



Potential evaluation study and application methods for biomass energy in the Northern Delta Vietnam

Tran Van Quy - HUS



Participants

*Leader: **Tran Van Quy***

Các thành viên tham gia thực hiện:

PGS.TS. Lưu Đức Hải, Khoa MT, ĐHKHTN

TS. Nguyễn Khánh Toàn, Viện Năng lượng

TS. Hoàng Ngọc Quang, Trường Cao đẳng Tài nguyên Môi trường

ThS. Phạm Thị Mai, Khoa MT, ĐHKHTN

ThS. Trần Thiện Cường, Khoa MT, ĐHKHTN

HVCH K14: Hoàng Thị Huê, ĐHKHTN

HVCH K15: Trần Thị Quỳnh, ĐHKHTN

CN. Nguyễn Xuân Huân, Khoa MT, ĐHKHTN

Sinh viên K49 CNMT: Đường Xuân Phúc, Hồ Thị Phương



Objectives

- To assess status and potential of agricultural by-product in the Northern Delta
- To collect information about agricultural biomass energy potential in The Northern Delta Provinces
- To suggest appropriate methods that can utilize agricultural biomass energy to partly reduce environmental pollution and pressures on the environment.



Object and location

- **Object of research**

Agricultural by-products: rice straw, rice husk, corncob, etc

- **Location**

Northern Delta provinces

Research contents

Theme 1. Socio-economic status

Theme 2. Agricultural production status

Them 3. Rice cultivation by products use status

Theme 4. Other by products use status

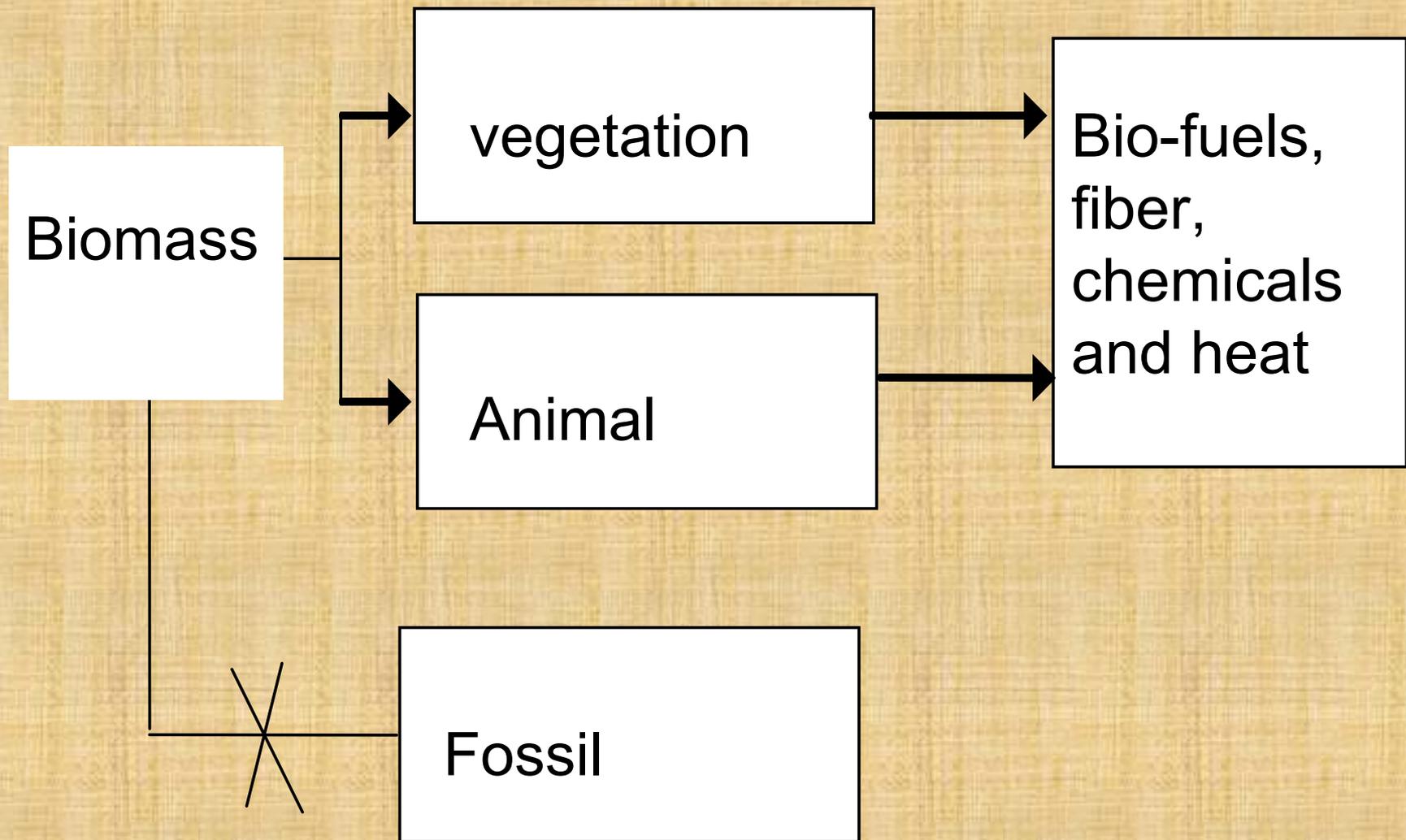
Theme 5. Evaluation and analysis of energetic and environmental benefits of agricultural by products use

Theme 6. Recommendation of applicabale technologies for agricultural by products use



Biomass and biomass energy

- **Biomass:** is biological material from living, or recently living organisms
- **Biomass energy:** is defined by any organic materials that can be burned and used as a source of fuel





