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Zurich, October 27, 2018

Dear Dr. Hilbeck,

you have asked me to comment on the soil analysis results for the field stations "Morogoro", "Chambezi", and Masasi" conducted by Sokoine University of Agriculture. Since I do not have the laboratory protocols, I can only provide comments on the plausibility and interpretation of the data, but not on the quality of the analyses.

The soil pH values in Morogoro are in the moderately acidic range (average pH(H_2O)=6.06; pH($CaCl_2$)=5.27). This can be considered to be favorable for agricultural use, since Al-toxicity problems are not to be expected. The variability of soil pH is fairly small and no differences between the plots R1, R2, and R3 were detected. The texture analysis shows that the soils are predominantly sandy clays, with an average clay content of 40% (with 6% silt and 54% sand). Some samples were analyzed with higher silt contents (up to 29%), leading to a higher relative variability in the silt contents. It seems possible that these few samples were not perfectly dispersed, which would lead to an overestimation of silt at the expense of clay contents. However, since I do not have the laboratory protocols, this is difficult to judge. Overall, the differences between the plots R1, R2, and R3 in terms of soil texture appear to be insignificant. The organic carbon (C_{org}) and total nitrogen (TN) contents of the soils are relatively low (0.91% Corg; 0.08% TN), and the C/N ratio is 10.94, a typical value for such soils. The C_{org} content corresponds to about 1.6% organic matter. There were no differences in C_{org} and TN between the three plots R1-R3. Considering the low contents in organic matter, soil management and organic fertilizer amendments may result in significant differences after some years.

The analysis of the exchangeable cations Ca, K, and Mg is useful for estimating the amounts of plant available nutrients. The values for K (average 0.7 meq/100g) and Mg (average 2.1 meq/100g) are mostly medium and in some samples even high, meaning that the soils will be able to support these nutrients to crops, provided that they are not further depleted. Also Ca deficiency should not be expected based on the soil analysis results (average 2.4 meq/100g). On the other hand, the extractable P values (Bray-P) are very low to low (average 12.6 mg/kg), and therefore P may turn out to be a yield-limiting nutrient (in addition to N). The small-scale soil heterogeneity with respect to nutrient contents appears to be greater than for other soil parameters such as pH and texture, which is typical for areas with natural vegetation. However, the three plots R1-R3 appear to be very similar to each other.

Unfortunately, the contents of exchangeable Na and Al+H were not determined. Therefore, it is not possible to calculate the effective cation exchange capacity (ECEC), percent base saturation (BS), and percent Na-saturation from the provided data. The latter would be important if you consider irrigating the agricultural field, which may lead to an increase in Na-saturation if the irrigation water quality is low. I therefore recommend analyzing the soils also for exchangeable N and Al+H. From the sum of exchangeable Ca, K, and Mg and assuming that the BS is fairly high, I would expect low CEC values per kg of clay, suggesting that the soils may have kaolinitic clay mineralogy, which is typical for highly weathered soils.

Compared to the Morogoro soils, the Masasi and Chambezi Field stations have much more sandy soils which are very low in organic matter, clay, and extractable P (Bray-P) contents. A comparison of the field stations (Fig. 1) shows that soils at Chambezi are lowest in organic carbon and clay, and consequently have the lowest CEC. This is compensated to some degree by a higher pH and base saturation (about 50%), but the soils are still lower in exchangeable nutrient cations than soils in Morogoro. They are very low in Bray-P. Soils in Masasi are intermediate in comparison to Morogoro and Chambezi in terms of organic matter content, clay content, and CEC, but they are the most acidic, have the lowest base saturation, and are lowest in Bray-P. I would expect that P is a limiting nutrient both in Chambezi and Masasi soils. All soils have a low Na saturation (based on potential CEC), but a few soils in Masasi have slightly elevated levels. If the soils are irrigated, the irrigation water quality and Na saturation of the soils should be monitored.

