

## ***Interactive comment on “Soil carbon sequestration by three perennial legume pastures is greater in deeper soil layers than in the surface soil” by X.-K. Guan et al.***

**Anonymous Referee #1**

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General Comments: The study under review aimed to assess the contribution of three perennial legume pastures grown on a degraded land for 7 years to soil C sequestration. While it is widely known that growing a perennial vegetation cover on a degraded land leads to higher soil C concentrations and stocks, the novel finding of this study is that this increase is higher in subsoil layers than the surface layer. However, at the same time, there is no explanation as to why there are more stocks in subsoil layers than the surface layer since the latter is home to most of the plant root biomass hence higher C inputs especially under pastures. Specific comments: The discussion section needs substantial improvement since in its present form, it looks like an extension of ‘Results’. For example, the authors can compare the rates of soil C accumulation in

C4586

their study with those of similar studies. Above all, they should find an explanation as to why there is more soil C accumulation in deep soil layers and how it is possible that plant species producing substantially varying amounts of biomass end in sequestering similar amounts of soil C under them. Unfortunately, the authors apparently did not estimate the amount of root biomass present in different soil layers that would have been helpful in explaining the results. However they can speculate based on other related studies. Technical comments: Page No. 10116 Lines 5-10: “and to estimate the long term potential for SOC sequestration in the soil under the three forage legumes” must be deleted. This gives the impression as if the authors intend to make future projections which they do not. Similar statements elsewhere in the manuscript like in the discussion section should be removed. Line 14: “in the bare soil” instead of “under bare soils” Lines 15-16: Change the sentence to “The sequestration of SOC in the 1-2 m depth of the soil accounted for 79, 68 and 74 % of the SOC sequestered in the 2m deep soil profile under alfalfa, bush clover and milk vetch, respectively. Lines 22-24: Isn’t it other way around i.e. soil C stocks are two times of those in terrestrial biomass and three times of those in atmosphere? Page 10117 Lines6-8: over what time span this depletion has occurred? Page 10118 Lines 10-13: I don’t see any difference in the two stated objectives. Line 24: ‘The site is level’ means “The site is plain”? Page 10119 Line 7: Fertilizer application rates mean 108 kg N/ha? Line 8: change “the site remained fallow” from ‘the site lay fallow’. Lines 24-25: Change the last sentence to “Treatments were completely randomized in three replicate blocks”. Page 10121 Line 2: replace ‘by Statistical’ by ‘using Statistical’. Page 10123 Lines 22-26: Root biomass does influence the rate of C deposition thereby its sequestration in soil. But the qualitative differences between different roots may influence C deposition significantly e.g. if a plant produces more fine root biomass that the other, even if producing lower overall biomass, it is likely to have higher root turnover rate in the soil that may lead to higher soil C accumulation. See studies on fine root biomass turnover and C stabilization. Similarly higher fine root biomass versus coarse root biomass is likely an indication of higher exudation rates which influence the stability of plant C in soil. See Shahzad

C4587

et al. 2015 SBB. Page 10124 Lines 25-29: It is true that most soil C is derived from root C but that doesn't explain the difference of plant C sequestration in different layers in this study. Being the semi-arid nature of the area under study, plants must have produced deep roots and of varying specific root lengths depending on the plant type. The presence of different biomass/specific-root-length along the profile might have resulted in varying sequestration of varying C amounts along the profile under different species. However this remains a speculation until one knows the root characteristics. Page 10125 Lines 3-5: Just a question out of curiosity: why did the authors chose to study only the legumes which are high water consuming plants in a semi-arid area?

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Interactive comment on Biogeosciences Discuss., 12, 10115, 2015.

C4588