Response to Reviewer #1 comments

1. To me this MS presents rather limited novelty to the study by Sanz-Cobena et al. (2014). Also the added 15N approach brings nothing really new to the current knowledge. The authors should therefore elaborate more clearly the novel and innovative character of their research.

We have tried to highlight in the Manuscript the novelty that our study has with respect to Sanz-Cobena et al. (2014). One of the main differences is the use of Integrated Soil Fertility Management (ISFM) in the current study as opposed to conventional fertilization in Sanz-Cobena et al. (2014). The results of the latter study hinted that the effects in soil N availability induced by contrasting cover-crops could represent an opportunity to adjust N fertilization for the cash crop accordingly, without significant yield penalties. This innovative point has now been highlighted in the title ("Effect of cover crops on greenhouse gas emissions in an irrigated field under integrated soil fertility management") and the introduction: "Only one study has investigated the effect of CCs on N_2O emissions in Mediterranean cropping systems (Sanz-Cobena et al., 2014). These authors found an effect of CCs species on N_2O emissions during the intercrop period. After 4 years of CC (vetch, barley or rape)-maize rotation, vetch was the only CC species that significantly enhanced N_2O losses compared to fallow, mainly due to its capacity to fix atmospheric N_2 and because of higher N surplus from the previous cropping phases in these plots. In this study a conventional fertilization (same N synthetic rate for all treatments) was applied during the maize phase; how ISFM practices may affect these findings remains unknown."

With regards to the ^{15}N approach, we agree that there are some previous studies which have evaluated the interactive effects of different crop residues with N synthetic fertilization through ^{15}N methods (e.g. Baggs et al., 2003; Garcia-Ruiz and Baggs, 2007; Frimpong et al., 2011). Furthermore, ^{15}N has been used in different cover-cropping experiments (e.g. Bergstrom et al. 2001; Jayasundara et al., 2007; Gabriel and Quemada, 2011, Gabriel et al., 2016) but all of these studies were focused on plant recovery or N leaching. The study of Li et al. (2016) measured $^{15}N_2O$ after the application of different CC residues (including roots) and N synthetic fertilizer but under laboratory conditions. To our knowledge, no previous studies have evaluated the relative contribution of CC residues/soil N (which involve the aboveground biomass and the decomposition of root biomass) and N synthetic fertilizers to N_2O emissions under field conditions employing stable isotope techniques. We have elaborated more clearly this novel point in the introduction: "Moreover, the relative contribution of mineral N fertilizer, CC residues and/or soil mineral N to N_2O losses during the cash crop has not been assessed yet. In this sense, stable isotope analysis (i.e. ^{15}N) represents a way to identify the source and the dominant processes involved in N_2O production (Arah, 1997). Stable Isotope techniques have been used in field studies evaluating N leaching and/or plant recovery in systems with cover crops (Bergström et al., 2001; Gabriel and Quemada, 2011; Gabriel et al., 2016). Furthermore, some laboratory studies have evaluated the effect of different crop residues on N_2O losses using ^{15}N techniques (Baggs et al., 2003; Li et al., 2016); but to date, no previous studies have evaluated the relative contribution of cover crops (which include the aboveground biomass and the decomposition of root biomass) and N synthetic fertilizers to N_2O emissions under field conditions."

Baggs, E. M., Stevenson, M., Pihlatie, M., Regar, A., Cook, H., and Cadisch, G.: Nitrous oxide emissions following application of residues and fertiliser under zero and conventional tillage. Plant Soil, 254(2), 361-370, 2003.

Bergström, L. F., and Jokela, W. E.: Ryegrass Cover Crop Effects on Nitrate Leaching in Spring Barley Fertilized with (15)NH4(15)NO3. J. Environ. Qual., 30(5), 1659-1667, 2001.

Frimpong, K. A., Yawson, D. O., Baggs, E. M., and Agyarko, K.: Does incorporation of cowpea-maize residue mixes influence nitrous oxide emission and mineral nitrogen release in a tropical luvisol? Nutr. Cycl. Agroecosys., 91(3), 281-292, 2011.

Gabriel, J. L., and Quemada, M.: Replacing bare fallow with cover crops in a maize cropping system: yield, N uptake and fertiliser fate. Eur. J. Agron., 34, 133-143, 2011.

Gabriel, J. L., Alonso-Ayuso, M., García-González, I., Hontoria, C., and Quemada, M.: Nitrogen use efficiency and fertiliser fate in a long-term experiment with winter cover crops. Eur. J. Agron., 79, 14-22, 2016.

Garcia-Ruiz, R., and Baggs, E. M.: N_2O emission from soil following combined application of fertiliser-N and ground weed residues. Plant Soil, 299(1-2), 263-274, 2007.

Jayasundara, S., Wagner-Riddle, C., Parkin, G., von Bertoldi, P., Warland, J., Kay, B., and Voroney, P.: Minimizing nitrogen losses from a corn–soybean–winter wheat rotation with best management practices. Nutr. Cycl. Agroecosys., 79(2), 141-159, 2007.

