

BIOMASS-ASIA WORKSHOP

BIOFUEL PRODUCTION FROM BIOMASS AND THE STATE BIO-ENERGY DEVELOPMENT PROGRAM OF VIETNAM



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INTRODUCTION

Vietnam has surface area 331,200 km², population at the 2006 mid-year 84.2 mill., population density 254 Per./km². The population living in rural areas is 73%, so that agricultural economy is an important part of GDP. According to the Statistical Yellow Book of Vietnam 2006, GDP by sector is follow:

- Agriculture, forestry and fishing : 20.36%;
- Industry and construction : 41.56%;
- Service : 38.08%.

National Energy Development Program puts emphasis on: "Strengthen R & D for new types of energy, in which attention was paid on sunlight, wind energy and especially the renewable energy (biomass)".

Biomass sources in Vietnam

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graph TD; A[Biomass sources in Vietnam] --> B[Agriculture]; A --> C[Forest]; A --> D[Industrial crops]; A --> E[Other waste]; B --> B1[-Paddy]; B --> B2[-Maize]; B --> B3[-Cassava]; B --> B4[-Sweet potato]; C --> C1[-Natural]; C --> C2[-Planted]; C --> C3[-Wood]; C --> C4[-Dispersed]; D --> D1[-Sugar cane]; D --> D2[-Peanut, coconut]; D --> D3[-Cotton, jute, sedge]; D --> D4[-Elephant grass]; E --> E1[-Industrial residues (sawdust, molasses)]; E --> E2[-Livestock residues]; E --> E3[-Solid waste];
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Agriculture

- Paddy
- Maize
- Cassava
- Sweet potato

Forest

- Natural
- Planted
- Wood
- Dispersed

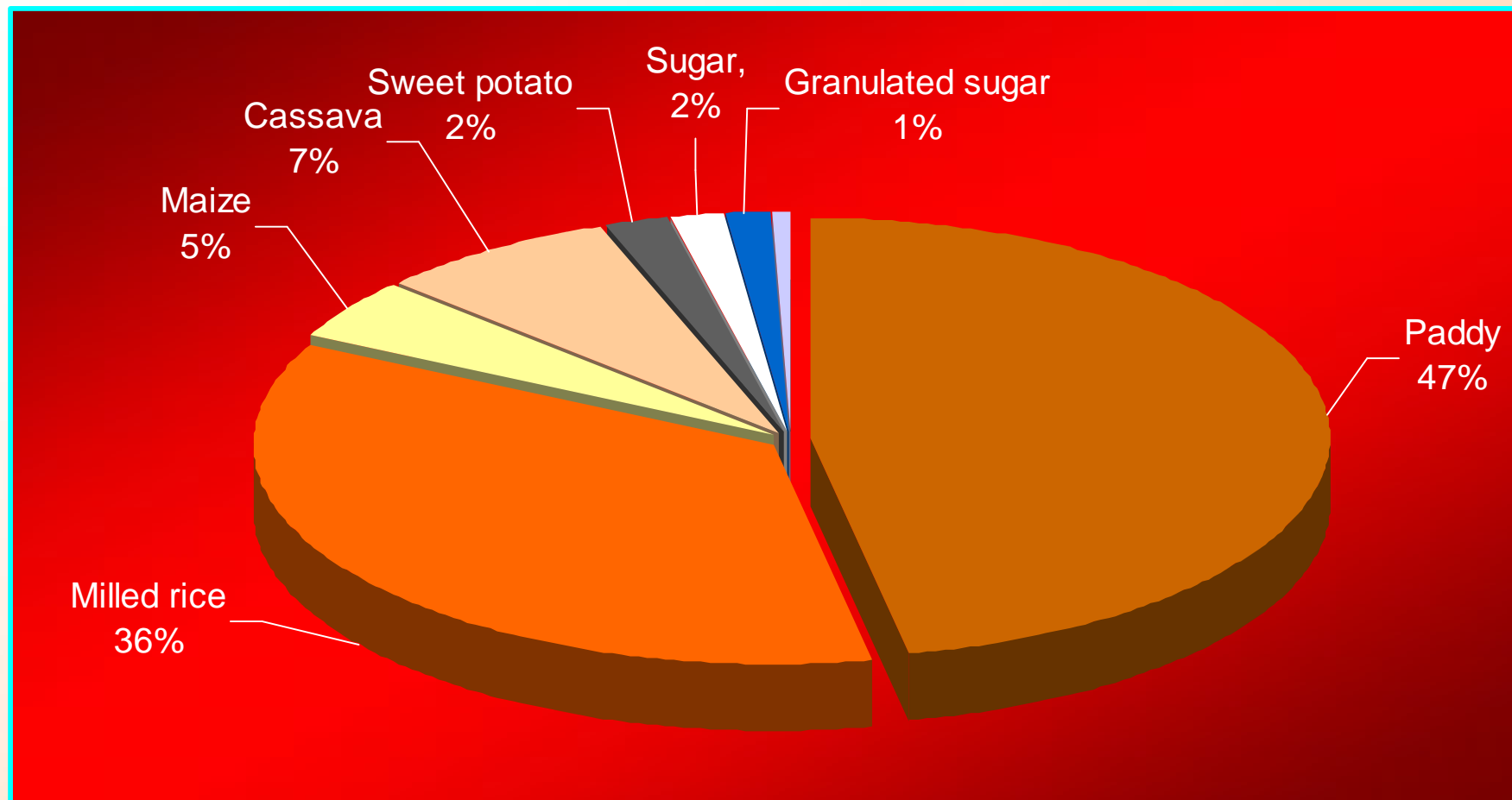
Industrial crops

- Sugar cane
- Peanut, coconut
- Cotton, jute, sedge
- Elephant grass

Other waste

- Industrial residues (sawdust, molasses)
- Livestock residues
- Solid waste

Agricultural Percentage products of Vietnam



Planted area and production of cereals in Vietnam

(Data from Statistical Yearbook 2006)

N ^o	Year	Planted area (Thousands Ha)			Production (Thousands. tons)		
		Total	Paddy	Maize	Total	Paddy	Maize
1	2000	8399.1	7666.3	730.2	34538.9	32529.5	2005.9
2	2001	8224.7	7492.7	729.5	34272.9	32108.4	2161.7
3	2002	8322.5	7504.3	816.0	36960.7	34447.2	2511.2
4	2003	8366.7	7452.2	912.7	37706.9	34568.8	3136.3
5	2004	8437.8	7445.3	991.1	39581.0	36148.9	3430.9
6	2005	8383.4	7329.2	1052.6	39621.6	35832.9	3787.1
7	2006	8357.7	7324.4	1031.6	39648.0	35826.8	3819.4

