Low carbon farming technology : rice field

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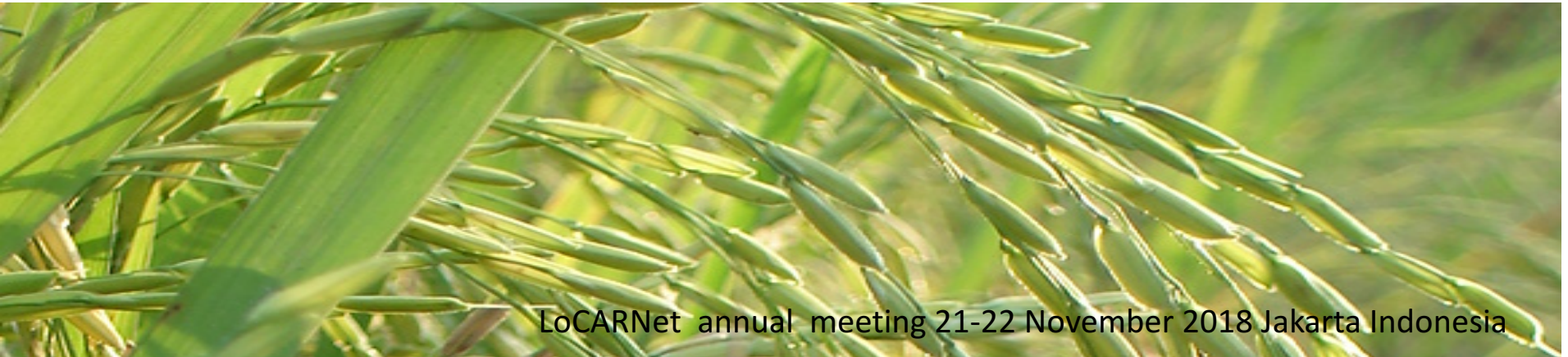
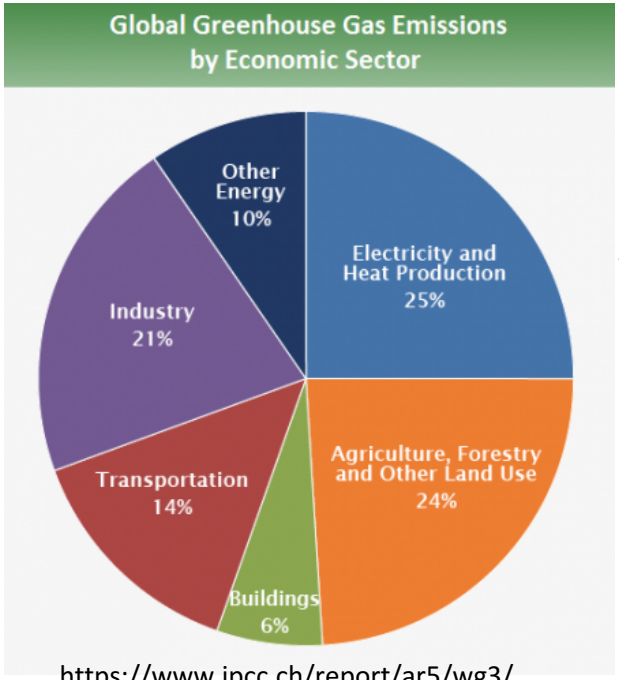


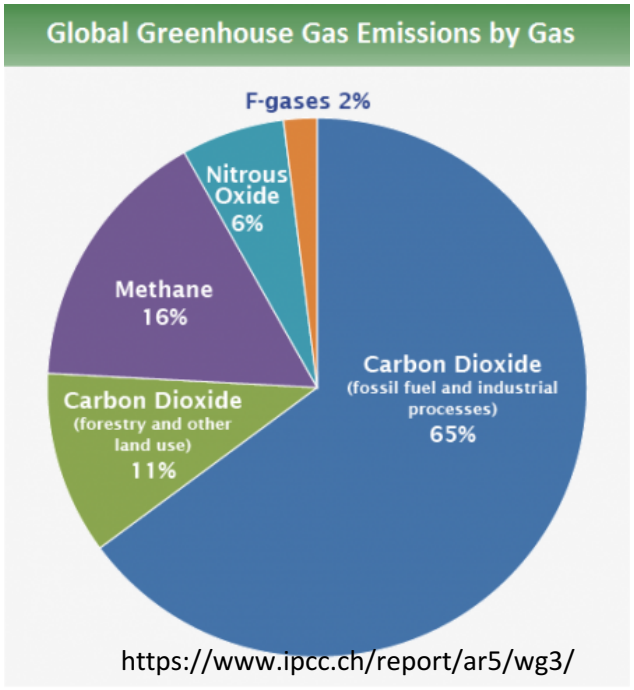
LoCARNet annual meeting 21-22 November 2018 Jakarta Indonesia



https://www.ipcc.ch/report/ar5/wg3/

Emission from Agriculture sector

24 % Agriculture
16% CH4
6% N2O



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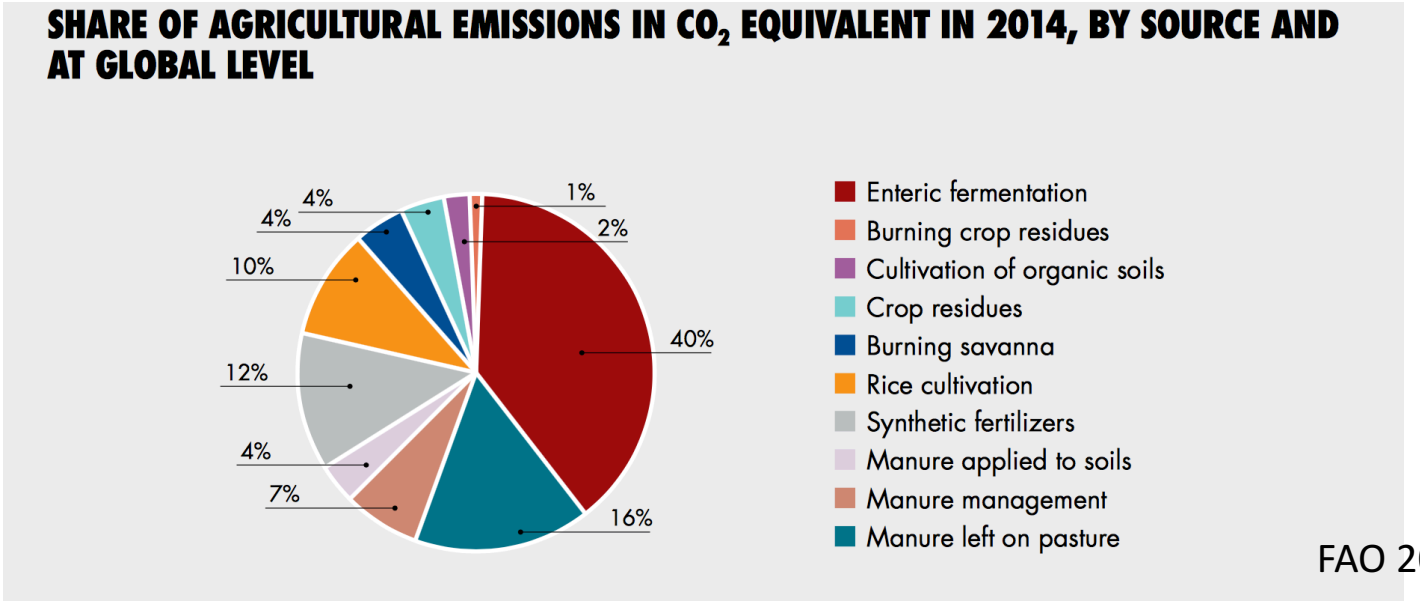
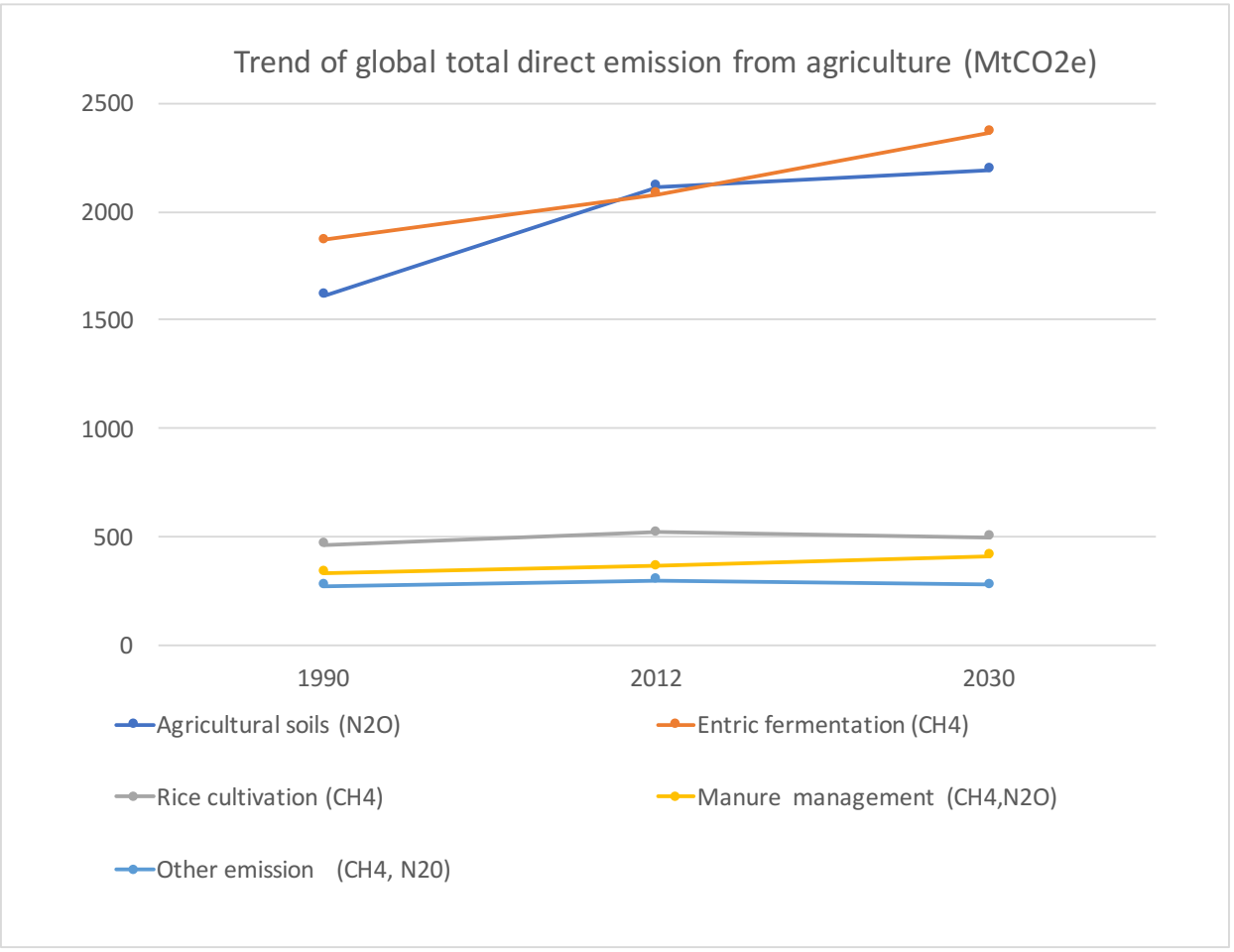


