

The following points highlight the major problems I found in this manuscript and provides some ideas to enrich the discussion. I also propose a new organization for the discussion, which I hope will help the authors to find a more logical way of discussing their results.

1) Many repetitions can be avoided thorough the entire manuscript: rephrasing the same idea is not useful for the comprehension; it just adds length to the manuscript.

One telling example is the two juxtaposed sentences found Line 179 to 181:

Sentence 1: “The reasons for the SOC content difference result from precedent soil conditions and cultivated grasses.”

Sentence 2: “Different types of cultivated grasses, as well as the precedent soil conditions are probably the two reasons for the SOC content differences between leguminous and gramineous grasslands.”

2) The description of the results can be clarified by removing the sub-sections and preventing, again, many repetitions (e.g. Line 167-170, Line 171-174, etc). In fact, the results for each measured criteria (i.e. total biomass, SOC content, SOC storage, sequestration rate and efficiency) can be described in no more than 1 or 2 sentences. The sub-division is therefore unnecessary, more so because the titles themselves are not adequate.

- For example, the Section 3.1 is labeled “Aboveground net primary productivity” but the following text only describes the “total biomass”. What are you actually talking about? The sum of above and belowground biomass? What do you call “net productivity”? You have to be consistent and specific about your terminology.

- The Section 3.2 is labeled “Soil SOC content and controls”: the term soil is already comprised in the acronym SOC, and what are those controls you are referring to?

If you wish to preserve the sub-division of the results, use simple and accurate terminologies similar to the one you are referring to in the following text.

Note also that the first lines of the discussion (Line 176-178) belong to the results!

3) The implications of the results are not enough emphasized in the manuscript. Why does it matter? What perspective? This is somehow mentioned in the introduction, but you should recall this in your discussion and use it to put your work into the broader picture! This would contribute to make the study more attractive and significant for the scientific community.

4) The abstract lacks the key elements presented in the discussion, which are the importance of the micro-organisms and their effect on the degradation of plant tissues and nutrient availability, which in turn affects the SOC storage. The abstract should emphasize this, instead of only the higher efficiency of leguminous grasslands...also a word on the importance of the results would be welcome.

5) The poor English writing, such as grammatical mistakes, wrong choice of past and present tense conjugations, wrong verbs and misuse of vocabulary, renders difficult the comprehension and reading of the manuscript...I strongly recommend collaborating with native English speakers to thoroughly correct the paper!

6) The discussion is problematic in that it is poorly organized and lack scientific rigor. It looks like a succession of your results juxtaposed with ideas/results from other studies, but it badly misses the link between the two (to much shortcuts...), which can be avoided by providing an actual discussion of the processes behind. Some of the processes are partially

discussed, but the overall organization makes it hard to understand as you jump back and forth from one concept to the other.

More importantly, you have to discuss the differences between natural, cultivated and uncultivated outcrops, not only the difference between leguminous and gramineous!! Otherwise it is not necessary to present these results.

Similarly, most of the discussion seems dedicated to leguminous grasslands. You should also discuss why the gramineous grasslands are less efficient...

I strongly suggest reorganizing the whole discussion! For example, 1 paragraph per important idea...with a deeper discussion of each of the processes. To help the authors, here is a suggestion for re-organizing the discussion:

Paragraph 1: Recall here the main goal of the study.

Recall the reader here that you investigate the efficiency of SOC storage and especially compare the differences between gramineous and leguminous grasslands (recall briefly why it is important! Re-use key parts of the introduction for example).

Then, explain that your results show significant differences among the SOC content and storage efficiency between the various plots, which you believe is due to (1) the condition of the soil and (2) the nature of cultivated grasses. In the following discussion, you will explore and discuss various parameters that explain the variable efficiency in your samples.

Paragraph 2: Basic principle of SOC regulation by plant

First of all, you have to summarize the main role of plants in the local C cycle, based on the literature! This is important to further discuss the processes linked to this cycle!

Outputs of C from soils = Regulation by plants through carbon assimilation, transfer and storage in the root system, then through plant respiration and release to atmosphere as CO₂ = output from the soil!! Not sequestration!

Inputs of C to soils = The storage occurs only during the decay/decomposition of the above and belowground plant tissues (e.g. roots, leaves, etc).

Paragraph 3: Important finding of your study

Your results show that leguminous grasslands are more efficient to store carbon: they show higher SOC content and higher rate of storage than gramineous grasslands. Moreover, they contain higher biomass, which may be the key of their efficiency... In the following paragraphs, you will try to explain what parameters can explain such difference between the leguminous and gramineous species.

Paragraph 4: First parameter(s) = Soil conditions

From your discussion, one key parameter seems to be the conditions of the soil. Here, you should explain in which aspects the soil can contribute significantly to the storage of carbon. For example, you mentioned that the irregular distribution of precedent plant residues and roots results in the irregular distribution of nutrients. It also affects the SOC and BD measurements. You have to discuss the significance of such "memory effect" from previous plantations! How does it affect your results? Can it account for the different SOC content between your outcrops? Certainly not, and you will look into other, more significant parameters in the following paragraphs.