Biomass energy use

- Fossil fuels substitute
- Environmental protection

Difference with other renewable energies

- *Controllable;*
- *Able to generate heat and electricity simultaneously*



World biomass use

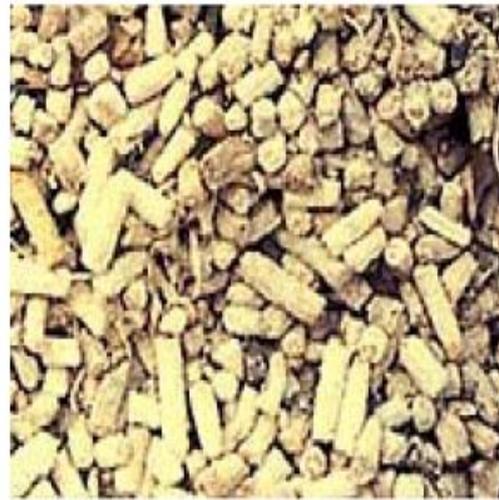


*By 2020,
renewable energies
reach 20%, (1/3
biomass energy) of
total energy
consumption*

- **Leading by USA**
- **Countries pay much consideration to biomass:
China, Japan, Brazil, etc**



Vỏ trấu



Chất thải ngô/ngũ cốc



Chất thải đậu cọ



Mảnh vụn gỗ/bào cưa



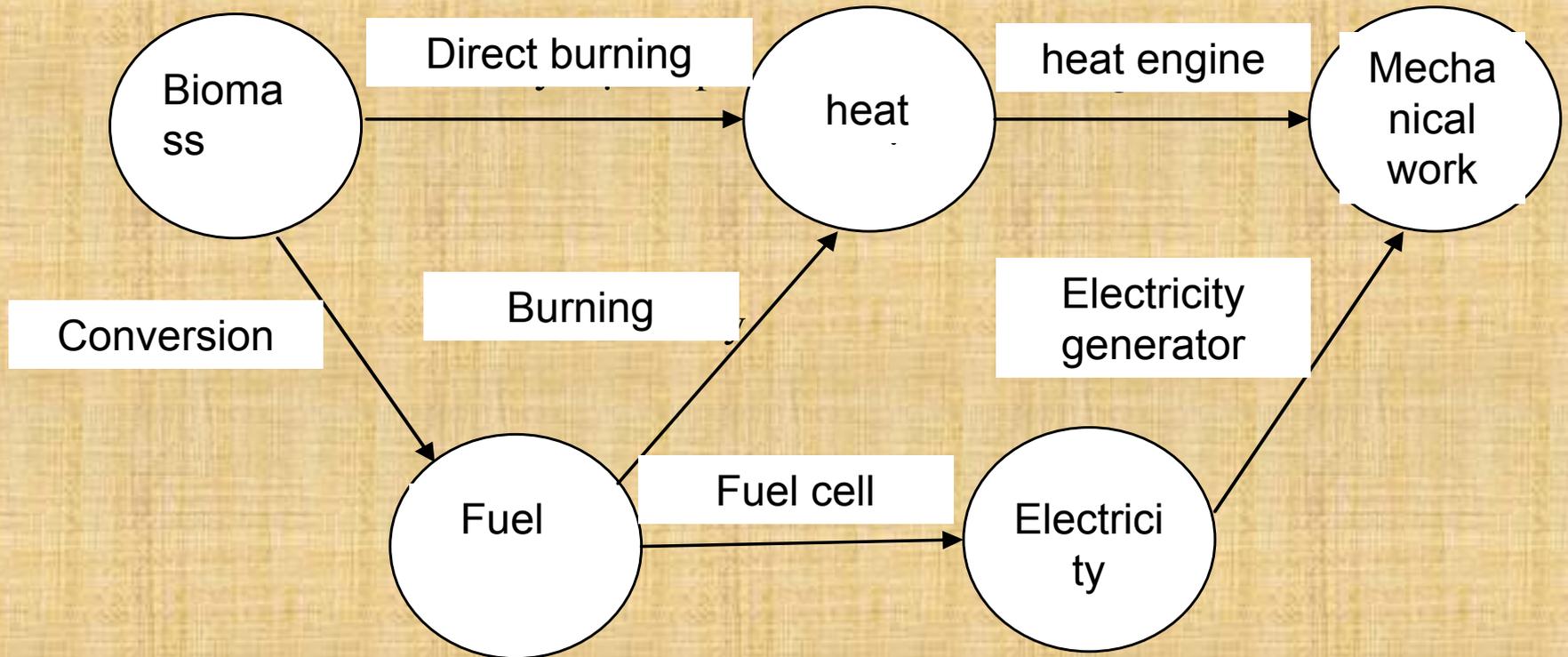
Chất thải gỗ



Cây mía

Two ways of using Biomass:

- Burn to generate heat and electricity
- Convert into other forms



Bio-fuels conversion process

*** Favorable conditions for biomass use in Vietnam**

- *Favorable nature;*
- *Recognized by Vietnamese government*
- *International situation.*

*** Difficulties**

- *Competed by other energy sources;*
- *High cost (technology);*
- *Lack of appropriate policies,...*



