Comment on soil-2021-115

Anonymous Referee #1
Referee comment on "Dynamics of carbon loss from an arenosol by a forest/vineyard landuse change on a centennial scale" by Solène Quéro et al., SOIL Discuss.

The present study wants to give insights about the effect of the conversion of forest to vineyard grown on organic carbon dynamics in arenosol. The manuscript is not acceptable for publication because of the poor quality of the text and for the lack of true replicates.

"poor quality of the text":
=> Since the reviewer has not provided any elements illustrating the poor quality of the text, it was hard for us to improve it, notably as: (1) from the grammar and syntax standpoint, the English was corrected by a professional English-speaking scientific translator, and (2) Referee #2 confirmed that the English was correct and did not highlight any issues with regard to the linguistic quality of the text. Upon re-reading, however, we recognize that some of the wording may have been a bit clumsy and that some arguments could have been better presented. We will try to improve the text as much as possible. "

"lack of true replicates"
=> Studies that only aim at mapping stocks or studying stock variations at regional or even plot scales justify the multiplication of sampling points ("mosaic strategy" of Eldon and Gershenson, 2015). Our objective was different—we sought to compare the impact of a change in land-use and associated agricultural practices on carbon dynamics at the scale of a soil profile (including topsoil and subsoil, down to the parent rock). We therefore opted for a profile comparison approach (paired-site strategy as defined by Eldon and Gershenson, 2015), as for example Torn et al. (1997) did with 14C in their article published in Nature, and as Jagercikova et al. (2015) did for 10Be. These cosmogenic isotope approaches allow access to the soil processes, contrary to simple stock analysis, yet these are very high cost analyses so only a small number of samples can be screened (Mathieu et al., 2015). This last aspect is generally offset by careful selection of the profile analysed, thereby ensuring the comparability (see description below). The study of Laurence et al. (2020)—where a large number of paired-sites were investigated with 14C approaches—illustrates the interest of this type of approach in soil carbon dynamics.

For this reason, we conducted a detailed analysis at the pit scale. By using ^{14}C, we had two objectives: (1) to compare the dynamics of carbon (from topsoil to parent rock) in crop and forest soils, and (2) to determine the ^{14}C variability at the pit scale. Our results showed that a composite sample was highly representative of the mean ^{14}C trend. Otherwise, had we not studied the variability on the different sides of the pits, we would not have been able to demonstrate the very marked differences between the two sites: in the forest, there was very low variance at a single depth, whereas this variance was very high above 50 cm in the vineyard. This finding highlighted the effect of agricultural practices (deep ploughing) on the C dynamics. Without this fine analysis, we would not have been able to reach this conclusion. This warrants our sampling protocol.

However, we would like to point out to Referee #1 that the location of these pits was based on a careful choice of the sampled profile, i.e. they only differed in terms of land use. This selection was carried out in 7 successive stages:

1. In the French Mediterranean area, a granitic pluton outcrop was sought to make sure that arenosols would be present: the granite of Plan de la Tour (Maures, South of France, represented by the north-south elongated red zone, in the center

of the geological map below (source https://www.geoportail.gouv.fr/carte) (Figure 1).

Figure 1 : geological map (source https://www.geoportail.gouv.fr/carte)

2. In the Plan-de-la-Tour granite area, places with adjacent vineyard and forest plots were identified on the basis of satellite images.

3. To be sure that the forest C dynamics were representative of a forest pedogenesis and not the result of recent afforestation, we selected only sites already in forest in the 1800s (Napoleonic land register 1808-1848, see Supplementary information, and Ordnance Survey map, 1820-1866, see Figure 2).

4. Among these sites, we selected only those with comparable topographic situation for two land uses and ideally with the flattest possible topography in so as to minimize differences in C dynamics that could result from differential erosion between crop fields and forests. (topographic map at 1:25,000 scale)

5. We went to the fields at the 5 sites selected based on the above criteria. We then selected one site ("Les Brugassières") according to their accessibility and the sampling authorizations.