FAO 2016

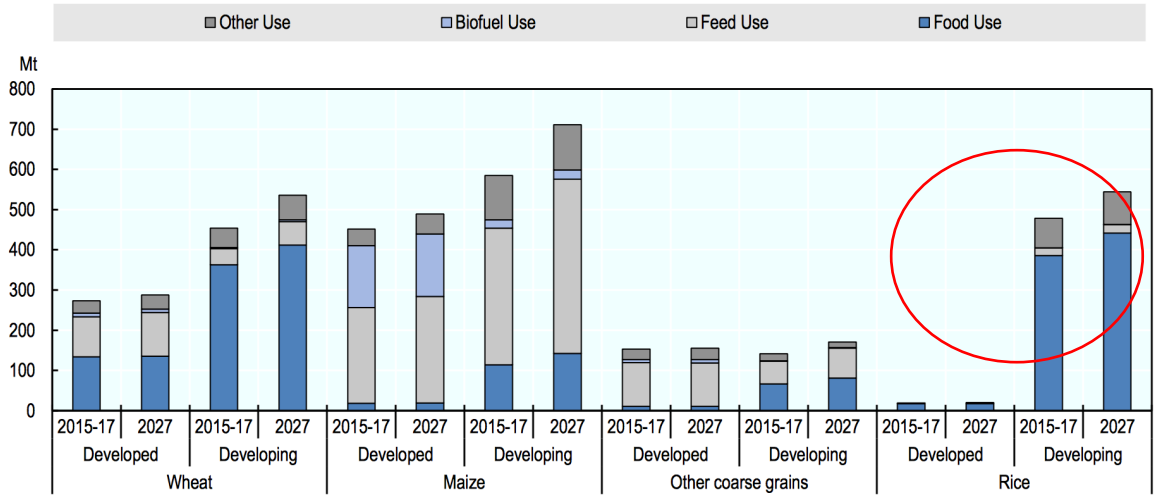
Projection of GHG emission Agricultural Sector



- Emission from agriculture is increasing
- Nitrous oxide from Soil

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

Cereal use in developed and developing countries



Source: OECD/FAO (2018), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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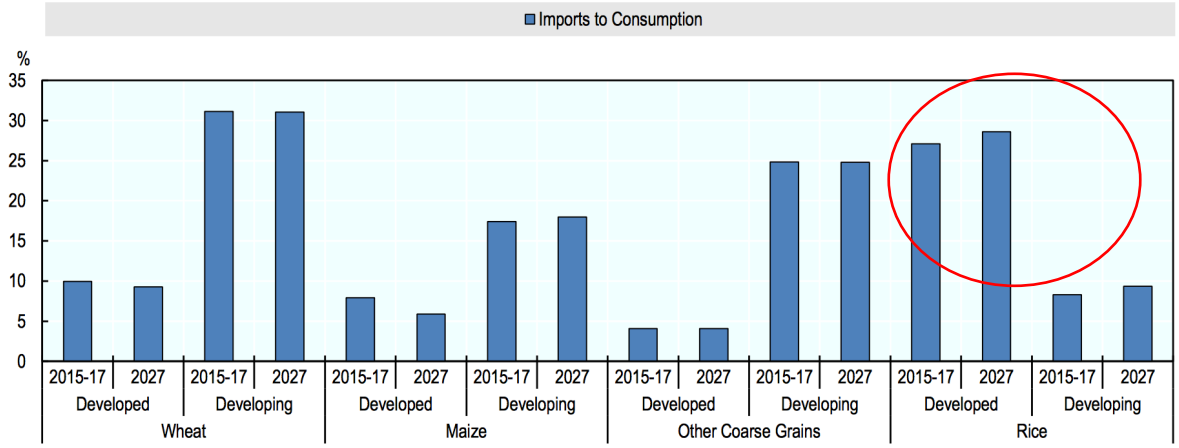
Trade as percentage of consumption



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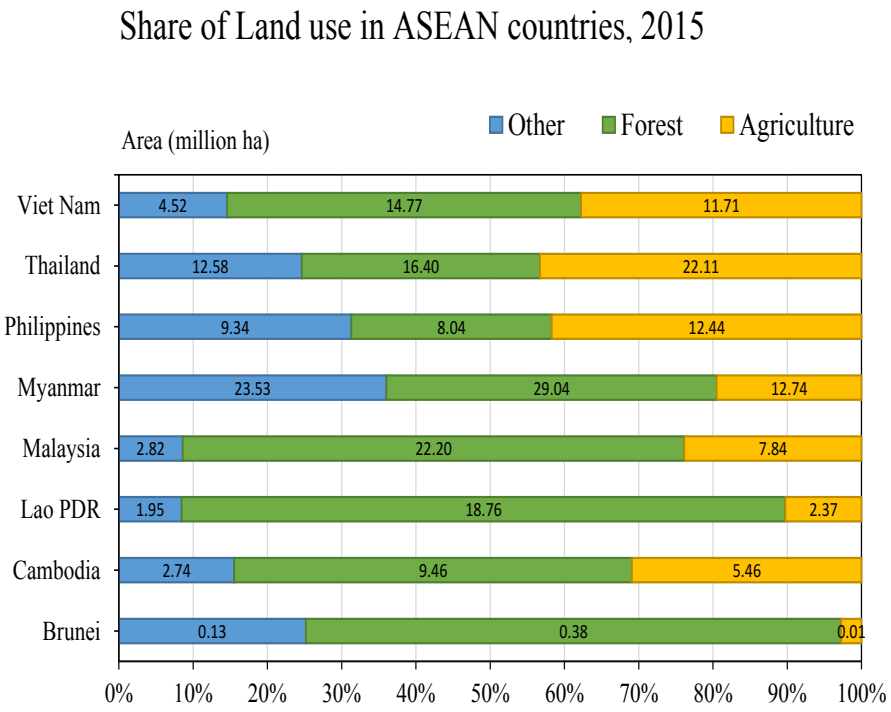
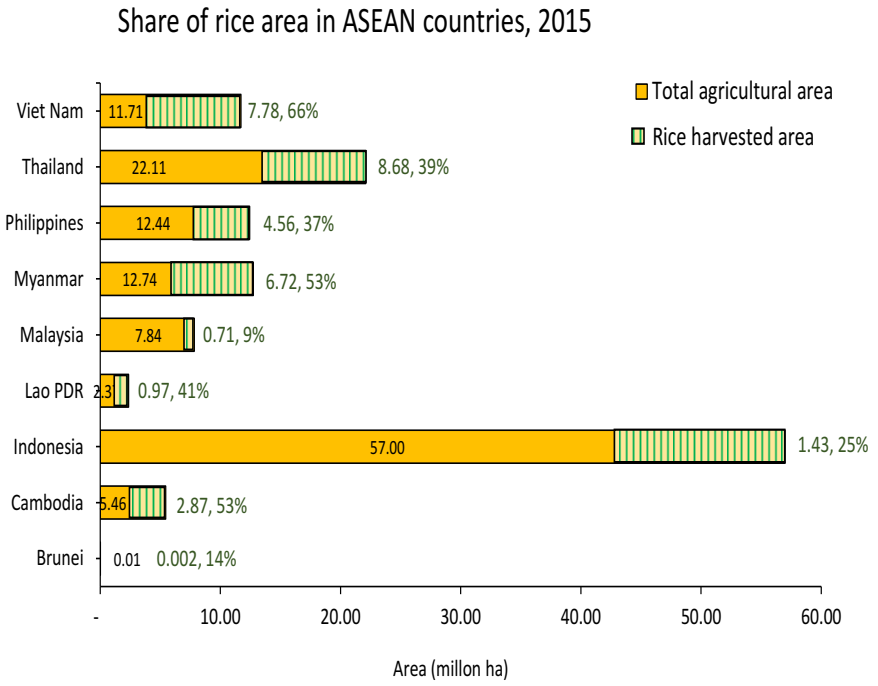
StatLink http://dx.doi.org/10.1787/888933742929

