Wide-range assessment of spatial and temporal variability of soil attributes by an electromagnetic induction (EMI) sensor in Brazilian sugarcane fields
ECa can help us to characterize the soil spatial variability in sugarcane fields by EMI sensor?

Source: Sanches et al., 2019
The present study aimed to provide a wide-ranging assessment of the relationship between soil attributes (clay, K, Ca and Mg) and ECa at spatial and temporal level in Brazilian sugarcane fields by an EMI sensor.
How we measure!
Why EMI sensor?

Source: Sanches et al., 2016
High relationship with Yield potential
6 fields assessed
### Material and Methods

#### Soil and ECa Dataset

<table>
<thead>
<tr>
<th>Field</th>
<th>Area [ha]</th>
<th>Years</th>
<th>Grid [m]</th>
<th>Samples [samples ha⁻¹]</th>
<th>Dens.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>52.57</td>
<td>2011, 2012, 2013 and 2014</td>
<td>50 x 50</td>
<td>204</td>
<td>3.88</td>
</tr>
<tr>
<td>B</td>
<td>95.88</td>
<td>2014</td>
<td>50 x 50</td>
<td>303</td>
<td>3.16</td>
</tr>
<tr>
<td>C</td>
<td>34.81</td>
<td>2014</td>
<td>50 x 50</td>
<td>128</td>
<td>3.68</td>
</tr>
<tr>
<td>D</td>
<td>102.06</td>
<td>2016 and 2017*</td>
<td>50 x 50</td>
<td>424</td>
<td>4.15</td>
</tr>
<tr>
<td>E</td>
<td>37.50</td>
<td>2017</td>
<td>75 x 75</td>
<td>66</td>
<td>1.76</td>
</tr>
<tr>
<td>F</td>
<td>90.04</td>
<td>2017</td>
<td>100 x 100</td>
<td>119</td>
<td>1.32</td>
</tr>
</tbody>
</table>

2,000 soil samples collected
400 hectares mapped
The present study comprised experimental fields with wide clay content variability;

- Fields assessed were from
  - very sandy (clay < 150 g kg\(^{-1}\))
  - until very clayey (clay > 600 g kg\(^{-1}\))

- Fields B and F showed the greatest clay content variability, while fields C and E the smallest;
Outliers Detection

Data set

$X_i$ samples

$k$ soil attributes;
$y$ fields;
$w$ years;

By soil attribute, field and year

Data Standardiz.

ECa Classification Method Testing

Data Analysis

By quantile

By natural breaks (jenks)

By geometrical interval
ECa classes can reflect the spatial and temporal variability of soil attributes?
Quantil classification method showed the best division of clay content for ECa classes.

All iterations produced, for NB and GI methods, overlap of classes 3 and 4.

We assumed that the Quantil method was the most suitable for separation and classification of ECa data into classes.
Spatial Variability Assessment

Trend of growth content from class 1 to 5;

Low ECa evidenced sandy areas with lower contents of K, Ca and Mg;

CV showed that the less conductive classes presented greater variability in the contents, with a decrease trend from class 1 to 5;
**Temporal Variability Assessment – Field A (4 years)**

At time level, factor 1 showed the same growth trend from class 1 to 5.

Patterns founded at spatial variability level, were temporarily remained, where class 1 showed smaller average contents than class 5.
The results showed that ECa, measured by an EMI sensor, shows a high correlation with soil texture variability of fields assessed ($R^2 = 0.97$).
ECa classes, defined by quantil method, showed that the low electrical conductivity sites tend to present lower Clay, K, Ca and Mg contents.

Higher ECa classes showed smaller CV for all soil attributes assessed, i.e., sites that can be characterized with smaller amounts of samples to an adequate soil mapping than lower ECa classes.

Clay content variability was directly proportional to the ECa variability ($R^2 = 0.97$).

The EMI sensor is an excellent tool for defining the spatial variability of soil fertility and can be used for site-specific management of sugarcane fields.
Thank you

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