Production of cassava by zone of Vietnam (Thous. tons)

	2000	2001	2002	2003	2004	2005	2006
Whole country	1986.3	3059.2	4438.0	5308.9	5820.7	6716.2	7714.0
Red River Delta	74.4	79.5	80.8	87.6	86.6	82.5	82.5
North East	426.7	450.5	492.7	534.6	583.6	608.4	674.2
North West	265.3	259.7	296.6	337.3	388.9	388.3	400.2
North Central Coast	255.2	258.1	314.7	464.3	568.2	709.8	830.7
South Central Coast	329.5	446.3	548.5	667.8	784.5	916.8	969.0
Central Highlands	351.5	380.9	715.7	948.4	1062.8	1446.6	2020.8
South East	215.5	1512.7	1866.3	2125.6	2295.4	2499.8	2671.4
Mekong River Delta	68.2	211.5	122.7	143.3	50.7	64.0	65.2

Planted area and production of key industrial crops in Vietnam

Kind of crops		2000	2001	2002	2003	2004	2005	2006
Cotton	Thous. ha	18.6	27.7	34.1	27.8	28.0	25.8	20.5
	Thous. tons	18.8	33.6	40.0	35.1	28.0	33.5	25.9
Jute	Thous. ha	5.5	7.8	9.8	4.8	4.9	5.6	5.9
	Thous. tons	11.3	14.6	20.4	12.4	12.6	12.6	10.5
Sedge	Thous. ha	9.3	9.7	12.3	14.0	13.0	12.5	12.5
	Thous. tons	61.4	64.5	88.1	95.8	89.8	80.5	92.6
Peanut	Thous. ha	244.9	244.6	246.7	243.8	263.7	269.6	249.3
	Thous. tons	355.3	363.1	400.4	406.2	469.0	489.3	464.8
Soya-bean	Thous. ha	124.1	140.3	158.6	165.6	183.8	204.1	195.8
	Thous. tons	149.3	173.7	205.6	219.7	245.9	292.7	258.2

Production of sugar-cane by zone of Vietnam (1000 tons)

	2000	2001	2002	2003	2004	2005	2006
Whole country	15044.3	14656.9	17120.0	16854.7	15649.3	14948.7	15678.6
Red River Delta	137.5	130.1	139.5	144.4	143.6	126.8	108.1
North East	703.0	593.6	685.5	687.3	612.5	535.9	552.6
North West	481.0	508.0	596.0	606.3	578.3	552.1	545.0
North Central Coast	2743.0	2693.5	3175.6	3221.4	3098.6	2852.3	2970.2
South Central Coast	2496.9	2345.0	2407.7	2354.7	2338.9	2011.4	2186.2
Central Highlands	1091.8	1190.8	1339.4	1534.1	1534.1	1249.5	1452.2
South East	2432.4	2765.9	3217.4	3106.2	2973.7	2990.1	2918.5
Mekong River Delta	4958.7	4430.0	5558.9	5200.3	4469.6	4630.6	4945.8

Potential of main agricultural residues based on product sources

Areas of country	Agriculture by production [million tons]			
	After processing		After harvesting	Total by product
	Rice husk	Bagasse	Straw & cane leaf	
The North mountain and midland	0.54	0.32	3.12	3.98
The Red river delta	1.30	0.04	5.19	6.53
The North central	0.58	0.76	2.79	4.13
The Central coast	0.35	0.67	2.83	3.85
Central Highlands	0.15	0.35	0.84	1.32
The South - East	0.33	0.76	2.78	3.87
The Mekong river delta	3.55	1.55	16.51	21.25
Whole country	6.78	4.45	34.4	45.63

Rice husks: 7.8 million tons,

Bagasse: 3.0 mill. tons

Other biomass and residues types: Coffee husks, nuts shells, body/core of corns, beans, coconuts, top/leaves of sugar canes, wood chips etc: 1.68 million TOE in 2002.



Area of forest in 2006 by zone of Vietnam

Thous. ha

Zone	Total	Of which	
		Natural forest	Planted forest
Whole country	12663.9	10177.7	2468.2
Red River Delta	130.4	58.2	72.2
North East	3026.8	2173.1	853.7
North West	1504.6	1394.5	110.1
North Central Coast	2466.7	1977.3	489.4
South Central Coast	1271.4	984.4	287.0
Central Highlands	2962.6	2809.9	152.7
South East	967.1	726.5	240.6
Mekong River Delta	334.3	53.8	280.5

GROSS OUTPUT OF WOOD BY ZONE

Thous. m³

Zone	2000	2002	2003	2004	2005	2006
Whole country	2375,6	2504.0	2435.8	2627.8	2996.4	3007.2
Red River Delta	133.0	112.7	98.4	93.1	102.8	97.3
North East	489.1	530.0	525.2	638.5	771.2	804.8
North West	245.5	207.3	185.0	171.3	279.7	242.4
North Central Coast	237.0	226.8	293.6	292.2	310.8	324.2
South Central Coast	275.9	314.3	324.9	428.9	482.4	480.6
Central Highlands	372.8	419.8	313.0	324.1	309.3	329.1
South East	160.0	132.7	113.9	110.6	130.4	122.9
Mekong River Delta	462.3	560.4	581.8	569.1	609.8	605.9

BIOMASS UTILIZATION IN VIETNAM

Biomass accounts in Vietnam for around 60 – 65% of the primary energy consumption:

- Cooking fuel
- Organic fertilizer
- Biogas for domestic cooking
- Electricity production (in paper mills)
- Fuel for automobile
- Bio-ethanol production

