



10th European Conference on Precision Agriculture
July 12th - 16rd, 2015

Yield mapping methods for manually harvested crops

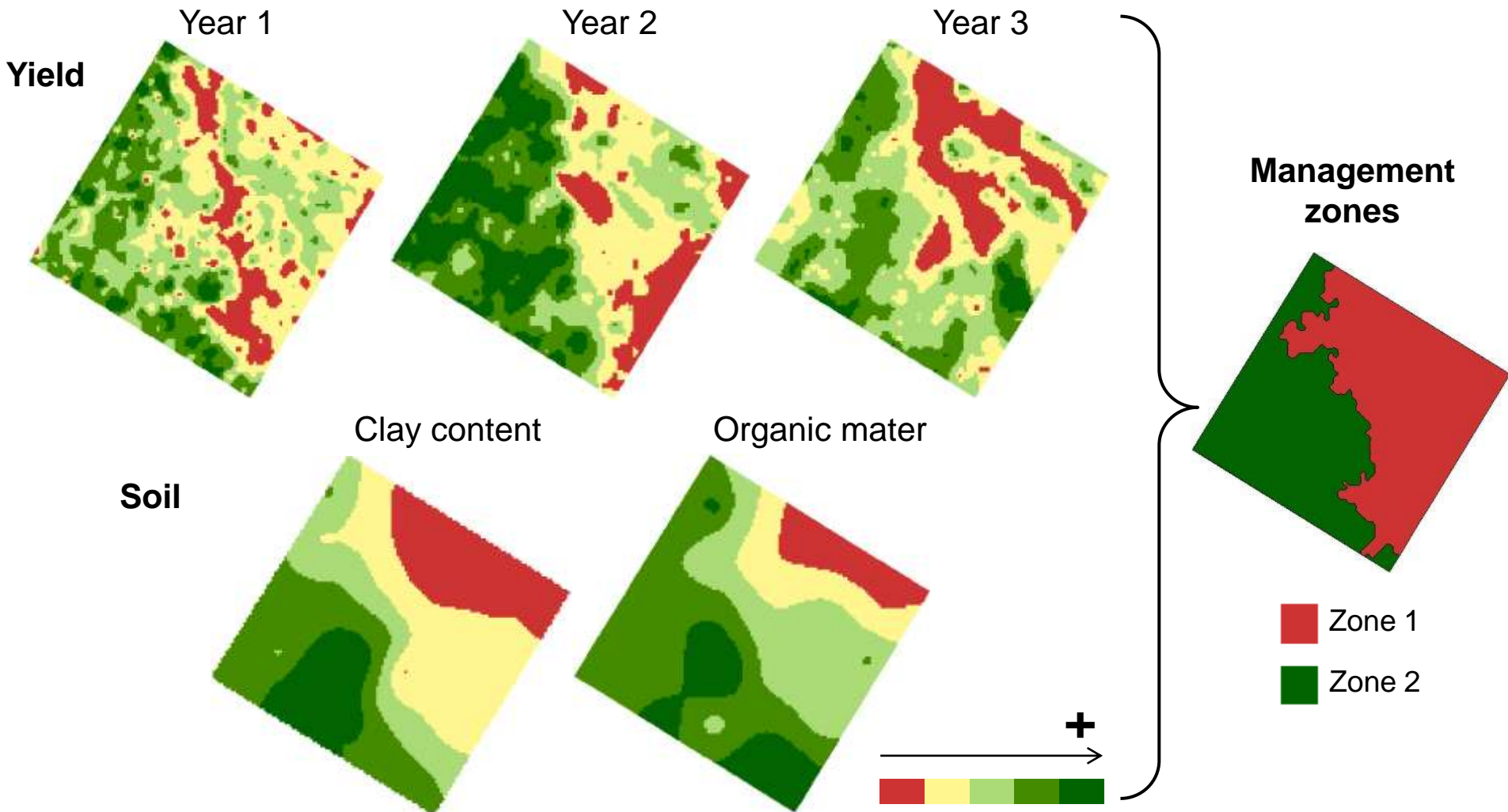
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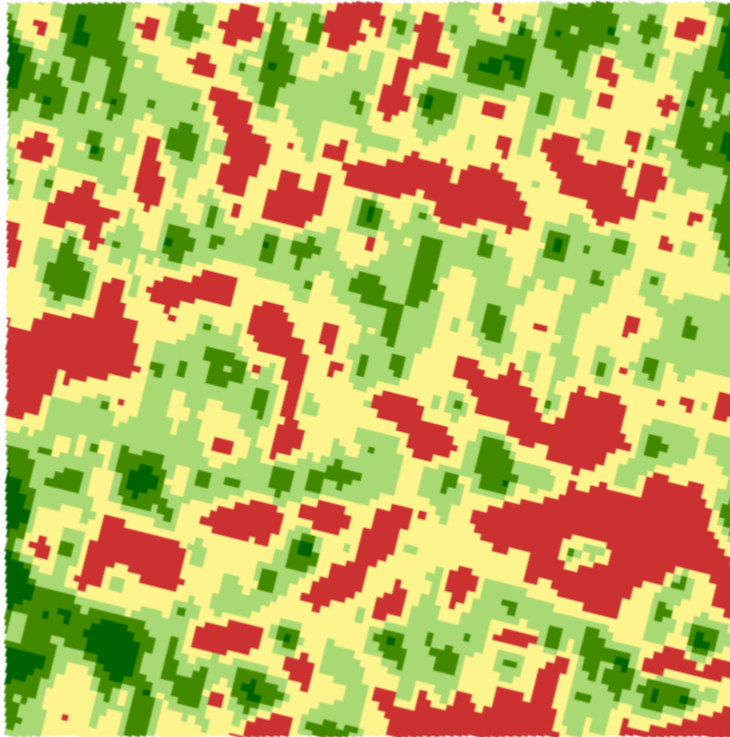
Introduction

