Panel Discussion

The 6th Biomass Asia Workshop

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Drive for biorefinery society

- Society of 80% reduction of CO_2 emission by 2050 will not be able to accomplish without the establishment of biorefinery society!!
- Framework and central technologies for biorefinery society have been established on 1950's (USA, Canada, Japan, Sweden)!!
- Biorefinery society can be established even now, if cost can be disregard.

➔How can fall the cost?

→Fall by technological innovation

→Carbon neutralization of energy charge

→Introduction of carbon tax

➔What are characteristics of biomass?

→Sparse and far-reaching distribution comparing with petroleum

→Bulky solids in general

→Wide varieties of characteristics

→re-productivity and sustainability

- Biorefinery society can activate rural area, but is difficult to get "Mass merit" as petroleum refinery industry

→Petroleum refinery industry: Huge size, Intensive, Harbor location….

→Biorefinery industry: Small scale, Decentralization, Rural location….

→Analysis of rural circumstance: Extent of skill, HDI, Education & training

- Construction of Biomass Industrial Complex

  Analysis and grasp of relationship of products, by-products, wastes…

Biomass Industrial Complex (BIC)

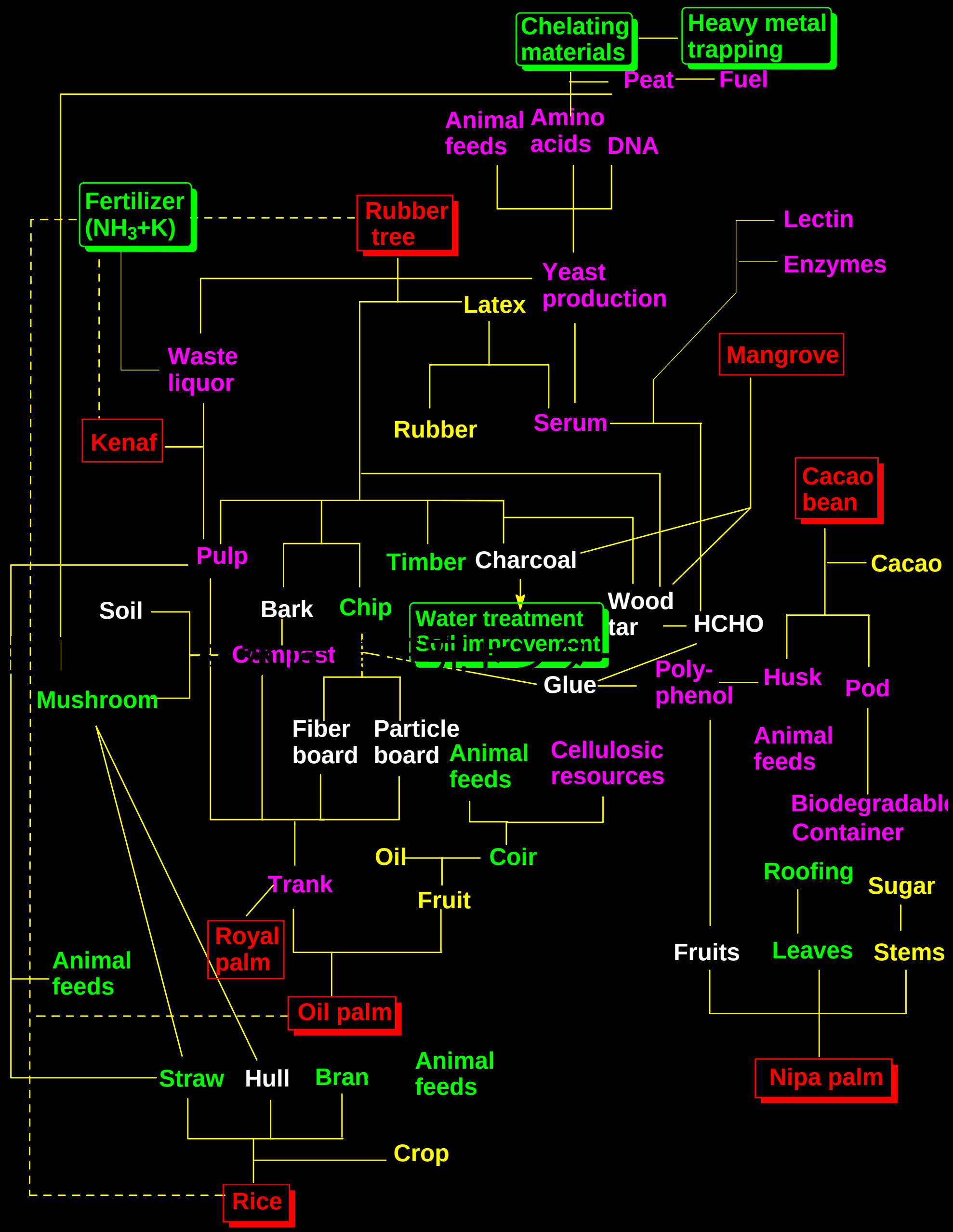
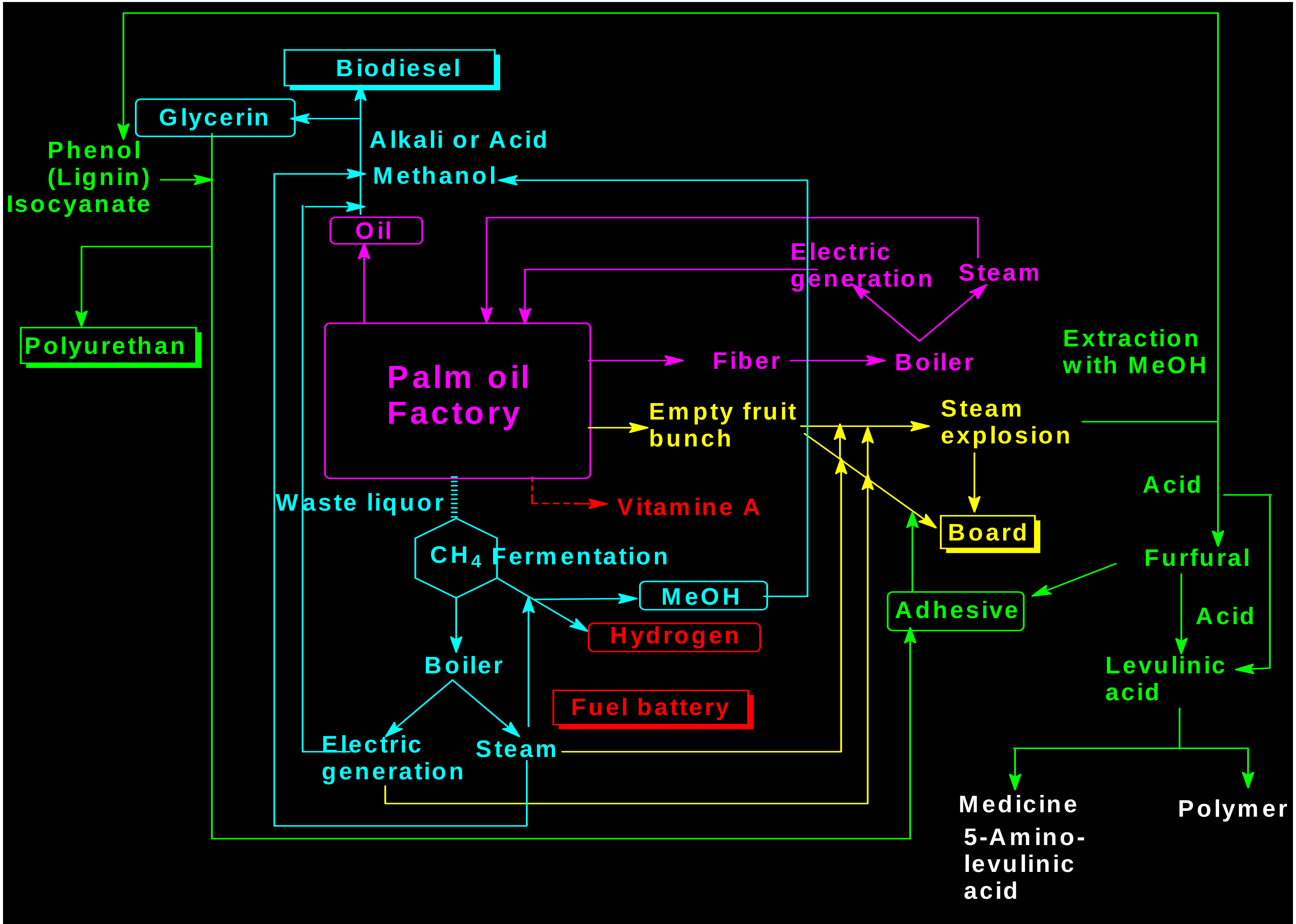


Fig. 1 Example of material flow of biomass industrial complex (BIC) using plantation and agricultural wastes