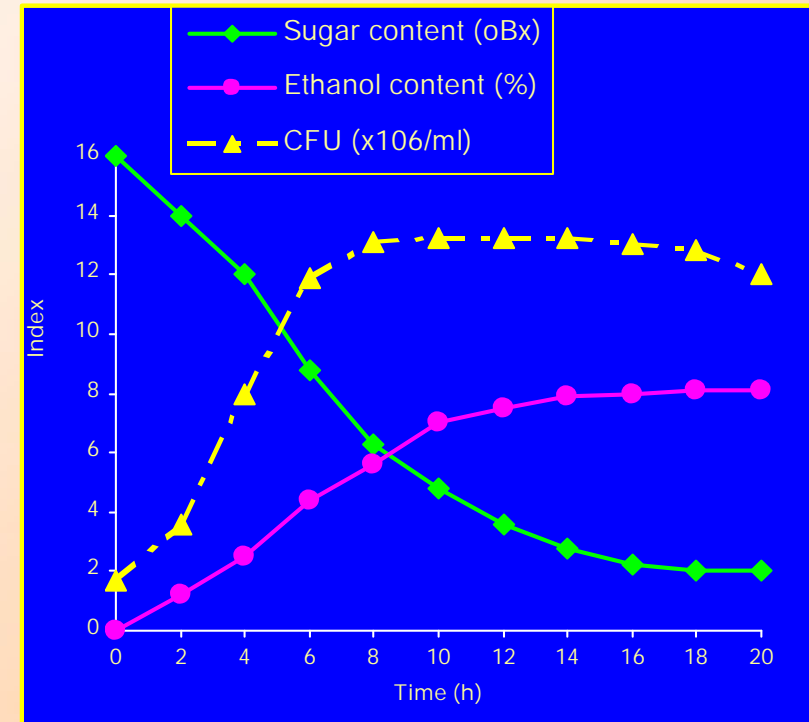
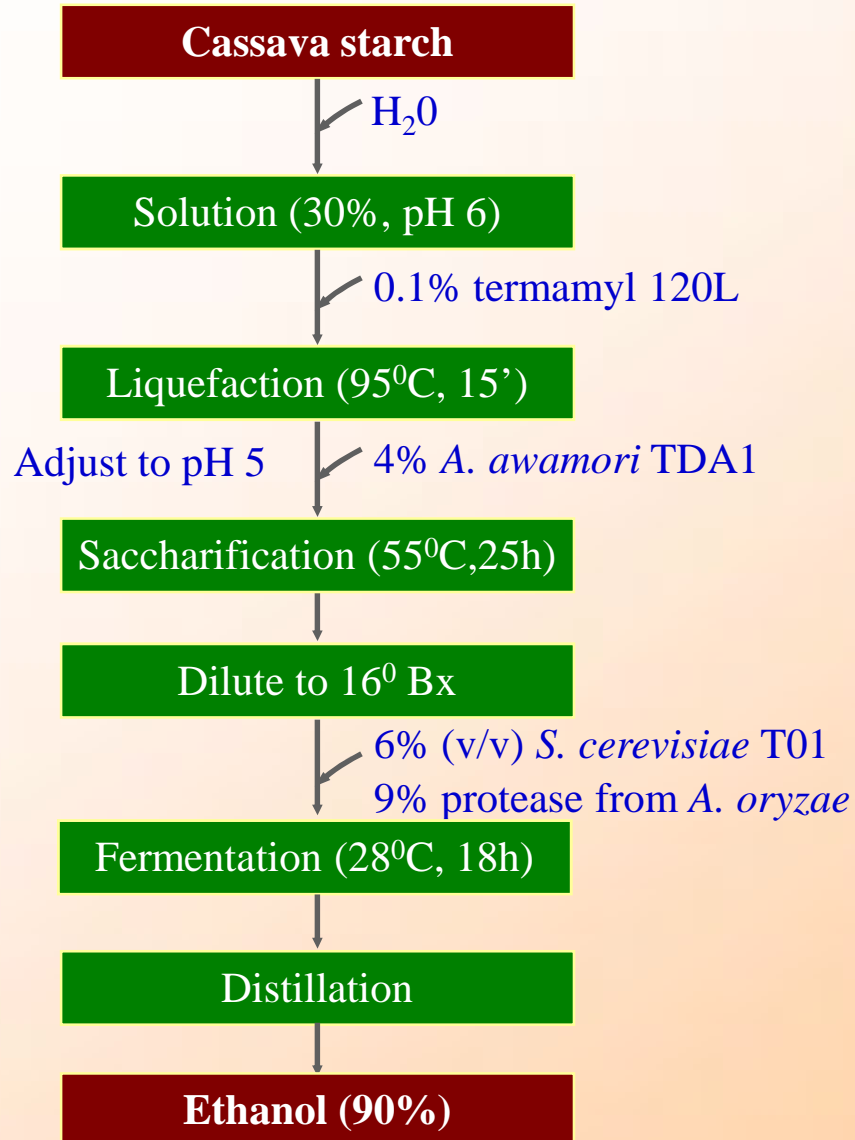
Production of alcohol of Vietnam

Area of Country	Output, mill.L/year
- Eastern and Western North	1.83
- Red river delta	10.20
- North Central	25.00
- Central and Highland	7.70
- HoChiMinh city and Eastern South provinces	19.50
- Mekong River delta	12.40
Total	76.63

The Main Alcohol Companies in Vietnam

No	Company	Material	Output, mill.L/year
1	Lamson sugar company	Molasses	25
2	Hanoi wine company	Starch	3.0
3	Dongxuan wine company	Starch	1.0
4	Quangngai sugar company	Molasses	4.0
5	Hoabinh sugar company	Starch	1.0
6	Binhtay sugar company	Molasses	3.0