- Yield Map

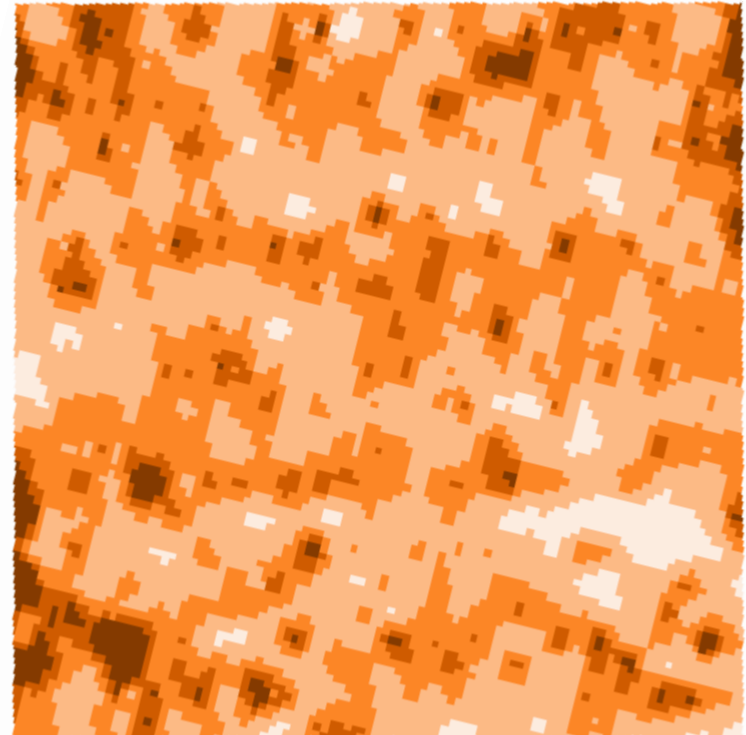
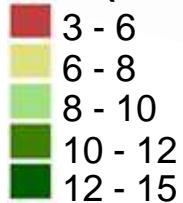


Introduction

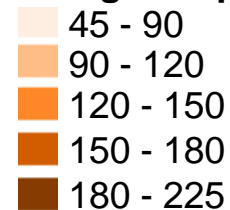
- Yield Map



Yield (t ha^{-1})

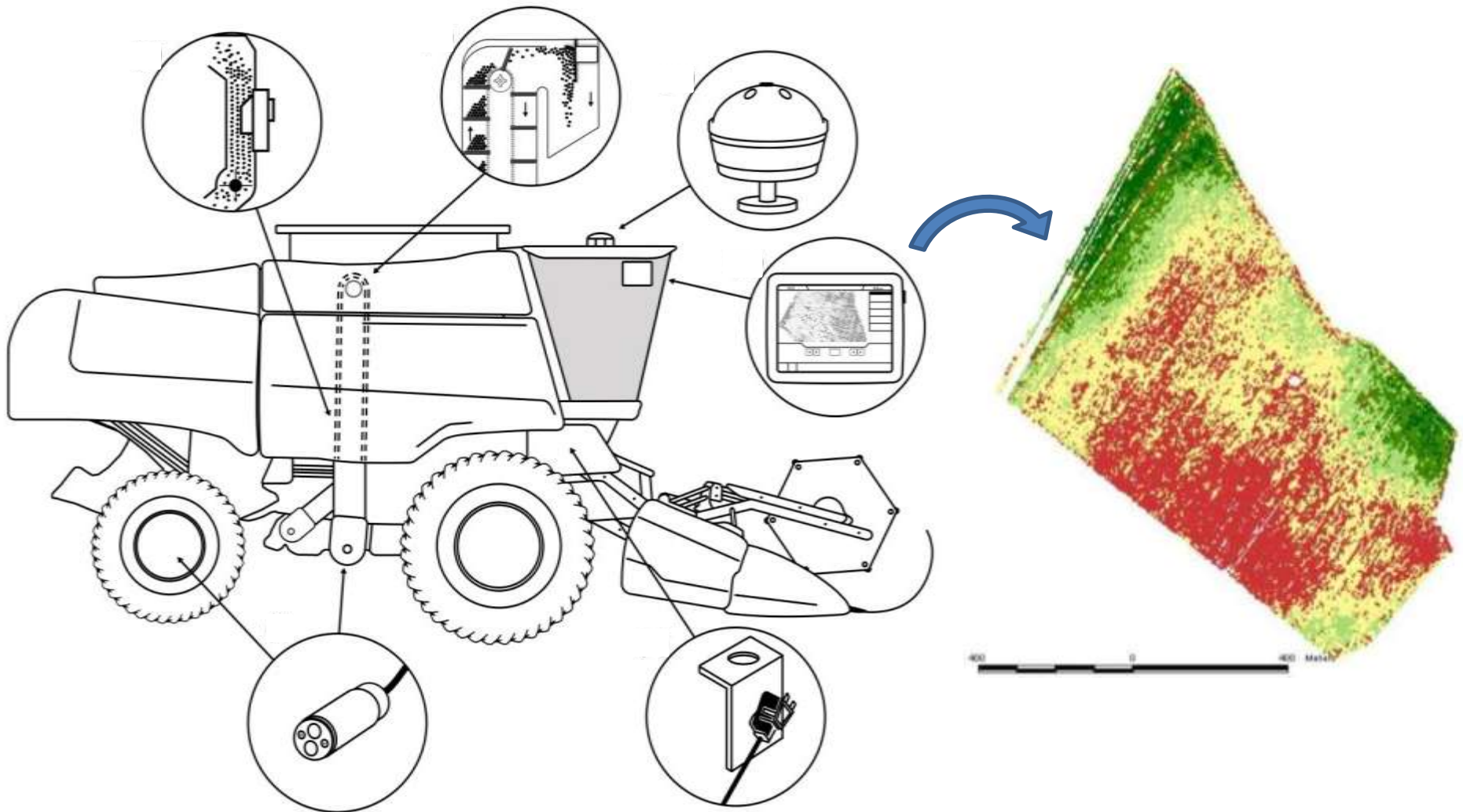


Nitrogen export (kg ha^{-1})



Introduction

- Yield monitor



Introduction

- Manual harvest



Source: Revista dinheiro rural (2010)



Source: Agencia de noticia São Joaquim online (2009)

