China Biochar Story: From crop straw to biomass industry

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Why biochar: SOM depleting lands…

Why biochar: straw unrecycled as pollution

Totally 1 Gt, half in northern China

Why biochar: safe recycling in agriculture

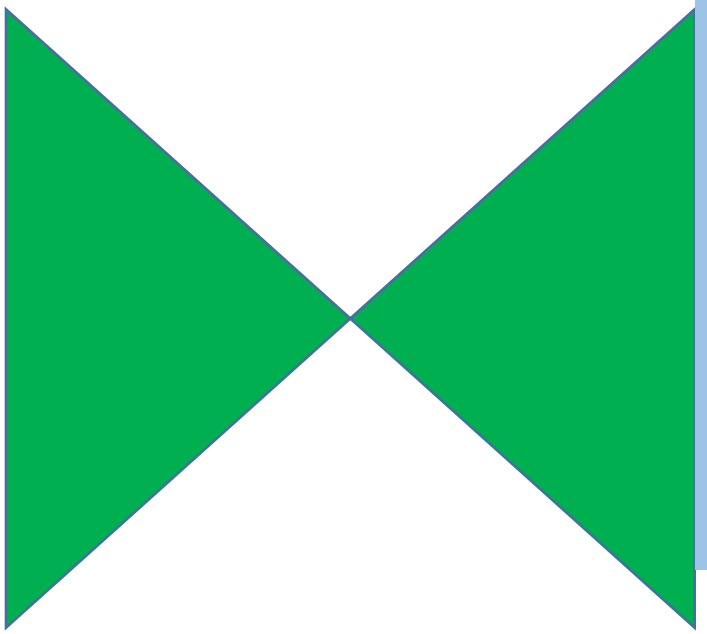
Partioning to maximize capital

Carbon

Nutrient

Energy

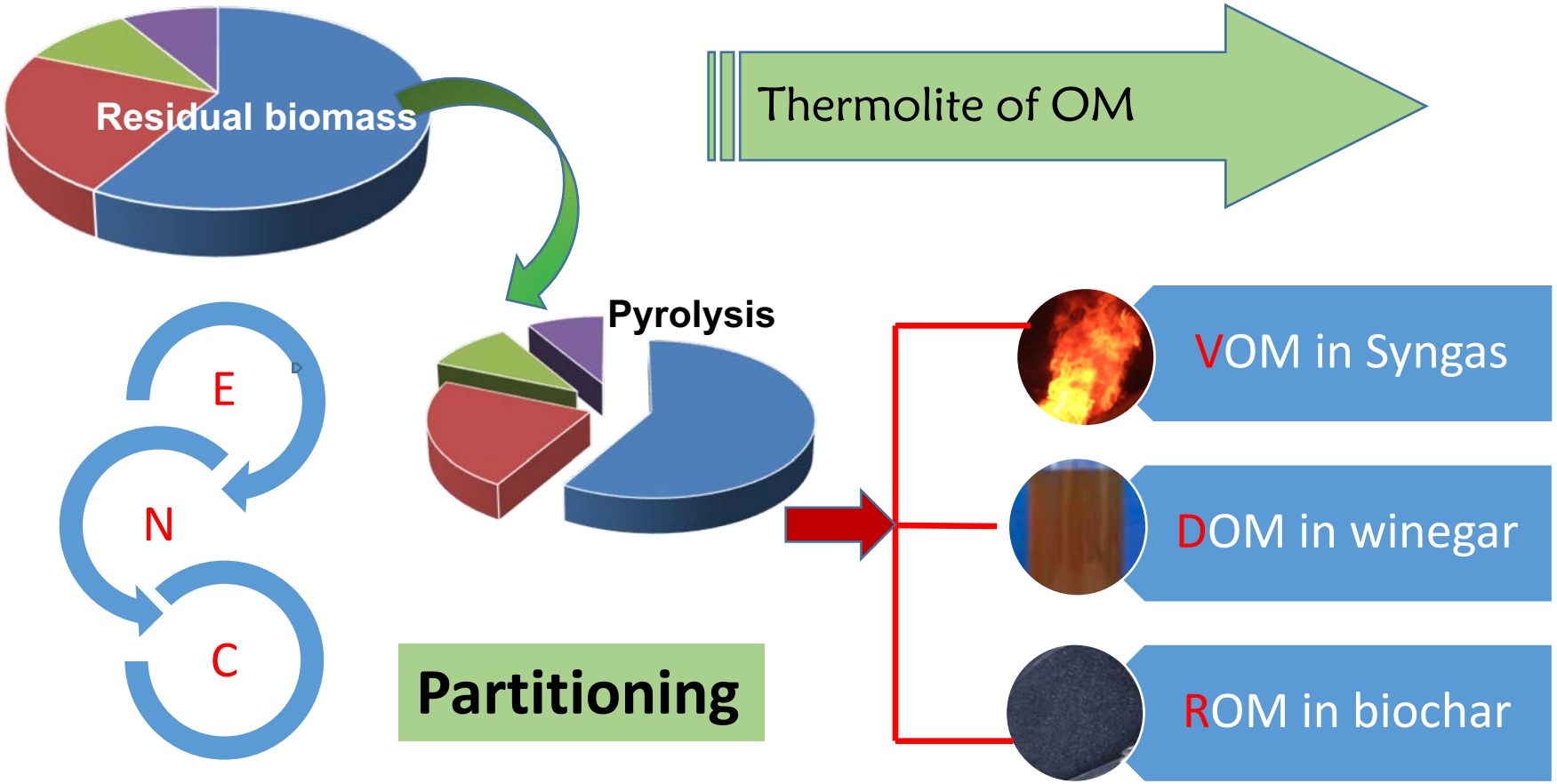
Deform, transform, reform



Engineering biomass to biochar

Transforming to minimize E-risk

How biochar: Engineering pyrolysis system for agriculture and..



Differentiated pyrolysis, designed products and distributed system of biochar production, 3D approach

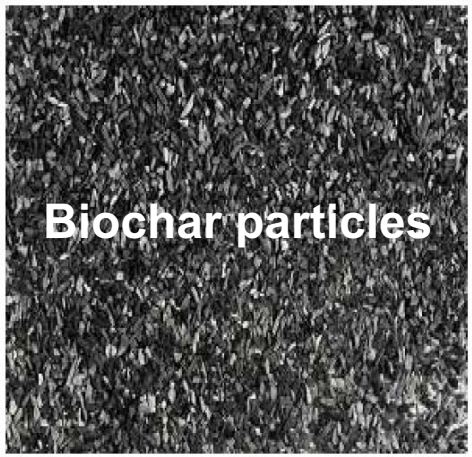
Crop straw pyrolyzer, continuous rotatory kiln

