Biomethanol production and CO_2 emission reduction from forage grasses, trees and residues of crops

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Background (Global)

More than 10 billion tons of fossil fuels are annually consumed in the world.

1) Acid rain

2) Photochemical Smog

3) Increase of atmospheric CO_2 - Global warming

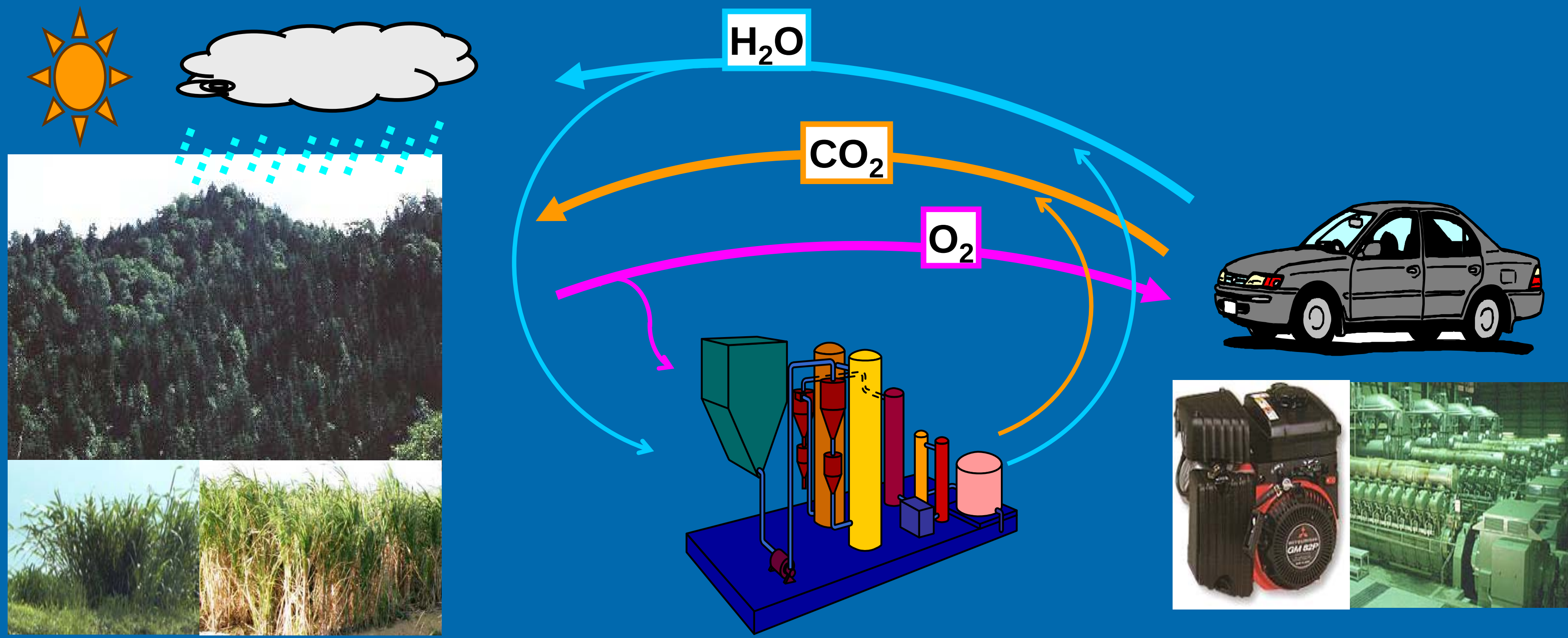
4) Running out of fossil fuel

Background (Local)

1) Byproducts and residues from agriculture and forest industries are cast off or just burnt.
2) Increase of energy consumption not only in developed countries but also in Asian and African countries.

We can Reduce CO_2 by shifting from fossil fuels to biofuels utilizing solar energy

1) The solar energy that produces biomass is the ultiimate sustainable energy resource.
2) Plants reduces atmospheric CO_2 through photosynthesis.
3) Even though, combustion produces CO_2, it does not increase the amount of CO_2.
4) Liquid fuels are easily applied as an altanative fuel for factory, automobile and other engines requiring petroleum to operate.
5) It is clean and does not produce soot or SO_x.
6) In terms of storage, it ranks next to petroleum, far better than batteries, natural gas and hydrogen.



Biomass Production → **Biomethanol Production** → **Consumption of biomethanol**

$CO_2 + H_2O \rightarrow CH_2O + O_2$

$CH_2O \rightarrow CH_3OH$

$CH_3OH + 1.5O_2 \rightarrow CO_2 + 2H_2O$

Carbon cycle of photosynthesis, biomethanol production and consumption of biomethanol **(Carbon neutral)**

Objective

Analysis and evaluation of various forms of biomass for biomethanol production by gasification method with partial oxidation toward the establishment of a new farm system producing biomethanol.

Principle of methanol synthesis by gasification method (the C1 chemical transformation technology)

Gasification | **Synthesis**

(Partial oxidation) | **(with Catalyst)**

Carbon Hydrates → **Mixture of gases** → **Biomethanol**

1,000 C

Pressure 40-80 atm.

