



Biogas Production from Crop Straw through Anaerobic Digestion

**——Key Technologies and Demonstrations
in China**

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Contents

1

Problems on the use of crop straw

2

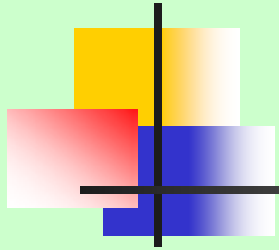
Key technologies for effective biogasification of crop straw

3

Demonstration projects in China

4

Challenges



1. Problems with crop straw in China

Amounts and Problems

- 700 million tons of various crop straw are generated every year in China
- ~50% are used as feedstock, animal bedding, construction materials, soil amendments, etc...
- The rest is **burnt in open field**

Fire disaster!



Air pollution!



Traffic accident!





Utilization as bio-resources

- **As fuels:**

- **Burn directly** smoke...
- **Pyrolysis** tar...
- **Gasification** char...

- **As substrate:**

- **Ethanol fermentation** long way to go...
- **Anaerobic digestion** comparatively reliable!
——produce bioenergy & reduce the
pollution from crop straw



Existing Problems

- ◆ **Low biodegradability, low biogas yield, and long digestion time**
 - due to high content of lignocellulose in crop straw

- ◆ **Inconvenience in industrial applications**
 - due to special characteristics, such as intertwining, hard to load in and discharge, low bulking density, inflation in water, not uniform...



Potential Solutions

◆ Pretreatment

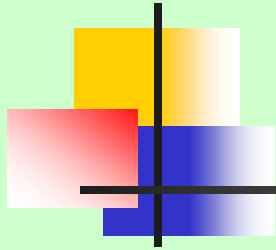
— to improve the biodegradability

◆ Optimizing the digester

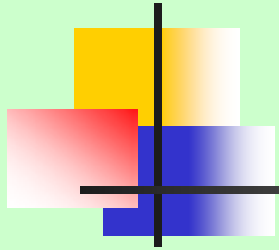
— to adapt to the special material properties, and meet the biological requirements

◆ Optimizing operational parameters

— to determine optimal parameters to achieve the best performance

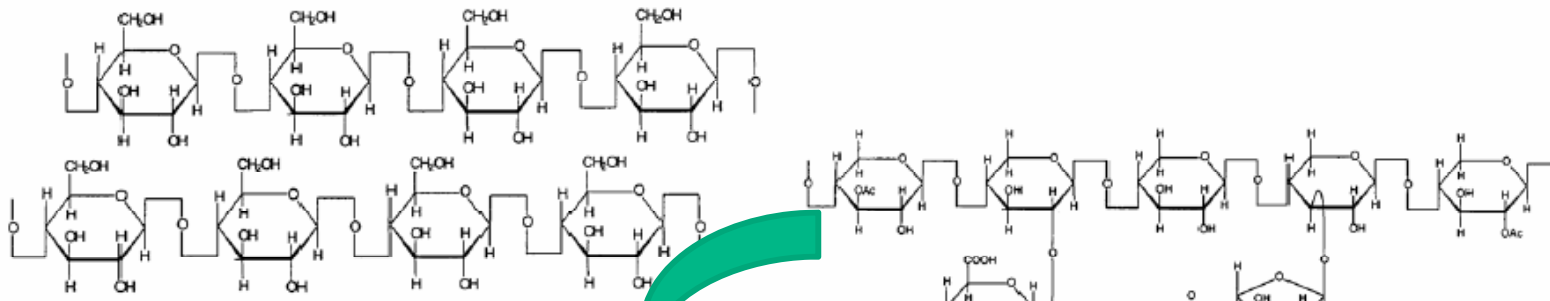


2. Key technologies for effective biogasification of crop straw



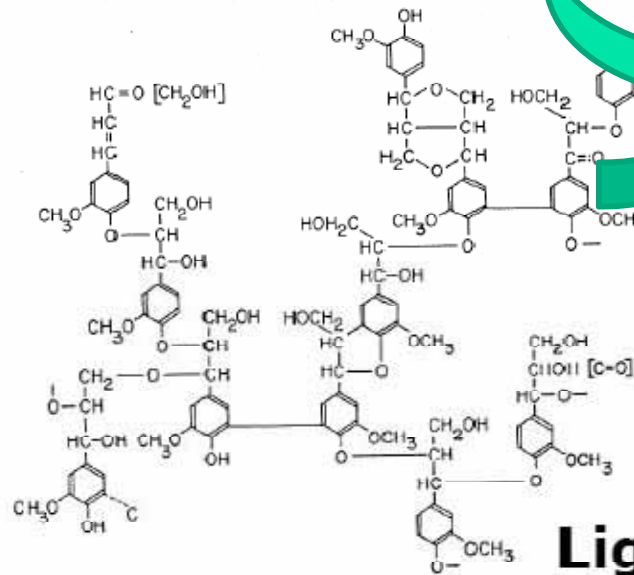
2.1 Pretreatment technologies

Why Pretreatment is needed?