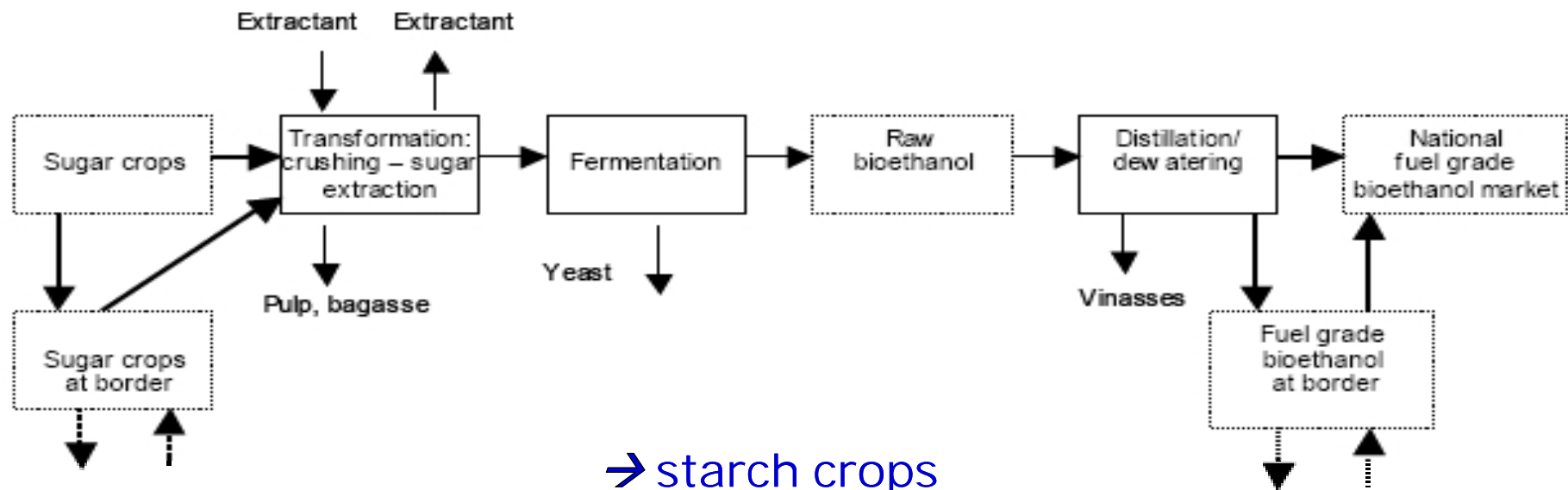
Producing ethanol from cassava starch



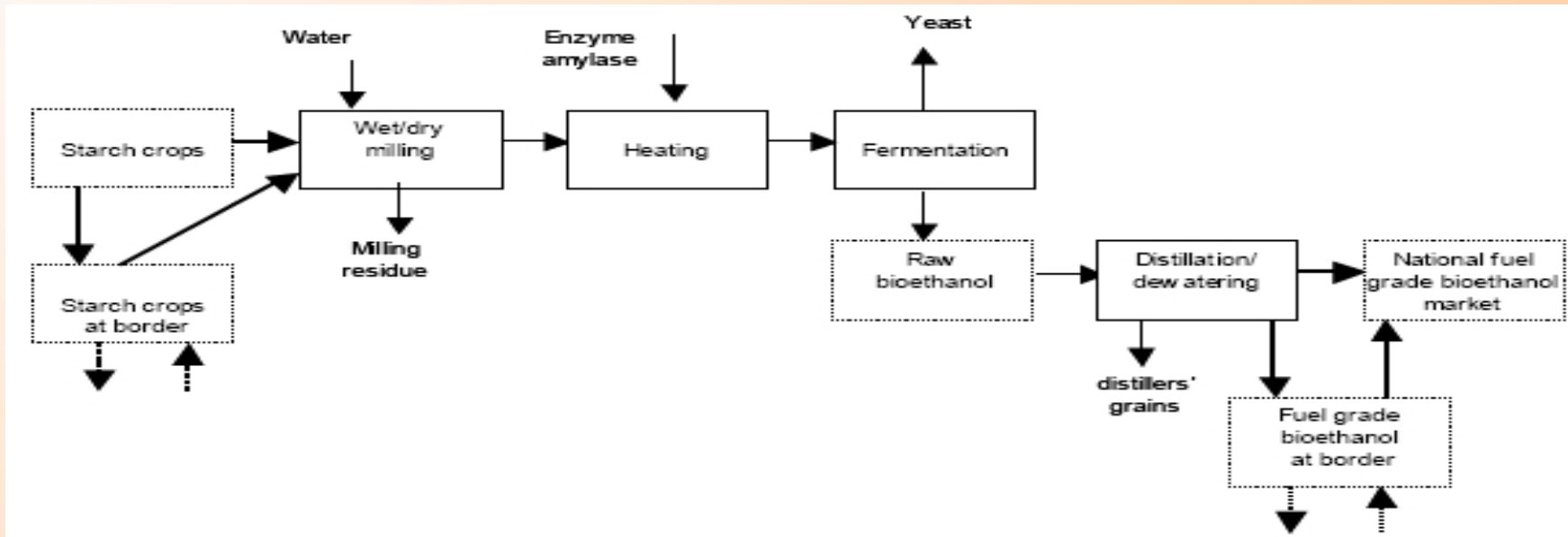
Kinetic of ethanol fermentation

Bio-ethanol production process in Vietnam

→ sugar crops



→ starch crops



Bioethanol factories under construction

In 2007, many Ethanol Production Factories will be under construction and planned in Vietnam:

1. Joint Stock Bio-ethanol Company had be construction new ethanol factory 66 mill. tons ethanol/year in DaLak province. They are given 4000 ha for Sorghum planted, which will be supplied starch for factory.

2. Bien Hoa Sugar company cooperated with one Singapore company to construct new Ethanol Factory 50 mill. Tons /years in Tayninh province (Used mollasses and cassava starch)

3. Project cooperated between Petrosetco Vietnam and Itochu Company (Japan) will construct bioetanol factory 100 mill. liters/year (used cassava starch in Ho Chi Minh City.

The Aims of State Biofuel Development Program of Vietnam signed by Government Primer Minister at November 20th, 2007 are: To develop renewable biofuels from biologically derived organic resources to replace a part of fossil fuel for future State energy security and environmental protection;

- To the year of 2010, to export in commercial 100 thousands tons of E5 and 50 thousands tons of B5 (0.4% of mass fuel consumption of the country);
- To the year of 2015, to provide 250.000 tons of ethanol and vegetable oils equivalent 5 mill. tons of E5 and B5.
- To the year of 2020, the yields of ethanol and vegetable oils will be 1.8 mill. tons.

Due to the aims of Program, it is necessary:

- ✓To develop new technology for bioethanol production from various biomass (especially from lignocellulose material): to develop new type of cellulolytic enzyme, high yield fermentative microorganisms and equipments and technology...
- ✓To establish flexible technology for biodiesel production from various kind of oils: vegetable, cooking waste, rubber seed, fish and animal fat...

Lignocellulosic biomass
(woods, baggase, rice straw, elephant grass, etc.)

