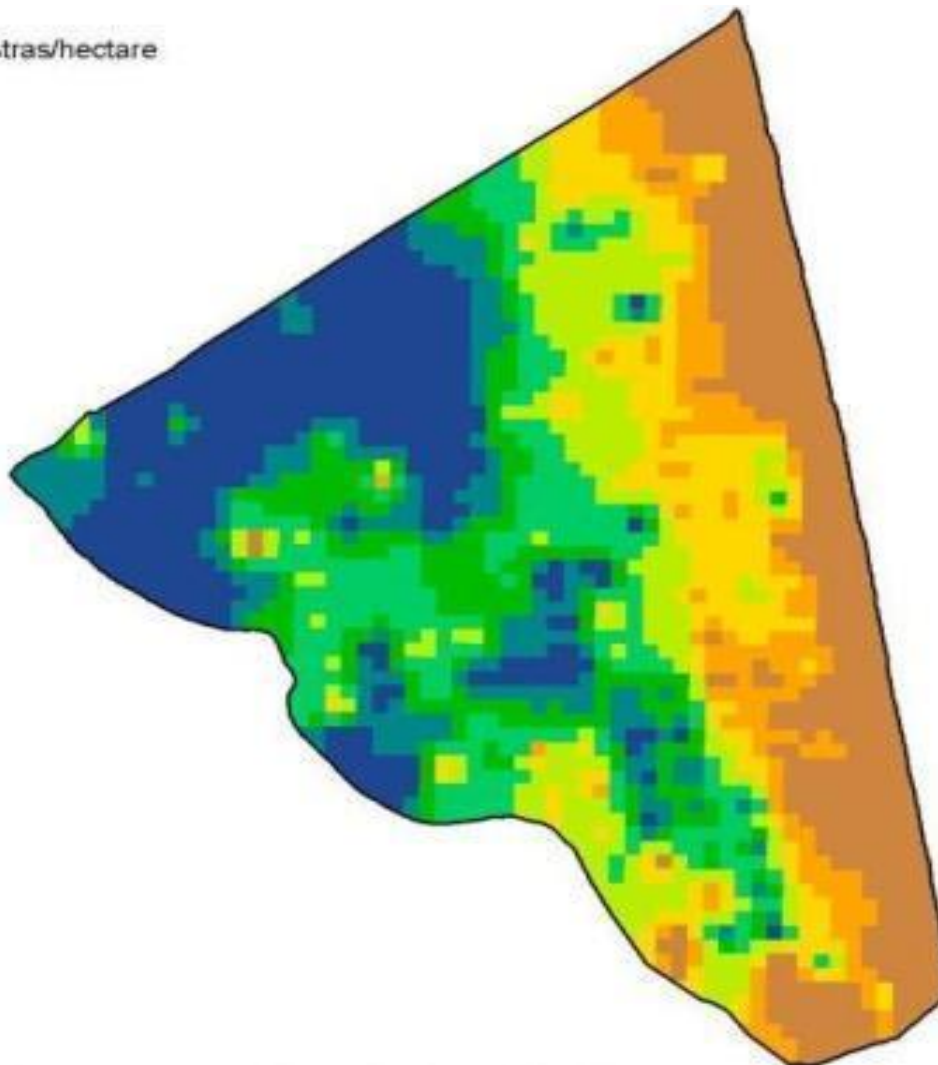
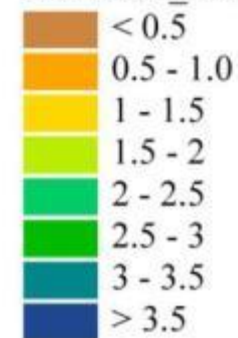
1 amostra/3 hectares



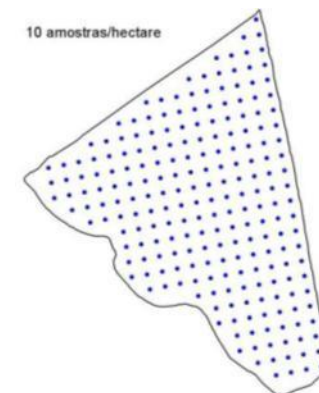
Aplicação de Calcário

10 amostras/hectare

Toneladas Hectare



10 amostras/hectare

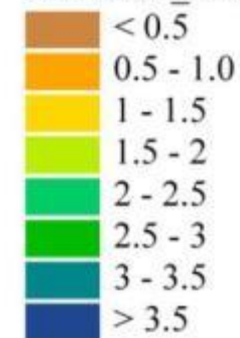


80 0 80 160 240 320 Meters

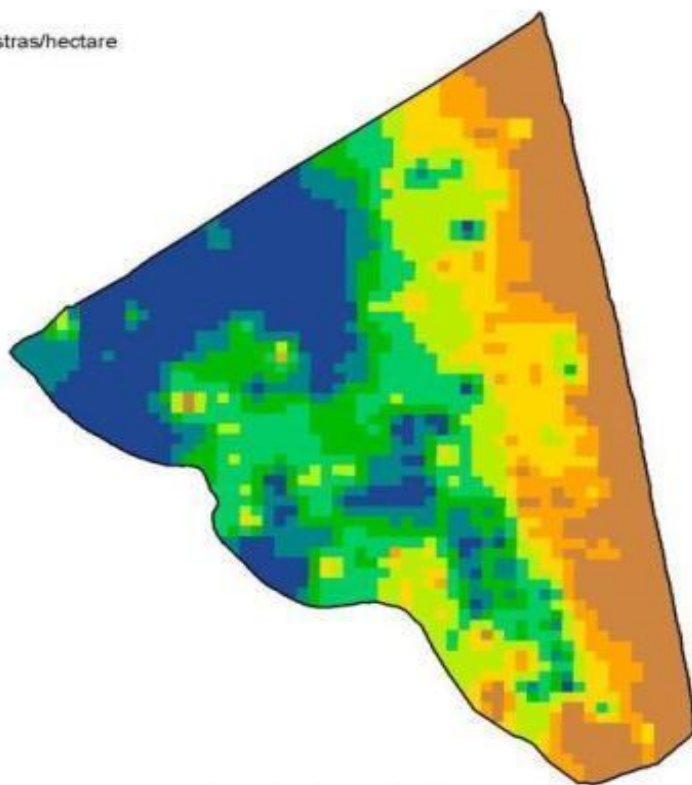


Aplicação de Calcário

Toneladas Hectare

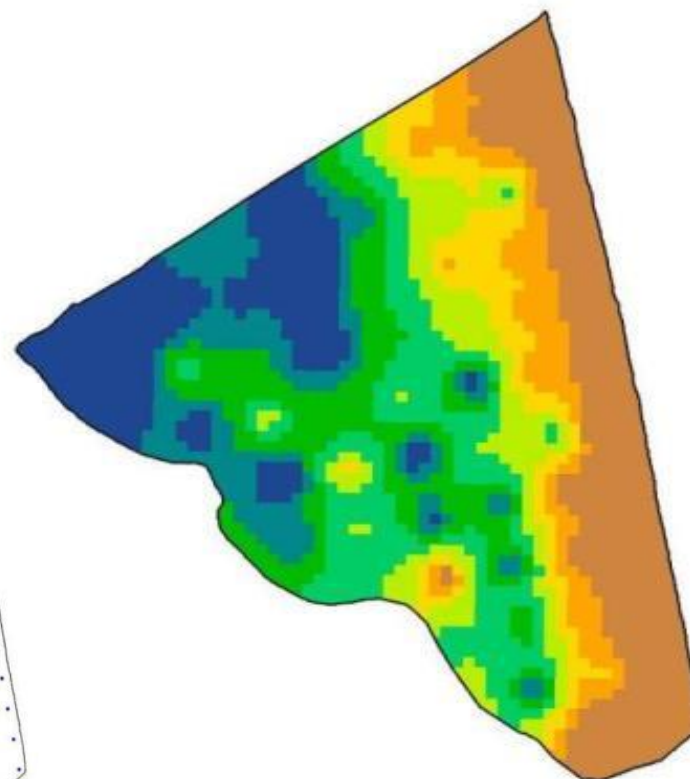
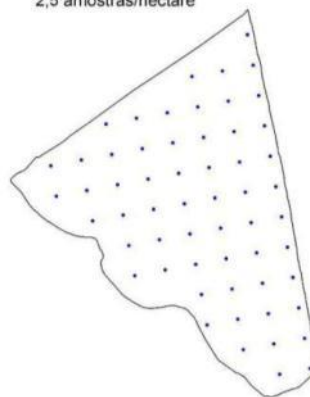


10 amostras/hectare



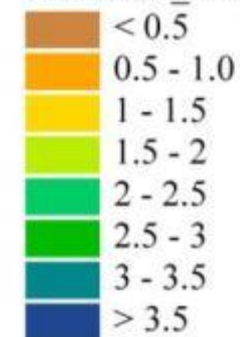
2,5 amostras/ha

2,5 amostras/hectare

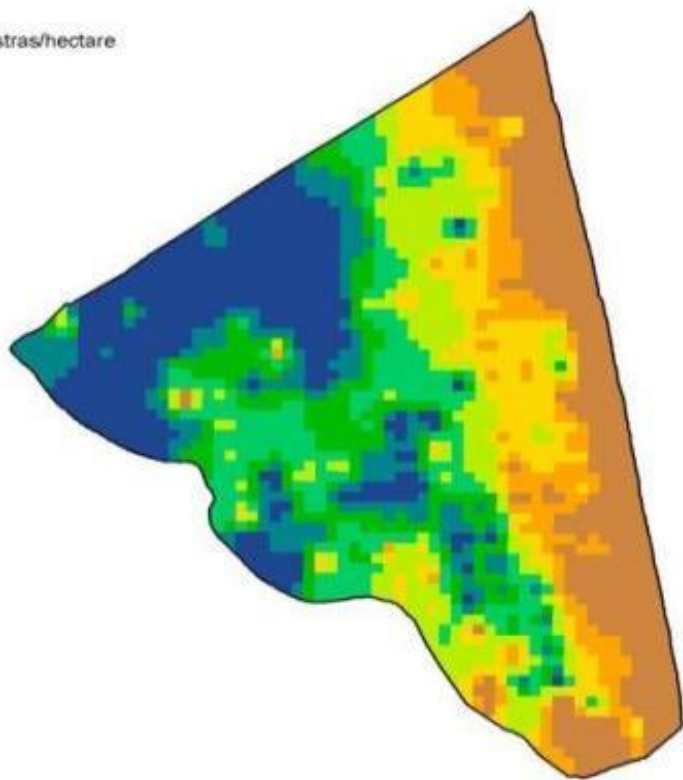


Aplicação de Calcário

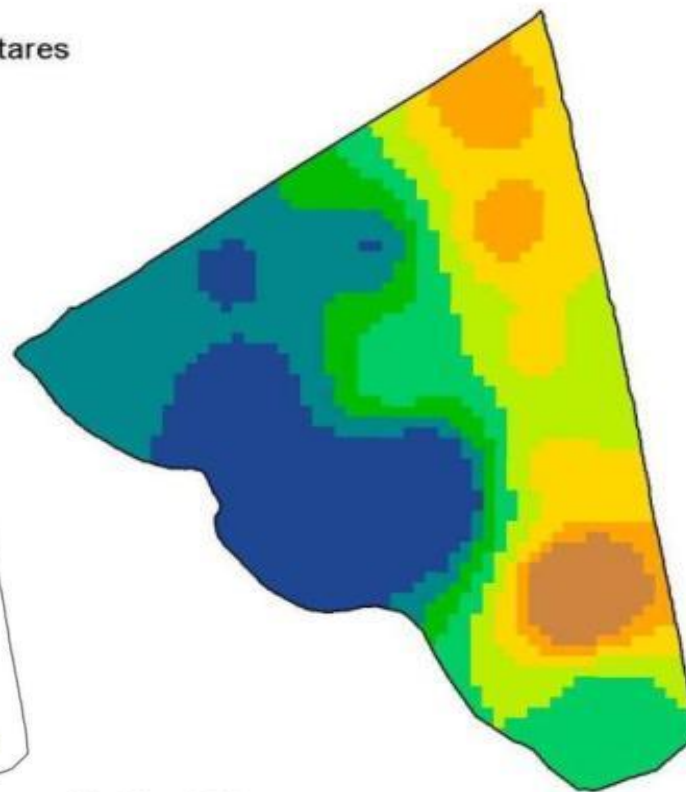
Toneladas Hectare



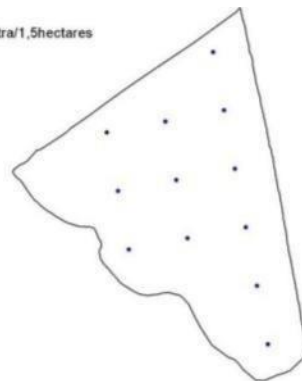
10 amostras/hectare



1 amostra/1,5hectares

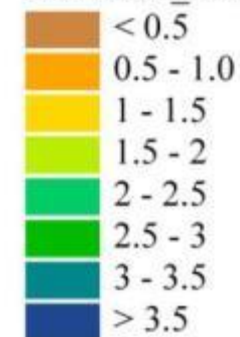


1 amostra/1,5hectares

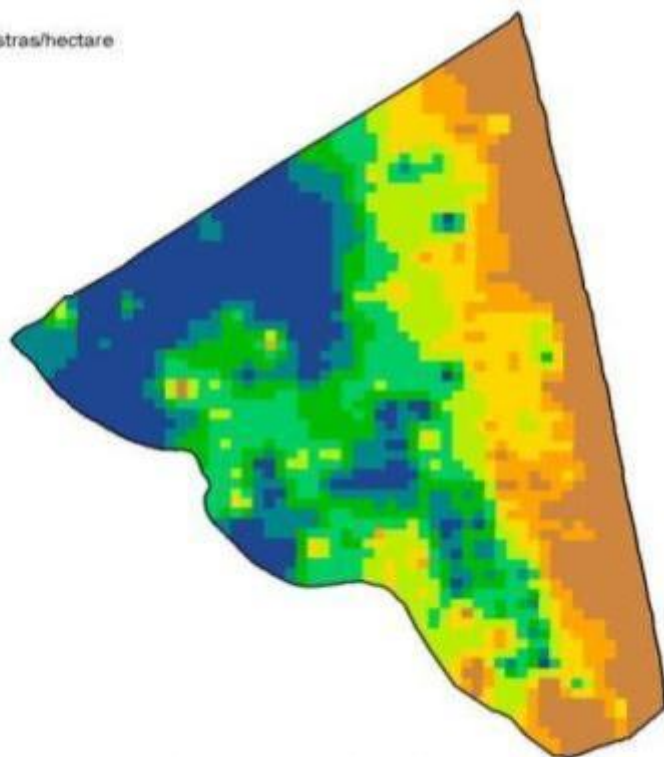


Aplicação de Calcário

Toneladas Hectare

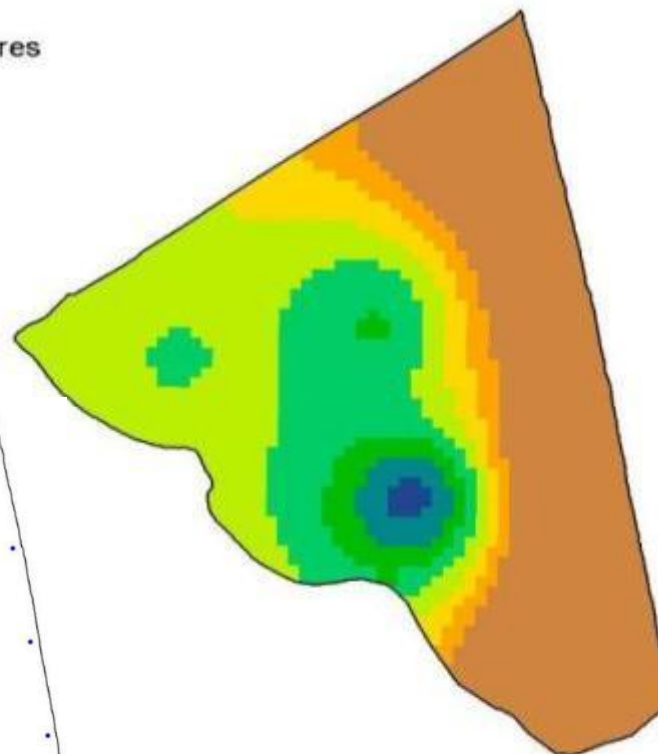
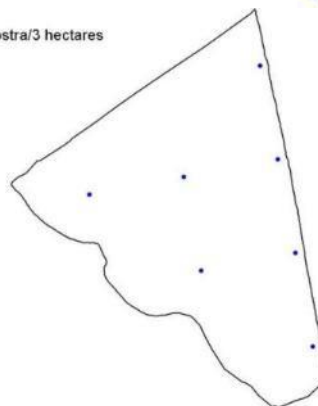


10 amostras/hectare



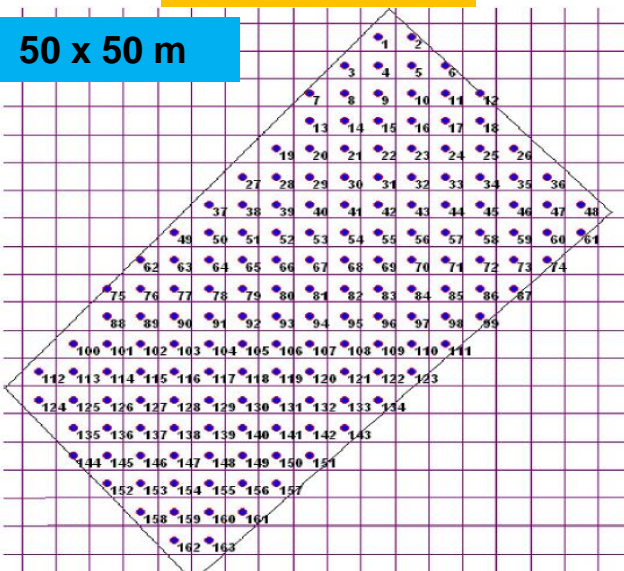
1 amostra/3hectares

1 amostra/3 hectares

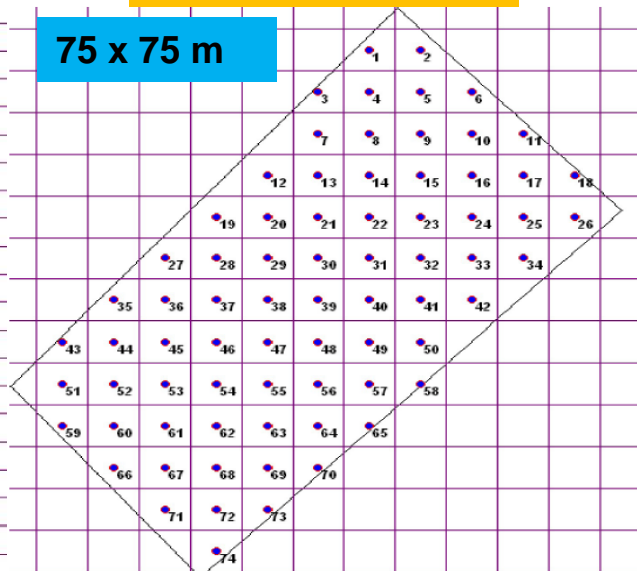


Qual a dimensão ideal da grade amostral?