- Rice is used as food in developing countries but trade for consumption in developed country
- High share of rice area in agriculture in most SEAN countries
- Major source of emission in ASEAN countries

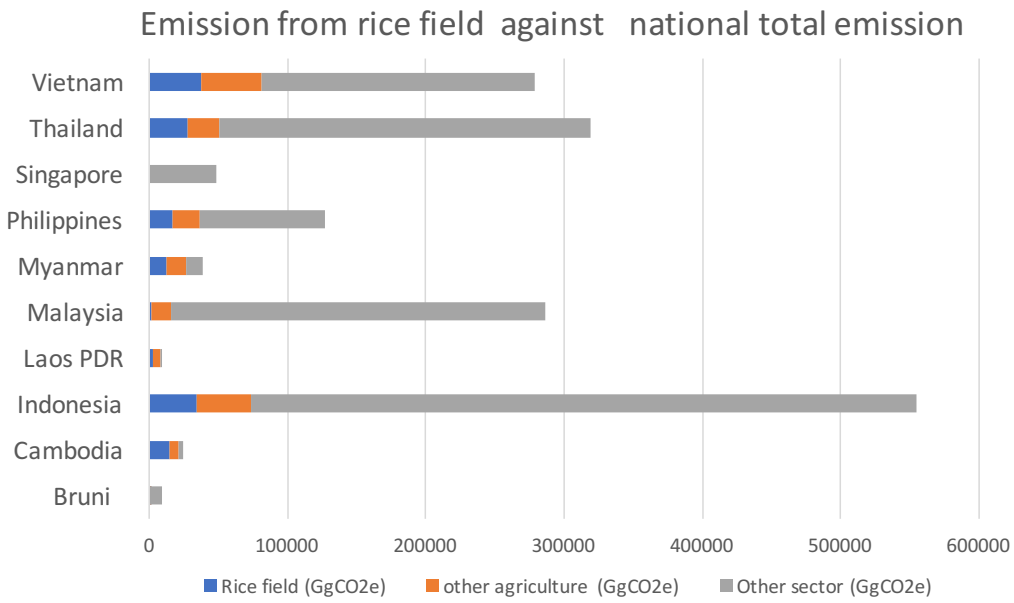
Agricultural land and rice area in SEA countries

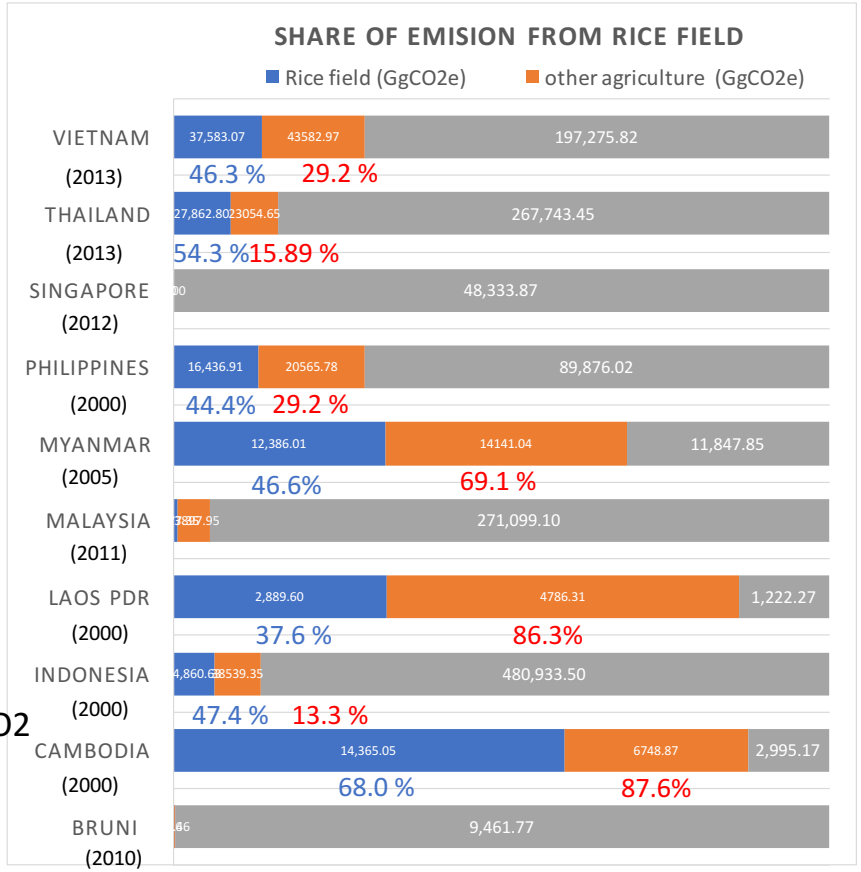




Derived from FAO by Cha-un and Chidthaisong 2018

Situation of GHG emission in SEA





-Total emission from rice field of SEA country approx. 150,000 GgCO2 eq

-Share of emission from rice field to national total =10.7 %

-Country with high emission from rice field ,Vietnam, Thailand, Indonesia cover 78% of emission from rice field in ASEAN country

Data from NC and BUR

Emission reduction targets of SEA countries (NDC)

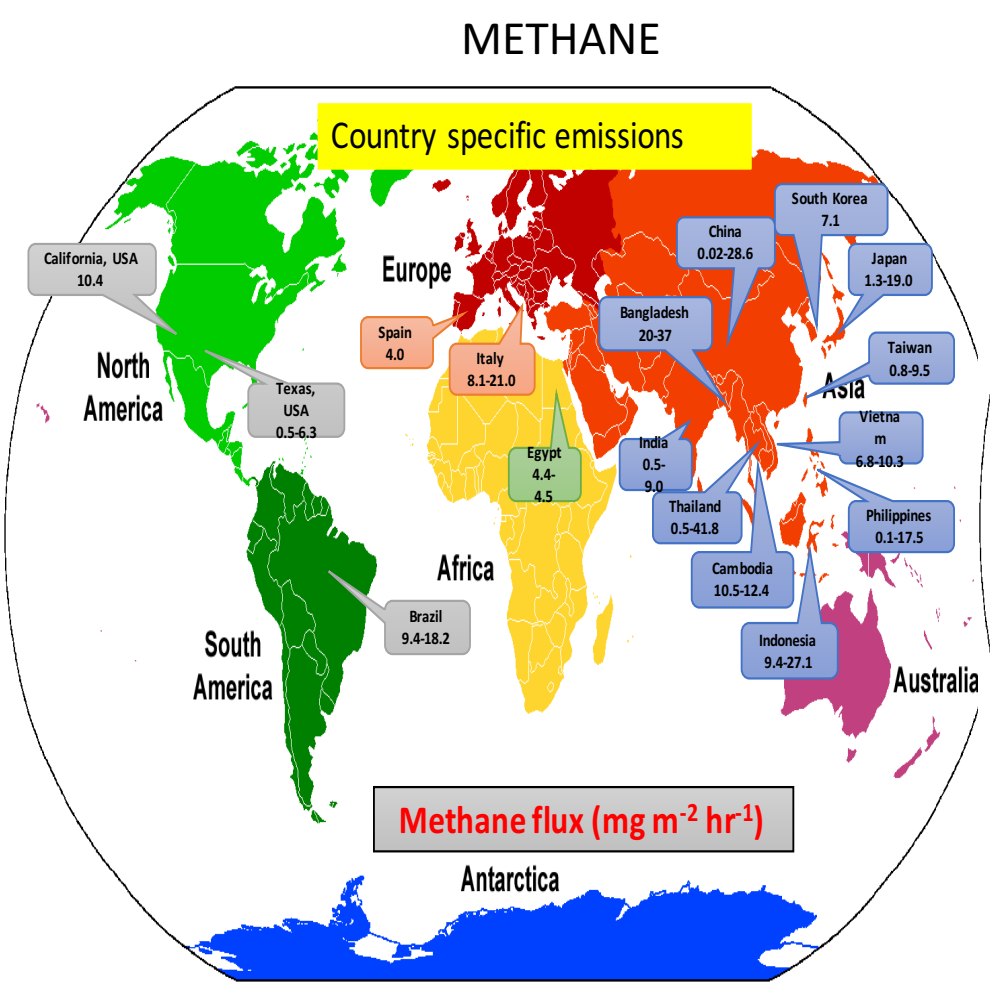
Country	Target (%)	Conditions
Indonesia	29-41	Reduction below BAU by 2030
Thailand	20-25	
Vietnam	8-25	
Philippines	67	BAU 2010-2030
Malaysia	35-45	GHG intensity below BAU by 2030
Singapore	30	Reduction below 2005 base year