$(CH_2O)_n$

$+ O_2$

$+ H_2O$

Dry, crush into Powder

H_2

CO

CO_2

H_2O

$$CO + 2H_2 \rightarrow CH_3OH$$

Materials 1

Material 2

Deforested mountain

Logs of Japanese cedar

Bark of Japanese cedar

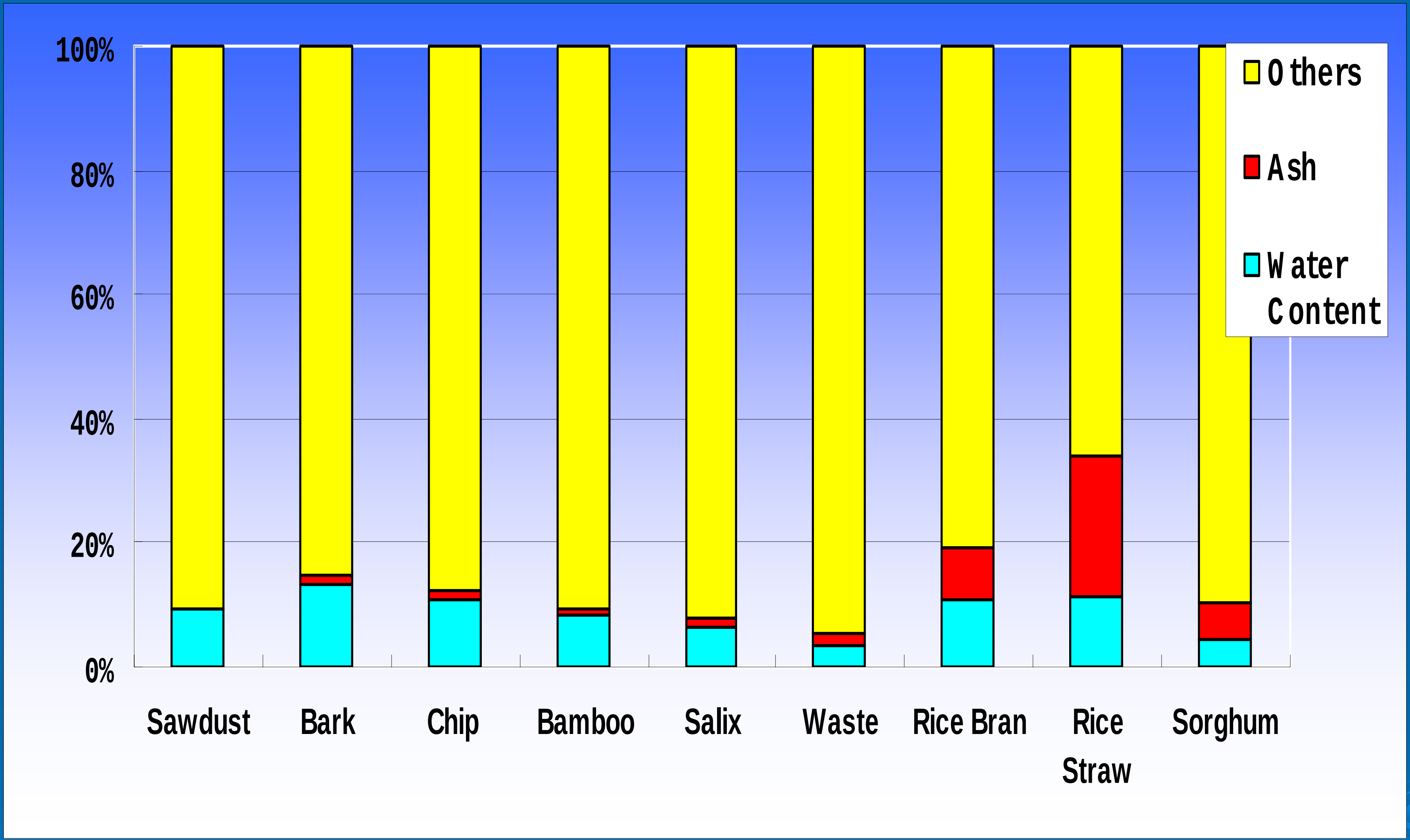
Chips of Japanese larch

Wastes in sawmill (Japanese cedar)