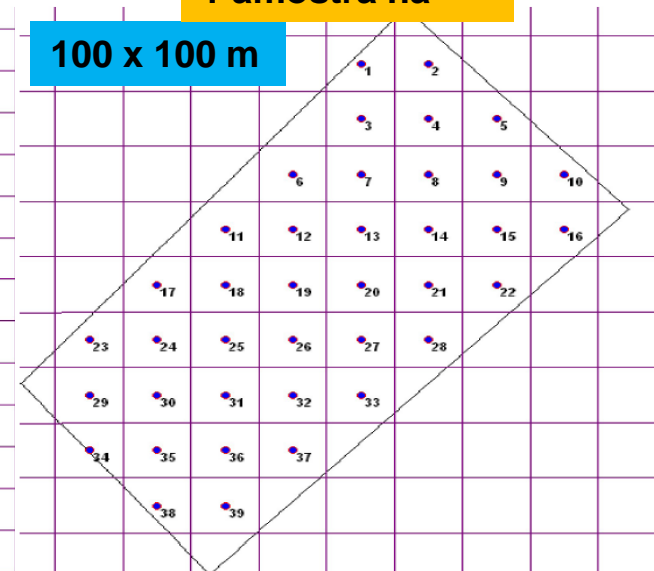
4 amostras ha⁻¹



1,77 amostras ha⁻¹



1 amostra ha⁻¹



1 amostra cada 1,56 ha

125 x 125 m

A 125x125m grid with a diamond-shaped sampling area. The grid is composed of 125 columns and 125 rows of small squares. A diamond shape is inscribed within the grid, with its vertices at the corners of the grid. The diamond contains 27 numbered points, starting from 1 at the top vertex and ending at 27 at the bottom vertex. The points are arranged in a regular grid pattern within the diamond.

1 amostra cada 2,25 ha

150 x 150 m

A 150x150m grid with a diamond-shaped sampling area. The grid is composed of 150 columns and 150 rows of small squares. A diamond shape is inscribed within the grid, with its vertices at the corners of the grid. The diamond contains 17 numbered points, starting from 1 at the top vertex and ending at 17 at the bottom vertex. The points are arranged in a regular grid pattern within the diamond.

1 amostra cada 3,06 ha

175 x 175 m

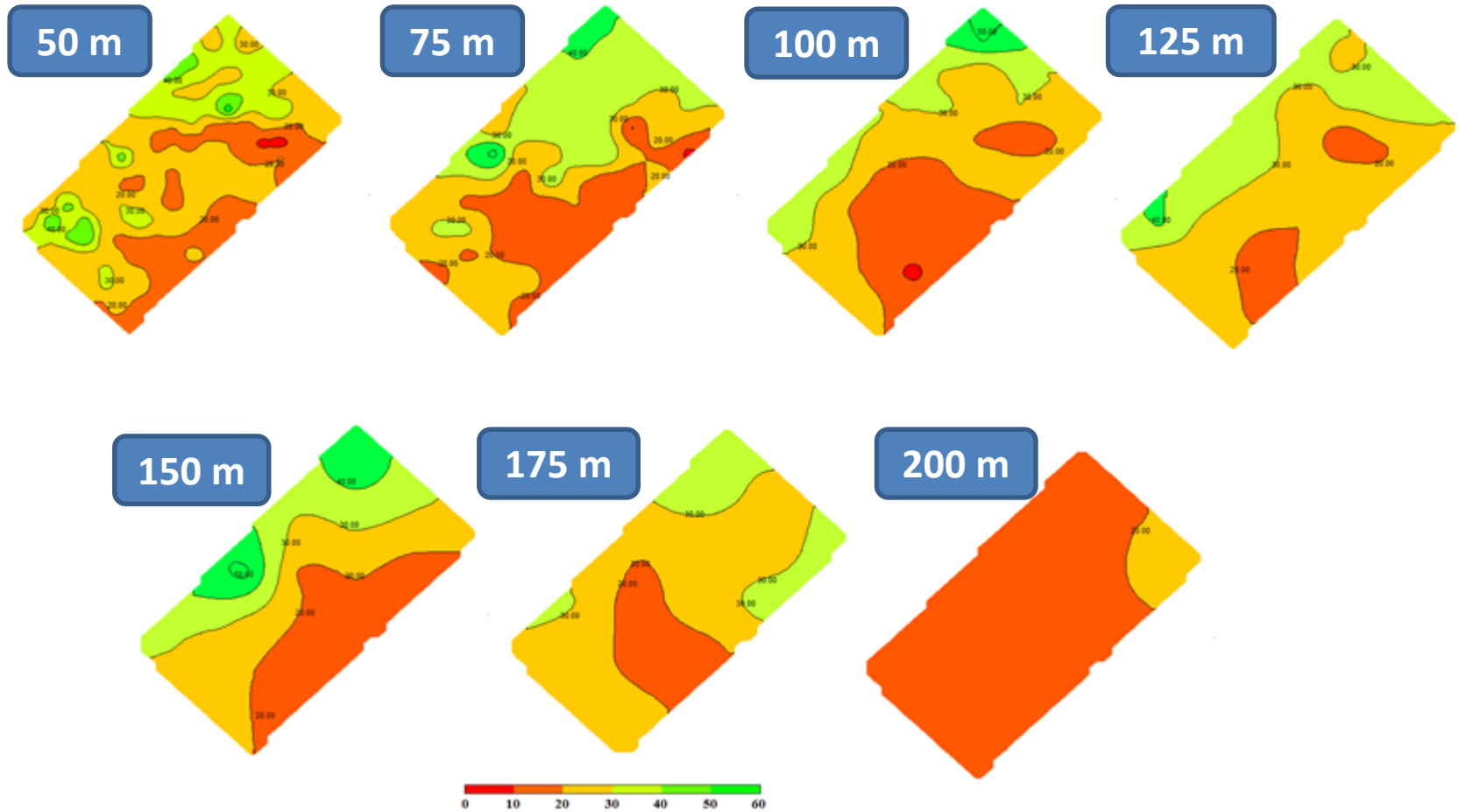
A 175x175m grid with a diamond-shaped sampling area. The grid is composed of 175 columns and 175 rows of small squares. A diamond shape is inscribed within the grid, with its vertices at the corners of the grid. The diamond contains 15 numbered points, starting from 1 at the top vertex and ending at 15 at the bottom vertex. The points are arranged in a regular grid pattern within the diamond.

1 amostra cada 4 ha

200 x 200 m

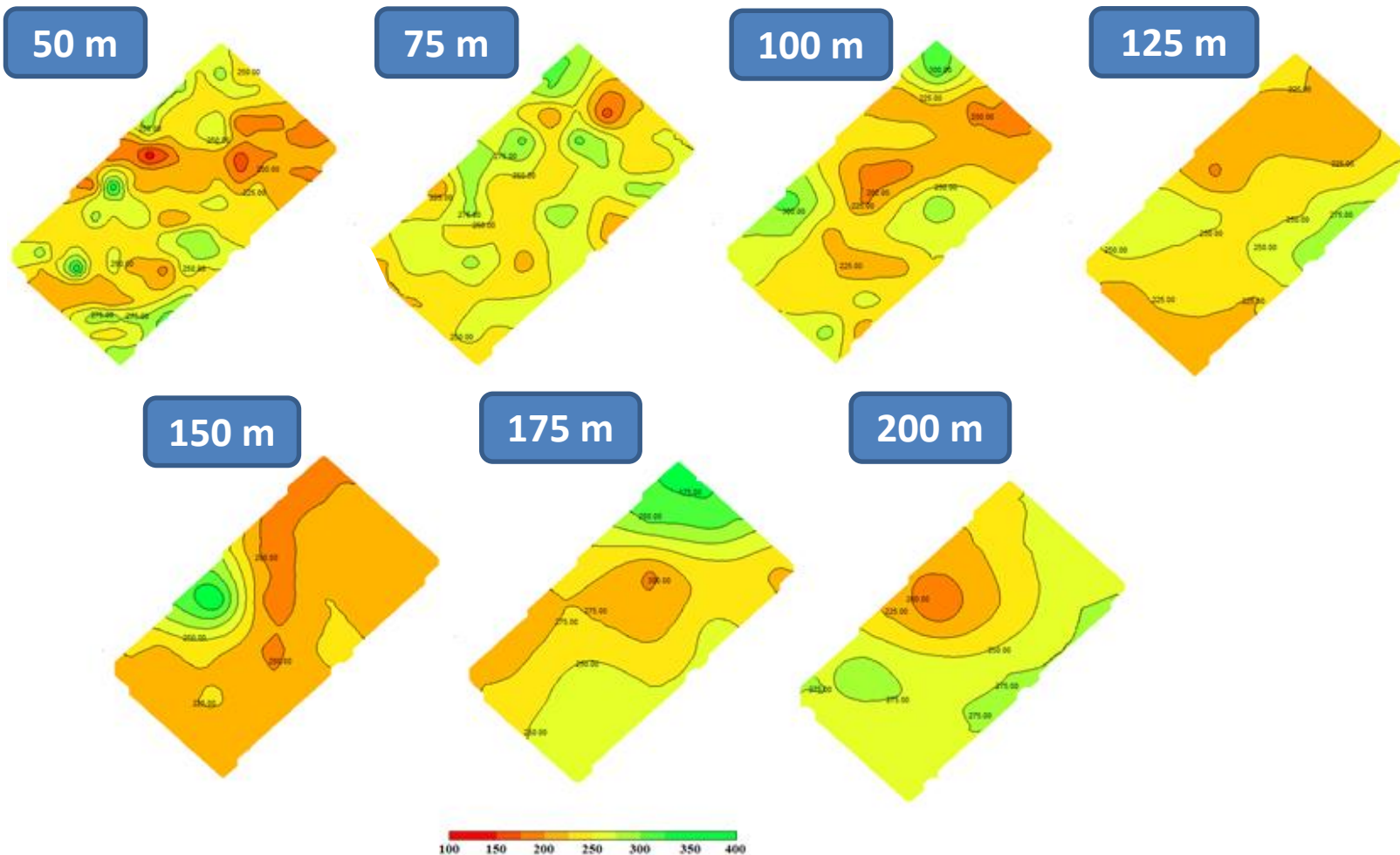
A 200x200m grid with a diamond-shaped sampling area. The grid is composed of 200 columns and 200 rows of small squares. A diamond shape is inscribed within the grid, with its vertices at the corners of the grid. The diamond contains 9 numbered points, starting from 1 at the top vertex and ending at 9 at the bottom vertex. The points are arranged in a regular grid pattern within the diamond.

Fósforo



Cherubin et al. (2015)

Potássio



Cherubin et al. (2015)

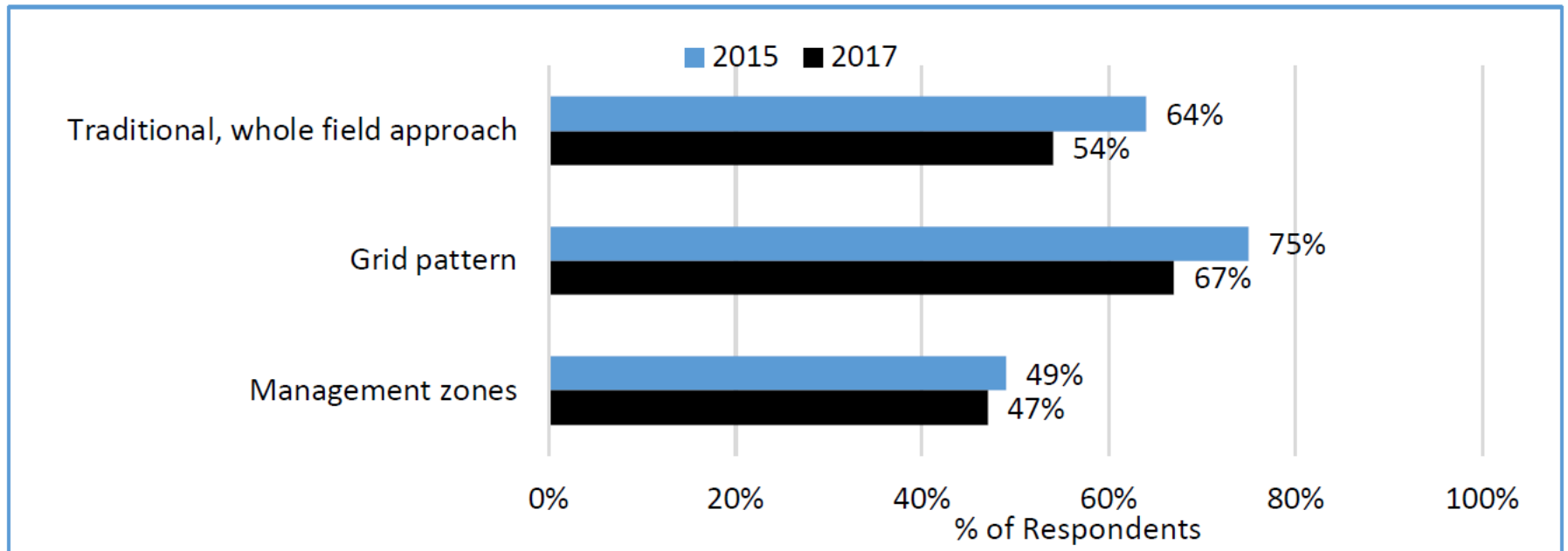
A qualidade (exatidão) do mapa

Atributo do solo	Variabilidade espacial (amplitude)	Variabilidade temporal
Textura	Média – alta (entre 20 e 98 m)	Baixa
Carbono orgânico	Alta (entre 22 e 78 m)	Média (entre 5 e 10 anos)
CTC	Média – alta	Média
pH	Média – alta (entre 30 e 100 m)	Média – alta (entre safras)
P disponível	Alta (entre <10 e 31 m)	Alta (dentro e entre safras)
K disponível	Alta (entre 18 e 68 m)	Média – alta (dentro e entre safras)

TAVARES, T (de Viscarra Rossel e Lobsey 2016)

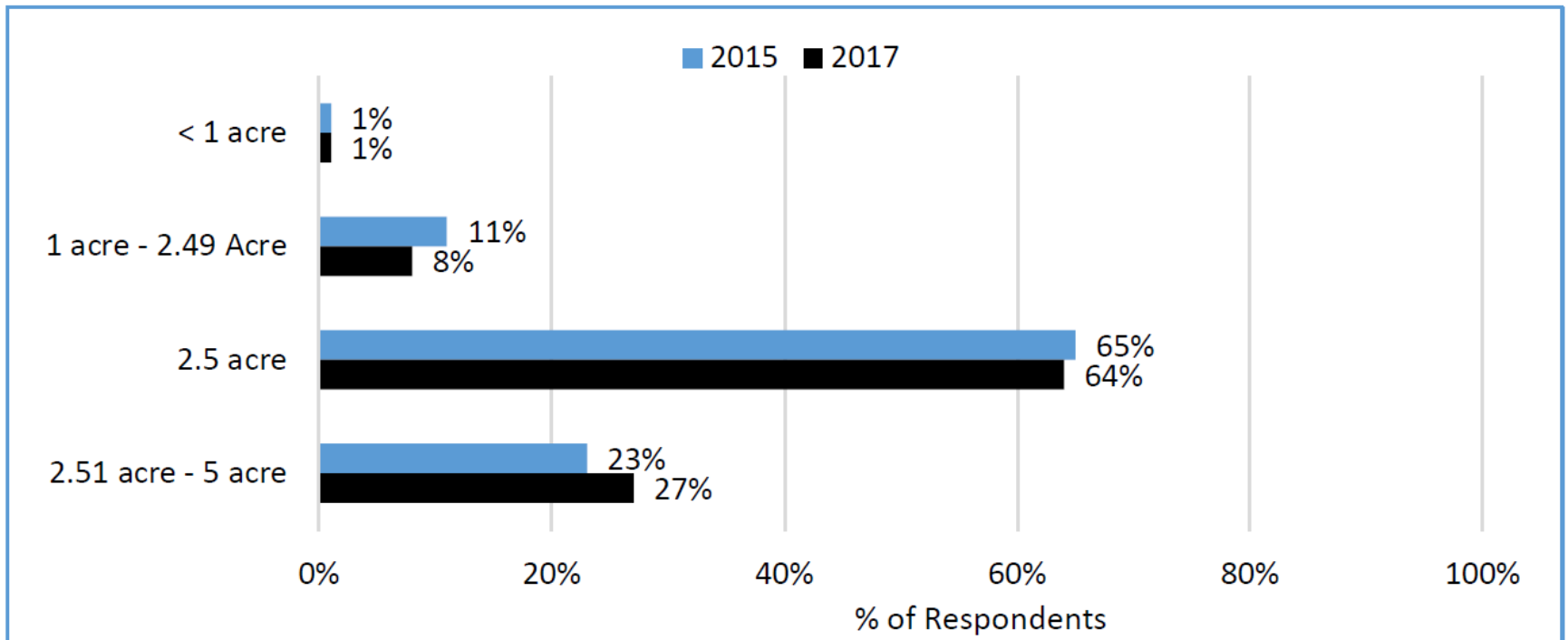


Tipos de amostragem de solo oferecida nos EUA



B.Erickson, J. L. Lowenberg-DeBoer & J. Bradford (2017)

Tamanhos de grades amostrais praticadas



B.Erickson, J. L. Lowenberg-DeBoer & J. Bradford (2017)

AGRICULTURA DE PRECISÃO

Boletim Técnico 03

AGRICULTURA DE PRECISÃO: NÚMEROS DO MERCADO BRASILEIRO

José P. Molin¹

04/2017

¹Professor e Coordenador do Laboratório de Agricultura de Precisão (USP-ESALQ).