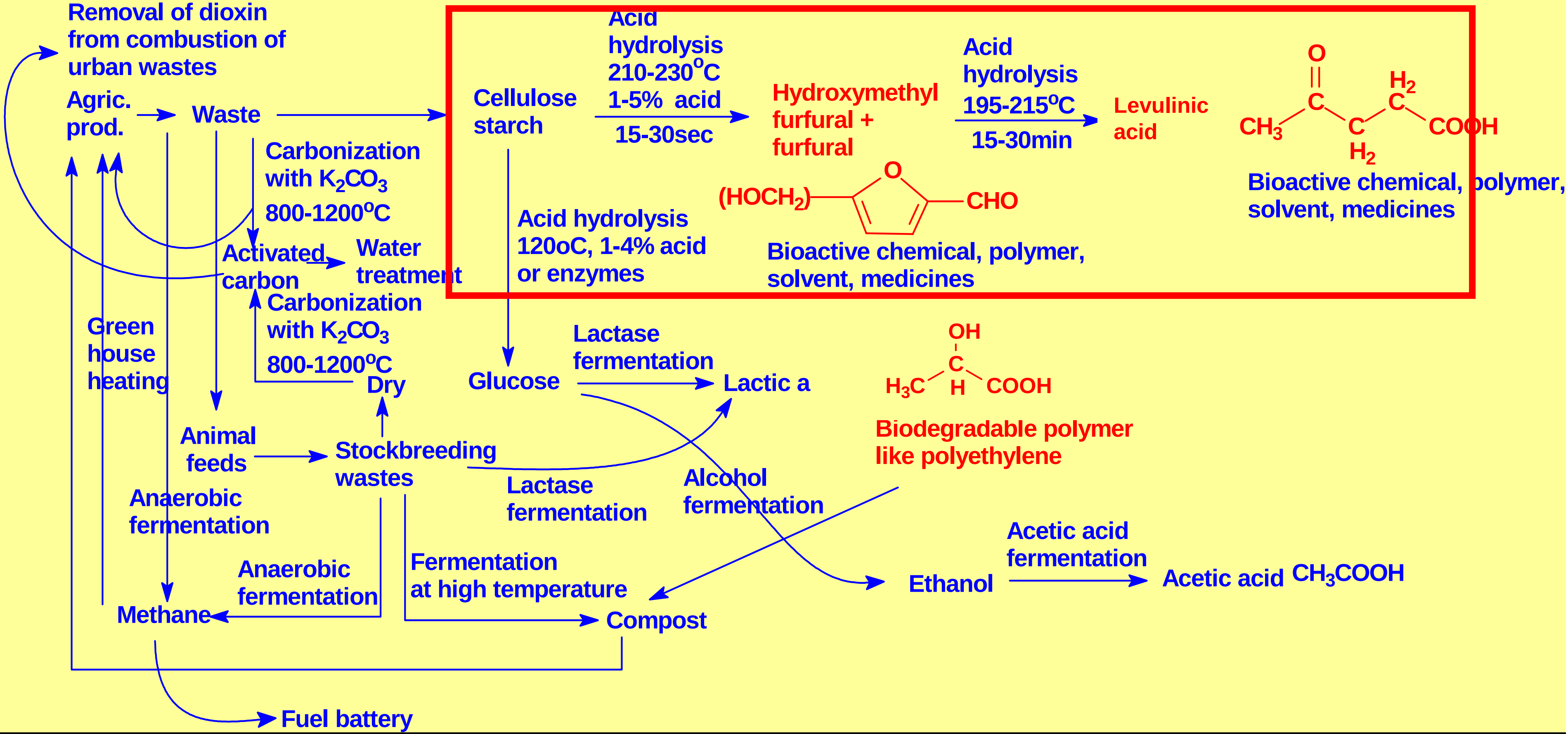


Biomass Industrial Complex based on palm oil factory

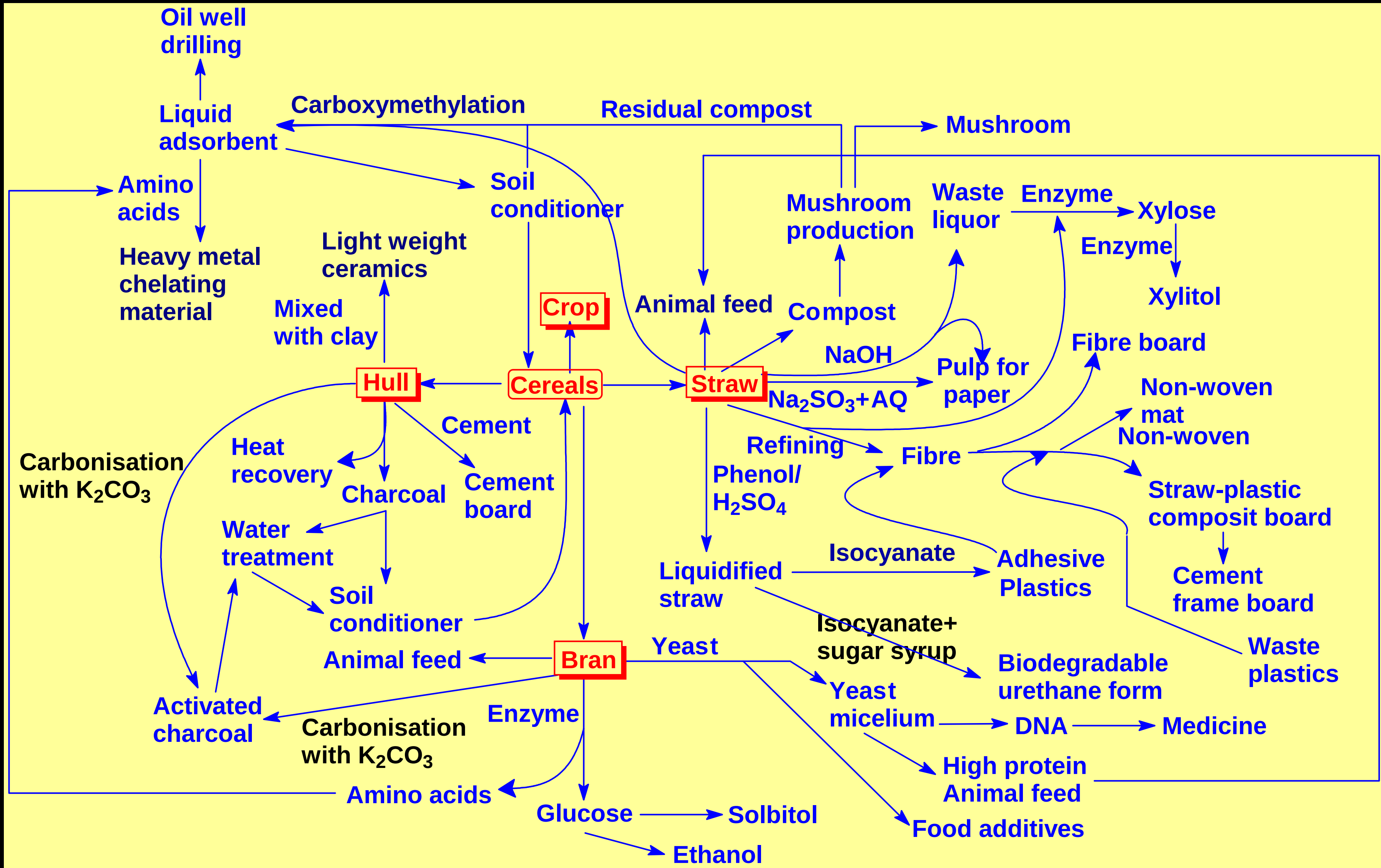
Possible effective utilization of agricultural wastes (1)

Agricultural wastes: Rich in nitrogen, starch, and easily biodegraded wall components

