Bamboo and Energy

Bamboo: Its suitability as energy crop

- Bamboo is fastest growing plant on earth.
- Perennial “Woody Grass”, rapid growth : annual selective harvesting possible (no clear felling) for 50 years.
- Environmental protection: Soil erosion, water recharge, reclaiming degraded lands, etc.
- Additional benefits: Bamboo shoots (food security), fodder, multiple uses, etc
- Yield: 5 to 47 metric tons per hectare (Priority species: > 10 MT per annum).





Energy or Calorific values comparison (Bamboo Vs Wood)

- Calorific value of dry bamboo: ~ 19 MJ/kg or 4500 Kcal/Kg (Scurlock, 2000)

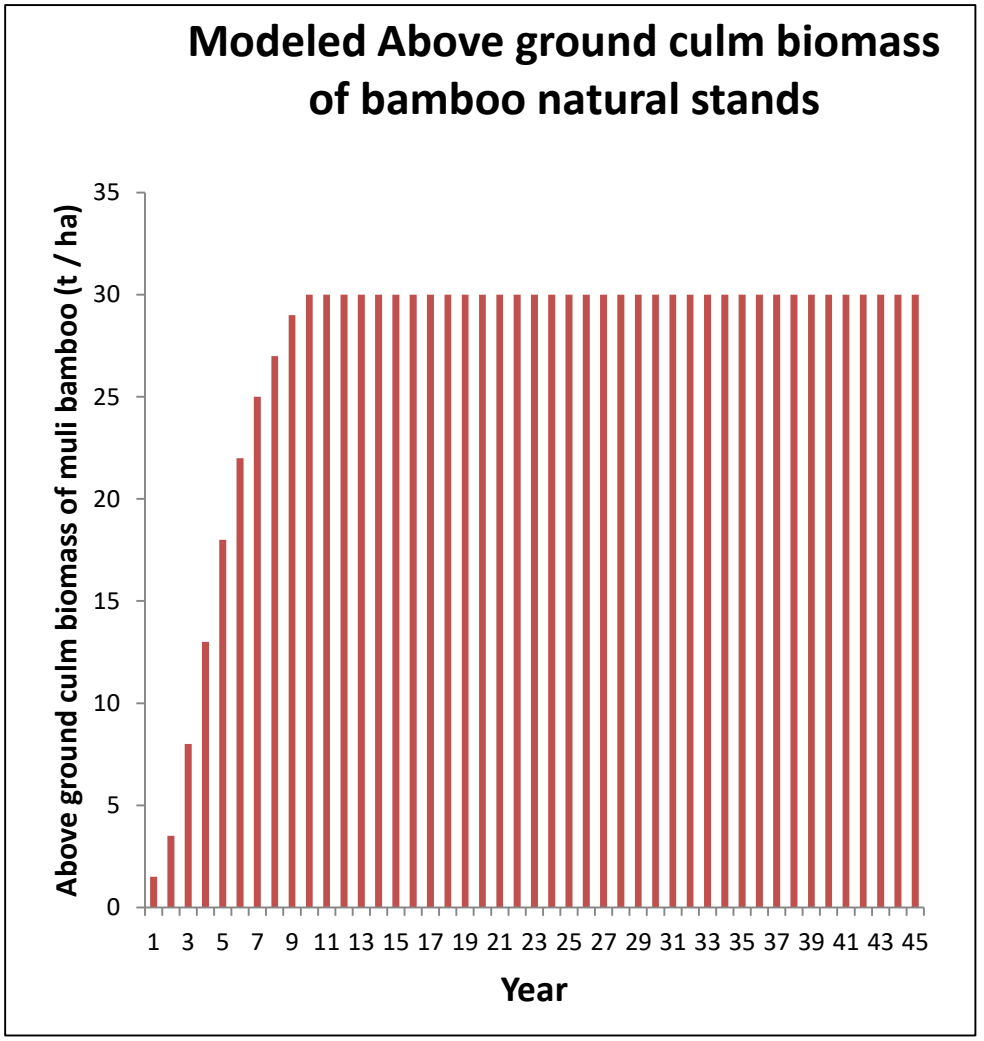
Biomass	HHV	
	MJ / Kg	Kcal / Kg
Bamboo	19.8	4729
Eucalyptus	19.6	4681
Hybrid popular	19.7	4705
Willow	19.7	4705

- Low ash and alkali content; C and H similar to wood.
- Calorific value of bamboo charcoal: 26 - 29 MJ/Kg or ~ 6600 Kcal/Kg

Botanically, bamboo is a grass
..... And not a tree

Modeling biomass / carbon dynamics of bamboo forest

- Rapid growth and regrowth.
- Reach stable carbon in a period of 6 -10 years (beyond that, bamboo forests are carbon neutral (Liese, 2009)
- Above ground and high underground biomass ratio: 66: 34 percent
- Leaf litter: 6 – 8 percent of total biomass (1 to 37 MT per annum) (Kleinhenz and Midmore, 2001).
- Soil carbon: 15 – 17 percent of leaf litter and underground biomass.
- Gregarious bamboo flowering at end of life cycle.
- Active management necessary for improving carbon sequestration.

