Geoderma 387 (2021) 114861

Contents lists available at ScienceDirect

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

Soil analysis is pivotal for fertilizer recommendations: Comment on “Soil based, field specific fertilizer recommendations are a pipe-dream” by A.G.T. Schut and K.E. Giller. Geoderma (https:/doi.org/10.1016/j.geoderma.2020.114680)

Gerard H. Ros[a,b,*], Mila Luleva[b], Wim de Vries[a]

[a] Environmental System Analysis Group, Wageningen University, the Netherlands
[b] AgroCares BV, the Netherlands

Handling Editor: Ingrid Kögel-Knabner

By evaluating error propagation via sampling and laboratory protocols, Schut and Giller conclude that site-specific soil based NPK fertilizer recommendations are missing a scientific basis, considering the large uncertainty in estimated soil supply of these nutrients based on a single composite soil sample. Their proposed solution is to make use of generic regional recommendations using a model based approach, which is then adapted to a field, based on indigenous farmer knowledge regarding the crop response to differences in soil fertility and past management. We doubt, however, that the statistical analysis done supports the harsh conclusion that recommendations based on field specific soil samples will remain elusive like *a fantastic notion produced by opium-smoking*. We also doubt whether the proposed solution leads to more reliable estimates of soil nutrient supply. The analysis done raised the following questions:

First, the approach differs from the way in which soil data are used in most fertilizer recommendation systems. The classic agronomic approach is to evaluate the crop response for an individual nutrient given spatial variation in soil nutrient contents and to define a nutrient level below which crops will respond to added fertilizers (Eckert, 1987). In this context various analytical procedures have been developed to provide a measure of the bioavailability of nutrients in soil, either measured as nutrient intensity (directly available), quantity (potentially available) or buffering capacity (the rate of change in quantity with respect to intensity). Fertilizer recommendation systems are subsequently based on empirical relationships between crop yields and one of those soil availability indicators of which the scientific basis is supported by numerous field experiments over the last 50 years, even though the results are often published in grey literature. Because farmers' field as well as the recommendations are derived from field trials making use of field averaged subsamples, the spatial variation in soil properties and fertilizer responses inside fields are inherently accounted for. This implies that recommendations are based on empirical relationships derived from field trials that make use of field aggregated, measured soil nutrient availability indicators. Even though there are uncertainties in these empirical relationships, we strongly doubt that a regional and model based approach, combined with farmers experience, will result in more reliable and sustainable recommendations. Indeed, other growth limiting factors might overrule the impact of soil nutrient levels, in particular in smallholder farms in Africa, but this fact supports the correct selection of representative field trials (with corresponding target yields) rather than the conclusion that soil derived and site specific fertilizer recommendations are nothing more than “*a pipe-dream*”, a fantastic, impracticable plan or desire.

Second, the statistical procedure applied assumes that the error distribution of soil properties can be derived from WEPAL reported among-laboratory CV's as well as a modest 10% CV for within-field variability. This assumption however leads to an undesired negative bias. WEPAL samples are not necessarily collected from arable soils and reported statistics are derived from a mixture of labs varying from high to medium quality. Consequently, the variation among labs is huge, as shown in Table 1 of the paper. Since farmers usually send their samples to one laboratory, the actual uncertainty due to laboratory errors is for most nutrients smaller than 5 or 10%. The WEPAL data rather support the conclusion that it matters which lab is chosen, than that substantial errors exist *within* certified labs.

Lastly, the authors present a thorough statistical analysis of soil sampling and simulated crop growth but, in contrast, ignore recent developments in spectral assessments of soil nutrients. Since 2015 new algorithms in the field of machine learning have shown incredible improvement, and with more data available one expects even greater leaps by implementing deep learning technologies. This is confirmed by the recent Global Spectral initiative by the FAO (GLOSOLAN Spectroscopy WG) that heavily focus on capacity building and international collaboration to use spectroscopy as a tool to measure soils. In addition,

* Corresponding author at: Environmental System Analysis Group, Wageningen University, P.O. box 47, 6700 AA Wageningen, The Netherlands.
E-mail addresses: gerard.ros@nmi-agro.nl, Gerard.ros@wur.nl (G.H. Ros).

https://doi.org/10.1016/j.geoderma.2020.114861

Available online 11 December 2020

IEEE Geoscience and Remote Sensing Society/Standards Committee started this year with a global initiative to develop standard calibration and operation procedures to overcome the laboratory issues mentioned. Hence, quantifying this spatial variation with soil sensors might overcome the inside-field variation and has potential for the development of improved site-specific empirical crop response relationships. This approach has in our view much more potential than the presented alternative approaches that strongly depend on *collected information of past management and observed yields*.

We certainly support the inclusion of more site specific properties as well as target yields in fertilizer recommendation systems around the world, but the analysis done does not support the claim that soil analysis can be replaced by indigenous farmers knowledge and yield estimates. Sustainable crop production intensification will require the development of an array of nutrient management strategies tailored to field-specific conditions, and soil analyses are key for the future development of precision farming technologies.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Reference

Eckert, D.J., 1987. Soil test interpretations: basic cation saturation ratios and sufficiency levels. In: Soil testing: Sampling, correlation, calibration, and interpretation. SSSA Spec. Publ. 21, SSSA, Madison, WI.