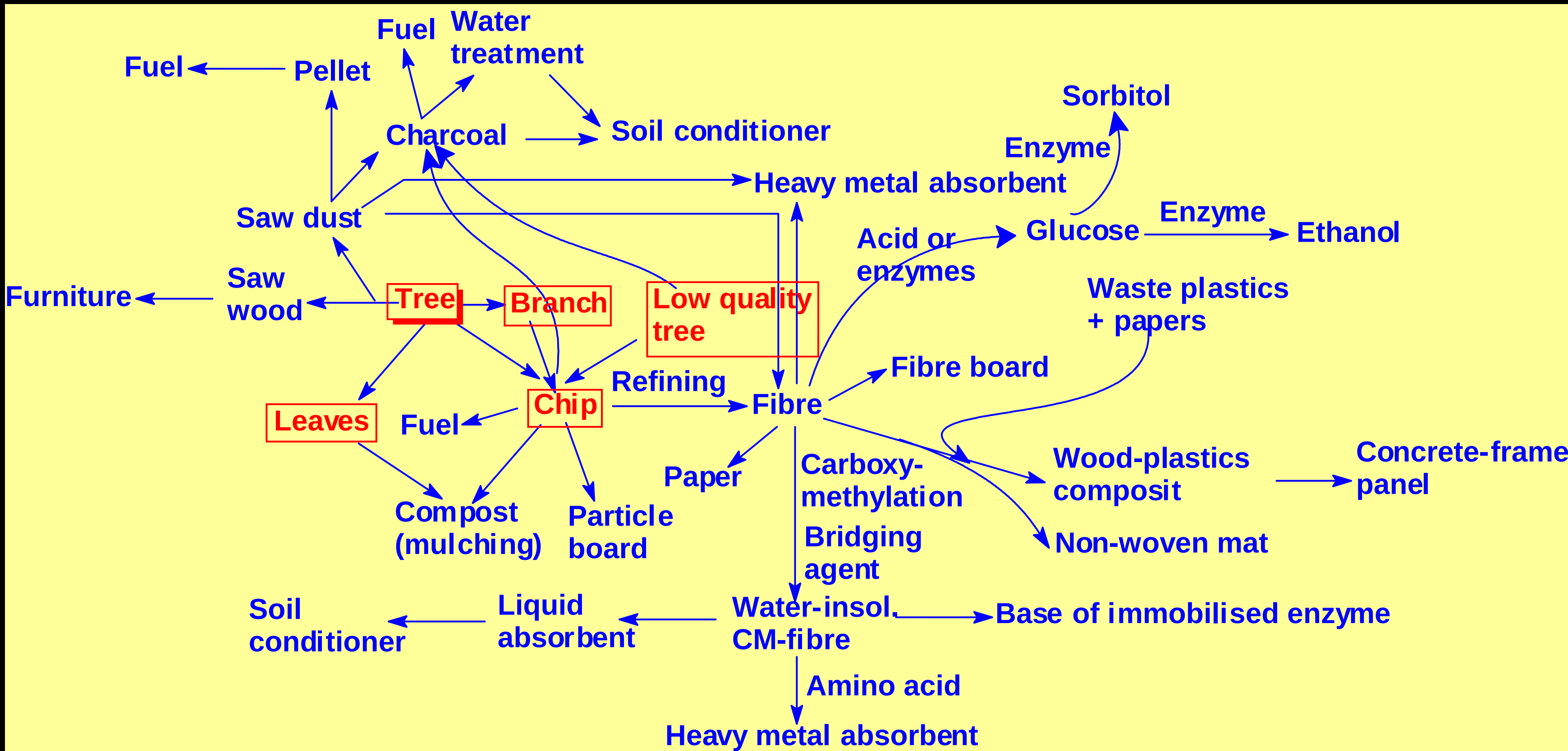
Stockbreeding wastes: Rich in nitrogen from microflora and wall components resist to biodegradation



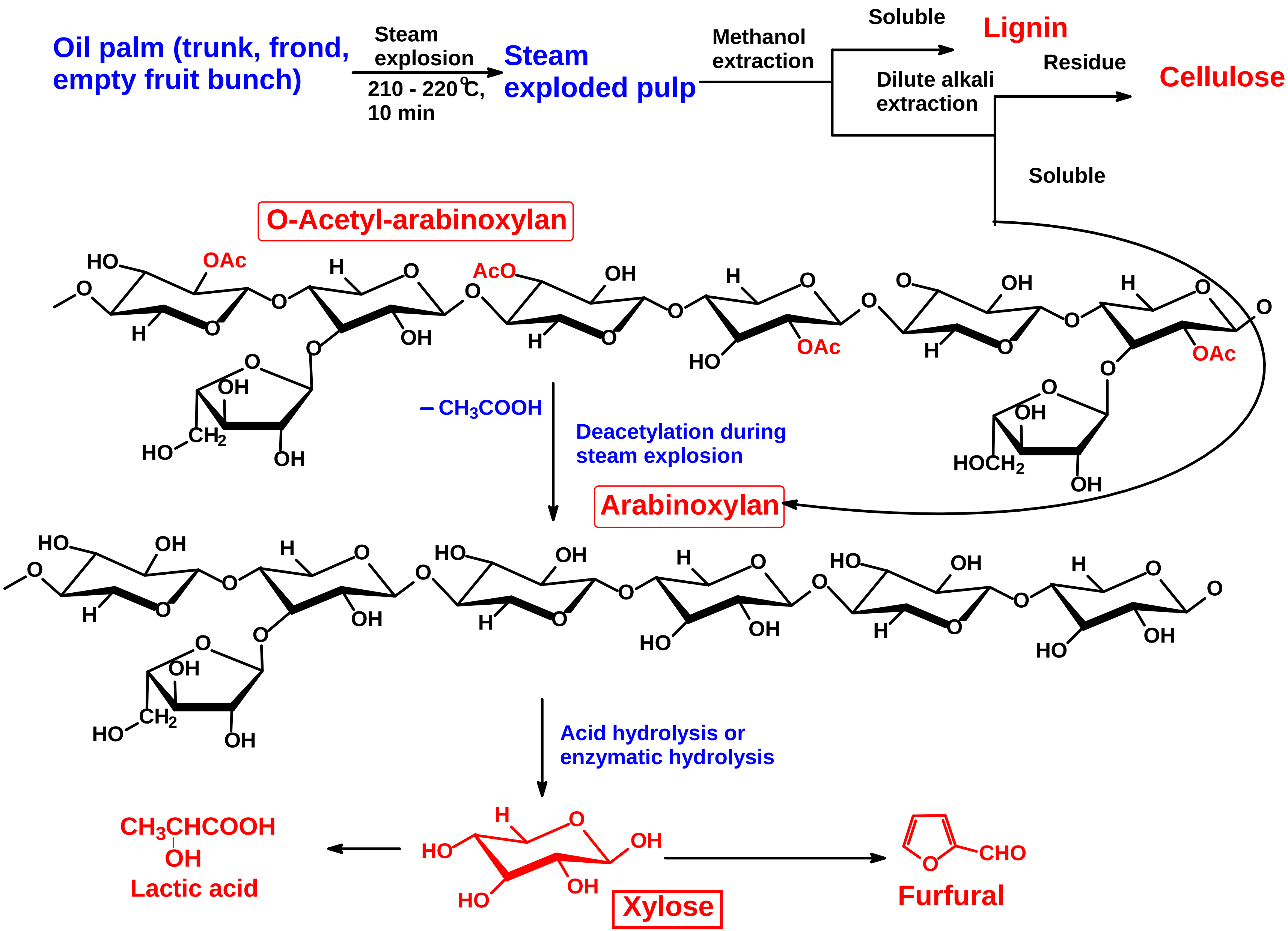
Possible effective utilization of agricultural wastes (2)



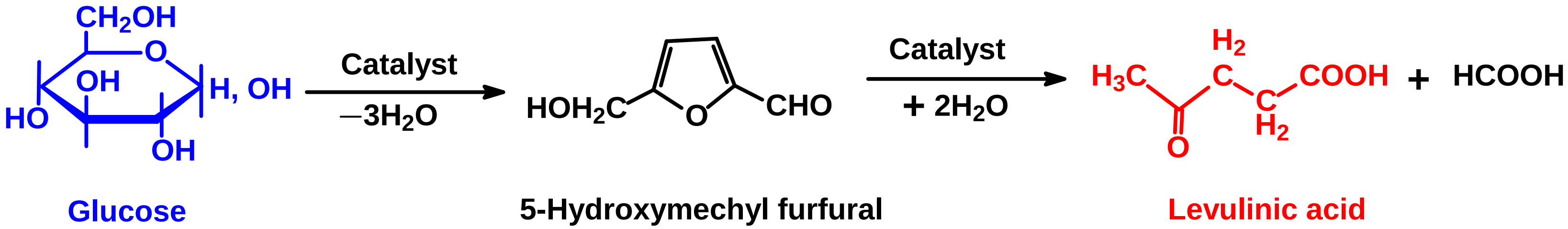
Possible effective utilization of angiosperm wood

