

## Climate benefits of improved organic waste management through the 3Rs approach in developing Asian countries

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### Research background

#### Problems of the waste sector:

- Increasing waste generation
- Increasing social resistance to new landfill and incineration projects.

#### Problems of the climate sector:

- Increasing anthropogenic GHG emissions
- Rising climate change impact



#### Matching solutions

- Reducing waste generation
- Decreasing waste to disposal site
- Reducing anthropogenic GHG emissions

**3Rs**

## Key research questions

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- 1) How much the 3Rs can reduce GHG emissions from the waste sector?
- 2) Do developing Asian countries include the 3Rs in their national climate action plans/strategies?
- 3) How to enhance the 3Rs implementation successfully in developing Asian countries?

## Research activities

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1. Reviewing national greenhouse gas (GHG) **inventories and national climate action plans/strategies** of 10 studied countries.
2. Estimating potential **GHG emissions** from organic waste in the studied countries.
3. Identifying **climate benefits of the 3Rs for** organic waste.
4. Reviewing the **3Rs practices** for organic waste management.
5. Identifying appropriate organic waste **management hierarchies** regarding climate change impact and resource efficiency.
6. Developing a **decision diagram** for associating local governments in selection of organic waste management option.

## Overview: GHG emissions and the waste sector

### National GHG Inventories in 1994

Country	National GHG inventories in 1994 (MtCO <sub>2</sub> eq.)*	GHG emissions from the waste sector in 1994 (MtCO <sub>2</sub> eq.)		Sources
		MSW	% MSW to total emissions	
China	4,081	42.6	1.04	Chinese Government, 2004
India	1,252	12.2	0.97	MoEF, 2004
Indonesia	883	8.44	0.96	MENLH, 1999
Thailand	325	0.411	0.13	MSTE, 2000
Viet Nam	154	1.39	0.90	MNRE, 2003
Malaysia	144	21.9	15.2	MOSTE, 2000
Philippines	169	4.25	2.51	IACCC, 1999
Bangladesh	76.3	1.31	1.72	MoEF, 2002
Cambodia	59.7	0.124	0.21	MOE, 2002
Laos**	24.2	0.240	0.99	STEA, 2000
<b>Regional</b>	<b>7,168</b>	<b>92.9</b>	<b>1.3</b>	

\* Sinks are not included.      \*\*GHG inventory in 1990.

## Current trend of GHG emissions from the waste sector

### GHG emissions estimation

- Report of methane emissions from landfill of organic waste is required.
- **Inclusion of CO<sub>2</sub> emissions from burning of waste containing fossil fuel is currently on voluntary basis.**

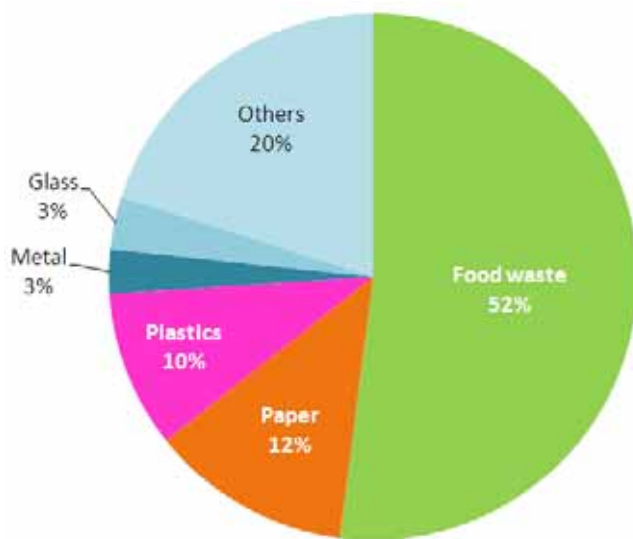
### Waste management:

- Increase waste generation
- Increase waste collection rate
- Improved waste treatment from open dumping to landfill and incineration



