Point by point response - Referee #1

Plastic film residues on cropland: monitoring soil contamination through optical remote sensing

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We are very grateful that the reviewer could invest again time and energies in the review. This is very valuable to us.

Please find below our detailed answers (in italics). Line numbers refer to the marked-up manuscript version.

General comments

Congratulations on a good case study overall that is focusing on a timely global challenge that could benefit from complementary monitoring approaches. The general revisions have addressed some of the aspects that needed to be improved by the authors. An addition to Figure 2 is also positively recognized providing the reader an overview of the methods. However, a few open points are below:

Open issues

1. The title of the manuscript needs to be changed to include the phrase ‘case study’ because
    a. The authors fully acknowledged ‘We agree that our study did not include all possible soils where plastic films could be found….we still believe that this is the common case for environmental studies’

As correctly mentioned by the reviewer, ‘we still believe that this is the common case for environmental studies’. Our reply was provided as a reason why not to include ‘case study’ in the title. We apologise if the comment was not clear.

b. The current version is missing also the ‘diversity of ecosystems present at regional to global scales.’. The lack of variability in plastic types, colour of materials, soil types is the specific reason the authors should present the research as a ‘case study’

For the discussion about plastic types and colour, we refer the reviewer to the next comment. About soil types, as we mentioned earlier, this is the common case for laboratory or field experiments.

After a short literature review, the authors could not find consensus among a clear definition of ‘case study’, which is a debate mostly belonging to social sciences. For sake of simplicity and for the purpose of this review, we will adopt the definition provided by Gerring 2004 (https://doi.org/10.1017/S0003055404001182), who proposed ‘to define the case study as an intensive study of a single unit for the purpose of understanding a larger class of (similar) units’. We agree that this definition of case study — like many others — well adapts to the purpose of framing our study as a case study. As we believe it does for most of experimental research, especially in environmental sciences. Most of the experiments, and natural sciences are in great part experimental, could be defined as case study — we believe.

Even among our reference list, where most of the studies could be framed as case studies, only two publications included the term ‘case study’ in the title. We would prefer to align with the great majority of the current literature, where the word case study is rarely used. We believe it unnecessarily complicates the title and may convey an inaccurate impression of the scope of the study, which is not limited to a contextualized case, narrower than what already stated in the title.

An effective, clear, and simple title can partly determine a successful outreach, especially in the context of exponentially increasing number of research items. At the same time, we do not believe our title is incorrect or misleading. However, we also acknowledge that we cannot undeniably proof that our study is not a ‘case study’. To conclude, we believe that this is an editorial choice, and we will align to the line adopted by the editor.

c. Examples in the diversity can be seen in https://doi.org/10.4060/cb7856en

We agree that many types of plastics are used in agriculture. However, our study deals with 'Plastic film residues on cropland', as already stated in the title. Within this group, plastic films used as crop covers are the major source of contamination. As already highlighted in the previous review, the reviewer provided a reference stating that 'the main kinds of coloured plastic mulches used in different parts of the world for different crops are, black, white, and clear plastic mulches' (https://doi.org/10.1186/s40538-020-00201-8). These films were all considered in our study.

We cannot find references acknowledging other plastic films as a major source of plastic contamination for cropland.

2. The authors also argued 'The other study proposed by the reviewer does not discuss the generation of residues from silage films, nor from packaging.'
    a. For clarification the point was meant to indicate the diversity of colour in the plastics used but of course the production of residue is bound to happen
    b. To the following comment by the authors 'we are not aware of studies acknowledging plastic packaging or silage films as a major source of plastic contamination in agricultural soils' see google scholar for citations including https://doi.org/10.4060/cb7856en