Demolition wastes

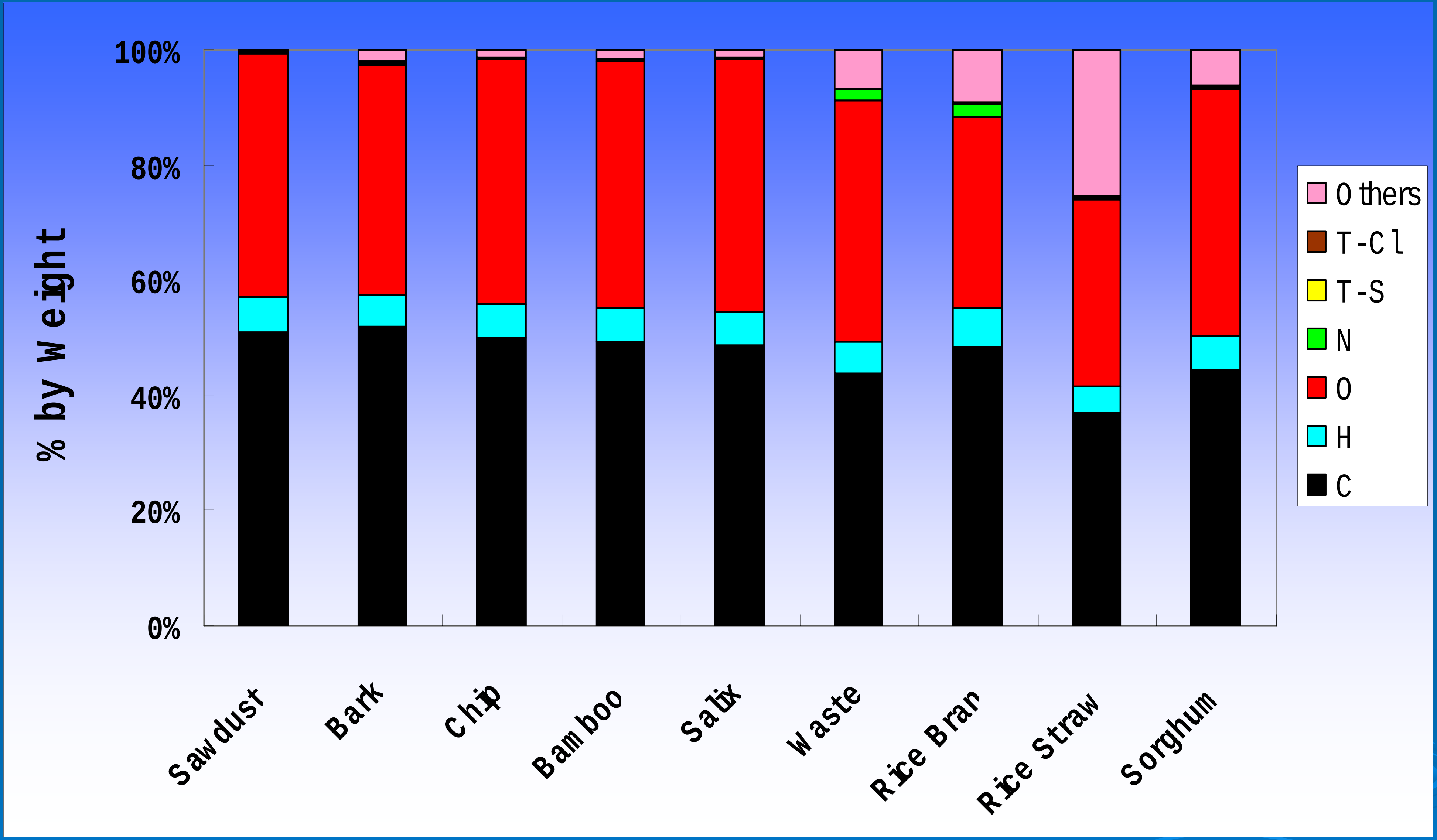
Methods

1) Water and ash content (%)
2) Content of some elements (C, H, O, N, S, Cl)
3) High and low heating values
4) Chemical composition of the biomass (ratio of C : H : O)
5) Size of biomass (handling characteristics)
6) Gas yield and generated heat (H_2, CO, CO_2, H_2O)
7) Methanol yield (estimate)