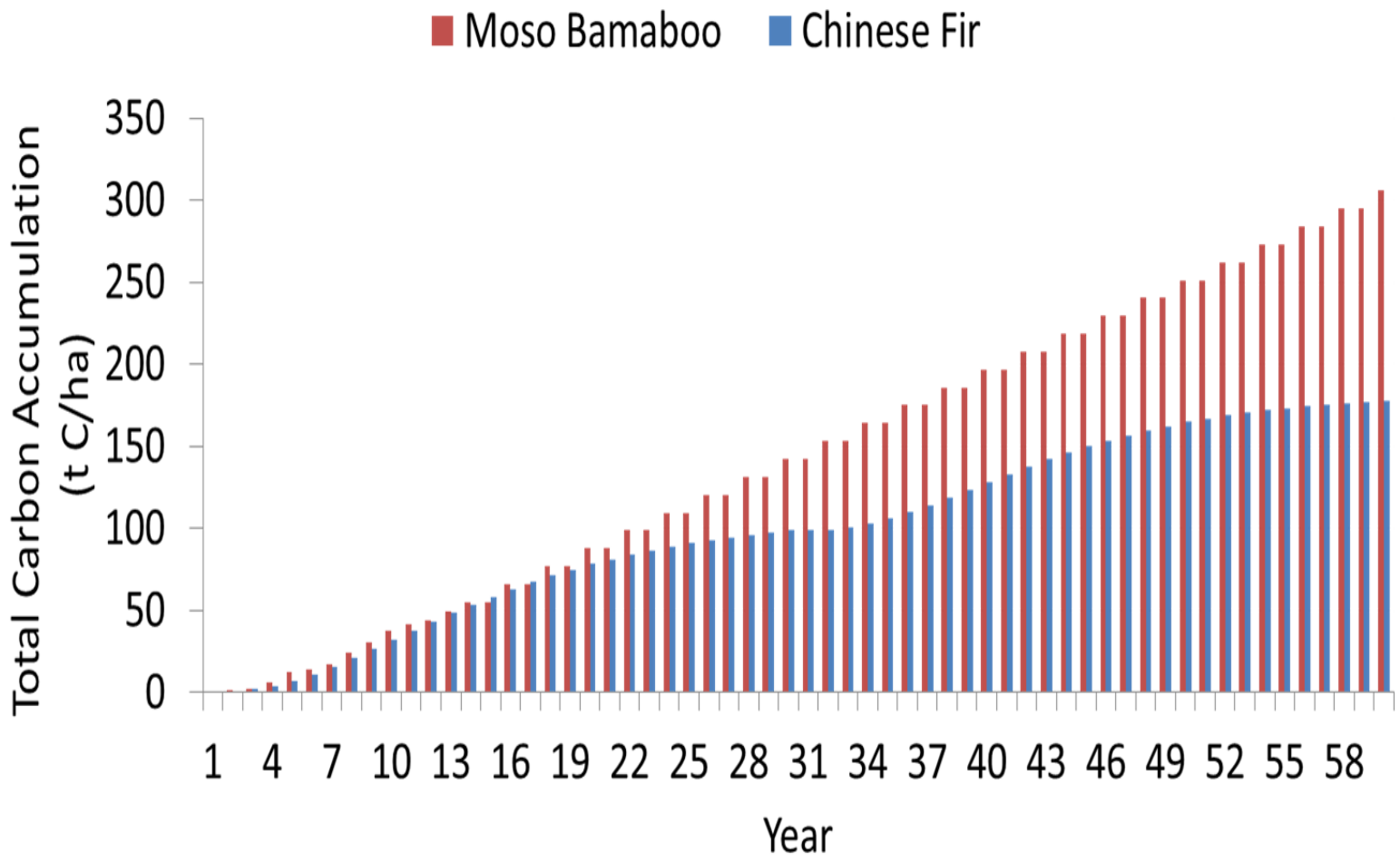







Modeling carbon sequestration of Moso bamboo (INBAR, 2010)

- Fast growing, annual yielding crop
- When managed, bamboo can outperform fast-growing species in terms of carbon sequestration

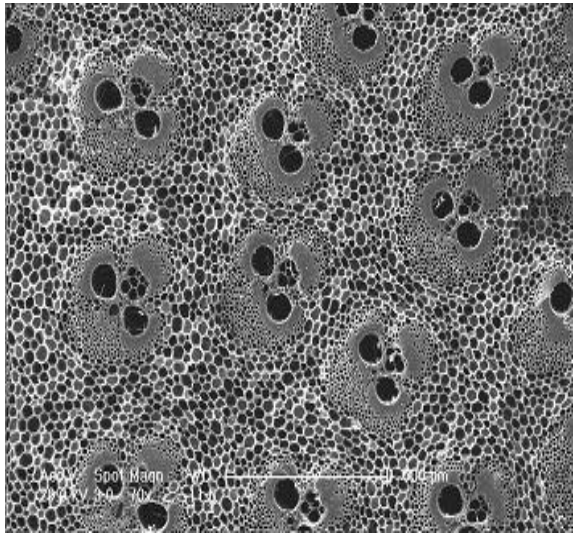


Bamboo and Energy: Fuel wood and Charcoal Production Technologies

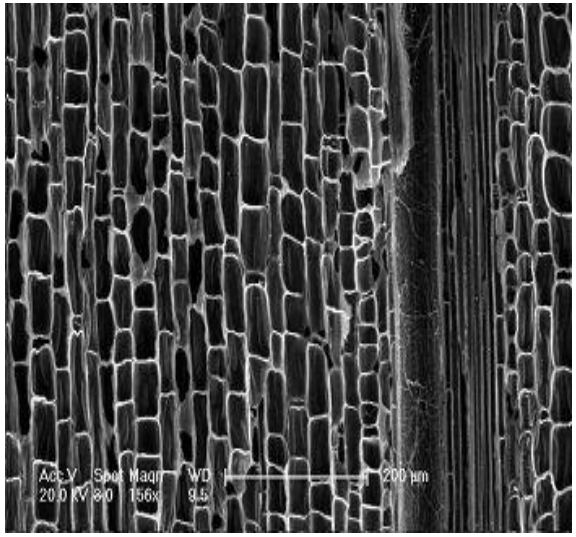
What is Bamboo Charcoal?

Bamboo charcoal is a product from bamboo materials in high temperature pyrolysis with no air or by controlling or limiting the airflow, i.e. oxygen.

Bamboo Charcoal



Cross Section



Vertical Section

Charcoal

How to obtain bamboo charcoal?

Bamboo

Equipment and Process

Charcoal

Drum Charcoal

- Portable
- Low investment
- Charcoal Yield: 22 – 25 percent

Drum Charcoal - Model 2

Drum Charcoal - Model 3

Drum Charcoal - Model 4

Dome Charcoal

Large Kilns for high quality charcoal production

Traditional kilns in China (vertical and horizontal)