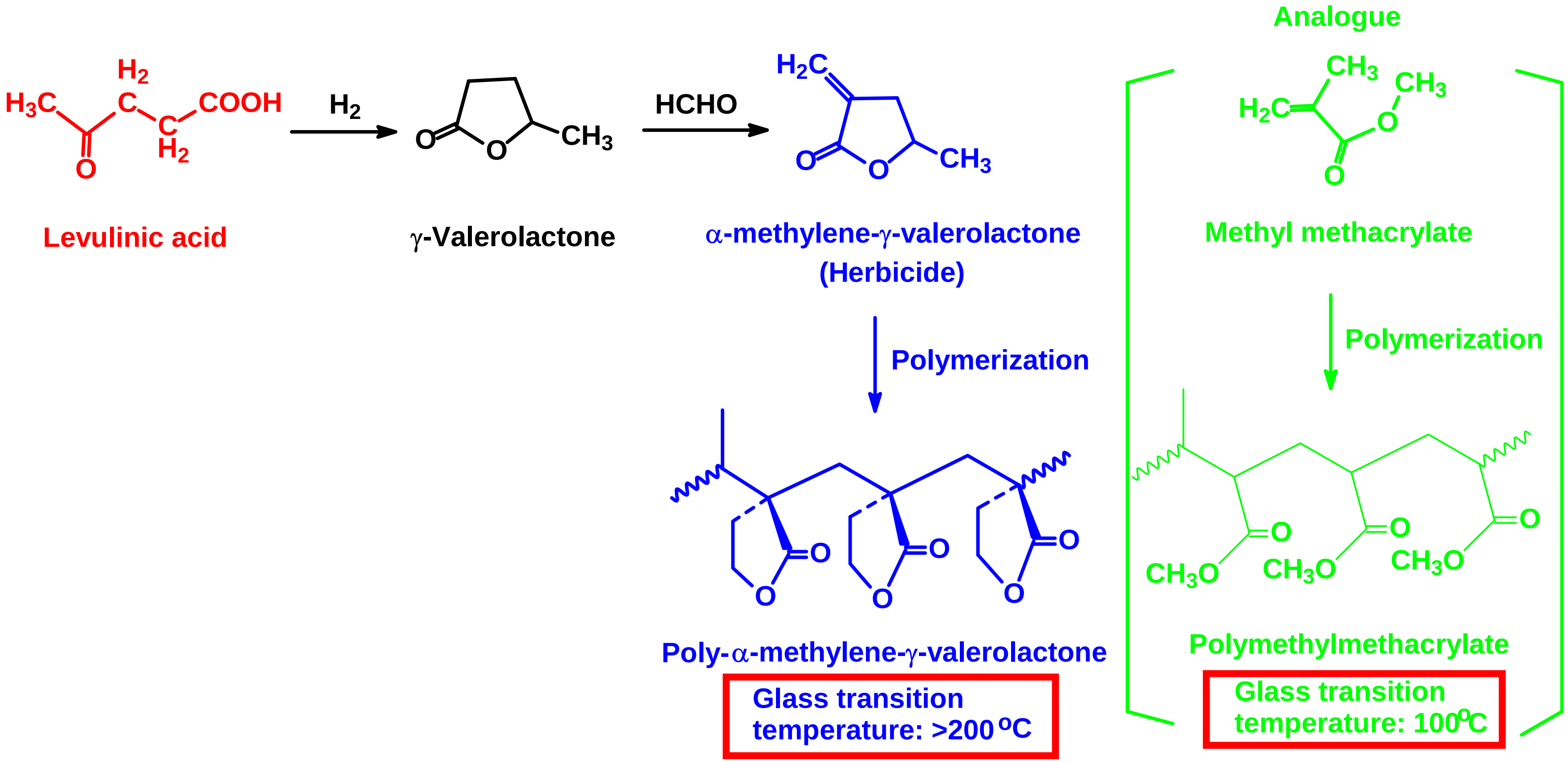


Production of chemicals from xylan

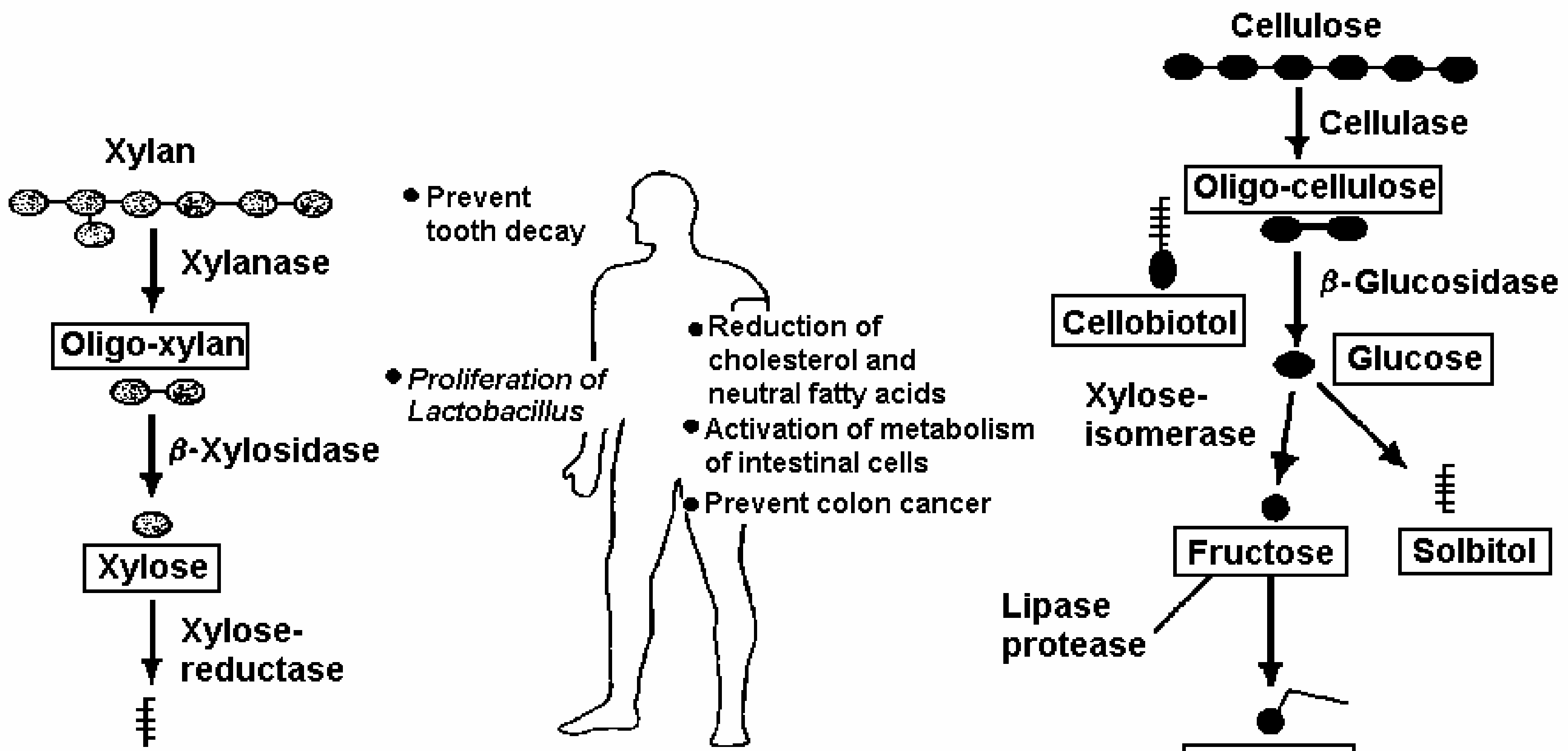


Synthesis of polymer from levulinic acid

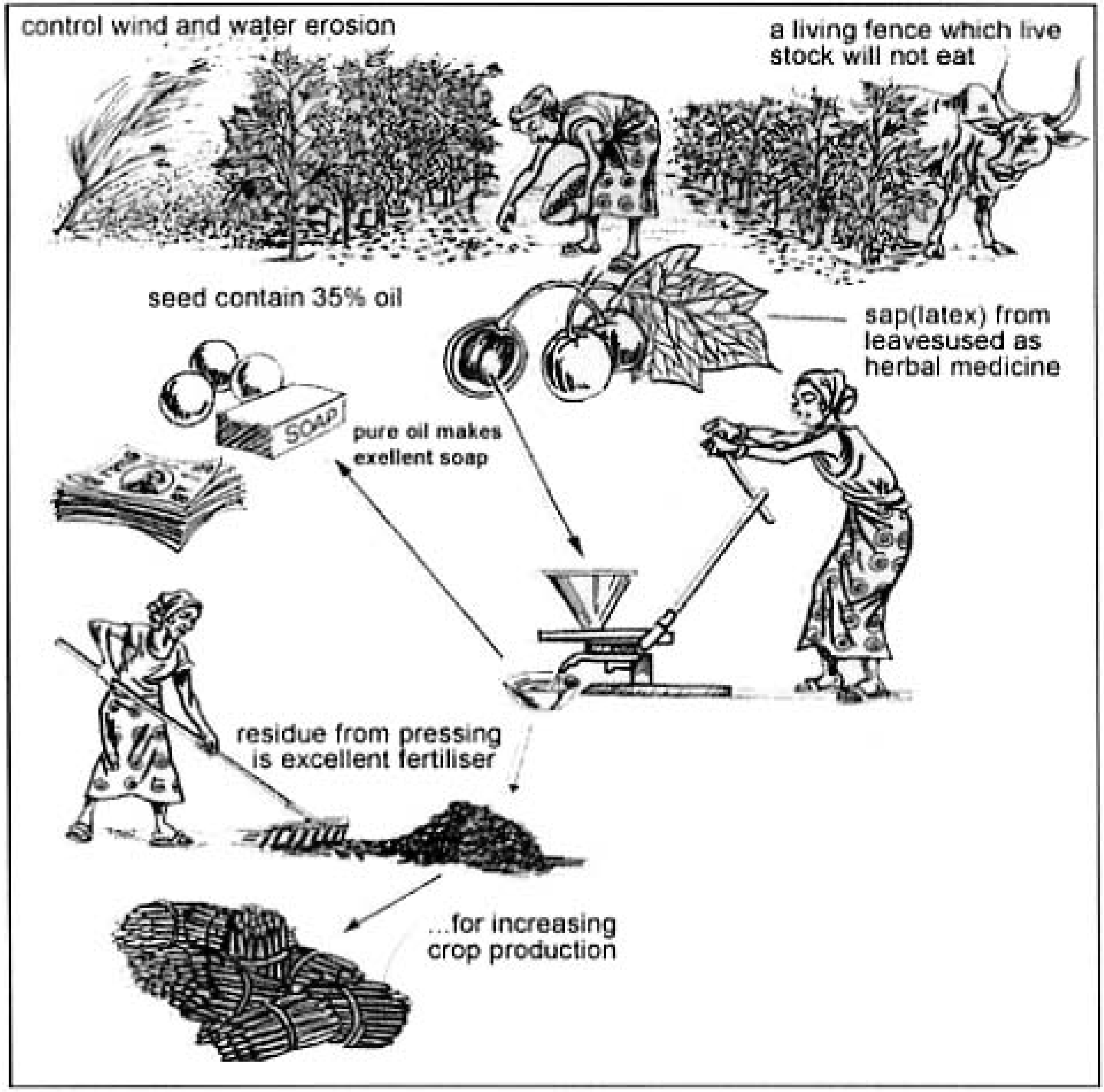




Valuable materials produced from lignocelluloses

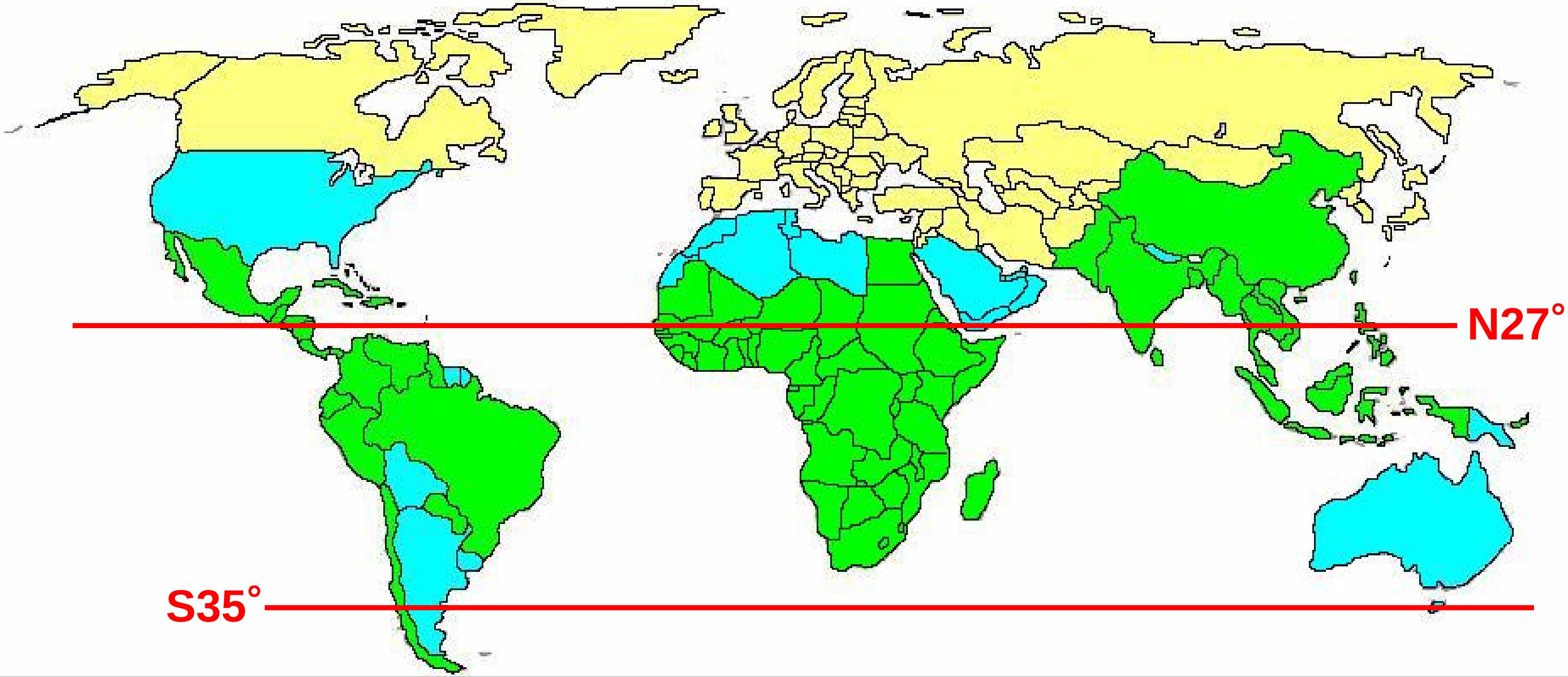


Bioactive food additives from lignocellulose



