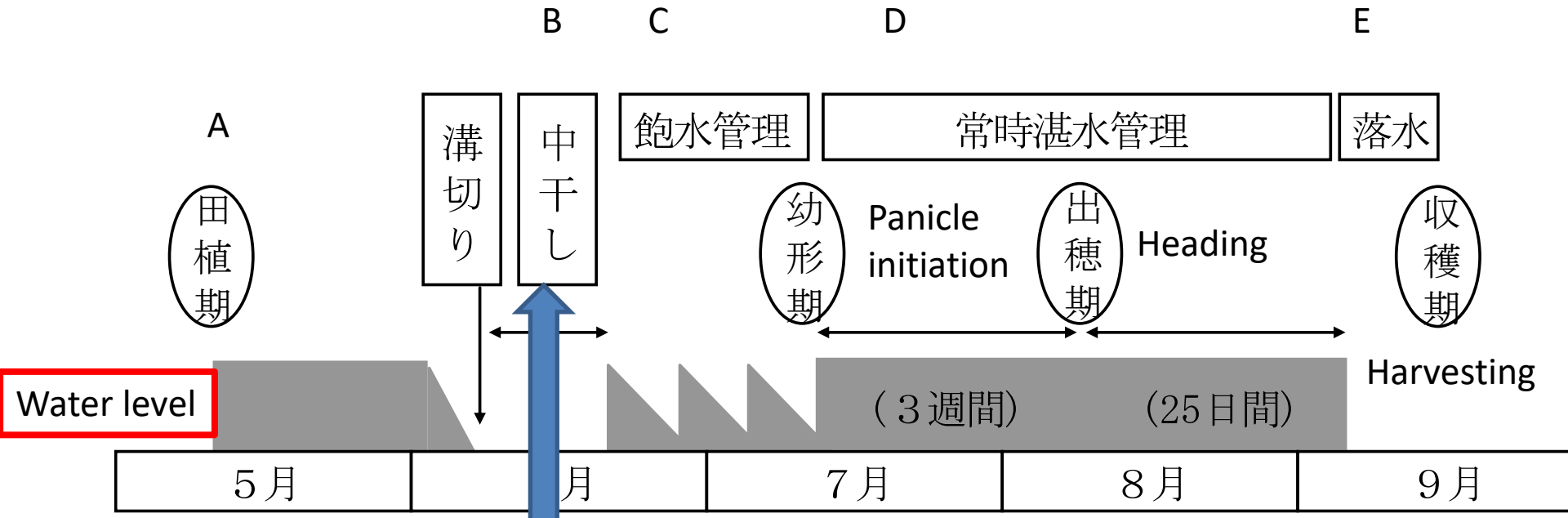
January 13th, 2023
India-Japan EW:

Negative emission technology for carbon dioxide in agricultural fields

Institute for Agro-Environmental Sciences, NARO

Typical rice paddy water management in Japan



A. Transplanting

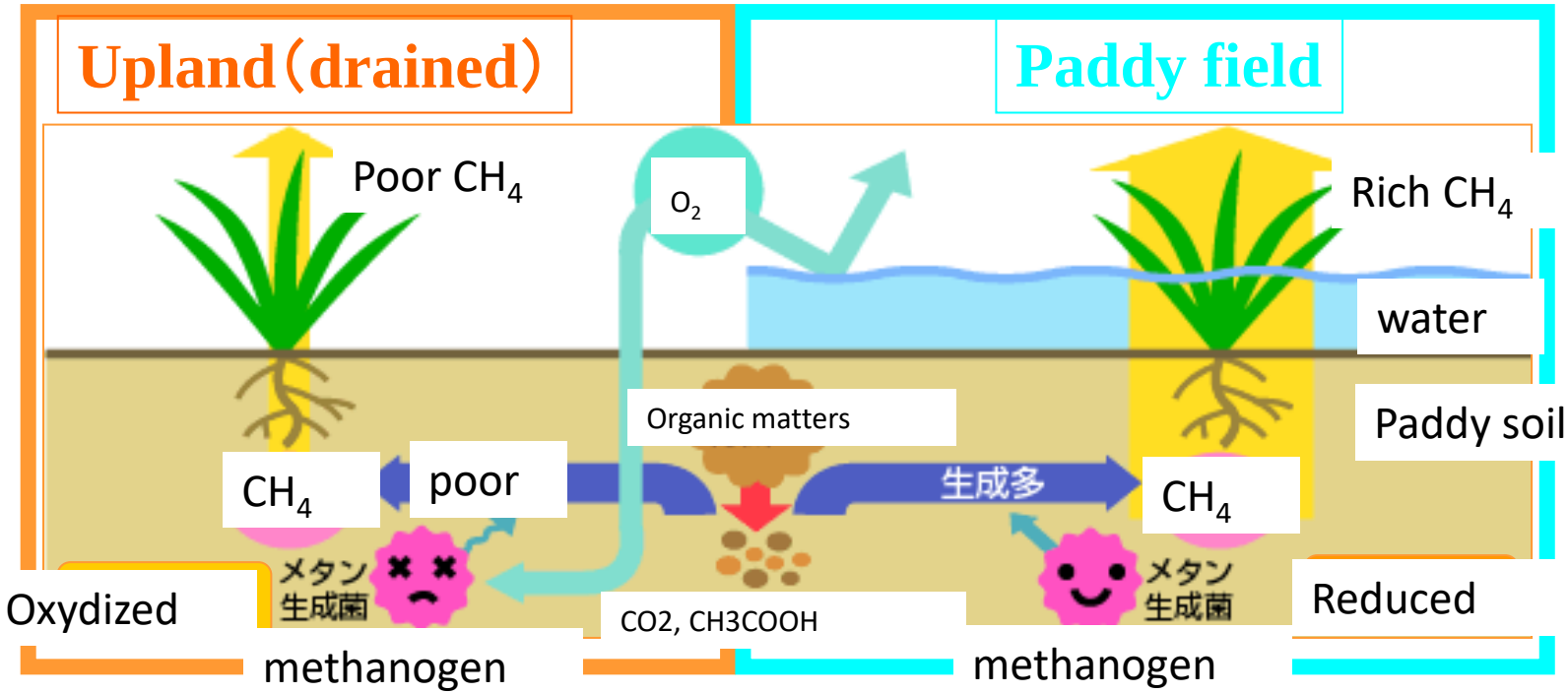
B. Mid-season drainage(MD)

C. Saturated water management

D. Flooded

E. Final drainage

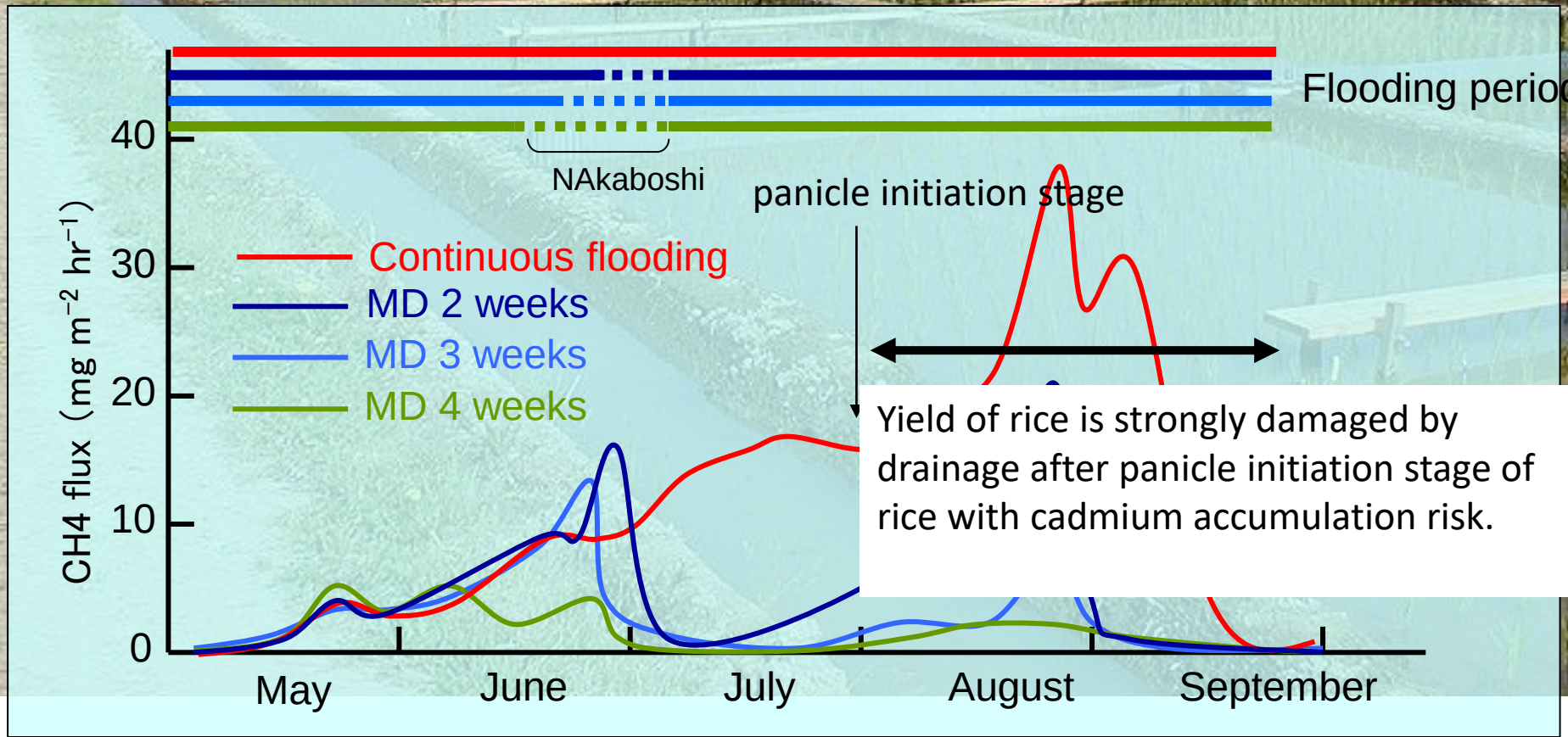
Mechanisms of CH4 emission from rice paddy field