Traditional kilns in Ghana

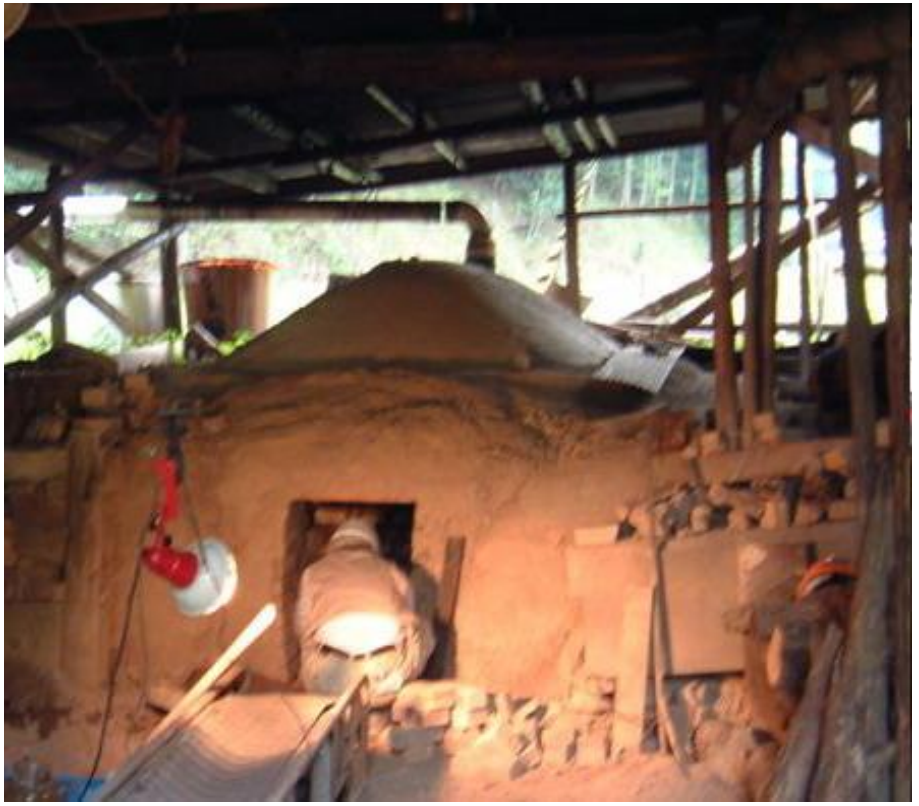
Mechanical kilns in China (Continuous (Left) and Periodic Types (Right))

Furnace

Successional (vertical)

mechanical

Mechanical and Traditional kilns in Taiwan, China



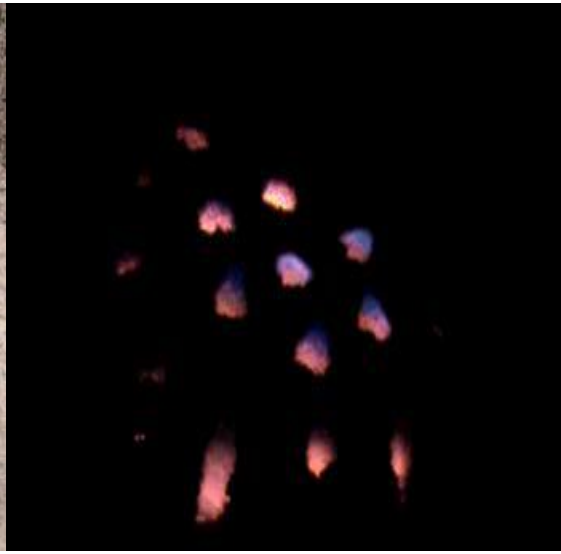
Traditional kilns in Korea

Briquetting Enterprises

Ram-type and screw-type biomass briquettes from farming households

Currently, four processing units are operational with a combined capacity of 12,000 tons/annum, which is $500,000 new income to the farming households who would have otherwise just burned the residue in the fields.

Manual Briquetting Enterprises



Semi-mechanized pelleting enterprises (Alaknanda, Uttarakhand, India)

Mechanized briquetting units (Mbeya, Tanzania & Uttarakhand, India)

Mechanized Honey-Comb Briquetting (Coal dust, Vietnam

Mechanized honey-comb

Bamboo and Electricity

- 1.2 Kg biomass produces 1 unit of electricity.
- Bamboo biomass is a suitable feed stock for electricity generation.
- Wastes arising out of industrial processes could be used for electricity generation.
- 100 per cent producer gas engine
- Combined diesel and producer engine
- Combined charcoal and electricity generation units

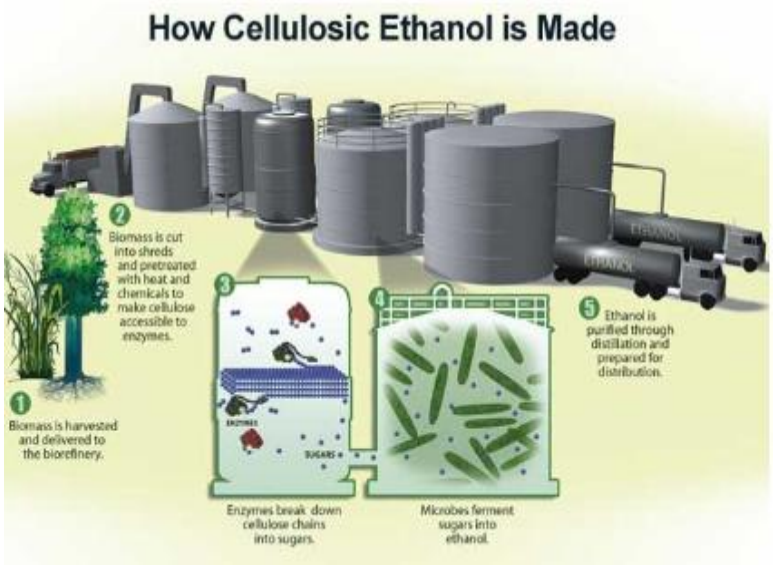
Combined gasifier and charcoal production units

Gasifier system for electricity generation (Uttarakhand, India)


REACTOR

Technology: Bio-ethanol

- **Bio-chemical process:** The recalcitrant cellulose and hemi-cellulose in the biomass is converted into digestible glucose or sugars using pre-treatment methods and the resulting glucose is further converted into alcohol though the process of fermentation (Zhu et al., 2008; Zang et al, 2009; Leenakul and Tippayawong, 2010).



Main Process:

Size reduction
Pre-treatment
Enzyme hydrolysis
Fermentation
Distillation


Source: www.abengoabioenergy.com

Scope: Ethanol Production

Model: 1000 Lts production capacity

Input:

Bamboo: 3000 Kg

Energy, Water, H_2SO_4, Lime

Output:

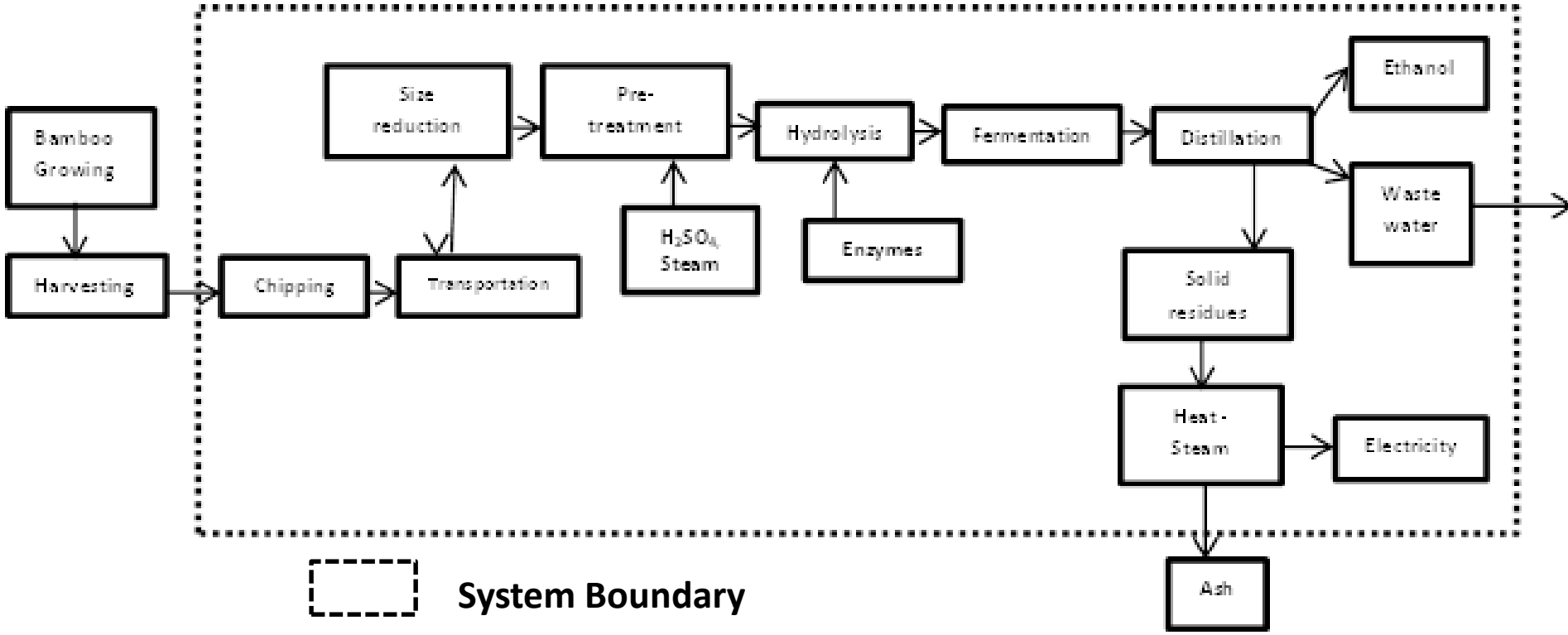
Bioethanol: 1000 Lts

Electricity: 666 kWh

Data:

Ethanol Calculation: Theoretical ethanol Calculator (DOE, 2012)

Energy / GHG CO_2 EQ. data: Literature review

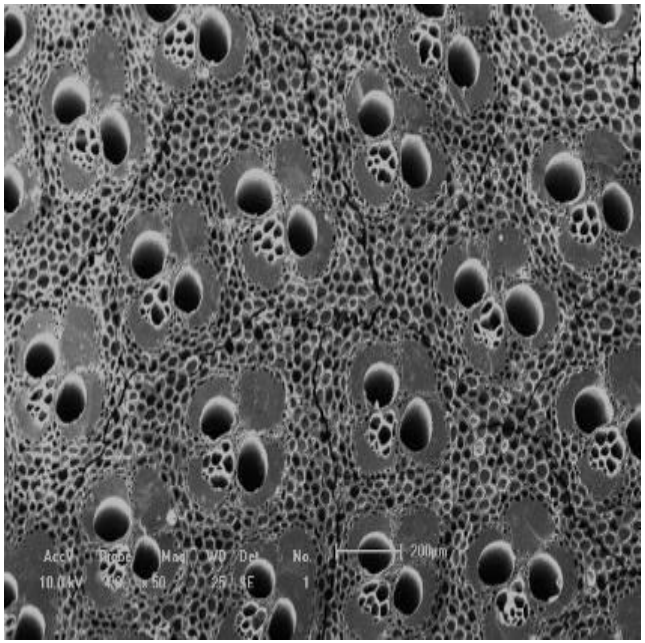


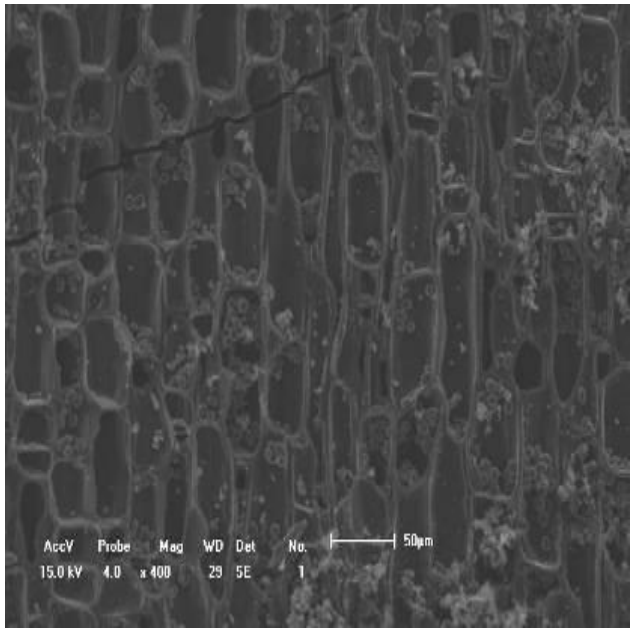
Functional Unit: 1 MJ of energy.

Application

Why is the application of bamboo charcoal?

Bamboo Charcoal





Horizontal section **Vertical cross**

- Porous material, large holes, small porous, microporous

Application

What is the application of bamboo charcoal?

- Daily Use
- Interior Decoration
- Environmental Protection
- Forestry and Horticulture
- Other Uses

