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Introducing sustainable biofuel in Japan - How do we choose sustainable biofuel?

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Outline

1. Background
2. Method
   - Comparing sustainability by Ecological Footprint analysis
3. Case Studies
   - Brazil (sugarcane), USA (corn), and Japan (rise straw)
4. Conclusion

1. Background

- Biofuel is facing at some difficulties as its sustainability is considered
  - Reason for people who is anti-biofuel
    - Food or Energy?
    - Environmentally Sustainable?
    - Socially Sustainable?

On condition that biofuel production is SUSTAINABLE,

biofuel can strongly take a role as alternative energy to oil, CO_2 reduction, sustainable agriculture, …

1. Background

- Sustainability Criteria for Biofuel has set in some countries
  - Life Cycle Analysis of CO2
  - Environmental sustainability
    - Water use, biodiversity, land use…
  - Social sustainability
    - Labor environment, no exploitation…

How can we tell which biofuel is sustainable??
-imported biofuel
-R&D phase (ex. 2nd generation biofuel)

1.Background

- Japanese backward biofuel policy
  - Target
    -0.5 million kL (crude oil-eq) in 2010
    -3.6 million kL (crude oil-eq) in 2030

⇔ Bioethanol production:30kL/year (as of 2006)
Biodiesel production:4000~5000kL/year (as of 2006)

⇒ Import biofuel
Promotion of research on 2nd generation biofuel

Choose more sustainable biofuel NOW!!

2. Method

- How can we tell which biofuel is sustainable?
  - CO2 is not enough.
  - Sustainability Criteria is now being established but some is qualitative.

2. Method

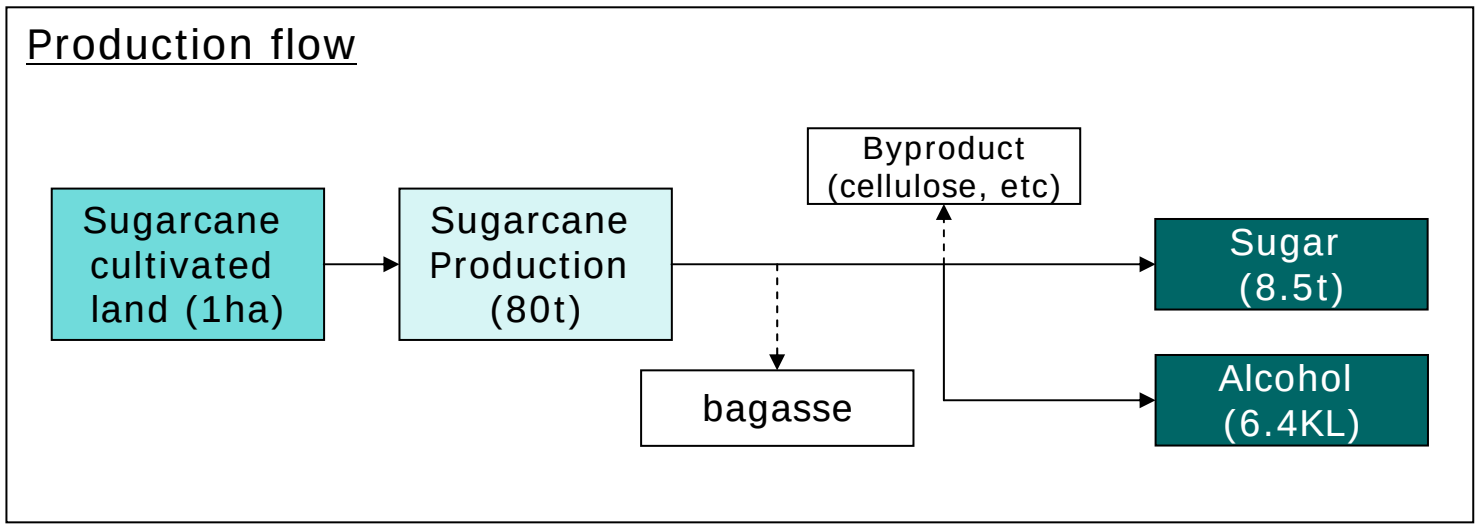
- What is EF?
  - Taking into account not only energy but land use, water, material...
  - Converted into a normalized measure of land area
  - Adopted as sustainability indicator in
    - “Living Planet Report” by WWF International
    - Calculation of civil sustainability by EU