Cellulose

Hemicellulose



Lignin



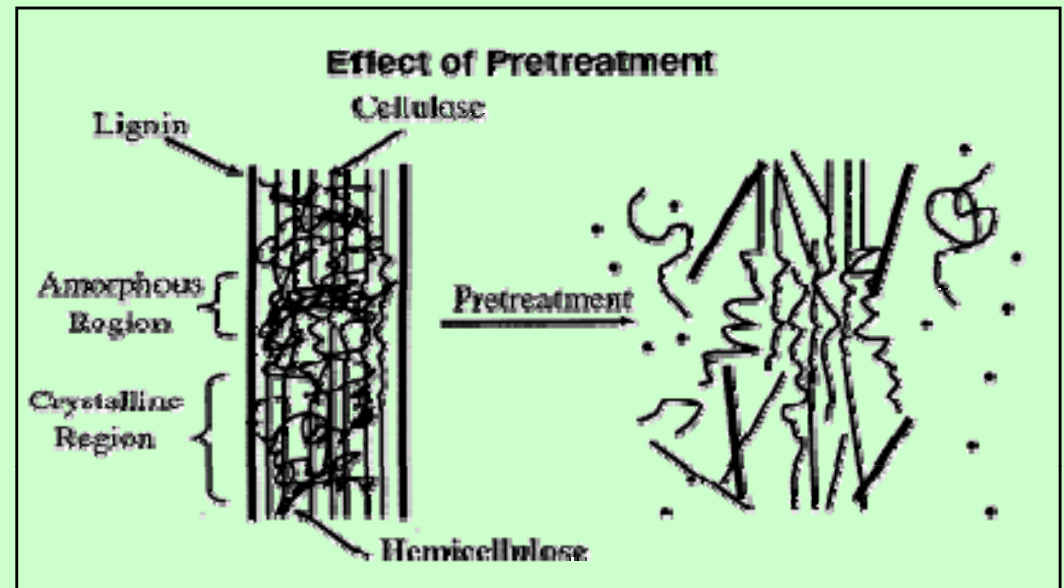
Purpose of Pretreatment

— to improve the biodegradability through:

(1) breaking the links between cellulose, hemicellulose and lignin, making more carbohydrate available

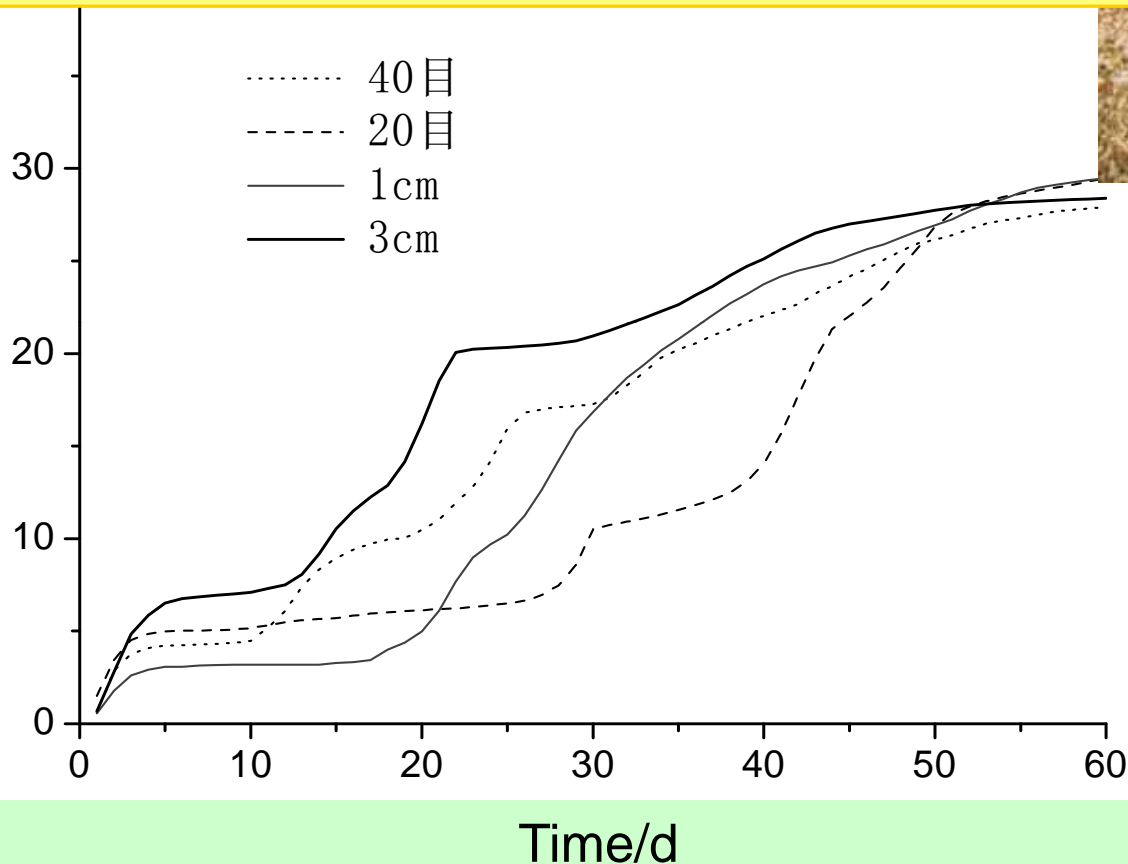
(2) decomposing lignin, cellulose, and hemicellulose to obtain more readily biodegradable substances

- **Physical methods:** chopping, grinding, steam explosion, extrusion etc...
- **Chemical methods:** NaOH, KOH, NH₃, H₂SO₄, etc...
- **Biological methods:** ensilage, white-rot fungi, retting etc...



Physical Pretreatment

Cumulative biogas production/L



- ✓ Grinding: 0.6 mm, 1.3mm
- ✓ Chopping: 1cm, 3cm
- ✓ Raw material: Rice straw
- ✓ Loading rate: 50g/L

for rice straw:

no significant biogas production differences at different sizes
1.3mm(29.47L) > 1cm(29.46L) > 3cm(28.39L) > 0.6mm(27.93L)