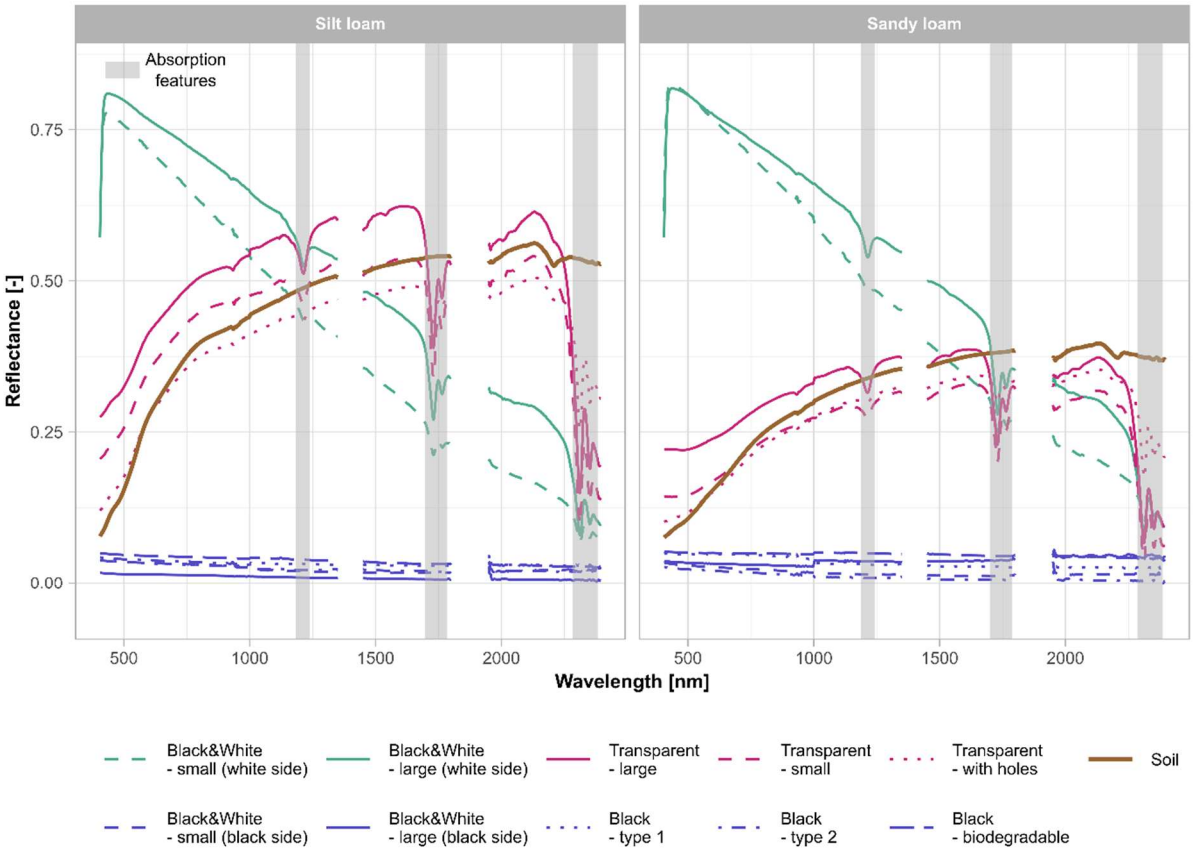
Thank you for the clarification about the comment. However, we could not find in the report clear references acknowledging silage films or plastic packaging as a major source of plastic contamination in agricultural soils.

3. Figure 3 can be improved for better visualisation and after checking the different versions of the manuscript it is still not visible or maybe the revised figure was not included?
    a. 'We changed the legend in all the figures of the spectra in the manuscript (Figure 3) and in the supplements. Please find below the example of Figure 3.'

The figures have been changed in the previous revision, wrapping the text of the legend and creating more space for the plots. For the new revised manuscript, we will follow the suggestion in the next comment and change the figure once more.

b. It is better to have larger plots and have the legend below the figures

The figures have been changed accordingly. See example of figure 3 below:



4. The authors must rephrase the sentences about hyperspectral sensors to clarify specific points

   a. 'Hyperspectral sensors are generally not suitable for plastic residue detection on agricultural soils because of the size of the residues, which rarely exceed 100 cm2'. The issue is about pixel resolution and not about the capabilities of the sensors to detect the optical properties that are specific to plastic residue.

