Prediction of SOC change under a climate change scenario using DNDC model

THEME 1

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INTRODUCTION

- Monitoring the change of soil organic carbon is necessary for soil management.

Asia accounts for about 90% of the world rice-growing area and production. In Korea, paddy soils occupy 55% of arable land. Mean organic matter concentration in rice paddy soils decreased from 26 g kg^{-1} in the 1960s to 24 g kg^{-1} in 2000. Low soil organic matter levels and imbalanced nutrient management are the main factors for the decrease in rice grain yields.

- Long-term experiments are alternative tools for estimating the changes of soil organic carbon in agricultural management practices.

OBJECTIVES

A SOC model might be an effective tool to simulate accurately SOC turnover for soil productivity in paddy soils. However, most of the existing models cannot be applied to paddy soils since they have been developed for simulating conditions prevailing upland soils.

Climate change as it affects atmospheric temperatures, is a factor affecting the soil organic matter in agricultural soils. We predicted the changes of soil carbon content by using the DNDC model under global warming scenario to suggest reasonable strategies for soil carbon conservation in paddy soils.

METHODOLOGY

- Testing the suitability of DNDC model for simulating soil organic carbon dynamics

The paddy soils were subjected to different fertilization practices: inorganic fertilizers (NPK, N-P-K=120-34.9-66.7 kg ha^{-1} yr^{-1} during 1967-1972 and 150-43.7-83.3 kg ha^{-1} yr^{-1}) from 1973 to 2007), straw based compost(Compost, 10 Mg ha^{-1} yr^{-1}), a combination of inorganic fertilizer (NPK) and compost (NPK+Compost), and no fertilizer(Control).

DNDC model was run from the data recorded. Soil and farming management information was basically obtained from annual reports (1973-2007).

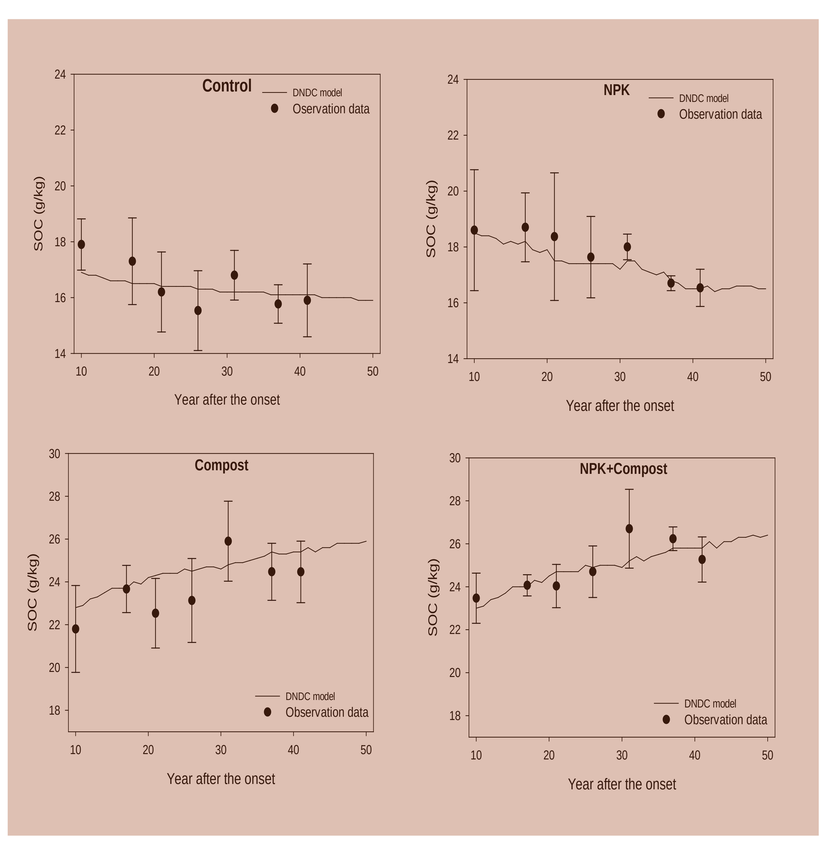

Fig. 1: Comparison between the observed changes in the SOC content with time and the prediction by DNDC model using modified crop parameters in paddy soil. Crop parameters in the DNDC were modified so that simulated crop growth agreed with the observed one

- Prediction for the changes of SOC in paddy and upland soils under a climate change scenario

