2014.10.08-10
LCAfood2014 Conference, San Fransisco, USA

Comparative Assessment of Environmental and Regional Impact from Rice Production

Naoki Yoshikawa*[1)], Phongthep Hanpattanakit[2)], Koji Amano[1)], Koji Shimada[3)]

[1)]Faculty of Science and Engineering, Ritsumeikan University,Japan
[2)]Faculty of Environmental Culture and Ecotourism, Srinakharinwirot University, Thailand
[3)]Faculty of Economics, Ritsumeikan University, Japan
*n-yoshik@fc.ritsumei.ac.jp

Background

◆ Changing cultivation methodology has impact not only on environment, but also on farm economy, and regional economy
→Improving these aspects is important to promote sustainable agriculture
Measuring these aspects is meaningful for decision making for farmers/company/government
- ◆ Selecting organic/chemical cultivation
- ◆ Assessing company's sustainability
- ◆ Making agricultural /environmental policies

◆ Rice is one of the globally cultivated crops and production methodology is varied
It is meaningful to compare impacts of each cultivation methodology because farmers have many options and recommendation will be helpful

◆ This study aims quantify compares the three impacts on sustainability (environment, economy, and region) by several rice cultivation methodology in Japan and Thailand. This paper focuses comparison between two options of environmentally-cultivated rice (Japan) and irrigated and rainfed rice cultivation (Thailand).

Fig. 1: Rainfed paddy field in Thailand

Methodology

◆ Goals and scope

This study compares greenhouse gases emission, farm economy, and regional economy change of cases in two options of environmentally-cultivated rice in Japan and two irrigation system in Thailand
Farm economy change is derived from change of production cost, crop price. Regional economy change is caused by change in economic ripple effect by change of farm economy. Structure on environmental load(Greenhouse gases and fossil energy use) and economic cost are also compared with cultivation methodology and produced countries (e.g. from conventional to organic)

◆ Functional unit and system boundaries

This study uses multiple functional unit; 1 kg of brown rice and 1 ha. System boundary covers from cradle to farm gate, which contains soil preparation, raising seedling, planting, spreading fertilizer and agrichemicals, harvesting, collecting grains. It does not contain drying rough rice, rice husking, rice milling, and transportation of rice husk. Regional economy covers not only economic ripple effect from input of agricultural materials but also that from change of household expenditure due to change of farmer's income by shifting cultivation methodology.

◆ Data collection

✓ Foreground data

Quantity of input materials, labor time, cultivation schedule, prices of inputs and wage
Thailand: interview investigation in 2012.
Japan: interview iin 2008.

✓ Background data

Background database: IDEA(AIST,Japan)
Field emission: IPCC guidelines(2006) taking into account of water regime and organic matter application

Table 1: Summaries of practices in rice cultivation

	Chemical(1)	Chemical(2)	Rainfed	Reduced Chemical	Green manure
Country	Thailand			Japan	
Region	Pathum Thani Province		Cha Choengsao Province	Shiga prefecture	
Yield (kg/ha)	4500	4250	2000	4797	4598
Cultiveted area (ha)	11.2	5.6	0.8	107	25
Water regime	Irrigated		Rainfed	Irrigated	
Plowing	Machine				
Seeding	Throwing Manual		Transplanting Manual	Transplanting Machine	
Harvesting	Machine		Manual	Machine	
Fertilizer	Chemical fertilizer			Chemical fertilizer Organic fertilizer	Green manure Chemical fertilizer (for raising seedings)
Agrichemicals	Herbicide Pesticide		No usage	Herbicide Pesticide	
Total N input (kgN/ha)	157	80	79	62	160 (Incl. green manure)

