POSTER 19

Comparison of Net Carbon Budget Between Barley-Rice Double Cropping Paddy and Rice Mono Paddy

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I. Introduction

The concentration of carbon dioxide (CO_2) in the atmosphere is influenced by field management, and the information regarding the potential of agricultural ecosystem to act as sink or sources of carbon dioxide is important for the mitigation and adaptation to climate change. Ecosystem scale observations of net carbon budget between barley-rice double cropping paddy and rice mono cropping paddy is useful to understand the role of photosynthesis and respiration and it can develop the sustainable forms of field management. The eddy covariance method is widely considered as the standard micro-meteorological method to monitor fluxes of CO_2, water vapour, and heat. The objectives of this study were to estimate and compare net carbon budget between rice-barley double cropping and rice mono cropping system using eddy covariance technique and methane chamber.

II. Materials and Methods

2.1. Site description

A long–term field experiment was set up in 2012 at rice-barley double cropping paddies and rice mono cropping paddies (35.44°N, 126.51°E) in Gimje of South Korea. The instrument fetches ranged from 150m to 300m (rice-barley double cropping paddies) and fetches from 600 m to 900 m (rice mono cropping paddies). Soils are classified as silt loam based on the USDA soil texture triangle. Soil organic matters were 32.2 g C kg^{-1} and the pH was 5.8 at harvesting dates for rice.

2.2. CO_2 and CH_4 flux measurements

The carbon budgets of the rice paddies were assessed by measuring all import and export fluxes from and to the field. The carbon budget is quantified to subtract Ecosystem Respiration (Re) and methane emission rate from Gross Primary Production (GPP). The Net ecosystem exchange (NEE)

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of CO_2 was measured with the eddy-covariance method and GPP and Re was estimated by an ecosystem model from NEE. The eddy covariance fluxes of CO_2 was assessed following the FLUXNET standardized methodology (Aubinet *et al*., 2009). The CH_4 fluxes were measured using a closed chamber method. CH_4 concentrations were measured 8 times a day using a gas chromatography with a flame ionization detector (GC-FID, IGC-7200 Donam Inc., Korea).

III. Results

3.1. CO_2 flux

Distinctly different seasonal variations in daily GPP, Re, and NEE can be seen between the two different rice cropping system (rice mono, barley-rice double). In the barley-rice double cropping paddies, the daily GPP of barely growing season was very low until winter-rest stage, and then it started to increase and reached at the maximum of 11.8 g C m^{-2} d^{-1}. Since then it declined untill the harvest time. The Re was higher than GPP during the early vegetative stage because the barley seedlings were still small. The Re started to increase continuously until anthesis date, and then showed a decrease in maturing stage. After transplanting time of rice, the daily GPP was very low during rooting stage and it increase and reached at the maximum of 13.2 g C m^{-2} d^{-1} at anthesis time of rice and then it declined until the harvest time. The Re was higher than GPP during the rooting stage, and then it started to increase and reached at maximum of 5.7 g C m^{-2} d^{-1} at anthesis date. The seasonal trend of daily GPP and NEE was similar at barley-rice double cropping paddy and rice mono cropping paddy during the rice growing season. After rice transplanting, the daily GPP was very low during rooting stage, and then it started to increase and reached the maximum of 13.2 g C m^{-2} d^{-1} at anthesis date. Then it declined until harvest time. Ratoon started growing immediately after harvest, which resulted in a GPP greater 1.5 g C m^{-2} d^{-1} until the paddy field was plowed (Fig. 2).

3.2. CH_4 emission rate

Seasonal changes of CH_4 emission rate during the rice growing season differed between the two different rice cropping system (rice mono, barley-rice double). Seasonal variation of CH_4 emission rate generally showed one peak in each rice growing stage and gradually decreased to the end of the growing season. The rice mono cropping paddy showed the highest CH_4 emission peaks at elongation stage, while the rice-barley double cropping paddy observed at tillering stage. The maximum CH_4 emission rates of rice mono and rice-barley double cropping paddy were 48.5, 64.8 mg CH_4 m^{-2} h^{-1}, respectively. And, the cumulative CH_4 emission rates of rice mono and rice-barley double cropping paddy were 16.7, 17.5 g C m^{-2}, respectively.

