SOIL Discuss.,
https://doi.org/10.5194/soil-2019-91-RC1, 2020

Interactive comment on "Management-intensive Grazing Affects Soil Health" *by* Casey Shawver et al.

Anonymous Referee #1

Received and published: 4 March 2020

The study has addressed potential 'Management-intensive grazing' (MiG) effects on soil health represented by 11 soil variables. Results show significant positive changes in soil biological properties after the land use change (from cropland-to-grassland) and negative effects on soil bulk density and soil P availability. The authors conclude that MiG could have positive benefits for soil health and environmental and economic sustainability. Although the results of this study are interesting (increases in microbial biomass and extra-cellular enzyme activity, decreases in bulk density), it is very difficult to state that MiG is actually responsible for these changes. This is because: - The study measured these variables only 1 and 2 years after soils had been under cropping for at least 10 years. Thus changes in soil variables could be simply due to a change in land use from cropland-to-grassland and/or to water irrigation (and thus to

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increased soil moisture) and not necessarily to MiG. - The impact of MiG was tested only between August 2017 (when cows were firstly introduced to paddocks) to May 2018 (when soil samples were taken for the last time). Thus comparing changes in soil properties between 2017 and 2018 when grazing was applied only between August and October 2017 leaves lots of uncertainty about potential grazing effects on soil health. Most of these changes could be simply related to the land use change and the establishment of a grassland ecosystem. To address MiG effects on soil health data from at least few years should be collected and MiG should be compared to a different permanent grassland system perhaps not irrigated. - The fact that the grass swards did not establish well due failure of legume growth 2017 and 'hostile' climatic conditions between 2017 and 2018 adds more uncertainty to net effects of grazing on soil health. I would collect data from more years to provide evidence that MiG is benefiting soil health, which could well be the case.

Specific comments Lines32-34: I would rephrase the last sentence, which at the moment seems to consider only MiG positive effects on soil biology but not negative MiG effects on soil P availability and soil structure (increased compaction). Given these contrasting results one could argue why the authors conclude that MiG is 'promoting soil health for environmental and economic sustainability'. Line 40: after 'benefits' needs literature reference(s). Lines 46-49: This sentence needs rephrasing to introduce the definition/concept of 'soil health' supported by literature references. Lines 56-60: These lines would need to be rewritten to explain better the role of extracellular enzymes in soils. In particular, microbes produce extra cellular enzymes to acquire C or nutrients from SOM and as a consequence affect C, N dynamics. Line 93: Needs to explain/summarize why grazing has positive effects on soil 'health'. Lines 112: I am not sure that hypothesis two is well supported. For example, microbial biomass C and enzyme activities can be stimulated by animal waste more than lack of tillage? Need to better support this hypothesis in the Introduction. Lines 136-139: Perhaps few lines explaining the rationale behind species assemblages (e.g. simple vs complex) would be useful. Line 174: I think this is August 2017 and not 2018 Lines 210: A significant

problem associated with the robustness of the dataset assembled under this project is that potential grazing effects on soil health have been addressed only after one grazing season between August 2017 (when cows were firstly introduced to paddocks) to May 2018 (when soil samples were taken for the second time). This is quite a short period of time to address potential grazing effects on multiple soil parameters given that cows grazed only between August and October 2017 on swards which had not established well (legumes were almost absent from swards), the soils were cropped until 2016 and climatic conditions were quite variable and 'hostile' at 1500 m asl. If more soils had been collected in 2019 (after at least two grazing seasons) this would have been better and provided more data to compare... Lines 236-245: It is not clear how the SMAF works, how field measurements are 'transformed' in indexes through SMAF. More details need to be given here. Lines 246-253: Statistical analyses are not properly described, clear description of independent and depend variables is not given. 'Years' is the variable indicator of potential grazing effects on soil parameters? Lines 284-285: The fact that BG activity increases it could be due (as the authors suggest) to land use change from cropland to pasture. This could occur however following any cropland-to-grassland land use change and not necessarily only to MiG on irrigated grasslands. Also there is a problem with 'perennial' pasture because the grassland in this study is only 1 year old. Lines 296-300: Increases in microbial biomass, again, could be related to the land use change and not necessarily to MiG. To test for the effects of MiG on multiple soil parameters, data should be collected at least for few years and also compared to permanent grasslands, which are not irrigated for example. Other variables such as soil N mineralization could have increased because of greater soil moisture due to irrigation and not necessarily to MiG. It is not surprising that soil C has not changed because of the short period of time considered (2017-2018) (line 372) It is actually surprising that soil P availability decreased (and not increased) under the MiG system with more cattle dung and urine being returned to soils. I think this could be due to the fact that most P has been retained by soils and partly perhaps because more P was uptaken by plants. This however shows the difficulty to interpret these results after

only a short grazing season had occurred on these newly established grasslands.

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