Japanese Farmers' Economic Incentive to Implement Prolonging of Midseason Drainage for Reducing CH_4 Emission from Irrigated Rice Paddies

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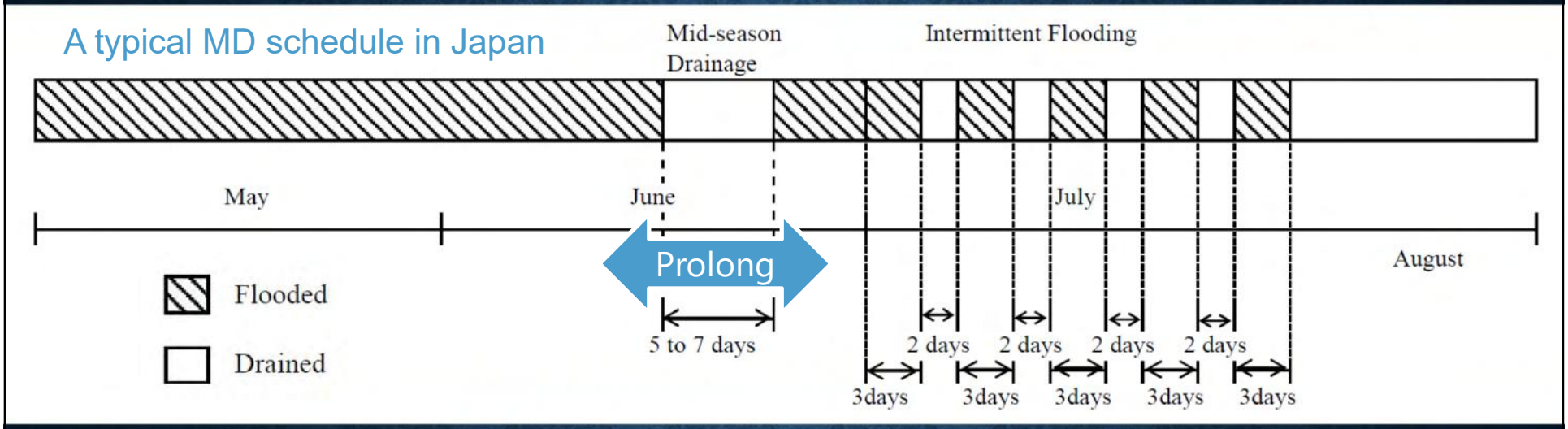
Contents

- Introduction
- Scientific evidence: *monitoring and modeling for prolonging of midseason drainage in Japan*
- Economic incetivization: *Japanese subsidy system for environmental conservation by farmers*
- Upcoming research targets

Rice cultivation in Japan

- 10th world's largest rice producer as of 2012 (FAOSTAT, 2016) for self consumption.
- The dominant staple food.
- All rice paddies are irrigated.
- A single cropping system with transplanting is dominated.
- Midseason drainage (MD) is commonly practiced for sound rice growth, except for cold northern region (Leon *et al.*, 2015).
  - ➔ Also effective in reducing paddy CH_4 emission by soil aeration.

Challenging conventional MD



National Greenhouse Gas Inventory Report of JAPAN (2016)