Introduction

- Yield mapping in manual harvest



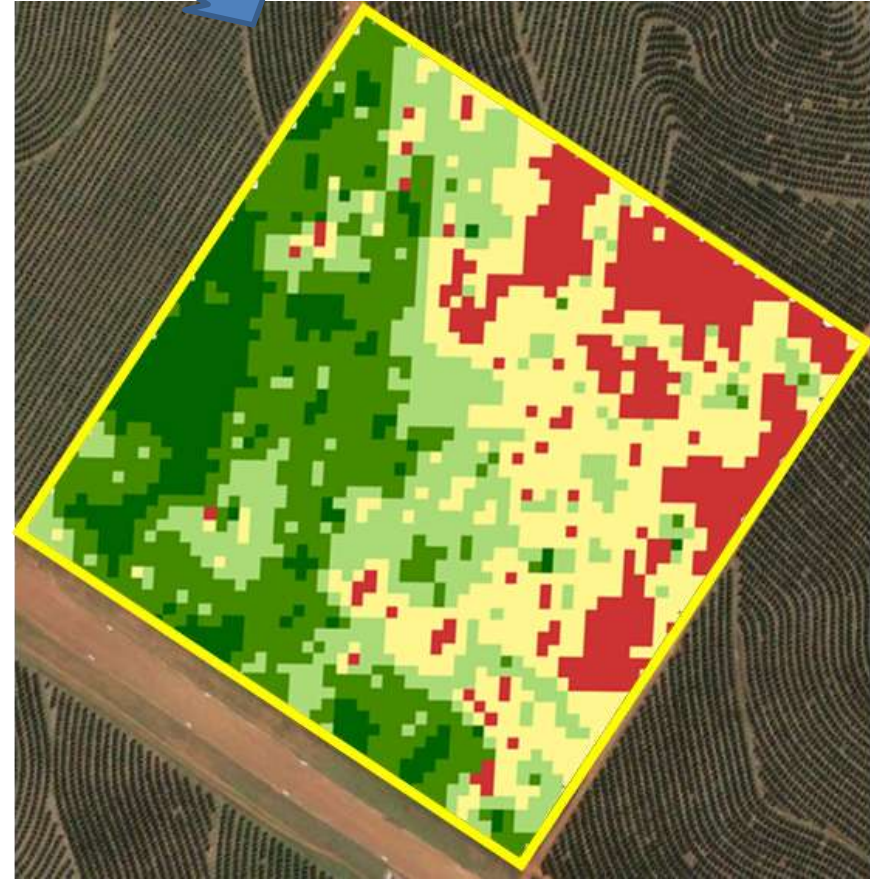
Introduction

- Yield mapping in manual harvest

Data processing



Georeferencing of bags



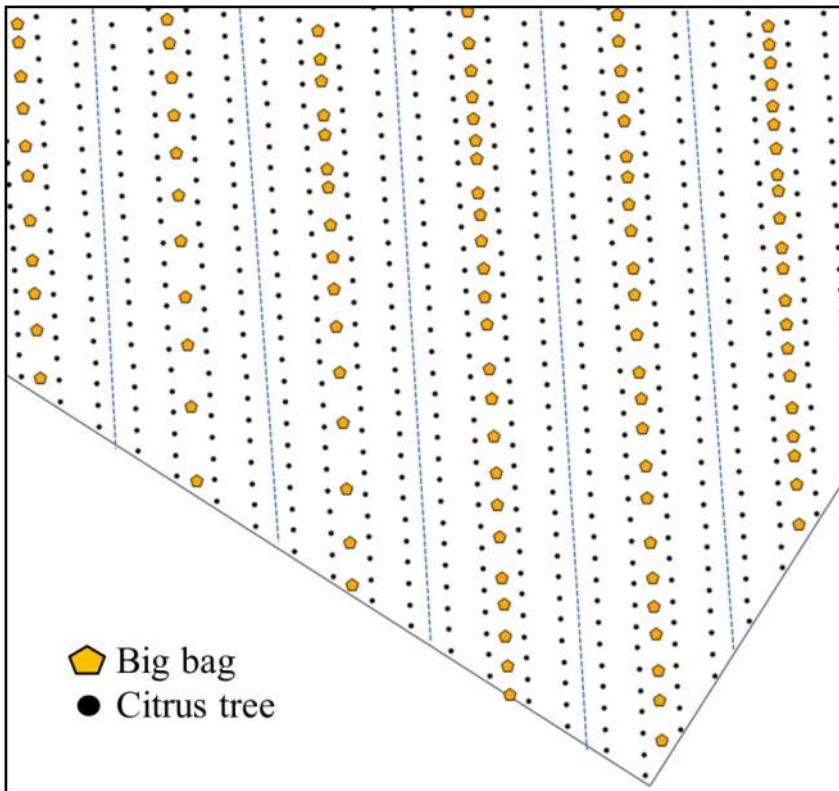
Yield map

Objective

- ✓ To demonstrate and compare different data processing methods for yield mapping in manually harvested crops,
- ✓ To verify the accuracy of each method.