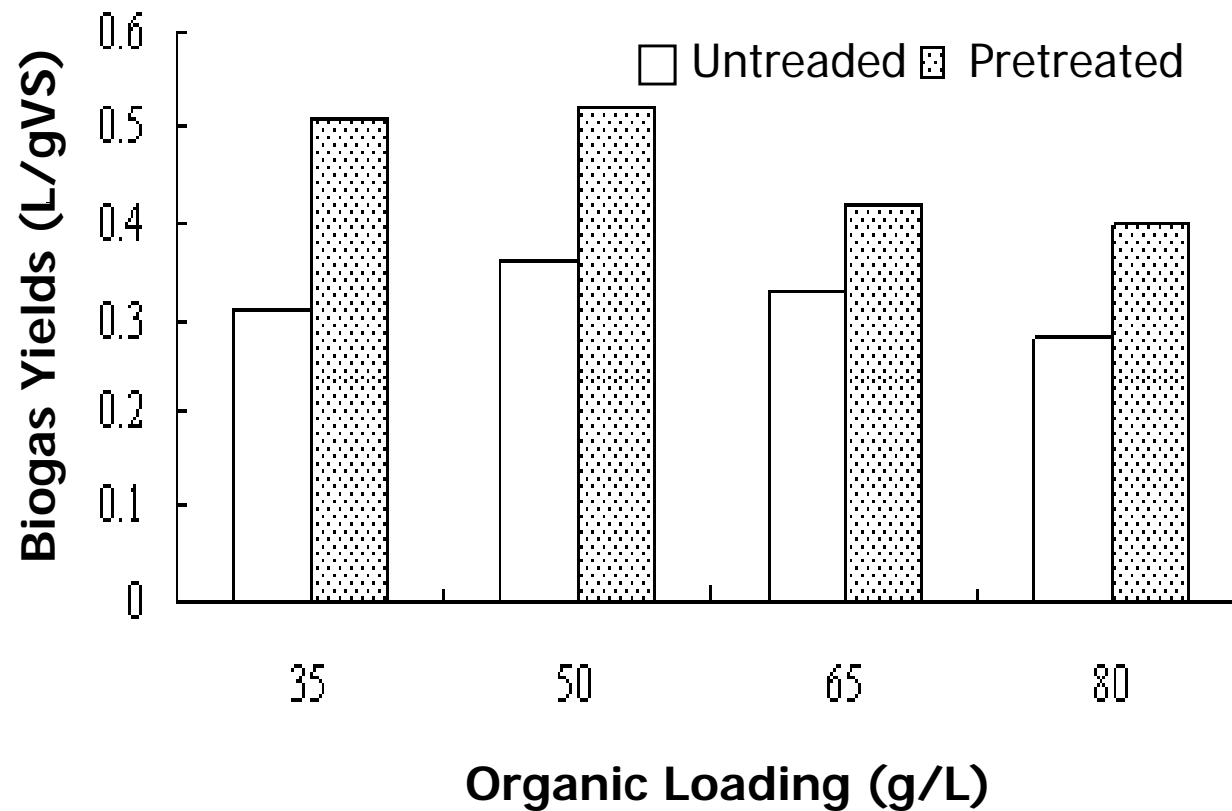
Solid-state NaOH Pretreatment

Patented



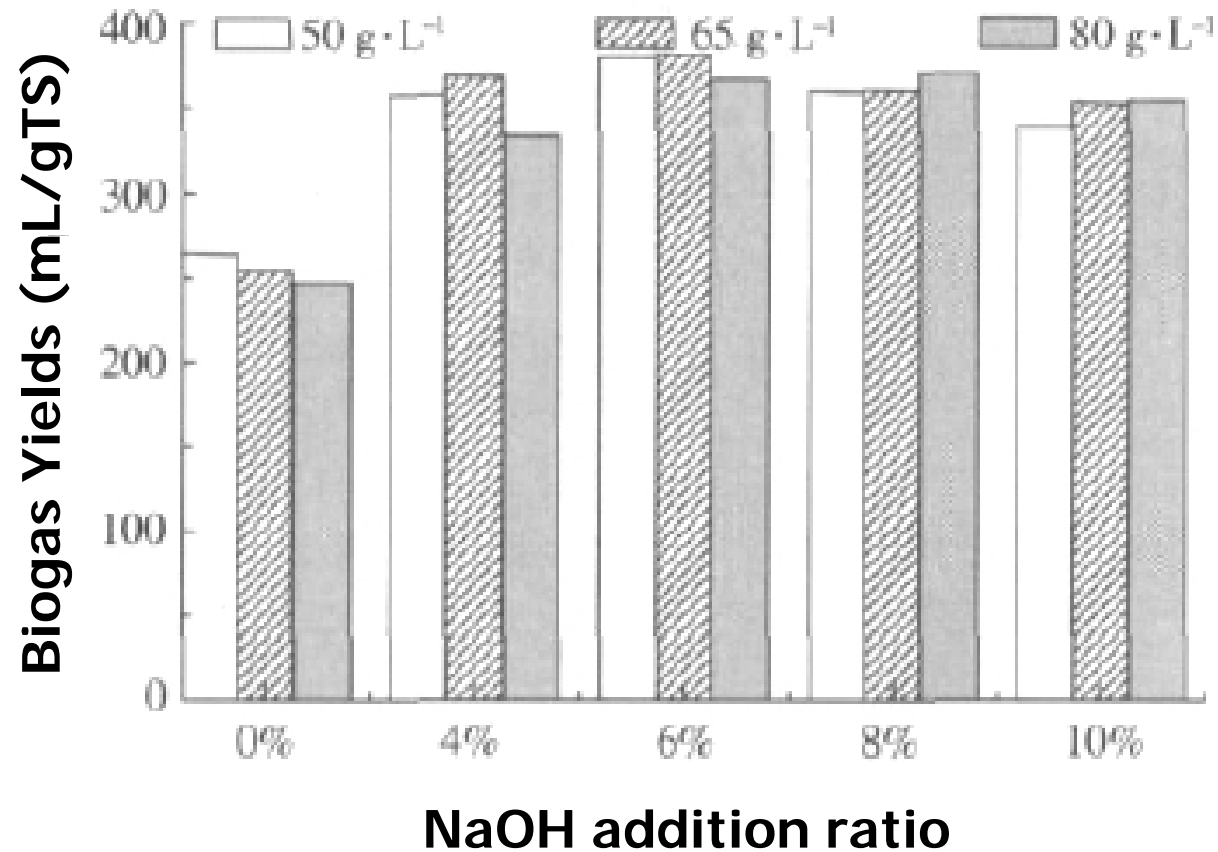
To break down the lignin structure
Low moisture content (60%)
Short retention time (2 ~ 3 d)