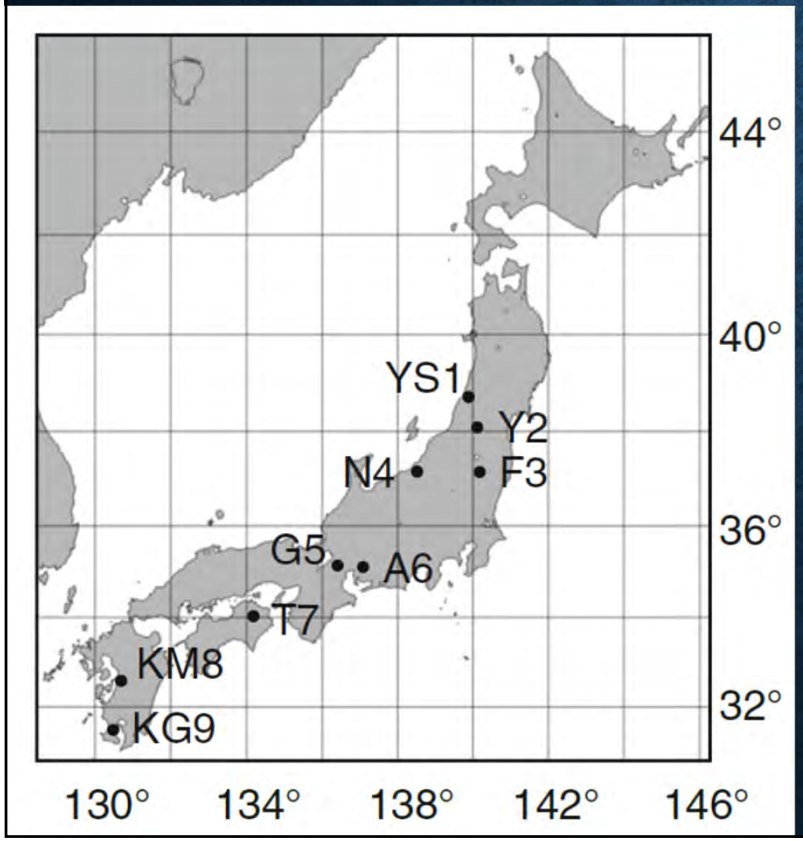
- The optimal duration, timing, and frequency of water management to gain high rice productivity depend on locally conventional practices.
- However, such conventional practices are often conservative, thereby leaving room for more CH_4 emission reduction.

➔ Can prolonging of MD be a possible option?

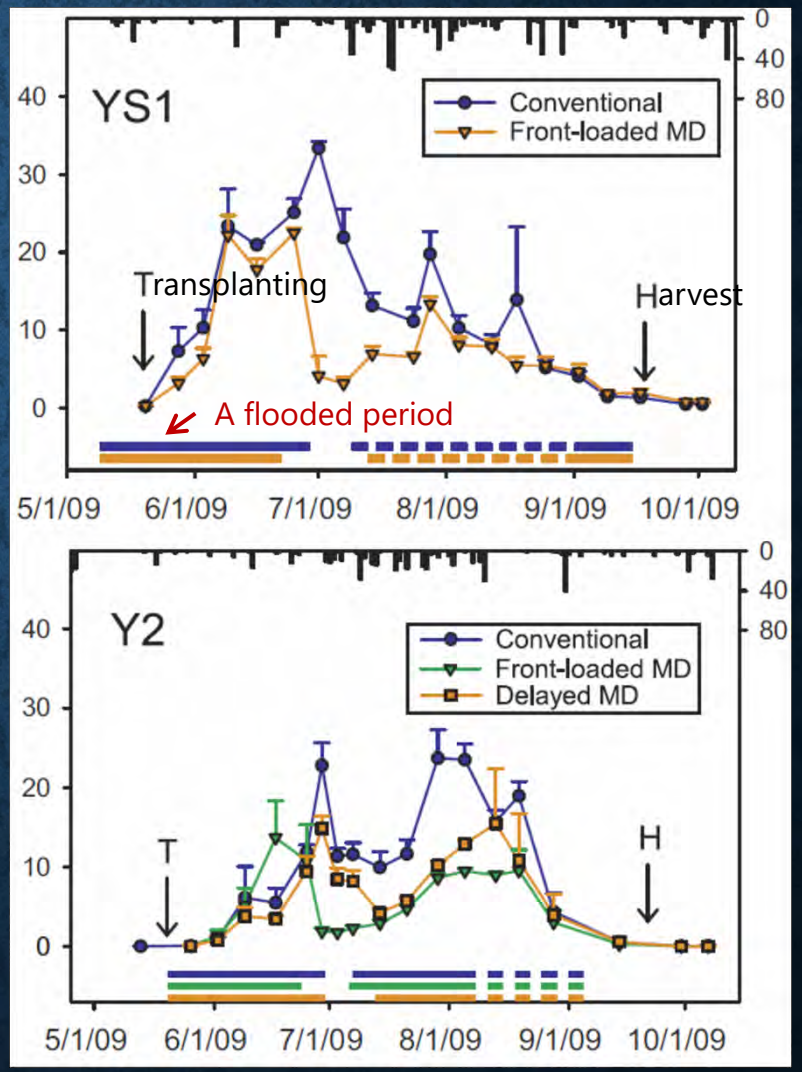
➔ If so, how much is the nationwide mean effect?