We think there may have been a misunderstanding between what was written in the reply to the reviewer and what was changed in the manuscript. The reported issue on spatial resolution was already made explicit in the manuscript (lines 505-507):

‘Plastic residues rarely exceed 100 cm2 on agricultural land (Piehl et al., 2018; Stefano and Pleissner, 2022; Wang et al., 2022), placing high requirements on spatial resolution, which is traded off with spectral resolution and areal coverage in sensor technology (Shaw and Burke, 2003).’

b. Same issue is about area coverage using drones and aircrafts the pixel size is affected by the flight altitude right? So the text should be specific about this considering with hyperspectral sensors with high SNR it is feasible to also detect objects better at sub-pixel levels

We agree that a low flight altitude potentially allows an aircraft with hyperspectral sensors to detect plastic. However, we must consider that our study discusses tools that could reasonably be employed on a large scale for monitoring plans, ‘at which remote sensing is most needed’ (line 542). We do not question their capabilities in detecting the residues, which are demonstrated by the results of the study (Figure 4), but the possibility to use them at large scales. We changed the text at lines 507-511 to better explain the problems connected to hyperspectral sensors and flight altitude:

‘This strongly limits the use of technologies with large areal coverage, such as satellite data. In addition, the use of technologies with high spectral resolution on airborne platforms, such as hyperspectral sensors, would require low flight altitudes, resulting in increased flight time and associated costs, as well as the collection, storage, and processing of large volumes of data.’

c. There are several examples of studies that have demonstrated the above points and also used hyperspectral drones with very high pixel resolutions

We are not sure whether the reviewer refers to studies using hyperspectral drones to detect objects below 10 cm. If so, the use of these examples should consider that a possibility to cover large areas is expected and that the financial interests behind their use in monitoring plans are comparable (e.g., detecting precious ores has higher financial interests than detecting macroplastics). With this premises, we cannot find studies proving that the monitoring of macroplastic on soils with hyperspectral drones would be a viable option.

5. Section 4.3 should make it clear for ‘precision’ that hyperspectral sensors are very useful but the potential has not been explored
    a. One issue being point 4 above

Point 4 above has already been discussed.

    b. The authors should acknowledge the available relevant tools (e.g. APEX, AVIRIS-NG, EnMAP….) and efforts by space agencies for example CHIME “Hypersense” Campaigns

We would acknowledge these tools if their utility for monitoring plans could be demonstrated for the problem at hand, considering the actual spatial coverage, spatial resolution, and revisit time of these tools. Please refer to the next comment for a more detailed answer regarding APEX or a general hyperspectral sensor mounted on a drone, which are considered as the data sources with the highest spatial resolution

    c. The arguments using the cited papers misses the proof or link to remote sensing meaning unless the authors have a paper or proof that ‘Hyperspectral sensors are generally not suitable for plastic residue detection on agricultural soils’ the text should reflect this is an assumption based on sizes found in the natural environment but the case studies are missing to support the suitability of current hyperspectral sensors on airborne or satellites.

Among the proposed data sources, APEX – the tool providing the highest resolution – can cover 5% of the surface of the biggest plastic residue that can normally be found on cropland. Even assuming that 5% of pixel occupation is enough to accurately detect the residue – which should be supported by current literature – the great majority of the residues is smaller than 100 cm^2. We refer the reviewer to the suggested literature at lines 505-506.

Referring to the possibility of having a hyperspectral sensor mounted on a drone, we believe that the changes implemented at lines 507-511 already covered the issue:

‘This strongly limits the use of technologies with large areal coverage, such as satellite data. In addition, the use of technologies with high spectral resolution on airborne platforms, such

as hyperspectral sensors, would require low flight altitudes, resulting in increased flight time and associated costs, as well as the collection, storage, and processing of large volumes of data.'

6. The authors are urged to check data access policy for AVIRIS under the NASA's Earth Science Data Policy
    a. 'These data are indeed airborne, but we would not consider AVIRIS as open data, since the mission planning and the data are typically obtained upon the submission of a formal request.'

From the AVIRIS website (https://avirisng.jpl.nasa.gov/newdata.html):

'All groups and agencies interested in acquiring AVIRIS-NG data must submit an experiment proposal to NASA headquarters and a flight request to Armstrong Flight Research Center.'