- CH_4 in paddy soil is emanated by the activities of anaerobic bacteria which is called methanogen. CH4 is produced by reduction of CO_2 or decomposition of acetic acid
- It is effective to control methane emission from rice paddy that period is prolonged on intermittent irrigation drainage, composted rice straw is incorporated as fertilizer instead of flesh one, or other.

Reduction of CH_4 emission by prolonged MD (mid-season-drainage) period; Fukushima Prefectural Agricultural Center in 2004.

●CH4 emission in paddy field is able to reduce prolonged 'Nakaboshi' treatments.



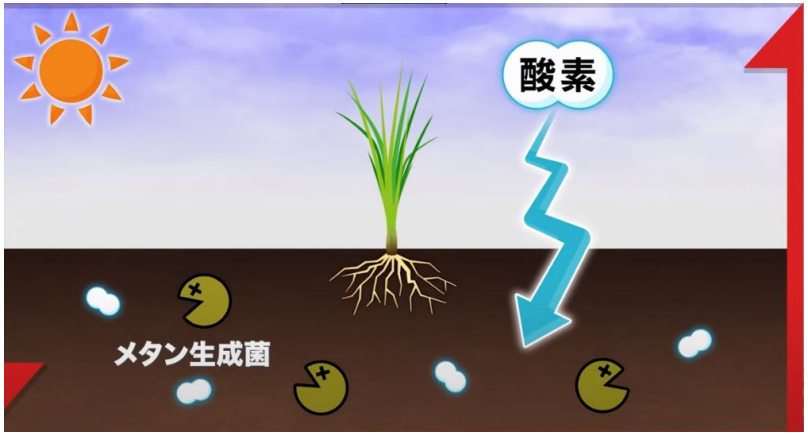
Yield of rice is strongly damaged by drainage after panicle initiation stage of rice with cadmium accumulation risk.

Technologies for reducing greenhouse gases emitted from farmland

Methane (CH4) emissions can be reduced by approximately 30% by extending the mid-season drainage period of paddy fields by one week compared to conventional water management.

Average amount of methane generated in conventional paddy fields = 200 kg ha^{-1}
(CO_2equivalent to 5.0 t/ha)

Methane reduction effect by midseason drainage water management＝2.0 t/ha
Equivalent to CO2 emissions from one car for one year



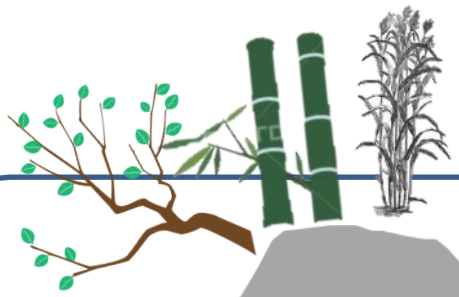
Mitigation of methane emissions from paddy fields by prolonging midseason drainage, Masayuki Itoh, Shigeto Sudo, Shizuka Mori, Hiroshi Saito, Takahiro Yoshida, Yutaka Shiratori, Shinobu Suga, Nanako Yoshikawa, Yasufumi Suzue, Hiroyuki Mizukami, Toshiyuki Mochida, Kazuyuki Yagi, AGRICULTURE ECOSYSTEMS & ENVIRONMENT 141(3-4) 359-372(2011)