Natural condition and socio-economic status of researched regions

Natural condition

Natural resources

Socio-economic status

ADVANTAGES

DISADVANTAGES

Agricultural cultivation status

Land use

Cultivation area, yield, productivity of main plants

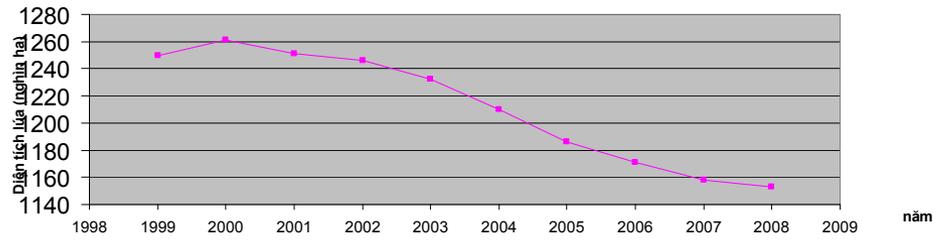
Rice

Corn

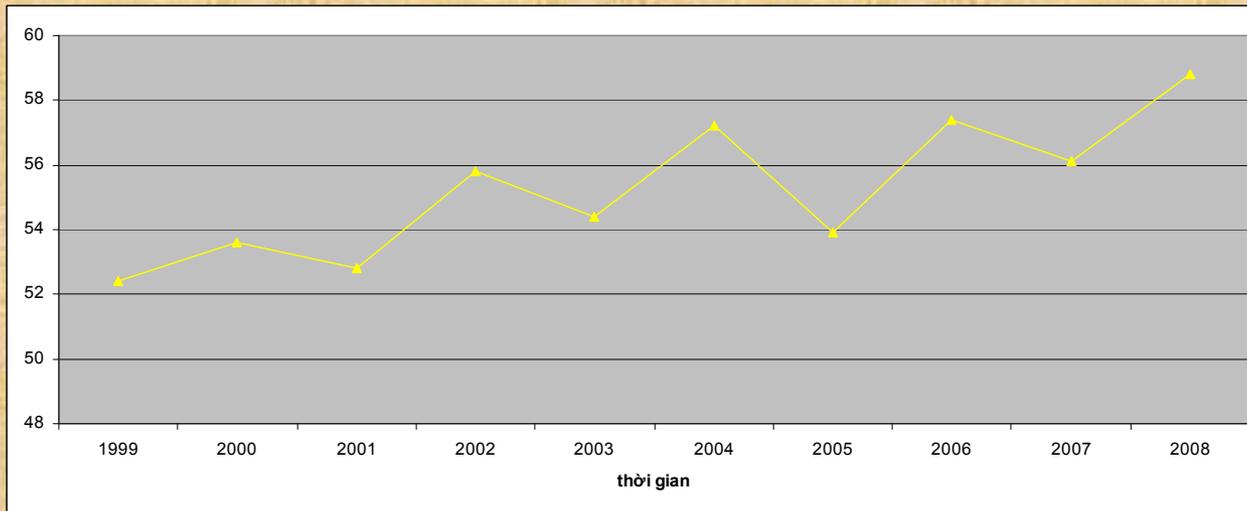
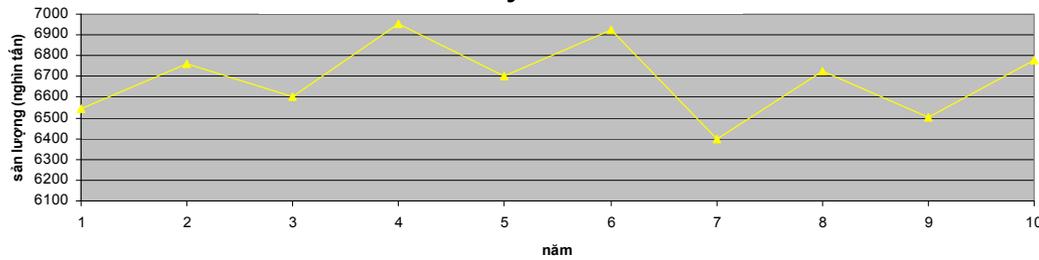
Peanut



Rice cultivation area



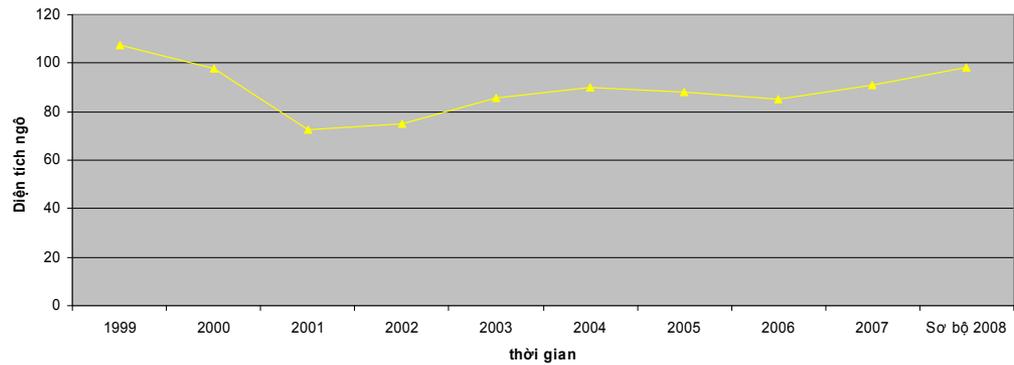
Rice yield



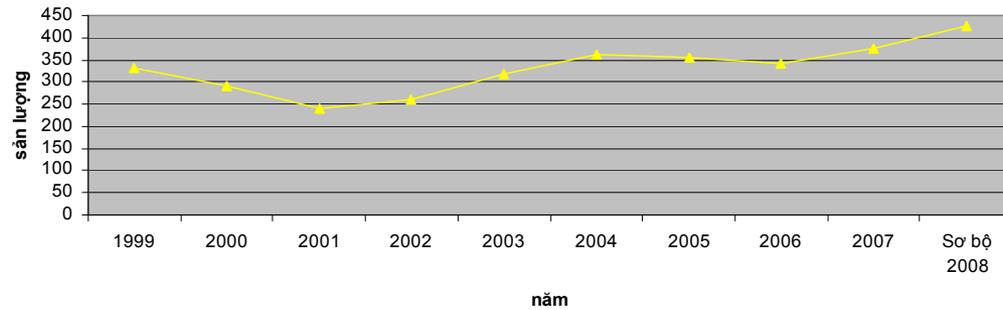
Rice productivity (quintal/ha)