Batch Digestion of Rice Straw



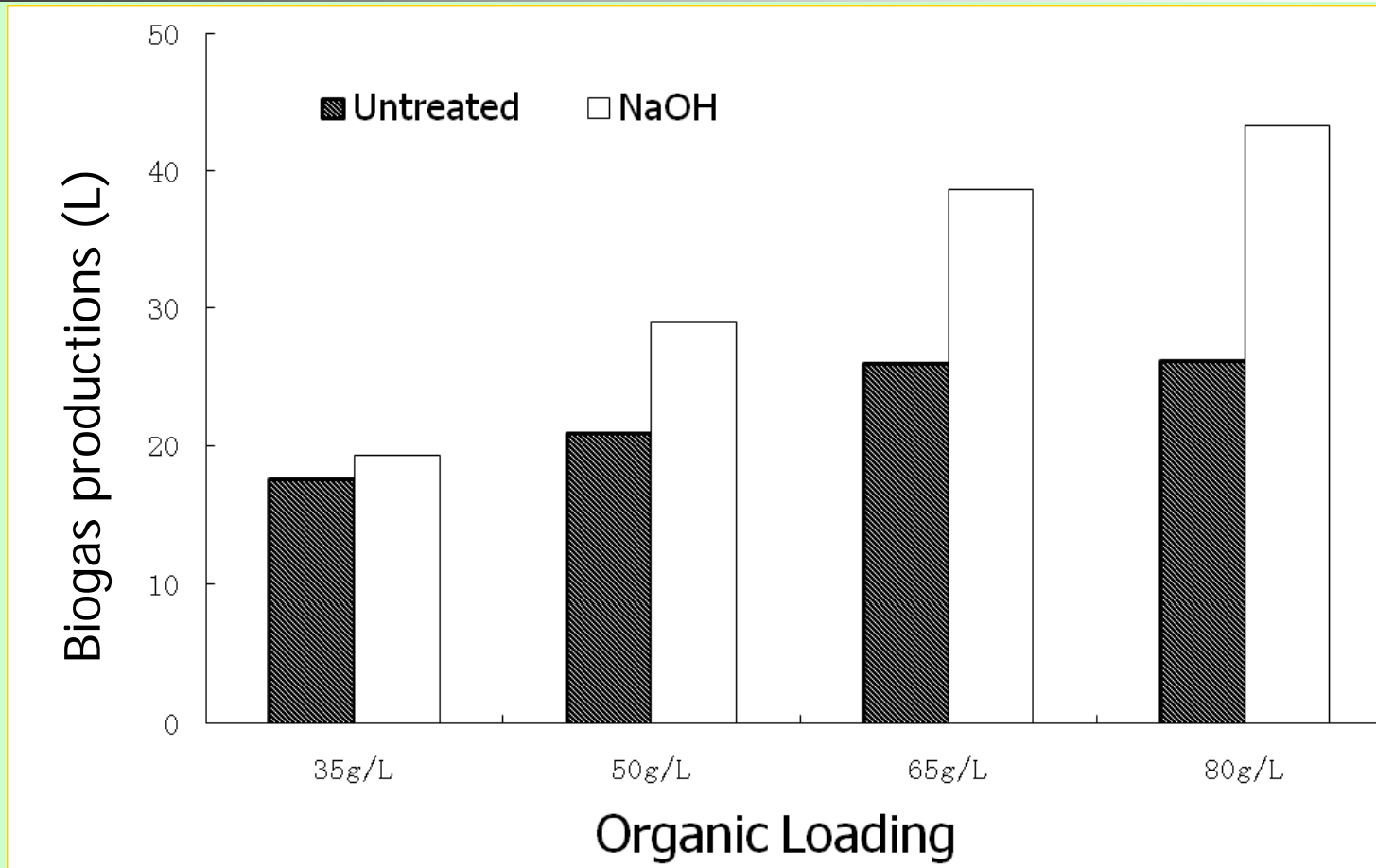
✓ Biogas yields were increased by 65%, 44%, 27% and 43%

Batch Digestion of Wheat Straw



✓ Biogas yields were increased by 28-50%

Batch Digestion of Corn Stalk



✓ Biogas yields were increased by 10%, 38%, 49% and 65%

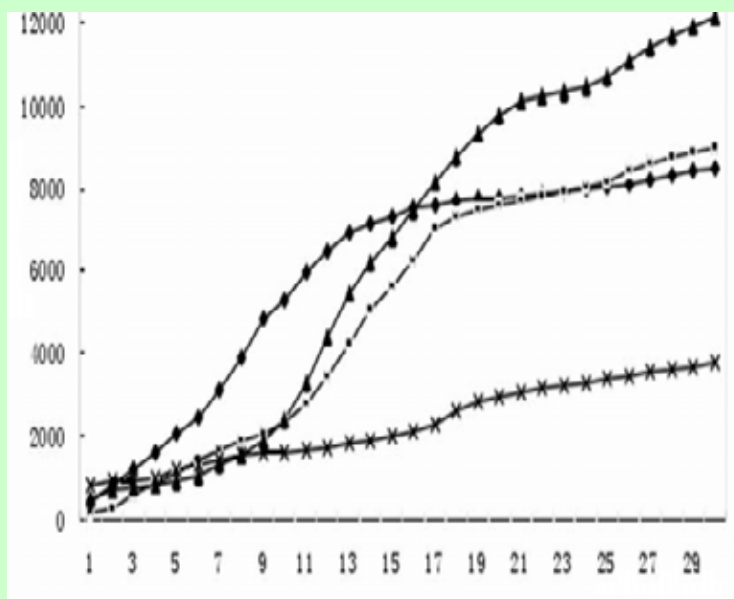
Biological Pretreatments

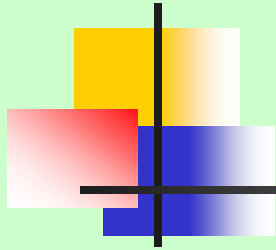
- ◆ **White-rot fungi**—Beijing University of Chemical Technology
- ◆ **Ensilage**—Chinese Academy of Agriculture Engineering
- ◆ **Soaking**—Beijing University of Chemical Technology