Direct payment subsidy for environment-conserving agriculture
(Ministry of Agriculture, Forestry and Fishery, Japan)

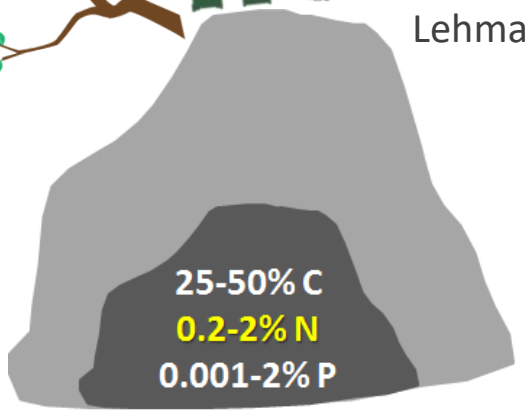
Subsidy conditions:
(1)The main crop is paddy rice.
(2)At least one ditch per 0.1 hectare should be cut during the middle stage of rice growth, followed by mid-drying for at least 14 days.

Sequestration of carbon by biochar

Biochar is one of charcoal. Its origin is biomass. Biochar is produced by low temperature(<300 ^{o}C) combustion of biomass under insufficient oxygen supply.



Lehmann J. & Joseph S. (2015)

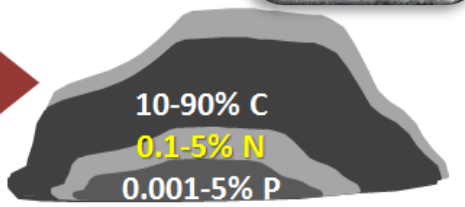


biomass

70 (25-75)%
Biomass loss

Pyrolysis
熱分解

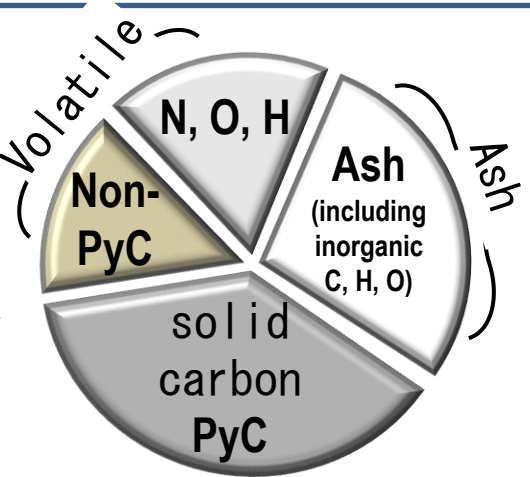
50 (10-60)% C loss
50 (0-80)% N loss
5 (0-43)% P loss

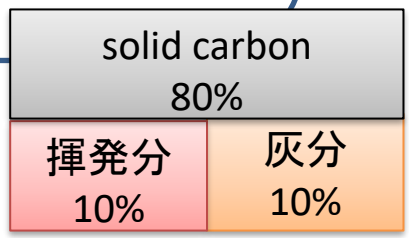


biochar

燃焼イメージ

analysis standard JIS8812





Biochar as carbon sequestration technology

○Biochar remains in the soil as persistent carbon for a long period of time (in units of 100 years)

○ Domestic CO_2 absorption potential of biochar is about 14 million t/yr in Japan which is equivalent to about 40% of total GHG emissions in the agricultural sector