Two-year field monitoring campaign

- 9 field sites in 2008-2009.
- 1~3 prolonged practices *vs*. conv.
- A closed chamber method.



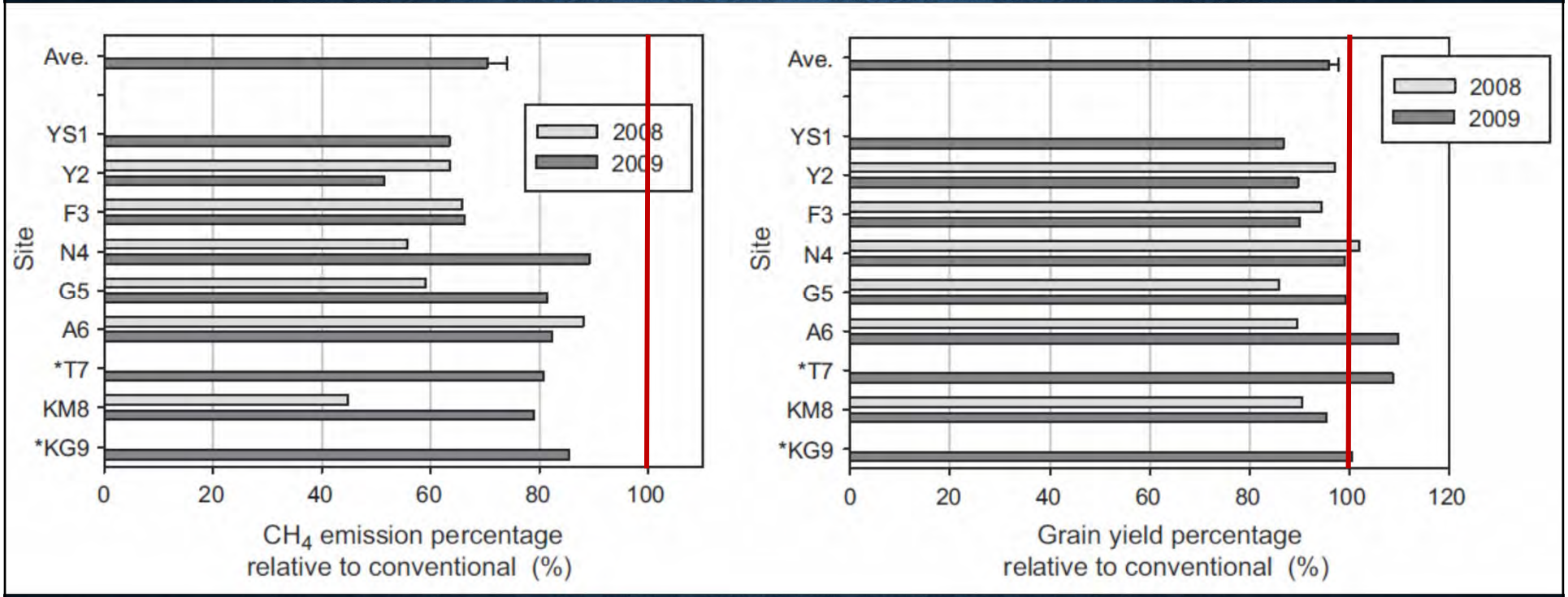
(n = 3, mean with upper SE)



Itoh *et al.* (2011) *Agric. Ecosyst. Environ.*

Seasonal total CH_4 emission and rice grain yield

CH_4 Yield



On average, prolonged MD reduced the total CH_4 emission by 31% compared to conventional MD while maintaining grain yield as high as 96%.