3.3. Net carbon budget

The total net carbon budget of both barely-rice double cropping and rice mono cropping paddies integrated from 2012 to 2013 (Table 1 and 2). Photosynthetic CO_2 uptake (GPP) stands exceeded CO_2 losses (Re) from respiration leading to cumulative NEP (net ecosystem production) of 449.1 g C m^{-2} during barley and rice growing season. When methane emission rate (-16.5g C m^{-2}) was considered, the carbon budget was total 432.6 g C m^{-2} at barely-rice double cropping paddies On the other hands, the cumulative NEP was estimated as 584.0g C m^{-2} during the rice growing season and -197.5 g C m^{-2} during the fallow season, respectively. Methane emission rate was estimated as 16.7 g C m^{-2}, thus the net carbon budget was total 369.8 g C m^{-2} in rice mono cropping paddies. As a result, this short-term data showed significant differences in carbon budget between barley-rice double cropping and rice mono cropping paddies.

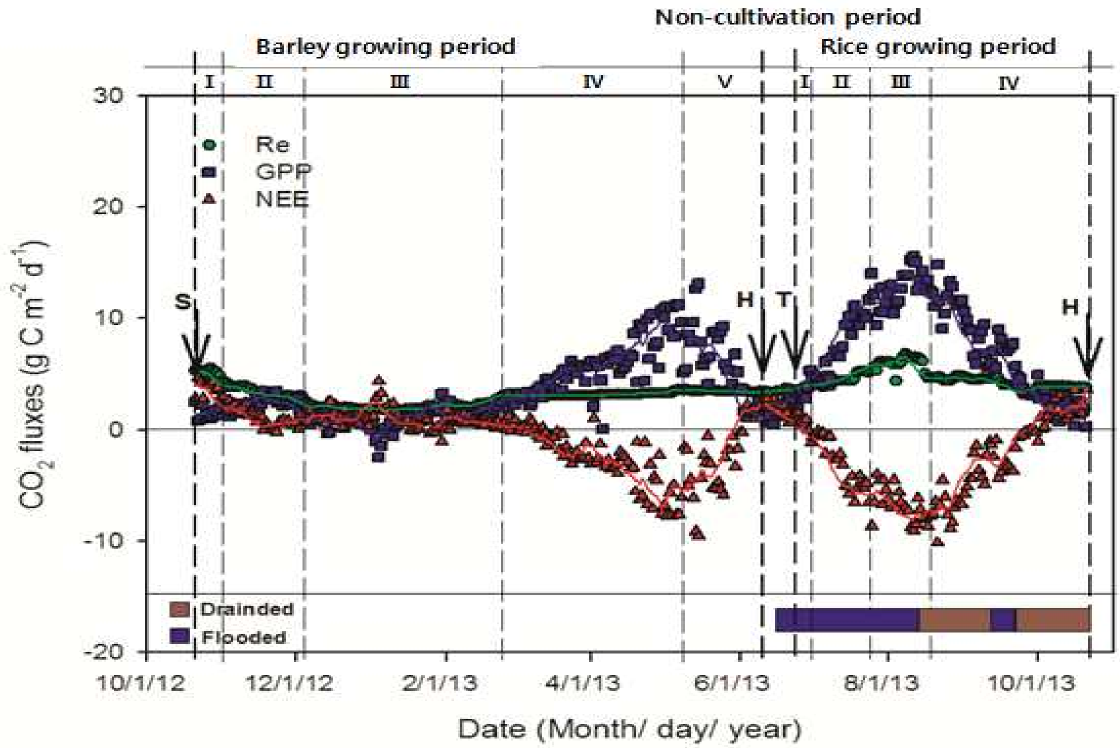

Fig. 1. Seasonal variation in daily GPP, Re, and NEE in rice-barley double cropping paddies. Solid lines are 7 days running mean values.