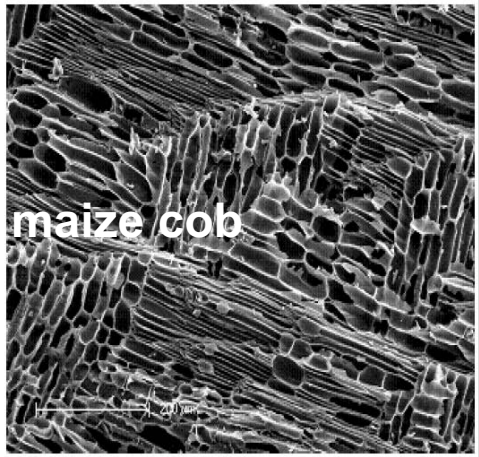
30 thousand ton per year feedstock

Developed by Beijing Sanju in cooperation with NJAU

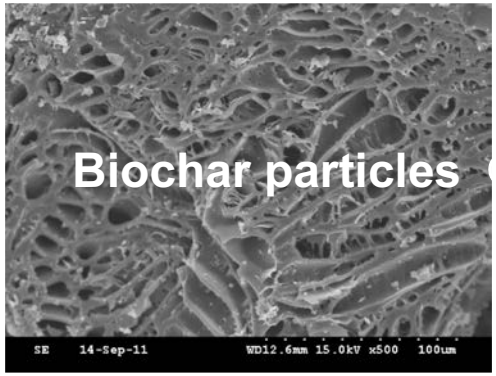
Co-Pyrolyzer: mixed feedstock

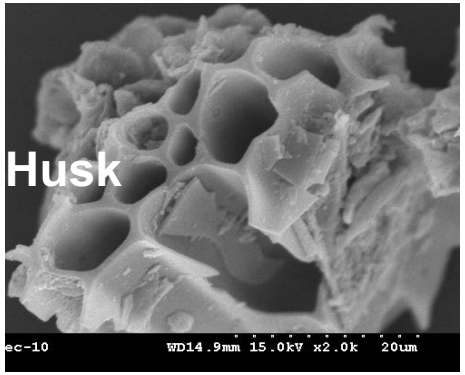
Designed biochar: single or combined use





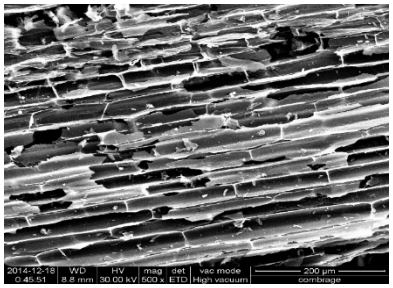
SA of biochar derived from(m^2/g)	
Wheat straw：	16.66
Maize straw：	4.49
Peanut husk：	11.08
Municipal waste：	3.83

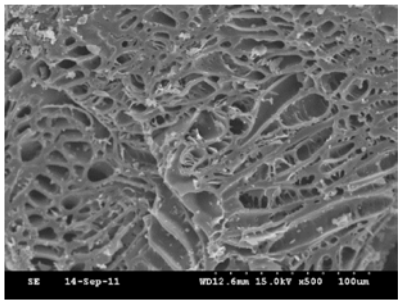


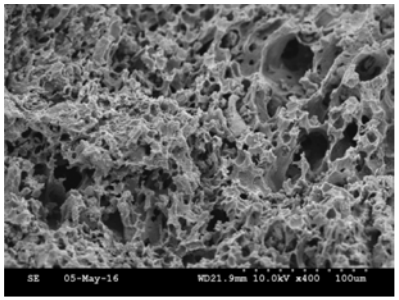


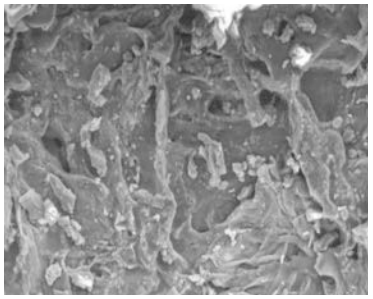
创新生物质材料：
肥料炭载体、饲料炭载体、吸附剂、钝化剂、食品加工佐剂
创新生物质产品：
纳米盾、炭基肥、土壤改良剂、园艺基质及融雪剂

Designed biochar: from combined feedstock to combined biochar material





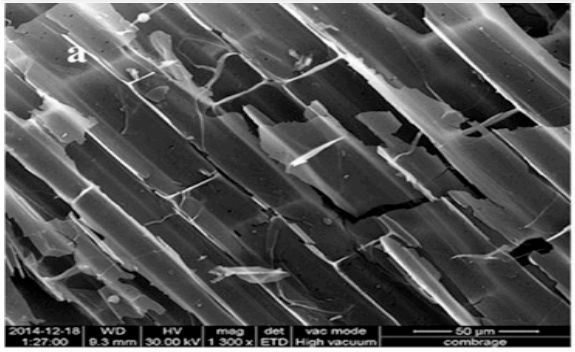


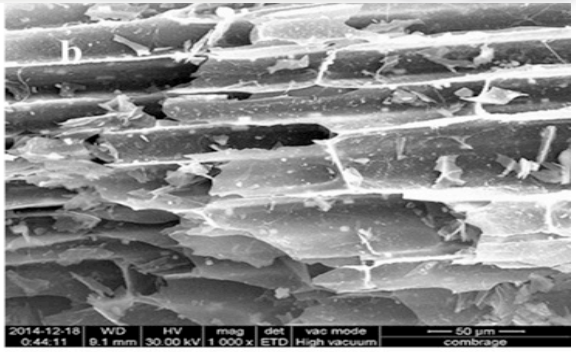


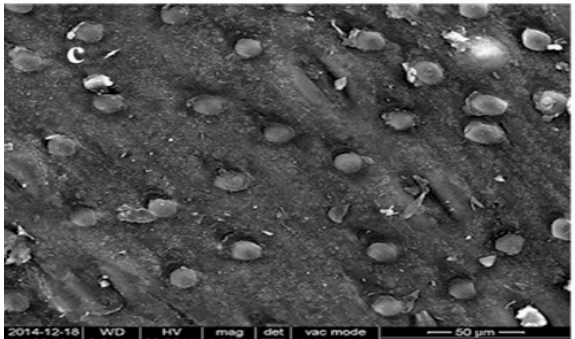
Extraction, modification, formulation and granulation…

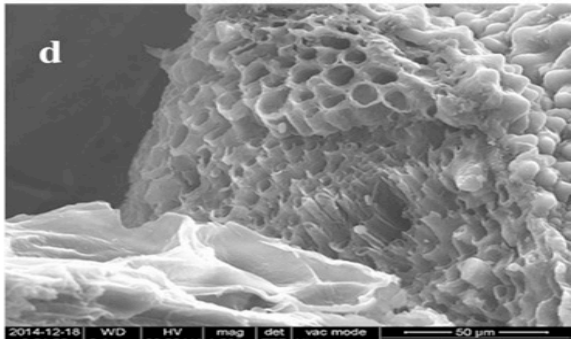
Main feedstock: straw resource available

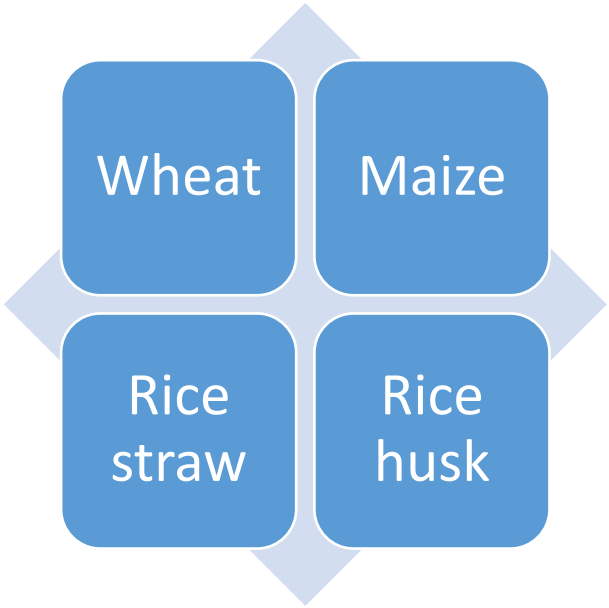
Properties concerned:
CEC, SA, pH;
VOMs, porosity;
Ash, ….