Material and Methods

Citrus manual harvest



Material and Methods

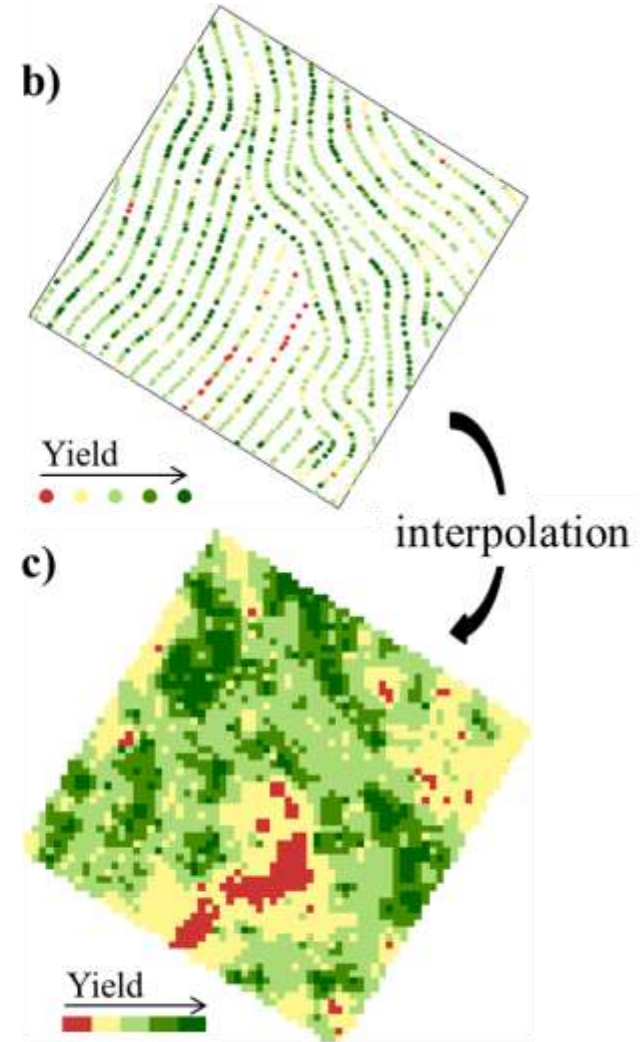
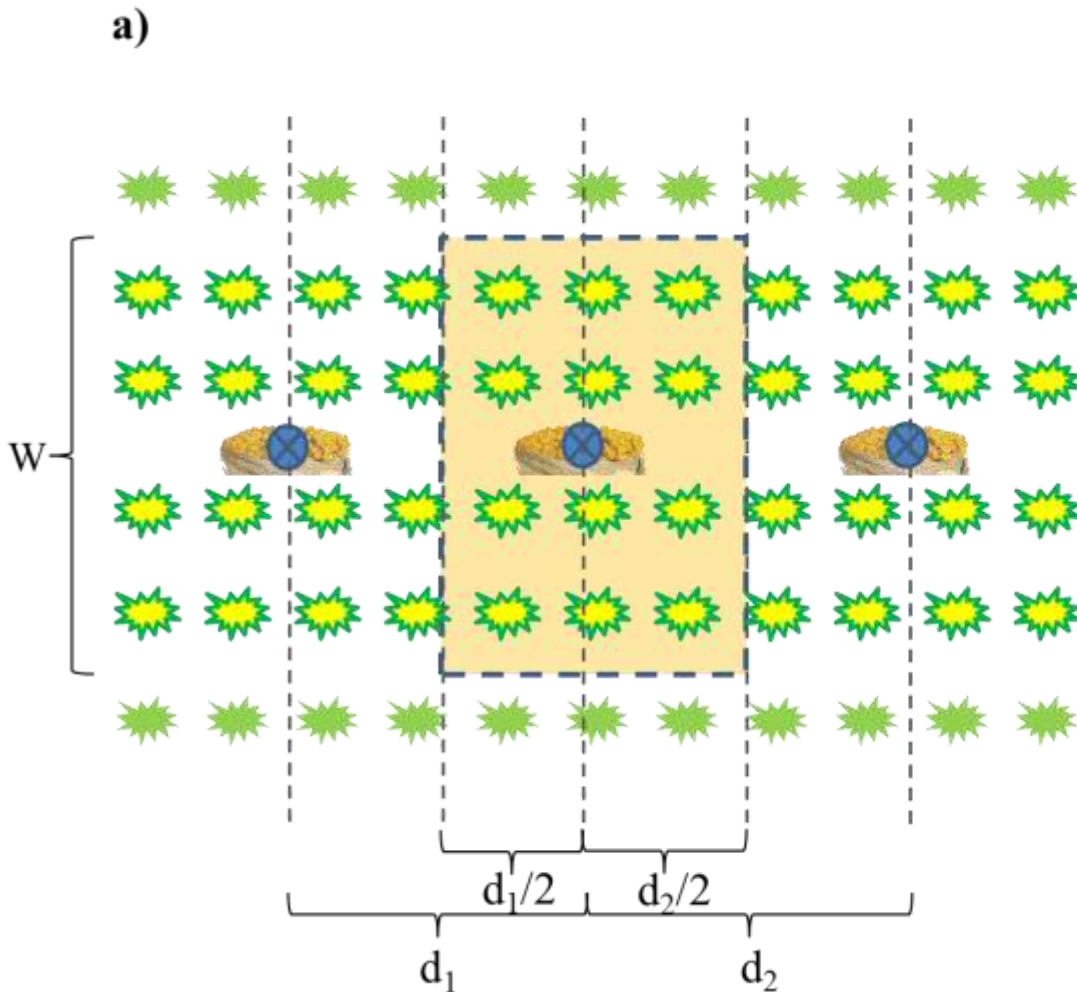
Data processing methods

Total of six methods divided into two types:

- ✓ The first type calculates yield at each bag location, based on the mass and coverage area of the bag.
- ✓ The second type calculates yield in a given area based on the number of bags found within a searching field.