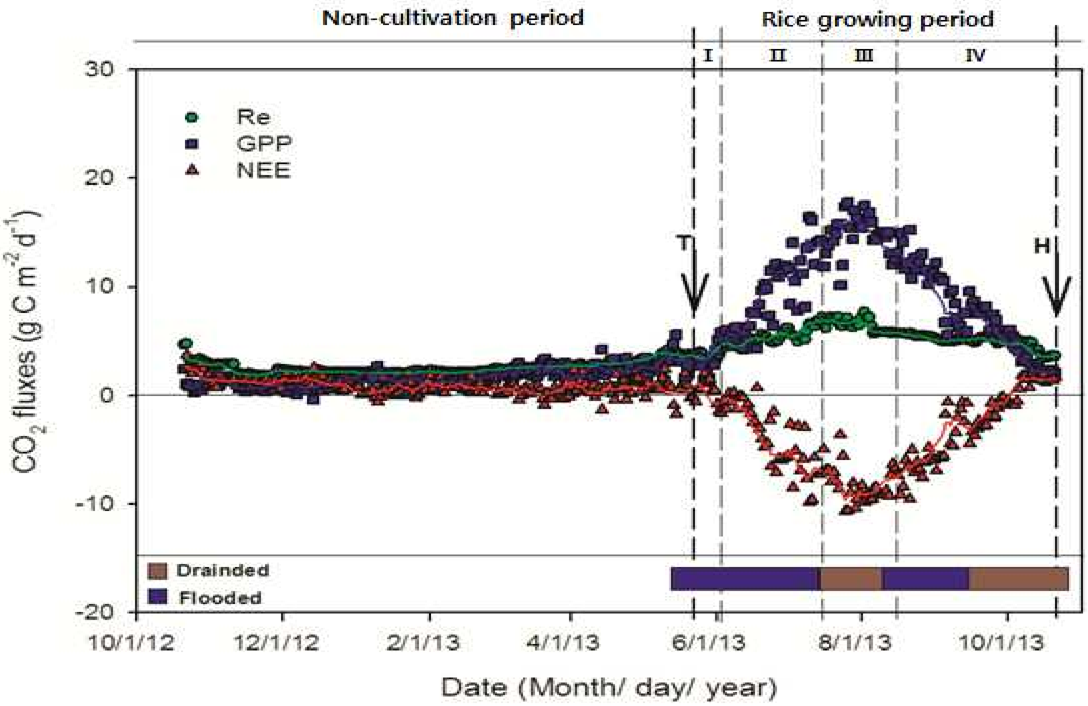

Fig. 2. Seasonal variation in daily GPP, Re, and NEE in rice mono cropping paddies. Solid lines are 7 days running mean values.

Table 1. Carbon budget (g C m^{-2}) of each cultivation period in barley-rice double cropping paddy field

		Barley	Rice	Fallow	Total
Gain	GPP	782.7	931.2	16.6	1730.5
Loss	Re	682.5	557.1	41.2	1280.8
	CH_4	0.2	15.9	1.4	17.5
	NEP = - NEE(= GPP - Re)	100.2	374.1	-24.6	449.1
	CO_2 + CH_4 (= GPP - Re - CH_4)	100.4	358.2	-26.0	432.6

Table 2. Carbon budget(g C m^{-2})of each cultivation period in rice mono paddy field

		Rice	Fallow	Total
Gain	GPP	1385.3	361.1	1746.4
Loss	Re	801.3	558.6	1359.9
	CH_4	14.1	2.6	16.7
	NEP = −NEE (= GPP − Re)	584.0	-197.5	386.5
	CO_2 + CH_4 (= GPP − Re − CH_4)	69.9	-200.1	369.8

* Net ecosystem production (NEP), Gross primary production (GPP), Ecosystem respiration (Re).

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