A agricultura de precisão (AP) tem sua origem na gestão da variabilidade espacial das lavouras,

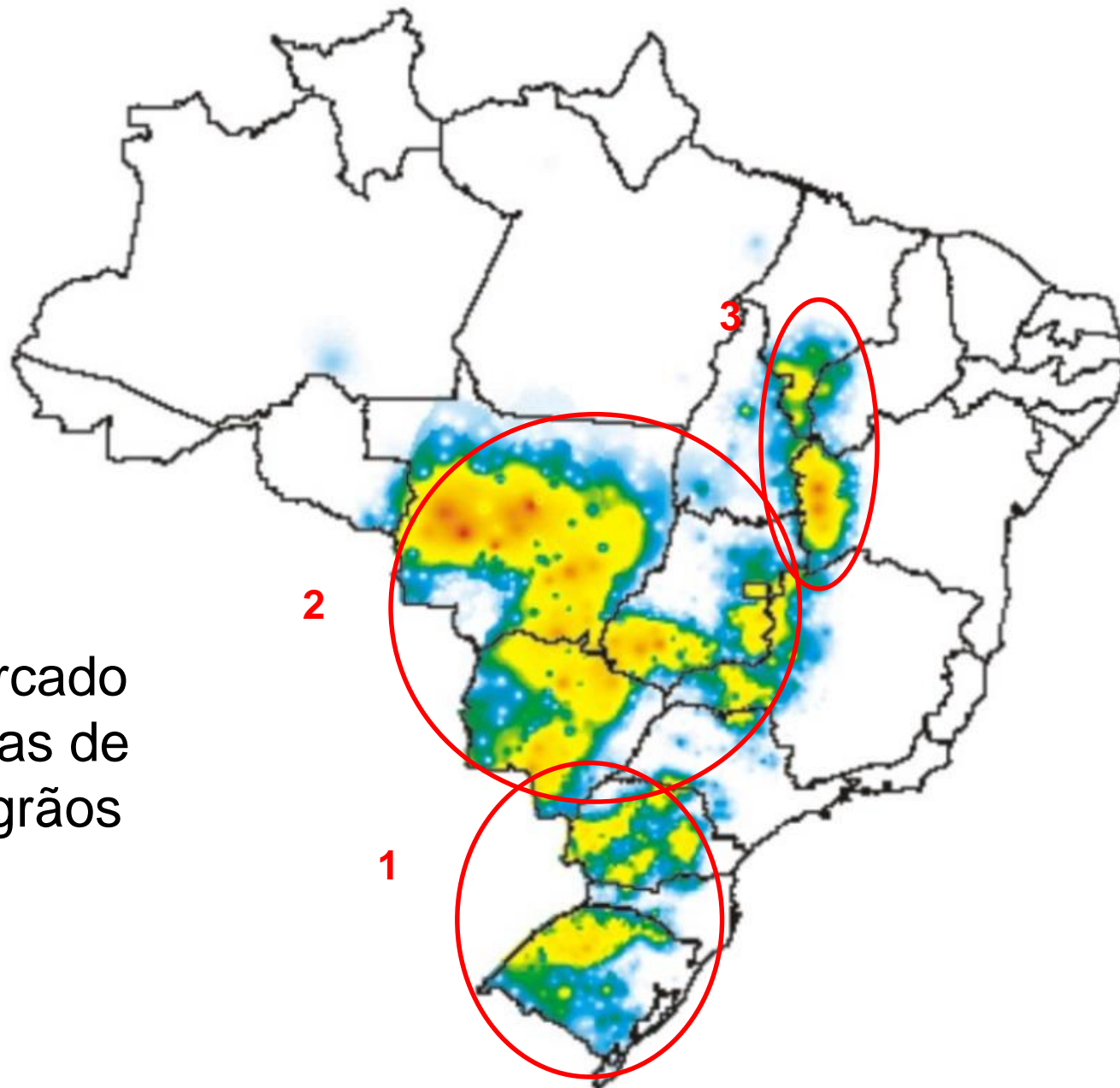
dados de produtividade expressos por mapas são fundamentais. A interpretação da variabilidade

www.agriculturadeprecisao.org.br

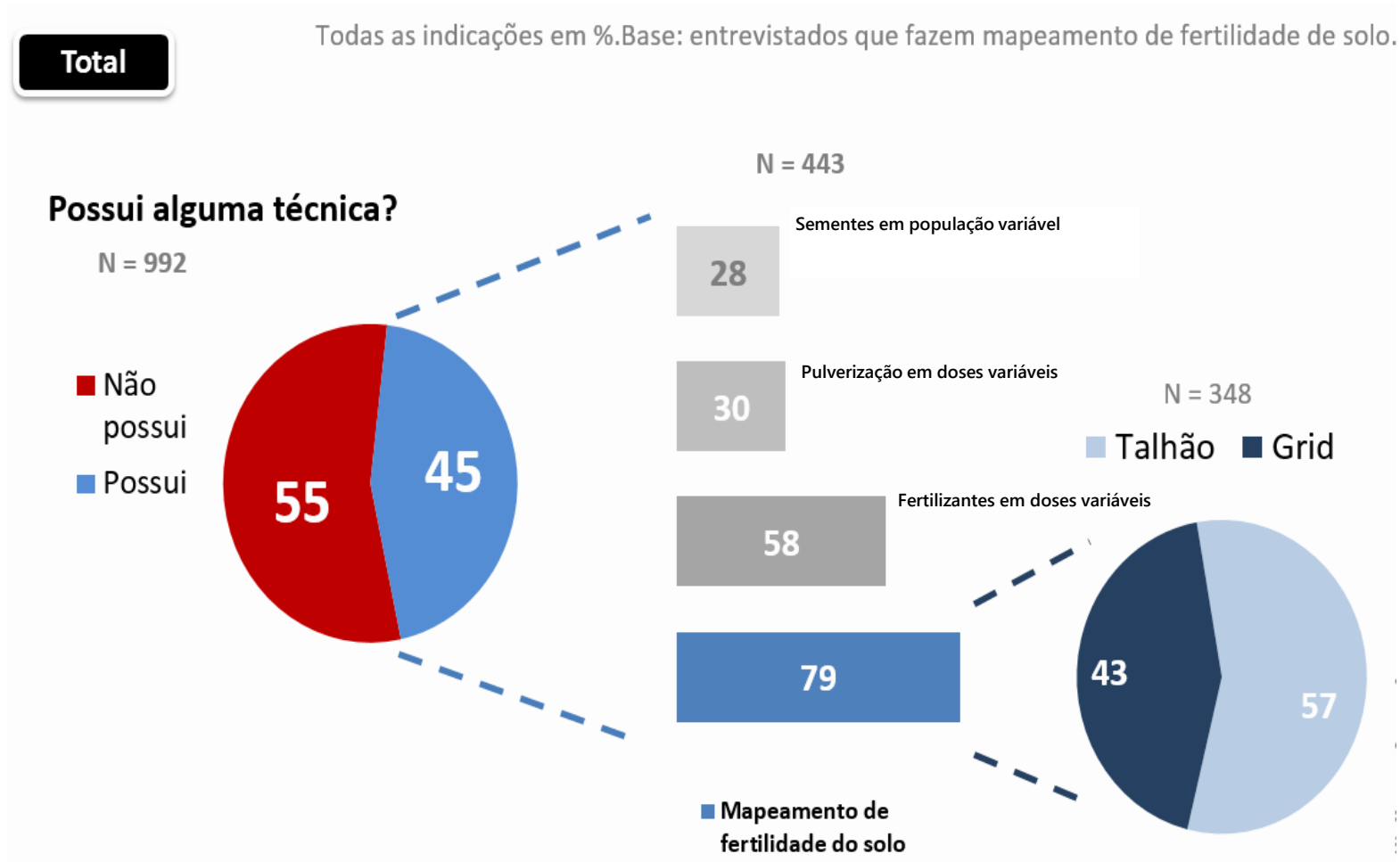


Prof. J. P. Molin

Dados do Mercado
de AP em áreas de
produção de grãos



Nível de adoção de técnicas de AP relacionadas com a variabilidade espacial das lavouras e de amostragem de solo em grade



Tamanho das grades amostrais, em hectares, praticadas em cada região do Brasil

Todas as indicações em %. Base: Entrevistados que realizam o mapeamento da fertilidade do solo por grades N = 148

■ Até 1 ■ 1,1 - 2 ■ 2,1 - 3 ■ 3,1 - 4 ■ 4,1 - 5 ■ 6,1 - 7 ■ 7,1 - 9 ■ Maior que 9,1

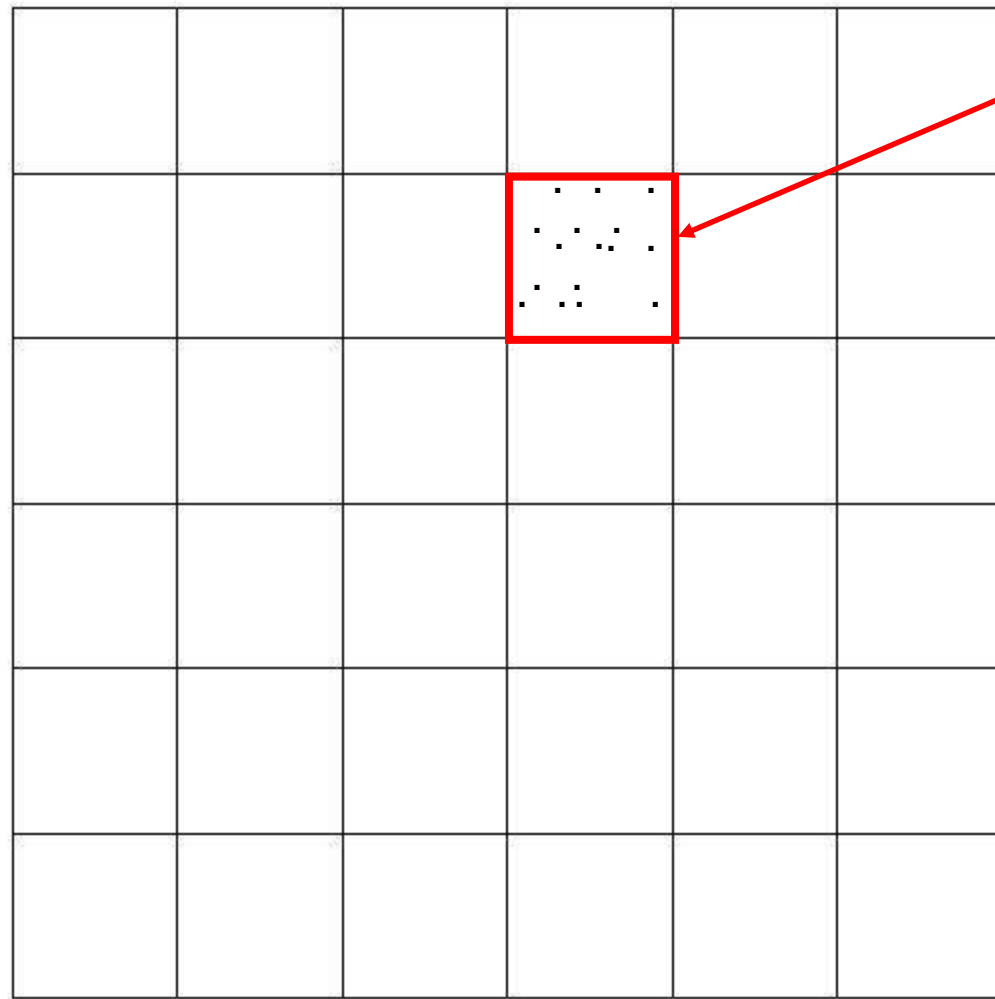


Kleffmann Group ®

J. P. Molin (2017)



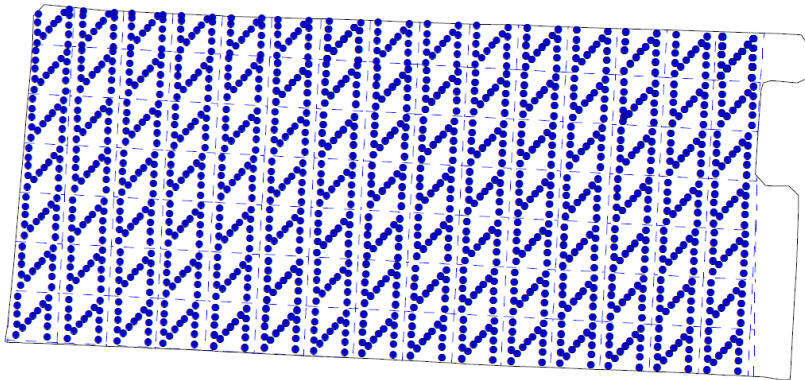
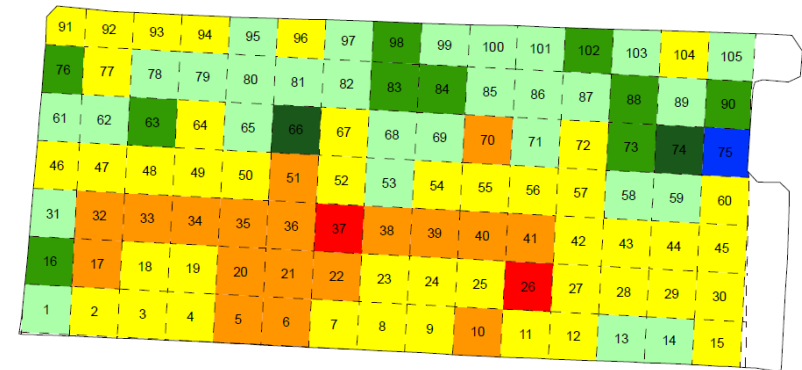
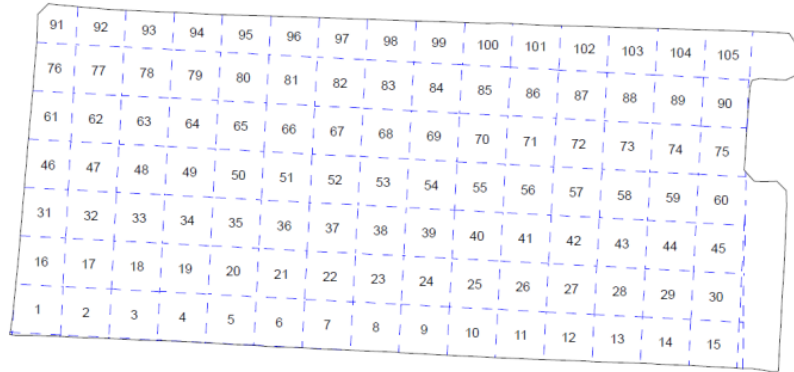
Prof. J. P. Molin



Célula amostral

Amostragem por célula

Amostragem por célula



- Maior número de subamostras
- Maior tempo de coleta
- Menor resolução
- Menor densidade (menos amostras)
- Menor frequência

Métodos de Amostragem

Sem conhecimento prévio da área

- Amostragem em grade
 - por ponto
 - por célula

Com conhecimento pleno da área

- Amostragem por unidades de gestão (UGD)

Unidades de gestão diferenciada (UGD) ou “zonas de manejo”

São áreas delimitadas, dentro de um talhão, com mínima variabilidade interna.