Li, X., Sørensen, P., Olesen, J. E., and Petersen, S. O.: Evidence for denitrification as main source of N_2O emission from residue-amended soil. Soil Biol. Biochem., 92, 153-160, 2016.

Sanz-Cobena, A., García-Marco, S., Quemada, M., Gabriel, J. L., Almendros, P., and Vallejo, A.: Do cover crops enhance N_2O, CO_2 or CH_4 emissions from soil in Mediterranean arable systems? Sci. Total Environ., 466, 164-174, 2014.

2. What is rather “non-innovative” is the fact, that the cover crops are killed chemically with glyphosate. This is somewhat disappointing for research in agricultural sustainability, as the safe use of glyphosate is under discussion since years. There are alternatives in place also for Mediterranean regions and might be found among farmers applying organic no-till agriculture. The authors should address this topic in the discussion section, that the application of glyphosate for cover crop management is disputable and alternative measures to remove the cover crops with smart methods are needed (e.g. European project TILMAN-ORG).

We agree and are aware that the application of glyphosate is under discussion since years, and now more than ever in the European Union it is a matter under the spotlight. However, the use of non-selective herbicides is a standard and broadly used method followed by conservation tillage growers for cover crop killing in Spain and many other regions. Another alternative for this kind of systems would be mowing but the adequate control is not always achieved, mainly in the case of legumes, in which regrowth is very common. The roller-crimper may be an alternative method but, as well, the legume killing effectiveness is under discussion. Therefore, the glyphosate use seemed an appropriate option that would ensure the killing in both barley and vetch treatments. Moreover, as the study was carried out in a long-term experiment of cover cropping system, it was decided to maintain the same killing method each year. Clearly, further research is needed to investigate this interesting topic, but we considered that it did not fit in any of the subsections of the discussion. Therefore, in the Materials and Methods section of the revised manuscript we have included more information with regards to the use of glyphosate as the killing method in our study: “The cover cropping phase finished on March 14th 2014 following local practices, with an application of glyphosate (N-phosphonomethyl glycine) at a rate of 0.7 kg a.e. ha-1. Even though the safe use of glyphosate is under discussion since years (Chang and Delzell, 2016), it was used in order to preserve the same killing method in all the campaigns in this long-term experiment under conservation tillage management".

Chang, E. T., and Delzell, E.: Systematic review and meta-analysis of glyphosate exposure and risk of lymphohematopoietic cancers. J. Environ. Sci. Heal. B, 51(6), 402-434, 2016.

3. Cover crop establishment: I am wondering that a hand broadcast technique is used for CC seeding. This might cause too many heterogeneities and influence yield-scaled N2O emissions. Please discuss.

In order to reduce economic costs to farmers interested in cover crops, a suitable choice for sowing would be the use of a centrifugal spreader. As the plot size was 12 x 12 m^2, the best way to emulate this type of sowing was by hand broadcasting. Results from several previous years and tests showed that this system ensures high homogeneity. Specifically, from cover crop emergence until its killing date, the ground cover was monitored by taking digital photos of four squares (0.5 x 0.5 m^2) marked in each plot and lately analyzed with a software based on colorimetry. At the first sampling date (23/10/2013), no differences were observed between vetch samples (ground coverage: 4.3% ± 0.2%), nor in barley (6.7% ± 0.5%).

4. The authors use too many and sometimes unnecessary abbreviations, please adapt.

We thank the reviewer for this remark. Some unnecessary abbreviations, e.g. ammonium nitrate (AN), yield-scaled N_2O emissions (YSNE), N use efficiency (NUE), dry matter (DM) have been removed. If the reviewer thinks that more abbreviations should be removed, we will do it.

5. Chambers for GHG sampling: I found it a bit too shallow to insert the stainless rings only 5 cm deep into the soil. There is a high risk of lateral N2O emission, when the rings/collars are inserted not deep enough (> 10 cm). Please explain.

We thank the reviewer for this comment and we agree that the stainless rings should have been inserted deeper. The rings we used had a height of approximately 10 cm and were inserted into the ground to a depth of ≥5 cm to get a practical height above soil surface of 4-5 cm needed to insert the chamber just above the ground, also preventing water accumulation in the soil surface due to irrigation. We have calculated our average air-filled porosity, which was slightly below 0.3 cm^3 cm^{-3}. Considering our chamber closure time, the average error may be slightly above 5% (since 6.2 cm is the adequate insertion depth for an air-filled porosity of 0.3 cm^3 cm^{-3} and one hour of closure time leading to an error of 5%) (Hutchinson and Livingston, 2001). In further experiments, we will adjust more accurately the insertion depth taking into account our experimental conditions, in order to reduce the error to a minimum.

Hutchinson, G. L., and Livingston, G. P.: Vents and seals in non-steady-state chambers used for measuring gas exchange between soil and the atmosphere. Eur. J. Soil Sci., 52(4), 675-682, 2001.