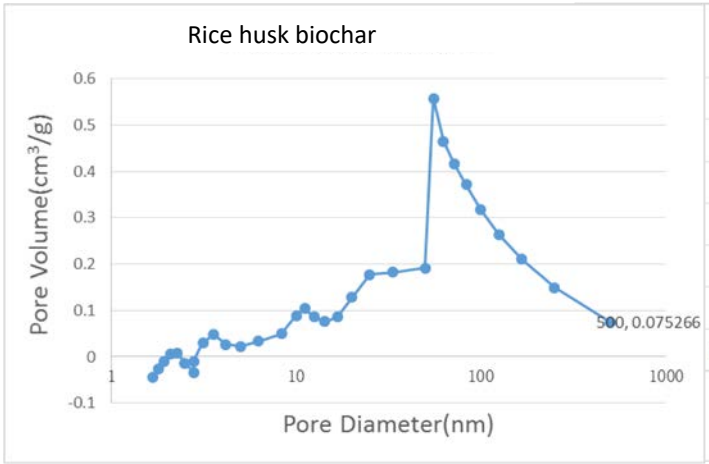


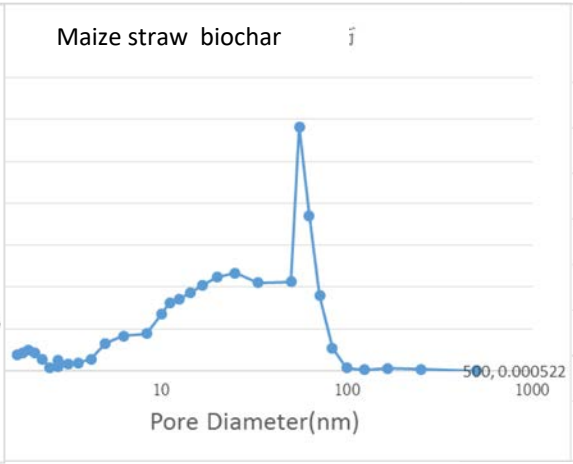


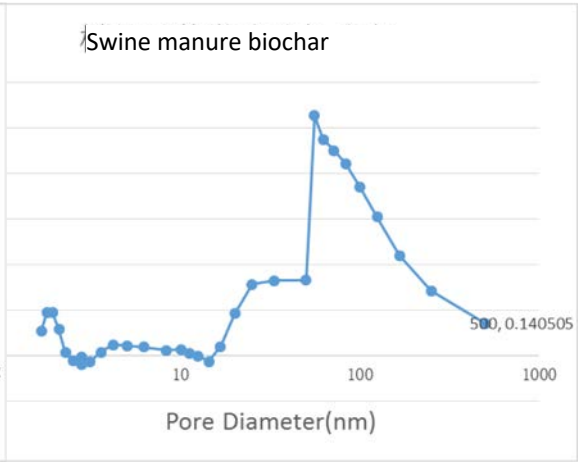


Porosity as a key factor: Cryo-porometry

Feedstock	Total (cm^3/g)	Median pore size (nm)	Minimum size(nm)	Size in 95% CI (nm)
Rice husk	0.41	80.0	2.0	3.5~250
Maize straw	0.55	50.1	1.2	2-83
Swine manure	0.72	80.0	2.0	15-500