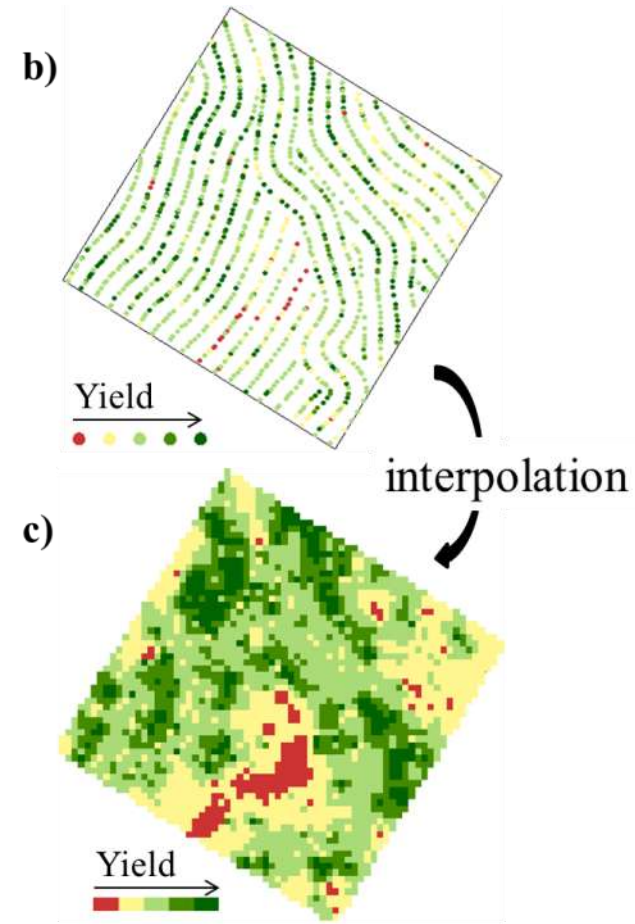
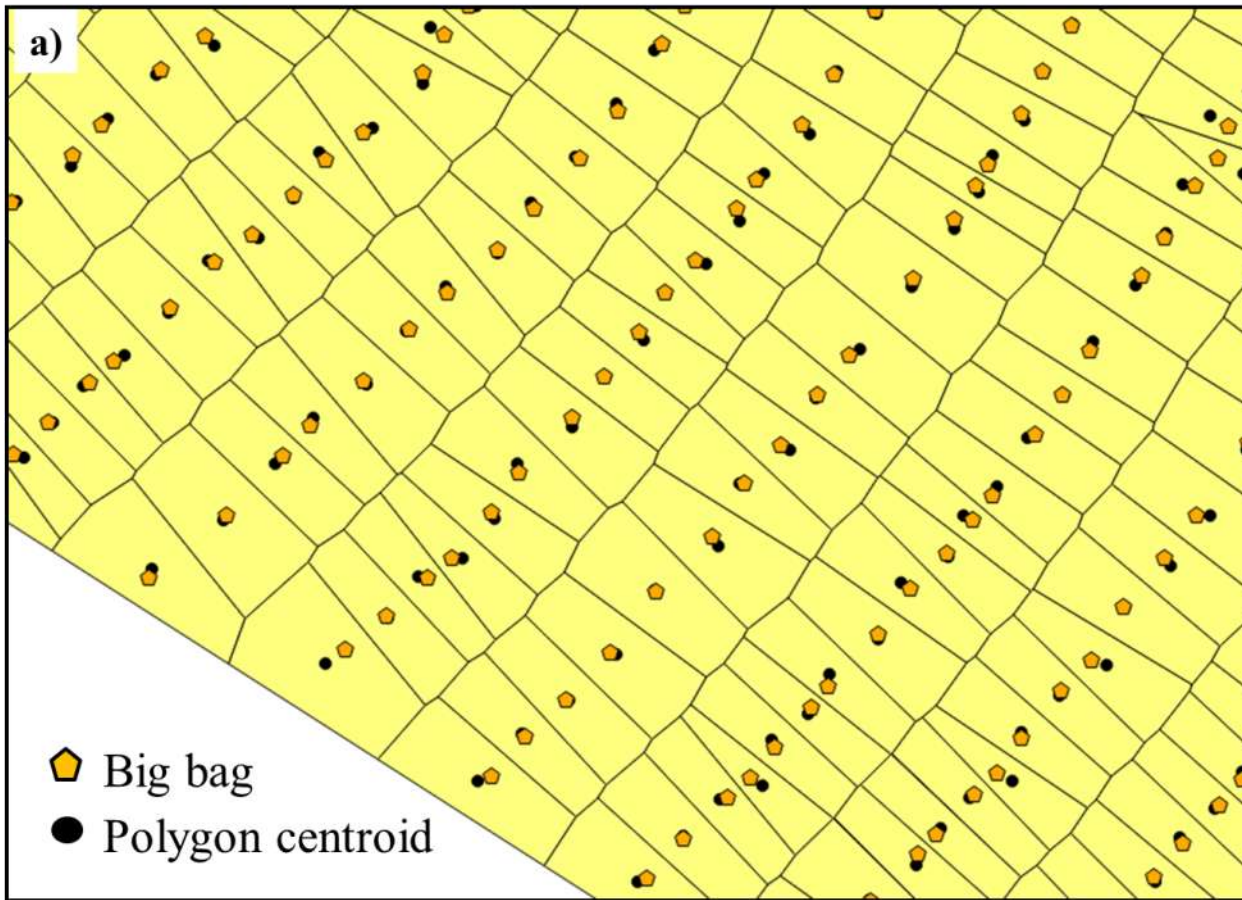
Material and Methods

Method 1 – rectangular bag coverage area



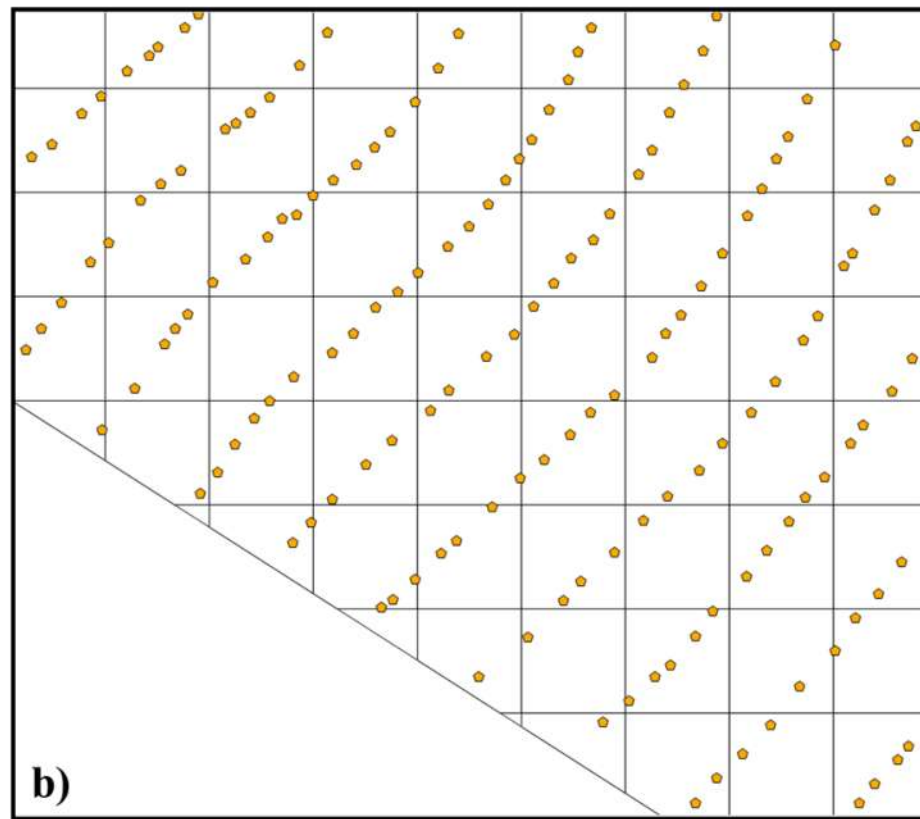
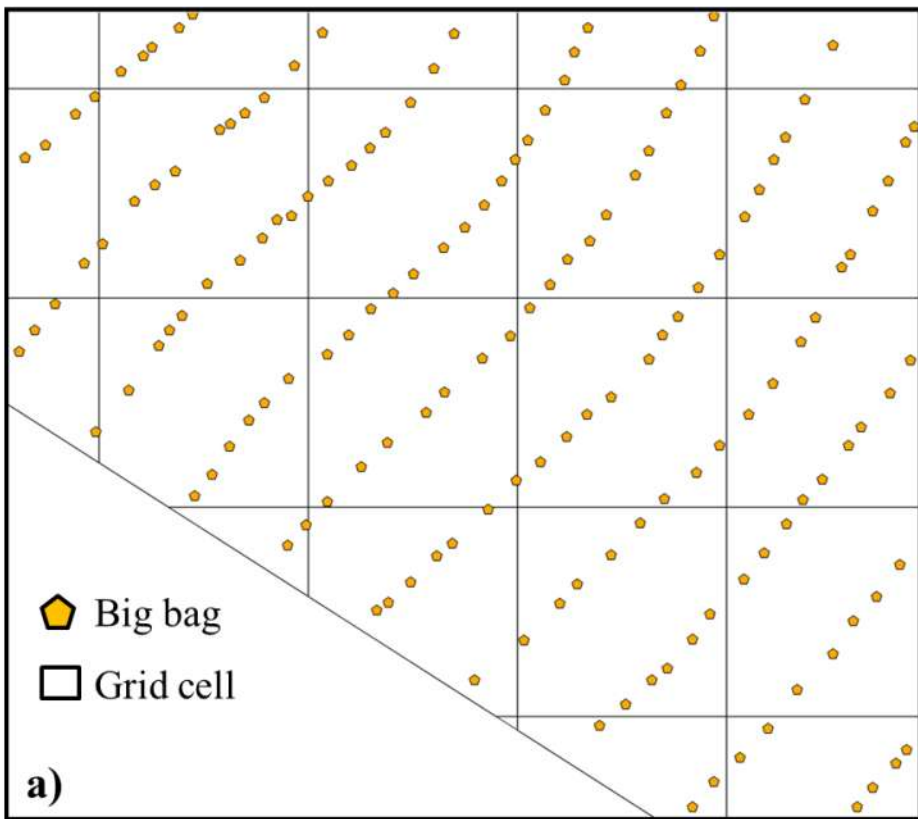
Material and Methods