## Main source of GHG emissions from the waste sector

### Waste compositions (regional average)



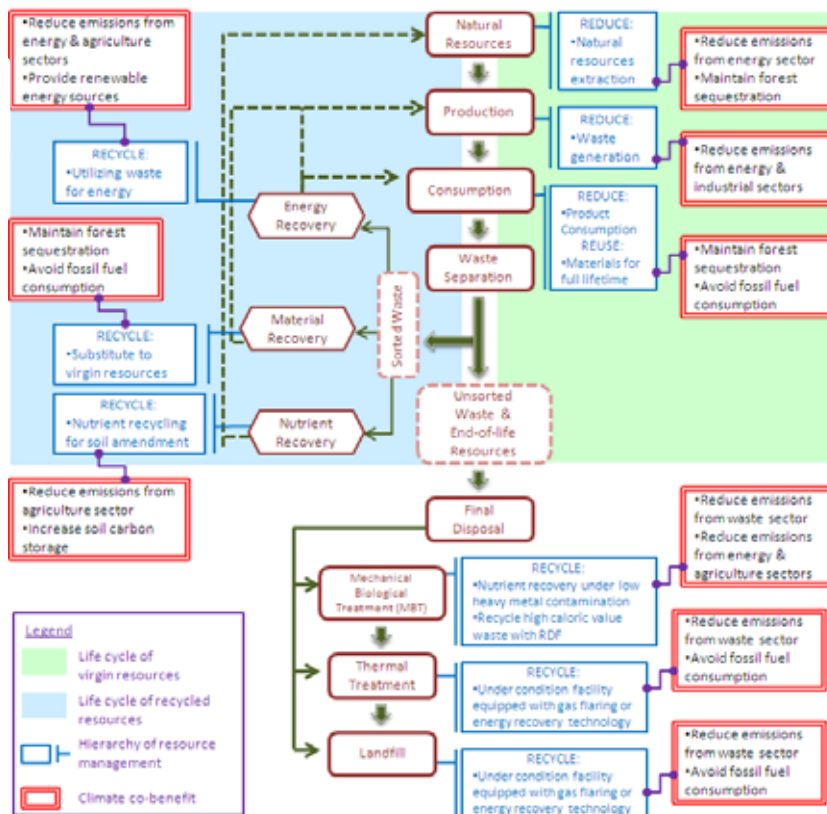
- Degradation of **organic waste** (152 mil. ton/yr) under anaerobic condition is the largest source of methane emissions.
- Burning of **plastic waste** (23 mil. ton/yr) is a major source of carbon dioxide emissions.

Note: Compile from various sources

## 3Rs in the national climate action plans/strategies

Countries	Mention of solid waste	Mention of 3Rs approach	Sources
China	Yes	Reduce, Recovery, Utilization	NCCCC, 2007
India	Yes	Reduction, Recycling	PMCCC, 2008
Indonesia	Yes	5Rs for industry & 3Rs for MSW	MENLH, 2007
Thailand	Yes	3Rs	ONEP, 2008
Bangladesh	Yes	No	MoEF, 2008
Philippines	Limited	No	IACCC, 1999
Viet Nam	No	No	MNRE, 1999
Malaysia	No	No	MOSTE, 2000
Cambodia	No	No	MOE, 2002
Laos**	No	No	STEA, 2000

## Climate benefits of the 3Rs



## Climate benefits of 3Rs: life-cycle approach

- Reduce emissions from energy, agriculture, industry, land use change & forestry, and waste sectors
- Maintain forest sequestration
- Increase soil carbon storage
- Avoid fossil consumption
- Provide renewable energy sources

## Potential GHG emissions reduction through the 3Rs

### Direct emissions reduction from organic waste

- 20-98% reduction by composting and 60-100% by anaerobic digestion of food waste (compared to landfill).

Organic waste	Potential net GHG emissions reduction compared to landfill (KgCO <sub>2</sub> eq / kg of organic waste)		
	Waste reduction	Composting	Anaerobic digestion
Food waste	0.42 - 1.05	0.07 - 1.03	0.25 - 1.05
Paper	1.12 - 2.80	0.20 - 2.74	0.70 - 2.80
Grass	0.48 - 1.19	-0.44 - 1.13	0.06 - 1.19

### Indirect GHG emissions reduction

- 94% by recycling of plastic.
- 80% by recycling of steel.
- 56-64% by using 50% recycled aluminum.
- 22% by increasing use of recycled glass from 25% to 59%.

## Potential GHG emissions reduction through the 3Rs

Country	Total MSW (Mt/yr)	Potential GHG emissions reduction from 30% reduction of organic waste dumped into landfills (MtCO <sub>2</sub> eq/yr)		
		Food	Paper	Sum
China	120	17.6 - 44.1	14.1 - 35.3	31.7 - 79.4
India	42	4.9 - 12.3	1.6 - 4.1	6.5 - 16.4
Indonesia	22.5	4.9 - 12.2	1.8 - 4.4	6.7 - 16.6
Thailand	14.7	2.8 - 6.9	0.9 - 2.3	3.7 - 9.2
Viet Nam	12.8	2.3 - 5.6	1.5 - 3.6	3.8 - 9.2
Philippines	11	1.5 - 3.6	1.4 - 3.5	2.9 - 7.1
Malaysia	8.7	1.3 - 3.2	1.2 - 2.9	2.5 - 6.1
Bangladesh	4.9	1.0 - 2.4	0.4 - 1.0	1.4 - 3.4
<b>Regional</b>	<b>236.6</b>	<b>36.3-90.3</b>	<b>22.9-57.1</b>	<b>59.2-147.4</b>

