SOIL Discuss., 1, C511–C516, 2015
www.soil-discuss.net/1/C511/2015/


SOIL Discussions Open Access

# *Interactive comment on* "Integrated soil fertility management in sub-Saharan Africa: unravelling local adaptation" *by* B. Vanlauwe et al.

**R. Voortman**

r.l.voortman@vu.nl

Received and published: 27 January 2015

SOILD-1-1239-2014 Integrated soil fertility management in sub-Saharan Africa: unravelling local adaptation

Dear editors,

A colleague called my attention to the above paper and I take the liberty to provide some comments. In short the authors strive to improve scientific practice in the field of development of fertilizer technologies that are locally adapted and appropriate for Sub-Sahara Africa. This is urgently needed indeed. Overall, I think that the authors could develop their ideas somewhat further, while maintaining theoretical rigour. Doing so may bring great benefits for African farmers. Below I summarize the ideas that come



to my mind on this issue.

The authors state that: i) Most of the commonly applied fertilizer in SSA contains mainly N, P, and/or K, which do not replenish SMNs under continuous cropping. ii) But indeed the reverse is more likely to be true: where SMN deficiencies exist, they can limit response to NPK fertilizers. iii) management of Al toxicity has received little attention in recent years in SSA These observations are very true. Given the many research findings in the past, it could be concluded that there has been an over-emphasis on high N and P doses in agronomic research in SSA. These high doses are unlikely to be affordable for African farmers and Figure 3 of the paper also shows that high doses are ineffective in raising yields. The emphasis on N and P as well as the lack of attention for liming materials is also remarkable from the theoretical point of view since the plant content of Ca, Mg and S is usually as high as P and frequently even higher. In addition, even though required in very limited amounts, micronutrient deficiencies can impose serious restrictions on crop yield.

The implication for the development of appropriate fertilizers, at least in my opinion, would be that from the outset the working hypothesis would be that any of the essential plant nutrients can be the most deficient or most toxic. However the authors do not really make that change of mind-set. They still mention: i) Much of the evidence relates to N fertilizer applied to maize as N is the most limiting nutrient in many African soils, ii) Blending commonly available NPK fertilizer with SMNs is a cost-effective process to achieve these benefits. iii) to assess the economics of incorporating secondary and micronutrients into NPK fertilizers iv) In the described nutrient omission trials N and P were not omitted (Figure 6) v) In Section 5.3 Nutrient Expert algorithms are recommended to determine N, P, and K fertilizer requirements under specific field conditions. Such observations and recommendations still constitute an emphasis on N, P and K as being the basics, while the use of other nutrients is considered as something that comes in addition. Theoretically the mere addition of SMNs to NPK is also problematic, because of the many interactions between nutrients where uptake by plants is

concerned (antagonisms and synergisms). For instance, on soils low in Cu and Zn it may not be wise, and it is likely to be inefficient, to apply their antagonist P.

Section 2.1 line 9-15: There are some serious ill-conceived generalizations here that affect the credibility of the paper. The main natural factors determining soil fertility are soil parent rock composition, rainfall amount and time. Weathering of parent rock produces soil and in young soils this is still an ongoing process (there are still weatherable minerals in the soil profile). However soil fertility perse, the type of nutrients and their levels, is initially determined by the original parent rock. Depending on the age of the soil and the amount of precipitation (in combination), the soil fertility may be altered by leaching. Soil nutrients have differential leaching rates and therefore not only the level of nutrients changes, but also the proportions of nutrients present in the soil (stoichiometry). Furthermore, soil types are only infrequently associated with slope position (in case of catena's). This is only the case when parent material is rather homogeneous over larger areas and if this occurs in combination with old-age topography (rather flat). Consequently, hills do not occur. Near the highest position at the interfluves soils are not necessarily gravelly and thin with rock outcrops. This is only the case when pockets of more resistant rock occur in the host rock, as is the case for instance in Sukumaland. In fact, at the top of interfluves soils may be deepest of all. Also, further downslope soils need not be more fertile. In fact lower slopes may be shallow and gravelly just above seepage zones, due to redistribution of iron (laterite gravel). In such landscapes the bottomlands (dambo or mbuga) are also not of alluvial origin: they are not deposited by rivers.

A similar observation on nutrient gradients as apparently mainly observed in Zimbabwe is in place. Some soils are considered as being degraded and strongly depleted of nutrients and where no significant response to "standard" fertilizer can be observed. At the same time it is mentioned that such soils occur on sandy soils developed from granite. Could it be that such soils are neither degraded and nor depleted (from something that was better), but that they are simply a different soil developed from different



soil parent material. Indeed this is what must be suspected in case of soil textural differences. This being the case, one would indeed suspect a different set of nutrient deficiencies.