Itoh *et al.* (2011) *Agric. Ecosyst. Environ.*

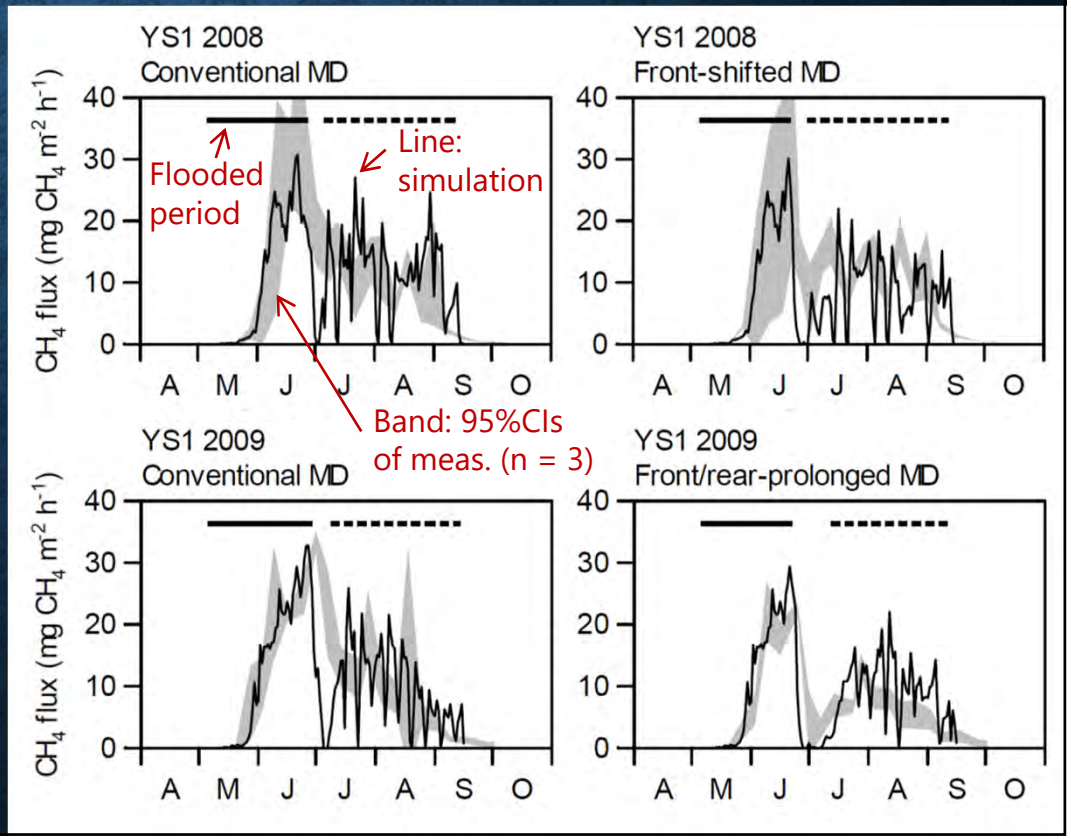
Uncertainty associated with rainfall during drainage

- The success or failure of drainage practices for CH_4 emission reduction is dependent on weather conditions during drainage events.

➔ Difficult to derive the mean effect of prolonged MD from the results of 2-year field experiment only.