Traditional use of J. curcas

Cultivation of J. curcas



1 st priority

Countries analysed with first priority: Highly suitable climatic conditions for Jatropha cultivation

→ Jatropha projects known or very likely to exist

2 nd priority

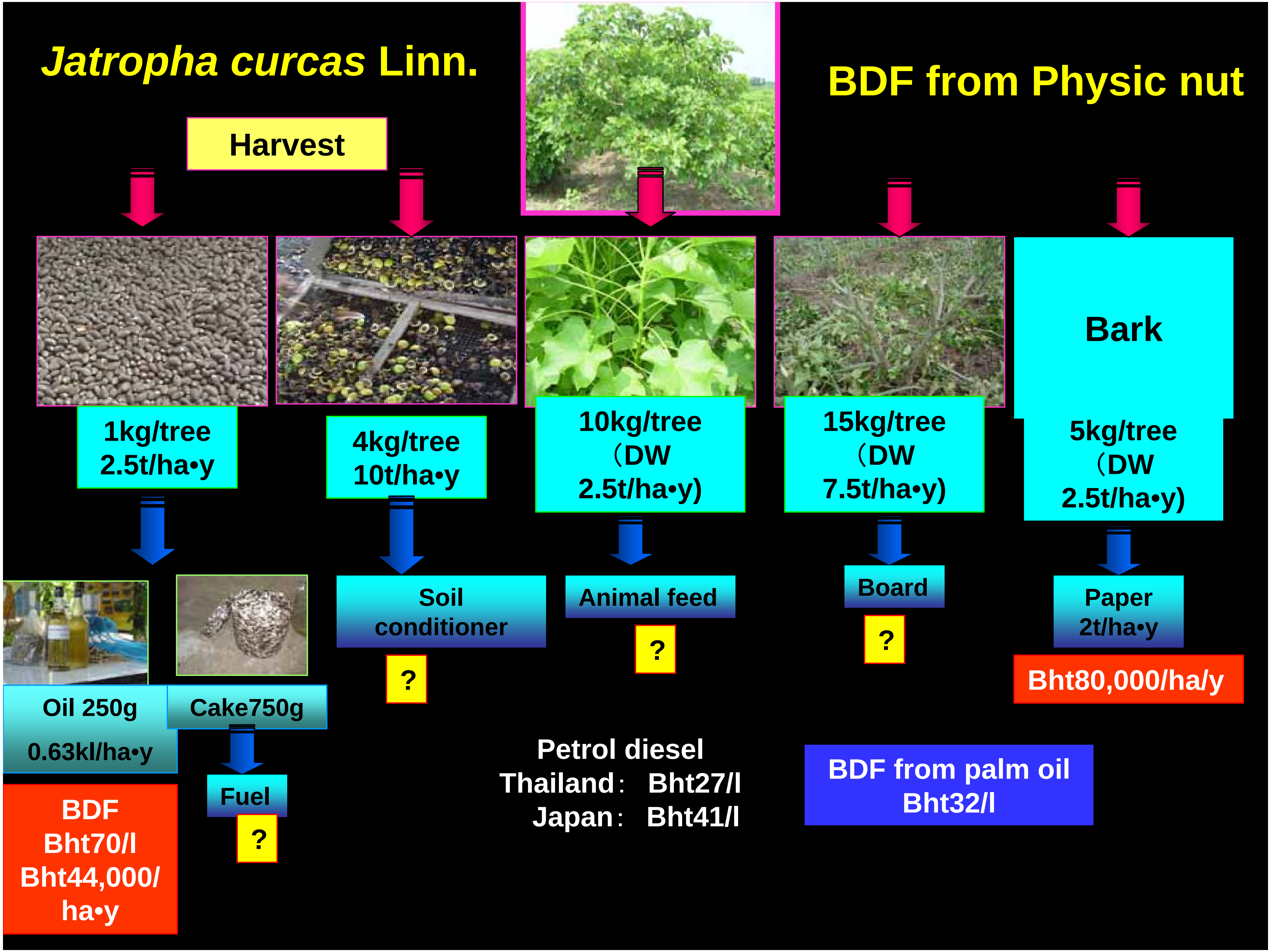
Countries analysed with second priority: Suitable conditions for Jatropha cultivation