Paragraph 5: Second parameter(s) = capacity to incorporate C

The second parameter is more focused on the species themselves: different species may incorporate more or less carbon according to their specific metabolism (cite other studies

here). Accordingly, the higher SOC content in leguminous grasslands may reveal a greater capability to incorporate C in their root system than gramineous species. Check in the literature if this is true: can you find actual numbers to show the different incorporation capacity of each species? Is it sufficient to explain your data?

Paragraph 6: Third parameter(s) = Plant productivity

Plant productivity seems to be the most important factor: the more productive the plants are, the more biomass they produce! Therefore, they integrate more carbon, which will be ultimately released during their decomposition (shown by other studies).

According to your results, the very high SOC content of leguminous grasslands is tightly linked to their higher biomass content, which may indicate greater productivity than gramineous grasslands: they produce more biomass and the corresponding high C content is transmitted to the soil during plant decomposition. Can you compare your results with other studies that found similar differences?

Paragraph 7: Origin of greater leguminous productivity

Then it is important to discuss why you think leguminous grasses are more productive!

One key idea is the capability of leguminous species to fix nitrogen within root nodules, with two consequences: (1) it promotes the fertility of the soil, which facilitates plant productivity, and (2) it promotes the symbiosis with micro-organisms, which in turns help with the fixation of limited nutrient, therefore enhancing the plant productivity. Both effects result in greater biomass production, and therefore elevated C content in the end.

Moreover, such micro-organisms are responsible for the decomposition of the plants, and therefore constitute the key of the transmission of the stored carbon into the soil! You say that the incorporation in the soil occurs through more complex processes: which ones?? No need to describe, but at least cite them!

Finally, micro-organisms may contribute themselves to the final SOC content by incorporating C in their mycelium: to what extent? Is it significant when you compare with the C brought by the plants themselves?

You also have to discuss the case of the gramineous! What kind of micro-organisms? Are the symbionts restricted to the leguminous samples? Why is the gramineous productivity lower? Etc.

Compare with other studies from the literature to confirm this idea.

Paragraph 8: Sequestration rate

Perhaps you can include here a paragraph discussing the sequestration rate. From you results, the rate of sequestration is higher in the leguminous grassland. The hypothesis you propose is that various plant species result in different nutrient conditions in the soil (which ones??), and therefore different decomposition rates. To argue for that, you cite other studies (see Line 205-206) and say that nutrient-poor soils favor faster storage due to slow rates of decomposition...*(this I do not understand: the faster you decompose, the faster you store carbon, right?)* Then you contradict yourself by saying that the storage rate was faster in leguminous grassland because they had greater biomass...this is inconsistent with your above statement about the nutrient effect! The **amount** of stored carbon may be higher because of the greater biomass, but the **rate** of storage shall be linked to the efficiency of the soil to decompose the biomass, right? Maybe you should re-write this section in a clearer way.

Paragraph 9: Significance of the study and perspective

Here you HAVE to emphasize the importance of your study! Why is it so important? Can

you give recommendations based on what you observed? What future work should be done? Etc. Put your findings into context!

7) Comments of specific sections/text

Section 1: The introduction is too long and part of it should be redirected into the discussion, especially to emphasize the importance of the finding of this study.

Note also that the first objective you describe is “to analyze the effect of SOC stock and sequestration under different grasslands”. I do not agree with that: you are not analyzing the **effect of SOC storage**, but the **differences of storage efficiency** under different grasslands, which is very different.

Section 2: In average, the whole section is too long compared to the result/discussion parts, and it can be easily condensed. You are providing a lot of details but you are not using them in the discussion...For example, what is the interest of knowing the cumulative temperature above 10°C and 0°C? How is this important for the present study? You already show the annual temperatures, so I think you don't need this...

Also, is the climate semi-arid or temperate? Can it really be both?

Section 3.2: Do not just refer to you tables but give some key numbers in the text, e.g. by how much does the SOC content increase overtime? L-MS has the highest SOC content: how much?, etc.

Section 3.3: Quantify the increase in terms of difference to make the reading easier, e.g. “the SOC storage under the L-MS, L-CV and L-OV grasslands increased by 5.22, 8.34 and 4.78 Mg.C.ha⁻¹ respectively”

Section 3.4:

Line 167: SOC sequestration or SOC sequestration rate?

Line 172-173: The term “respectively” applies to the “maximum and minimum” or to the “L-CV or G-PA grassland”?

8) Figures

- 1) Add one figure with the studied site localization and perhaps a picture of leguminous and gramineous grassland.
- 2) Perhaps add a schematic figure of the sampling strategy, e.g. a vertical profile from above to below the ground with specific location of the samples taken for soil, biomass and other target analyses.