LETTER TO THE EDITOR

Response to Briggs, Hanekamp & Crok

The main issue at stake stems from the assertion of Hanekamp et al. (2017) that “the uncertainty in the output of the equation given in Ryden & McNeill (1984) would result in emission uncertainties that would perhaps result in overlap between the different manure application techniques. Thus, the widely reported dividing lines between emissions from different manure application techniques are likely blurred”. Hanekamp et al. are implicitly questioning the rationale behind the regulations for emission-reducing manure application techniques to which farmers in the Netherlands are subject.

Figure 1 in Goedhart & Huijsmans (2017) undisputedly shows that, in pairwise experiments, narrow band application and shallow injection result in much smaller ammonia emissions than does broadcast spreading. The emission percentages depicted in this figure were obtained by application of the Ryden & McNeill (R&M) model to basic wind speed and concentration data. The emission percentages and the set-up of the experiments are listed in publicly available references and are not “recreated” as Briggs et al. write. In fact, most of these percentages are listed in Huijsmans et al. (2001), a paper that is referred to by Hanekamp et al. (2017) so that they are well aware of these data. The percentages depicted in Figure 1 are thus genuine, albeit with modelling and measurement errors. They further write that they “have no dispute” with our methods with which these percentages were statistically analysed. This seems to imply that, given that the percentages are genuine, they agree with our conclusion that “significant difference between surface broadcast spreading and the two low-emission methods stands”. We acknowledged in our paper that the R&M model can be improved. It is, however, highly unlikely that an alternative model would reverse any of the differences depicted in our Figure 1.

It is important to note that the analysis of all 199 emission experiments is not questioned in the letter of Briggs et al. This analysis revealed (Table 2, Goedhart & Huijsmans (2017)) large differences in mean percentage emission between surface broadcast spreading and the two low-emission techniques. Again, it is improbable that an alternative to the R&M model will change that conclusion. If not yet convincing enough, the efficacy of shallow injection was also provided by 14 out of 14 grassland response trials: the additional nitrogen yield of grassland after shallow injection, relative to surface spreading, matched well with the reduced emission (Huijsmans et al., 2016). We reiterate that our findings agree well with many international studies such as those reviewed by Sommer & Hutchings (2001) and Webb et al. (2010).

With respect to the manner in which the uncertainty is estimated, Briggs et al. write that our bootstrap and their approach “have strengths and shortcomings” and that “it is just that the two approaches are different”. However, this is not a matter of opinion, but of applying sound statistical methods. That their method is theoretically wrong is exemplified by the simple example given in Appendix S2 to our paper. It is bound to result in too wide confidence intervals, which they acknowledge by describing their method as liberal.

Briggs et al. write that we “have done a valuable service in emphasizing the need to estimate uncertainty in ammonia emissions”. In fact, we argued that, rather than focusing on the uncertainty per experiment, it is much more important to conduct many experiments to deal with the variation between experiments. This has the additional benefit that differences in emission between application techniques are revealed under a variety of circumstances, as in our Figure 1. In that sense, the discussion on how to estimate the uncertainty per individual experiment is less relevant.

The main purpose of our paper was to show, once again, that narrow band application and shallow injection do result in smaller emission percentages than broadcast spreading, and that the regulations to which farmers are exposed have a sound scientific foundation. Although this was implicitly questioned by Hanekamp et al. (2017), their scepticism is not repeated in their letter, which seems to indicate that they agree with that conclusion.

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