Estimation of annual CO_2 sequestraton by applying biochar to farmland

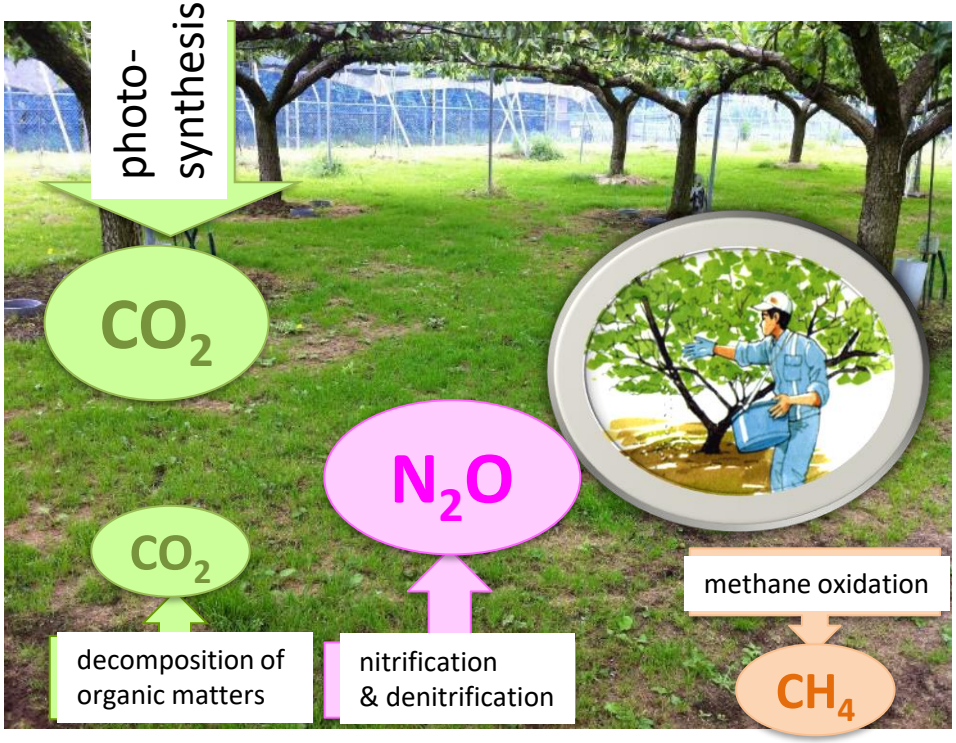
	Available biomass (Gg)	carbon content (%)	char carbon ratio	Carbon residual ratio after 100 yrs	CO_2sequestration (Gg)
wood	7500	40	0.77	0.89	7630
bamboo	2560	27	0.439		1130
rice straw	7510	50	0.49	0.65	4390
rice husk	2000	50	0.49	0.65	11700
total					**14,320**

CO_2Sequestration＝available biomass × carbon content × char carbon ratio × carbon residual ratio

- **Total CO2 emission in Japan（2020）＝1,150,000GgCO_2/yr**
- **GHG emission in agriculture（2020）＝ 30,000GgCO_2/yr （including CH_4＋N_2O)**

【GHG emission and sequestration in orchard】

GHG input and output in orchard

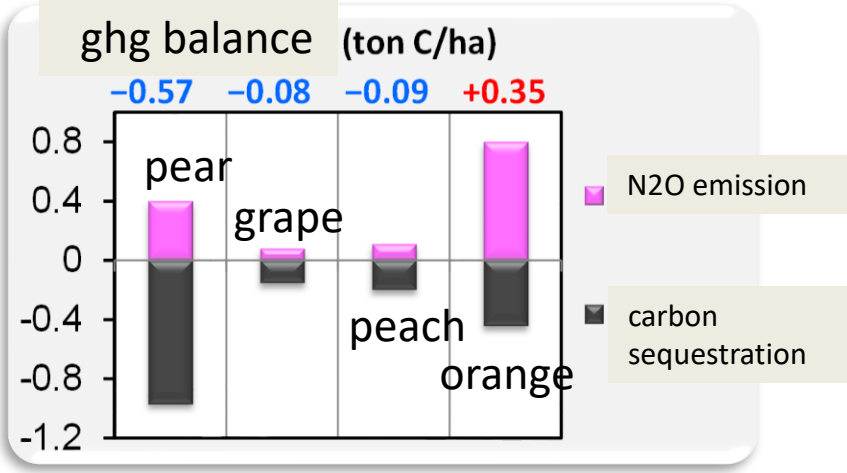


【GHG balance】

CH_4 absorption

N_2O emission (1% of applicated N fertilizer)

CO2 reduction by biochar application



Orchard field Biochar applicated orchard field can be carbon negative field.

rice stock warehouse in Japan

revolver type combustor

In Japan, rice husk is removed by machinery in warehouse. In some warehouse, rice husk is transported to revolver type combustor to make rice husk biochar.

biochar produce by rice crop residue

Yammer Company, Japan of agriculture machinery is now establishing bio-gas power generating system. This picture shows small scale test plant in Japan and Myanmar. The combustion source is rice husk and rice straw. By using this system, people remove rice crop residues to make electricity. The remaining residue after burning will be used as soil amendment.

Biochar involving rural carbon negative cycles

power gen. & carbonization

Eco Branding crops

harvest

agro-waste

biochar production in stock yard

utilization for fertilizer

power generation & biochar

crops, fruits, vege

livestock

biochar blended manure-chemical mixture fertilizer

ammonia

soil amendment

meat

egg

reduction of odder by biochar

・CCS (J-Credit)

・N2O reduction

pelletized manure

rural transportation

ペレット化

application of pelletized manure