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N₂O emission of different land uses in an intensive dairy farming region, Japan

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Introduction
The livestock sector grew rapidly to meet the increasing demand in meat and dairy productions. As a result, the increased manure applied to soil became one of the most important sources of N₂O emission from agricultural soils (Mosier, et al. 1998). Nitrous oxide flux from agricultural soils was strongly influenced by different crop systems, especially whether they are paddy or upland fields. At field scale, it was difficult to find the main influence factors and to establish strong predictive relationships between field fluxes and field scale parameters such as temperature, soil moisture, soil texture and so on (Groffman, 1991). This study was conducted at an intensive dairy farming area, where high amount of manure is applied. The data of N₂O flux from a field scale was analysed at regional scale, which contains different soil textures and different crop systems. The objectives of this research were (i) to explore the character of N₂O fluxes from different crop systems, and (ii) to evaluate the N₂O emission at the whole target region.
Methods
This study was conducted from January 2008 to February 2009 at upstream of Naka River watershed in Japan (36^o49[']- 37^o01[']N, 139^o54[']-139^o59[']W). In this region, major crop systems are one season cultivation of rice (R), maize (M), and a rotation of grass and maize (G/M). Dairy cow manure is the main fertilizer source. Eight farmer's fields were chosen according to different land uses, soil textures and location. N₂O fluxes in the fields were measured using static chambers.
Results
N₂O flux ranged from -9.1 to 205.6 g N m⁻²h⁻¹ in M and G/M systems and from -0.01 to 0.28 mg N m⁻²h⁻¹ in R systems. The highest N₂O fluxes were found in January, 2008, and then it decreased with the time. The fluxes were less than 0.05 mg N m⁻²h⁻¹ in March 2008 for M and G/M systems and in May 2008 for R systems. The cumulative N₂O emission of winter period from November to April was significantly higher than that of summer period from May to October (p<0.01). R systems had significantly higher N₂O emission than G and G/M systems (p<0.01). Significant interactions were found between the period and land uses, and between land uses and soil types (p<0.01). As a result, the annual N₂O emission of M and G/M systems ranged from 2.0 to 3.4 kg N ha⁻¹yr⁻¹ with an average of 2.8 kg N ha⁻¹yr⁻¹, and that for R systems ranged from 2.5 to 6.0 kg N ha⁻¹yr⁻¹ with an average of 4.1 kg N ha⁻¹yr⁻¹.
Conclusion
The results of this research demonstrate that N₂O emission in soils was regulated by land use types, application of fertilizer and special weather conditions. Annual N₂O emission from R systems was higher than that of upland soils. Summer season had a significant

lower N₂O emission than winter season. The controlling factors changed with the different scales. For R systems, the water regime and the concentration of NH₄⁺ in soil were the most important factor for N₂O flux. The concentration of NO₃⁻ and the WFPS in soil were the main factors of N₂O emission in upland systems. At the whole region, the soil moisture was the important factor to drive N₂O emission.

References

Mosier AR, Duxbury JM, Freney JR, Heinemeyer O, Minami K(1998) Assessing and mitigating N₂O emissions from agricultural soils. Climatic Change 40, 7-38.

Groffman PM (1991) Ecology of nitrification and denitrification. In 'Microbial Production and Consumption of Greenhouse Gases: Methane, Nitrogen Oxides and Halomethanes'. (Eds WB Whitman, J Rogers) pp.201-217.

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