Pretreatment time: 20, 35, 50 and 60d

Result: **biogas yields increased by 40%-50%**





2.2 Optimized technologies and digesters

Many kinds of anaerobic digesters have been developed in China to deal with crop straw

Completely Mixed Plug Flow Digester —BUCT

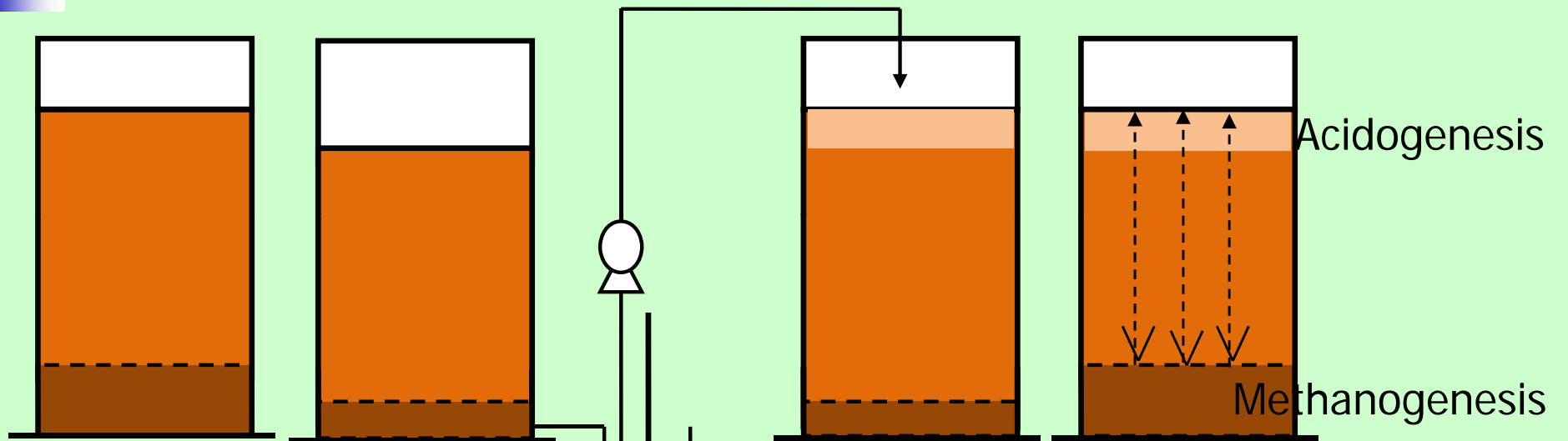
Patented

Parameters

- TS in digester: 65kg/m³
- HRT: 45-50 days
- C/N ratio: 20-25
- Temp.: 35°C
- Mixing: 2-3h/day
- Biogas yield: 330-350 m³/tonTS



Two Phase Anaerobic Digester —CAAE



① stable → ② discharging → ③ inoculation → ④ feeding → ⑤ settle down and self-phasing