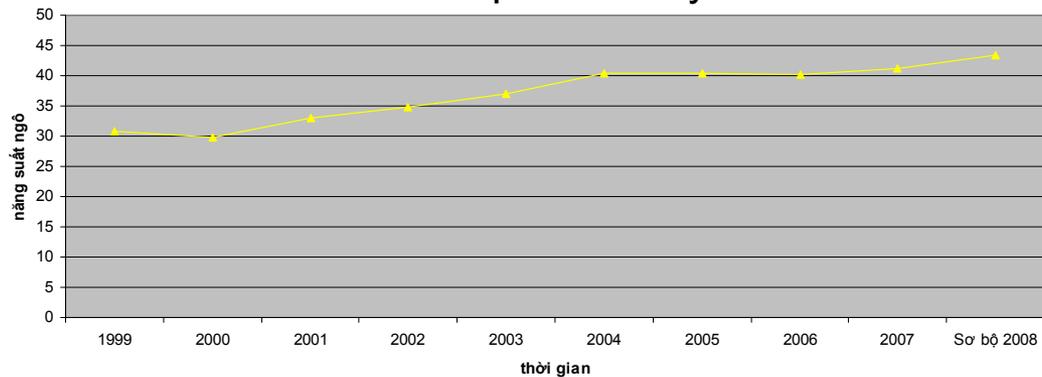
Corn cultivation area



Corn yield



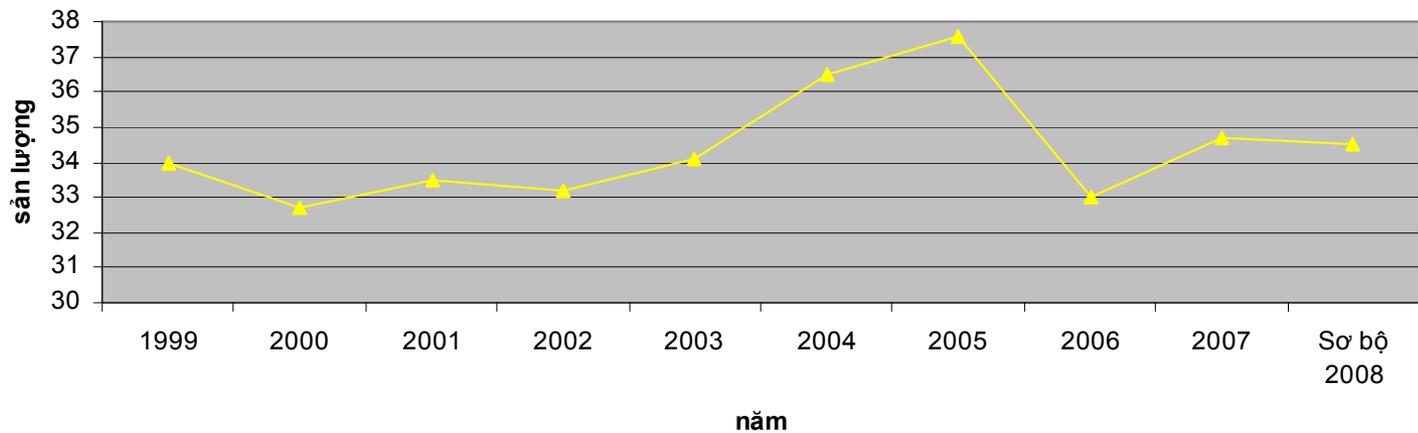
Corn productivity



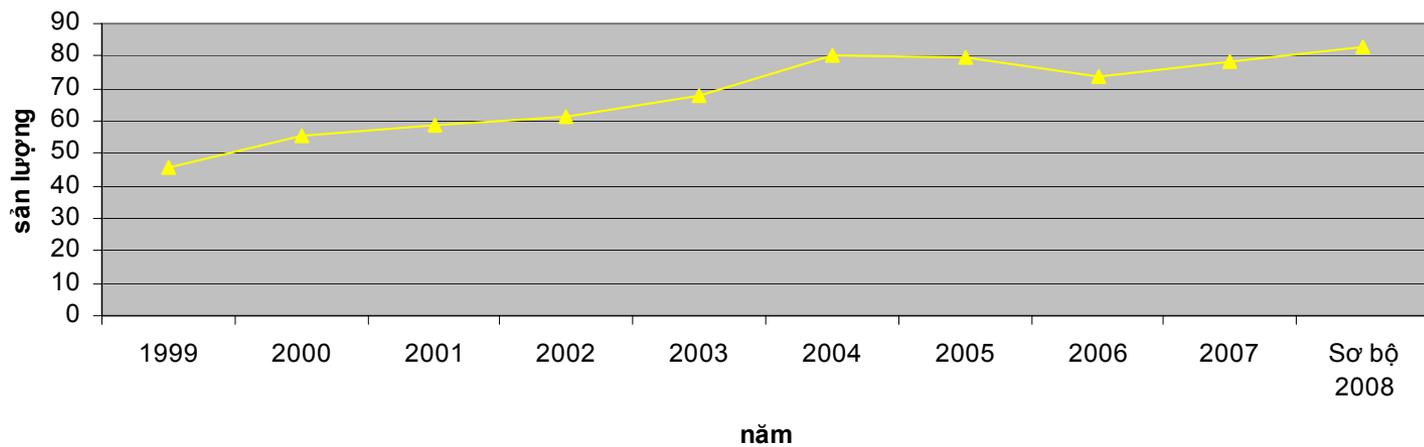
quintal/ha



Peanut cultivation area



Peanut yield



quintal/ha

Collection, use, and amount of by-products

- Collection and use
 - *Buring and used as cattle food*
 - *Mushroom planting*
 - *Fermentation*
 - *Paper making*

Post harvest by-products use

Purpose		COOKING	Husbandry	BURN, DISPOSE	Other
Ratio (%)	Rice straw	35	5	58	2
	Rice husk	98	-	2	-



Rural area household



For cooking



Rice straw accumulated



On-field burning



Environmental pollution

➤ *Rice milling*



Rice husk accumulated



Post harvest by products use (CONR)

Purpose	Ratio	
	Leaf, body	corn cob
Husbandry food	14	8
Cooking	84	89
Others (dispose)	2	3

Post harvest by products use (PEANUT)

Purpose	Ratio (%)		
	Body	Leaf	Cover
Cooking	92	10	94
Fermentation	-	87	-
Dispose	8	3	6