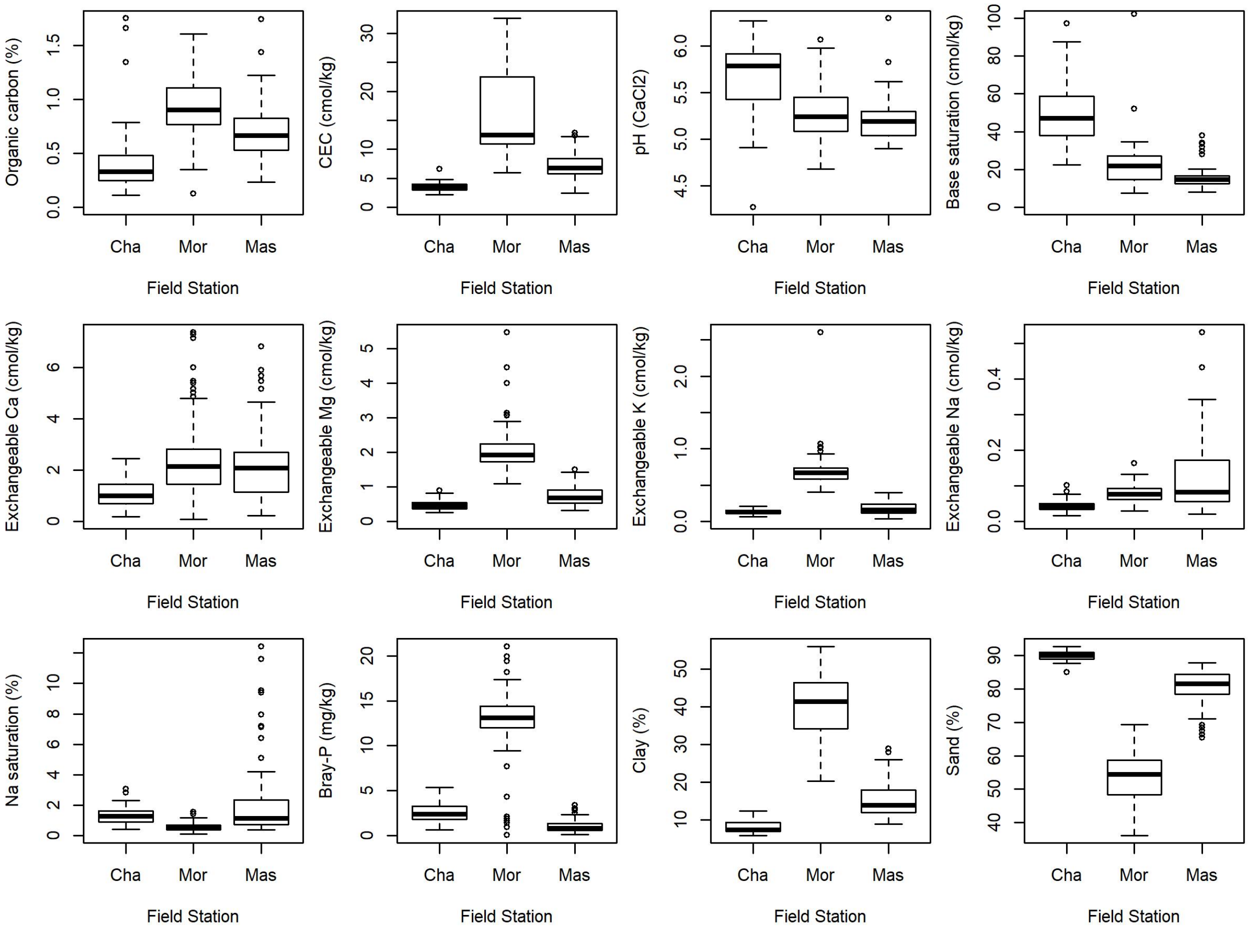
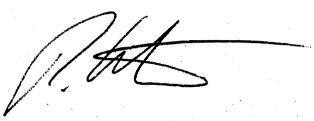


Figure 1: Comparison of some soil parameters for Chambezi (Cha), Morogoro (Mor), and Masasi (Mas) field stations.

A preliminary statistical analysis revealed that, in most cases, there are no significant differences between the plots within each field station to be used for the treatments “Compost”, “Legumes”, and “Pest Control” (see Fig. 2). Also, no significant differences were detected between plots assigned to different crops. In most cases, the only significant factors showing differences between the soils were the field station and soil depth.