## Recommendations:

- I. Waste separation at source
- II. Selection of waste management option

## I. Waste separation at source

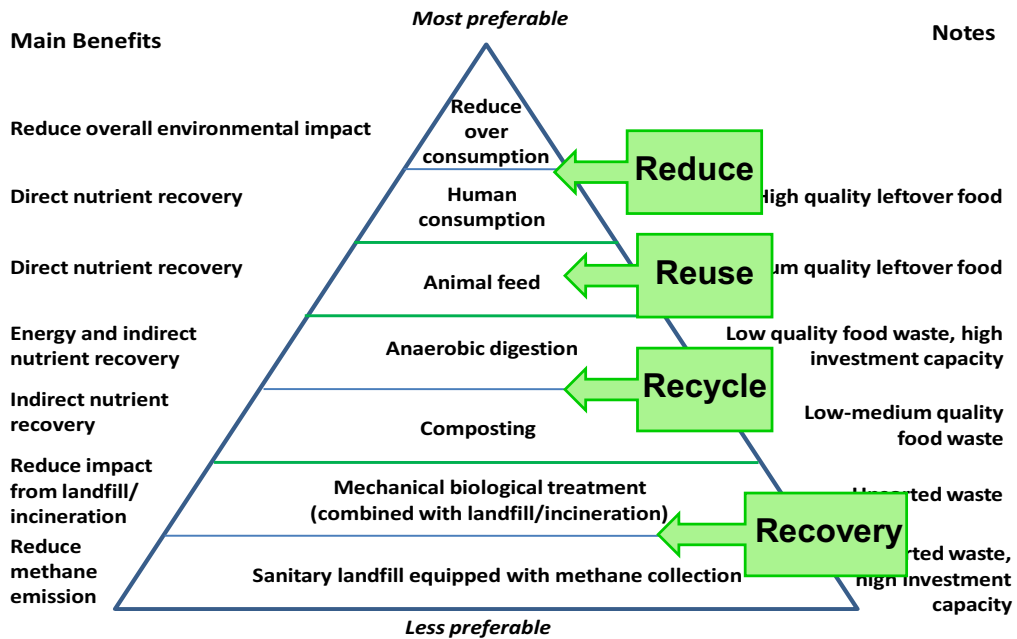
- Waste separation at sources is a key of success.
- Development of guideline for waste separation at source: category, bin, collection schedule, etc.
- Food waste separation at source should be prioritized.
- Paper, wood, and grass wastes separation should be promoted.

## II. Selection of organic waste management option

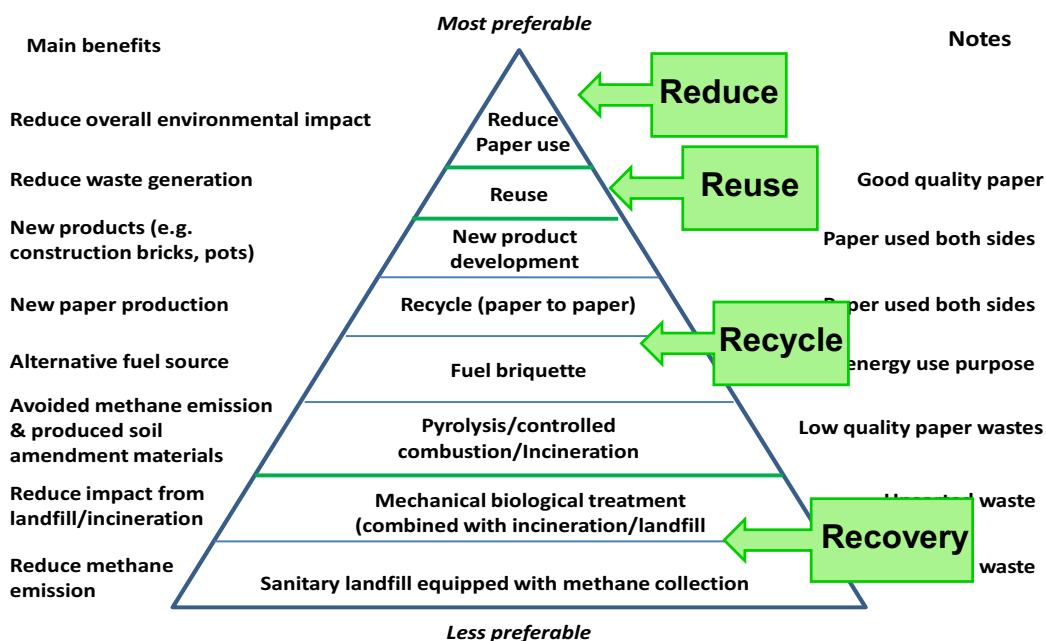
Municipality need	Social need	Preferable technology
<ul style="list-style-type: none"> <li>• Reduce waste flows to final disposal site</li> <li>• Improve collection and treatment of waste</li> <li>• Reduce cost for waste collection and disposal</li> <li>• Reduce environmental impact from waste treatment</li> <li>• Implement simple and easy to handle management system</li> </ul>	<ul style="list-style-type: none"> <li>• Food security</li> <li>• Energy security</li> <li>• Poverty reduction/ job creation</li> <li>• Income distribution</li> </ul>	<ul style="list-style-type: none"> <li>• Efficient resource recovery</li> <li>• Low GHG emissions</li> <li>• Low energy input</li> <li>• Low monetary investment</li> <li>• Low environmental impact</li> </ul>