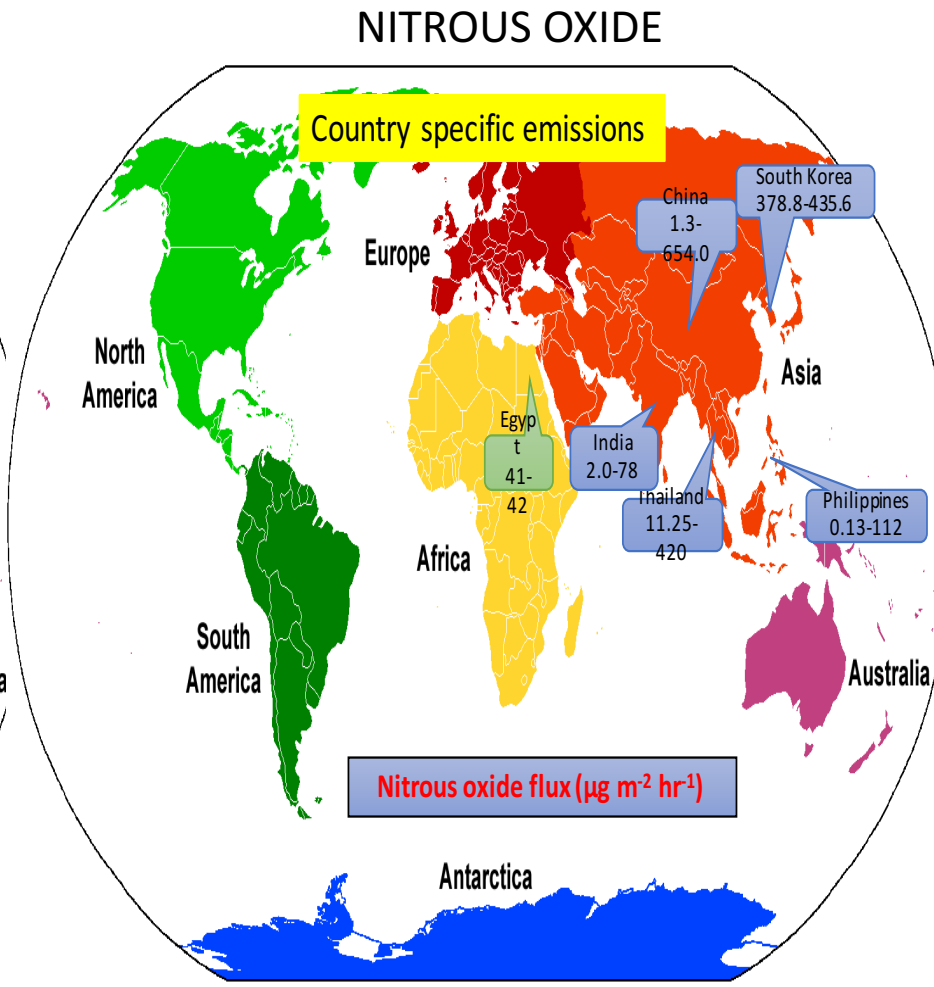
Vietnam:
-System of Rice Intensity (SRI) include reducing production input, (seed, fertilizer, pesticides, irrigation water) by 500,000 hectares and reduce 2 Mt CO_2eq/year

Indonesia:
-Low emission crop 926,000 hectares in 2030
- Water efficiency concept 820,000 hectares in 2030