6. The location of the sampling pit was chosen on the basis of a structural analysis, as is conventionally done in pedology studies (e.g.Humbel, 1987). We then augered to identify points where the soil was: (1) sufficiently deep (about 80 cm), (2) equivalent depths in the forest and crop soils, and (3) where there was very little distance between 80 cm-deep crop and forest soils (less than 20 m). We sought to find an area of the plot where the two pit sites would likely have identical pedogenesis patterns prior to vine planting.

7. Finally, we performed a screening (0-30 cm topsoil layer) to assess the homogeneity of total organic carbon contents in vineyard plots and adjacent forests.

Following these successive eliminations, the precise pit locations were chosen (Figure 2) :

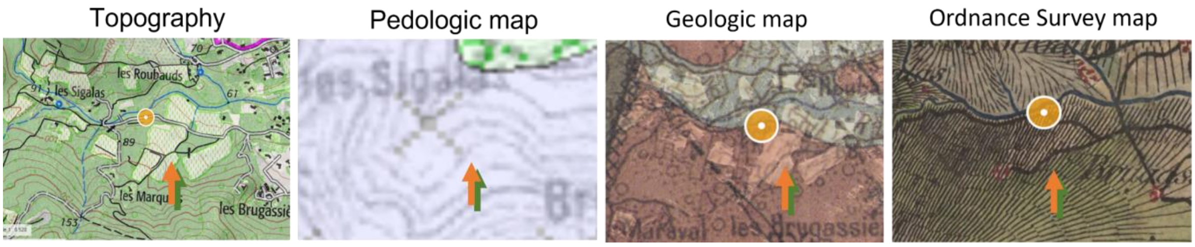

Figure 2 : topographic , pedologic (Source: Soil reference system of the VAR), geological and survey map (source :https://www.geoportail.gouv.fr).Brown arrow = crop; green arrow = forest.

This selection process seemed relevant to compare the evolution patterns of a soil associated with cultivation and agricultural practices in a detailed way and at the profile scale. We will outline this methodology in the revised version.

The introduction should be deeply revised. It includes several information written without following a clear framework.
=> It would be hard to precisely address the concerns of Referee #1 here because it is unclear what information actually needs to be better documented in the framework and exactly why the introduction needs deep revision. We improved it according to the recommendations of Referee #2 and as described below.

The aims seem to be not linked to the state of the art stated in the introduction section (e.g., you did not introduce the effect of vineyard on soil)
=> We agree with the Referee regarding the specific effects of the vineyard that were not detailed in the introduction. We will do so. This will help us reorganize the introduction as recommended. We propose to add the following paragraph:

"Relative to arable and pasture systems, SOC studies in vineyards have received less attention" (Payen et al., 2021), while viticulture is now a major agricultural growth sector under Mediterranean climatic conditions worldwide (Eldon and Gershenson, 2015). Yet, at the same time, vineyards in Mediterranean regions are among the most degraded agricultural crop systems (Ferreira et al., 2020). In their metanalysis of cultivated-uncultivated Mediterranean paired sites, Eldon and Gershenson, (2015) found that the soil carbon storage loss ranged from -30.6% to -52.1%, with the highest losses noted with the conversion to vineyards. Land degradation in Mediterranean vineyards is associated with loss of soil organic matter due to accelerated mineralization, decreased nutrient content, topsoil compaction and reduced water infiltration capacity, enhanced soil erosion rates, accumulation of metals and organic pollutants, and associated loss of soil biodiversity due to habitat deterioration (Bogunovic et al., 2019; Bordoni et al., 2019; Eldon and Gershenson, 2015; Ferreira et al., 2020, 2018; Kratschmer et al., 2018). These degradations result from a combination of relatively poor soils that prevail in Mediterranean regions, time of plantation and parent material, steep slopes, intense rainfall and, overall, the intensive crop management practices. These traditional wine-growing practices involve frequent tillage to minimize weed cover and soil compaction, postharvest removal of crop residues, and high mineral fertilizer and phytopharmaceutical compound application rates (Ferreira et al., 2020)"

Otherwise, we believe that the points outlined in the introduction showcase the state of the art and justify the approaches we implemented.