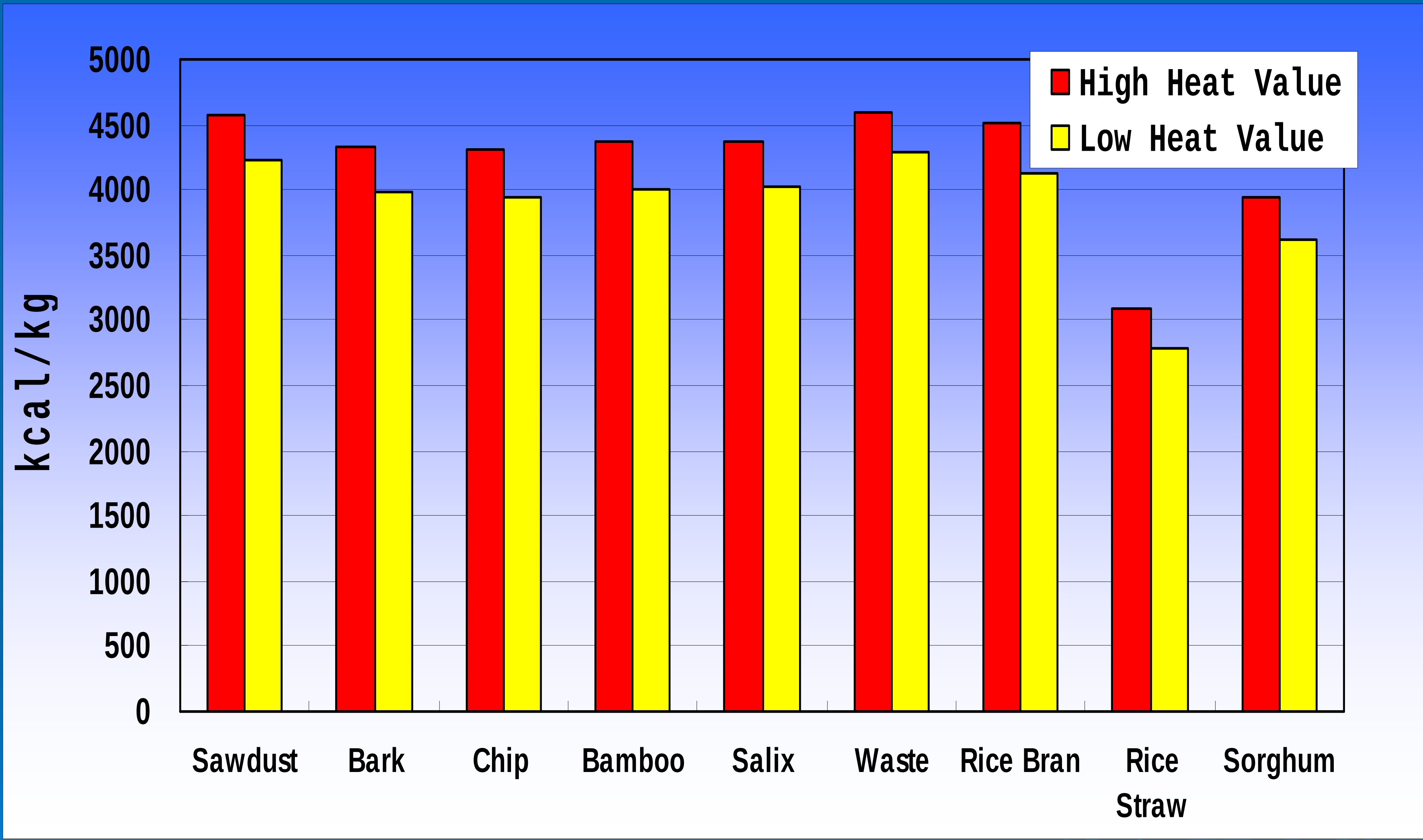
Content of water and ash in materials

Saw dust: Sawn wood of Japanese cedar (*Cryptomeria japonica*); Bark: Japanese cedar (*Cryptomeria japonica*); Chip: Japanese larch (*Larix leptolepis*); Bamboo: *Phyllostachys pubescens*; Salix: *Salix sachalinensis* and *S. pet-susu*; Waste: Sawn wood and demolition waste (raw material for particle board); Sorghum: foliage



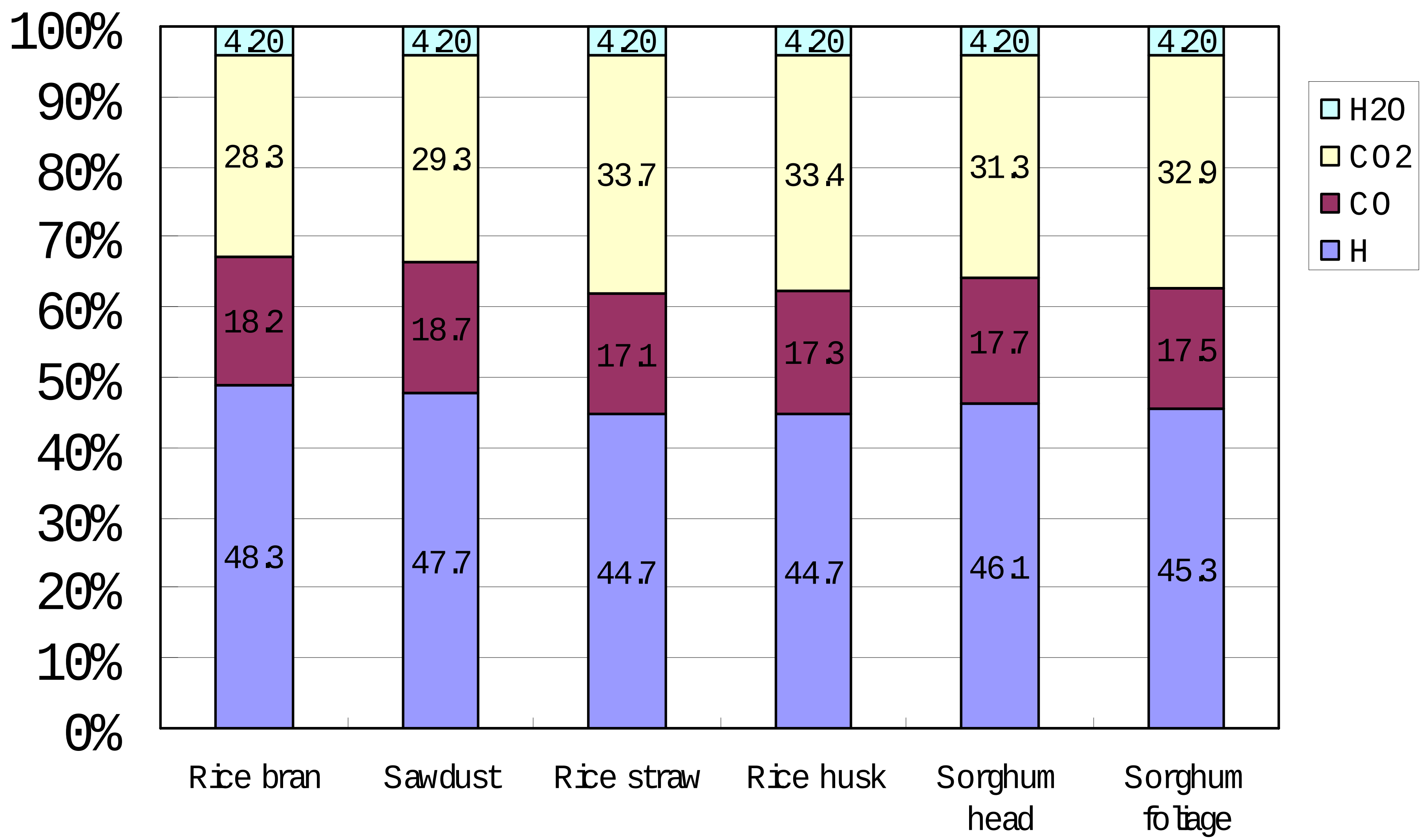
Content of some elements (% by weight) in materials without Water

C: carbon; H: hydrogen; O: oxygen; N: nitrogen; T-S: total sulfur; T-Cl: total chloride