Mínima variabilidade dentro das UGDs

Diferenças (variabilidade) entre UGDs

Os indicadores podem ser únicos ou, preferencialmente, compostos:

Plantas

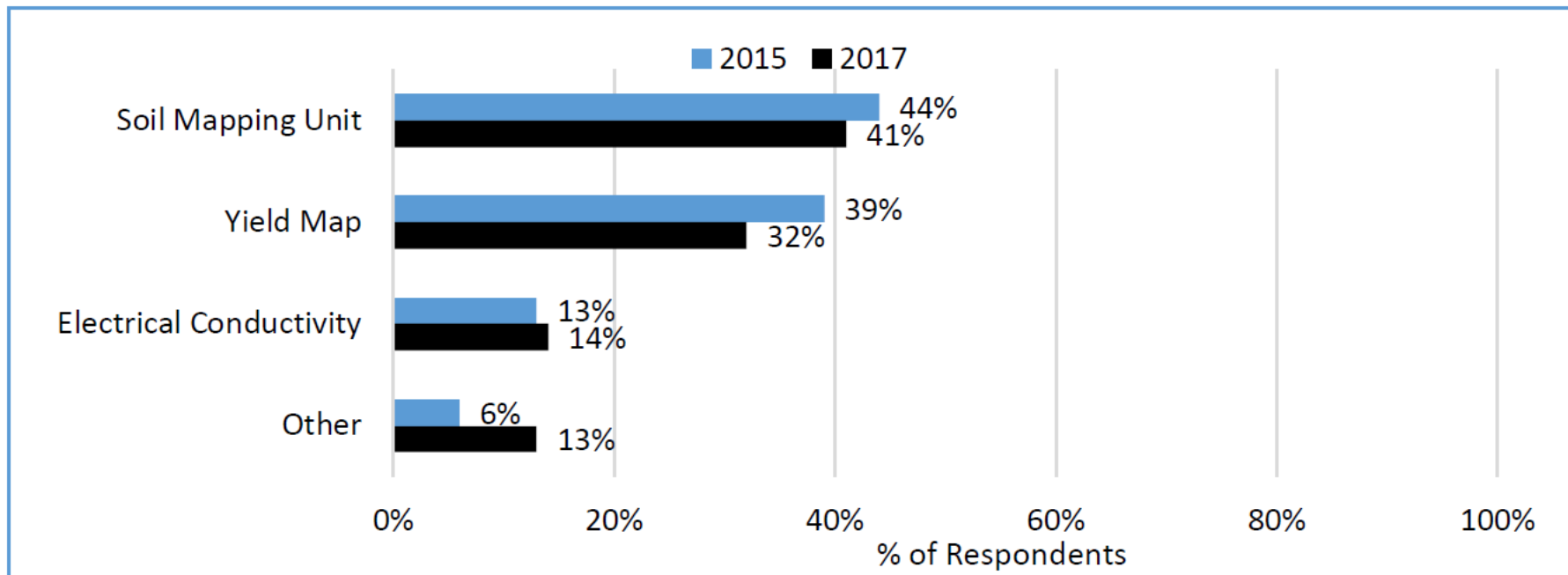
- produtividades
- vigor das culturas (biomassa) a partir de Índices de Vegetação

- condutividade elétrica do solo
- relevo
- pedologia

Solo

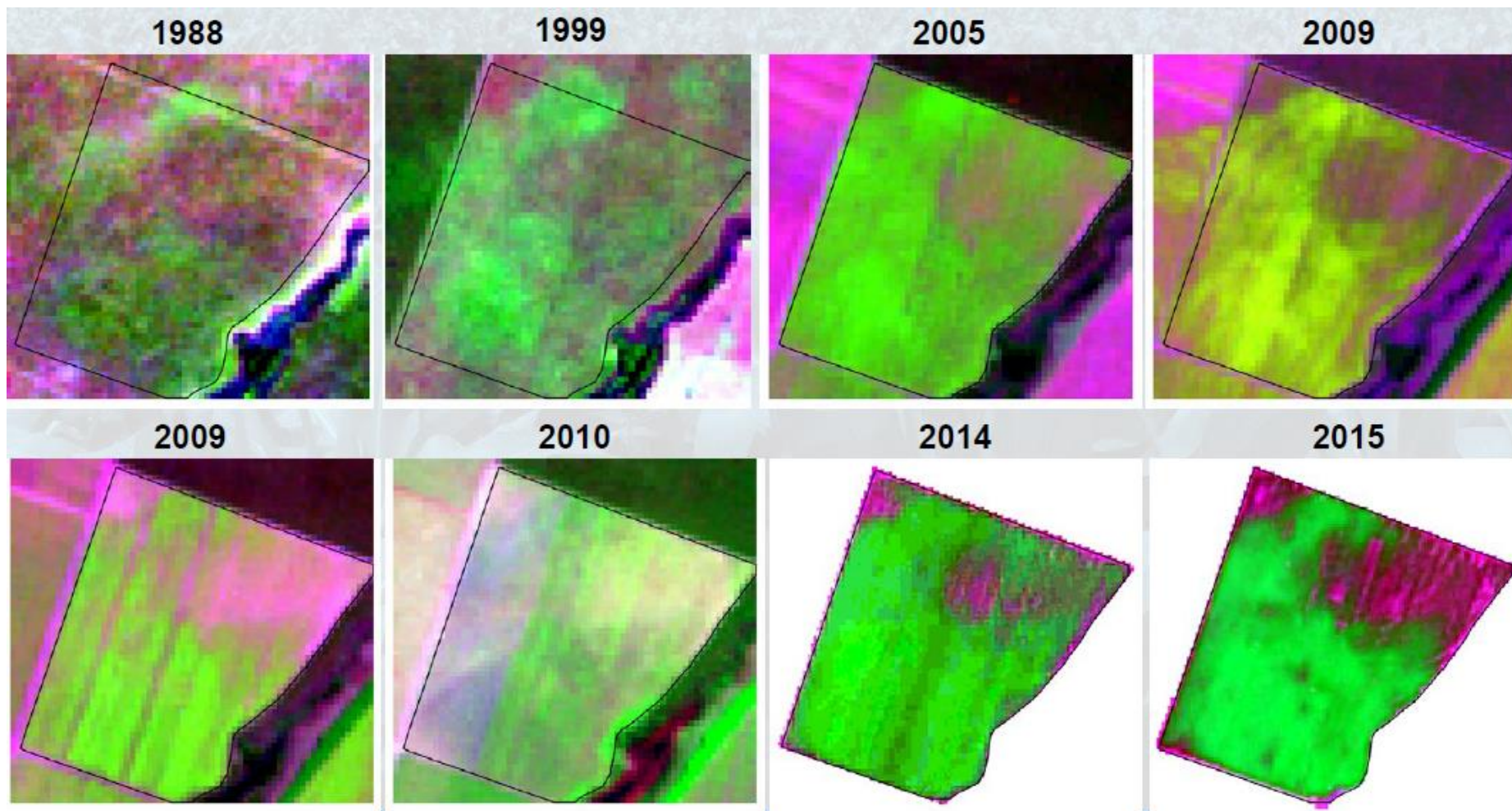
- conhecimento intrínseco (do agricultor ou...)

Fatores usados para determinar UGD ("zonas de manejo")



B.Erickson, J. L. Lowenberg-DeBoer & J. Bradford (2017)

Estabilidade temporal

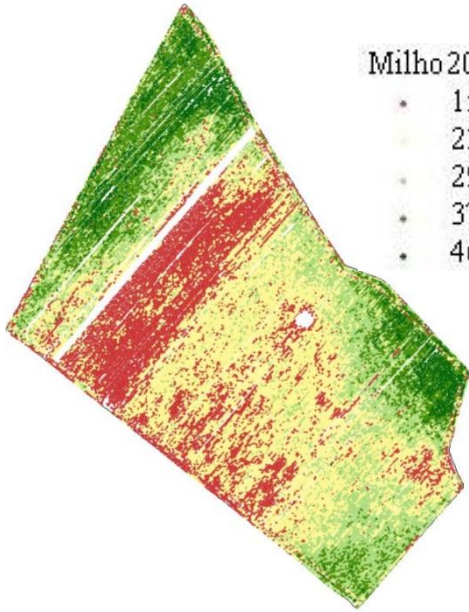


Trevisam, R. (2018)

Unidades de Gestão Diferenciada (UGD)

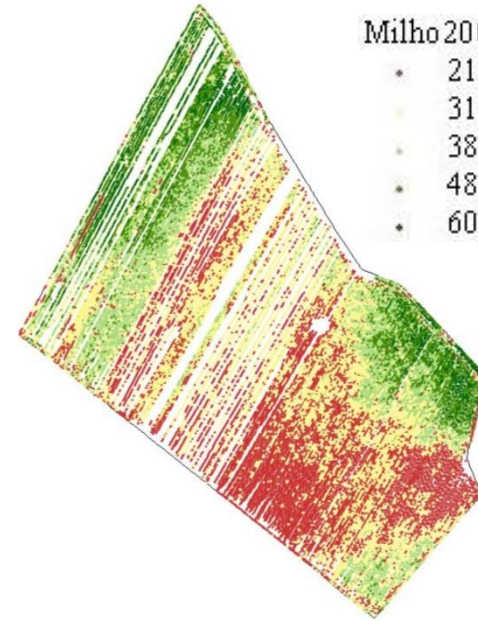
Milho2002b

- 1500.17 - 2369.13
- 2369.13 - 2970.62
- 2970.62 - 3728.42
- 3728.42 - 4692.63
- 4692.63 - 6794.93



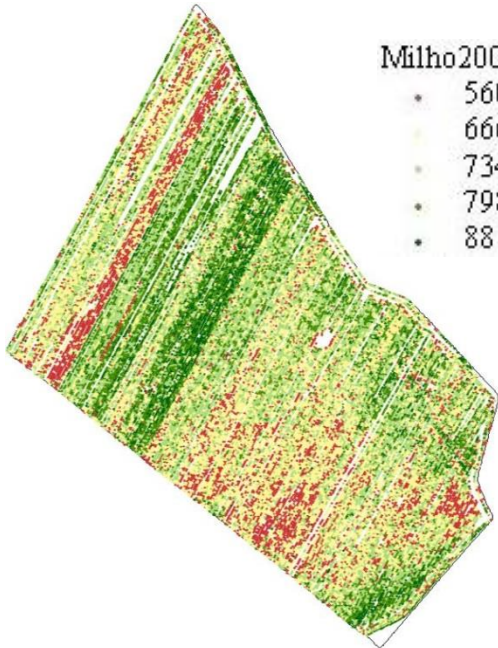
Milho2003b

- 2101.13 - 3108.84
- 3108.84 - 3874.79
- 3874.79 - 4879.6
- 4879.6 - 6072.77
- 6072.77 - 8493.56



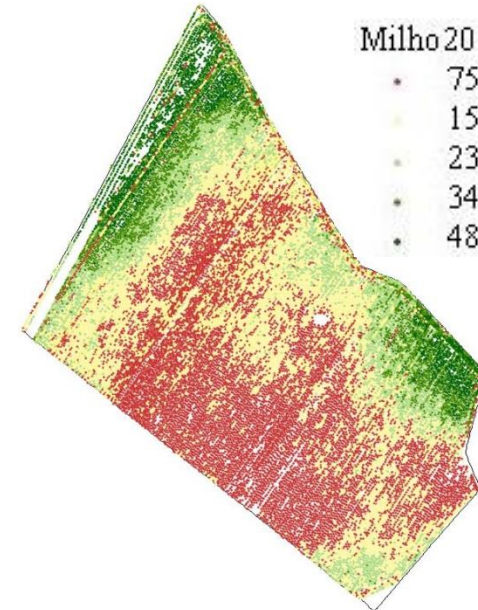
Milho2005a

- 5600.24 - 6669.72
- 6669.72 - 7343.13
- 7343.13 - 7989.91
- 7989.91 - 8812.51
- 8812.51 - 10496.52



Milho2006b

- 750.23 - 1521.29
- 1521.29 - 2305.03
- 2305.03 - 3444.3
- 3444.3 - 4837.29
- 4837.29 - 6699.78



Safrinha 2002

Safrinha 2003

Produtividades Normalizadas

- 0 a 40% da média
- 40 a 85% da média
- 85 a 105% da média
- 105 a 150% da média
- + 150% da média

Safrinha 2005

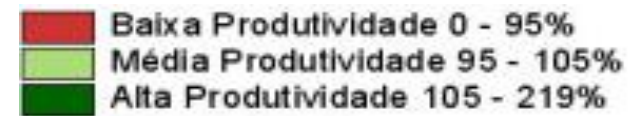
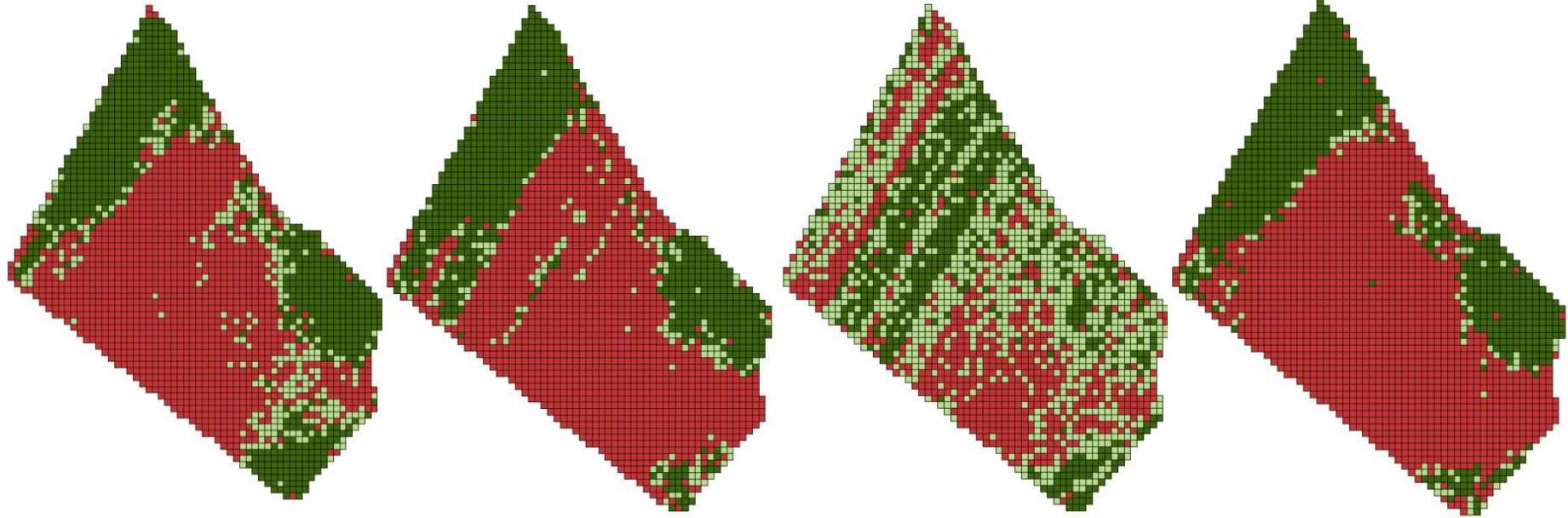
Safrinha 2006