Data (on filed survey) of average amount of rice cultivation by products

Số liệu thực nghiệm về khối lượng trung bình phụ phẩm từ canh tác lúa

rice variety	Field	Amount (kg/36m ²)	
		Rice straw	Rice husk
Tạp Giao	1	22,10	4,44
	2	21,08	4,54
	3	21,28	4,21
Lưỡng Quảng	1	20,67	4,26
	2	19,24	4,18
	3	18,22	4,10
Q5	1	24,15	4,64
	2	23,95	4,59
	3	24,48	4,77
Aver (kg/36m ²)		21,67	4,41
Aver (tonne/ha)		6,01	1,47

Data (on filed survey) of average amount of corn, peanut cultivation by products

Số liệu thực nghiệm về khối lượng trung bình các phụ phẩm từ canh tác ngô và lạc

Field	Amount (kg/36m ²)			
	corn		peanut	
	Body	Cob	Body	Cover
1	23,15	8,06	9,98	1,65
2	22,78	8,22	10,25	1,72
3	22,82	8,10	9,82	1,50
Aver (kg/36m ²)	22,92	8,13	10,00	1,62
Aver (tonne/ha)	6,36	2,25	2,78	0,45

Main product/by product ratio

Plant		Ratio
Rice		1/1
		1/5
Corn		4/1
Peanut		1,2/1

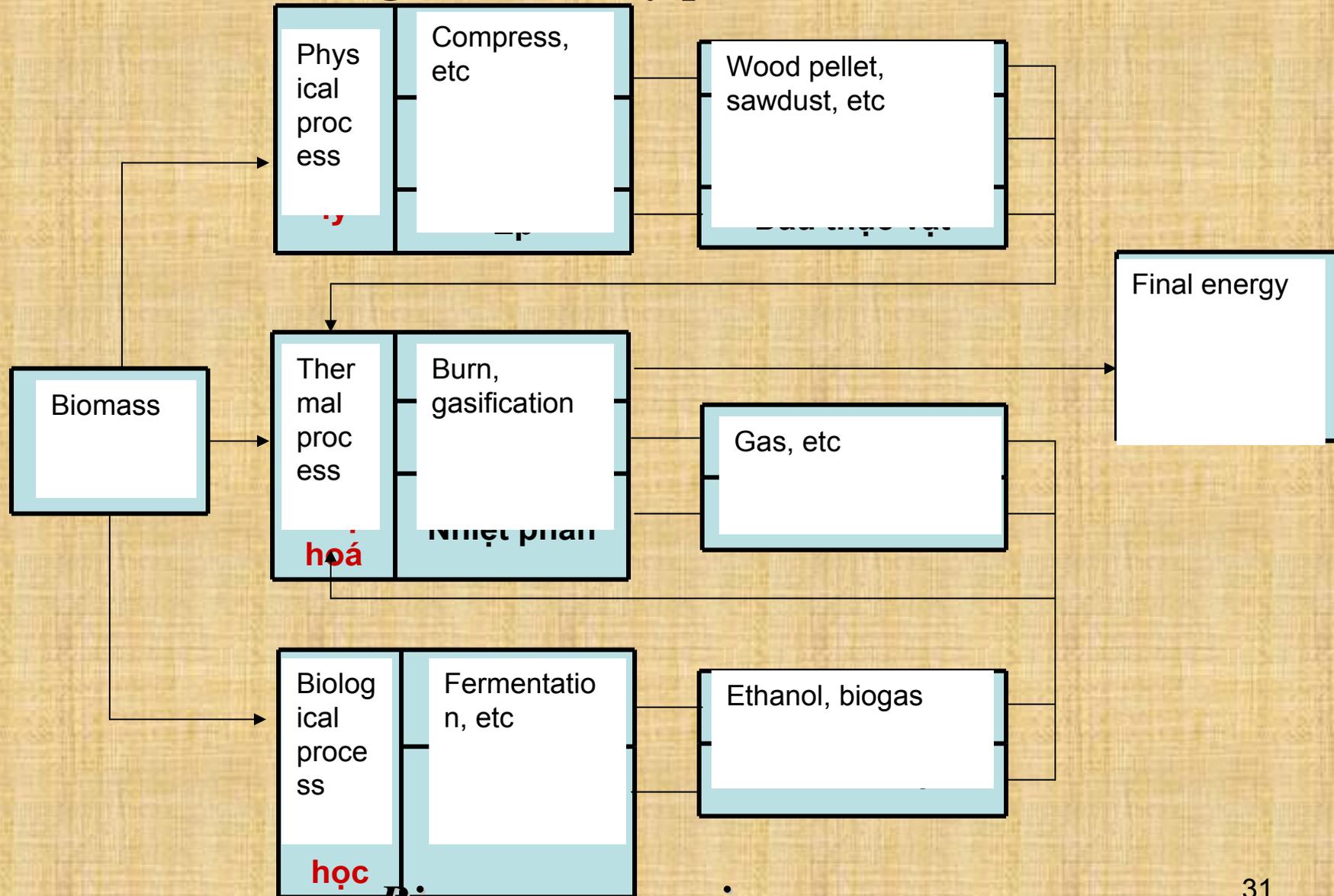
By product amount over time

***Khối lượng các phụ phẩm SK từ canh tác lúa, ngô, lạc ở các tỉnh vùng
Đồng bằng Bắc Bộ diễn biến qua các năm (*)***

Year	By product amount (thousand tonne)				Total
	Rice		Corn	Peanut	
	Rơm, rạ	Trấu	Thân, lá, lõi	Thân, lá, vỏ	
1999	6543,4	1308,7	1324,4	54,0	9230,5
2000	6762,6	1352,5	1170,0	66,8	9351,9
2001	6605,3	1321,1	964,0	70,8	8961,2
2002	6951,7	1390,3	1043,6	73,2	9458,8
2003	6701,5	1340,3	1271,6	81,5	9394,9
2004	6926,1	1385,2	1450,8	95,9	9858,0
2005	6398,4	1279,7	1425,6	95,6	9199,3
2006	6725,2	1345,0	1372,4	88,4	9531,0
2007	6500,7	1300,1	1498,4	93,6	9392,8
2008	6776,0	1355,2	1711,6	99,0	9945,8
Aver	6689,1	1337,8	1323,2	81,9	9432,4