Pre-treatments

High cellulase producing
microbial strains

Acidic hydrolysis

Enzymatic saccharification

Fermentation

Need R&D research
for create pentose
fermenting strains

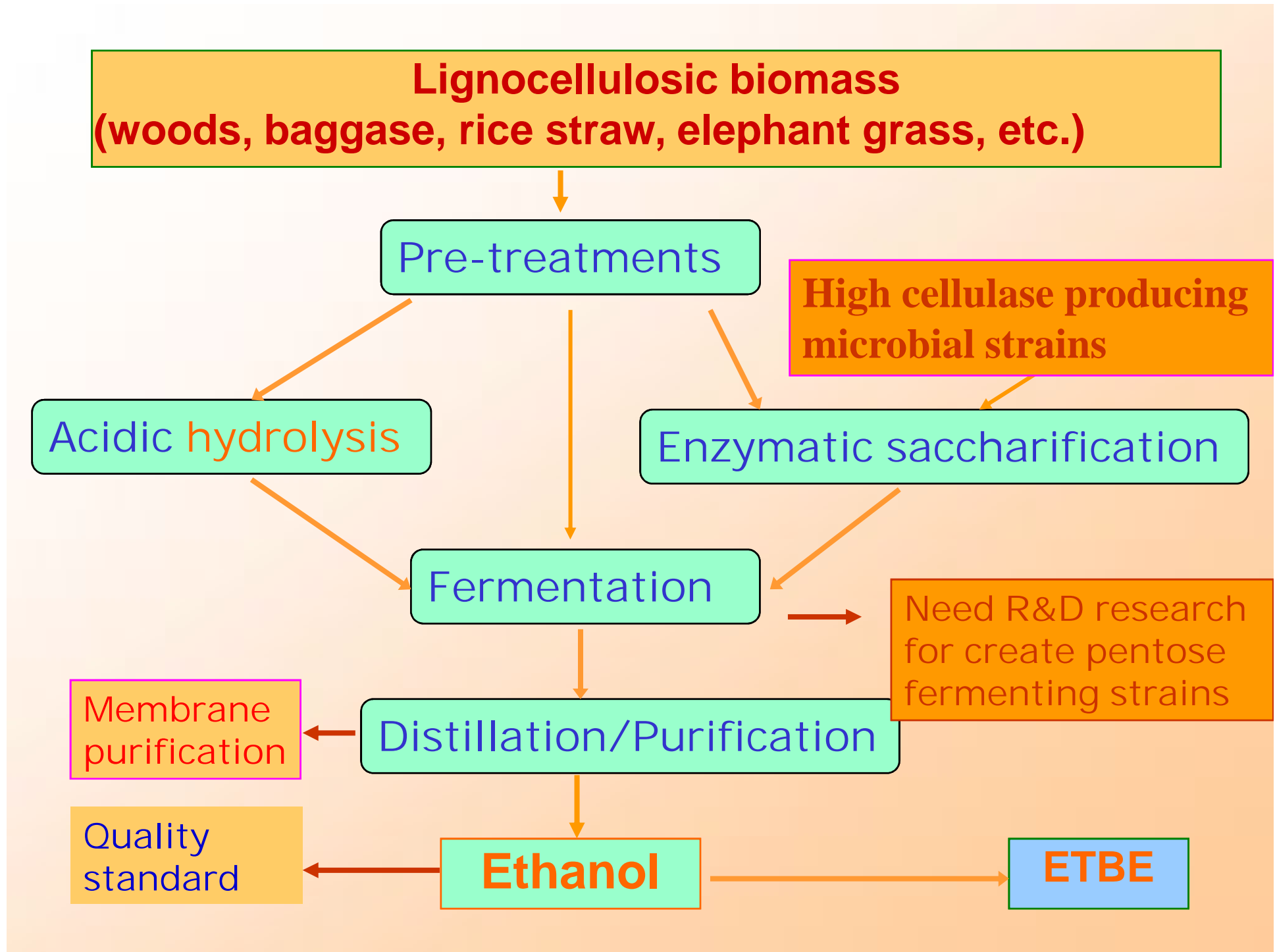
Membrane
purification

Distillation/Purification

Quality
standard

Ethanol

ETBE



Elephant grass (*Pennisetum purpurreum*)



Elephantidae (the elephants) is a family of Pachyderm. There are 3 living species:

- The African Bush Elephant;**
- The African Forest Elephant;**
- The Asian Elephant (The Indian Elephant)**