Ls 26-27: what do you mean for "and occur in layers about 100 cm deep"?
=> We agree that this sentence was not clear and propose to change the beginning of the introduction as follows:

"Arenosol is one of the 30 soil groups in the FAO soil classification system. Arenosols account for about 7% of the world's soils and are found mostly under desert, tropical and Mediterranean climatic conditions. They are silty-sandy or sandy soils, with less than 35% by volume of coarse elements, exhibit no or partial diagnostic horizon and are generally 100 cm deep. Given their excessive permeability and low nutrient content, agricultural use of arenosols requires careful management."

Ls 27-28: remove "for the richest" and "for the poorest"
=> We agree to remove these qualifiers that do not provide additional information.

L 27: what do you mean for "surface"
=> We will replace "surface" by "topsoil" here and elsewhere in the paper.

Ls 30-31: you could write "the conversion from forest or grassland to cropland can lead to......
=>Yes, we will change the sentence as proposed: *"As with other soil types, the conversion form forest or grassland to cropland can lead to a loss of carbon (Lal, 2004).*

Ls 31-32: all soil types are suitable to store carbon and to meet the 4 per 1000 initiative
=>Yes, we agree that all types of soil are suitable for carbon storage. We did not mean that only arenosols are suitable, but Referee #1 is right, the sequence of the sentences might suggest this.
In order to follow the logic of the paragraph on the effects of the forest/crop conversion, we will move this sentence to a paragraph dedicated to C storage later in the introduction. This will also be in line with the request of Referee #1 to reorganize the introduction.

L 36: the organic carbon loss, always occur after the conversion of forest and grassland to cropland, therefore the brackets should be removed and the sentence rephrased
=>OK, we will rephrase the sentence as follows: "*Loss of carbon due to conversion from forest or grassland to cropland is linked to the acceleration of erosion, runoff and/or mineralisation and could lead to a C depletion rate of about 50% in 10 years*".

L 37: remove "(CO_2 release)"
=> Ok, see sentence above.

L 43: where?
=>We do not really understand the Referee's question here. All agricultural research institutes run experimental sites. In France, the Grignon experimental site, for example, has been devoted to agronomy research since 1826.

L 49: "above criteria", which one?
We mean the criteria mentioned on line 47, namely "*same soil, same climatic conditions, same bedrock, flat topography*". We will clarify the sentence.

The quality of the materials and methods section is poor
=>We will rewrite the material and methods section. We will also note the statistical methods used (as requested Referee #2).

The present study does not have true replicates, it has just subreplicates. In order to satisfy the purposes of the present study, at least 3 soil profiles must be dug in each plot otherwise the findings cannot be considered valuable.
=>See our response at the beginning concerning the paired-site strategy. Following the advice of Referee #2, we also strengthened our results by using statistical approaches to confirm the observed differences between crop and forest soils.

References

Bogunovic, I., Pereira, P., Kisic, I., Birkás, M., Rodrigo-Comino, J., 2019. Spatiotemporal Variation of Soil Compaction by Tractor Traffic Passes in a Croatian Vineyard 12.

Bordoni, M., Vercesi, A., Maerker, M., Ganimede, C., Reguzzi, M.C., Capelli, E., Wei, X., Mazzoni, E., Simoni, S., Gagnarli, E., Meisina, C., 2019. Effects of vineyard soil management on the characteristics of soils and roots in the lower Oltrepò Apennines (Lombardy, Italy). Science of The Total Environment 693, 133390. https://doi.org/10.1016/j.scitotenv.2019.07.196

Eldon, J., Gershenson, A., 2015. Effects of Cultivation and Alternative Vineyard Management Practices on Soil Carbon Storage in Diverse Mediterranean Landscapes: A Review of the Literature 37.