Designed biochar: VOM molecules in biochar

~300 species

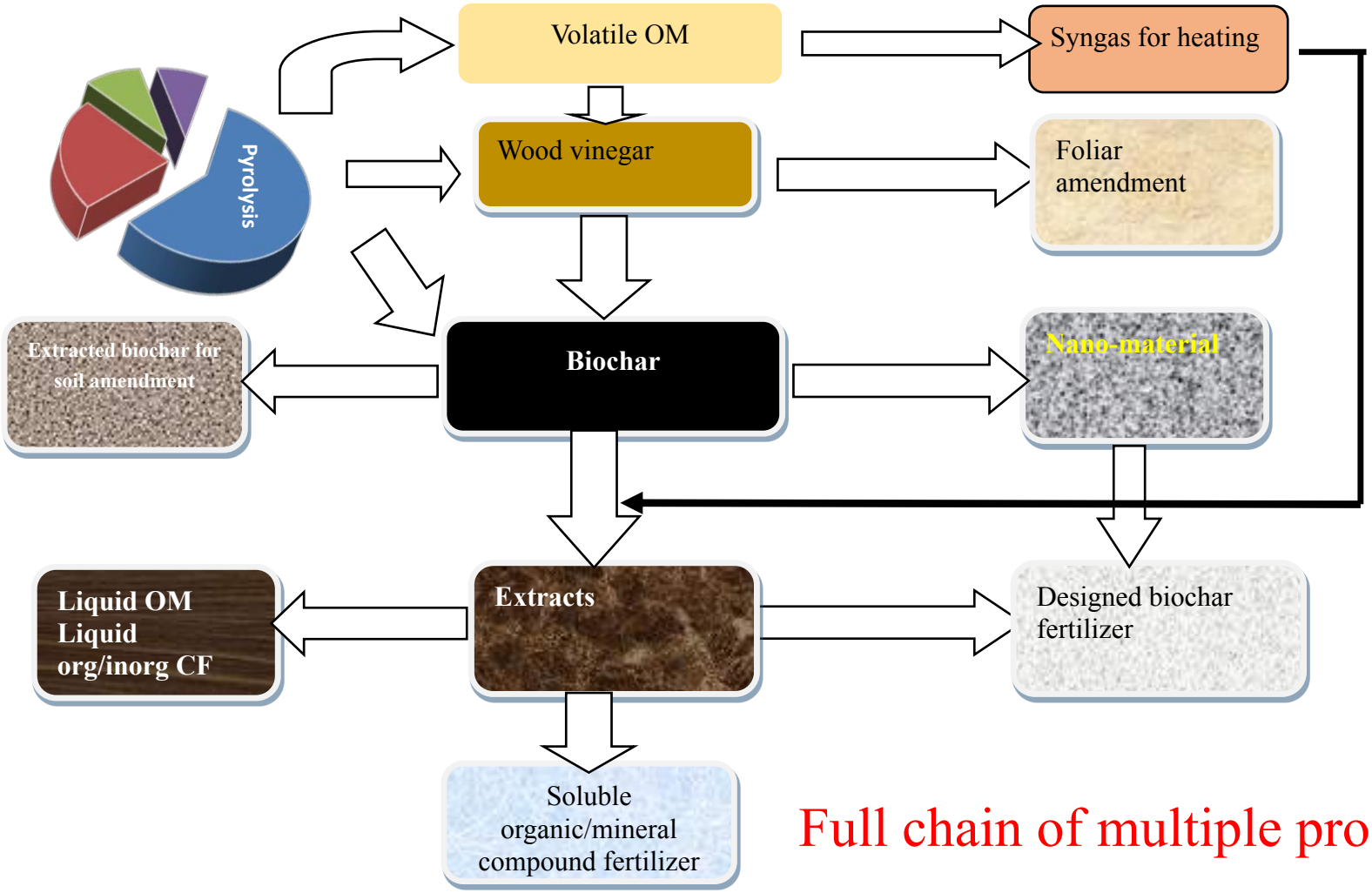
DOM 4%,

Liquid OM

Compounds		Wheat SL	Maize SL	Peanut husk	Wheat LH	Rice husk LH	Rice husk YJ	Maize SX	Wheat TY
2-Butenoic acid	2-丁烯酸	Y	—	Y	Y	Y	Y	Y	Y
Triethyl phosphate	磷酸三乙酯	Y	Y	Y	Y	Y	—	—	—
Benzenepropanoic acid	苯丙酸	—	Y	Y	—	—	—	—	—
Benzoic acid	苯甲酸	Y	Y	—	Y	Y	Y	Y	—
1-pentene	1-戊烯	Y	—	—	—	—	—	—	—
Phenol	苯酚	Y	Y	—	Y	Y	Y	Y	Y
Cyclopentene	环戊烯	Y	—	—	—	—	—	—	—
Formica acid	甲酸	—	—	Y	—	—	—	—	—
Valeric acid	戊酸	Y	Y	—	Y	Y	—	Y	—
Phthalic acid	邻苯二甲酸	Y	Y	Y	—	Y	Y	Y	Y
1,2-Benzendicarboxylic acid	1,2-苯二羧酸	Y	—	—	—	—	—	—	—
9,12,15-octadecatrienoic acid	9,12,15-亚麻酸	Y	—	—	Y	Y	Y	—	—
2-propenoic acid	2-丙烯酸	—	—	—	—	Y	Y	Y	—
Fumaric acid	延胡素酸	—	Y	—	—	—	Y	—	Y
n-Hexadecanoic acid	棕榈酸	Y	—	—	Y	—	—	Y	—
Erucic acid	芥子酸	—	—	—	Y	Y	—	—	—
Nicotinic acid	烟酸	—	—	—	—	—	—	Y	—
N-Methynicotinic acid	N-甲基烟酸	—	Y	—	—	—	—	Y	—
Heptadecanoic acid	十七烷酸	Y	—	—	—	—	—	Y	Y
Glycerol	甘油	Y	—	Y	Y	Y	Y	—	—
Ribitol	核糖醇	—	—	Y	—	—	—	—	—
1-Hexadecanol	十六醇	—	—	—	—	—	—	Y	Y
Behenic alcohol	二十二烷醇	Y	—	—	—	—	—	Y	—
Oleyl alcohol	油醇	—	—	—	Y	—	—	—	—
Isoquinoline	异喹啉	—	—	—	—	Y	Y	—	—
Naphthalene	萘	—	—	—	—	—	—	—	Y
Urea	尿素	—	—	—	—	—	—	Y	—
1-Monolinoleoylglycerol trimethylsily ether	单酰甘油三甲基硅醚	Y	—	—	—	—	—	Y	Y

Biochar industry:

Co-production and full use of pyrolysis products



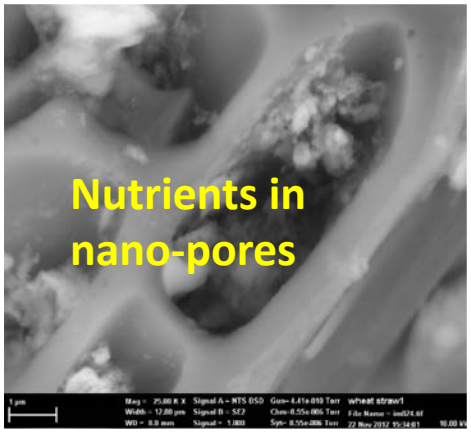
Full chain of multiple products

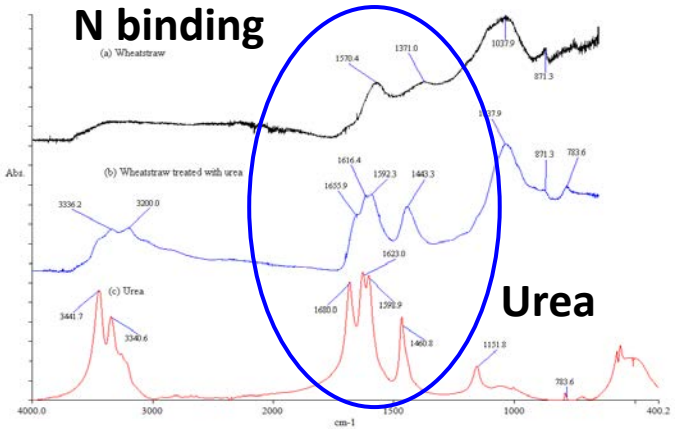
Core product:

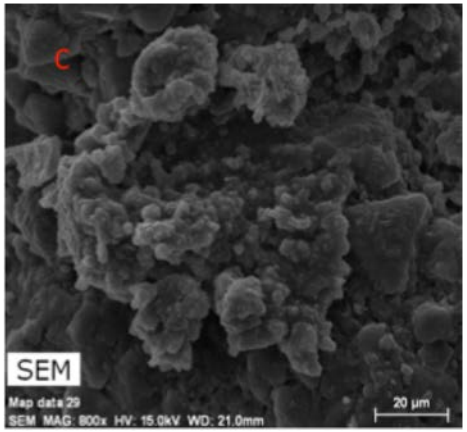
Blended biochar compound fertilizer (BCF)