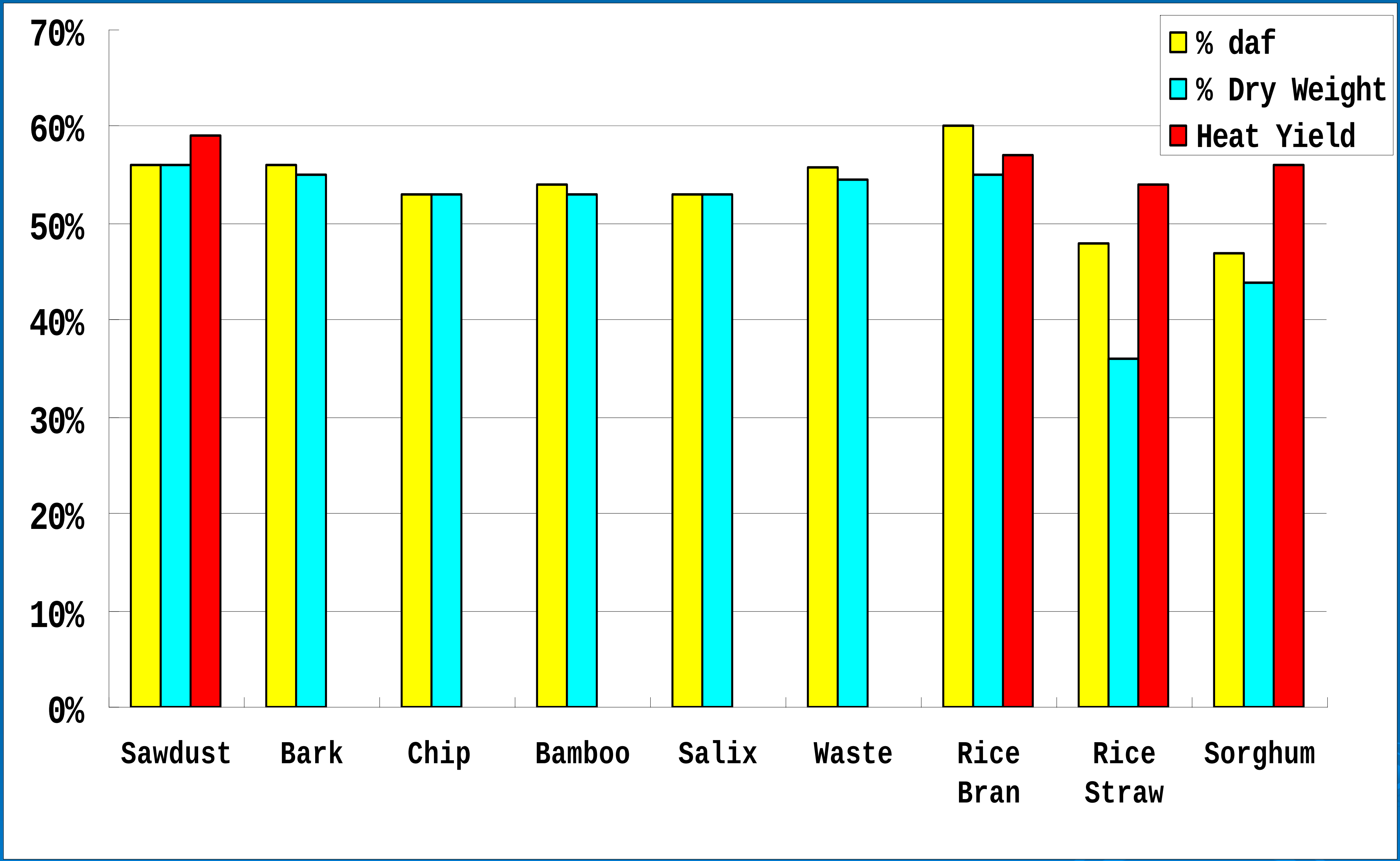


High and low heat value of materials

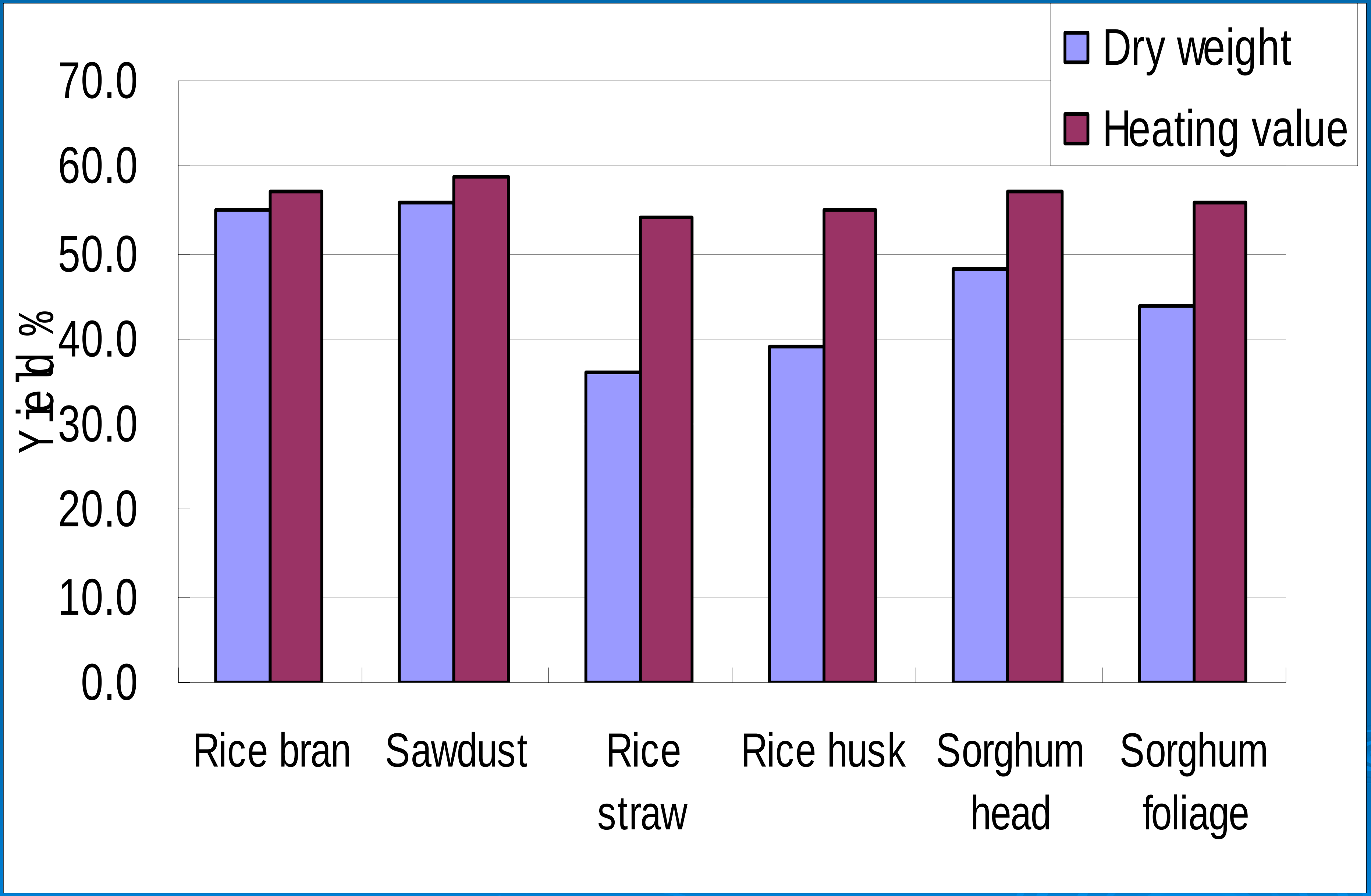
Low heat value = High heat value - [(9 x H + water) x 6]