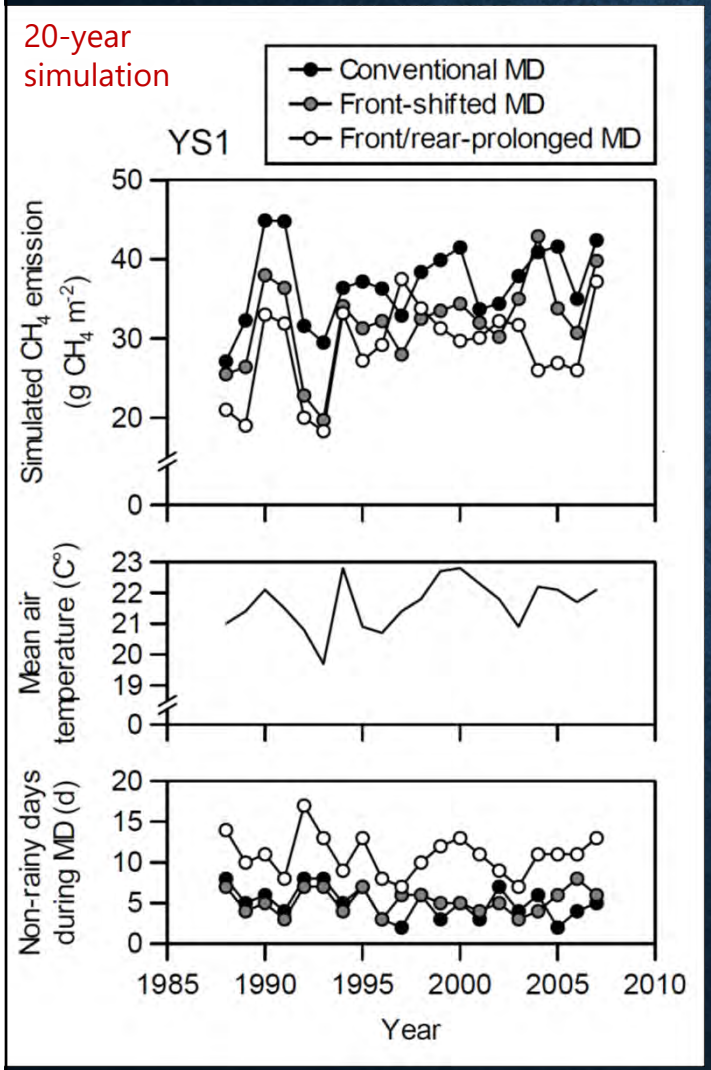
➔ A long-term (20 years) model simulation to derive the mean effect.

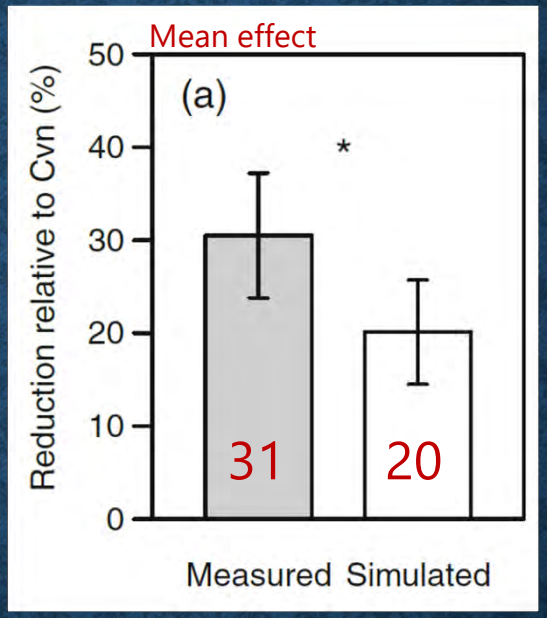
- The DNDC-Rice model is a revised version of the DNDC model in order to improve its performance in predicting paddy CH_4 emission (Fumoto *et al.*, 2008, *Glob. Change Biol.*).



Minamikawa *et al.* (2013) *Biol. Fertil. Soils*

Simulated results better represented the mean effect





- We targeted at "acceptable" prolonged MD with minimum yield penalty at each site.

(mean of 9 sites ± 95%CIs)

- 11-point higher reduction potential by measurement.

➔ Longer non-rainy days during prolonged MD at several sites than simulation.

- Affected by T_{air} & rainfall.

