Responses to comments of Referee 1

Page 1, lines 28-29: comments of Referee 1

I suggest that the introduction will be stronger and related to the importance of the soils in the Earth system and also in the production of food Something like:

Soils are a key component of the Earth System as they control the biological, erosional, geochemical and hydrological cycles and offer services, goods and resources for the human kind (citations 1). The main service the soils offers to the humans is the food supply and there is a need to find solutions to improve the crop yield (citations 2). Some of the problems arise with the degradation of the soils due to human mismanagement and abuse of the soil resources that results in the desertification (citations 3).

Reply: the following paragraph has been added in revised manuscript

Soils are the key component of the Earth System as they control the geochemical, biological, erosional and hydrological cycles and offer services, goods and resources for human kind (Keesstra et al., 2012; Brevik et al., 2015; Decock et al., 2015; Smith et al., 2015). They also play an important role on global food security, water security, biofuel security as well as human health (Brevik et al.,2015; Keesstra et. al., 2016). But, these soils are under threat and unable to fulfill the food demand due to soil fertility loss, erosion, drought and climate change (Muluneh et. al, 2015; Tsozué et. al., 2015; Mwango et. al., 2016; Potopová et. al, 2016; Singh et al., 2016). This situation might worsen due to increased population pressure on soil worldwide and thus enhance the degradation of soil. Moreover, soil degradation is due to intensive cropping, overgrazing, unsustainable land use, and desertification further aggravate the soil unfavorable for cropping (de Moraes Sá et al., 2015; Symeonakis et al., 2016; Yan and Cai, 2013). There is a need to find solutions to improve the crop yield. It is important to know the detrimental effect of intensive agricultural practices as well as their interaction with different kind of soils to ensure the security of food (Beyene, 2015).

References update:

Beyene, S. T.: Rangeland degradation in a semi-arid communal savannah of Swaziland: Long-term DIP-tank use effects on woody plant structure, cover and their indigenous use in three Soil types, *Land Degradation and Development*, 26 (4): 311-323, doi:10.1002/ldr.2203, 2015.

Brevik, E. C., Cerdà, A., Mataix-Solera, J., Pereg, L., Quinton, J. N., Six, J. and Van Oost, K.: The interdisciplinary nature of soil, SOIL, 1, 117-129, doi:10.5194/soil-1-117-2015, 2015.

Decock, C., Lee, J., Necpalova, M., Pereira, E. I. P., Tendall, D. M. and Six, J.: Mitigating N_2O emissions from soil: from patching leaks to transformative action, SOIL, 1, 687-694, doi:10.5194/soil-1-687-2015,2015.

de MoraesSá, J. C., Séguy, L., Tivet, F., Lal, R., Bouzinac, S., Borszowskei, P. R., Briedis, C., et al.: Carbon depletion by plowing and its restoration by no-till cropping systems in Oxisols of subtropical and tropical agro-ecoregions in Brazil, *Land Degradation and Development*, 26 (6): 531-543, doi:10.1002/ldr.2218, 2015.

Keesstra, S. D., Geissen, V., van Schaik, L., Mosse, K. and Piiranen, S.: Soil as a filter for groundwater quality, Current Opinions in Environmental Sustainability, 4, 507-516, doi:10.1016/j.cosust.2012.10.007, 2012.

Keesstra, S. D., Bouma, J., Wallinga, J., Tittonell, P., Smith, P., Cerdà, A., Montanarella, L., Quinton, J. N., Pachepsky, Y., van der Putten, W. H., Bardgett, R. D., Moolenaar, S., Mol, G., Jansen, B. and Fresco, L. O.: The significance of soils and soil science towards realization of the United Nations Sustainable Development Goals, SOIL, 2, 111-128, doi:10.5194/soil-2-111-2016, 2016.

Muluneh, A., Biazin, B., Stroosnijder, L., Bewket, W. and Keesstra, S.: Impact of predicted changes in rainfall and atmospheric carbon dioxide on maize and wheat yields in the Central Rift Valley of Ethiopia, Regional Environmental Change, 15: 1105-1119, doi: 10.1007/s10113-014-0685-x, 2015.

Mwango, S. B., Msanya, B. M., Mtakwa, P. W., Kimaro, D. N., Deckers, J. and Poesen, J.: Effectiveness of mulching under miraba in controlling soil erosion, fertility restoration and crop yield in the Usambara Mountains, Tanzania, *Land Degradation and Development*, 27 (4): 1266-1275, doi:10.1002/ldr.2332, 2016.

Potopová, V., Štěpánek, P., Farda, A., Türkott, L., Zahradníček, P. and Soukup, J.: Drought stress impact on vegetable crop yields in the Elbe River Lowland between 1961 and 2014, *Cuadernos De Investigacion Geografica*, 42 (1): 127-143. doi:10.18172/cig.2924, 2016.

Smith, P., Cotrufo, M. F., Rumpel, C., Paustian, K., Kuikman, P. J., Elliott, J. A., McDowell, R., Griffiths, R. I., Asakawa, S., Bustamante, M., House, J. I., Sobocká, J., Harper, R., Pan, G., West, P. C., Gerber, J. S., Clark, J. M., Adhya, T., Scholes, R. J. and Scholes, M. C.: Biogeochemical cycles and biodiversity as key drivers of ecosystem services provided by soils, SOIL, 1, 665-685, doi:10.5194/soil-1-665-2015, 2015.

Singh, K., A. K. Mishra, B. Singh, R. P. Singh, and D. D. Patra. 2016. Tillage effects on crop yield and physicochemical properties of sodic soils. Land Degradation and Development, 27(2), 223-230. doi:10.1002/ldr.2266.