Challenges

Global emission factor

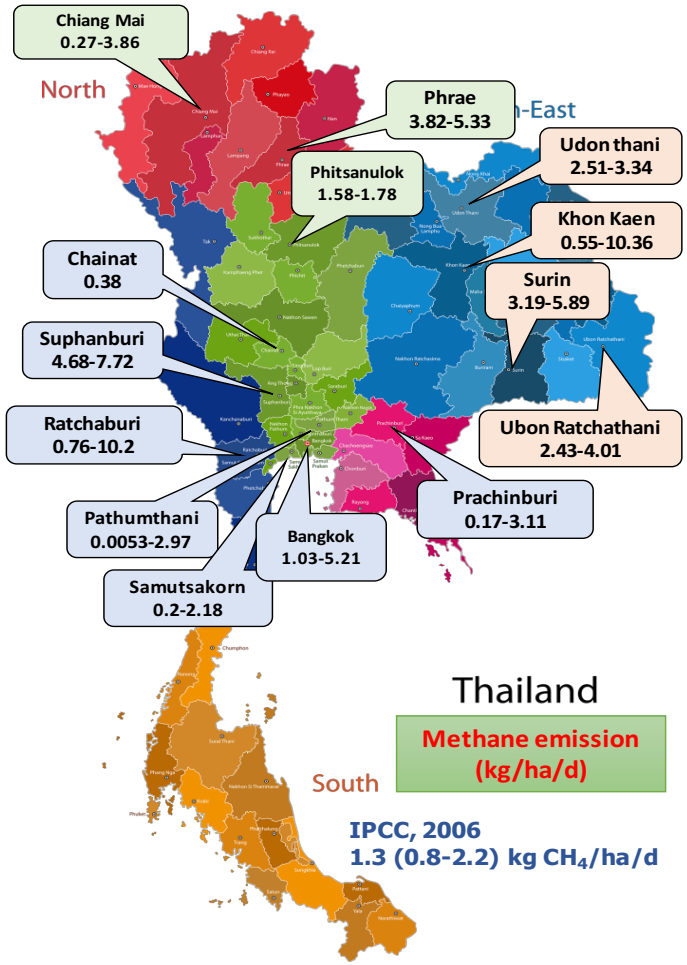


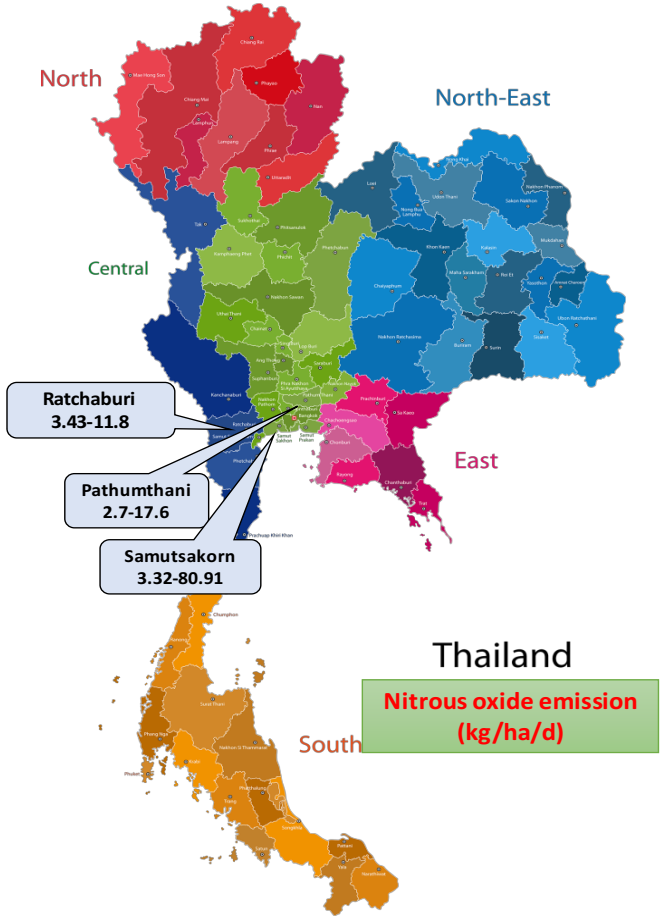


Broad range of emission

Challenges

Methane and nitrous oxide emission flux from field measure in Thailand





What is low carbon farming

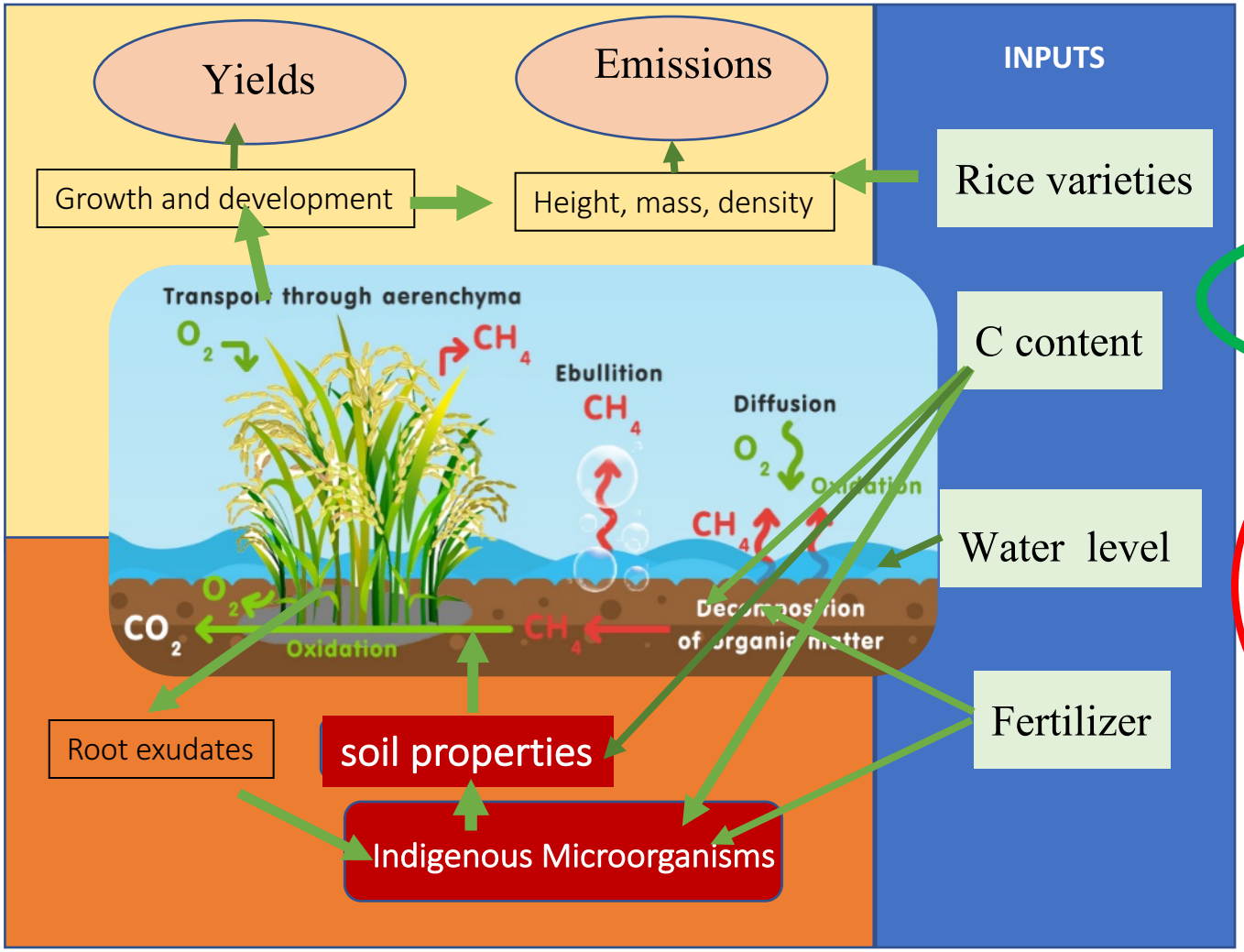
- Low carbon farming: use of farming methods or technology to reduce greenhouse gas emissions, and to capture/ hold carbon in plant and soils.

- Reduce GHG emission : no till cropping , nutrient sufficient application , water management

- Carbon capture in Soil : staw incorporation, biochar application, compost, cover crop

MECHANISMS

Low carbon technology



Rice plant

selected type

C -management

straw incorporate

crop rotation

biochar

Water management

multiple drainage

alternative wet and dry (AWD)

N- management

SO_4fertilizer

Tailor made

Integrated system

System rice intensify

AWD+biochar

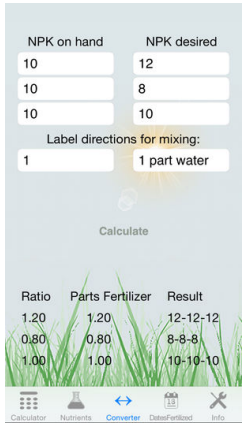
Low carbon farming technology in rice cultivation

N-management : Tailor-made fertilizer

Fertilizer application based on soil testing and "Tailor-made fertilizer"

- Right amounts of the right nutrient at the right time to the right crop at the right place.
- "**Tailor-made**" fertilization was comprised of four steps:
  1. Field identification of soil series
  2. Soil test kit analysis (pH, N, P, K) of field soil
  3. Fertilizer recommendations with computer-based decision-aids
  4. Farmer empowerment – people-centered development, interactive learning, farmer networking

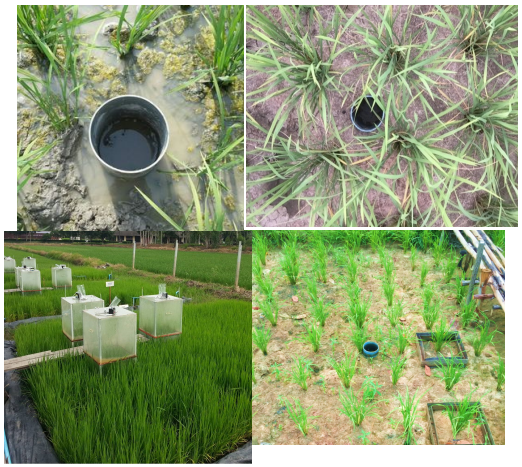
Crop year 2011	Tailor-made fertilizer technology	Farmer's practice
Rice yield (kg/ha)	6,006	4,950
Fertilizer cost (USD/ha)	75.4	124



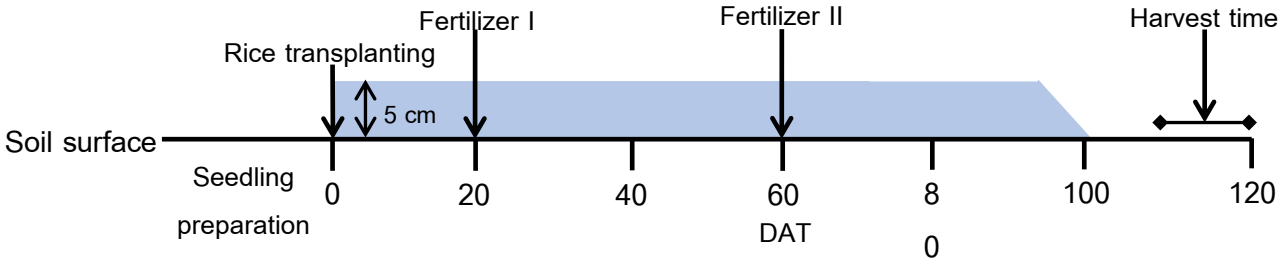
- Application of "Tailor-made fertilizer" can reduce fertilizer cost by 21%, and increase crop yield by 15% compared with farmer's practice (*Yost et al., 2013*).
- Applying tailor-made fertilizer in maize cultivation in Thailand can reduce GHG emission by 22% (*Khonpikul et al., 2017*)

Water management : alternative wet and dry

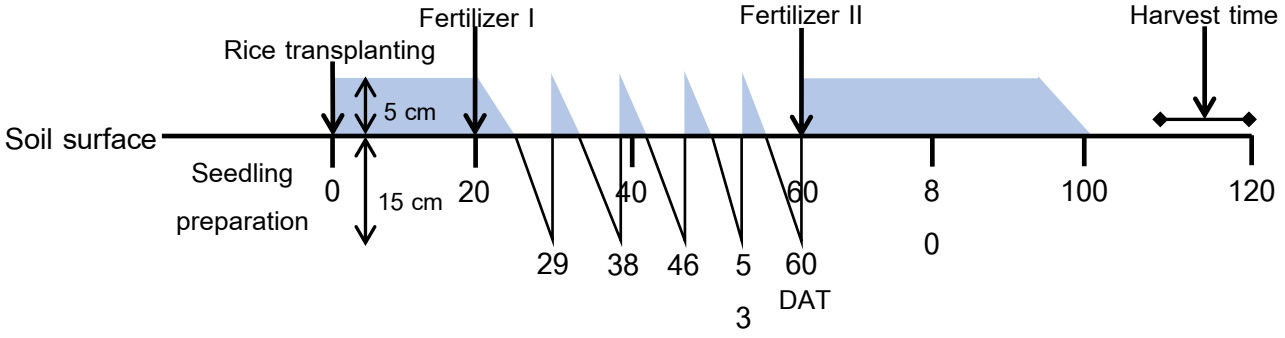
- AWD practice is allowing the water table to drop below the soil surface at one or multiple points during cultivation.
- AWD and other single- or multiple- drying practices have been used for several decades as water-saving practices.