Safrinha 2002

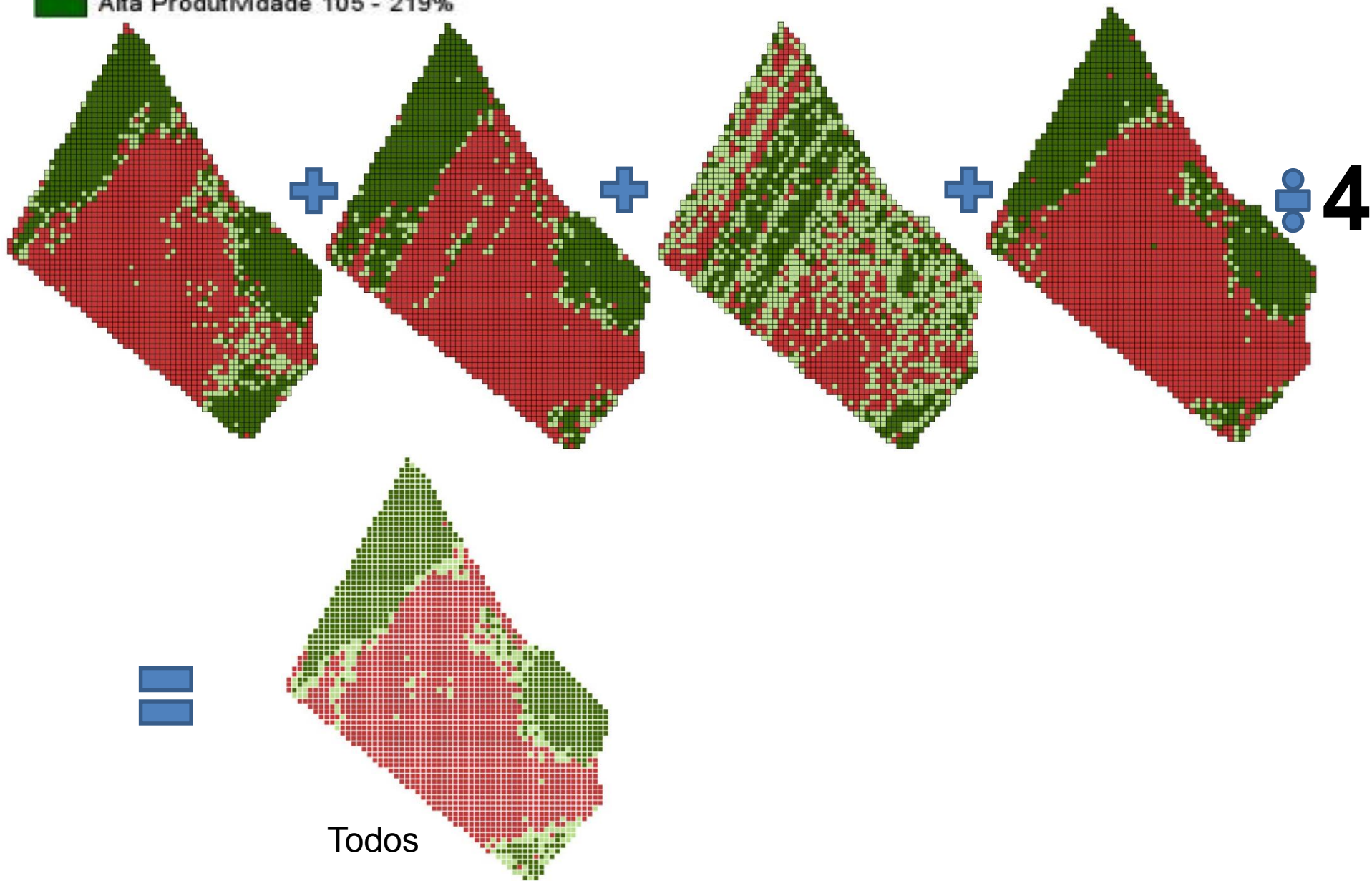
Safrinha 2003

Safrinha 2005

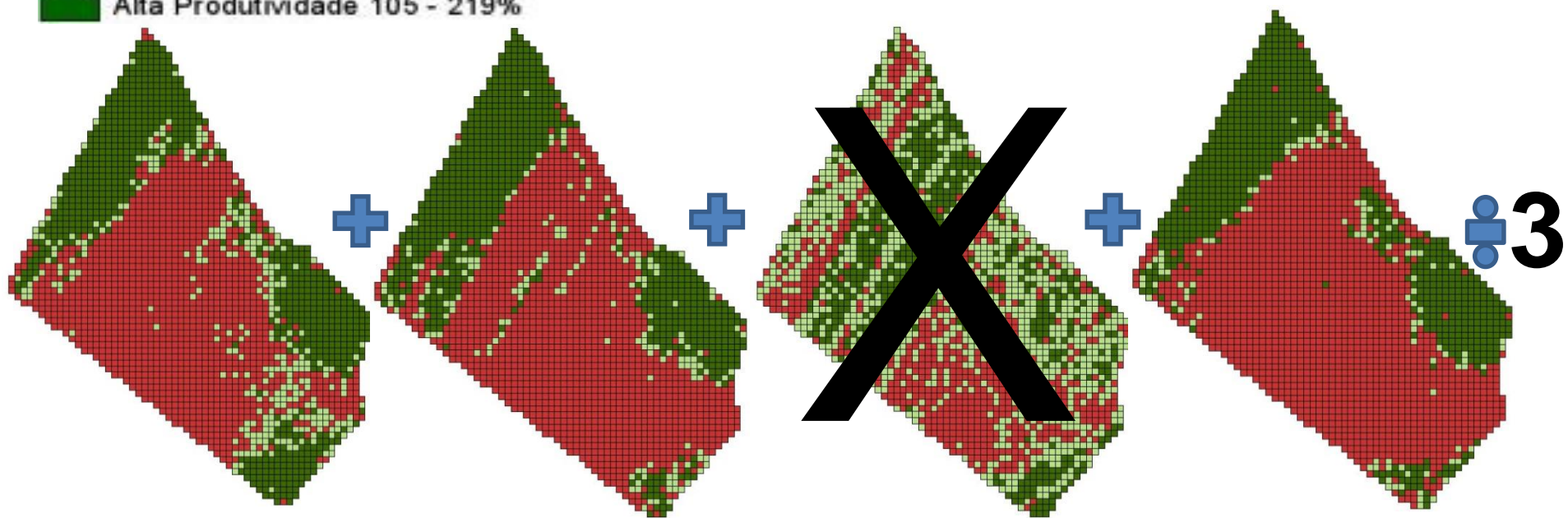
Safrinha 2006



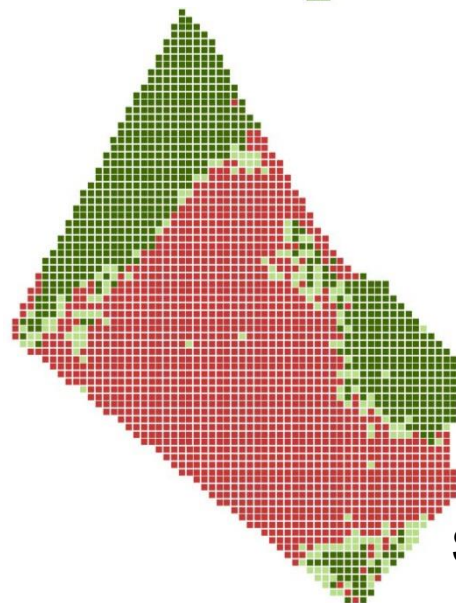
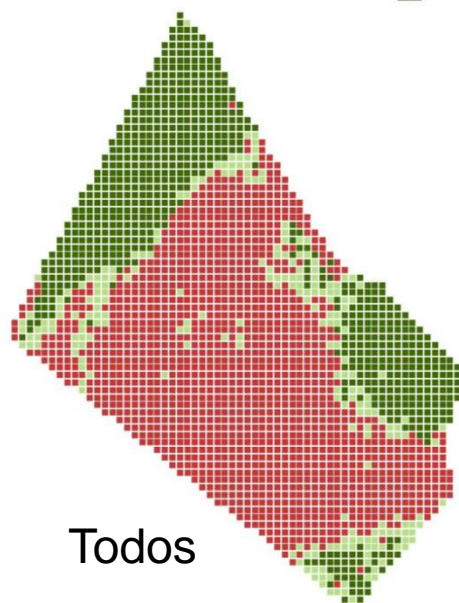
- Baixa Produtividade 0 - 95%
- Média Produtividade 95 - 105%
- Alta Produtividade 105 - 219%



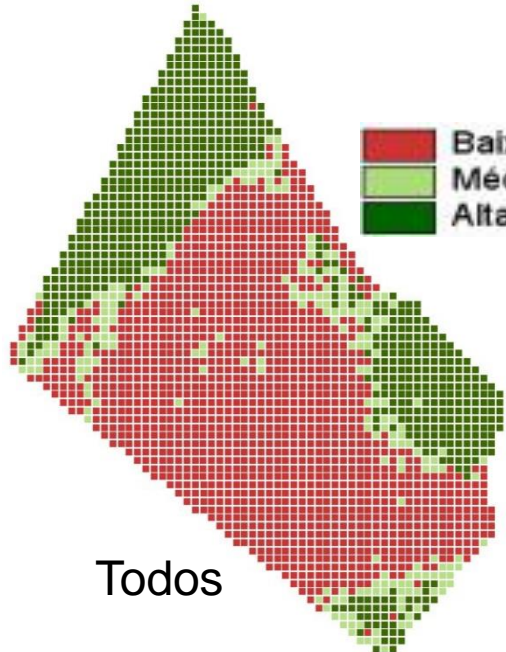
■ Baixa Produtividade 0 - 95%
■ Média Produtividade 95 - 105%
■ Alta Produtividade 105 - 219%



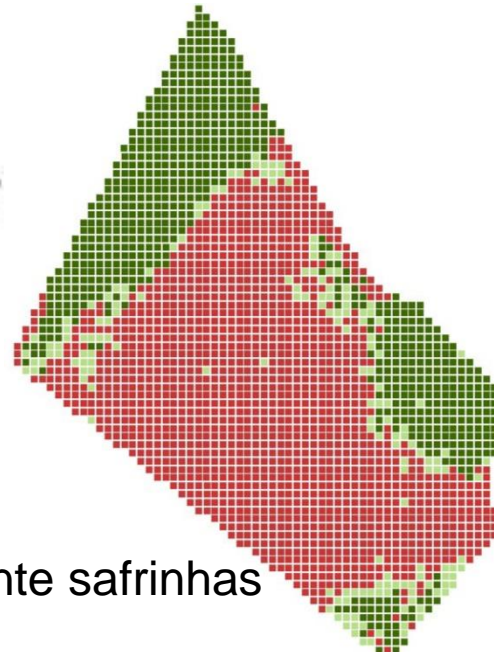
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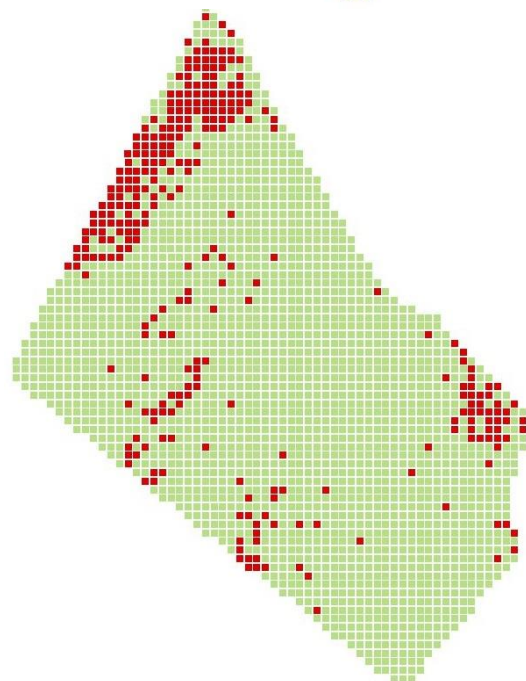
■ Baixa Produtividade 0 - 95%
■ Média Produtividade 95 - 105%
■ Alta Produtividade 105 - 219%



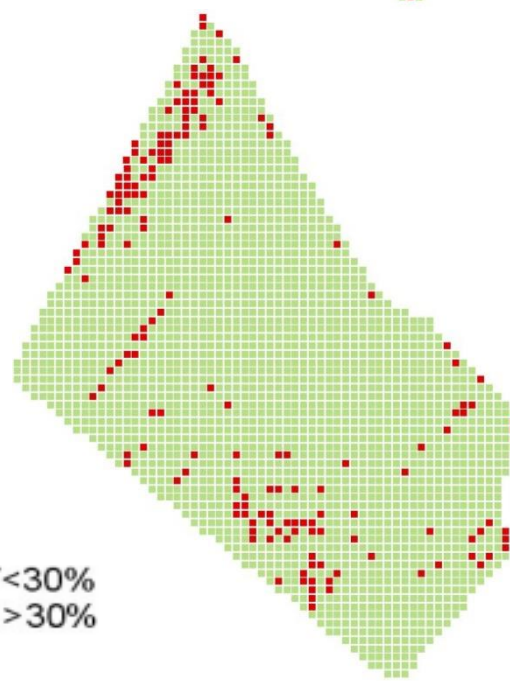
Todos



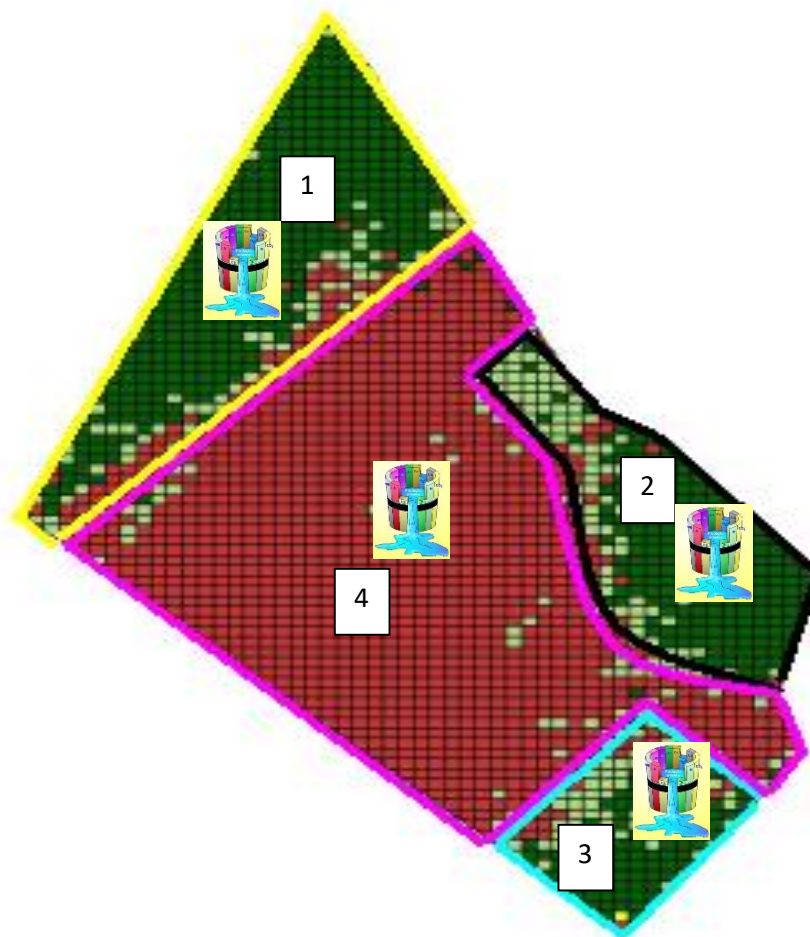
Somente safrinhas



■ Consistente - CV < 30%
■ Inconsistente - CV > 30%



Unidades de gestão diferenciada em função das produtividades médias normalizadas:



1, 2 e 3 – alta produtividade
4 – baixa produtividade

Formas de demarcar UGD

Método supervisionado: álgebra de mapas - empilhamento e operações entre mapas

Análise de agrupamentos: algoritmos para classificação, normalmente não supervisionada, de um conjunto de dados

visa:

- redução da variabilidade dentro da classe e
- maximização das diferenças entre as classes

Análise de Agrupamento

Análise de Agrupamento (“Clustering”; “Fuzzy Clustering”); algoritmos para classificação, supervisionada ou não, de um conjunto de dados.

Usam como técnica a redução da variabilidade dentro da classe e maximização das diferenças entre as classes.