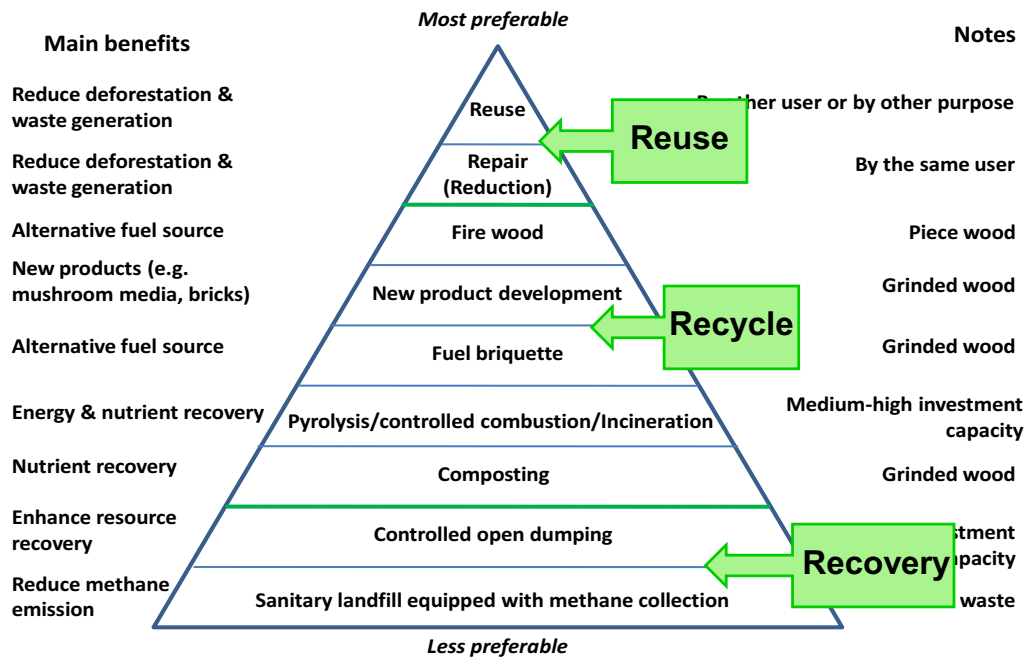
## Food waste management hierarchy



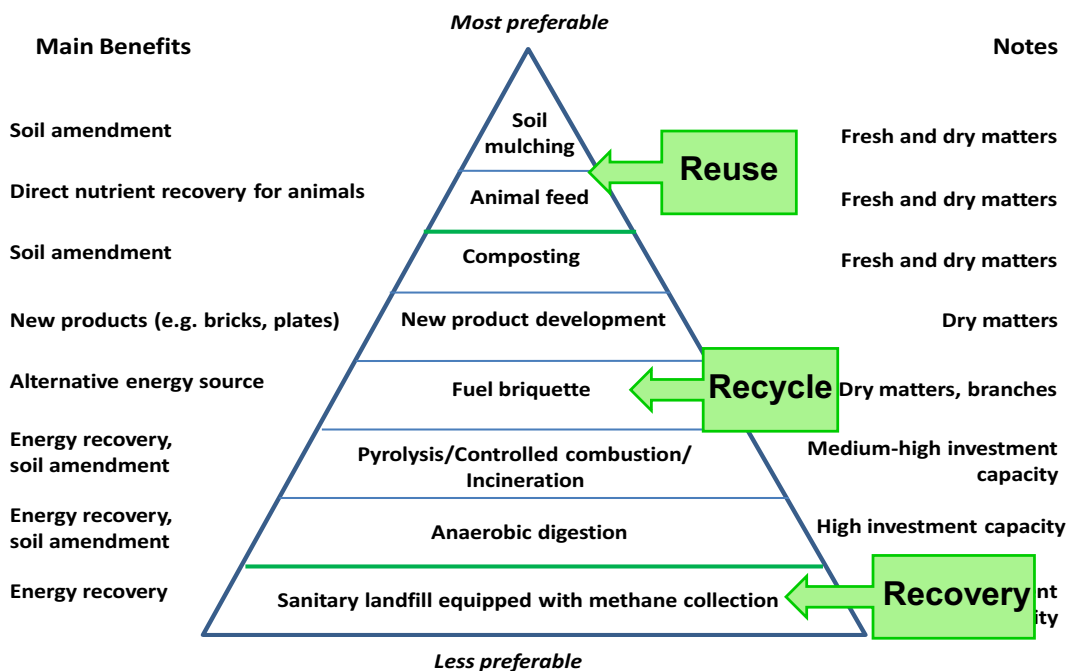
## Paper waste management hierarchy



## Wood waste management hierarchy



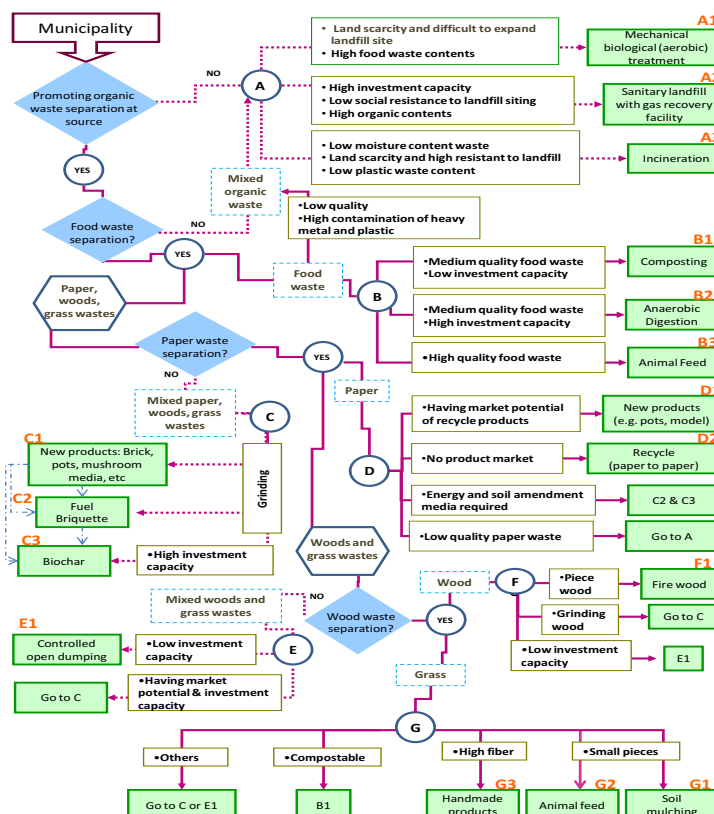
## Grass and garden waste management hierarchy



## A decision diagram for selection of organic waste management option

### Divided into 8 lines:

- A: Unsorted waste and mixed organic waste → no/less organic waste separation
- B: Food waste
- C: Mixed non-food waste
- D: Paper
- E: Mixed wood and grass wastes
- F: Wood waste
- G: Grass waste



Decision diagram for selection of appropriate organic waste management option

## Conclusion

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- The 3Rs are a national concern and **should be promoted widely** in order to reduce resource consumption, decrease GHG emissions, reduce the need for landfill, and avoid land-use conflicts.
- More research on the **various benefits of the 3Rs** in the studied region → Lifecycle assessment of GHG emissions and environmental impact, and cost-benefits analysis.
- **Improved interaction between researchers and policy-makers** are needed to enhance implementation.
- **Pilot project** demonstrating the 3Rs and waste separation at source should be granted.
- **Strengthened international research cooperation and improved information sharing** among countries in Asia are likely to be conducive towards that end.

## Further activity

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- Revising the report
  - Please send any comment to [sang-arun@iges.or.jp](mailto:sang-arun@iges.or.jp) by 10 December 2009.
- Publishing a policy report by mid 2010.