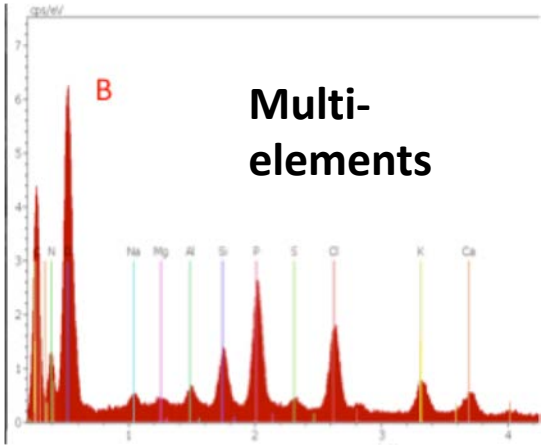
-N-P_2O_5-K_2O, 15-15-10, 40%

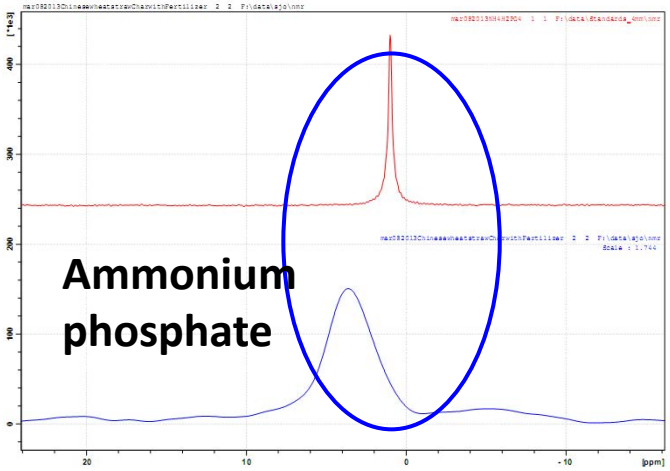
organic/inorganic, active Vs structure OM, Habitat and nutrients, macro and micro





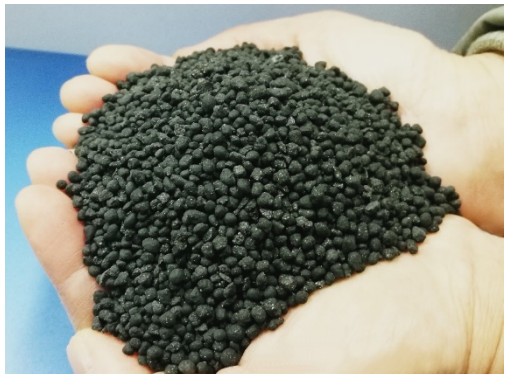


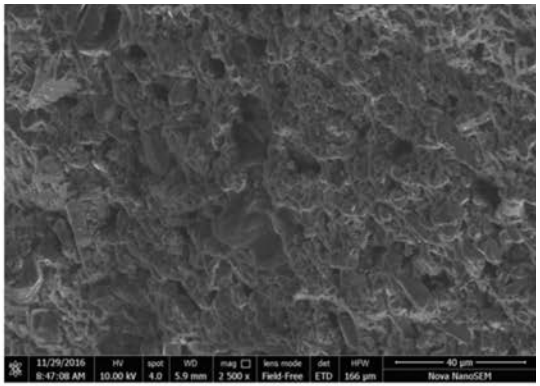


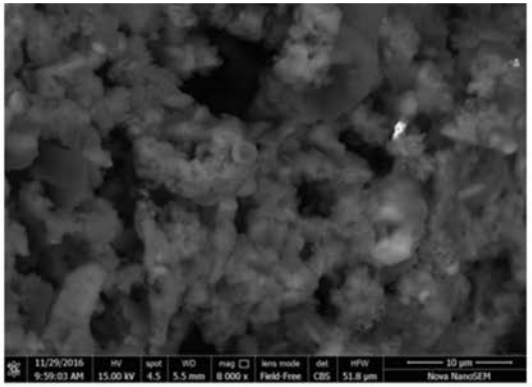


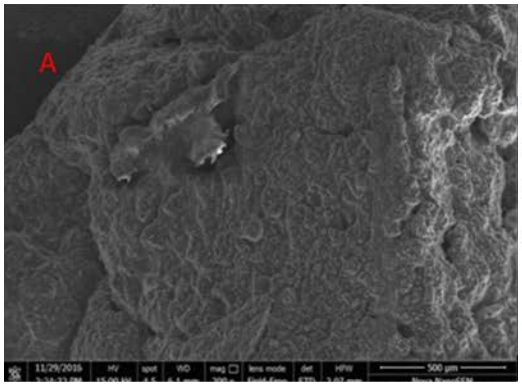
BCF 2nd Generation:

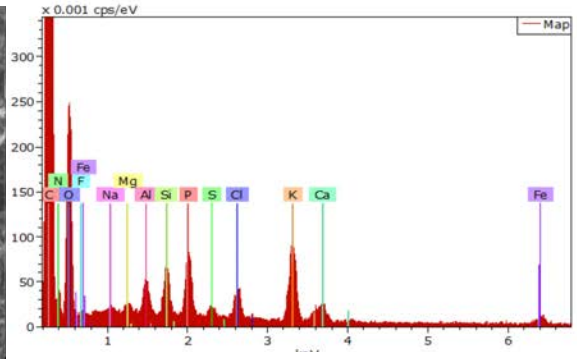
balance between org/inorg, N-P-K, major/micro, active /structured OM, quick/slow pool