Continuous Flooding (CF)

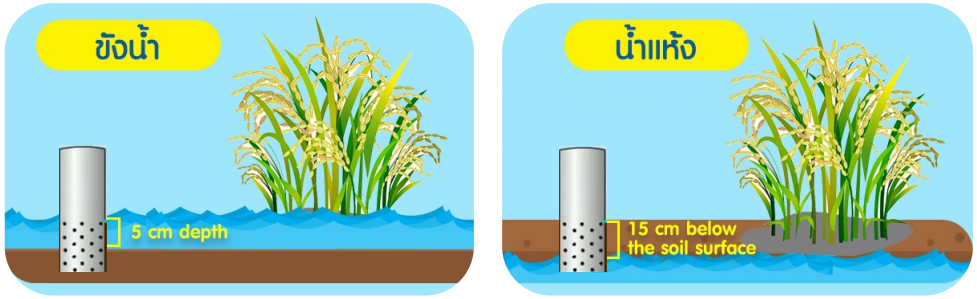


Alternate Wetting and Drying (AWD)

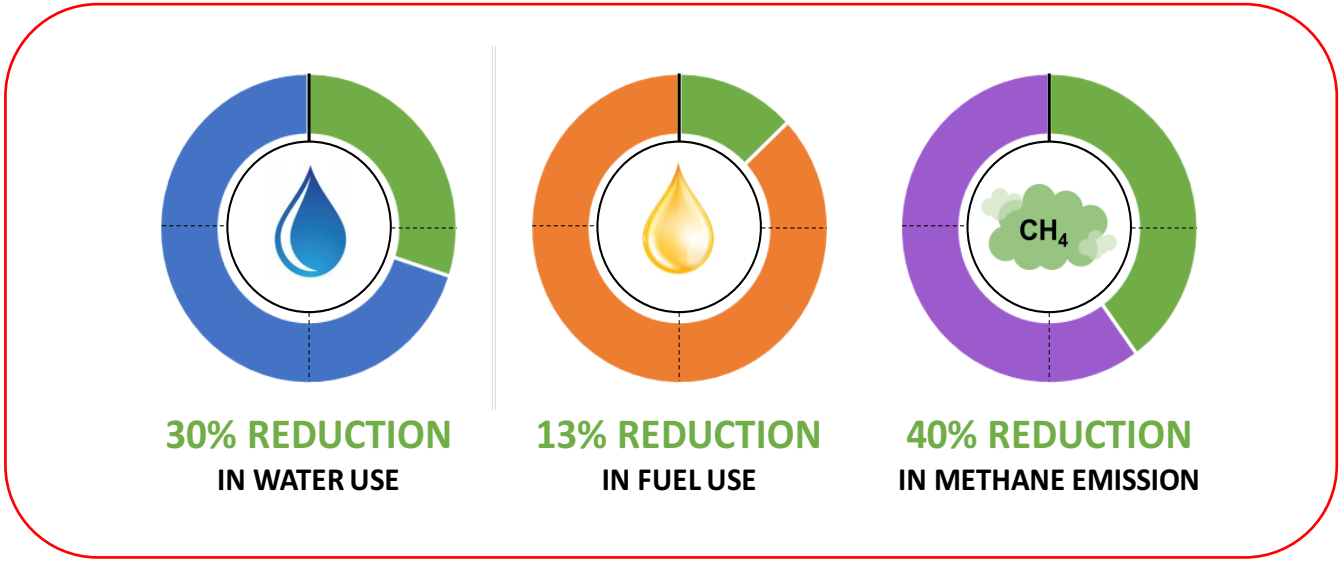


Salim, M. and Shehzad, F. D. (2008)

Water management : alternative wet and dry



- At present, AWD is widely accepted as the most promising practice for reducing GHG emissions from irrigated rice for its large methane reductions and multiple benefits.



Low carbon farming technology in rice cultivation

Water management : alternative wet and dry

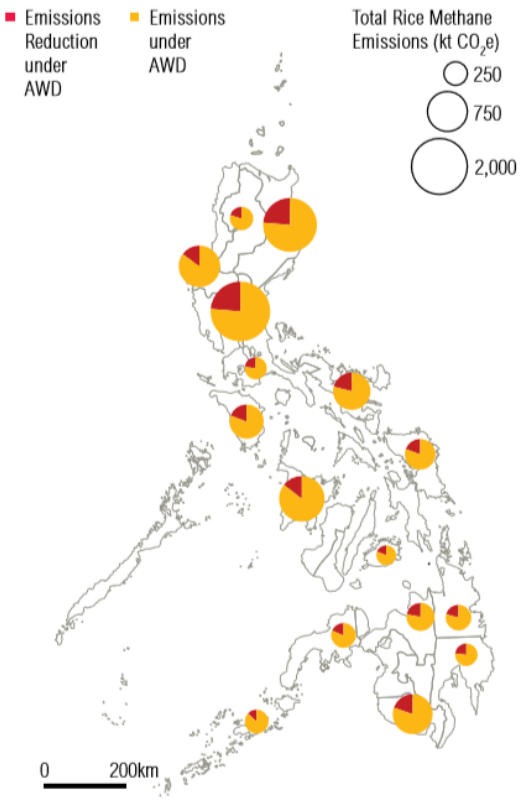
Country	CH_4 emission (%)	N_2O emission (%)	GWP (%)	Yield (%)	Water use reduction (%)	Ref.
Thailand	- 49.13	+ 24.71	- 25.67	- 6.89	- 41.99	Chidthaisong et al., 2018
	- 35.64	+ 3.58		- 10.80	-34.77%	Towprayoon et al., 2005
	- 10.52 to 26.20	+ 7.37 to 21.84	- 4.91 to 9.12	+ 1.59	- 4.16 to 10.31%	Sriphirom et al., 2017
Vietnam	- 67.14 to 71.30	+120.45 to 148.15	- 62.05 to 67.50	- 2.81 to 11.13		Paddy et al., 2014
	- 26	did not differ	- 26 to 29	+ 9.75 to 10.88	-14 to 15%	Tran et al., 2018

Country	CH_4 emission (%)	N_2O emission (%)	GWP (%)	Yield (%)	Water use reduction (%)	Ref.
Philippines	- 24.46 to 39.63	+ 64.38 to 118.75	- 9.64 to 13.21	- 0.23	- 42.79 to 51.51	Sibayan et al., 2018
					- 30	Richards and Sander, 2014
					- 42.8 to 53.7	Lampayan et al., 2014
Myanmar						
Cambodia	- 29 to 44					Ly et al., 2015
Indonesia	- 35 to 38	- 12.22 to 14.81	- 36.21 to 36.43	+ 1.56	- 5.50 to 7.37	Setyanto et al., 2018

AWD Research in ASEAN

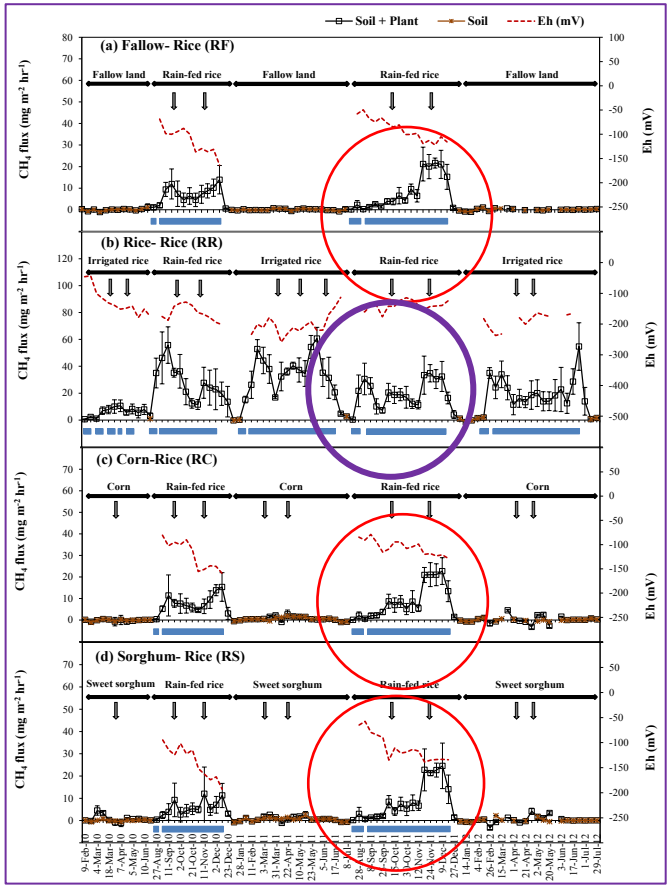
-Broad range of methane reduction by 20-60 %
-N_2O is increased
- Yield are varied

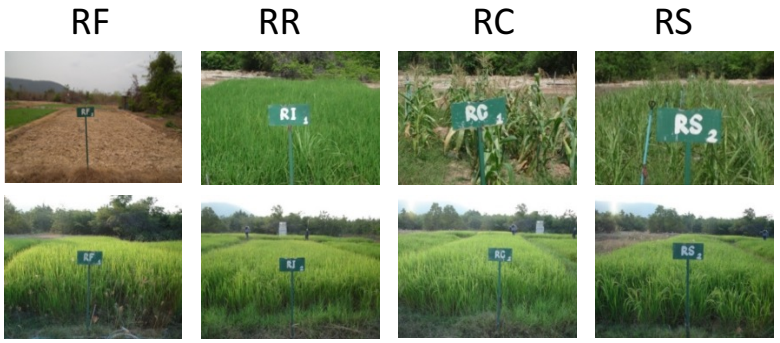
Application AWD in Philippines could reduce emission by 20 %