Section 2.1 line 24-28: This sentence is not clear.

Section 3.1 Line 2-3: A potential risk of liming at high rates is that it reduces the availability of all micronutrients except Molybdenum.

Section 3.1: No mention is made of Gypsum which can reduce Al saturation (to deeper levels than lime), maintain micronutrient availability, decrease surface sealing, improve water infiltration, decreases soil erodibility, allows deeper rooting and improves Ca and S nutrition. For instance in Brazil gypsum is considered a valuable soil ameliorant.

In this context it deserves mentioning that the shift in African agronomic research from SSP to TSP is deplorable, because SSP actually contains gypsum (Ca and S). Again, in Brazil about 90 percent of P is applied as SSP.

Section 3.2 line20: I do not think that it is wise/correct to state from the outset that multiple SMNs are the norm. This will have to be established by research. It would be interesting and very useful though, to investigate if there are unifying principles in the occurrence of multiple SMN deficiencies reflect common parent rock mineralogies that derive from the physical laws of nature of rock formation.

Section 3.2 line 24: It is also important to know which plant nutrients are present in excess. Therefore, I suggest to change the text 'demonstrating the importance of including all potentially deficient nutrients in an omission trial (Fig. 6)'. To: demonstrating the importance of including all essential plant nutrients in an omission trial.

Section 3.2 line 23-24: See observation on Section 6 line 24-27.

Section 3.3 line 1-3: All issues mentioned can also be addressed with gypsum, or more properly said by reducing the relative amount of Mg and Na at the exchange complex.

Section 4.1: One of the questions the text of this section raises with me is the extent to which nutrient and organic matter accumulation is merely a question of human influence. Could it not be that initially these soils were also of inherently better quality and were these therefore preferred for cultivation. It also would appear that the level of resource endowment as among others expressed in manure availability is then not an independent variable. Could it not be that because poor people have only poor soils that the ensuing resource endowment is an endogenous variable, relating to original soil quality. Using resource endowment as an independent factor then sort of represents circular reasoning.

Section 5.1: Would it not be meaningful to involve the farmers in local adaptation. Farmers are likely to avail of knowledge on the diversity of their soils and their spatial distribution. Such knowledge might be a meaningful point of departure for a scientific characterization and subsequent research.

Section 6 line24-27: I fully agree that nutrient omission trials are instrumental for developing site-specific and fine-tuned fertilizer technologies. However they are a first step only. Also this first step can still be improved compared to what is presented in Figure 6. The following questions can be raised. Why are there no all-N and all-P trials reported? The all-dolomite experiment may not be very informative as it contains both, Ca and Mg, and further a host of micronutrients, as well as toxic substances like Cd and U (thus calling for careful consideration of liming). Why have Fe, Mn and Mo not been tried? Moreover, Figure 6 gives only averages across sites. This means loss of information. The responses on individual sites is far more informative, certainly if combined with soil chemical analysis for all essential plant nutrients. Sensible interpretation can then be made. I would also suggest that the subsoil is analyzed, because topsoil properties are always somewhat equilibrated due to nutrient cycling. In fact the differences between topsoil and subsoil themselves may be informative on limitations for nutrient uptake. In this way one would be able to simultaneously address the issue of local adaptation as well as the generalization of overarching principles that are evi-



dent in the data collected. Interpretation of results (Figure 6) is also not an easy task, because, for instance, the yield decrease when B is withheld may reflect a B deficiency that is due to high N, K and lime applications, because N, K and Ca are antagonistic with B. Similarly the yield reduction when Cu is withdrawn may result from the Mg, N, P and Zn applied, while in case of Zn the antagonists consist of Ca, Cu, Mg, N and P. It is well possible that with lower levels of notably N, P, K and Ca similar 'All' yields would be obtained without a B, Cu and Zn deficiency to be evident. As such nutrient omission trials are a first entry only that serves to develop hypotheses that require verification, but now within the context of a well targeted research agenda

Generally, it is a pity that no references are made to the Brazilian literature, where ample experience with SMN is reported. Maybe Portuguese is a problem, but there are also papers in English. There is also no reference to relevant French literature. I would recommend: Boyer, J. 1978. Le Calcium et le Magnésium dans les sols des régions tropicales humides et sub-humides. Initiations-Documentations Techniques No. 35, ORSTOM, Paris.

---

Interactive comment on SOIL Discuss., 1, 1239, 2014.