Method 2 – Voronoi polygon



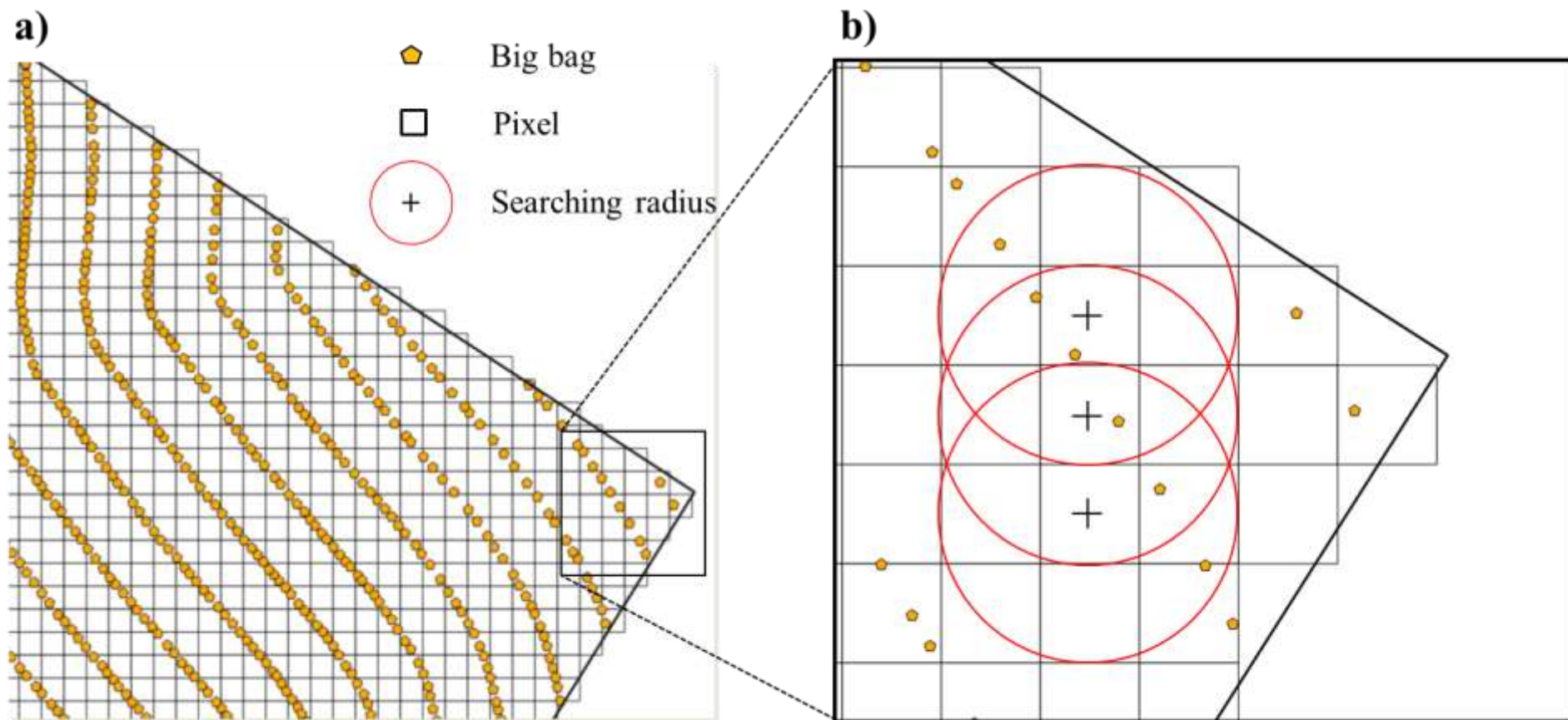
Material and Methods

Method 3 and 4 – counting bags within grid cells



Material and Methods

Methods 5 and 6 – counting bags within a given radius (heat map)