2. Method

- Application EF for biofuel production
  - Definition in this study:
    EF for 1kL of bioethanol production per year
  - Object:
    -Area for production
    -Input for production and transportation
  - Case study:
    -Sugarcane in Brazil (imported to Japan)
    -Corn in USA (imported to Japan)
    -Rice straw in Japan (domestic production)

3. Case Study

- Brazil-Sugarcane



3. Case Study

- Brazil-Sugarcane

energy consumption(kcal/kL of ethanol) : **746,713(kcal)**

Agricultural sector	operation	113713
	transportation	128263
	fertilizer	198625
	equipment	87125
	land improvement	57325
	seedling	17550
Industrial sector	electricity	0
	chemicals	19000
	plant	32250
	equipment	92863

(Source: Centro de Technologia Canavieira–Biomass Power Generation)

3. Case Study

- USA 1-Cone (negative energy-efficiency)

energy consumption(kcal/kL of ethanol) : **6,526,000(kcal)**

Agricultural sector	2,447,000
Industrial sector	4,079,000

- USA 2-Cone (positive energy-efficiency)

energy consumption(kcal/kL of ethanol) : **4,801,000(kcal)**

Agricultural sector	1,349,000
Industrial sector	3,452,000

3. Case Study

USA 1 (kcal/kL of ethanol)

Agricultural sector	labor	143592.2
	machinery	316,398
	gasoline	125,876
	diesel	311,736
	irrigation	99,457
	electricity	10,566
	nitrogen	760,845
	phosphorous	8,393
	potassium	78,013
	lime	97,903
	seeds	161,618
	insecticides	87024.19
	herbicides	192698.2
	transport	52524.94
Industrial sector	Corn transport	322000
	Stainless steel	12,000
	Steel	12,000
	Cement	8,000
	Steam	2,546,000
	Water	90,000
	Electricity	1,011,000
	95% ethanol to 99.5%	9,000
	Sewage effluent	69,000

USA 2 (kcal/kL of ethanol)

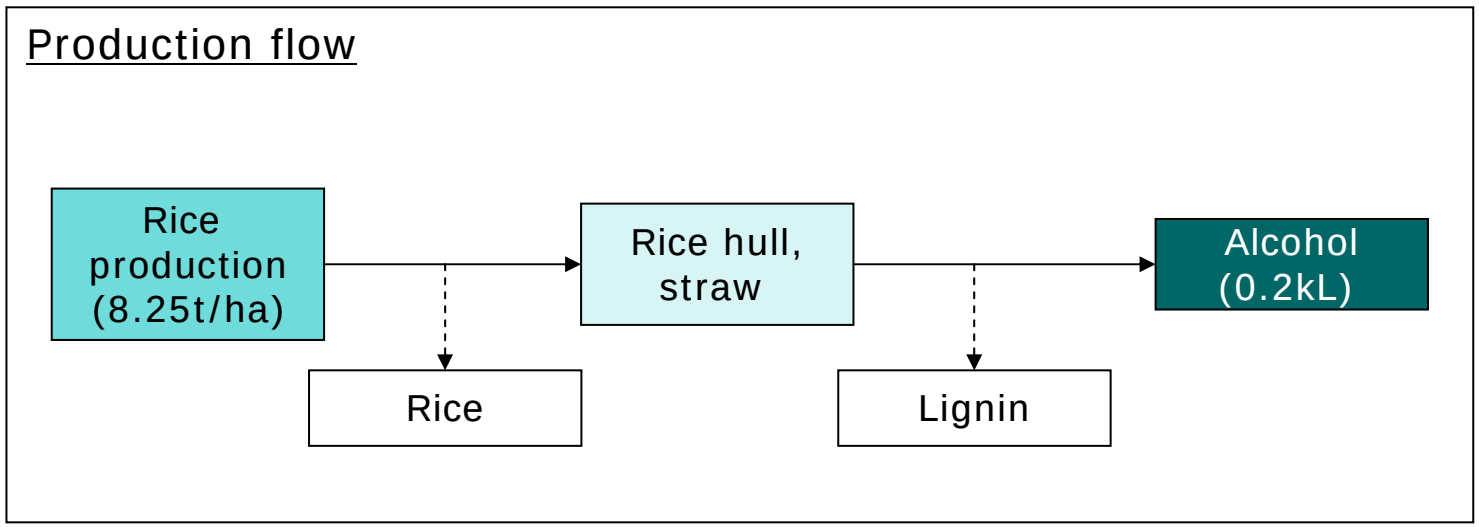
Agricultural sector	Seed		16,350
	Fertilizer	Nitrogen	636,583
		Potash	51,492
		Phosphate	44,224
		Lime	1,708
	Energy	Diesel	203,119
		Gasoline	95,420
		LPG	57,160
		Electricity	61,227
		Natural Gas	50,056
	Custom work		42,868
	Chemicals		79,745
	Purchased water		3,688
	Input hauling		5,477
Industrial sector	Corn transport		141,000
	Ethanol conversion		3,311,000