Análise de Agrupamento

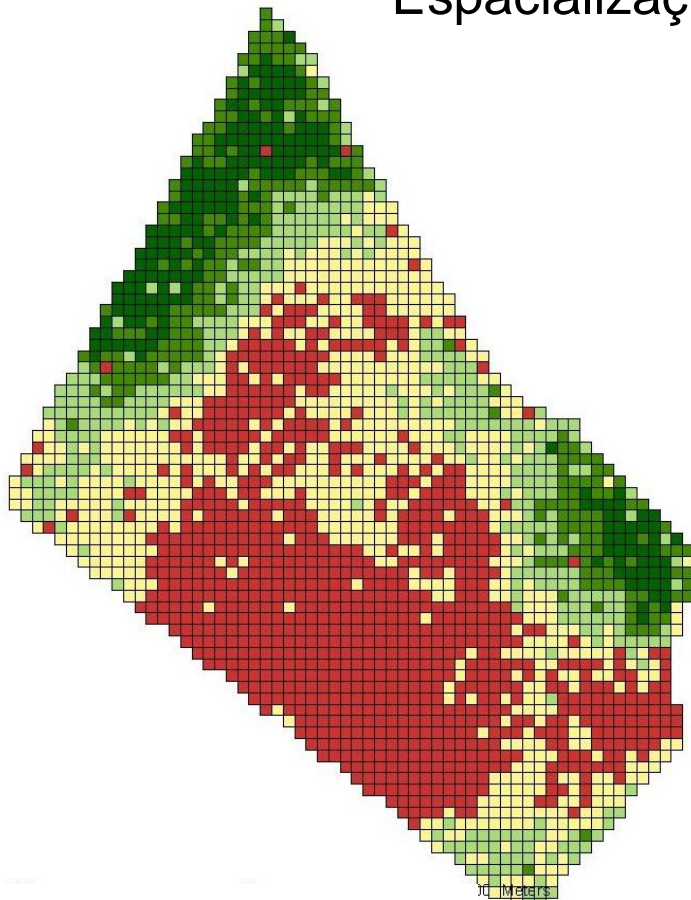
FuzME - Australian Centre for Precision Agriculture (ACPA)

<http://sydney.edu.au/agriculture/pal/software/fuzme.shtml>

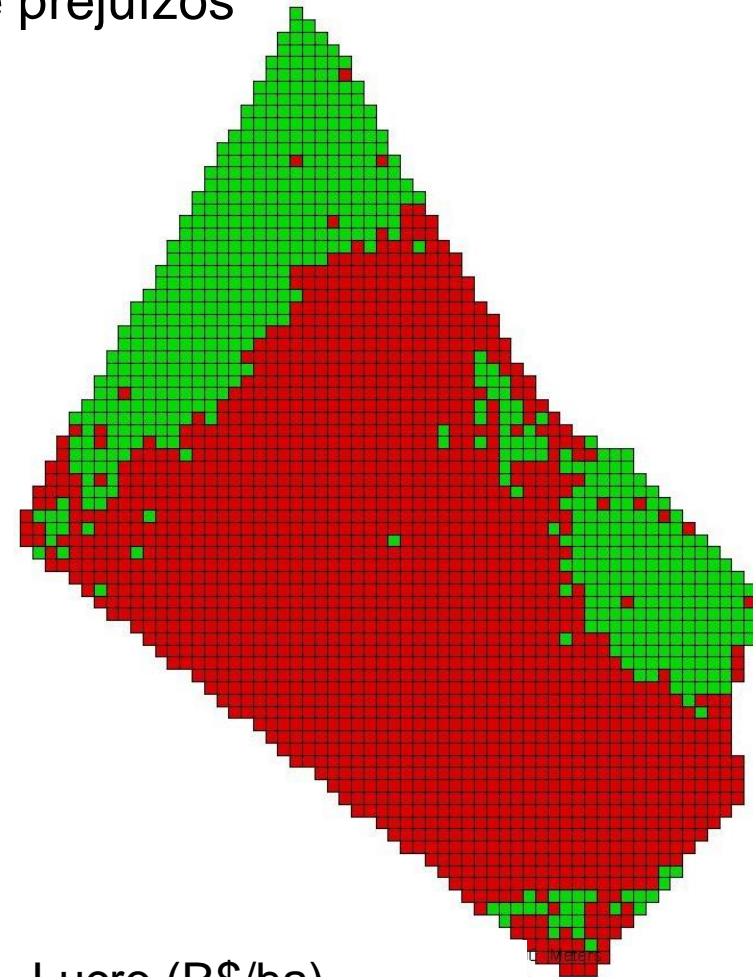
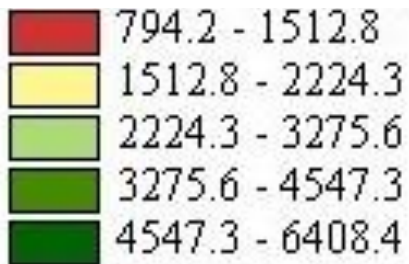
MZA - USDA

<http://www.ars.usda.gov/services/software/download.htm?softwareid=24>

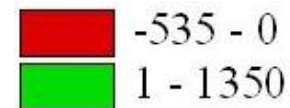
Espacialização dos lucros e prejuízos



Milho Safrinha 2006 (kg/ha)

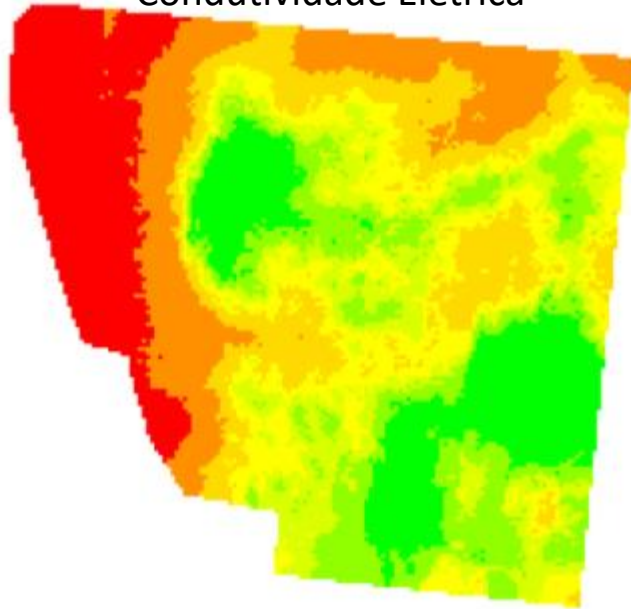


Lucro (R\$/ha)

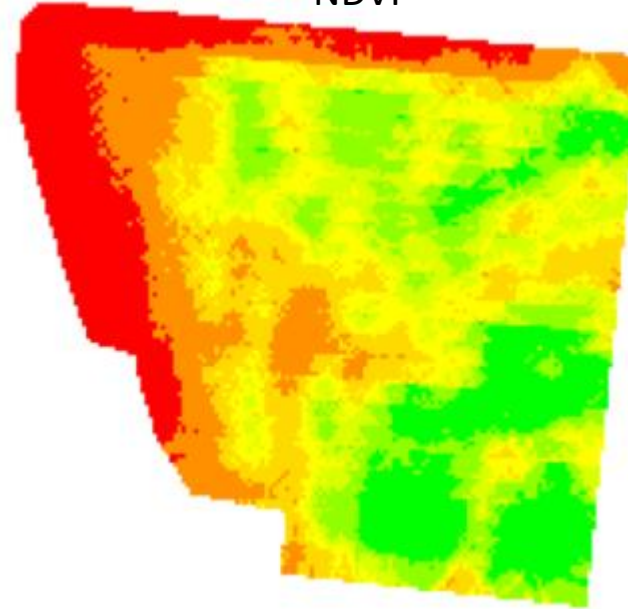


Valores atualizados para 2014:
R\$ 20,00/saco
Custo: R\$ 750,00/ha

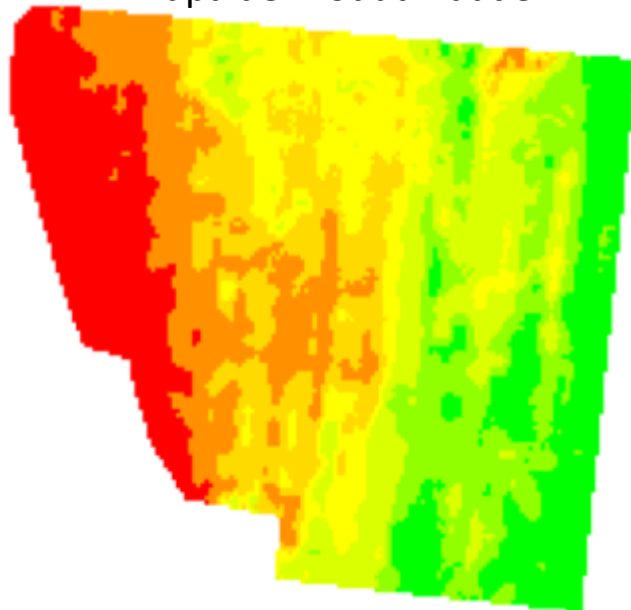
Condutividade Elétrica



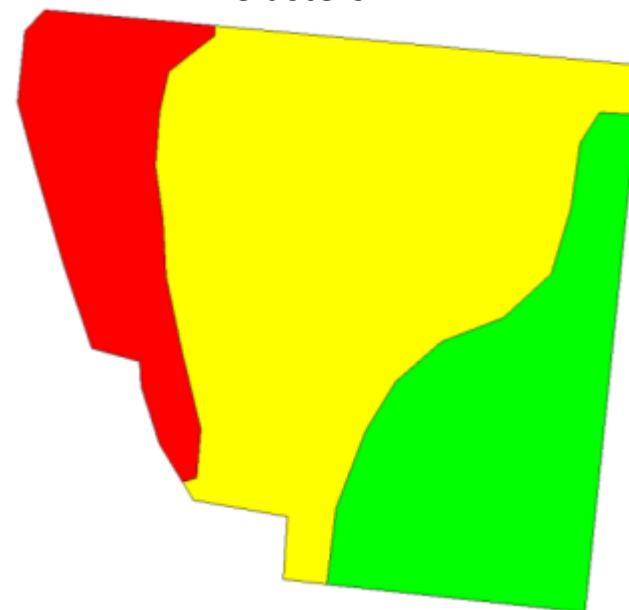
NDVI



Mapa de Produtividade



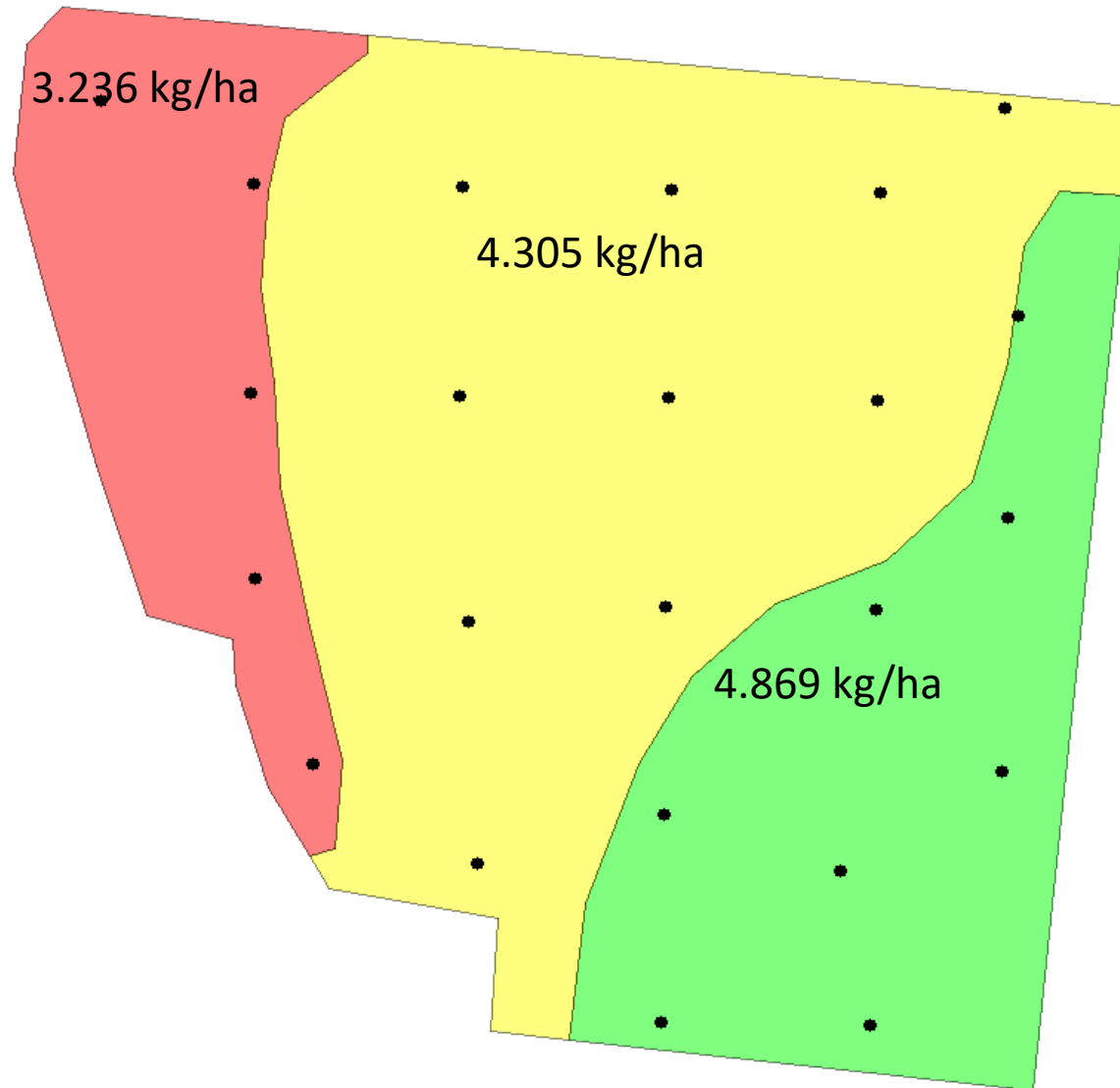
Clusters



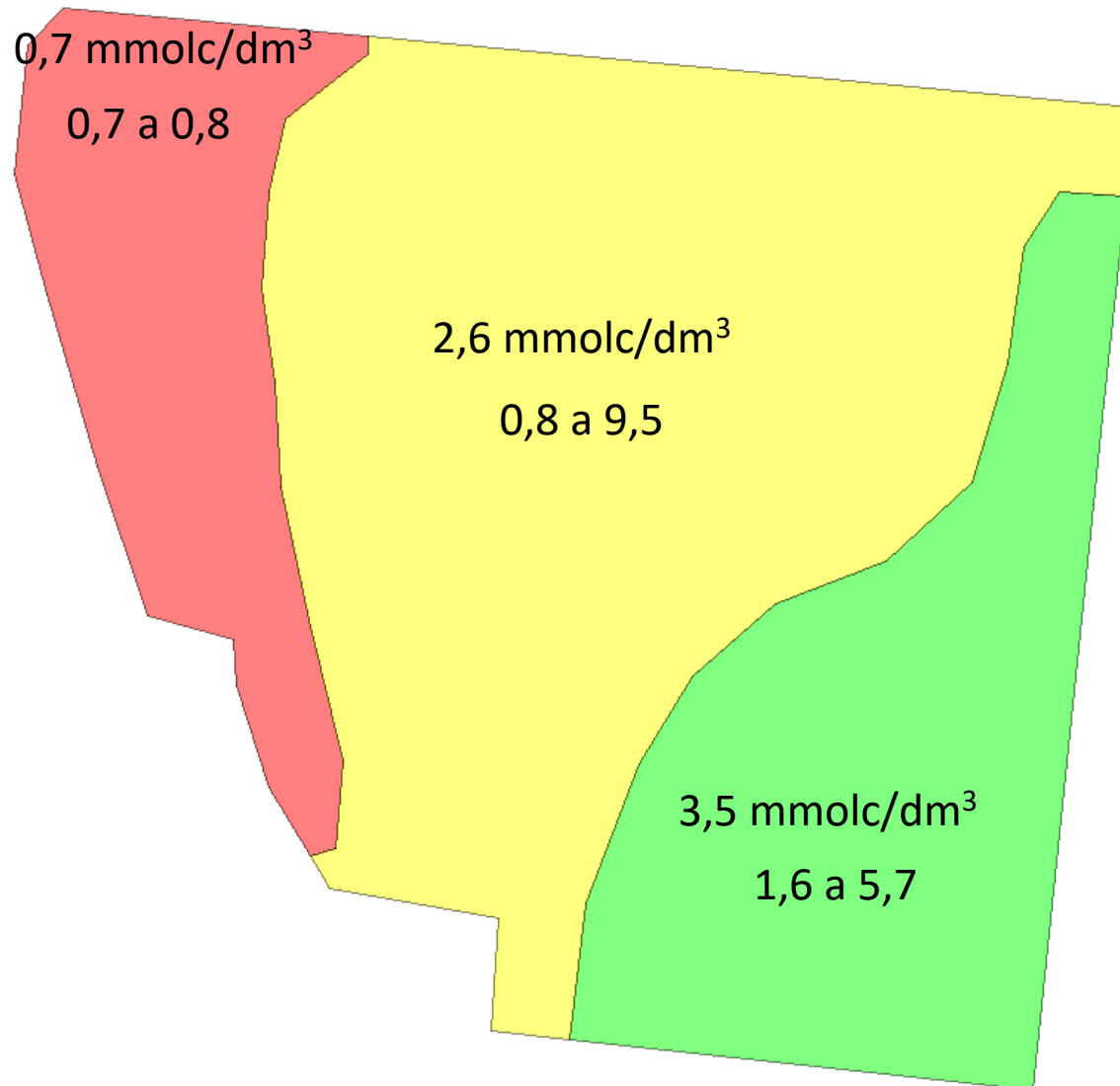
POVH, 2011



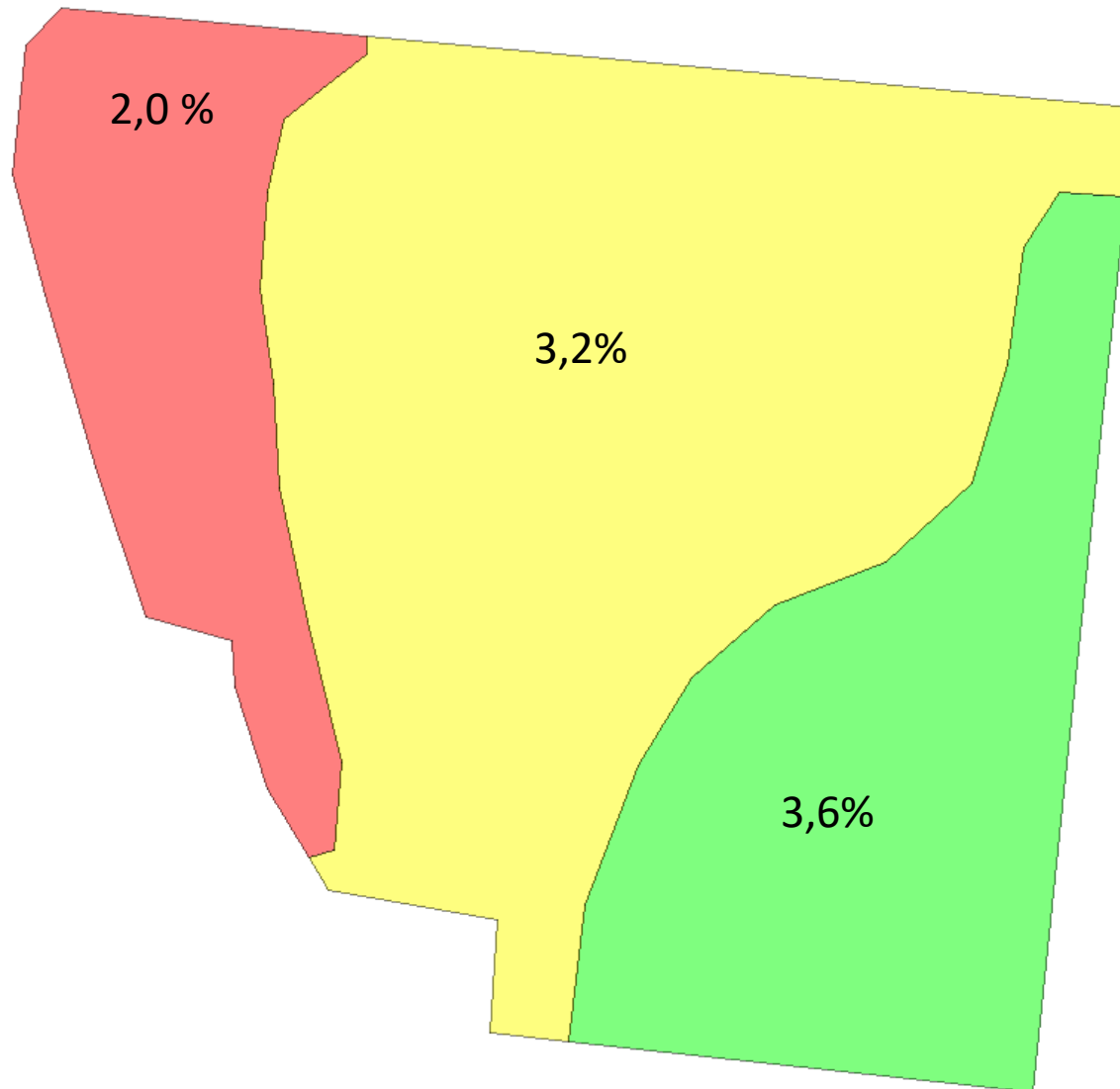
Produtividade de Trigo (safra 10/10) – 41,36 ha