Mixture of gases by gasification of partial oxidation produced by various materials



Methanol yield (weight %) and heat yield of various biomass materials.
daf: percentage of methanol weight to dry biomass weight without dry ash



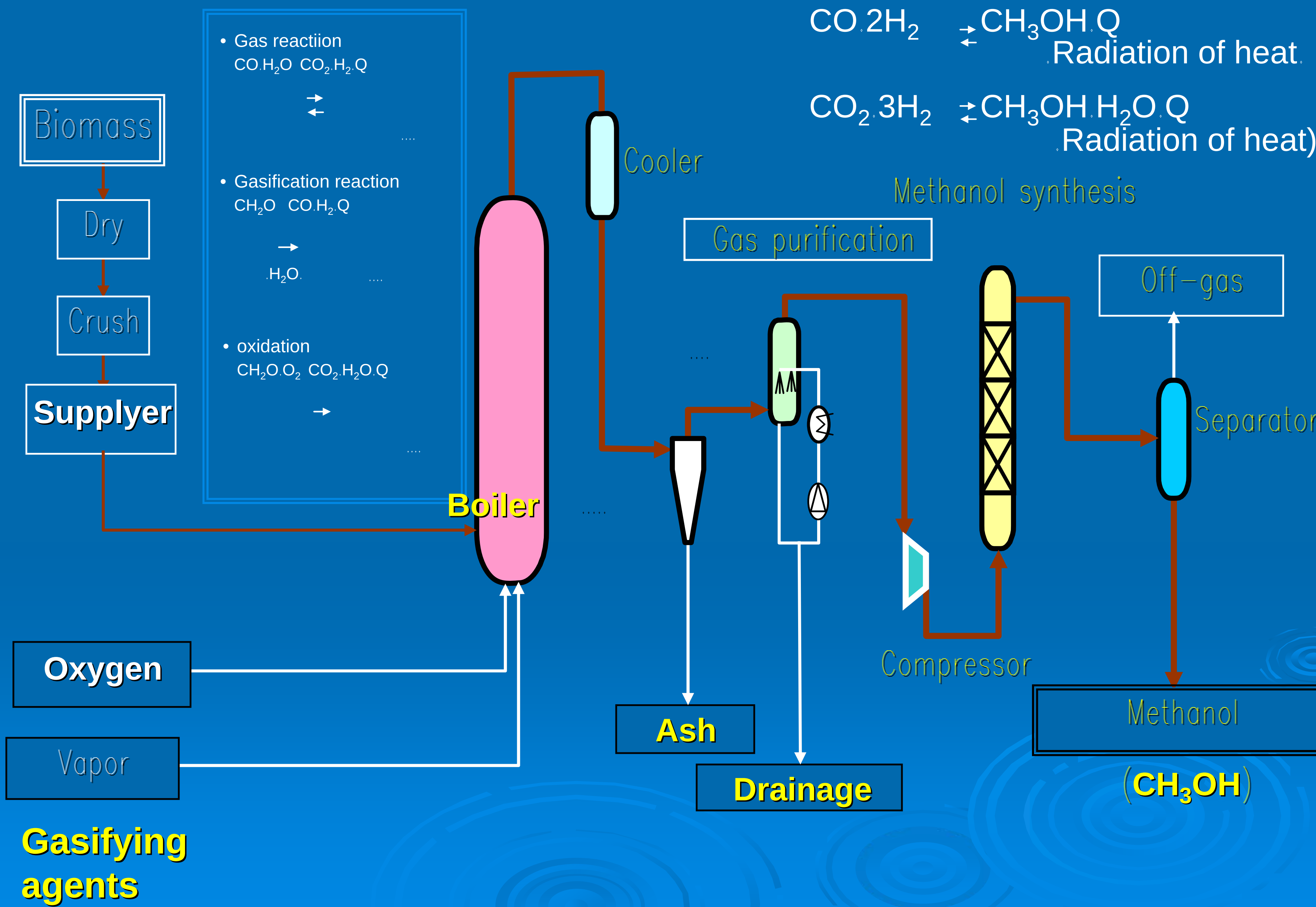
Methanol yield of various materials: we do not need to use our food for biomethanol production by this technology.