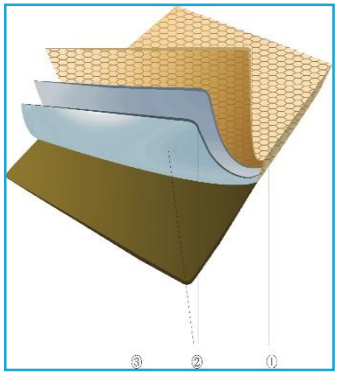
Necessity

Daily Use

Health care

Skin protection

Fresh keeping



Electromagnetic shield

Fuel

Necessity

Interior Decoration

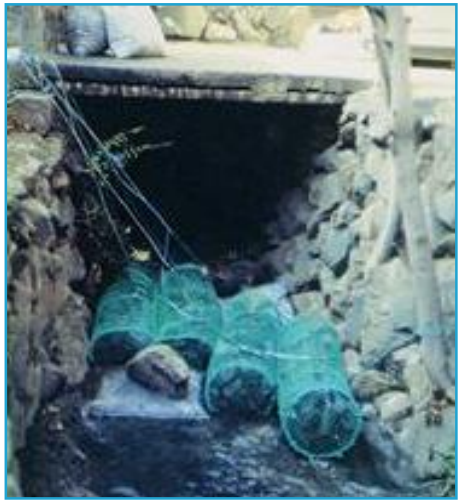
Dehumidification

Art work

Building materials

Necessity

Environmental Protection



Wastewater treatment

Air purification

Drinking water purification

Necessity

Forestry and Horticulture

Feed additive

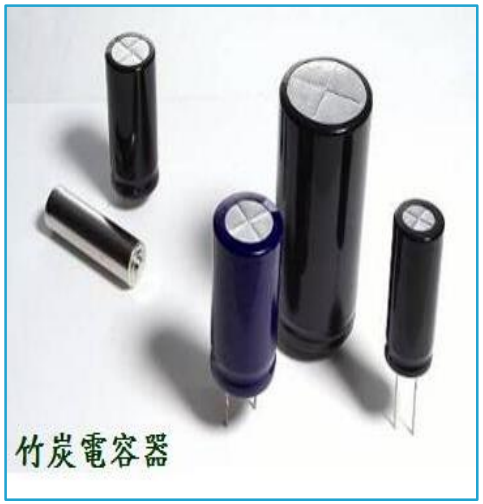
Soil improvement

Flowers and plants

Necessity

Other Uses

Activated charcoal



Capacitor

Cooking

Food

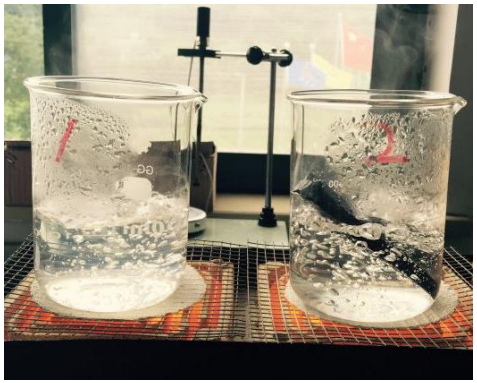

Bamboo
Charcoal
竹炭床垫

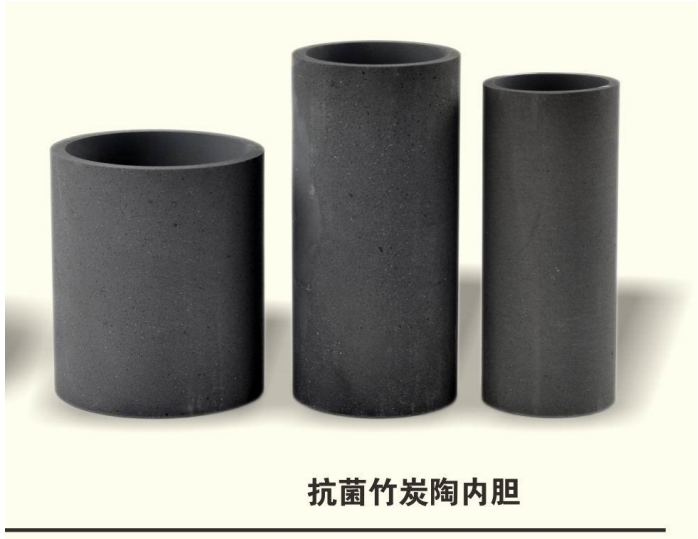

护肤用品系列
萃取天然○健康人生


炭卫士
米缸炭
去湿防霉 保质保鲜


炭卫士
竹炭橱味净

potassium(K), and sodium(Na), Calcium(Ca), Magnesium(Mg), Phosphorus(P), iron, Zink,

