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Carbon and nitrogen balance in Japanese agriculture sector

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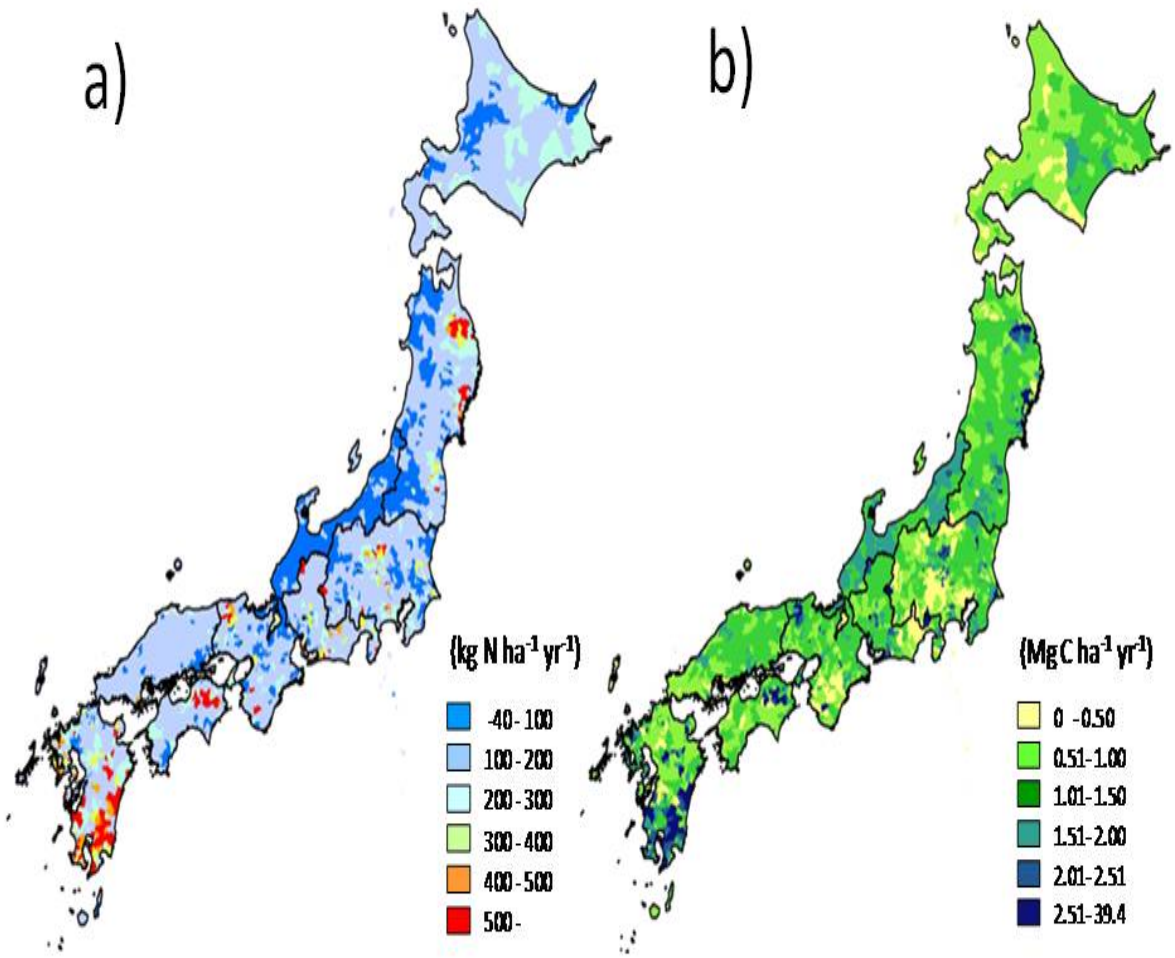

Figure 1. a)Farmland soil surface nitrogen balance and b) average carbon input of Japanese farmland soils in 2005 at municipal scale

Introduction

After industrial revolution, anthropogenic nitrogen (N) has doubled the reactive N in the world (Galloway 1998). The main purpose of anthropogenic N input is to increase crop and animal production, however, over supply of N has led to environmental damages. The amount of production must be maintained or increased and at the same time, green house gas (GHG) emission should decrease if the N flows are optimized. The analysis of the trade-off relation is defined as eco-balance analysis (Kimura and Hatano 2007). In this study, C and N flow concerning Japanese agriculture were quantified to analyse the available C and N resources at municipal scale. The objective of this study was to analyse the relation of farmland soil surface N balance (FSSNB) and global warming potential (GWP).

Methods

Following calculations were conducted for the 2520 municipals in Japan for the year 2005. Carbon and N in livestock manure was calculated from the amount of livestock excrements, additional materials such as urban compost and crop residue. The amount of livestock excrements was determined by the kind and number of livestock (MAFF 2009a, LEIO 2005). The calculation was conducted separately for 8 land use types, animal and fish product demand of humans (MAFF 200 9b). The FSSNB was the difference between all the input to farmland and the production, and carbon balance, methane and nitrous oxide emission calculated from emission factors were compared as GWP (IPCC 2007).

Results and Discussion

The average FSSNB of municipals ranged from -40-10,210 kg N/ha/yr (Figure 1a). The weighted mean for whole Japan was 166 kg N/ha/yr. There were 117 municipals that had a higher FSSNB value than 500 kg N/ha/yr. The extremely high FSSNB values might be wrongly calculated because the allocation of manure to other municipals was not taken into account. The carbon input to Japanese farmland soil at municipal scale is shown in Figure 1b. The values ranged from 0-39.4 Mg C/ha/yr, with a weighted mean of 1.22 Mg C/ha/yr for whole Japan. Municipals with high C input were similarly distributed as FSSNB and showed high values especially at south of Kyushu region, south Japan.

GWP increased as FSSNB increased. This tendency was also found for municipals with FSSNB below 250 kg N/ha/yr. As the three components of GWP was compared to FSSNB, GWP derived from C balance showed a negative correlation to FSSNB, while that from methane showed no correlation and that nitrous oxide showed a positive correlation. The increase of GWP derived from nitrous oxide emission was higher than the mitigation GWP by C balance.

Conclusion

The analysis of FSSNB in relation to amount of manure, agricultural production and GWP showed that the intensity of livestock production has a high influence on FSSNB. The calculated amount might be overestimated since the estimation was conducted at municipal scale and the tendency rather than the amount should be discussed. The analysis showed that there is a positive relation of FSSNB to agricultural production and GWP. It indicates that the reduction of FSSNB can also reduce GWP, however, the agricultural productivity will decrease under the present practice. An re-allocation of manure is required to reduce the N load from extremely high regions, but also changes in agricultural production structure that integrate livestock and arable farms are required to manage the N flow related to Japanese agriculture more sustainably.

References

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