Size and handling characteristics of bran, straw and husk

Biomass	Size (mm)		Density (g/ml)	Handling characteristics
	Diameter	Length		
Bran	0.31	-	0.31	No micro-crushing needed
Straw	3.0-4.0	400	-	Micro-crushing needed
Husk	2.05	-	0.11	Micro-crushing needed
Sawdust	0.78	-	0.07	Micro-crushing needed or no micro-crushing with ceramic wool
Sorghum	7.9	50	0.07	Rough- and micro-crushing needed

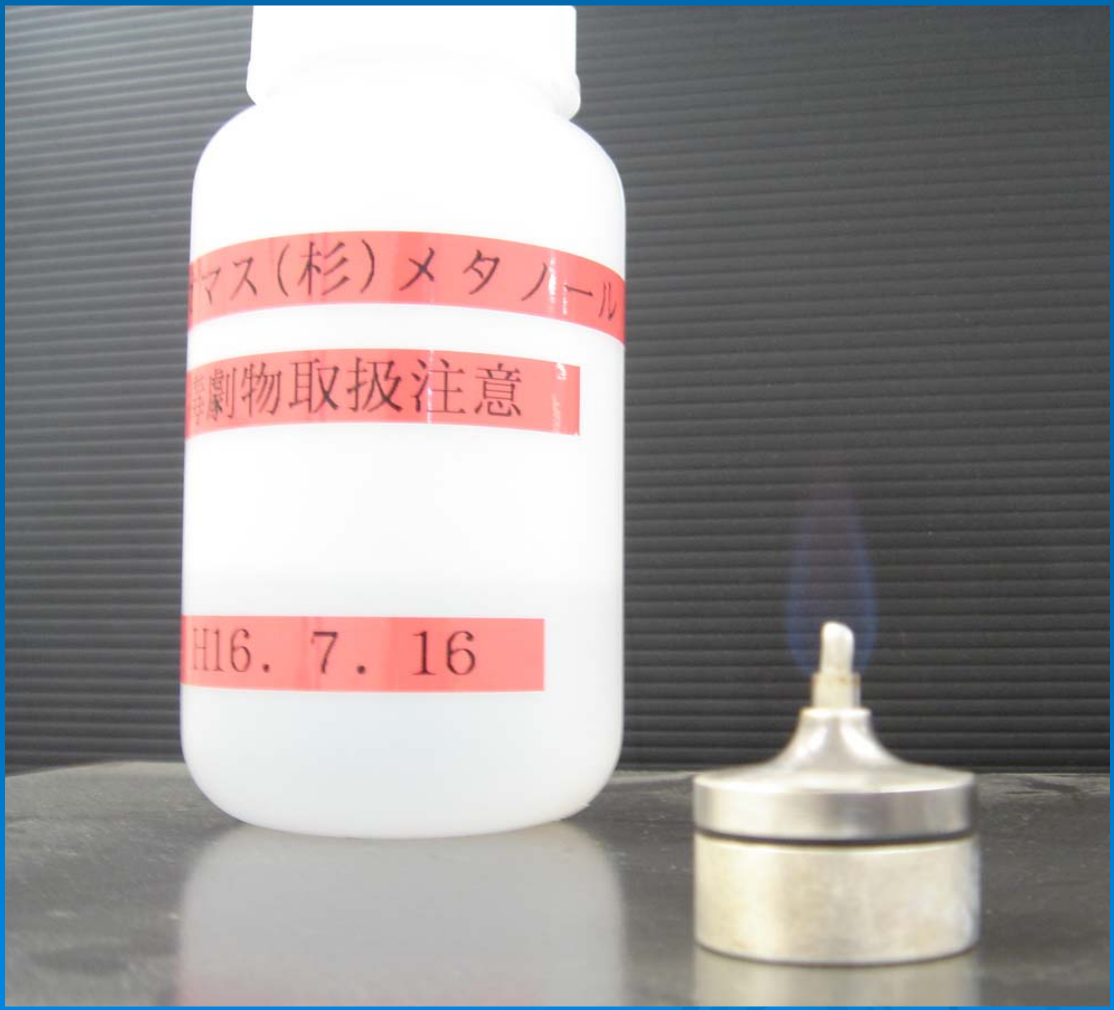

"Norin Green No. 1",
a test plant of biomethanol production (MAFF and Mitsubishi Heavy Industries)
There are 2 test plants in Japan