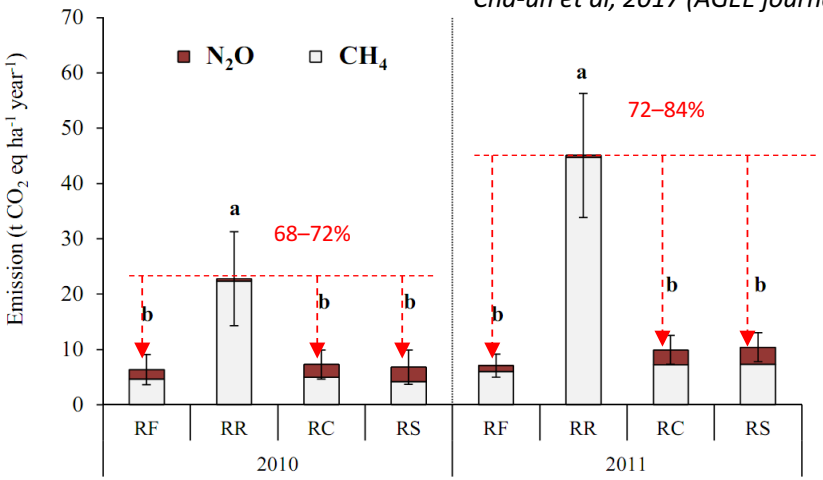
Low carbon farming technology in rice cultivation

Carbon Management : Crop rotation





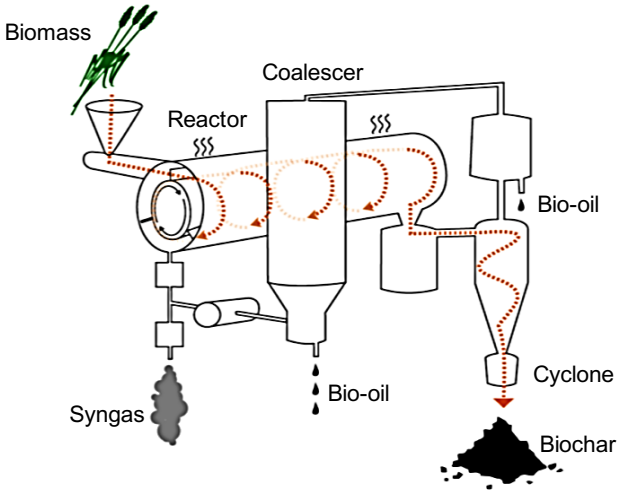
Cha-un et al, 2017 (AGEE journal, 2017)

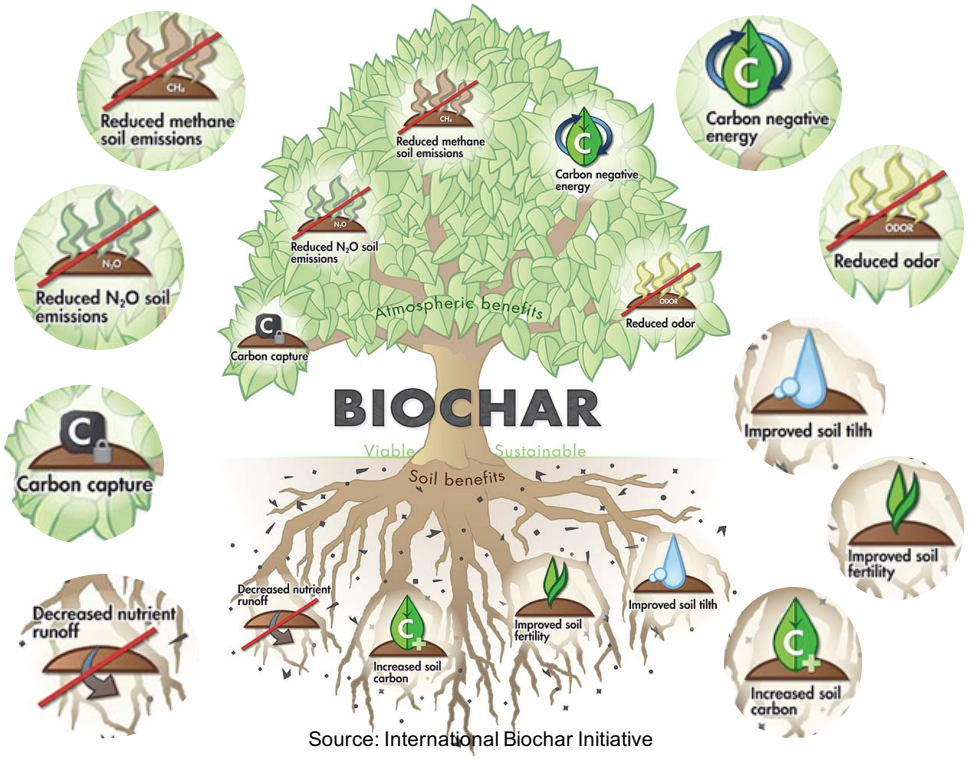


- **Crop rotation reduce CH4 from rice field in the next consecutive season by 40-45 %**
- **High reduction when compare to yearly double rice cultivation by 78-84 %**
- **N2O emission is high in rotation crop cultivation**

Carbon Management : Biochar application

- A stable solid material rich in carbon content that can effectively capture carbon and lock the carbon into the soil



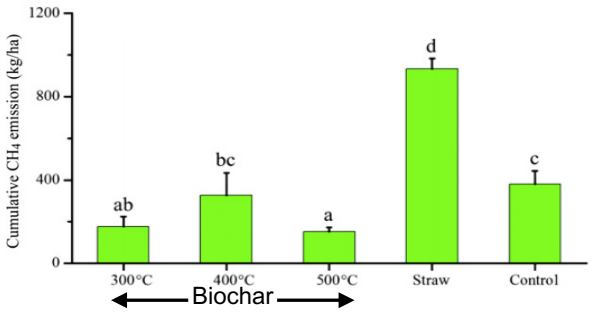


Source: International Biochar Initiative

Low carbon farming technology in rice cultivation

Carbon Management : Biochar application

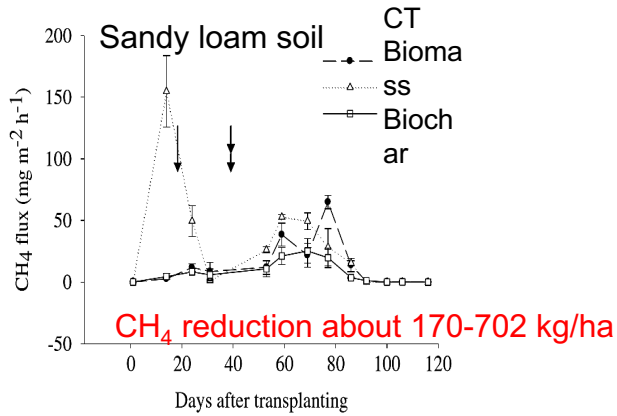
Country	CH_4 emission (%)	N_2O emission (%)	Yield (%)	Ref.
Thailand	- 15.38 to 46.15		+ 41.06 to 145.93	Thammasom et al., 2016
	- 10.30 to 42.48	- 7.89 to 31.79	+ 2.69 to 4.70	Sriphirom et al., 2017
Vietnam	- 41.77 to 56.19	- 14.10 to 30.93		Paddy et al., 2014
Philippines				
Myanmar				
Cambodia	- 56.04 to 62.22	+ 28 to 121		Ly et al., 2015
Indonesia				

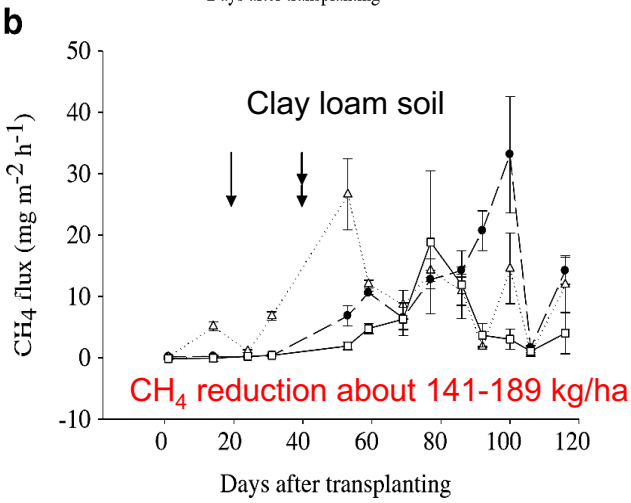


Reduced methane 10-60 %

N_2O both reduce and increase -7.8% to +121 %

Reduced CH_4 emission from China rice cultivation in several types of soils as compared to biomass and fertilizer application