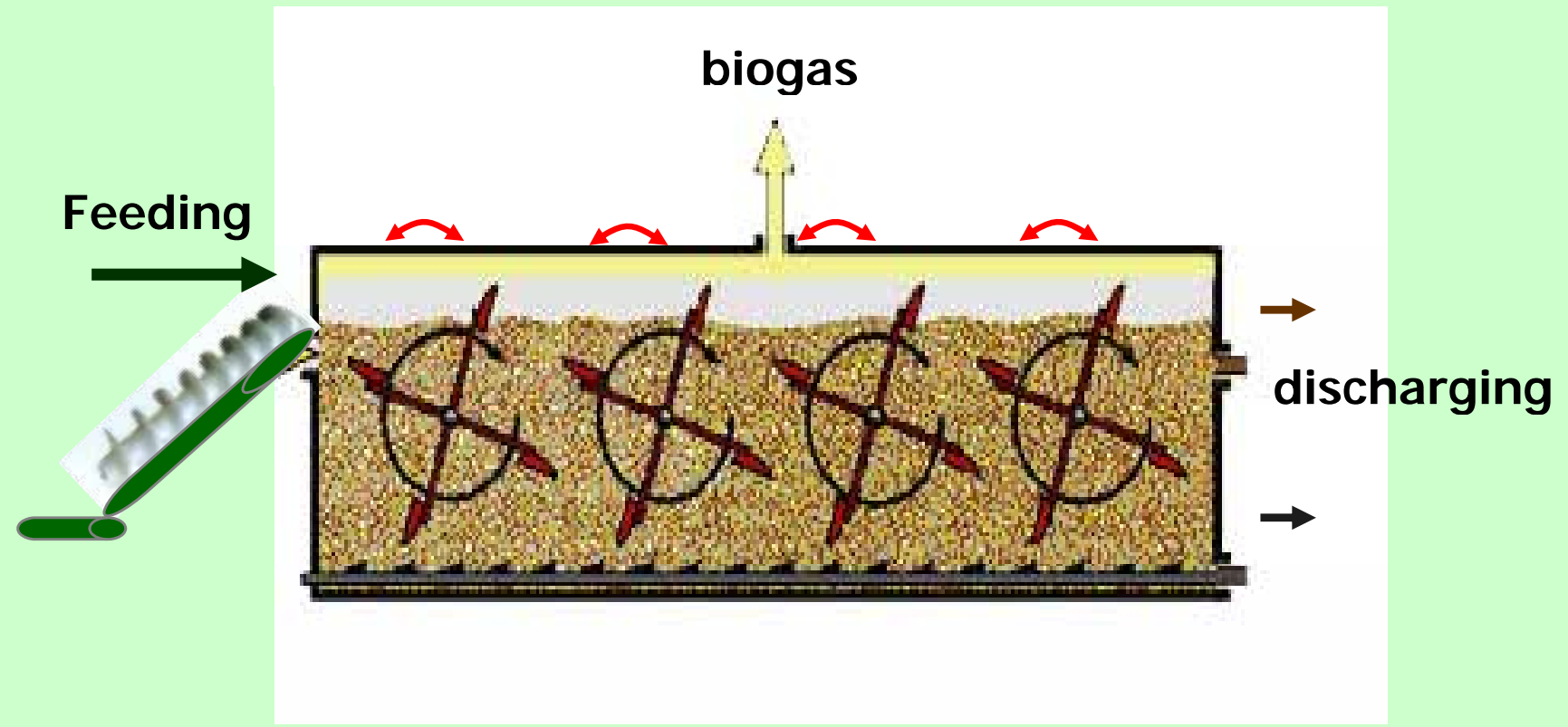


Vertical Plug Flow Digester —CIB



Batch Digester with mixing—BUCT

Patented

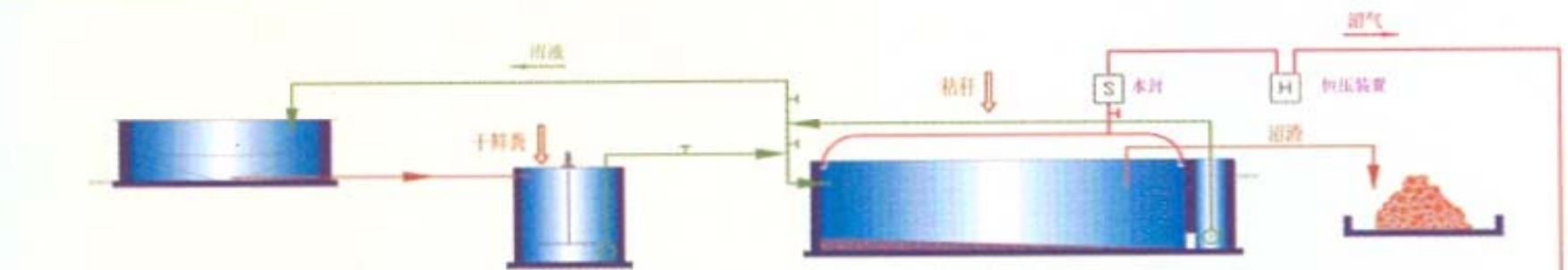


Batch Digester with mixing—BUCT



Batch Digester without mixing—Jiangsu

红泥塑料秸秆沼气工程工艺流程图



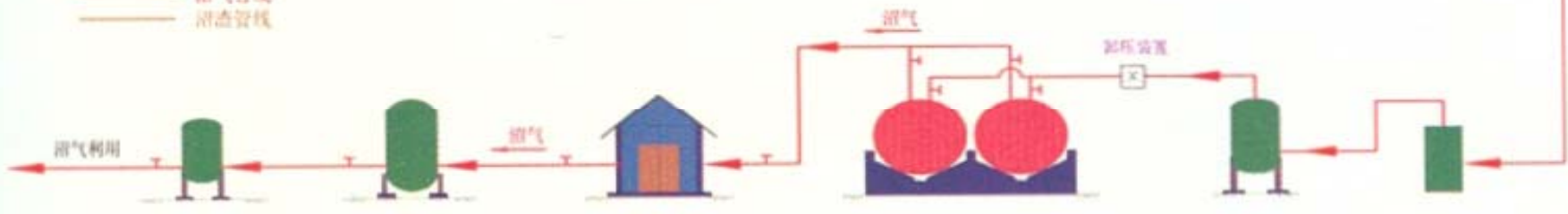
Biogas slurry pool

pulp pool

anaerobic digester

digester

图例：
 绿线 沼液管线
 红线 沼气管线
 黄线 沼渣管线



Fire Resistances

Holding pressure

Pressure room

Storage gas of red-sludge plastic

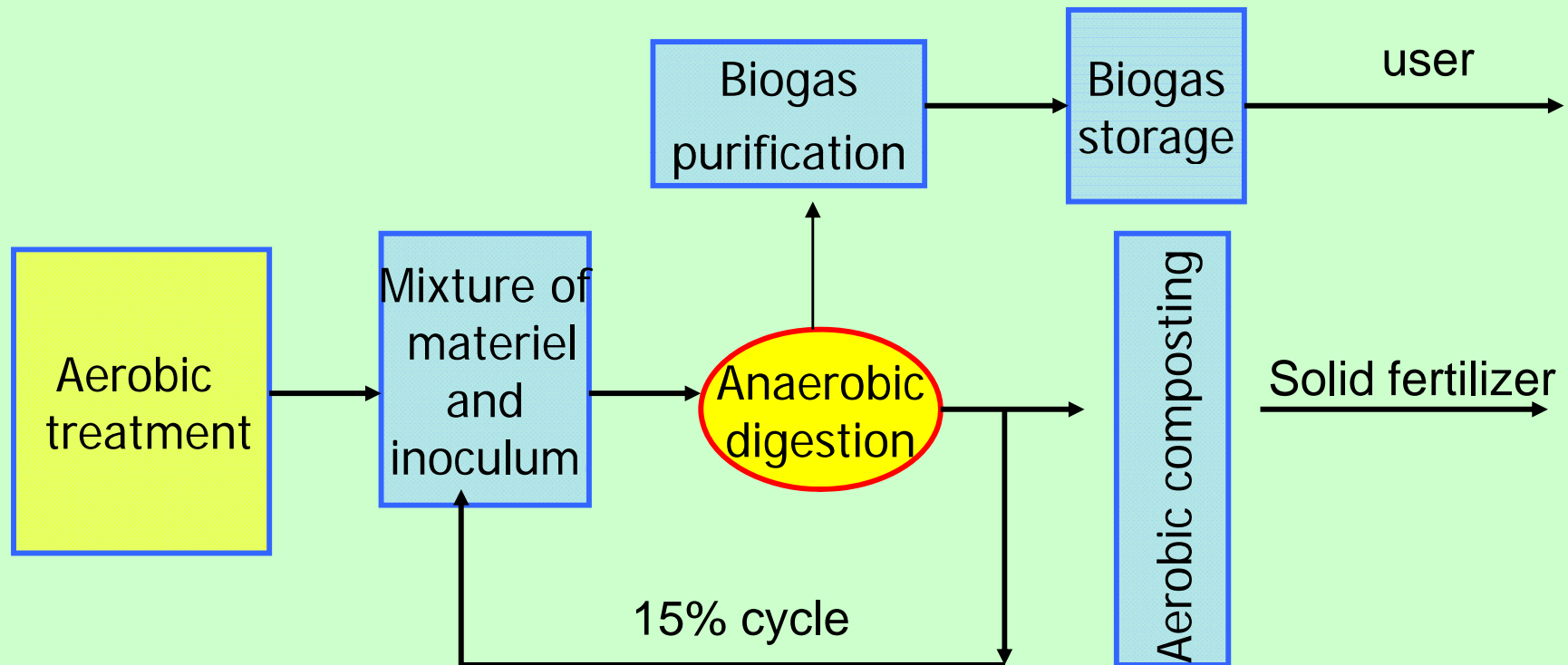
desulfurization

Dehydration

Batch Digester without mixing—Jiangsu