→ Jatropha projects may exist

3 rd priority

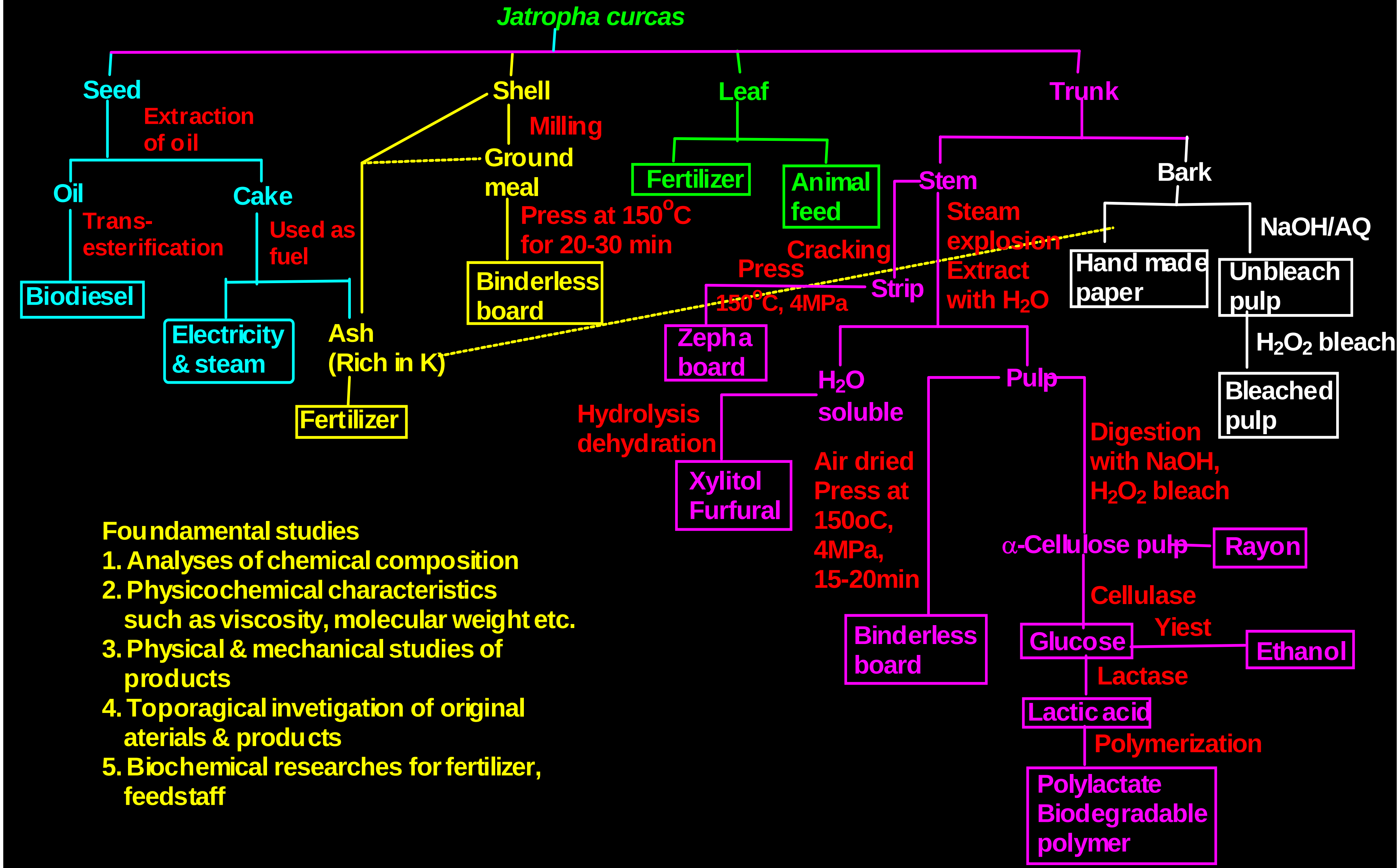
Countries not analysed:

Jatropha projects not expected (e.g. due to climatic reasons), highly unlikely (e.g. due to very high labour costs) or difficult to research (e.g. due to political crises)



Jatropha curcas Linn.
BDF from Physic nut
Harvest
1kg/tree
2.5t/ha•y
4kg/tree
10t/ha•y
10kg/tree
（DW
2.5t/ha•y)
15kg/tree
（DW
7.5t/ha•y)
Bark
5kg/tree
（DW
2.5t/ha•y)
Oil 250g
0.63kl/ha•y
Cake750g
Soil conditioner
?
Animal feed
?
Board
?
Paper
2t/ha•y
Bht80,000/ha/y
BDF
Bht70/l
Bht44,000/
ha•y
Fuel
?
Petrol diesel
Thailand： Bht27/l
Japan： Bht41/l
BDF from palm oil
Bht32/l

Preliminary study of utilization of *Jatropha* Industrial Complex based on Zero-Emission Initiative



Foundamental studies

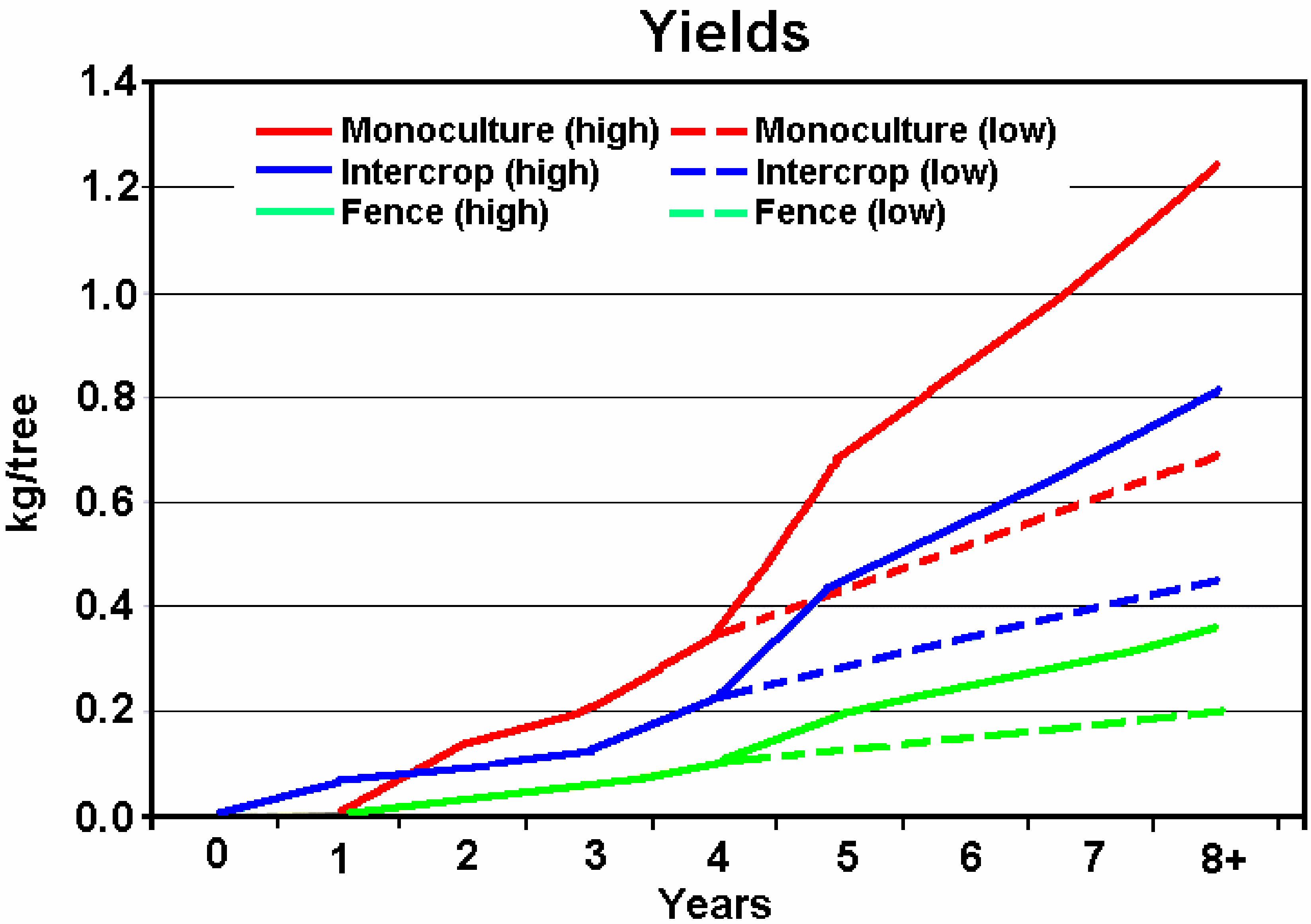
1. Analyses of chemical composition
2. Physicochemical characteristics such as viscosity, molecular weight etc.
3. Physical & mechanical studies of products
4. Toporagical invetigation of original aterials & products
5. Biochemical researches for fertilizer, feedstaff

Plantation Kasesart University farm

3 years old *J. curcas*

Harvest 4 times in a year

Yield of Jatropha fruits cultivated different conditions



Production data of *J. curcas* in China

	Low value	High value
Oil content, %	30	41
Planting interval, trees/ha	1,200	1,950
Yield of seeds (Degraded land), t/ha	1.7	2.2
Yield of seeds (Arable land), t/ha	3.9	7.5
Extractable oil, %	60	80
BDF yield (Degraded land), L/ha	340	795
BDF yield (Arable land), L/ha	795	2,840
Conversion factor, seed/BDF	5.5	3.0

BDF yield at degraded land is about 1/9 of that at arable land

➡Progress of encroachment of arable land

Cultivation of Jatropha

- *Jatropha* can grow devastated land, but yield of fruits is very low, sometime 1/10 comparing with kept up arable land.
- Large scale Jatropha plantation will invade certainly to well maintained arable land➔ compete with crop cultivation.
- Jatropha cultivation should be restricted in small scale at rural area, and oil should be consumed at rural area.
- Don’t need to prepare methyl ester in tropical and subtropical area, directly use to small scale machines for agriculture.