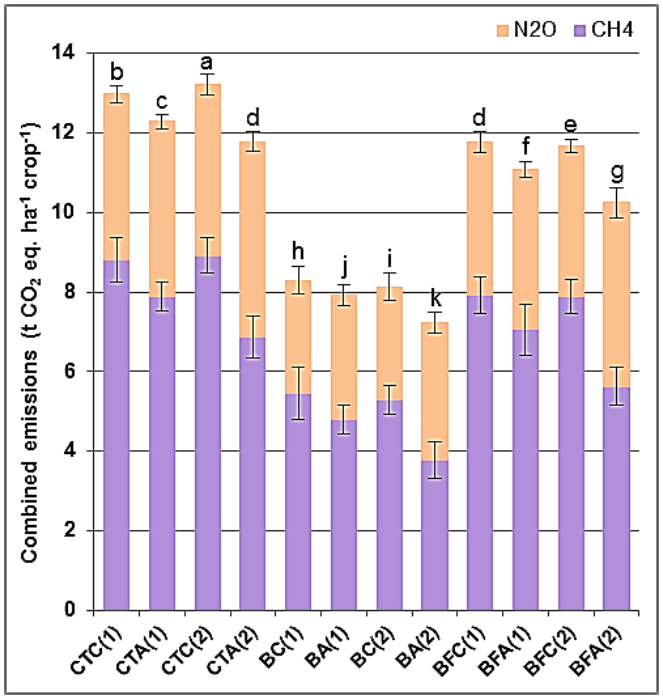


Feng et al., 2012; Wang et al., 2012; Xie et al., 2013; Zhang et al., 2010

Integrated system : AWD + Biochar

Seasonal Combined Emissions of CH_4 and N_2O

Fig. 7 Total GWP (100 years) of rice two crops under two systems.



Different letters denote significant differences ($P < 0.05$) between treatments of two crops under two systems.

Total GWP (100 years) of rice two crops under two systems.

Treatment	Total GWP (t CO_2 eq ha^{-1} $crop^{-1}$)	% changed from conventional*
First crop/Incomplete AWD (wet season)		
CTC	12.97±0.42 b	
CTA	12.28±0.36 c	- 5.32%
BC	8.29±0.41 h	
BA	7.92±0.38 j	- 4.46%
BFC	11.78±0.34 d	
BFA	11.08±0.46 f	- 5.94%
Second crop/Complete AWD (dry season)		
CTC	13.21± 0.37 a	
CTA	11.78±0.38 d	- 10.83%
BC	8.13±0.34 i	
BA	7.23±0.32 k	- 11.07%
BFC	11.67±0.38 e	
BFA	10.24±0.43 g	- 12.25%

*Percentage of change as compared with conventional system under the same treatment.

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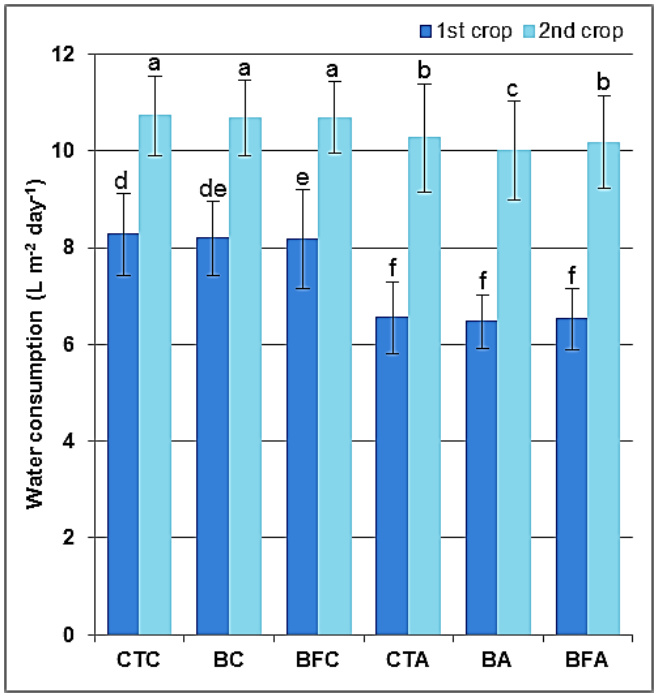
Low carbon farming technology in rice cultivation

Integrated system : AWD + Biochar

Water Consumption

Water consumptions of two crops under two systems.



Different letters denote significant differences ($P < 0.05$) between treatments of two crops under two systems.

Water consumptions of two crops under two systems.

Treatment	Water consumption ($L\ m^{-2}\ day^{-1}$)	% changed from conventional*
First crop/Incomplete AWD (wet season)		
CTC	8.27±0.86 d	
CTA	6.55±0.75 f	- 20.80%
BC	8.19±0.76 de	
BA	6.47±0.56 f	- 21.00%
BFC	8.17±1.03 e	
BFA	6.52±0.62 f	- 20.20%
Second crop/Complete AWD (dry season)		
CTC	10.72±0.82 a	
CTA	10.27±1.12 b	- 4.20%
BC	10.68±0.78 a	
BA	10.00±1.03 c	- 6.37%
BFC	10.69±0.75 a	
BFA	10.18±0.96 b	- 4.77%

*Percentage of change as compared with conventional under the same treatment.

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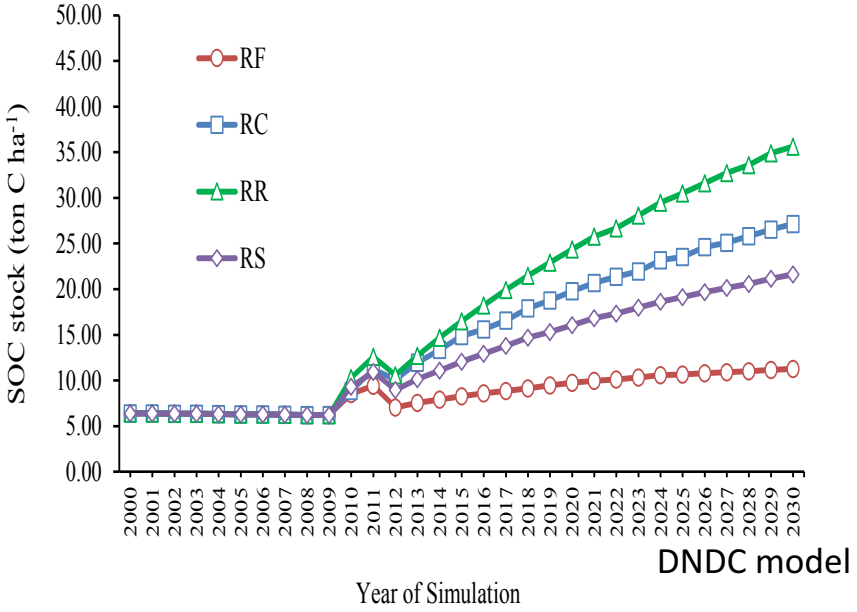
Multi-benefit and sustainability

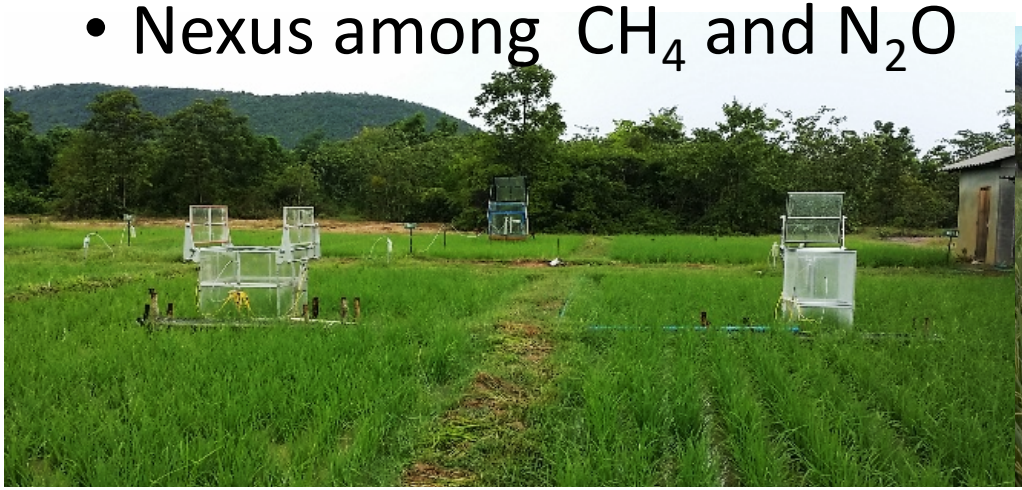
- Healthy Soil : increase soil C in the long run
- Water security : reduced by 30-40 percent
- Quality of life : low investment, high income
- Adaptation : precision farming, integrated farming



DNDC model

Remarks

- Rice cultivation play an important role in SEA in term of food security and GHG emission
- Low carbon farming technique can be implemented with long term benefit to environment and socioeconomics
- Technologies are varied by location and specific location
- Nexus among CH_4 and N_2O



Thank you

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