Ferreira, C.S., Veiga, A., Caetano, A., Gonzalez-Pelayo, O., Karine-Boulet, A., Abrantes, N., Keizer, J., Ferreira, A.J., 2020. Assessment of the Impact of Distinct Vineyard Management Practices on Soil Physico-Chemical Properties. Air, Soil and Water Research 13, 117862212094484. https://doi.org/10.1177/1178622120944847

Ferreira, C.S.S., Keizer, J.J., Santos, L.M.B., Serpa, D., Silva, V., Cerqueira, M., Ferreira, A.J.D., Abrantes, N., 2018. Runoff, sediment and nutrient exports from a Mediterranean vineyard under integrated production: An experiment at plot scale. Agriculture, Ecosystems & Environment 256, 184–193. https://doi.org/10.1016/j.agee.2018.01.015

Humbel, F.X., 1987. STRUCTURAL ANALYSIS OF SOIL MANTLES AND ORIENTATED DESIGNS OF AGRONOMIC EXPERIMENTS. Land developement - Mangement of acid soils 153–162.

Jagercikova, M., Cornu, S., Bourlès, D., Antoine, P., Mayor, M., Guillou, V., 2015. Understanding long-term soil processes using meteoric 10Be: A first attempt on loessic deposits. Quaternary Geochronology 27, 11–21. https://doi.org/10.1016/j.quageo.2014.12.003

Jiang, Y., Luo, C., Zhang, D., Ostle, N.J., Cheng, Z., Ding, P., Shen, C., Zhang, G., 2020. Radiocarbon evidence of the impact of forest-to-plantation conversion on soil organic carbon dynamics on a tropical island. Geoderma 375, 114484. https://doi.org/10.1016/j.geoderma.2020.114484

Kratschmer, S., Pachinger, B., Schwantzer, M., Paredes, D., Guernion, M., Burel, F., Nicolai, A., Strauss, P., Bauer, T., Kriechbaum, M., Zaller, J.G., Winter, S., 2018. Tillage intensity or landscape features: What matters most for wild bee diversity in vineyards? Agriculture, Ecosystems & Environment 266, 142–152. https://doi.org/10.1016/j.agee.2018.07.018

Lal, R., 2004. Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. Science 304, 1623–1627. https://doi.org/10.1126/science.1097396

Lawrence, C.R., Beem-Miller, J., Hoyt, A.M., Monroe, G., Sierra, C.A., Stoner, S., Heckman, K., Blankinship, J.C., Crow, S.E., McNicol, G., Trumbore, S., Levine, P.A., Vindušková, O., Todd-Brown, K., Rasmussen, C., Hicks Pries, C.E., Schädel, C., McFarlane, K., Doetterl, S., Hatté, C., He, Y., Treat, C., Harden, J.W., Torn, M.S., Estop-Aragonés, C., Asefaw Berhe, A., Keiluweit, M., Della Rosa Kuhnen, Á., Marin-Spiotta, E., Plante, A.F., Thompson, A., Shi, Z., Schimel, J.P., Vaughn, L.J.S., von Fromm, S.F., Wagai, R., 2020. An open-source database for the synthesis of soil radiocarbon data: International Soil Radiocarbon Database (ISRaD) version 1.0. Earth Syst. Sci. Data 12, 61–76. https://doi.org/10.5194/essd-12-61-2020

Mathieu, J.A., Hatté, C., Balesdent, J., Parent, É., 2015. Deep soil carbon dynamics are driven more by soil type than by climate: a worldwide meta-analysis of radiocarbon profiles. Glob Change Biol 21, 4278–4292. https://doi.org/10.1111/gcb.13012

Payen, F.T., Sykes, A., Aitkenhead, M., Alexander, P., Moran, D., MacLeod, M., 2021. Soil organic carbon sequestration rates in vineyard agroecosystems under different soil management practices: A meta-analysis. Journal of Cleaner Production 13. https://doi.org/10.1016/j.jclepro.2020.125736

Torn, M.S., Trumbore, S.E., Chadwick, O.A., Vitousek, P.M., Hendricks, D.M., 1997. Mineral control of soil organic carbon storage and turnover. Nature 389, 170–173. https://doi.org/10.1038/38260