Minamikawa *et al.* (2013) *Biol. Fertil. Soils*

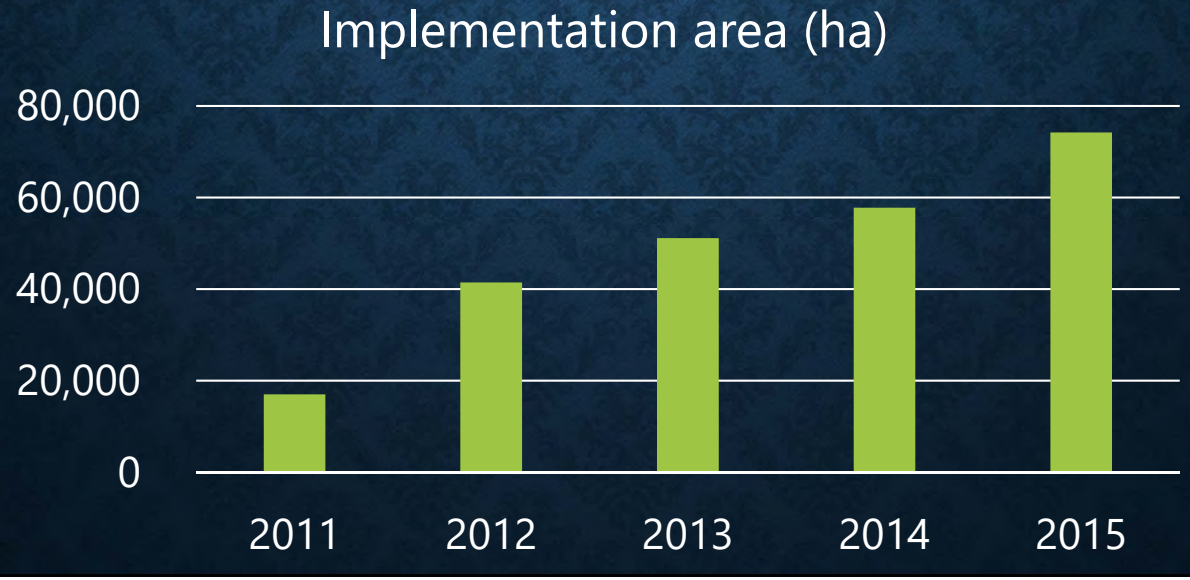
Effect of prolonged MD on CH_4 emission reduction with almost no yield penalty has been confirmed from the two studies.

Then,
how do we put prolonged MD into practice?

➔ A farmers' subsidy system in Japan

"Direct payment for environmentally friendly agriculture"

- Started from 2011.
- Supporting additional costs associated with agricultural production activities that contribute to conservation of natural environment.
- Aiming at reducing the consumption of chemical fertilizers and agrochemicals by >50% to prevent global warming and conserve biodiversity.

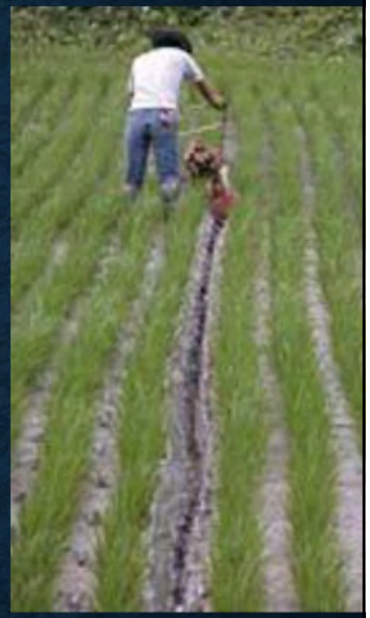


Details of the paid activities

- Three nationwide activities are cover crops, manure application, and organic farming.
- In addition, prefectural governments can set up "locally-approved activities" to consider its environment and farming situation.

➔ Prolonged MD in combination with *other practices* has been adopted as a locally-approved one in 5 (out of 47) prefectures as of 2016.

IPM (integrated pest management) or slow-release fertilizer application



Pref. N➔S	Conventional	Prolonged
Iwate	~7 days	>14 days with making open ditch
Ishikawa	No info.	>14 days
Shiga	No info.	>14 days w/OD
Kyoto	~7 days	>14 days w/OD
Oita	No info.	>14 days w/OD

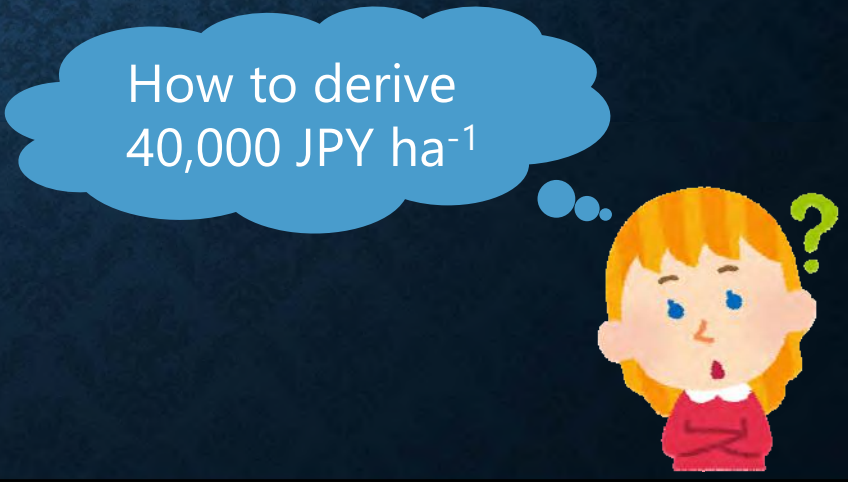
How much benefit?