Source: Hosein Shapouri et al.(2004)The 2001 Net Energy Balance of Corn Ethanol

Source: David Pimentel and Tad W. Patzek(2005), Ethanol Production Using Corn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower, Natural Resources Research, Vol.14, No.1

3. Case Study

- Japan-Rice straw



3. Case Study

- Japan-Rice straw

energy consumption (kcal/kL of ethanol) : **7,009,134(kcal)**

Agricultural sector (direct energy input)	429,874
Agricultural sector (indirect energy input)	1,126,879
Industrial sector	5,452,381

3. Case Study

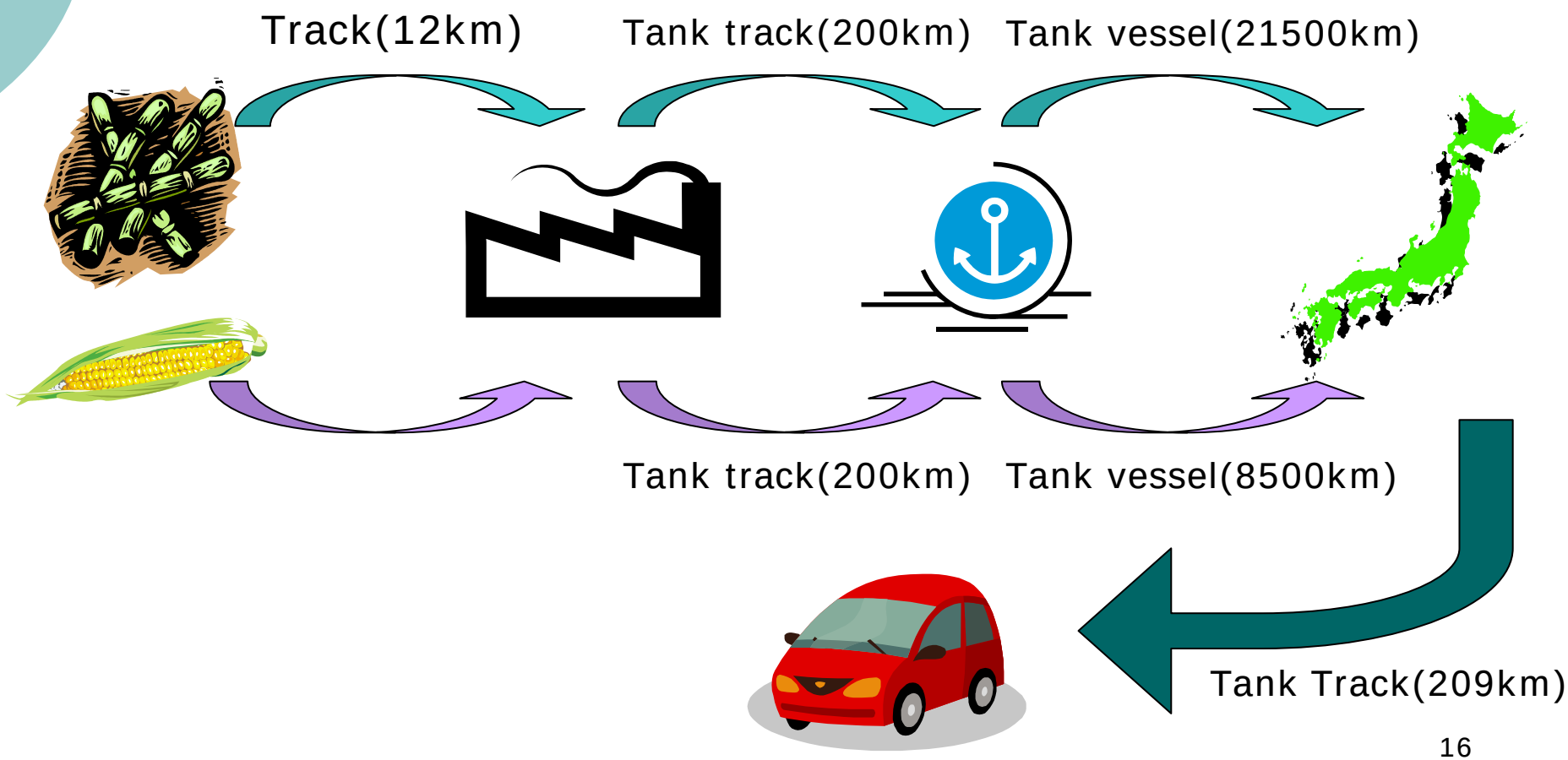
Japan-Rice straw (kcal/kL of ethanol)