Hybrid Dry Digestion—CAAE



Hybrid Dry Digestion—CAAE

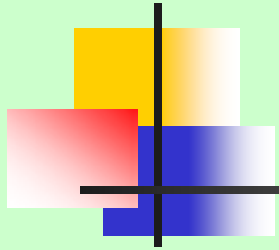


Aerobic process



Anaerobic process

Daxing district ,Beijing



3. Demonstration Projects



Financial Support from MOA China

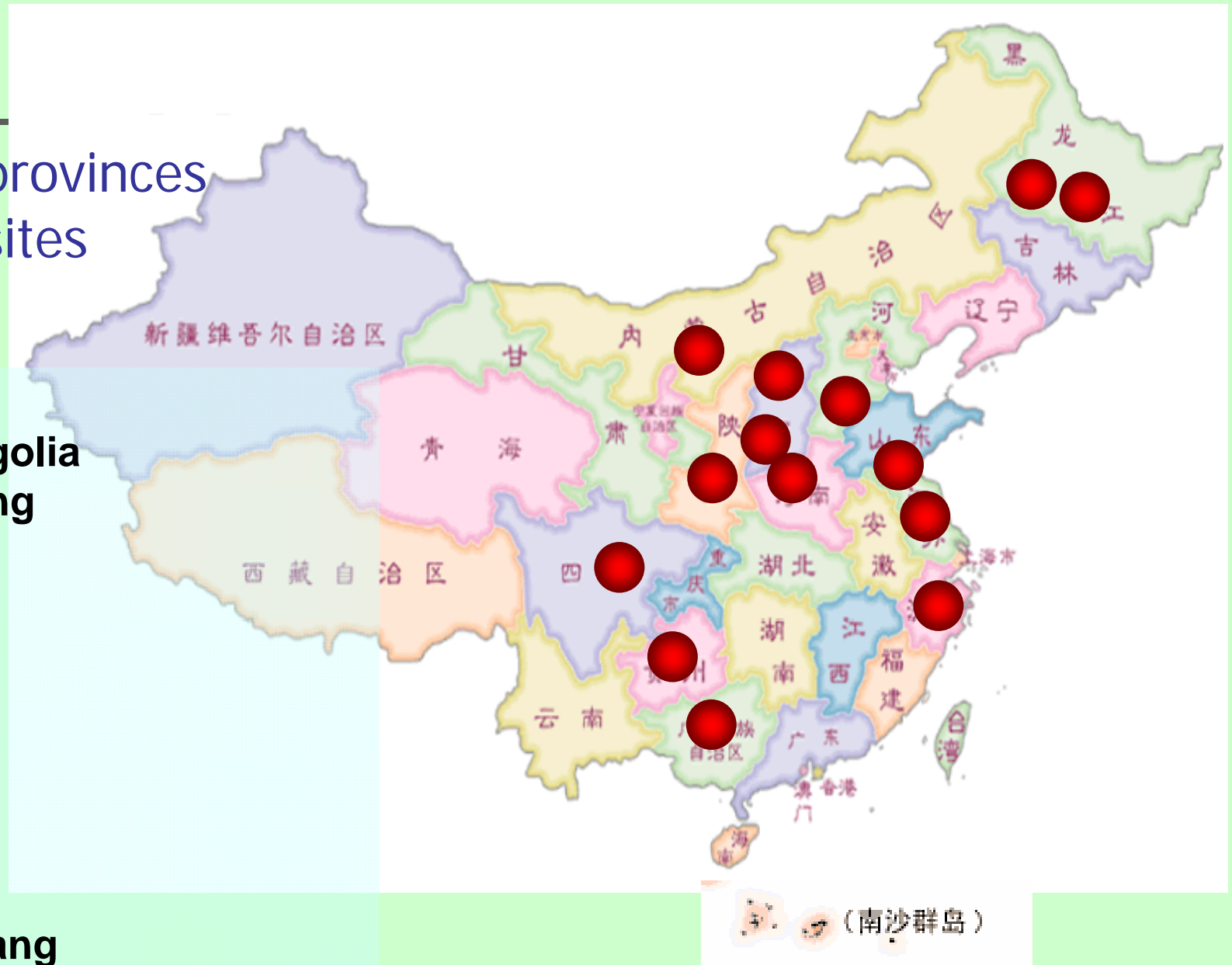
Most of the demonstration projects are supported by the Ministry of Agriculture, China

- 5000 million RMB/year, including 1600 million RMB dedicated for large scale (300~500 families) biogas plants
- each plant can get ~1.5 million RMB from MOA
 - Year 2009 16 plants in 12 provinces
 - Year 2010———31 plants in 27 provinces
 - Year 2011———more...

