

## ***Interactive comment on “Management matters: Testing a mitigation strategy for nitrous oxide emissions on intensively managed grassland” by Kathrin Fuchs et al.***

### **Anonymous Referee #2**

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This is an important paper, comparing N<sub>2</sub>O emissions from adjacent fields with different proportions of clover content. The paper is well written, and suitable for publication in BG. My main comments are as follows: 1) In the ‘mitigation’ treatment more clover was added, but as it took time to establish, the differences between clover % was rather small in year 2015 (15% & 21%), whereas in year 2016 the differences were large (4% and 44%). Similar differences were observed for the BNF rates (Table 2). These differences and their implications on the yield and N<sub>2</sub>O fluxes is not adequately addressed in this paper. 2) N<sub>2</sub>O was measured using eddy covariance, from 2 adjacent fields. The overall data coverage of both fields was similar (Table 3), but the authors need to demonstrate that the temporal coverage of measurements was similar for both

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fields. One would not want situations where the airflow is always from field 1 at dawn, for example.

Further suggestions of edits can be found below Abstract: needs to contain the grass clover proportions for the 2 fields

Introduction: ‘Apart from the environmental benefits of a reduced N surplus when mineral fertilizer is replaced by BNF, total GHG emissions from fertilizer production of 1.6–6.4 kg CO<sub>2</sub>-eq per kg fertilizer N, could technically be avoided (Andrews et al., 2007; Brentrup 5 and Pallière, 2008).’ R: In which country of climate zone can such GHG reduction rates be achieved?

Methods: ‘The site has been well investigated in terms of CO<sub>2</sub> exchange (Burri et al., 2014; Zeeman et al., 2010), as well as for N<sub>2</sub>O and CH<sub>4</sub> exchange under management that is typical for Swiss grasslands located on the Swiss Plateau (Imer et al., 2013; Merbold et al., 2014; Wolf et al., 2015).’ R: Add that CO<sub>2</sub> exchange is measured by EC and N<sub>2</sub>O/CH<sub>4</sub> by , presumably, static chambers.

R: Given that you have reduced the EC averaging time to 10 min from the usual 30 min, I assume that you must have had a relatively equal spread between coverage of both the two plots. You need to demonstrate this, for example by including a graph of N<sub>2</sub>O versus time with different colour dots for the two treatments.

R: Why did you fertilise with 296 kg N/ha/2015 and 181 in 2016?

Section 2.6: ‘and a subsample of 5 mg was weighed into tin capsules for further analyses (n = 5 for each parcel per date).’ R: You need to add: ‘...for further analysis of total C and N and .....’

R: Figure 1: include the prevailing wind direction, or say what it is in the legend

R: Legend to Figure 2 needs to be tidied up.

R: Figure 5: Why do you join the dots for graphs b-d, but not for graphs e-f? Looks like

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there is some inconsistency here.

R: Section 3.5: 'During the reference year 2013' Add the reference to these 2013 data

R: Figure 8 'the factor management' delete 'the factor', or place it before '(a)'

Discussion 1st Parag. 'major changes compared to the "business as usual" practice; (1) omitted fertilization and (2) over-sowing clover, leading to an increased clover proportion in the experimental sward' R: Add the % of clover to remind the reader ' to an increased clover proportion of x %'

R: Last sentence and elsewhere: change 'in sum' to 'in summary'.

Section 4.1: 'than our site, showed typically lower N<sub>2</sub>O emissions (0.38–2.28 kg N<sub>2</sub>O-N ha<sup>-1</sup> yr<sup>-1</sup>), which can be explained by lower fertilizer inputs compared to our site (Hörtnagl et al. 2018). 'In sum, our year-round measurements of N<sub>2</sub>O emissions are higher than multi-site averages due to its fertilizer regime and site conditions, but within plausible ranges compared to other sites. R: Discuss the differences in fertiliser rate and the differences in site composition between the Hortnagl study and yours in greater details, so that the reader also understands why your N<sub>2</sub>O fluxes are larger. Provide more information on the differences between your site and the Hortnagl sites. And, to improve the English change 'In sum, our year-round measurements of N<sub>2</sub>O' to 'In summary, our one-year measurements of N<sub>2</sub>O'

Section 4.2: 'N<sub>2</sub>O emissions in the clover parcel during our two-year observation period summed up to 1.9 and 3.8 kg N<sub>2</sub>O-N ha<sup>-1</sup> yr<sup>-1</sup> in 2015 and 2016, respectively. These values were clearly lower than the values observed from the control parcel.' R: You need to discuss these observations and others in this section with the fact that the differences in clover proportions between the two fields in 2015 were rather small compared to 2016 (Table 2).

'Jensen et al. (2012) based on site-years.' R: based on how many site years?

'In addition, high total N deposition (NH<sub>3</sub>-N, NO<sub>3</sub>-N, HNO<sub>3</sub>-N, NO<sub>2</sub>-N) on intensively

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managed Swiss grasslands (15–40 kg N ha<sup>-1</sup> yr<sup>-1</sup>, Seitler et al., 2016)' R: Can you be more specific regarding the N dep rate in your study area. The range you quote is very large.

Section 4.3: 1st paragraph: you should qualify phrases such as those shown below 'N<sub>2</sub>O emissions vary widely across sites' R: add the ranges of emissions, and presumably the studies for reference are from grasslands?) 'Higher N<sub>2</sub>O fluxes following cutting were similarly observed on a pasture in Central France (Klumpp et al., 2011).' R: what is the difference relative to your study? You have done this much better in the 2nd paragraph.

'In agreement with our result, an experiment without seasonal frozen soils at an Irish permanent ryegrass/clover mixture, annual N<sub>2</sub>O emissions between unfertilized ryegrass' R: 'change to ' In agreement with our result, measurements from permanent grasslands in Ireland, where winter freeze-thaw cycles are very rare, a comparison of a ryegrass/clover mixture, with . . . . .'

'The magnitude of the fertilization effect of 2.5-fold N<sub>2</sub>O emissions on average during the week after fertilization (at 43 kg N amendment per event on average) was comparable to the effect of a 14 °C soil temperature increment if further environmental variables remained constant.' R: This sentence requires an introduction and significant explanation. It is a bit out of place here.

Section 4.4 'Additionally, high SON content due to previous year's fertilizer amendments are expected to contribute to the persistently high production levels' R: I suppose you mean 'years' and not year's'

'the over-sowing was more effective and biologically fixed nitrogen found in shoot biomass in the clover parcel summed up to 130 kg N ha<sup>-1</sup> yr<sup>-1</sup> while only 14 kg N ha<sup>-1</sup> yr<sup>-1</sup> were measured in the control parcel' R: What is the reason for the legume proportion in the control to decrease between 2015 and 2016?

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'This indicates that biologically fixed nitrogen at the Chamau could reach higher amounts than observed during our experiment.' R: Can you really deduce this statement from the New Zealand study, where the climate, soil types and perhaps even the grass and clover species used may be rather different?

Section 4.5 'due to large springtime emissions (Virkajärvi et al., 2010) indicating that the mitigation strategy is likely to be inappropriate for sites with seasonally frozen soils.'

R: Your Swiss soils also experience winter freeze-thaw cycles, but your data suggest that this mitigation strategy works in Switzerland. Please address this discrepancy.

'Due to this effect, temporary grasslands may not reproduce the findings from permanent grassland.' R: You need to provide evidence for this statement. Temporary grasslands are maintained for several years, so are rather different to croplands.

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