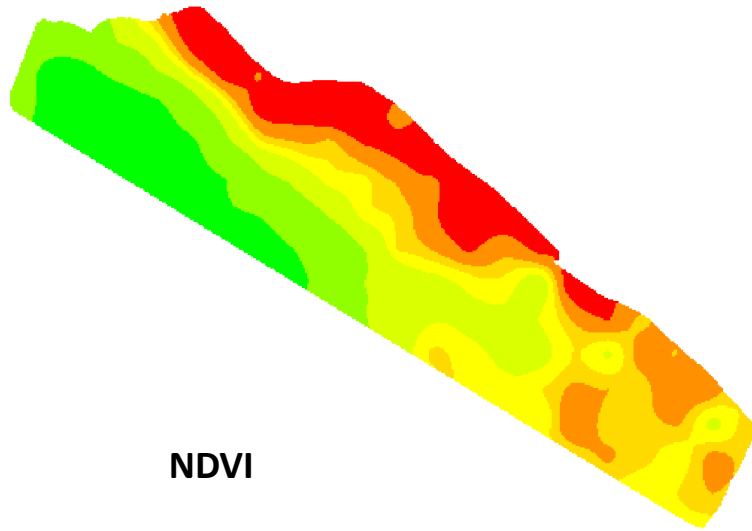
Potássio (0 – 20 cm)



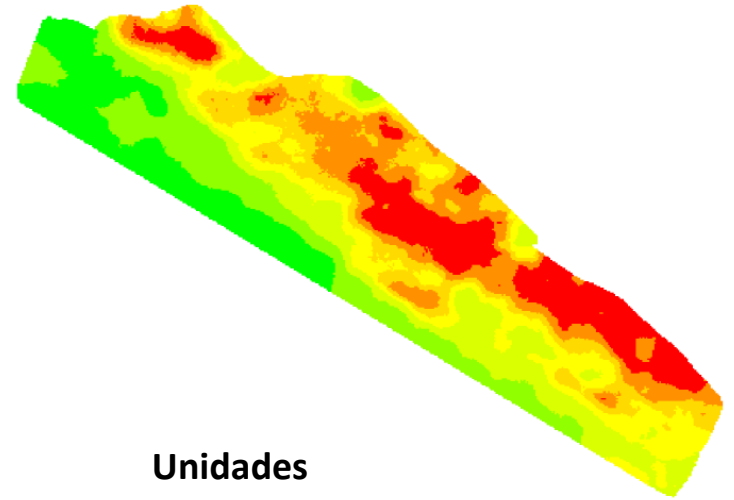
Matéria Orgânica (0 – 20 cm)



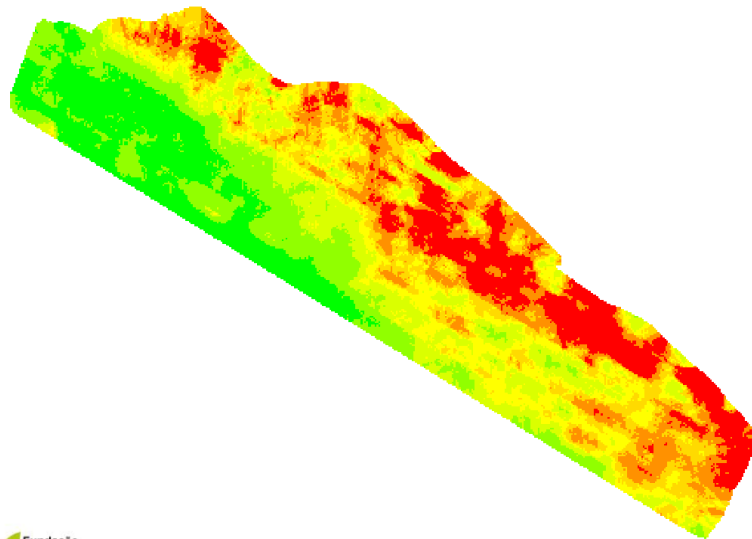
Argila



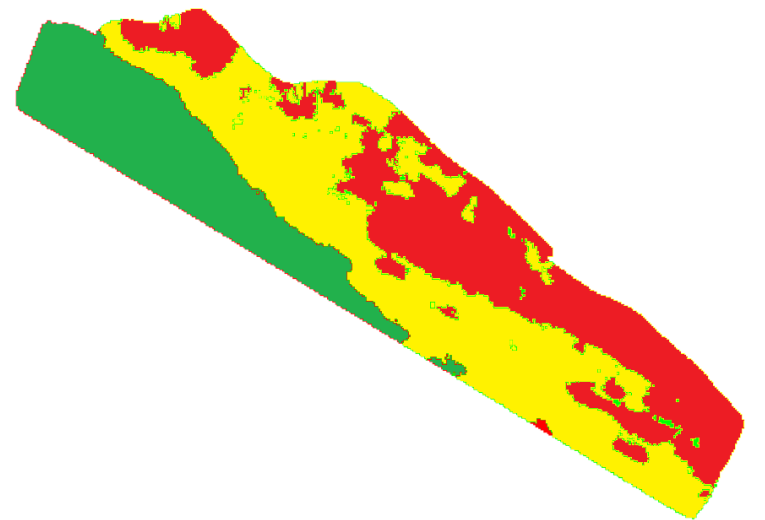
CE



NDVI



Unidades



0 120m

1
N

0 120m

1
N

1
N

UGD – (Zonas de Manejo)

Verde = 26 ha

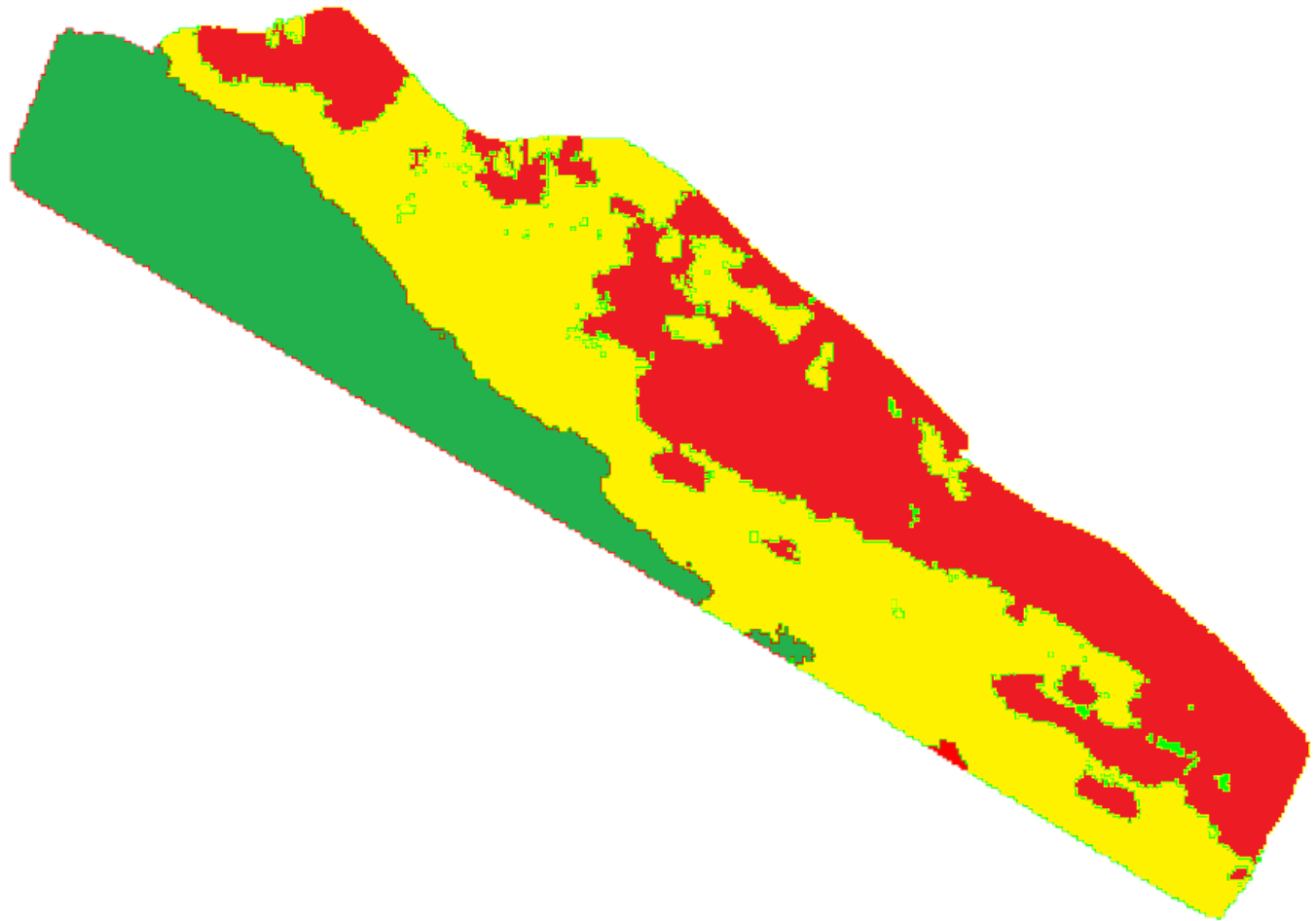
Trigo = 4.842 kg/ha
Milho = 12.940 kg/ha
P = 67 / K = 2,45

Amarelo = 46 ha

Trigo = 4.171 kg/ha
Milho = 12.290 kg/ha
P = 75 / K = 1,66

Vermelho = 38 ha

Trigo = 3.535 kg/ha
Milho = 10.740 kg/ha
P = 79 / K = 1,44



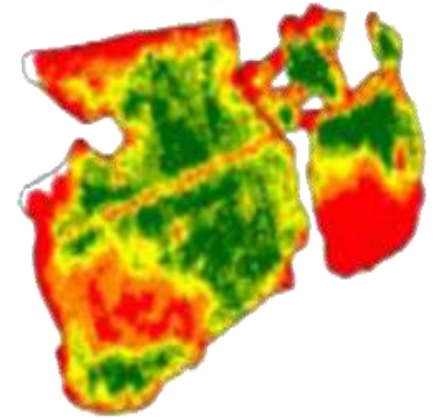
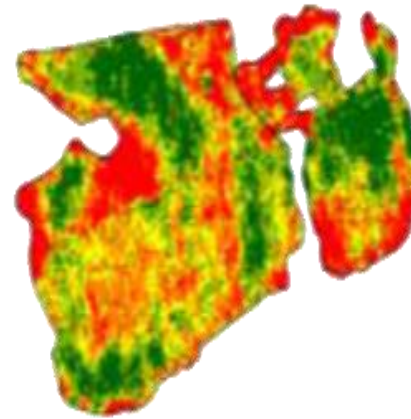
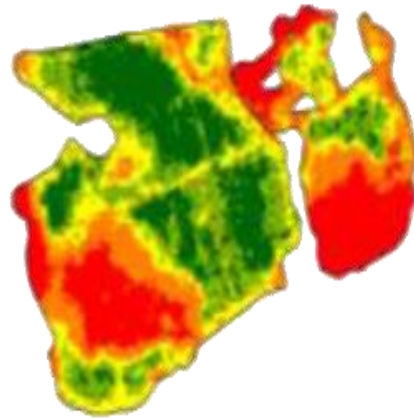
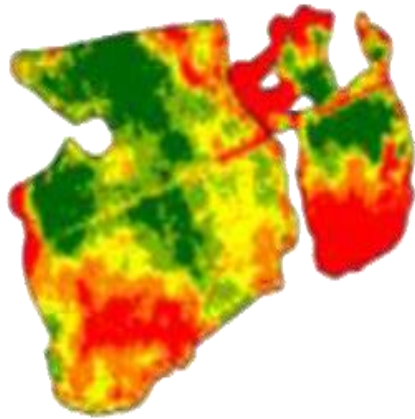
Estabilidade temporal