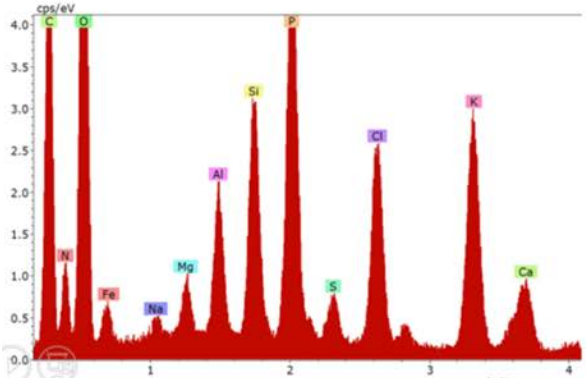






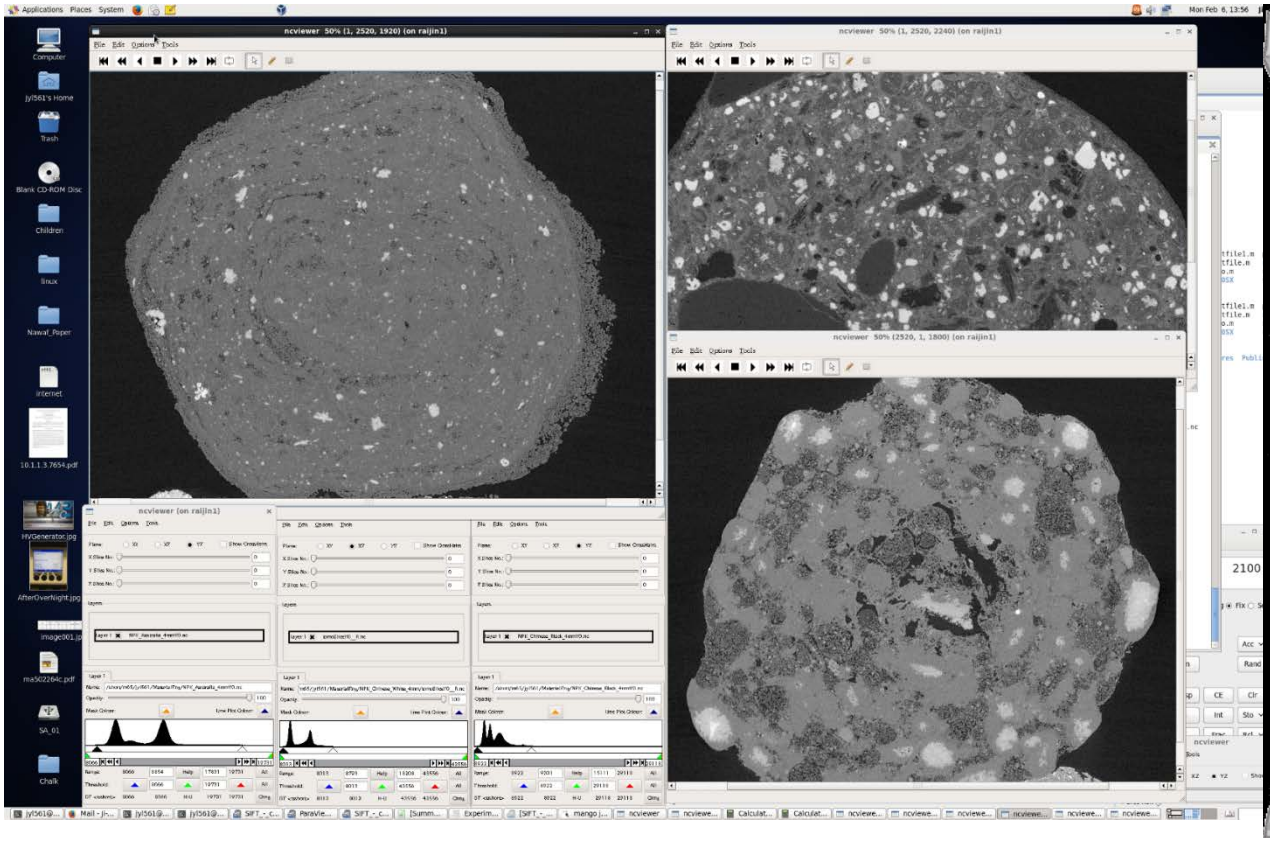






Simulating aggregates： not only for plants!

2nd BCF: Aggregate-like Compound mineral organo nano-fertilizer



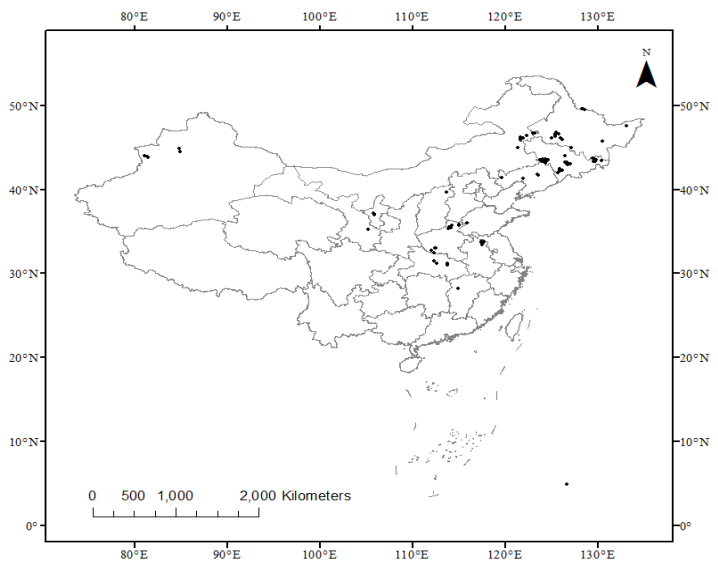
2nd Generation BCF: specifications

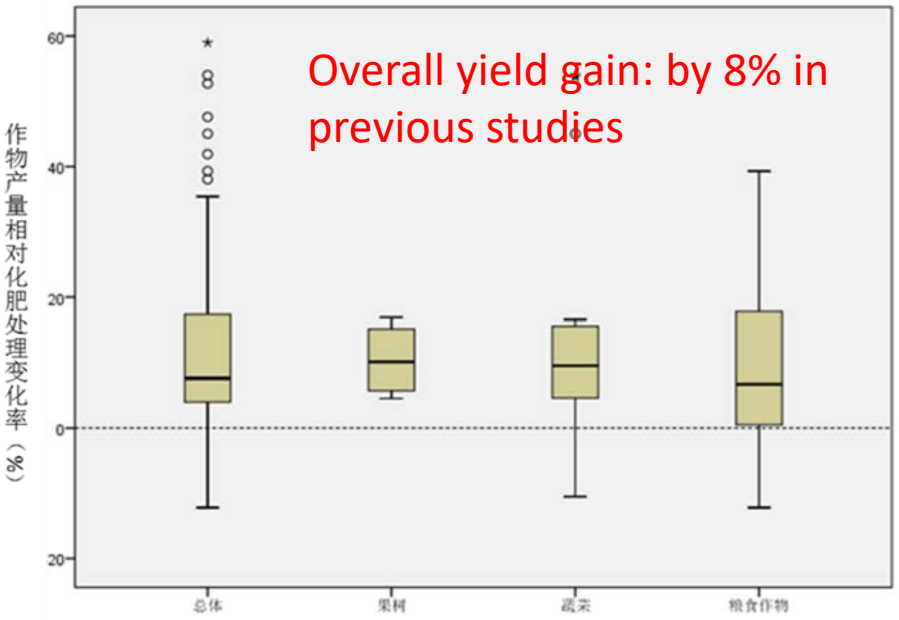
Biochar blended compound fertilizers, crop specific

Biochar and liquid combined seedling promotor

Biochar based amendment

Field demonstration in 2017





Overall yield gain: by 8% in previous studies

Mean yield increase by biochar fertilizer

(95% confidence interval)

Overall yield gain: 11%

2nd BCF

Rice: 9.1±1.1%;

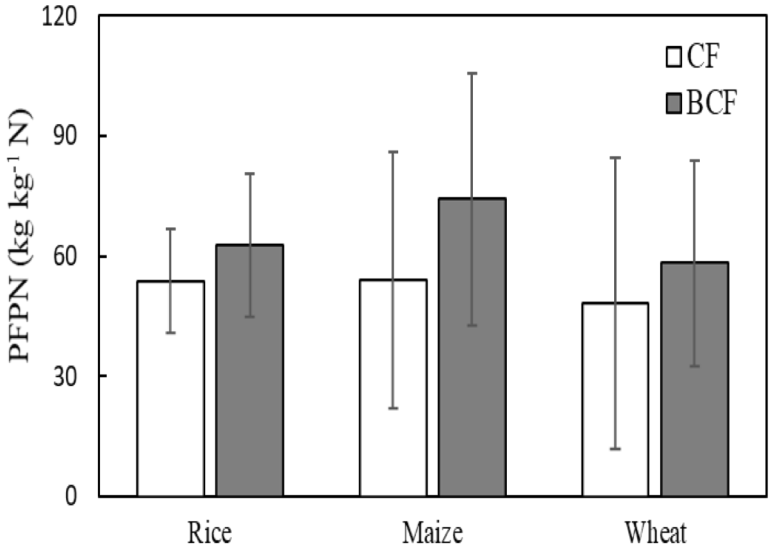
Maize: 5.0±6.2%;