Tab. 1: Summary of characteristics for long-term experiments and required parameters to run the DNDC model

MAIN RESULTS

- The changes of SOC in paddy and upland soils at elevated air temperature

DNDC model as carbon modelling for predicting the changes of soil organic carbon was used, and corrected main parameters of DNDC model with observation data of long-term field for 30 years.
The DNDC model simulated the decrease of soil carbon by 4-5% over 50 years. In particular, it predicted that the maximum SOC content would be reduced by 10% in rice fields.
It predicted that the organic matter should be added at rates 15.7-16.7% in the rice field and 4.6-7.6% in the field in order to maintain the organic matter level of the current fields under the condition of 2.0 ℃ higher than the current temperature.

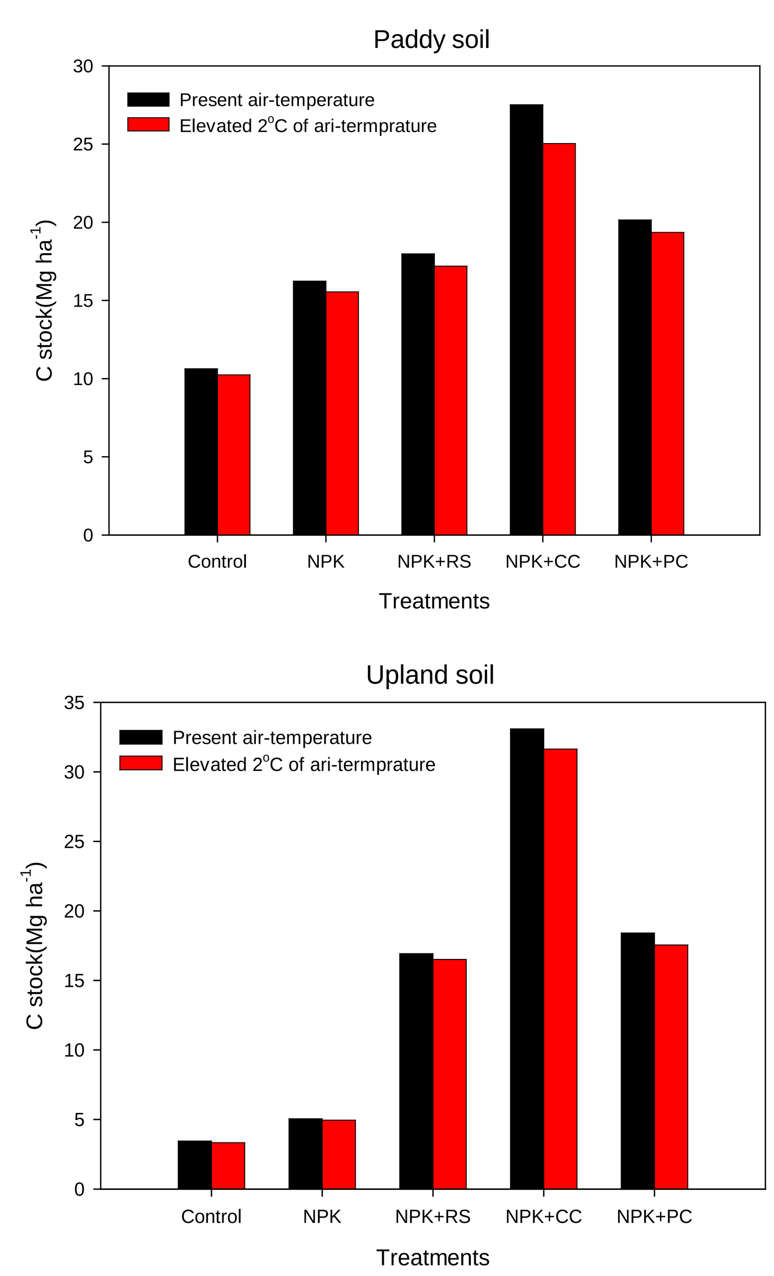

Fig. 3: Prediction of C stocks in paddy and upland soil applied with organic matter with DNDC model under global warming scenario

