IDENTIFICATION OF SOIL AND PLANT ATTRIBUTES RELEVANT FOR A SUSTAINABLE SUGARCANE MANAGEMENT USING PRECISION AGRICULTURE TECHNIQUES

Paulo S. Graziano Magalhães

Brazilian Bioethanol Science and Technology Laboratory (CTBE) / National Center for Research in Energy and Materials

FAPESP Process 2011/02817-9 | Term: Feb 2012 to Mar 2014

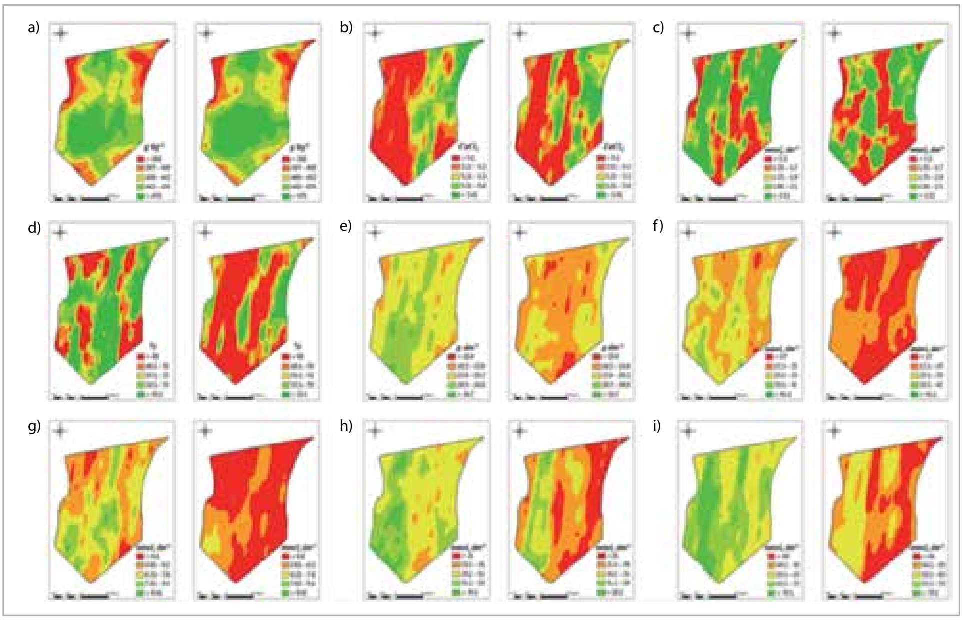

Figure 1. Soil chemical attributes determined based on a regular dense grid (left) and on oriented and reduced soil sampling using soil electrical conductivity (ECa) as external drift in Kriging (KED) (right)

The production of biofuels can only be justified if their economic and environmental impacts are favourable, compared to similar energy sources, and if there are real benefits to all segments of society directly involved. One of the innovations of science and technology that should be incorporated into the production of sugarcane is the Precision Agriculture (PA), which allows the producer to understand and control more precisely the inherent spatial variability found in the fields in order to obtain higher productivity, economic return and environmental protection. In this context, this project has as main objective the evaluation of the causes of spatial and temporal variability of sugarcane productivity in order to optimize the agricultural management through AP technique. The specific objective are identify the factors, and their interactions that influence the spatial variability of yield and quality of sugarcane. The project aim to improve agronomic diagnostic models and guide the development of sensors that allow a determination "on-the-go" of soil parameters to complement the scientific knowledge needed to extend the full potential of AP as an effective tool of crop management on a commercial scale. For this, two areas cultivated with sugarcane, each with 50 ha, one area applying PA concepts, such as fertilizer application at varied rate and one area with standard management, were evaluated regarding their soil attributes, chemical and physical, and plant nutritional status. This research project, seeks to contribute to the technical/scientific knowledge about the spatial variability of sugarcane productivity through: survey of more detailed data, to assist in understanding the crop response to variations in soil and climate conditions within the cane fields. Then, contribute to the development of new management strategies for sugarcane, aiming a vertical integration of productivity and reduction of environmental and economic impacts.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

The experiment comprised a diversity of technologies to measure soil and plant attributes within a 50 ha sugarcane area. In our data analysis workflow, the diversity of measured attributes was treated on a common ground, providing a platform to compare data acquisition technologies and to eventually select those technologies suited for large-scale PA practice. We are working to expand the sugarcane PA database, adding data from other finished and ongoing experiments. With the expanded dataset, we expect to recognize relevant patterns that are reproduced consistently across distinct experiments. For instance, data evidenced annual change in spatial distribution of sugarcane yield as well as a correlation structure relating soil pH with concentrations of organic matter and lime elements. This type of information is valuable for future PA practice. The proposed analysis workflow applied systematically to an ever-growing dataset will help consolidating the knowledge required for effective sugarcane PA.