Agricultural sector	energy	429,874
	seed	19,776
	fertilizer	212,668
	pesticide	159,177
	other materials	27,880
	water	82,668
	facilities	203,266
	building	60,299
	car	40,524
	equipment	319,326
	management	1,297
Industrial sector	electricity	1,373,810
	vapor	3,926,190
	water	66,667
	sulfuric acid	16,667
	lime	69,048

Source: Kiyotaka Saga et al.(2007); Net Energy Analysis of Bioethanol Production System from Rice Cropping

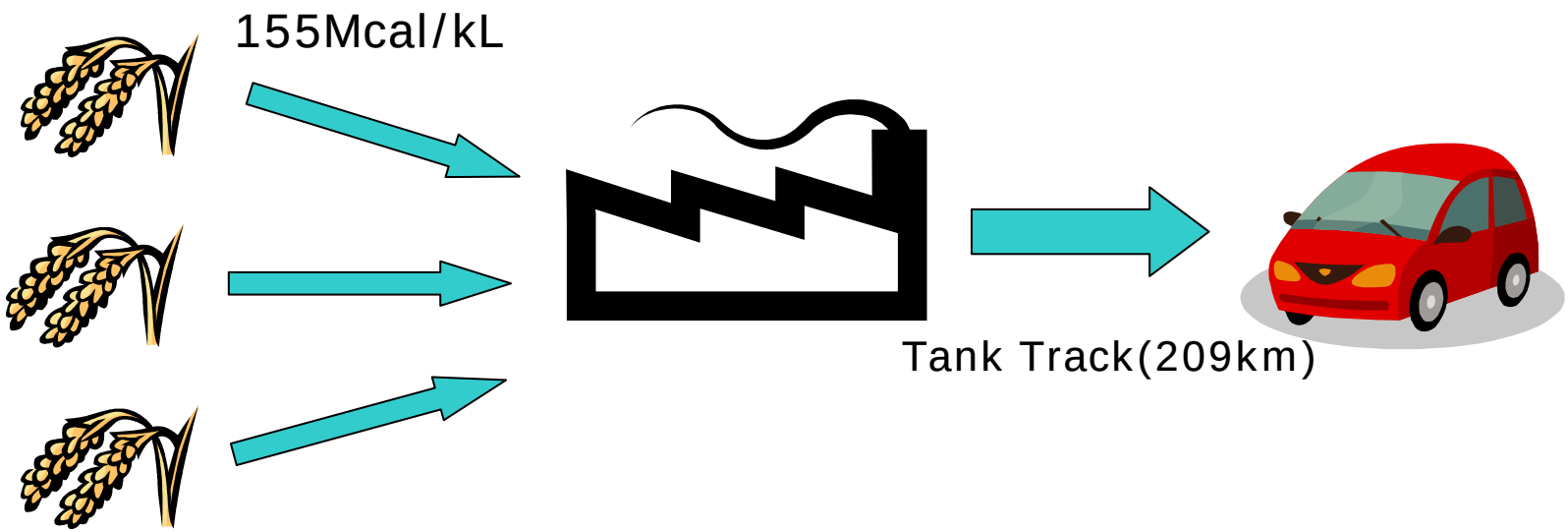
3. Case Study

- Transportation (Sugarcane, Cone)