(*)- *Khối lượng SK = (Sản lượng cây trồng) x (tỷ lệ phụ phẩm/chính phẩm)*

Analyze, evaluate and recommend applicable technologies for agricultural by products use



Biomass conversion processes



Current by-product use methods

- Burning
- Mushroom plating
- Convert into thermal-insulating material



Recommend applicabale technologies

Thermogenetic values of by products

Examined 4 samples

Corn: 25% cob + 75% body and leaf

Peanut: 15% cover and 85% body and leaf

Rice husk: 100%

Rice straw: 35% rice straw + 75% rice stubble



Thermogenetic values of by products

Giá trị sinh nhiệt của các phụ phẩm từ canh tác lúa, ngô, lạc

Burned at 3000 kPa

Sample		Corn	Peanut	Rice husk	Rice straw
Mass before burning (g)	Time 1	1,0224	1,0034	1,0211	1,0233
	Time 2	1,0213	1,0042	1,0223	1,0211
	Time 3	1,0226	1,0038	1,0216	1,0228
calorie (Cal/g)	Time 1	4023,4135	3775,2456	3679,7622	3703,7254
	Time 2	4001,5624	3698,9783	3723,2765	3692,7852
	Time 3	3998,7928	3782,5425	3755,1651	3721,6531
	Aver	4007,9229	3752,2555	3719,4013	3706,0546



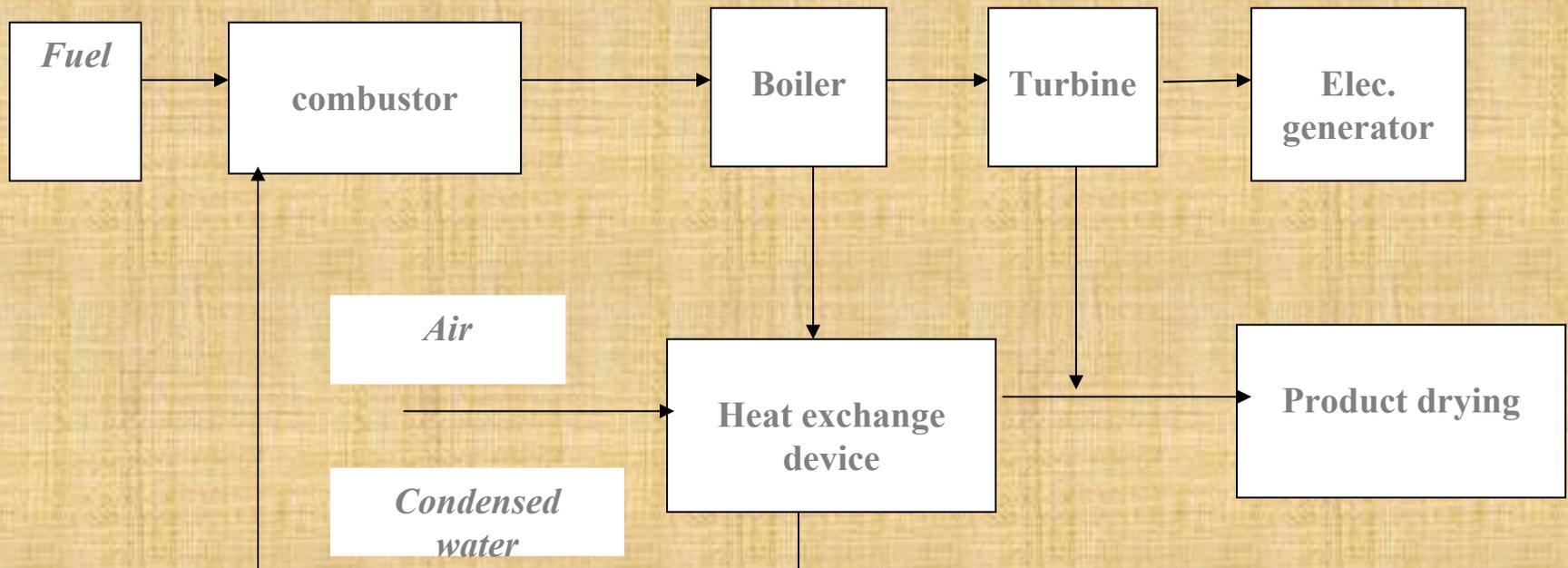
Data on ash, humidity, and total carbon analysis

Order	Sample	Result (%)		
		Humidity	Ash	Total carbon
1	Q5 (rom)	9,00	13,20	38,90
2	Lưỡng Quảng (rom)	9,80	140	38,10
3	Tạp giao (rom)	9,40	13,60	38,50
4	Q5 (rạ)	13,60	12,30	37,05
5	Lưỡng Quảng (rạ)	11,80	12,70	37,75
6	Tạp giao (rạ)	10,40	13,80	37,90
7	Q5 (trấu)	8,20	17,50	37,15
8	Lưỡng Quảng (trấu)	7,20	12,90	39,95
9	Tạp giao (trấu)	8,00	13,40	39,30
10	Lõi + vỏ bắp ngô	11,20	3,30	42,75
11	Thân ngô	12,40	10,70	38,45
12	Thân + vỏ lạc	13,60	12,60	36,90



Recommend applicabale technologies

➤ Heat-electricity co-generation





➤ ***Estimation of biomass electricity generation from by products in Hai Duong province***

- Rice husk burning efficiency: $\eta_1 = 0,8$
- combustor efficiency: $\eta_2 = 0,8$
- Boiler efficiency : $\eta_3 = 0,8$
- Turbine efficiency : $\eta_4 = 0,75 \sim 0,85$
- Heat exchange efficiency: $\eta_5 = 0,3$
- Electricity generator efficiency : $\eta_6 = 0,9 \sim 0,95$

Total efficiency:

$$\eta = 0,8 \times 0,8 \times 0,8 \times 0,8 \times 0,3 \times 0,92 = 0,11$$



If $\eta = 11\%$, 1 tonne of rice husk will be equivalent to:

$$1000 \times 4,32 \times 0,11 = 475,2 \text{ (kWh)}$$

Similarly, 1 tonne of rice straw $\sim 474,1$ kWh.