Through an optimised grid guided by ECa, it is possible to predict the spatial distribution of soil physical and some chemical properties using Kriging with external drift (KDE). We conclude that KDE (using dynamic secondary information) presents advantages when using sparsely sampled points, providing more reliable estimates of the attributes. To improve prediction, more information could be added from other soil sensors in the trend model. These results offer a perspective for obtaining other attributes that must be estimated over large areas based on sparse soil samples. This method could assist farmers with crop management and ensure higher economic returns and a sustainable production system.

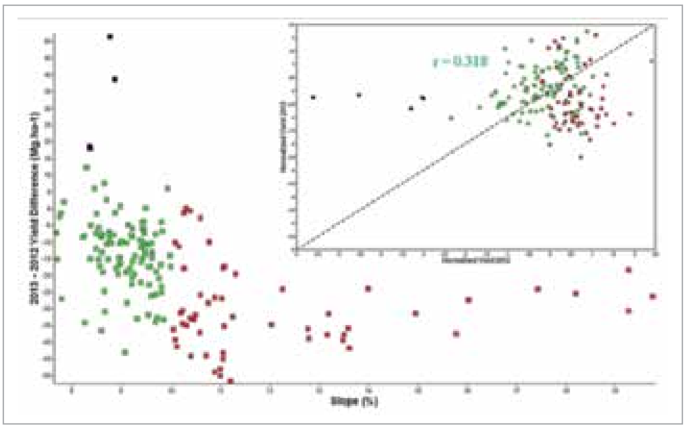

Figure 2. Yield decrease between successive years as function of the field slope and the Person´s correlation between the successive years yield normalized data

MAIN PUBLICATIONS

Rodrigues Jr FA, Magalhães PSG, Franco HC, Beauclair EGF, Cerri DG. 2013. Correlation between chemical soil attributes and sugarcane quality parameters according to soil texture zones. *Soil Science*. 178: 147-156.

Driemeier C, Ling LY, Pontes AO, Sanches GM, Franco HCJ, Magalhães PSG. Ferreira JE. 2014. Data-oriented analysis of experiments for sugarcane precision agriculture. *Proceedings of the 10th IEEE International Conference on e-Science*. **1**:163-168, DOI: 10.1109/eScience.2014.10. available at: http://ieeexplore.ieee.org/search/searchresult.jsp?queryText=10th%20IEEE%20International%20Conference%20on%20-Science&pageNumber=4&newsearch=true&searchField=Search_All

Magalhães PSG, Sanches GM, Molin JP, Portz G, do Amaral LR, Kolln OT, Duft DG. 2013. Potential solution to contribute for sugar cane spatial variability management. *Proceedings of EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation",* Turin, Italy, 24-27. June 2013. **1**:1-8.

Sanches GM, Franco HCJ, Remacre AZ, Magalhães PSG. 2014. Multivariate geostatistics as a tool to estimate physical and chemical soil properties with reduced sampling in area planted with sugarcane. *Proceedings of the 12th International Conference on Precision Agriculture (ICPA),* Sacramento, CA, July 2014, 8 pages, available at https://www.ispag.org/icpa/Proceedings/.

Magalhães PSG, Sanches GM, Franco HCJ, Driemeier C, Kölln OT, Braunbeck OA. 2014. Precision agriculture in sugarcane production. A key tool to understand its variability. *Proceedings of 12th International Conference on Precision Agriculture (ICPA)*, Sacramento, CA, July 2014, available at: https://www.ispag.org/icpa/Proceedings/.

Magalhães PSG, Sanches GM, Franco HCJ, Driemeier CE, Ling LY, Pontes AO, Ferreira JE, Braunbeck OA. 2014. Can precision agriculture contribute to sugarcane management? *Proceedings of 2^{nd} Brazilian Bioenergy Science and Technology Conference (BBEST)*.

Paulo S. Graziano Magalhães

Faculdade de Engenharia Agrícola
Universidade Estadual de Campinas
Av. Candido Rondon, 501 – Cidade Universitária
Caixa Postal 6192
CEP 13083-970 – Campinas, SP – Brasil

+55-19-3518-3170
paulo.graziano@bioetanol.org.br