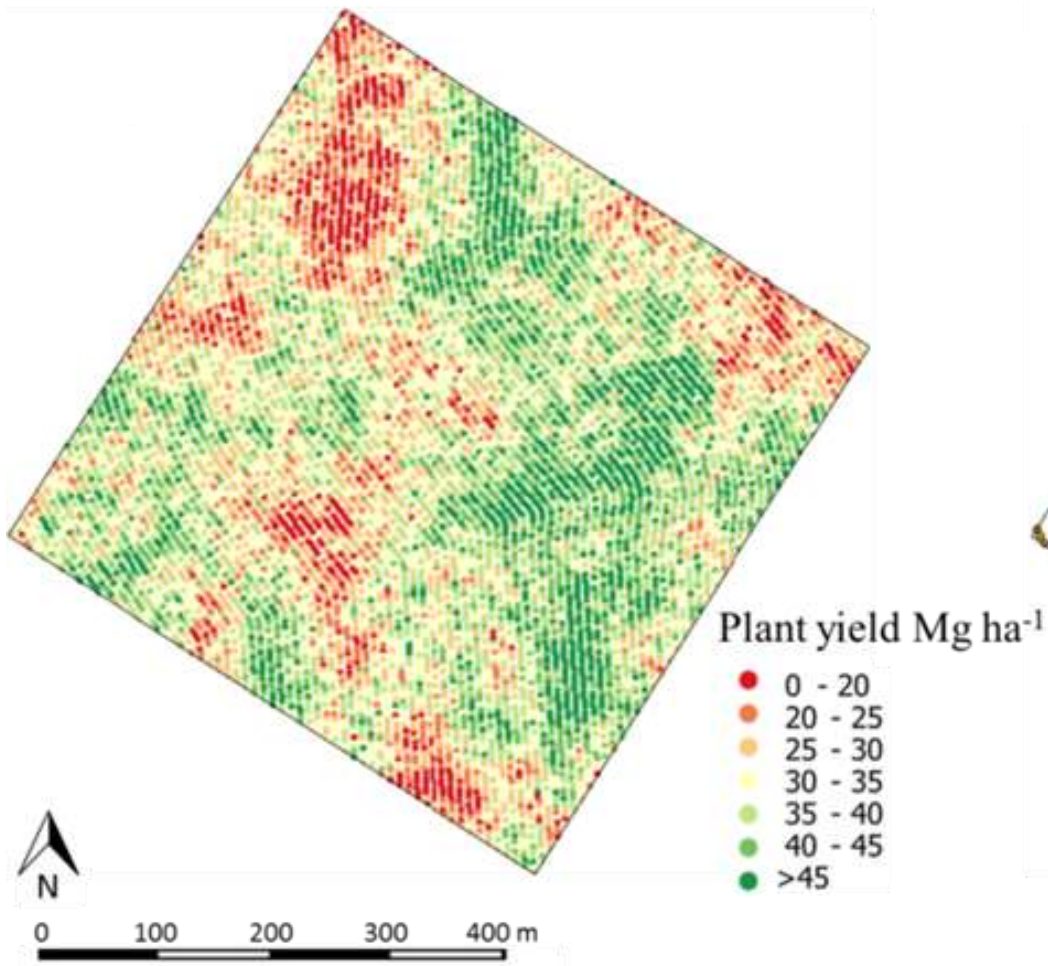
Material and Methods

Accuracy evaluation

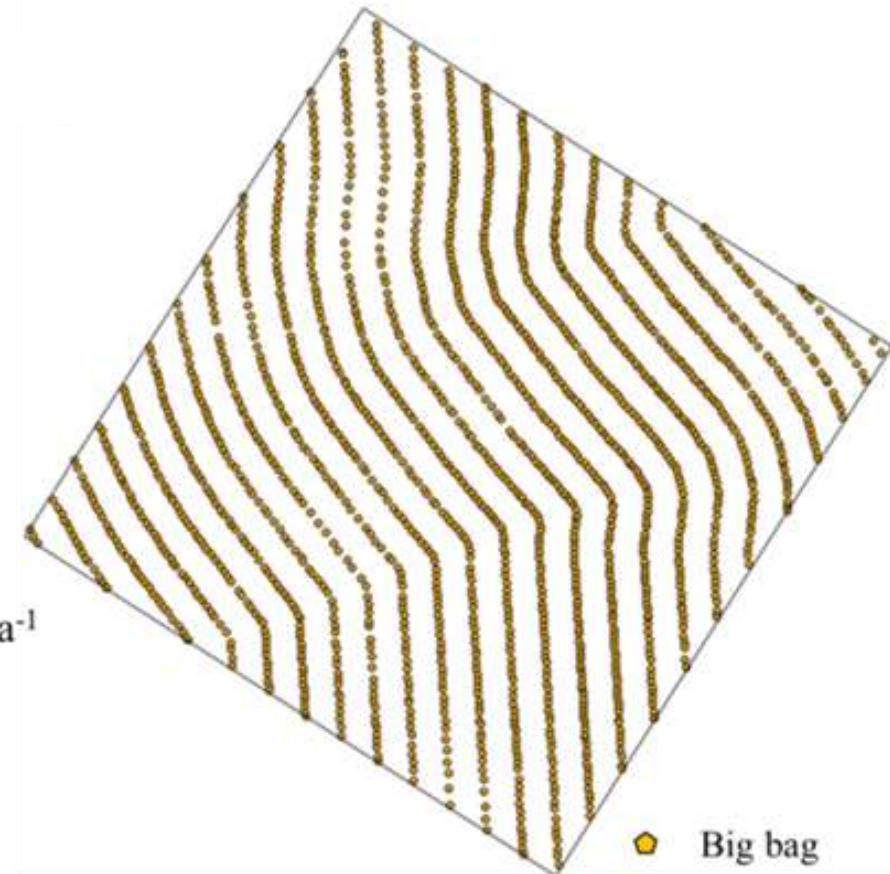
- ✓ Reference yield map (modeled)
 - Position of trees
 - Fruit yield of each tree
 - Bag locations
- ✓ Comparison between reference and each yield map
 - Correlation
 - Average error