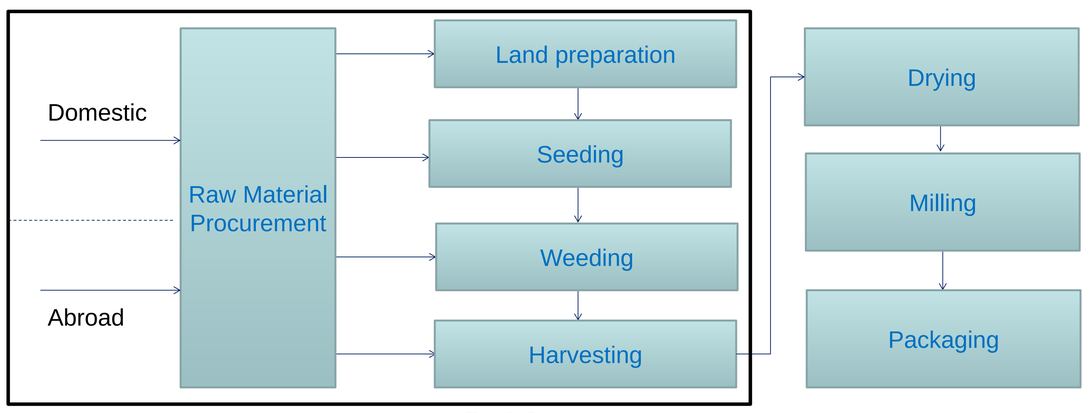

Fig 2:System boundary

Results and discussion

◆ Yield and CO_2 emission

Strongly influenced by fertilizer input and yield.
Rainfed cultivation which uses chemical fertilizer emits lower because of they harvests rice manually, however, low yield causes similar impact with Chemical(1).

◆ Energy

Lower energy use in cultivation which uses lower fertilizer

◆ GHG emission (include Field emission)

High GHG emission in Green manure use (High organic material input)
Lower GHG in rainfed farming

◆ Labor time and cost.

High labor time in rainfed farming because of manual operation in seeding and Harvesting.
Japanese cultivation inputs higher labor and materials than Thai irrigated farming and slightly higher yield

◆ Domestic procurement

Thai farming highly depends input materials on import

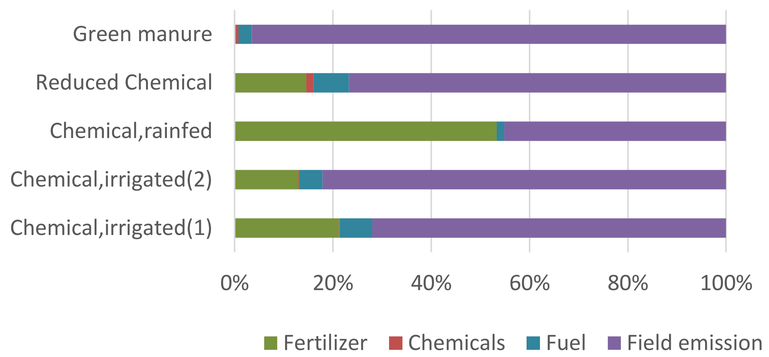

Fig. 2: GHG emission

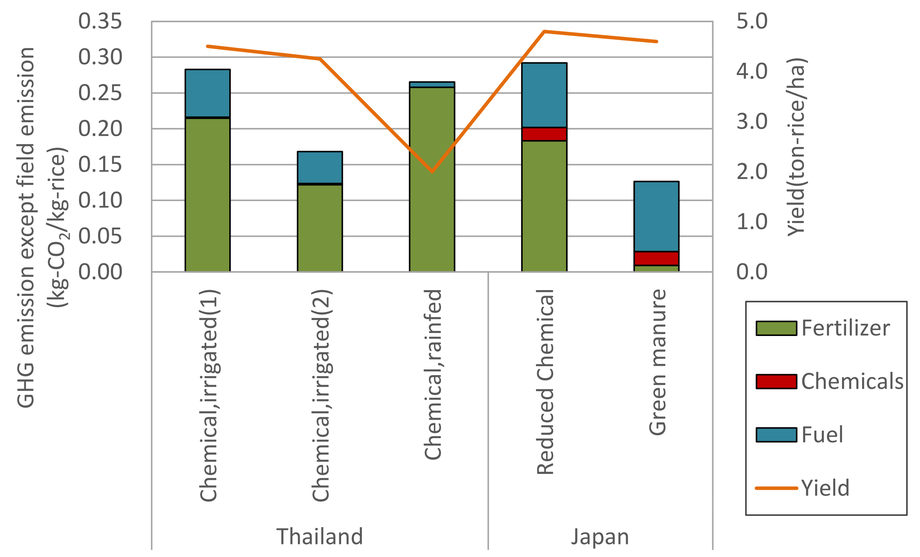

Fig. 3: Yield and LC-CO_2 emission by types of cultivation

Table 2: Comparison of each indicators about environmental and regional impact

	Thailand			Japan	
	Chemical(1)	Chemical(2)	Rainfed	Reduced chemical	Green manure
Yield(kg/ha)	100	94	44	107	102
LC-GHG (kg-CO_2/kg)	100	93	48	124	362
Fossil Energy(MJ/kg)	100	58	99	96	30
Labor time(hr/kg)	100	106	2,113	192	245
Input cost (USD/kg-brown rice)	100	91	109	854	606
(Domestic procurement)	8%	8%	15%	93%	62%

Chemical(1)=100
1USD=100JPY, 33THB

Conclusion

◆ Low input is not ralated to lower impact in this case. Circulation of organic material will make better impact on environment and regional economy
◆ Regional impacts needs further consideration (This study only consider "direct" impact of procurement