Symeonakis, E., Karathanasis, N., Koukoulas, S. and Panagopoulos, G.: Monitoring sensitivity to land degradation and desertification with the environmentally sensitive area index: The case of Lesvos Island, *Land Degradation and Development*, 27 (6): 1562-1573, doi:10.1002/ldr.2285, 2016.

Tsozué, D., Nghonda, J. P. and Mekem, D. L.: Impact of land management system on crop yields and soil fertility in Cameroon, Solid Earth, 6 (3), 1087-1101, doi: http://dx.doi.org/10.5194/se-6-1087-2015, 2015.

Yan, X. and Cai, Y. L.: Multi-Scale Anthropogenic Driving forces of karst rocky desertification in Southwest China, *Land Degradation and Development*, 26 (2): 193-200, doi:10.1002/ldr.2209, 2015.

Page 2: comments of Referee 1

There are some interesting papers which can refresh your reference list here.

Eimil-Fraga, C., M. J. Fernández-Sanjurjo, R. Rodríguez-Soalleiro, and E. Álvarez-Rodríguez. 2016. Aluminium Toxicity Risk for Pinus Pinaster in Acid Soils (Galicia, NW Spain). Land Degradation and Development. doi:10.1002/ldr.2539.

Mamedov, A. I., B. Bar-Yosef, I. Levkovich, R. Rosenberg, A. Silber, P. Fine, and G. J. Levy. 2016. Amending Soil with Sludge, Manure, Humic Acid, Orthophosphate and Phytic Acid: Effects on Infiltration, Runoff and Sediment Loss. Land Degradation and Development 27 (6): 1629-1639. doi:10.1002/ldr.2474.

Elisa, A.A., Ninomiya, S., Shamshuddin, J., Roslan, I. Alleviating aluminum toxicity in an acid sulfate soil from Peninsular Malaysia by calcium silicate application. (2016) Solid Earth, 7 (2), pp. 367-374. DOI: http://dx.doi.org/10.5194/se-7-367-2016

Behera, S. K. and A. K. Shukla. 2015. Spatial Distribution of Surface Soil Acidity, Electrical Conductivity, Soil Organic Carbon Content and Exchangeable Potassium, Calcium and Magnesium in some Cropped Acid Soils of India. Land Degradation and Development 26 (1): 71-79. doi:10.1002/ldr.2306.

Reply: References update as following:

Soil acidification is a serious process of agricultural land degradation, which leads to the decrease in soil pH and the increase in soil acidity (Behera and Shukla, 2015). (Page 2 lines 14-15)

In acidic soils, Al toxicity to plants and soil infertility are the main limiting factors for crop growth (Adams, 1984; Kochian, 1995; Ulrich and Sumner, 1991; Kidd and Proctor, 2000; Eimil-Fraga et al., 2016; Elisa et al., 2016). (Page 2, lines 23-24)

Liming of acid soils can increase soil pH and alleviate Al toxicity to plants, and thus maintain a suitable pH for the growth of a variety of crops (Slattery and Coventry, 1993; Mullen et al., 2006; Lollato et al., 2013; Mamedov et al., 2016). (Page 2, lines 32-33)

Page 7, line 24: comments of Referee 1

I think that a good end of your discussion will be the risk for the human and environmental health.

Brevik, E.C., Sauer, T.J., 2015. The past, present, and future of soils and human health studies. SOIL 1, 35-46. doi:10.5194/soil-1-35-2015

Zornoza, R., Acosta, J.A., Bastida, F., Dom ńguez, S.G., Toledo, D.M., Faz, A., 2015. Identification of sensitive indicators to assess the interrelationship between soil quality, management practices and human health. SOIL 1, 173-185. doi:10.5194/soil-1-173-2015

Roy, M. and L. M. Mcdonald. 2015. Metal Uptake in Plants and Health Risk Assessments in Metal-Contaminated Smelter Soils. *Land Degradation and Development* 26 (8): 785-792. doi:10.1002/ldr.2237.

Kasem Mahmoud, E., Mohamed Ghoneim, A. Effect of polluted water on soil and plant contamination by heavy metals in El-Mahla El-Kobra, Egypt. (2016) Solid Earth, 7 (2), pp. 703-711. DOI: http://dx.doi.org/10.5194/se-7-703-2016

Reply: A paragraph has been added in the end of Results and discussion to improved discussion on the risk for the human and environmental health. :

Soil pH and Al are important indicators of soil quality assessment in acidic Ultisols. Soil quality assessment is a big challenging issue due to its high variability in properties and functions. According to Brevik and Sauer (2015), soil has a distinct impact on health of human being. The availability of food and contamination of various chemicals and pathogens with human are influenced by soil. However, priority should be given to develop new technologies for maintaining the soil quality not only for productivity but also human health (Zornoza et al. 2015). According to our results and findings, the critical values of soils are varied among both locations for a particular crop. Different crop species have different sensitivity to soil acidity. These obtained critical values are only for specific soil types

and crops. It is suggested that liming should be done according to the critical values for the growth of same species in different soil types. Hence, site-specific agricultural management practices including liming can apply judiciously with proper crop selection which are economically as well as environmentally sound. Judicious application of lime is necessary in order to protect the soil from degradation as well as human health.

References update as following:

Brevik, E.C., and Sauer, T.J.: The past, present, and future of soils and human health studies, Soil 1, 35-46, doi:10.5194/soil-1-35-2015, 2015.

Zornoza, R., Acosta, J.A., Bastida, F., Dom ńguez, S.G., Toledo, D.M., and Faz, A.: Identification of sensitive indicators to assess the interrelationship between soil quality, management practices and human health, Soil, 1, 173-185. doi:10.5194/soil-1-173-2015, 2015.

Figures: comments of Referee 1

Remove frame of the graphs in Figure 1 be consistent with the other figures

Reply: Figures have been modified according to the suggestion.