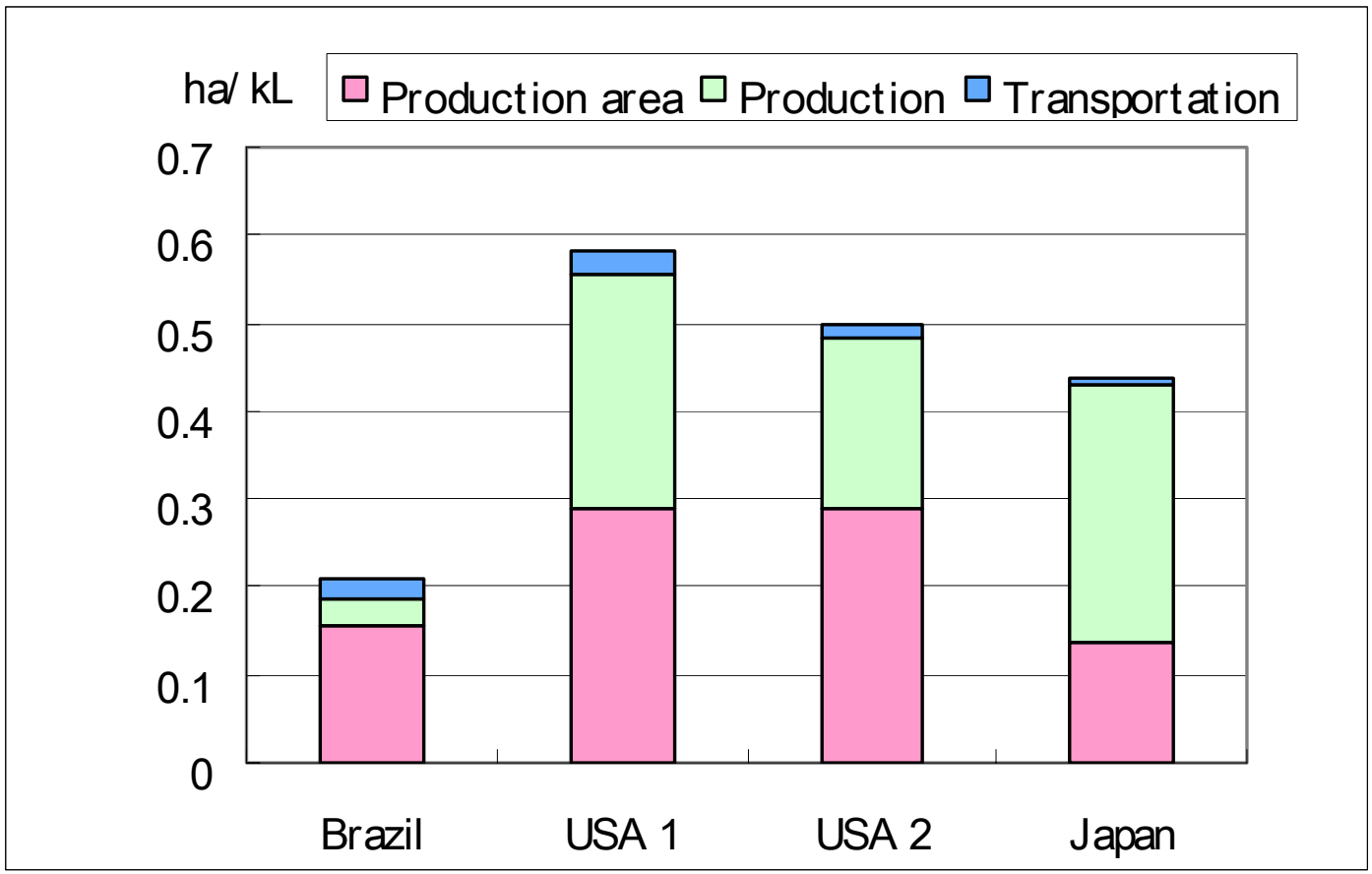
3. Case Study

- Transportation (Rice straw)