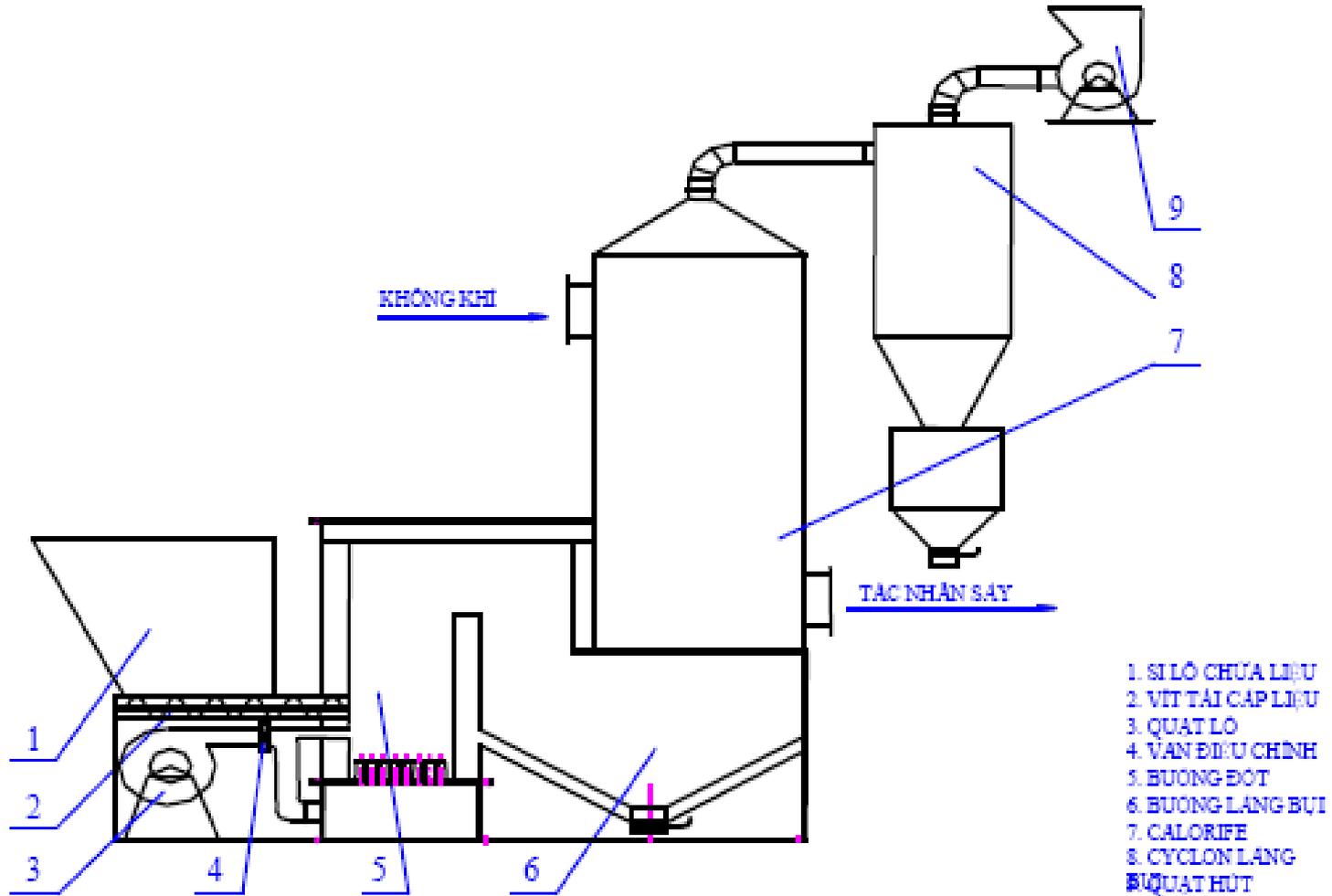
Electricity generation potential of by products over time

*Tiềm năng điện năng từ các phụ phẩm SK từ canh tác lúa, ngô, lạc ở các tỉnh vùng
Đồng bằng Bắc Bộ diễn biến qua các năm (*)*

Year	Electricity generation potential (Mill. kWh/year)				Total
	Straw	Rice husk	Corn	Peanut	
1999	3109,4	620,5	678,9	25,9	4434,7
2000	3213,6	641,2	599,7	32,1	4486,6
2001	3138,8	626,3	494,1	34,0	4293,3
2002	3303,4	659,1	534,9	35,1	4532,7
2003	3184,6	635,4	651,8	39,1	4510,9
2004	3291,3	656,7	743,7	46,0	4737,7
2005	3040,5	606,7	730,8	45,9	4423,9
2006	3195,8	637,7	703,5	42,4	4579,4
2007	3089,1	616,4	768,1	44,9	4518,5
2008	3220,0	642,5	877,4	47,5	4787,3
Aver	3178,7	634,3	678,3	39,3	4530,5



➤ **Combustor selection**



Principles of fluidized bed combustion



- **Socio-eco-environmental benefits**
- ✓ Generate heat-electricity
- ✓ Generate fertilizer (ash, etc)
- ✓ Mitigate GHGs



- **Socio-eco-environmental benefits**
- ✓ Save resource
- ✓ Generate a new energy in rural areas:
- ✓ Increase income

Recommendation on by products management

Policy solutions:

- Integrate renewable energy into development strategies
- Proper planning for agricultural and rural development.
- Financial and marketing support for bio-energy
- Prohibit uncontrolled by-products burning
- Disseminate and spread typical by product use examples

Economic solutions

- Financial support (investment, loan, etc)
- Support researches on biomass application;
- Establish by product collection center
- Improve traffic infrastructure in rural areas

Technological solutions

- Research on small scale heat-electricity co-generation system
- Research on effective mushroom planting techs

Propaganda solutions

- Improve awareness and knowledge on biomass energy through media
- Intergrate biomass-related lessons into schools
- Training on collection, storage and utilization of by products before harvest

Conclusions

- Applicable technologies have been analyzed, evaluated and recommended
- Using biomass for heat-electricity generation help improve socio-eco-environment of rural areas
- Further study is required.
- ✓ *By-product compression to generate high density material, reduce cost*
- ✓ *Appropriate technologies for Vietnam*

Summary

1. Northern Delta has favorable natural and climate conditions. The cultivation land is narrowed due to industrialization.
2. Estimated average biomass of by-products
3. Biomass is collected and used in households for cooking, feeding, fertilizer, etc.

4. Estimated theoretically 1 tonne of rice husk is equivalent to 475,2 (kWh) and 1 tonne of rice straw ~ 474,1 kWh.
5. If entire by products are collected and used for electricity generation, the energy from biomass will be $4530,5 \times 10^6$ kWh/year
6. Biomass might be a feasible substitute for coal



7. Recommended the FBC technology for heat-electricity co-generation
8. Heat-electricity co-generation from biomass brings high socio-economic benefits and mitigate environmental pollution
9. Complete collection of by-products is necessary in order to reduce GHGs emission

Recommendation

1. Appropriate policies to encourage and support food process factory to construct the heat-electricity co-generation system
2. Research on collection, transportation of by-products, conversion into solid compressed materials (pellet)
3. Encourage bio energy use by economic tools, encourage famers to use by products, guarantee the market for bio energy, etc



OUTCOMES

- Scientific results

A final (closing) report

8 special reports

3 articles on special journals

- Applicable results

Technological products:

Application of project's results:

- Training results

Bachelor: 02

Master: 01

Other applications

<http://nangluongsinhkhai.blogspot.com/2006/01/sn-xut-in-t-ph-thi-nng-nghip.html>

Other applications

<http://nangluongsinhkhai.blogspot.com/2005/08/sn-xut-in-t-rc-nng-nghip-c-hi-mi-cho.html>

Other applications

<http://sokhoahoccn.angiang.gov.vn/xemnoidung.asp?maidtt=2692&page=15>

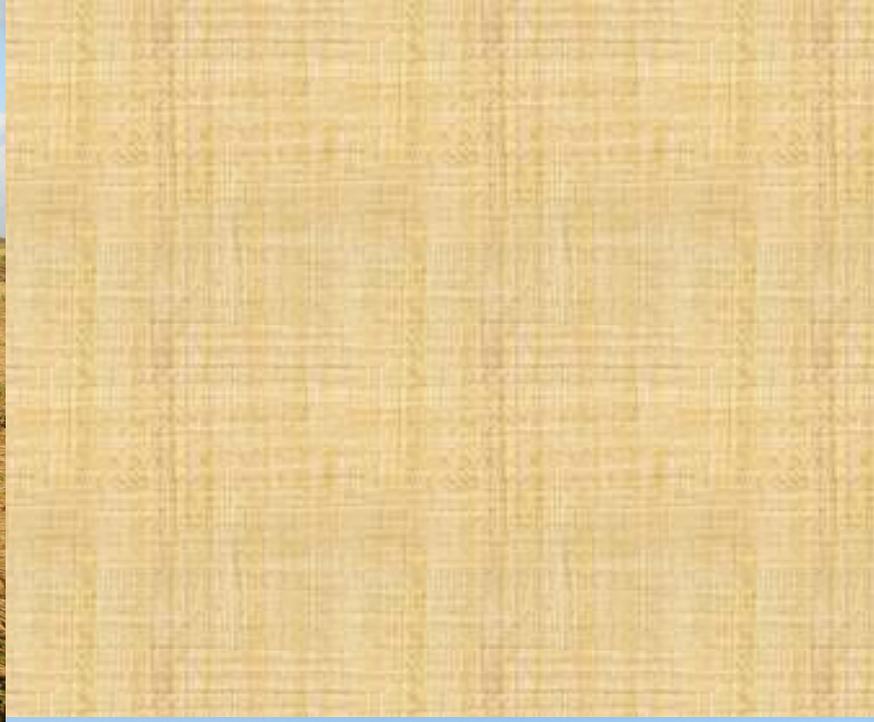


- Length: 200-300mm
- Diameter: 85mm
- Inner diameter: 20mm
- humidity: 6.83%
- ash : 15.02 %
- Calorie: 3900-4000 Kcal/kg
- sulphur: 0.055
- Specific weight: 1160 kg/m³



Coal char substitute

- Length : 3-5 cm
- Diameter: 4-8 cm
- humidity: 8 %
- ash: 15 %
- Calorie: 3900-4000 kcal/kg
- Specific weight :1.0 ton/m³
- Packing: p.p 2nd (35kg/p.p)



<http://www.vnexpress.net/GL/Xa-hoi/2008/10/3BA071F5/>





[http://www.vnexpress.net/
GL/Xa-hoi/2008/10/3BA071F5/](http://www.vnexpress.net/GL/Xa-hoi/2008/10/3BA071F5/)





[http://www.vnexpress.net/GL/
Xa-hoi/2008/10/3BA071F5/](http://www.vnexpress.net/GL/Xa-hoi/2008/10/3BA071F5/)





[http://www.vnexpress.net/
GL/Xa-hoi/2008/10/3BA071F5/](http://www.vnexpress.net/GL/Xa-hoi/2008/10/3BA071F5/)



Thank you!