(1 USD = 105 JPY this morning)

- 40,000 JPY ha^{-1} (~381 USD ha^{-1}) for the implementation of prolonged MD in combination with other practices in all the five prefectures.
- Nationwide mean rice production cost as of 2015 was 1,332,940 JPY ha^{-1} with the mean production area of 1.6 ha $body^{-1}$ (MAFF census, 2016).

➔ Corresponds to 3.0% of the production cost.

- For example, in case of Shiga prefecture, the implementation area (6,578 ha) reached 20% of the total paddy farming area (32,200 ha) in 2015.
- In addition, Shiga prefecture promotes domestic eco-labelling for such certificated agricultural products to add value.

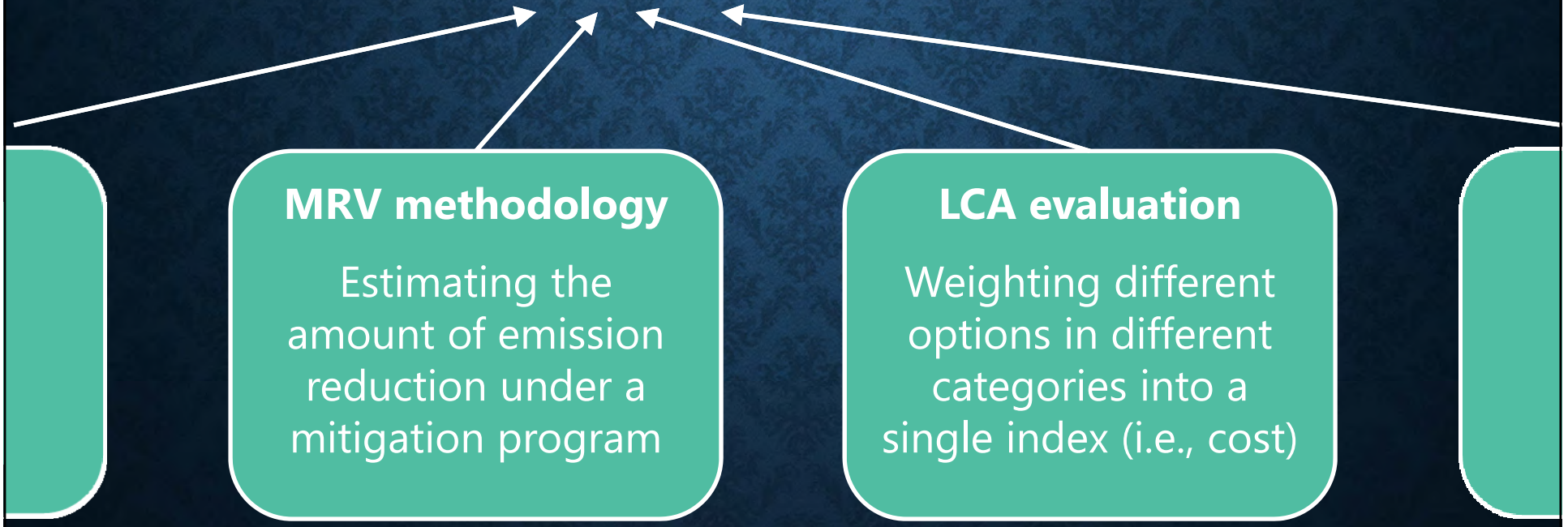


Upcoming research targets

- At present, the amount of payment is derived from additional production cost (i.e., labor and materials).

➔ Not consider carbon price set through a carbon market.

➔ Establish a new tax/subsidy system to reflect carbon price.



MRV: monitoring, reporting and verification
LCA: life cycle assessment