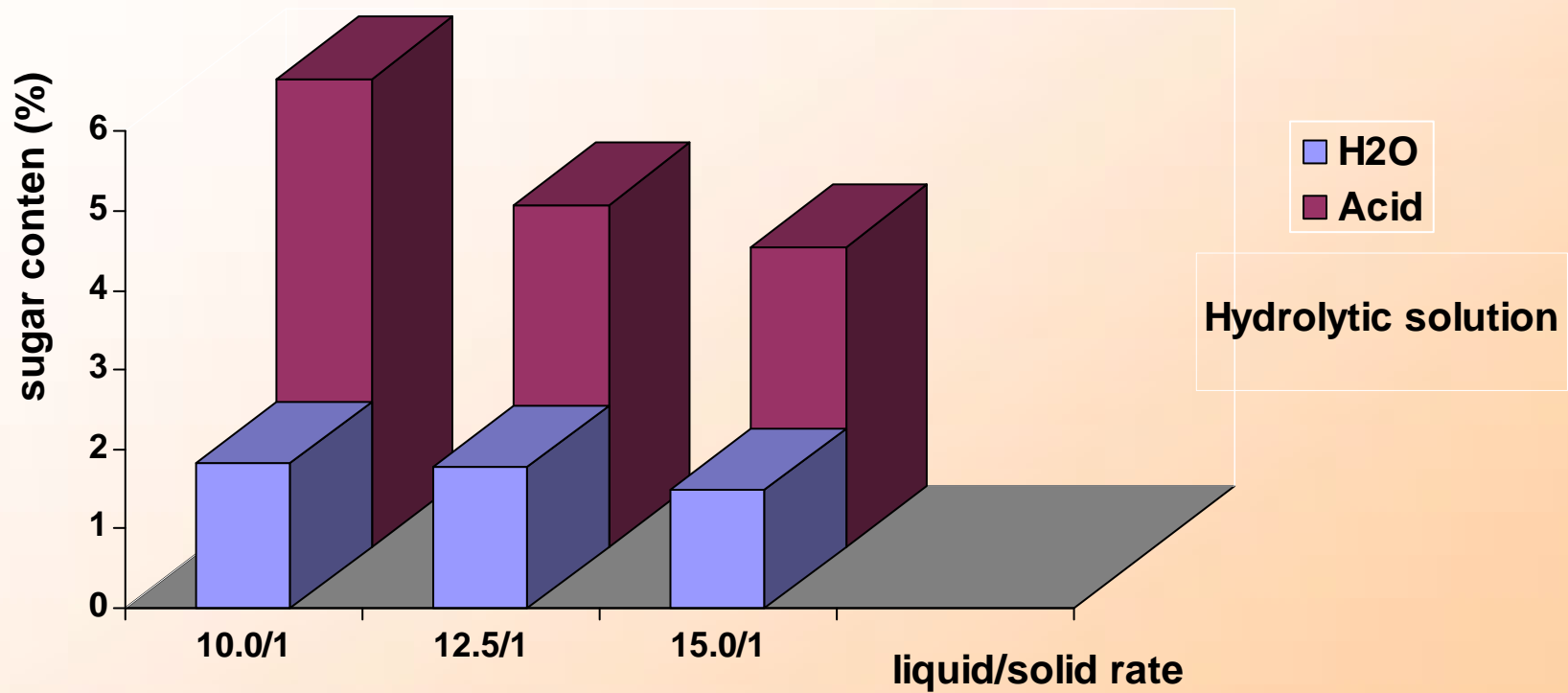
Elephant grass in Vietnam



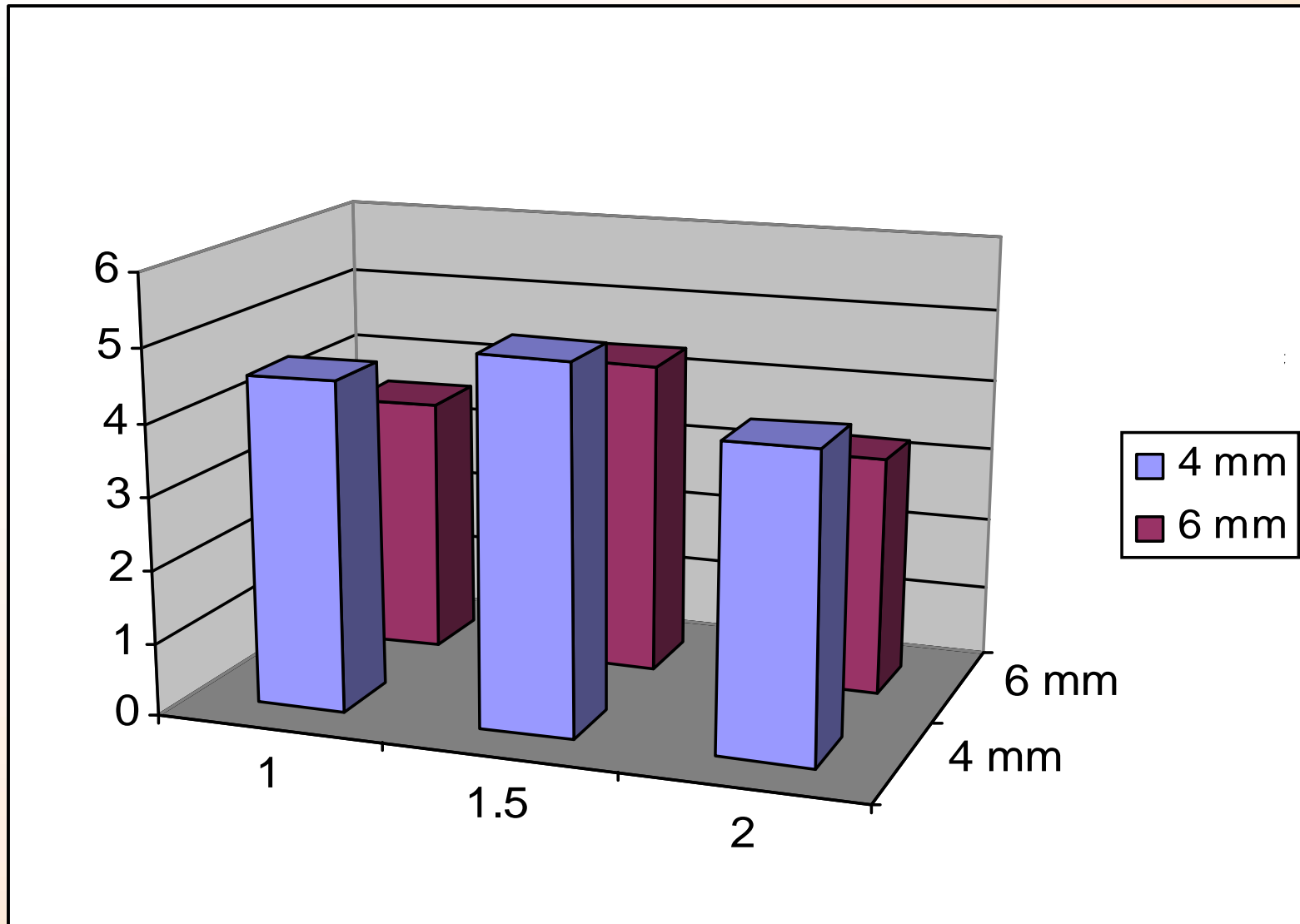
- Can growth at the dry area; Productivity: 320 ÷ 400 tons/ha/year (~ 40 tons dry biomass/ha/year);
- The area planted of Elephant grass (2006): Dongthap province: 67 ha; BacKan: 100 ha; Tuyen Quang: 200 ha...; Costs: 15.0 ÷ 20.0 \$US /ton

Chemical composition of the elephant grass and woody residues of vietnam

N°	Chemical contents	Methods	Elephant grass	Woody residues
1	Moisture, %	T201 wd-98	10.13	20.09
2	Ash, %	T221 om-93	7.91	2.31
3	Solution substance, %	T204 cm-97	6.01 – 10.5	3.01
4	Lignin (%)	T13 wd-74	6,0 - 11.32	22.67
5	Cellulose (%)	T17 wd-70	36.2 - 43.95	40.58
6	Pentozan (%)	T223 cm-84	13.05 - 20.8	11.2



**Effect of hydrolyze module on sacchrification of elephant grass
(at 160 °C; time: 1-3 h)**



**Effect of pH and mechanical size on sacchrification of elephant grass
(at 160 °C; time: 1-3 h)**



School of sardines around *Sargassum* beds.