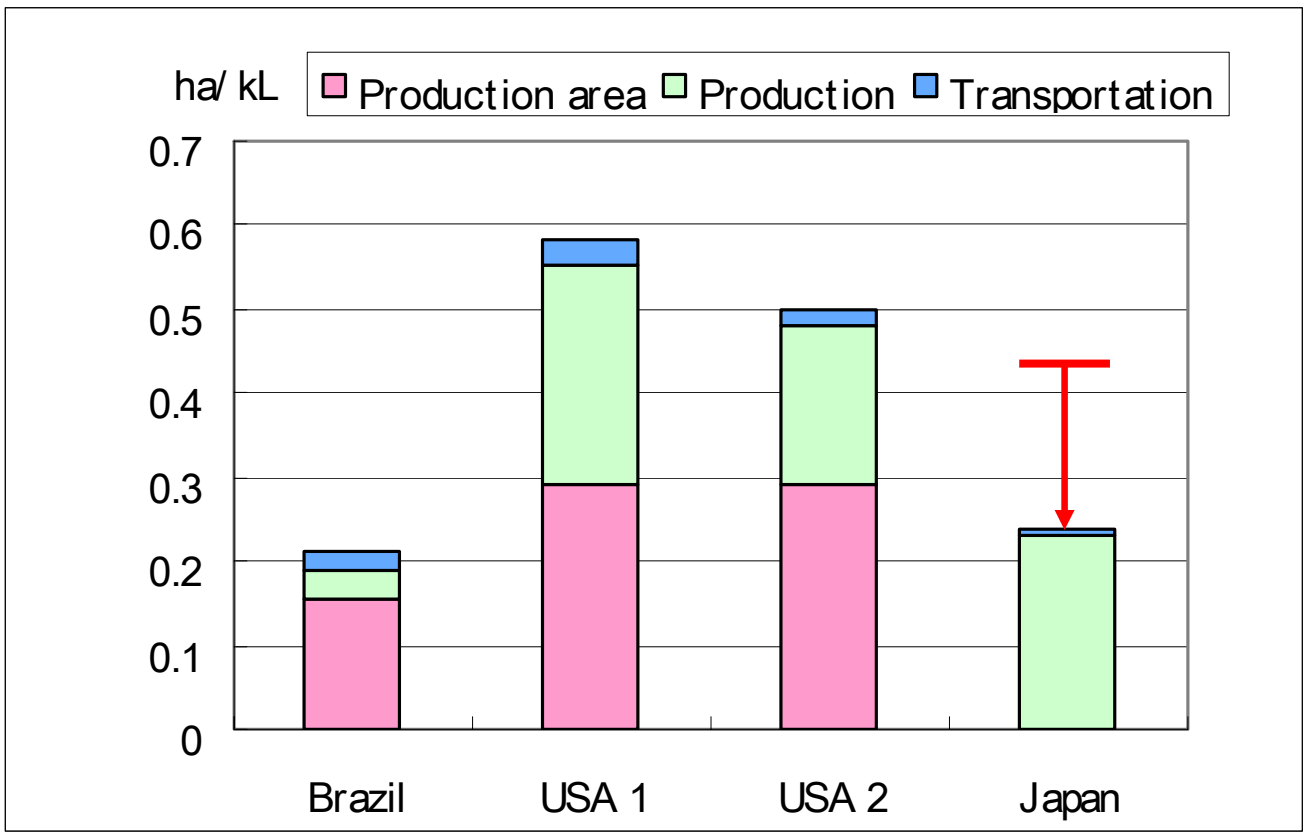
3. Case Study

- Sugarcane in Brazil is the most sustainable in EF.



3. Case Study

- Rice straw in Japan can be as much as sugarcane in Brazil if we consider it is additional activity in rice production.



Conclusion

- Total environmental sustainability is comparable.
  - Import or Domestic
  - Food or Energy
  - Type of raw materials
  - Type of production process
- More case studies are needed
  - China, Southeast Asia
  - ETBE, Biodiesel

Conclusion

- What Japanese biofuel policy has to consider now is
  - Choose more sustainable import biofuel
  - Emphasize development of more sustainable biofuel

Thank you very much for your kind attention.