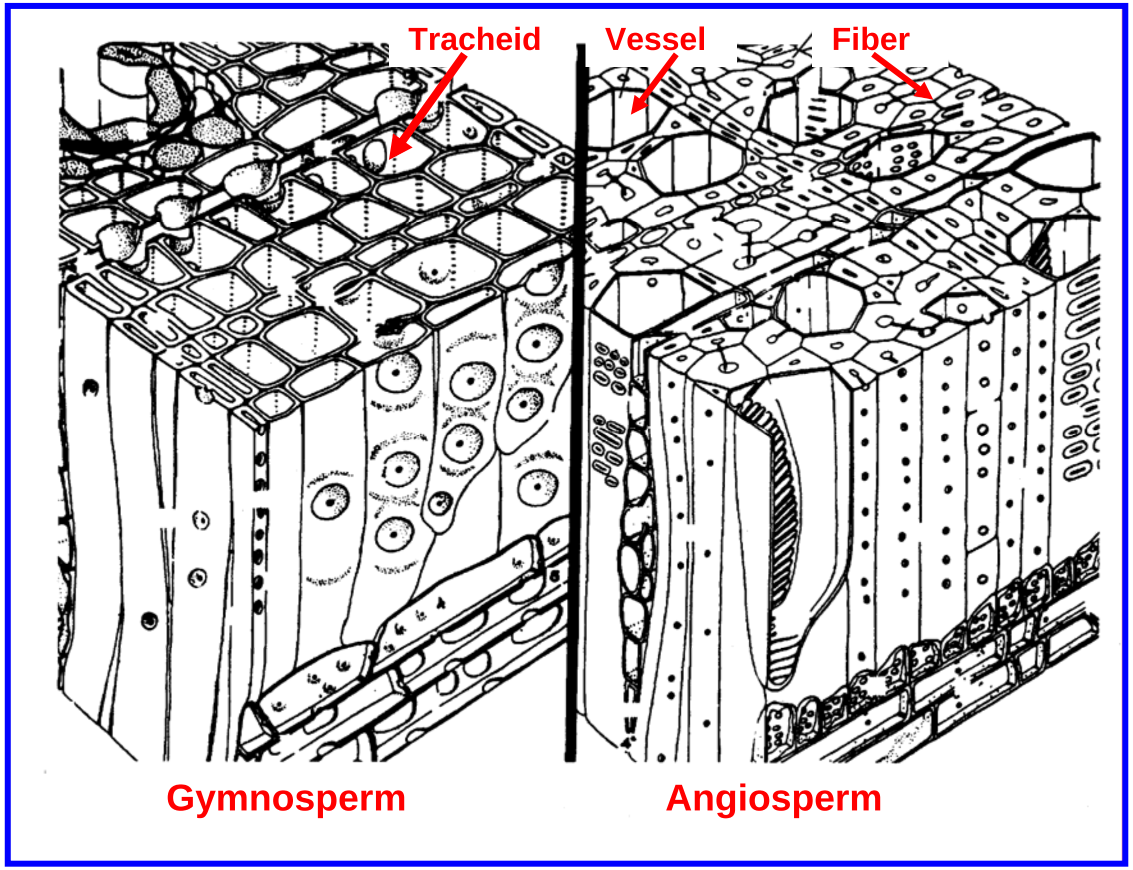
Resources for bioethanol

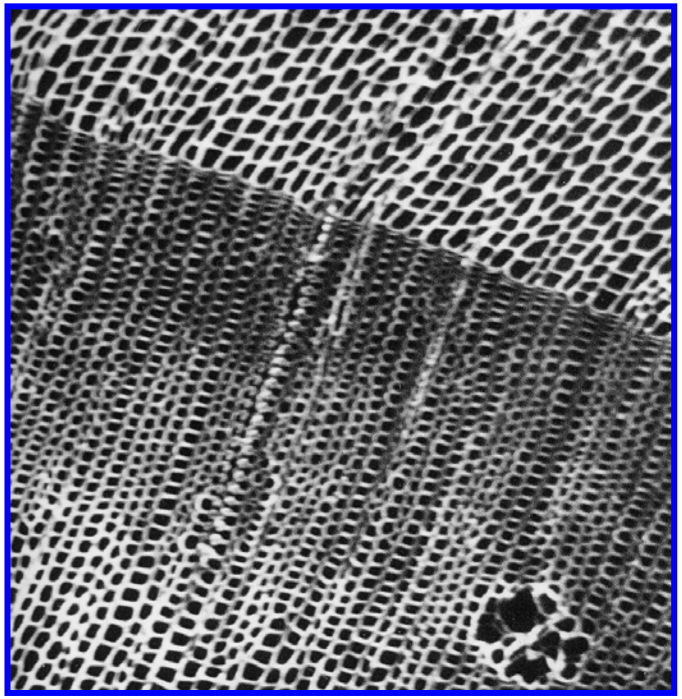
- Secondary fiber of copy paper,
- Fine fiber (pass 150μm) during pulping and bleaching
- Vascular plants sunk in water such as *Egeria densa* and *E. nuttallii*.

Resources for biodiesel

- Palm oil
- Micro algae such as chlorella.