Sargassum
bed in
coastal
Vietnam



Green type



Brown type

Development new kind
of Biomass as raw
materials for Biofuel
production from sea:
Kappaphycus alvarezii



photo data

Place: Cam Nghĩa, Cam Ranh
Depth: 0.5 m
Date: 19 Jul. 2003

Gracilaria
tenuistipitata
Zahang et Xia var.
tenuistipitata



Long line
cultivation of
Kappaphycus
in Vietnam

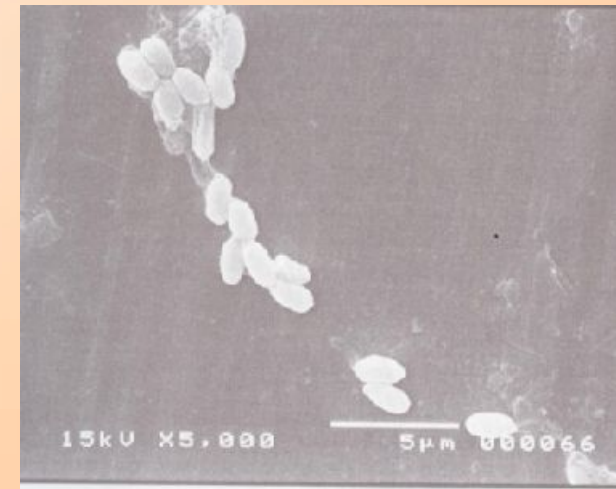
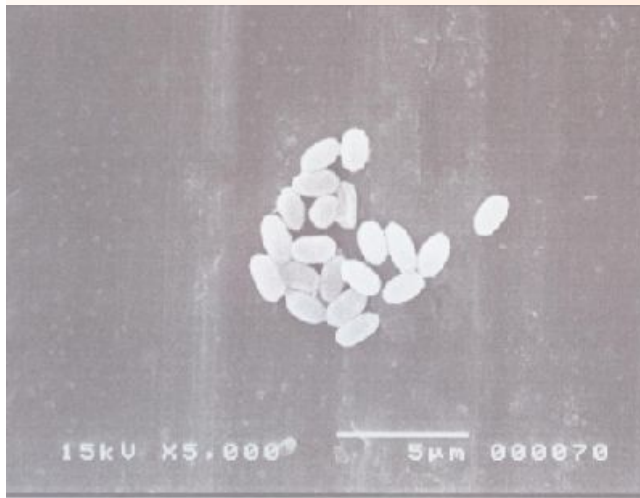
SCREENING BACTERIAL STRAINS
PRODUCING THERMOSTABLE
CELLULASE
USING FOR BIOMASS HYDROLYSIS



05

ML03

Colony morphology of the some isolated bacterial thermophilic strains producing cellulase

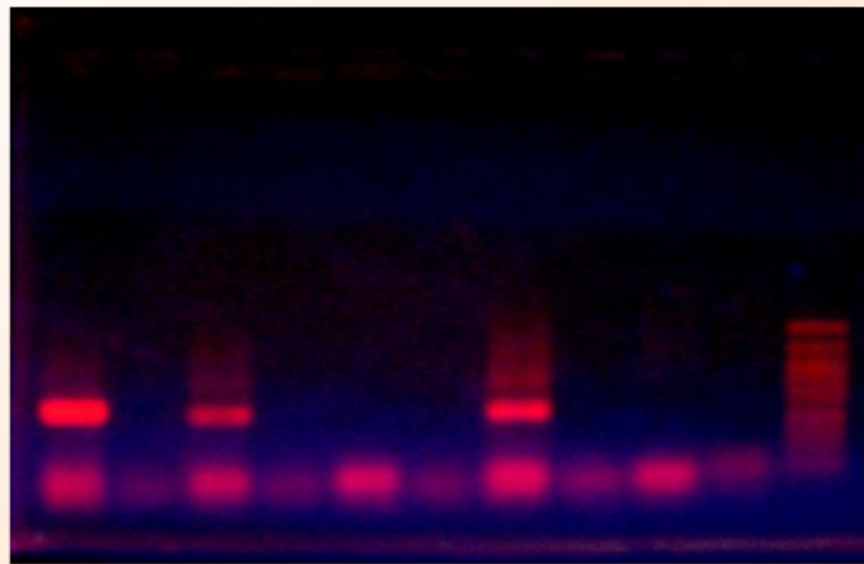


ML07

Electron microsopy diagram of the three isolated bacetrial strain cells

Table 3. The cell's properties of three bacterial strains isolated

No.	Strains	Spore forming	Cell shape	Cell size (μm)
1	ML03	positive	Short rod	0,5-0,7 x 1,4-1,6
2	ML05	positive	Short rod	0,3-0,5 x 1,2-1,4
2	ML07	positive	Short rod	0,4-0,6 x 1,3-1,5



(1) (2) (3) M



(1) (2) (3) M

Figure 3. Diagram of electrophoresis on agarose PCR products (A) and fragment of DNA treatment (B) of strains ML03 (1), ML05 (2) and ML07 (3)