In conclusion, the soils appear to be well suited for the planned field experiments and significant treatment effects can be expected for the application of compost and intercropping with legumes. The planned experimental design appears to be justified in terms of selection of plots for treatments and different crops. Of course, there is a significant amount of soil variability at all sites, and it is therefore very important to include quality control samples in future soil analyses.

Sincerely yours,



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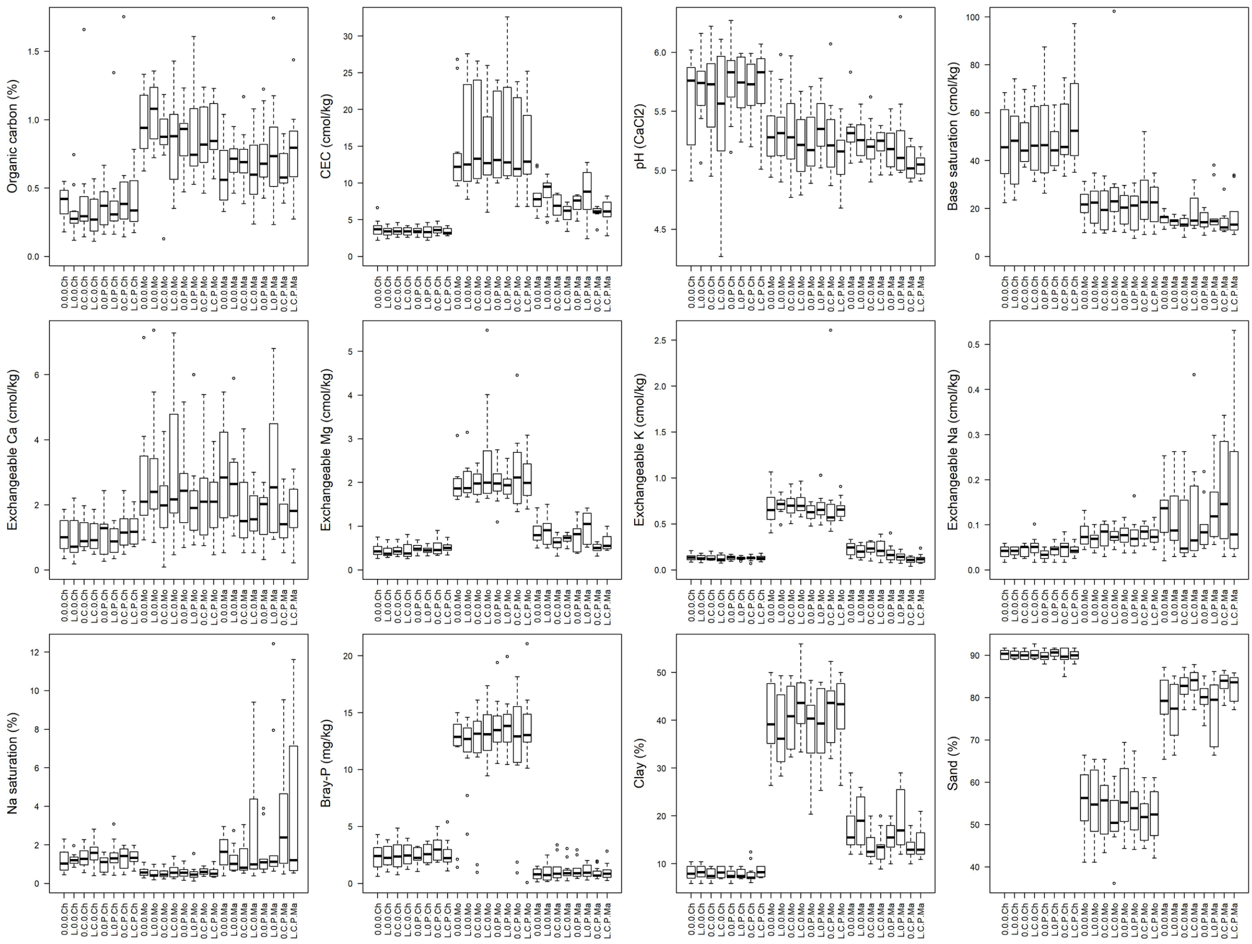

Figure 2: Comparison of some soil parameters for Chambezi (Cha), Morogoro (Mor), and Masasi (Mas) field stations. Within each station, values are shown for all treatment combinations.