Egeria densa ***E. nuttallii***

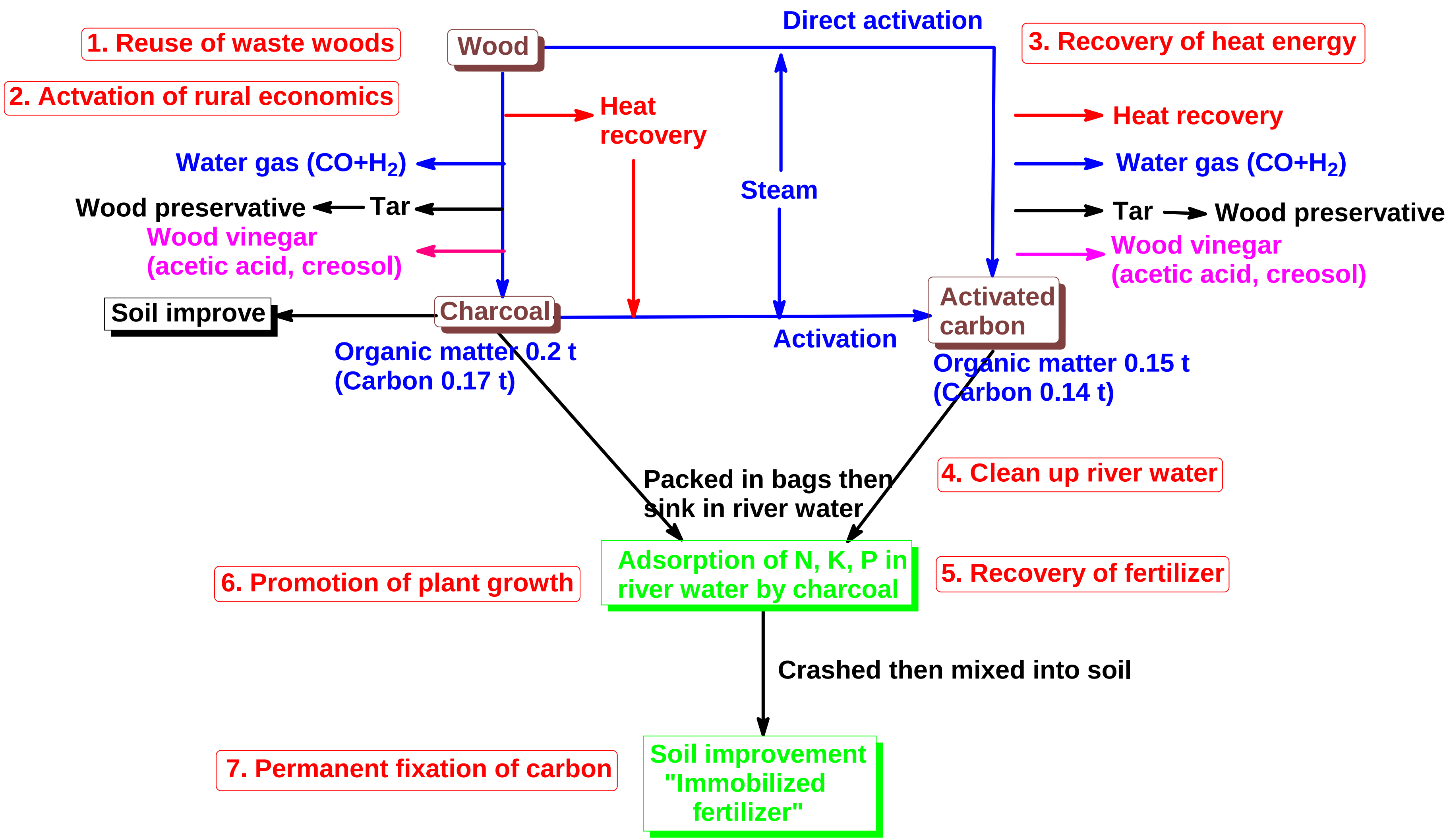




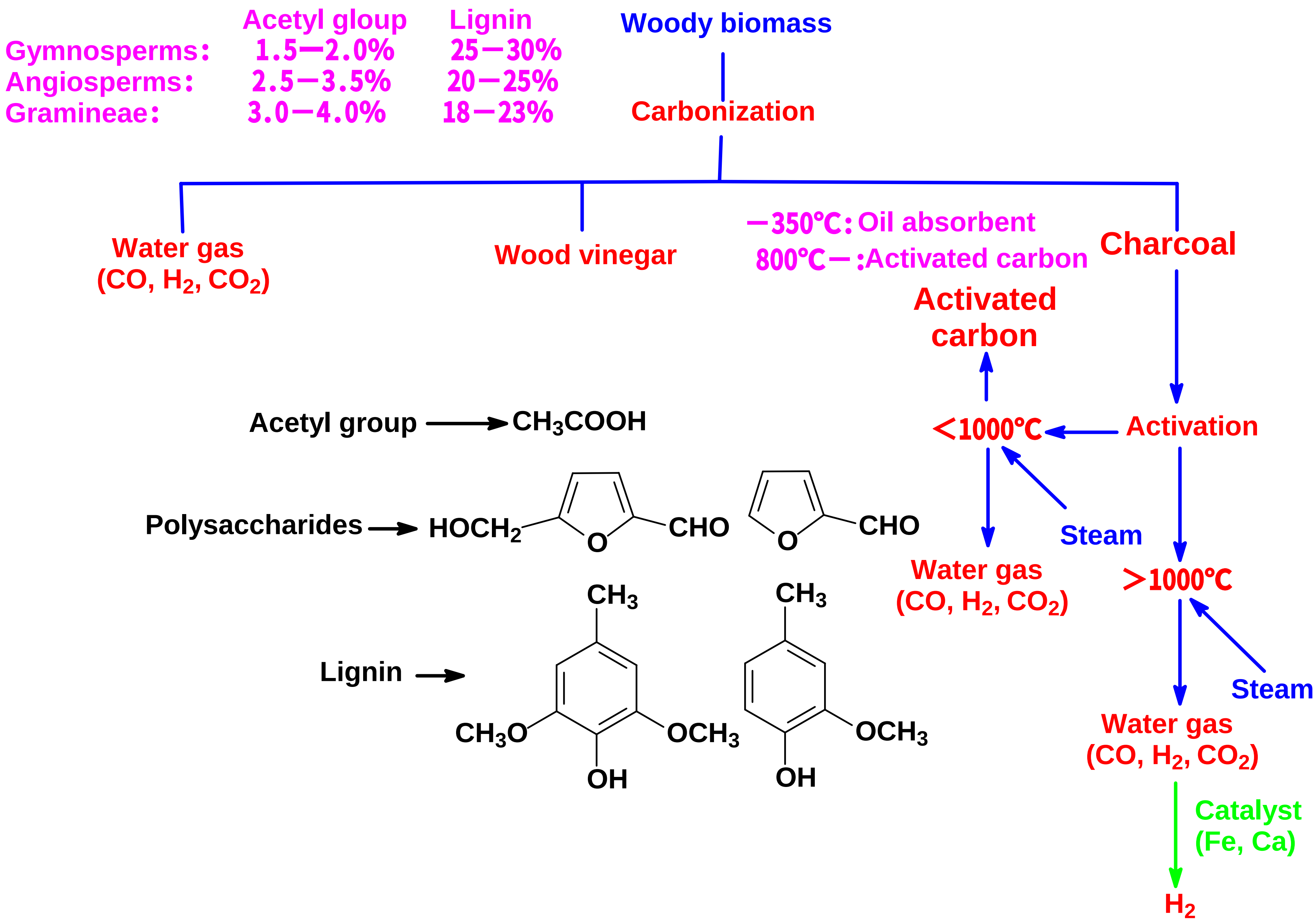
Charcoal

Charcoal is a carbonized product of woody biomass at 600-800℃ (yield: 10-15% of woody biomass, never decomposed by microorganisms. Charcoal is quite porous（inner surface of charcoal: 200-300m^2/g, activated carbon: 600-800m^2/g）, is keeping huge amount of oxygen in pores. Charcoal supplies oxygen to plant roots when charcoal is plowed into soil, and plant growth is promoted by propagation of aerobic microbes. Charcoal absorbs fertilizers (N, K, P) by sinking in river water. Charcoal absorbed fertilizer is applied to cultivated area as an "immobilized fertilizer".

Function of charcoal and permanent fixation of carbon



Huge amount of fertilizers are flowing out into small river at rural area. Such fertilizers are adsorbed by charcoals. The river is cleaned up and charcoal is changed to immobilized fertilizer.

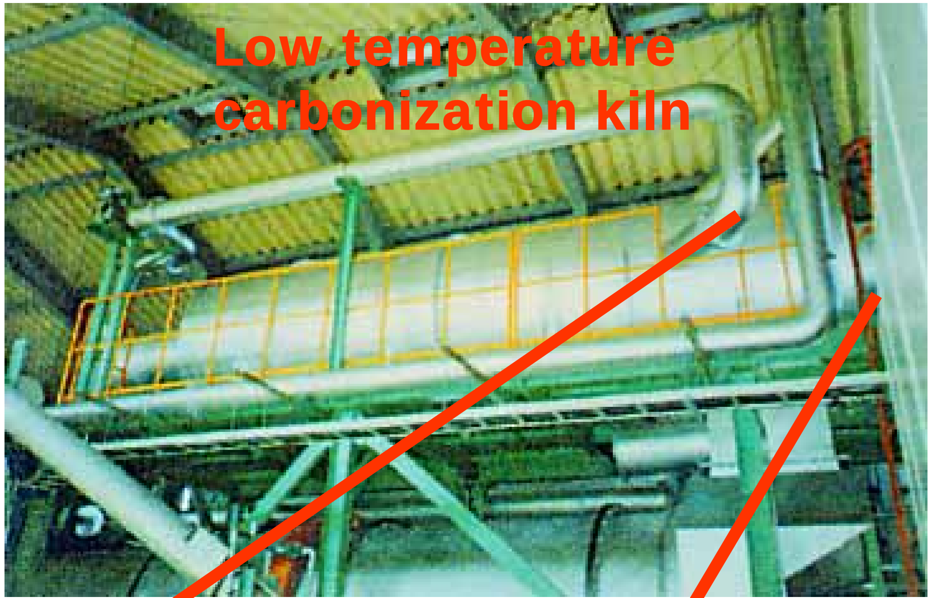

Acetyl gloup
Lignin
Woody biomass
Gymnosperms: 1.5−2.0% 25−30%
Angiosperms: 2.5−3.5% 20−25%
Gramineae: 3.0−4.0% 18−23%
Carbonization
Water gas
(CO, H2, CO2)
Wood vinegar
−350℃: Oil absorbent
800℃−: Activated carbon
Charcoal
Activated carbon
Acetyl group
CH3COOH
Polysaccharides
HOCH2
CHO
O
Lignin
CH3
CH3O
OCH3
OH
<1000℃
Activation
Steam
Water gas
(CO, H2, CO2)
>1000℃
Steam
Water gas
(CO, H2, CO2)
Catalyst
(Fe, Ca)
H2

Charcoal production with very low investment

Adsorption experiment of charcoal in Indonesia

Promotion of plant growth with charcoal

Modern charcoal production system at Saku city in Japan



Tar-free wood vinegar is applied as soil improvement.

Charcoal production from coconut shells (Philippines)

Charcoal production from coconut shells
(Indonesia)

Woody biomass is mildly burned to collect wood vinegar only.

Smoke is cooled by long tube of bamboo, and collect wood vinegar

Production of wood vinegar as pesticide at Nakhon Rachashima, Thailand