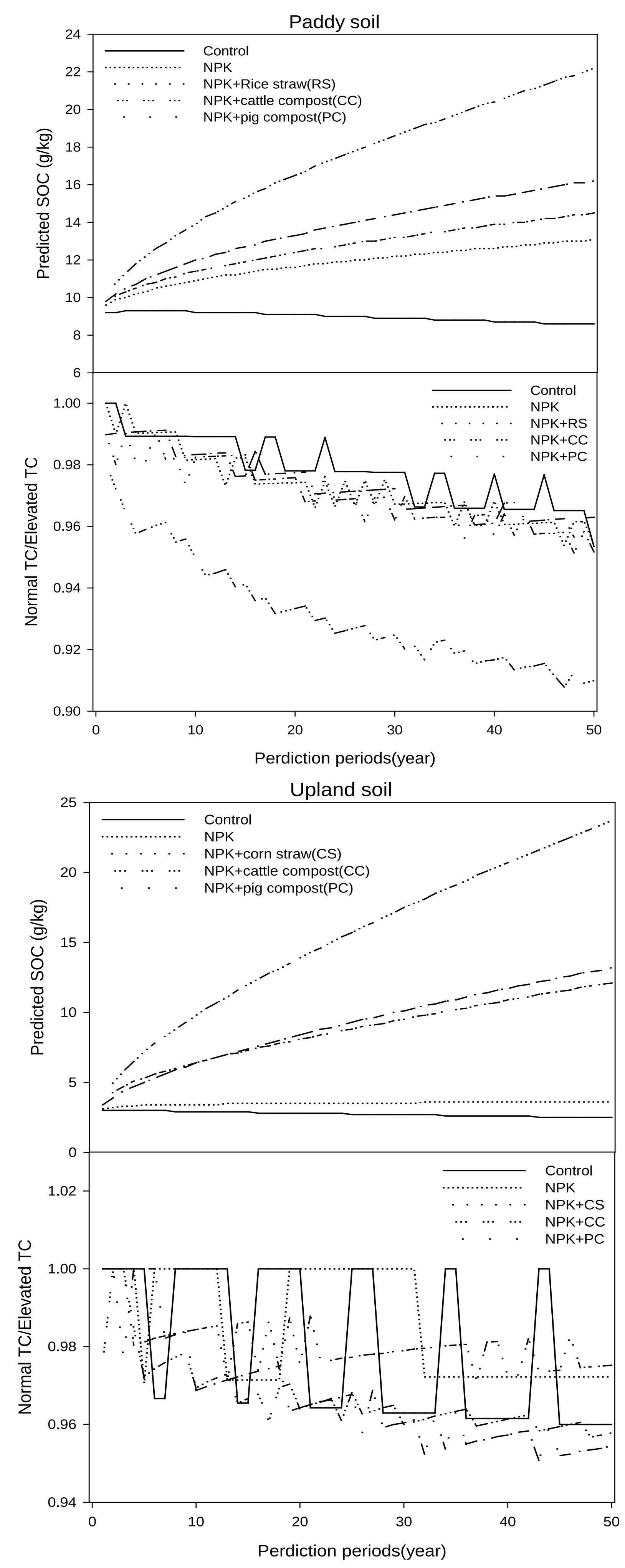

Fig 2: Prediction of carbon concentration in soil applied with organic matter with DNDC model under global warming scenario

CONCLUSION

These results indicate the necessity of managing for soil organic carbon in agricultural soils under climate changes. We need efforts to find the best soil management technique for conservation of soil organic carbon considering its role in food sustainability and mitigation of global warming in agricultural soils in the future.

ARABLE	CLIMATIC FACTOR	SOIL INFORMATION	CROP MANAGEMENT
PADDY	- Temperature(Jeonju) · Max, Min Temp. · Precipitation Others: default	- Soil texture: Laom - Bulk density: 1.4(g/cm3) - pH: 6.9 - SOC:0.009(kg C/kg) - Others: default	- Crop: Rice - Inorganic N: 90 kg/ha(2 split) - C & N input of OM(kg/ha) · Rice straw: 2,160, 31(C/N: 69.2) · Cattle compost: 3,072, 128(C/N: 23.9) · Pig compost: 927, 60(C/N: 15.4) - Others: default
UPLOAD	- Temperature(Jeonju) · Max, Min Temp. · Precipitation Others: default	- Soil texture: Sandy loam - Bulk density: 1.4(g/cm3) - pH: 6.0 - SOC: 0.0028(kg C/kg) - Others: default	- Crop: Corn - Inorganic N: 132 kg/ha(2 split) - 유C & N input of OM(kg/ha) · Corn residue: 5,122, 72(C/N: 70.7) · Cattle compost: 5,120, 214(C/N: 23.9) · Pig compost: 1544, 100(C/N: 15.4) - Others: default