Wheat:10.5±4.3%;

Potato: 22.0±11.5%

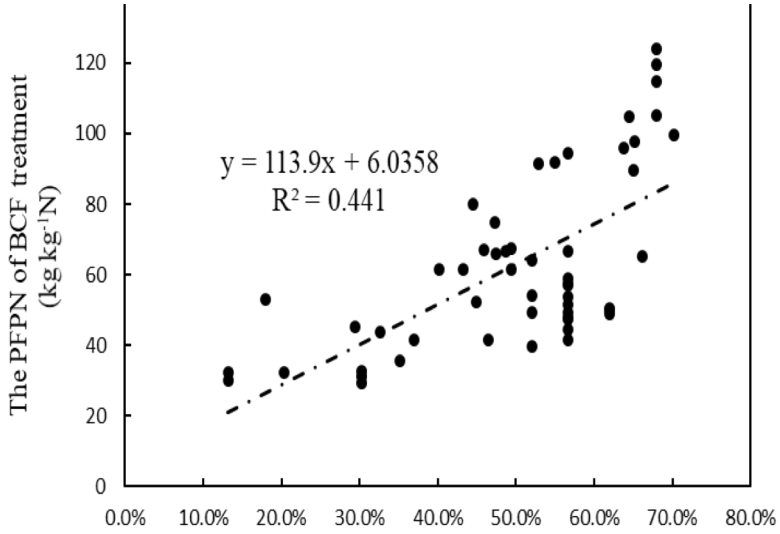
compared to 11% (Jeffery et al., 2011 soil amendment 20t/ha)

Agronomic use efficiency



Improvement of PFPN (95% confidence interval)

- Rice:13.6±3.8% ;
- Maize:47.7±10.8% ;
- Wheat: 47.3±80.9%。 ;



Increase in PFPN correlated to biochar portion in the fertilizer

Table grape at mature

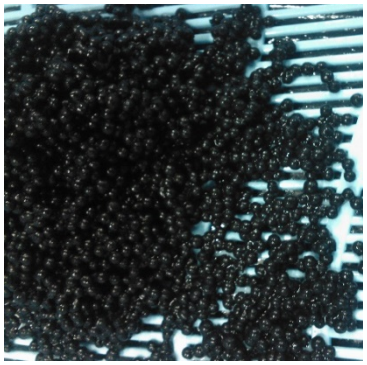
14-08-18

Quality changes (Table grape)

Fertilizer	SPAD	Fruit size (mm)	Sugar (%)	Soluble Prot (mg/g)	Vc (mg/100g)	Acidity (%)	Sugar to acid
CF	38.88±3.40b	21.05±1.22b	17.52±0.13b	56.91±1.18b	3.29±0.12b	0.95±0.02a	18.48±0.31b
BCF1	40.48±2.85b	24.06±1.26a	18.50±0.12a	60.27±1.52a	4.37±0.35a	0.86±0.03b	21.54±0.82a
BCF2	43.66±2.72a	23.10±1.27a	18.62±0.04a	60.67±1.08a	4.24±0.19ab	0.87±0.01b	21.34±0.21a

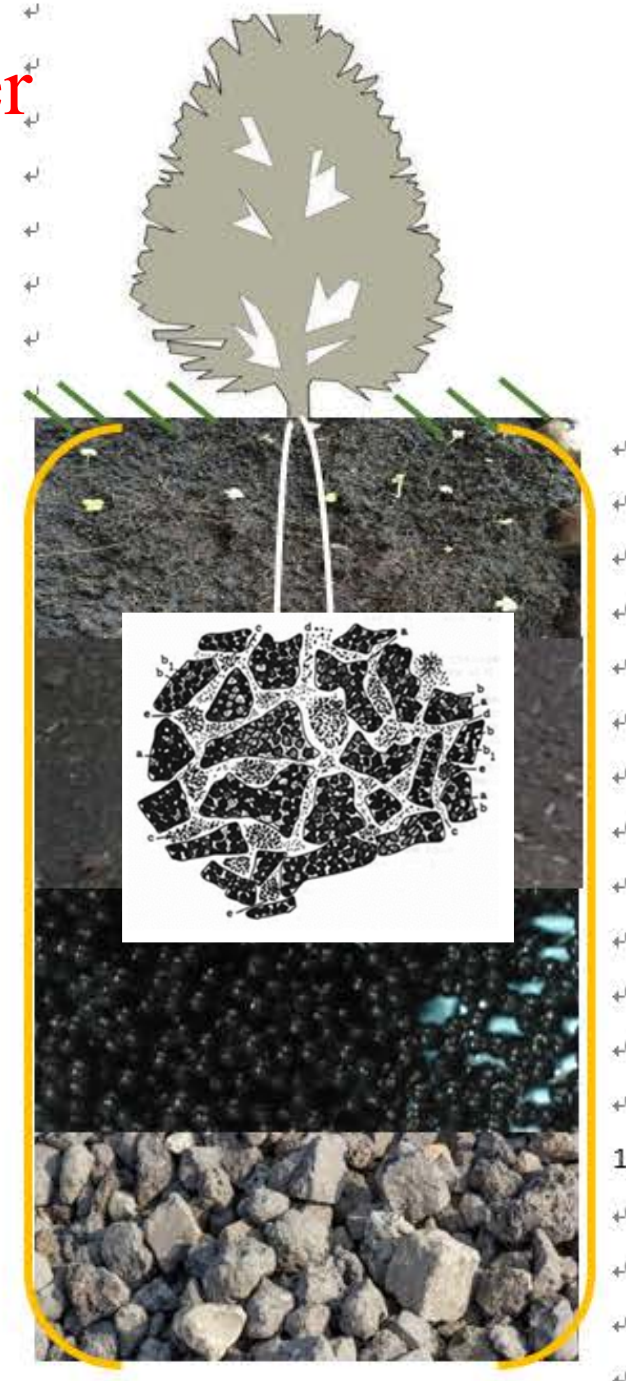
Improvement: 2-3mm size; 10%,sugar content but 30% for Vc, others improved by 15-20% !

Main product: Biochar soil conditioner

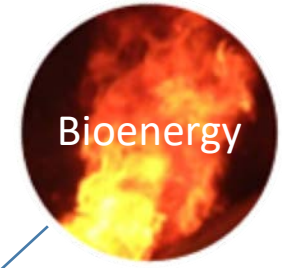


Soil restoration and rehibitation

Combination, formulation and configuration



Distributed biomass industry



- Heating
- Vapors
- drying

- solid
- liquid

- Soil-water
- Food/forage
- Municipal use

Thermolite, transform and segment only

No amendment, no synthesis and no release of chemicals

Distributed system of Biomass-Biochar Industry

Village level

Logistics

County level

Individual farmers, cooperative farmer groups, feedstock company..

