Reply to the reviewers

MS Title: Development of soil biological quality index for soils of semi-arid tropics
Author(s): Selvaraj Aravindh et al.
MS No.: soil-2019-60

All the points mentioned in the interactive comment of **Anonymous referee #1** were carefully considered and suitable reply for each point in given in red font. All the replies were compiled as Single PDF file and attached with this reply.

Anonymous referee #1

The topic presented in this manuscript is of high interest. A valid and general soil assessment is urgently required and there are many attempts to develop soil quality indices (SQI). This publication adds to the necessary discussion, although the suggested SQI (or biological SBQI) appears not to be the final solution.

Reply: As pointed out by referee, this is not the final solution for measuring soil quality. It is an attempt to narrow down the issues to measure the soil quality (especially agricultural soils) through identifying potential indicators. Here, we should substantiate that these six variables were chosen based on their consistent performance, relatively quick and simple for assessment and informative.

The authors investigated three different long-term fertilization experiments, each with four different fertilization systems. In total 12 soils were used to develop the scoring scheme that was subsequently tested with 25 farm soils. The parameters selected were 1) soil organic carbon, 2) microbial biomass carbon, 3) labile carbon, 4) protein index, 5) dehydrogenase activity and 6) substrate-induced respiration. Data were converted into SBQI, testing five different methods. In his fundamental publication, Nortcliff (2002) stated that any SQI must consider soil functions. Since soil functioning largely depends on soil biota, it is agreed that the authors focus on the soil biological status. However, the parameters selected are all measures of quantities; the dehydrogenase activity and substrate-induced respiration are microbial activities, yet they are so widespread and unspecific that they mostly reflect microbial biomass. That can be seen also in this study from the very close correlation of microbial biomass carbon with dehydrogenase activity and substrate-induced respiration (Tab. 2). All these parameters again very much depend on the content of soil organic carbon. Correspondingly, the loading of all these parameters on the first principal component in principal component analysis (PCA) is very similar (Tab. S4). Anyhow, the authors are able to clearly differentiate the 12 samples from long-term experiments by using PCA. Yet, it must be assumed that this differentiation is mostly due to the systematic differences in the soil samples, which result from the different treatment in the long-term experiments.

Reply: As referee pointed out, there is no single soil parameter to measure the soil quality. Hence, we tried to use inter-related biological variables and their values to measure the soil functioning. We agree that all the five variables are dependent of soil organic carbon. However, the SOC alone cannot able to describe the soil functioning. Hence, we used microbial biomass carbon and dehydrogenase as the total amount of microbiome; soil protein index and labile carbon as indicator for available nutrients for the microorganisms; substrate induced respiration represents the microbial activity as influenced by these factors. All these variables are inter-related to each other, making their measures into soil biological quality index was quite easy and we

demonstrated that these values are constant for the soils under different nutrient management regimes.

The authors should test, in how far soil samples are separated solely by soil organic carbon and protein index (and vice versa, whether the other parameters are dispensable).

Reply: Before the cumulative approach as described in the manuscript, we have assessed the SBQI considering SOC as independent sole indicator representing soil quality. Likewise, for each variable, but the method did not show any apparent conclusion. Hence, we adopted minimum data set method, for which we have chosen these six inter-related variables and their threshold values to measure the SBQI.

The test of five different methods for deriving a SBQI from the data set nicely shows that it doesn't depend so much on the calculation method. This is shown by the results in Tab. 5 (and partly Tab. 6). Method 1 and 2 as well as 3 and 4 deliver content-related the same data (the regression coefficient is 1 and not 0.97 as written in Tab. 6).

Reply: As mentioned by referee, theoretically method 1 and method 2 as well as method 3 and method 4, which used same set of data should have regression coefficient of 1.0. However, we re-analyzed the data and found the typo-error. The statistical analysis gave 0.995 (due to decimal changes in the processed data) which will be corrected in Table 6 of revised MS.

Even more relevant and worth to discuss is the interpretation of the derived SBQI. How do we know which value is natural, desirable, sustainable? The authors come up with a "the more the better" target, based on average values calculated from their data. Yet, is for example more respiration better than lower respiration? Here it seems to be a more promising approach to go for ratios such as the metabolic quotient, the microbial quotient or the carbon use efficiency of soil microbiota.

Reply: During revision, we will include the suggestion about the 'natural, desirable and sustainable values' and improve the interpretation for 'more the better'.

The text contains a number of small language errors that have to be fixed by careful proof reading and editing.

Reply: We will thoroughly check for language errors.

As was already indicated, the data in Table 6 must be checked and corrected.

Reply: As pointed out by the referee, we have reanalyzed the data and found error in transferring values as table form, this will be corrected in the revised MS.

Normal distribution of data is claimed by the authors. However, the Fig. 1 shows clear deviations from normal distribution. Distributions are left-skewed for soil organic carbon and labile carbon, while dehydrogenase activities show a bimodal distribution.

Reply: The discussion of the above result will be changed as left-skewed and bimodal distributions in the revised MS.