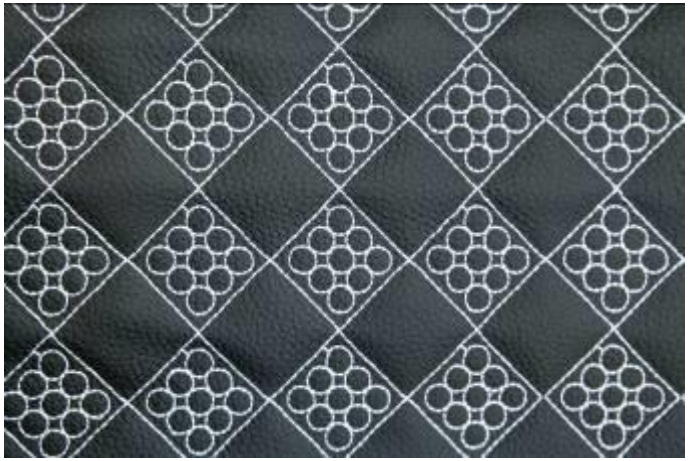




抗菌竹炭陶内胆

功能性聚氨酯炭基复合材料生产线


Charcoal-Leather



Charcoal root crafts

Bamboo Charcoal Ceramic

Beijing opera

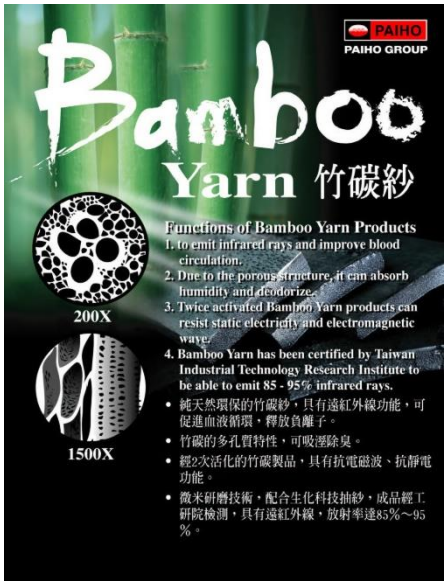
Bamboo charcoal air purifier products

processing

bamboo

textiles

blending



Carbo
nization

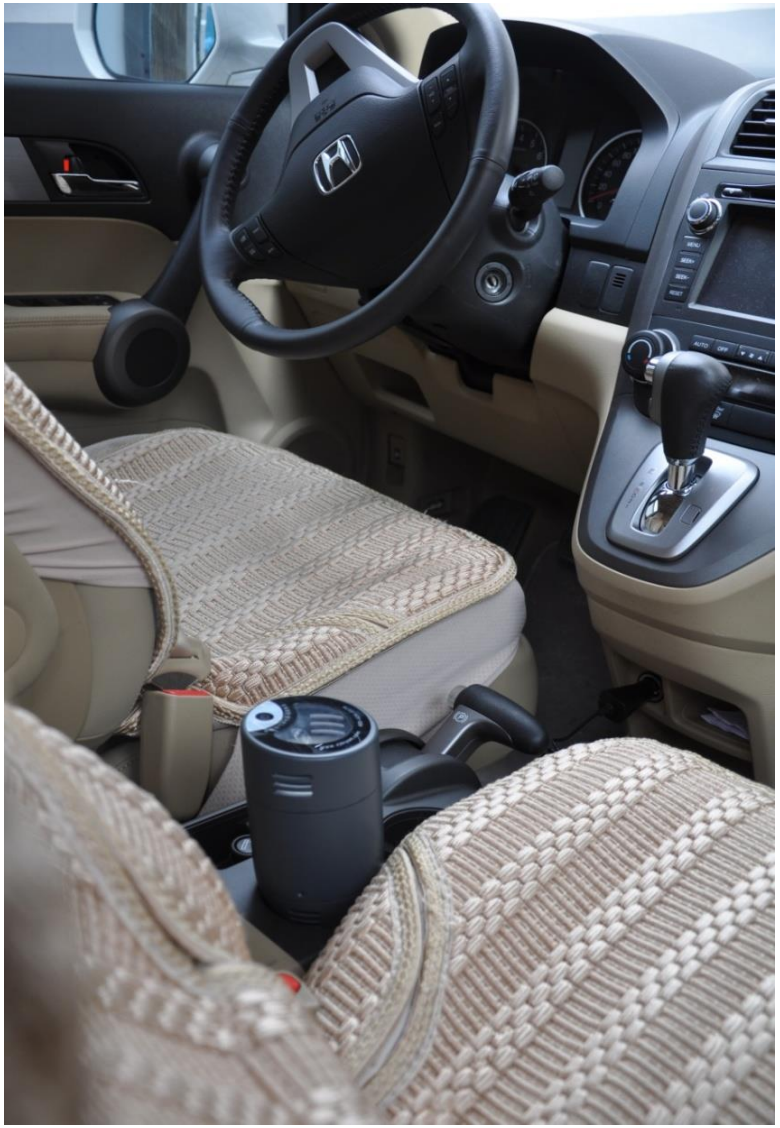
grinding

drawnwork

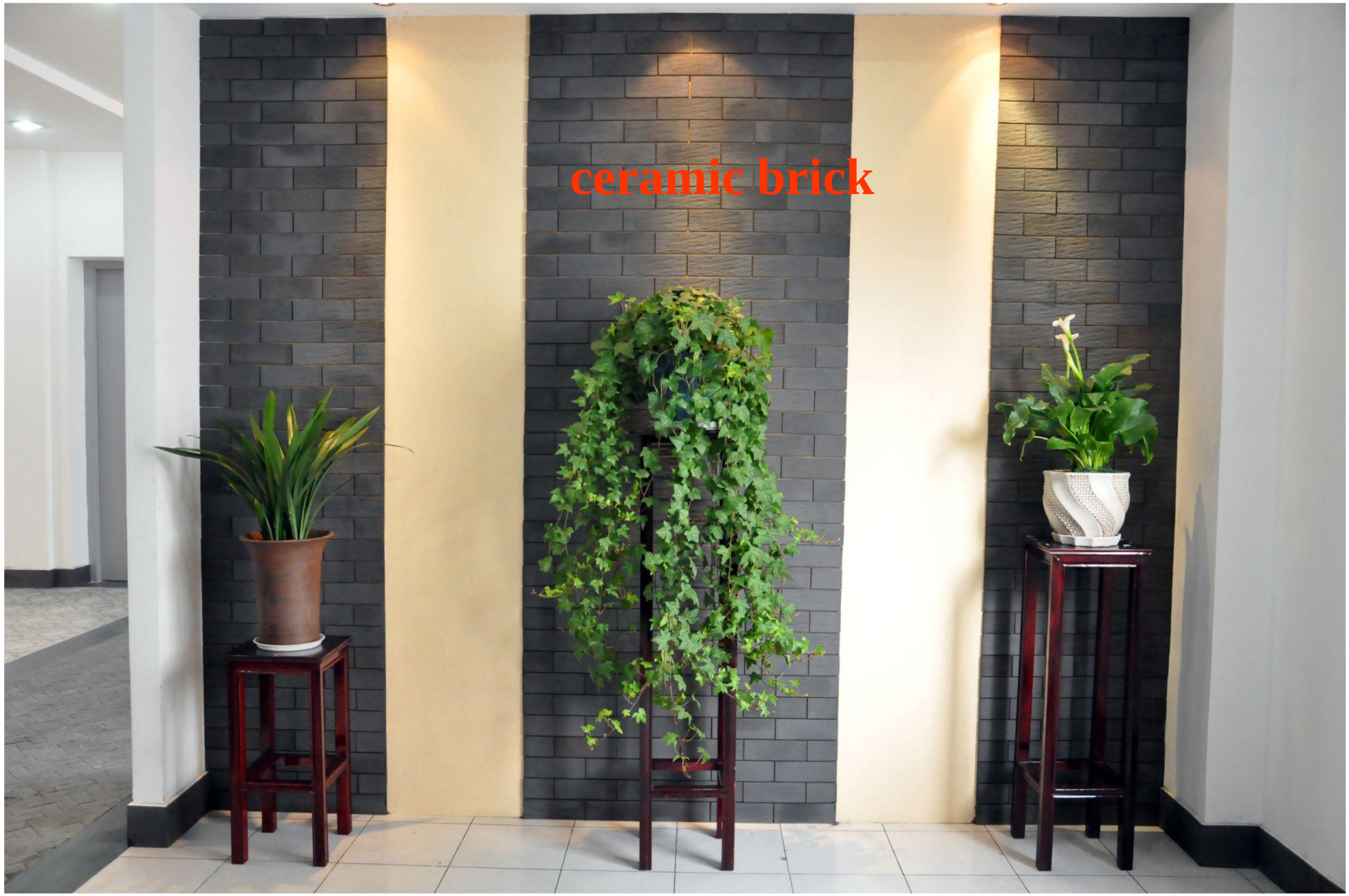
Spin
thread


竹炭


竹炭纤维袜

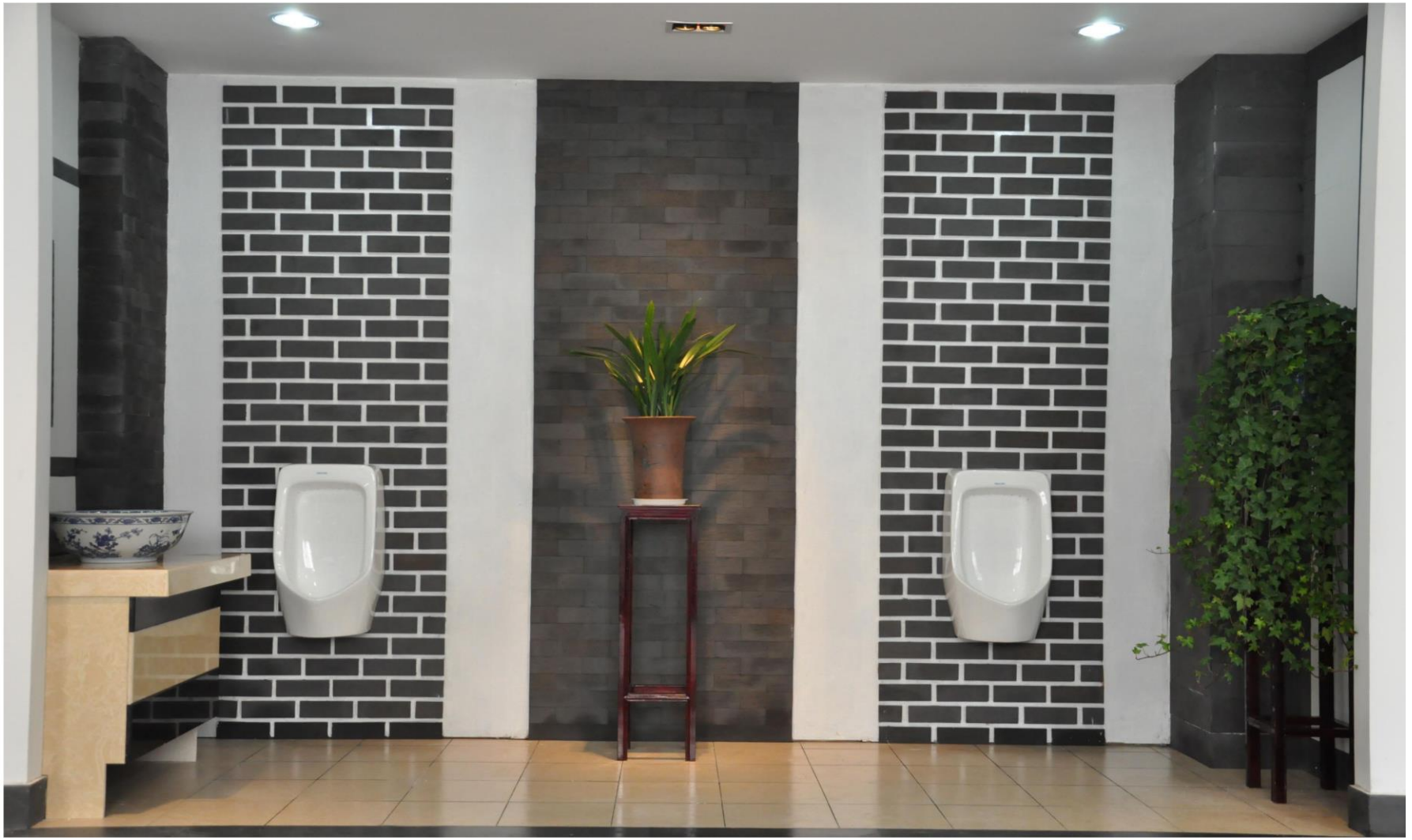


purification air pulltion

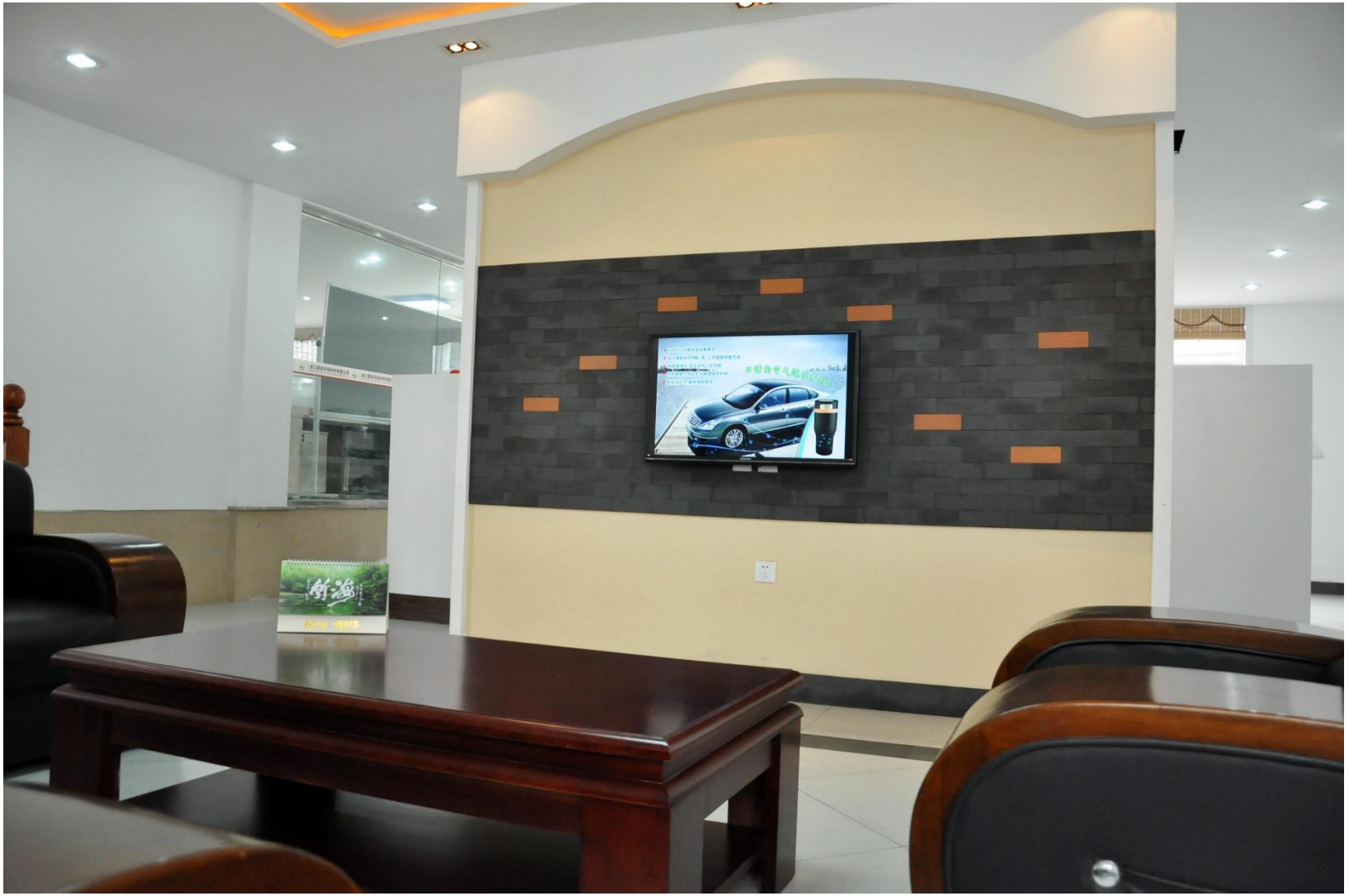


Bamboo charcoal environmental protection decorates a wall

In addition to smell toilet decorates



Bathroom decoration with charcoal composite material



TV setting wall