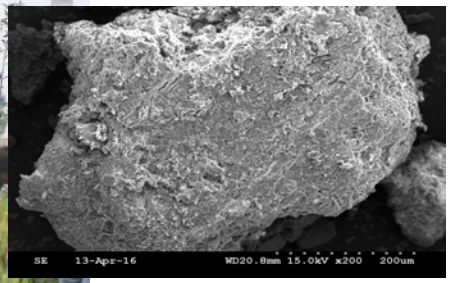
Feedstock: local collection and processing, sealing to biochar plant via logistics

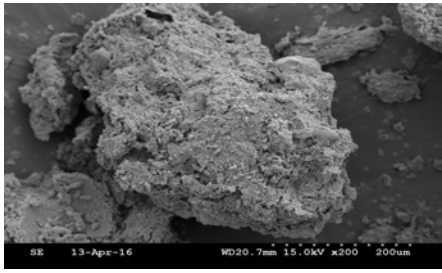

2018/4/26

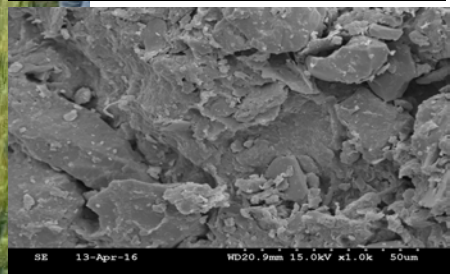

38160

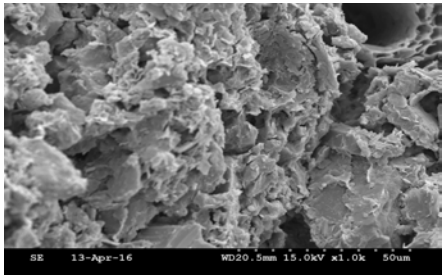

生物炭基肥料
源自农业 反哺农业

Government appraised, recognized by extension agency..









Being state policy supported

秸秆炭化还田技术受到国家部委认可

三聚绿能

Low carbon key tech, CRD

“秸秆炭化还田——土壤改良技术”，被国家发改委列入国家重点推广的低碳技术目录。

Cutting edge tech, National Chemical Association

“农作物秸秆炭化还田—土壤改良技术开发与应用”被中国石油与化学工业联合会组织专家委员会鉴定为国际领先水平

2014年9月

2017年4月

2017年8月

2018年8月

“秸—炭—肥还田改土模式”被农业部列入“秸秆农用十大模式”

Recommended as 10 top technique of resource recycling, MoA

秸秆炭化制肥项目被国家生态环境部列为“废弃资源综合利用业”

Appraised as comprehensive resource cycling industry, MEP

项目背景——符合国家政策方针

三聚绿能

China's state policies regarded to biochar in agriculture

- 2012: Demonstration projec
- 2013: Key technologies of Lc
- 2015: Extension project by M
- 2017-05: Top 10 Key techno
- 2017-07: BCF standard issue
- 2017-11: Co-production of b sector, State Energy Bureau,
- 2018-07: Biochar technology planed by MoA;
- 2018-08: Straw to biochar fe MEEP,
- more to come up…

Technical advises and services provided for project

三聚炭肥示范田建设

三聚绿能

示范田分布情况

三聚地沃炭基肥示范田

- 示范田328块。**(2018)**
- 第三方权威机构试验报告146份。
- 编制《2017年生物质炭基肥料示范田报告汇编》及《示范田建设与管理手册》。

Product standards, operation guideline
and quality control protocol available

Biochar industry:

Linked to local economy development: County

BCF for special rice in Wuchang County

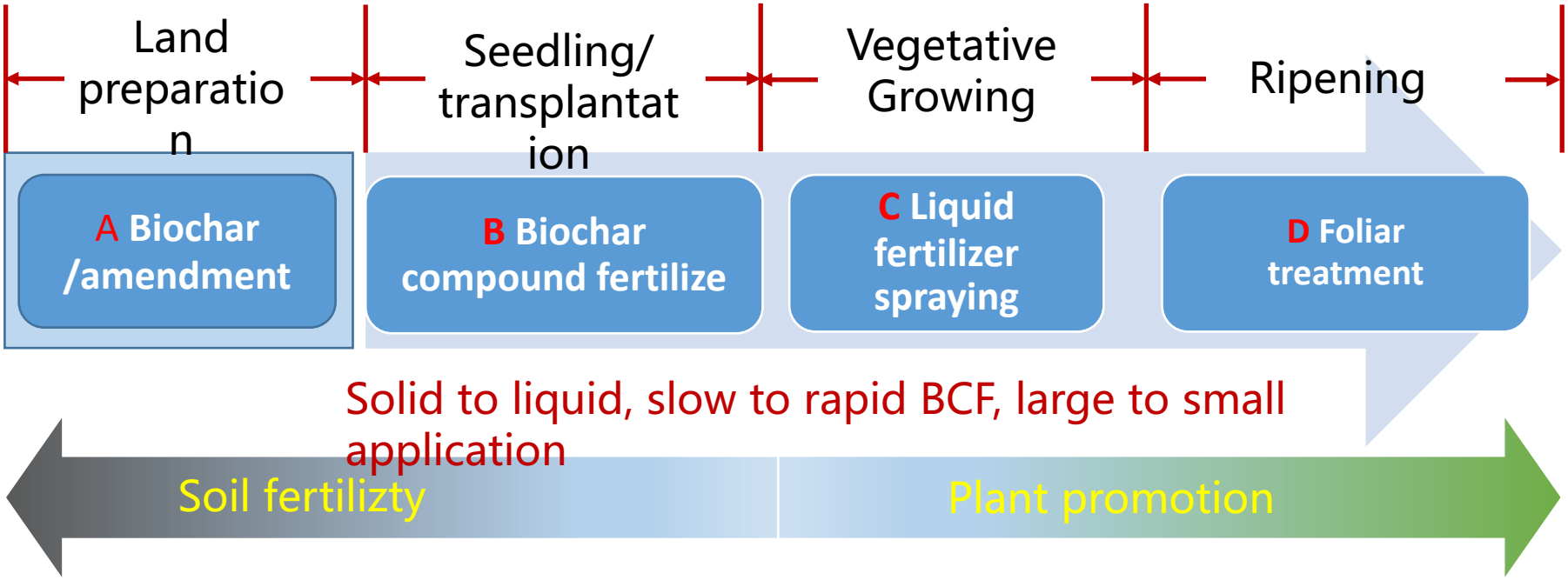
Biochar industry:
linked to Re-vitalization (poverty reduction) in remote rural area

From waste to wealth as from straw to biochar-based agriculture, as in Jianping Liaoning, China

Quality to value

From waste management to food and health improvement!

Integrated soil-plant manipulation technologies under development



Biochar fertilizer based high quality agro-products for special sector: grain for wine

Biochar fertilizer for soybean for food: high yield and quality soybean under testing

Biochar agriculture: cobenefits should not be ignored

Biochar for new green agriculture

Government, academic, extension and business in close cooperation