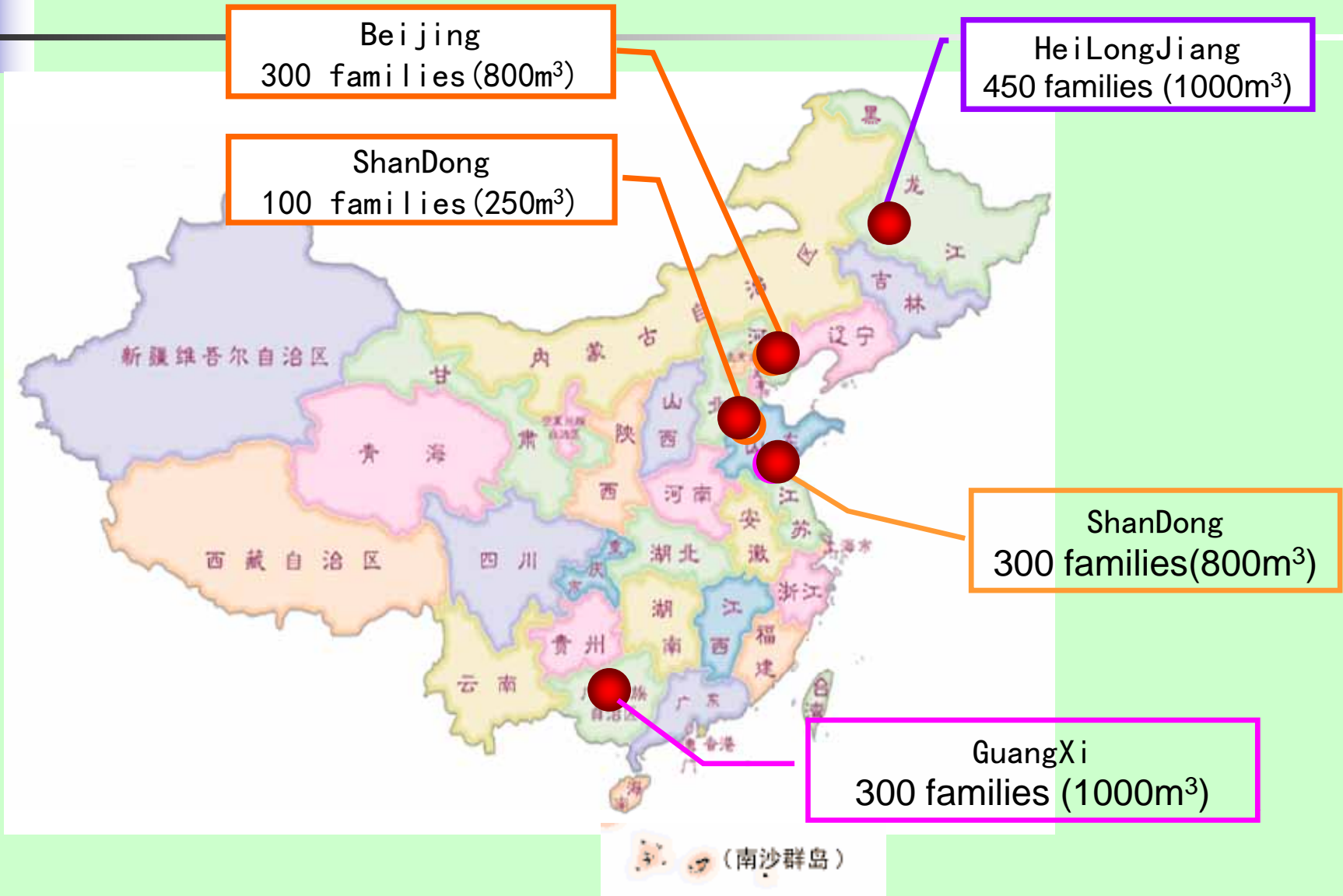
Year 2009

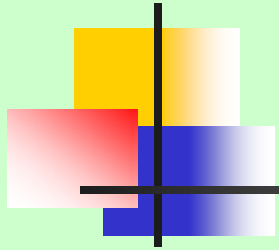
12 provinces
16 sites

- 1、ShanXi
- 2、Inner Mongolia
- 3、Heilongjiang
- 4、Zhejiang
- 5、Jiangsu
- 6、Shandong
- 7、Henan
- 8、GuangXi
- 9、Sichuan
- 10、Guizhou
- 11、Shanxi
- 12、Heilongjiang



Demonstration projects built by BUCT





Beijing



Shandong

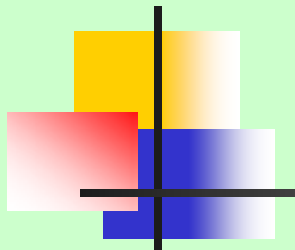


Heilongjiang



GuangXi





Henan

10X3000m³





Upgraded
biogas as
vehicle
fuels

Patented





4. Challenges

- Material price (up to 300-400RMB/ton)
- Technology issue
- Mechanical issue
- Quality of the construction
- Maintenance & management issue

A large, 3D, golden-yellow 'Thanks!' graphic is positioned in the center of the image. The text is rendered in a bold, sans-serif font with a slight shadow, giving it a three-dimensional appearance. The background is a lush green field of tall grass or rice, with a small building and trees visible in the distance under a blue sky with scattered white clouds.

Thanks!

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