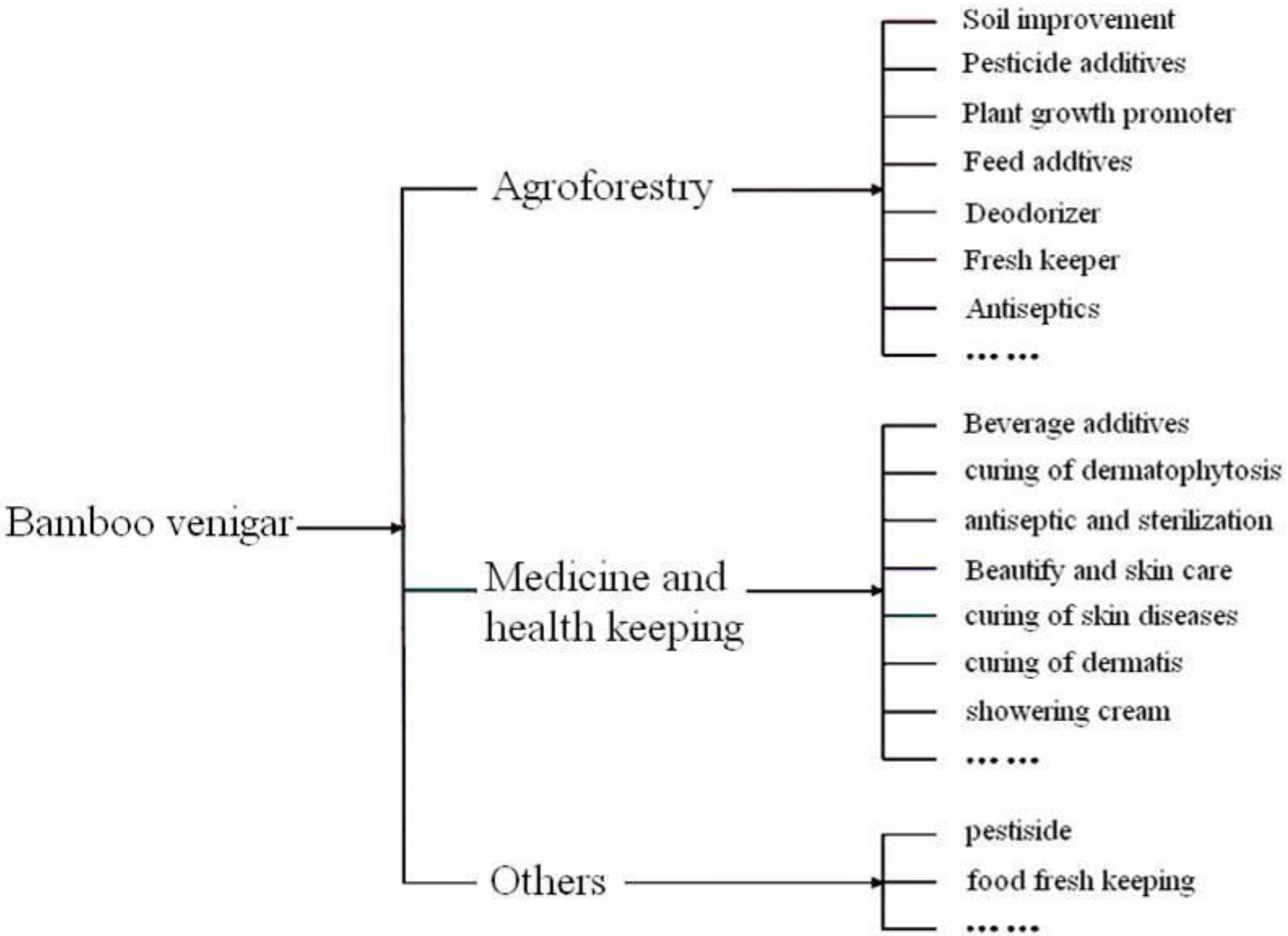
Bamboo vinegar

•Bamboo vinegar is a liquid produced during the pyrogenic decomposition of bamboo. Its color is puce, the smell is strong and irritant. The composition of the bamboo vinegar is very complicated, mainly include: water, organic acids, phenols, ketones, alcohols, etc., there are in total more than 200 components.

•The formation of bamboo vinegar is also a complicated process. The yield is largely depending on the specie of the bamboo, the moisture content of the material as well as the pyrolysis techniques. The components of the vinegar also changes, it depends on the method of collection, the pyrogenic temperature, and the storage method, etc..

Bamboo vinegar

water, organic acids, phenols, ketones, alcohols, etc.


Bamboo venigar
Agroforestry
Soil improvement
Pesticide additives
Plant growth promoter
Feed addtives
Deodorizer
Fresh keeper
Antiseptics
……
Medicine and health keeping
Beverage additives
curing of dermatophytosis
antiseptic and sterilization
Beautify and skin care
curing of skin diseases
curing of dermatis
showering cream
……
Others
pestiside
food fresh keeping
……

Athlete's foot /beriberi

Anti-bacteria lotion

Body soap
Perfumed soap


竹醋
竹醋
竹醋


竹醋


竹醋


竹醋
皂


竹醋
洗发液

Shampoo


竹醋黄金皂
遂昌文照竹炭（北京）有限公司


遂昌文照竹炭（北京）有限公司
www.bjwz.cn
竹醋
洗手液
竹醋
洗手液

Bamboo vinegar skincare

Bamboo vinegar series made in China

Plant growth agent and foliar fertilizer

Thank You