Responses to the Reviewer

Comments

This is simple and nicely conducted field experiment showing that the soil C sequestration induced by legumes may have been underestimated in many studies omitting to prospect deep soil layers. This study presents other interesting results: 1) a steady SOM accumulation over the 7 years of study challenging the common idea of limited capacity of soils to sequester C (Smith, P GCB 2014), 2) the SOM accumulation is not simply linked to plant production challenging another common belief. These findings are of interest for the readership of Biogeoscience and deserve to be published. I provide here some recommendations with the aim of improving the interpretation of results.

RESPONSE: Thank you for the positive comments on the paper and the suggestions for improvement. We have endeavored to revise the manuscript as suggested.

Based on your results, it seems that the persistence of legumes is not guaranteed: the biomass from all legume species peaked around 2006 and then decreased. Could you interpret this result?

RESPONSE: The aboveground biomass of the legumes peaked around 2006 mainly due to soil water depletion. In our previous study (Guan et al., 2012 *Grass and Forage Science*, 68, 469–478), we reported that the soil water content over the 5 m was depleted to 161 mm, 188 mm and 191 mm for milk vetch, alfalfa and bush clover, respectively, which was close to the wilting point of the soil at the experimental site.

Your material and methods section does not specify whether legumes have been fertilized with P, K, S etc. The lack of fertilization combined with substantial plant forage exportation may have led to nutrient depletion in soil responsible of the decrease in legume biomass production.

RESPONSE: The legumes were not fertilized, but the previous wheat crop had been heavily fertilized for many years leaving good residual fertility. The plots were not inoculated, but relied on naturally-occurring root nodule bacteria from previous growth of the three species of legumes on the experimental station. There were no observations of poor nodulation in the experiment. See lines 124 -128 for changes to the paper.

How has the plant cover evolved during these 7yr of experiment? Have you observed the invasion by other plant species?

RESPONSE: The legume species were evenly sown but the distribution gradually changed to a patch distribution, without any decrease in plant density (see lines 121-123). As mentioned in the Methods (line 123), weeds were removed by hand using local farming practice, so there was no invasion by other plant species.

The C sequestration under legumes treatments is quantitatively important. To allow the readers to make his own idea on the feasibility of such C sequestration, could you compare this soil C sequestration to estimated GPP and NPP of these cultures (roughly estimates are always better than nothing).

RESPONSE: Thank you for this suggestion. The aboveground biomass production has now been presented in similar measures as the SOC sequestration (see lines 177-180). As roots were not measured in this study, the NPP could not be calculated. Instead, we have calculated the root mass ratio (root DW/total DW) that would result from assuming all

the sequestered SOC was derived from root biomass. The calculations suggest that root biomass could account for the C sequestered by the soil in alfalfa and milk vetch, but not in bush clover (see lines 248-255). We trust that this acknowledges the reviewer's suggestions without making wild assumptions about the root:shoot ratios or root mass ratios in the three species.

Finally, this SOM accumulation involves the sequestration of nutrients including N that must enter into the system. Could you estimate the amount of N sequestered in SOM? Comparing this amount with an estimation of N fixation by these three legumes may help to understand the difference of C sequestration between legumes.

RESPONSE: Soil and plant nitrogen contents were not measured in this study, so we do not think that we should speculate about nutrient sequestration, particularly for a volatile and mobile element such as nitrogen.