Corn 2007

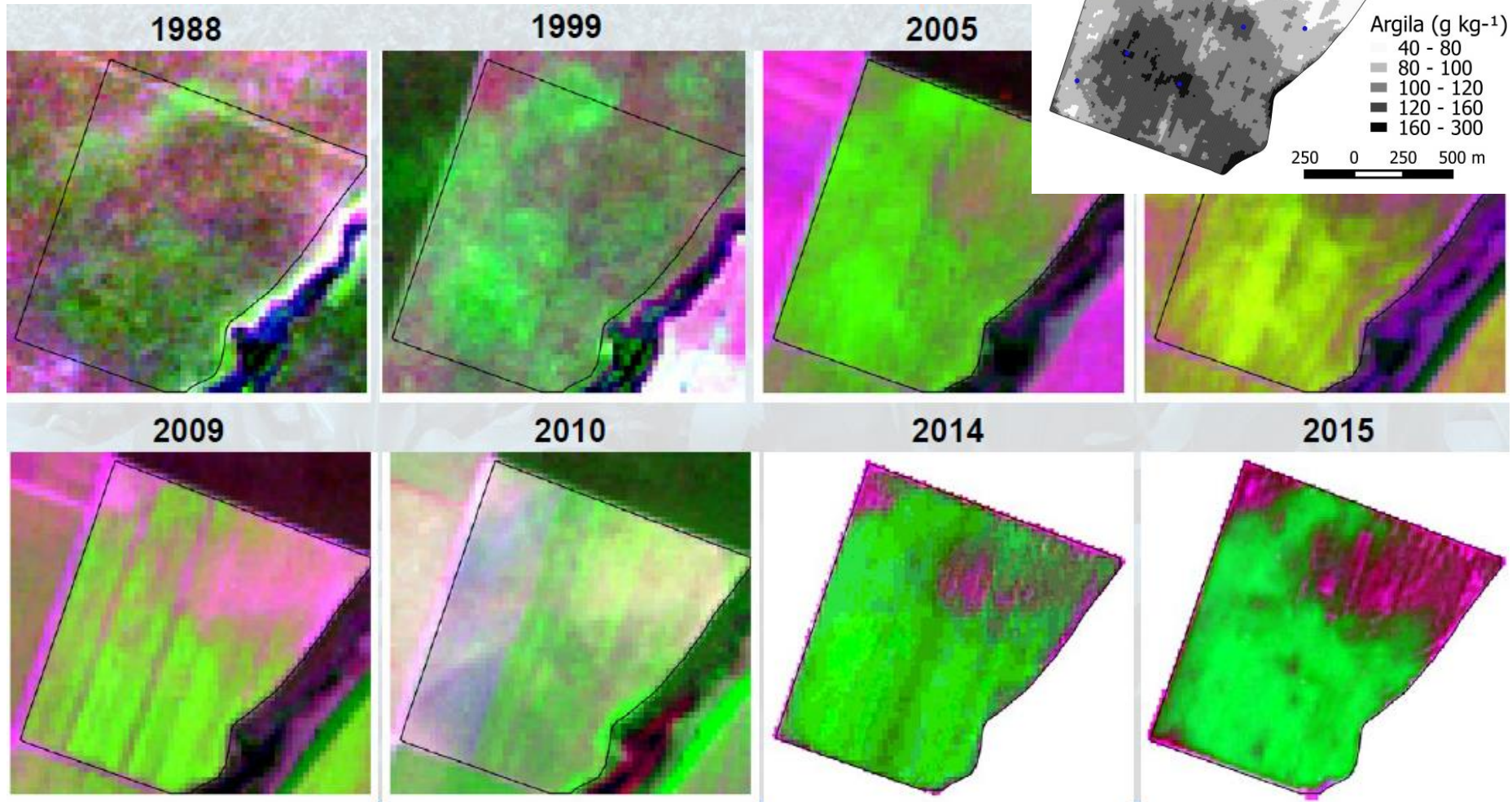
Corn 2009

Soybeans 2010

Corn 2010



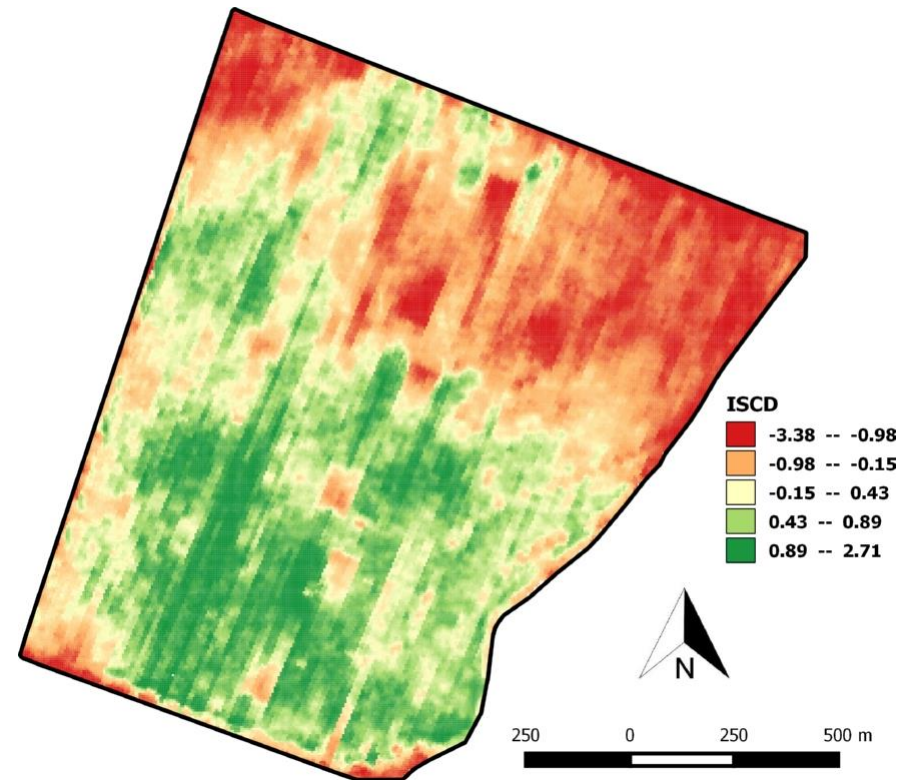
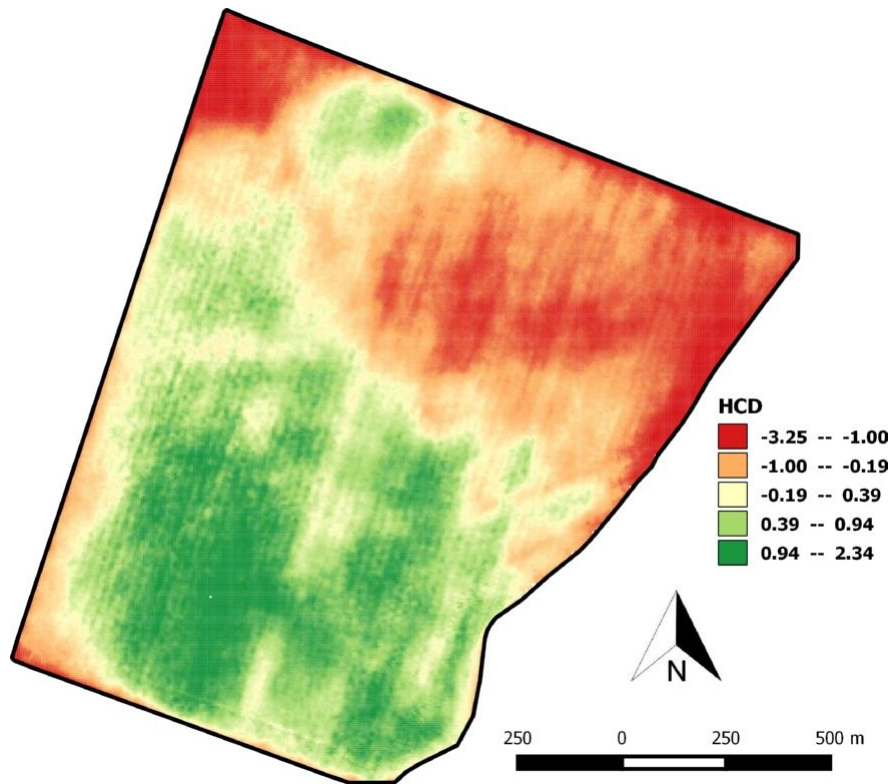
Estabilidade temporal



Trevisan, R. (2018)

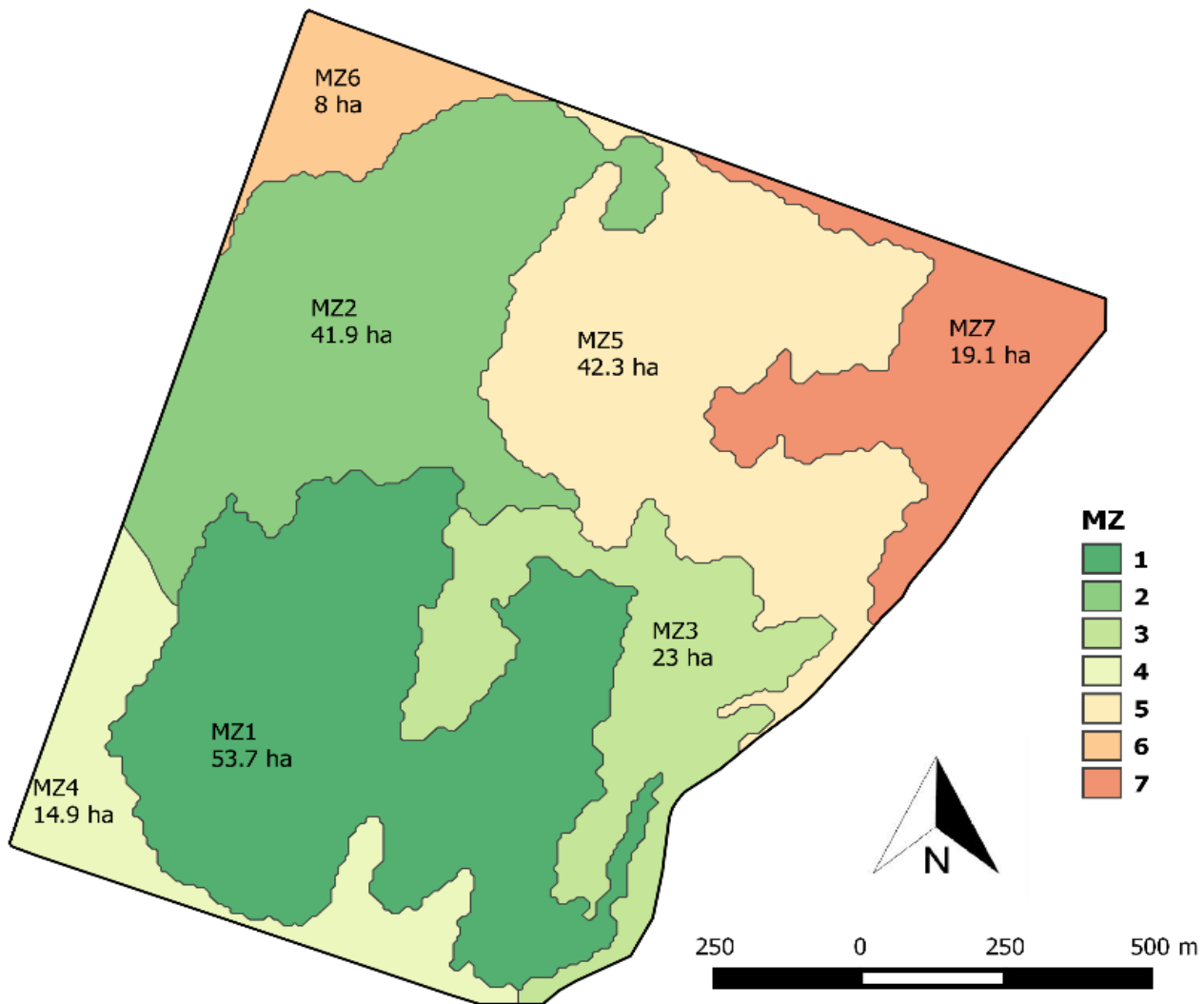
12 historical NDVI maps

N-Sensor, satellite derived NDVI and ultrasonic measured crop height at mid-season and pre-harvest



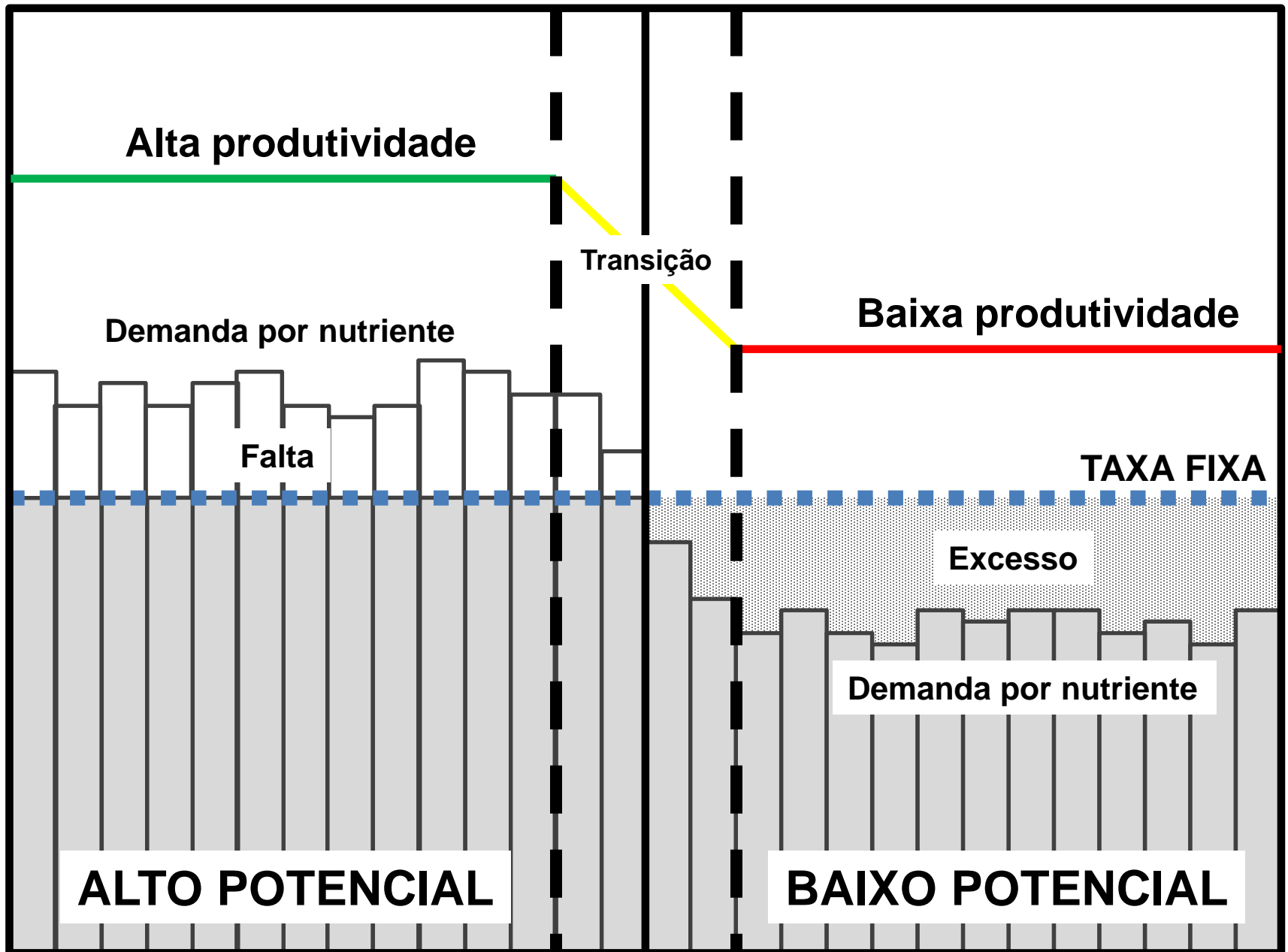
Maps of the first pair of latent variables from the canonical correlation analysis, representing historical crop development (HCD) and in season crop development (ISCD) for a cotton field in Campo Verde – Mato Grosso – Brazil

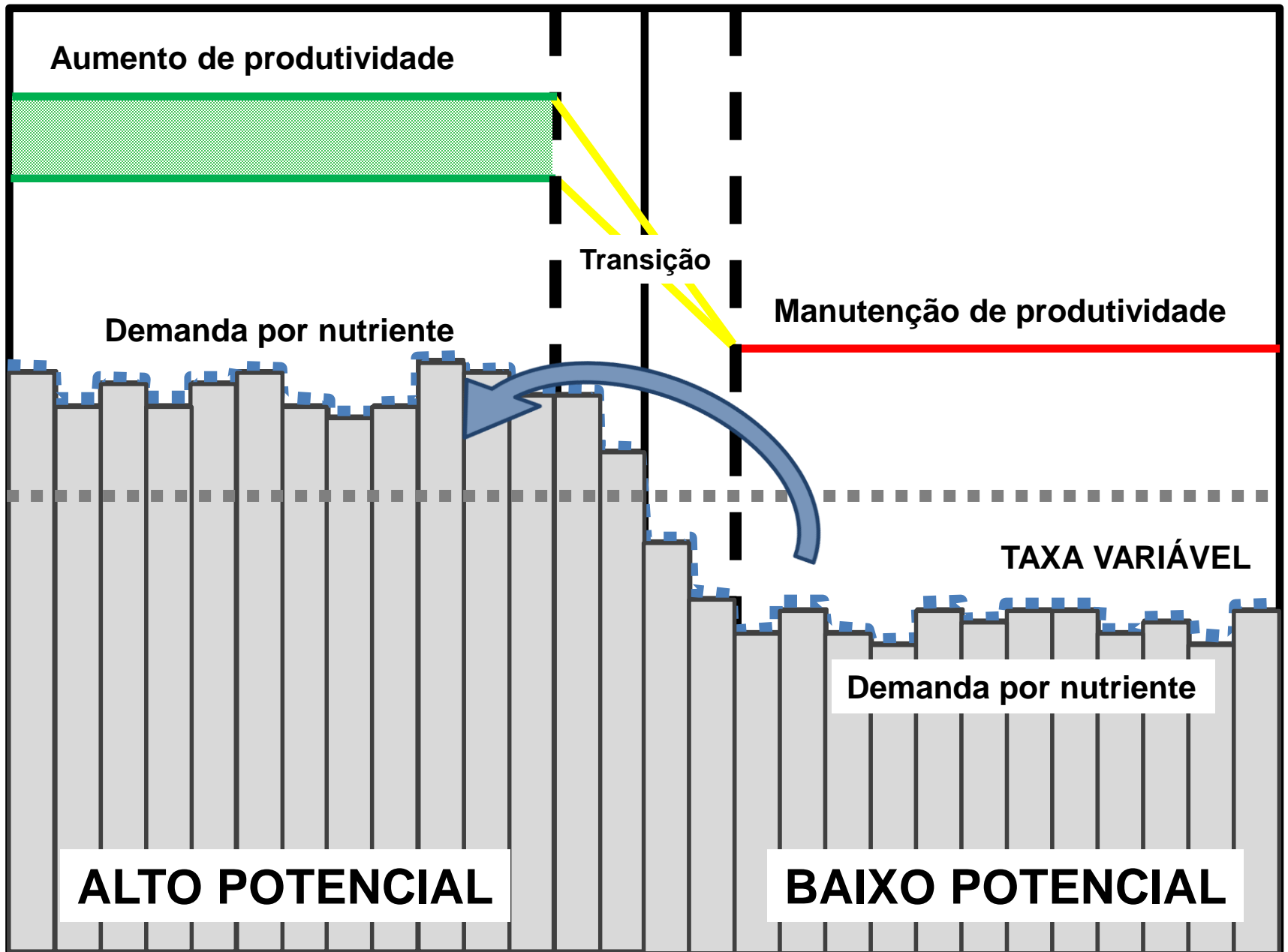
Trevisam, R. (2016)



Map of the management zones delineated for a cotton field in Campo Verde – Mato Grosso – Brazil

Trevisan, R. (2016)





Amostragem por células (sem interpolação)