Biomethanol synthesis system



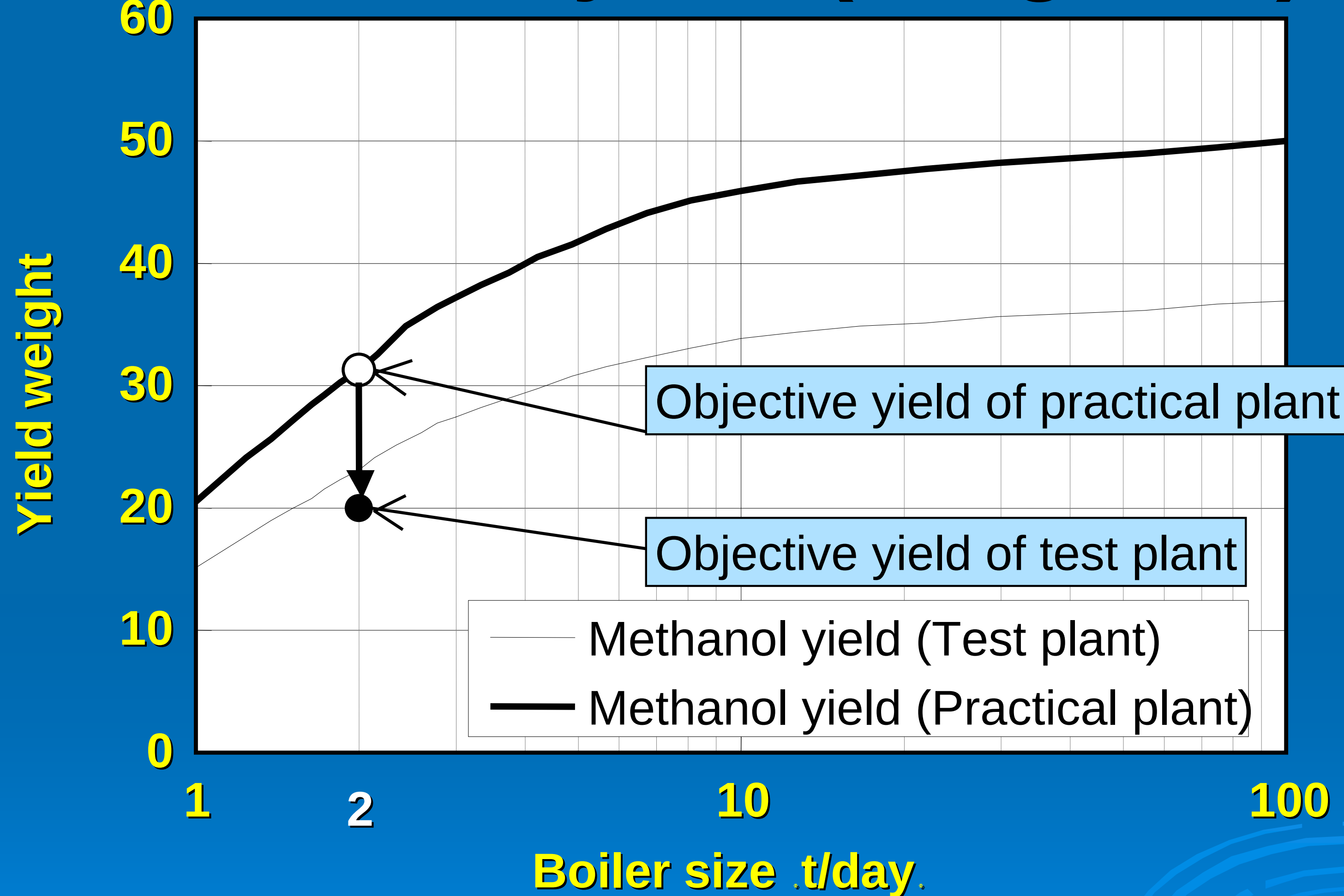
Methanol Production

Methanol Yield 20% (by weight) was attained
Practical Plant level: 40%



	Methanol Yield by Weight %
Run3 Cedar	18.5%
Run6 Cut Tree	20.2%
Run7 Drift-wood	16.0% Purity ca.95%

Objective ability Boiler size and methanol yield (weight %)



Larger the better

Yield (weight .).Methanol weight produced/Dry weight of raw materials

Objective ability Test plant and practical plant

Item	Test Plant	Practical Plant
Boiler Size Dry biomass to be processed	2t/day	100t/day
Yield (Heating value %)	65%	70~75%
Methanol Yield (by weight)	20%	40~50%

Yield (Heating value %) = Gas mixture produced/Raw material
Yield (Weight %) = Methanol produced/Dry weight of raw material

Conclusion

1) We can produce methanol by any kind of biomass (even lignin) with different yields. Therefore, we don't need to use our food for biofuel production.
2) Saw dust and rice bran is estimated to produce high methanol yield (55 %; by weight); rice straw and husks returned ca. 36 and 39 %, respectively.
3) Wood chips, rice straw, husks and bran are clean when they are gasified (little $S0_x$,$N0_x$).
4) Saw dust and rice bran can be used as raw materials without any processing; micro-crushing is required for rice straw and husks.

Application of this technology into agricultural and forest industries in Japan

The positive economic effects of biomethanol production on Japanese farming system and social system will come through by reducing CO_2 emission.

1) recycling of abandoned upland and paddy field, and woodland in mountainous areas.

2) recycling of overproduced animal manure

3) recycling of wastes of agricultural and Forest products.

4) generating new industry in depopulated mountainous areas and small islands.

Application of this technology into Agriculture and forest industry system in Asian and African countries

Second only to food production policies, energy policy is among the most important issues confronting Asian and African nations.

1) The consumption of electricity and petroleum is dramatically increasing and will be increasing much more in the future.
2) Most of these countries are relying on fossil fuels, coal, petroleum and natural gas, which will run short in a few decades.
3) The developing countries located in tropical and subtropical regions should pursue the development of a biofuel-based energy resource because photosynthesis (biomass production) of plants is higher in the regions.
4) Amount of by products of Agriculture, forest and fruit tree industry (plantation) including oil palm is huge in tropical and subtropical regions.

The future of humanity (the environment, the earth and mankind) will be directed by the decisions we make today.

a) The development of a sustainable biofuel production system.

Or

b) The adherence to the traditional fossil fuel system.

This C1 chemical transformation technology suggest one possibility for biomethanol production because it can use all types of biomass efficiently as raw materials.

Thank you