Results and Discussion

Reference yield map



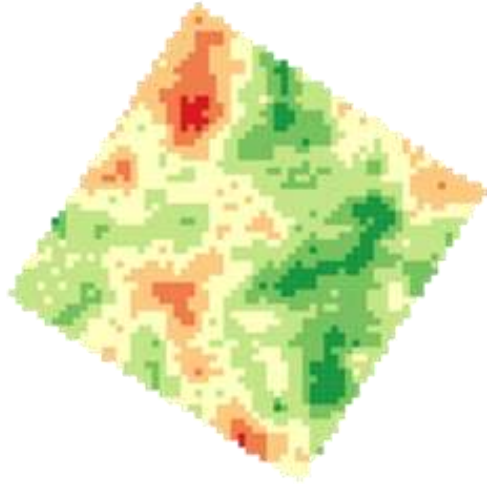
Bag locations



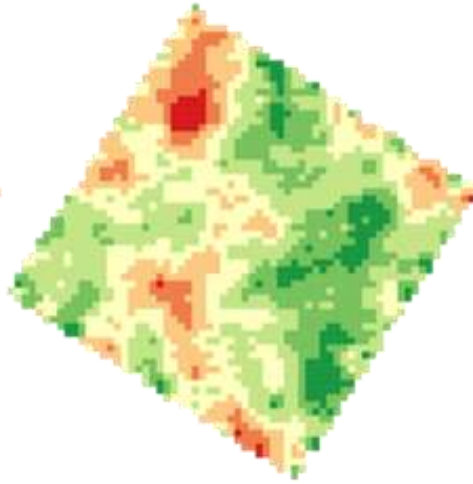
Results and Discussion

Reference

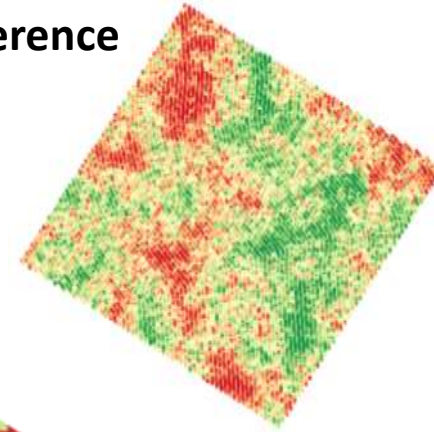
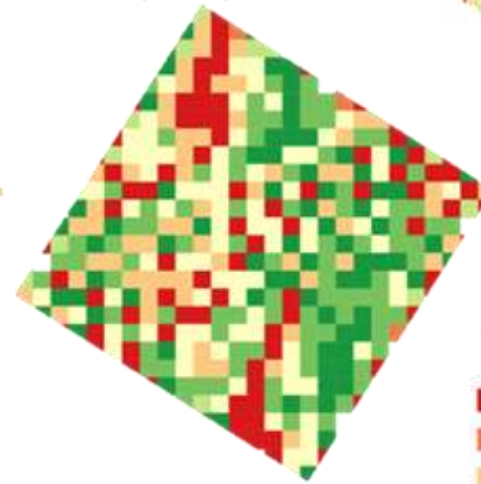
Rectangular bag coverage



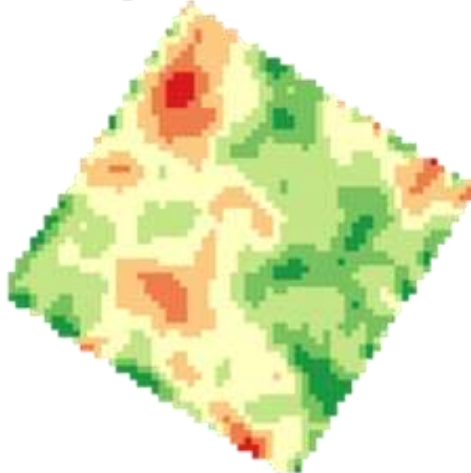
Voronoi



Grid cell (25 m)



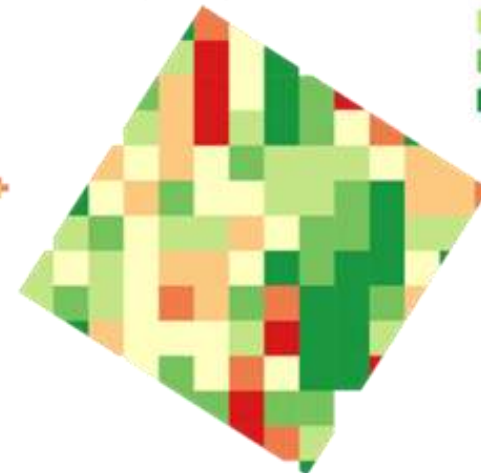
Heat map (15 m)



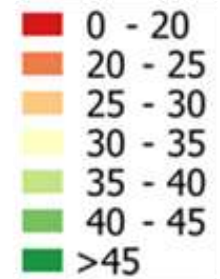
Heat map (30 m)



Grid cell (50 m)



Yield Mg ha⁻¹



0 100 200 300 400 m

Results and Discussion

Descriptive statistics of the reference yield map and from different yield mapping methods

	Reference yield map	Rectangular bag coverage	Voronoi	Heat map (15 m)	Heat map (30 m)	Grid cell (25 m)	Grid cell (50 m)
Count	8450	2360	2360	2360	2360	416	113
	----- Mg ha ⁻¹ -----						
Mean	34.85	35.09	35.35	34.94	34.94	33.93	35.85
Minimum	3.28	14.55	16.54	16.26	21.30	0.00	10.80
Maximum	64.21	53.63	54.11	67.75	51.28	108.01	108.01
Range	60.93	39.08	37.57	51.49	29.97	108.01	97.21
Standard Deviation	8.92	6.17	6.49	6.40	5.48	16.12	12.16
	----- % -----						
Coefficient of Variation	25.59	17.58	18.36	18.31	15.68	47.51	33.91

Results and Discussion

Correlation and average error between yield mapping methods and reference yield

	R^2 *	Average error (%) *
Rectangular bag coverage	0.77	15.19
Voronoi	0.75	15.72
Heat map (15 m)	0.68	17.09
Heat map (30 m)	0.54	20.12
Grid cell (25 m)	0.44	31.14
Grid cell (50 m)	0.55	21.37

* Against reference yield map

Conclusion

- ✓ All methods presented similar average yield and spatial variability patterns, but different level of detail and accuracy.
- ✓ The best yield mapping performance was found on methods that calculate yield at every bag location.
- ✓ These maps can show yield variability with good level of detail.

Next steps

- ✓ Test the methods in different scenarios and sensitivity analyses (GPS error, spatial variability patterns, etc).
- ✓ More repetitions and statistical delineation



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