Screening hydrolytic enzymes producing strains isolated from My Lam Hot spring

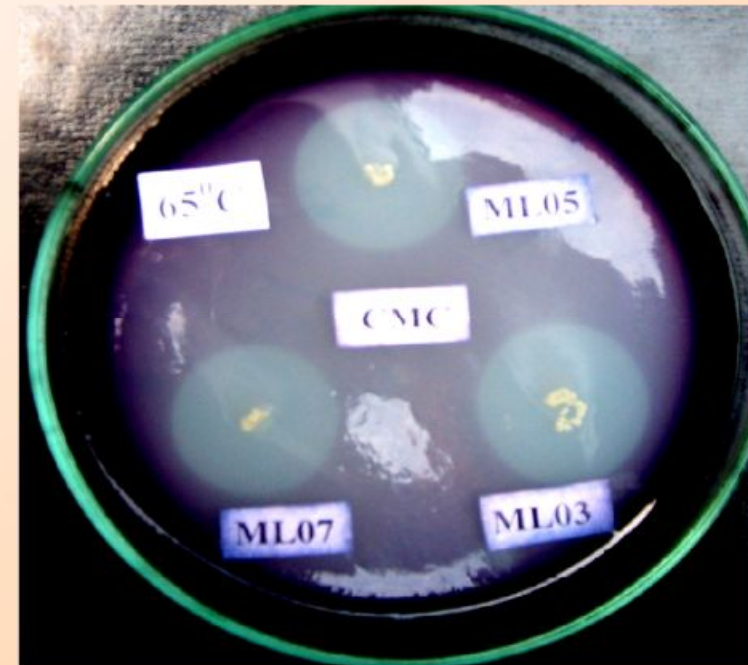
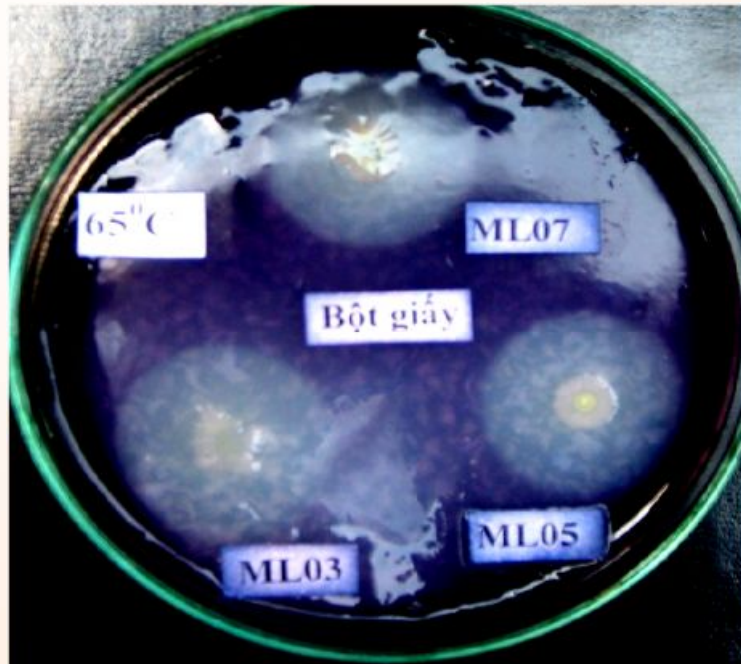


Figure 4. The activity of cellulose meal and CMC hydrolysis of strains ML03, ML05 and ML07

Effect of temperature on cellulase production of three strains isolated

Relative activity (%)

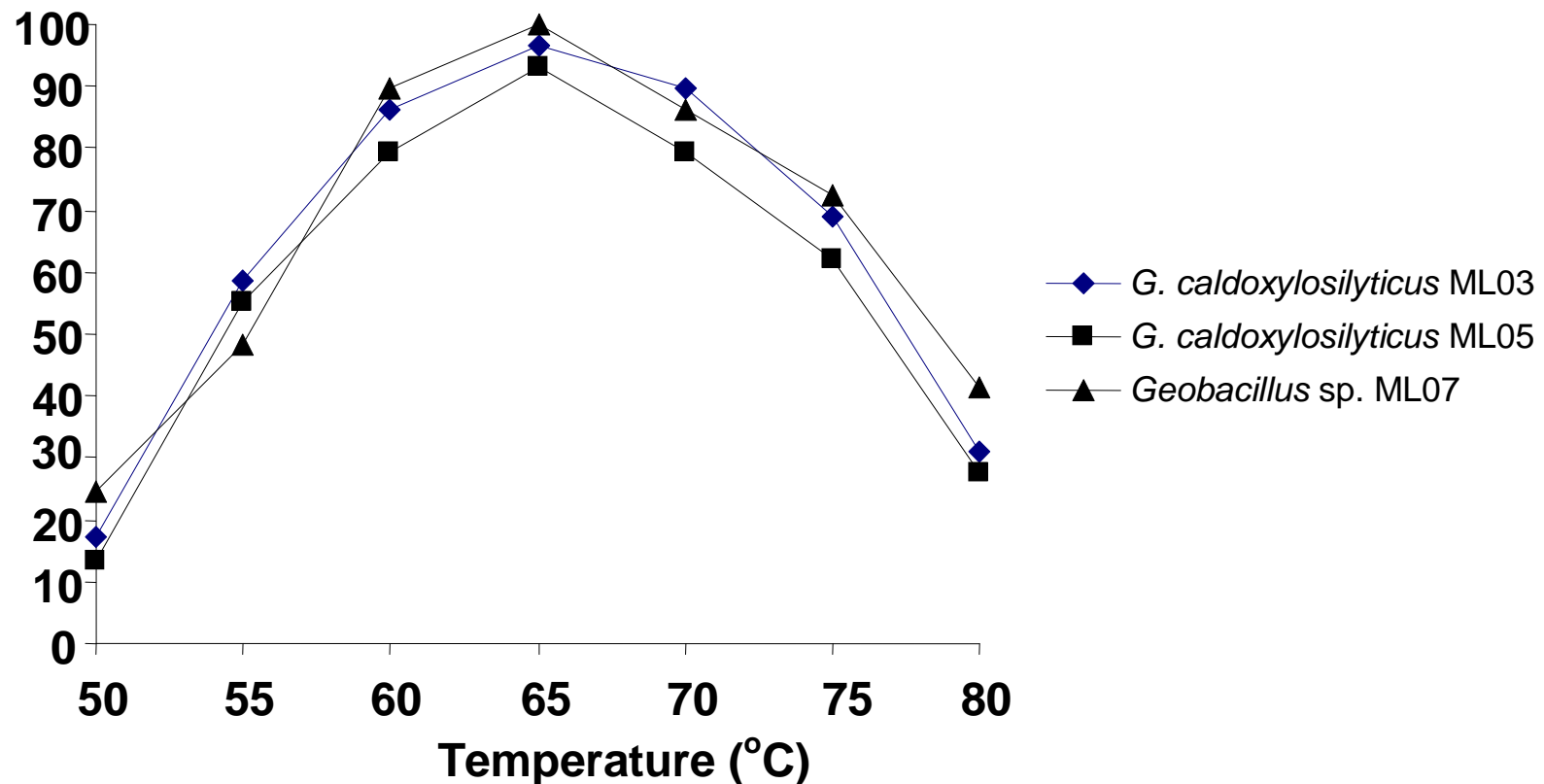


Figure 6. Effect of temperatures on cellulase production of three bacterial strains isolated

Effect of pH on cellulase production of three strains isolated

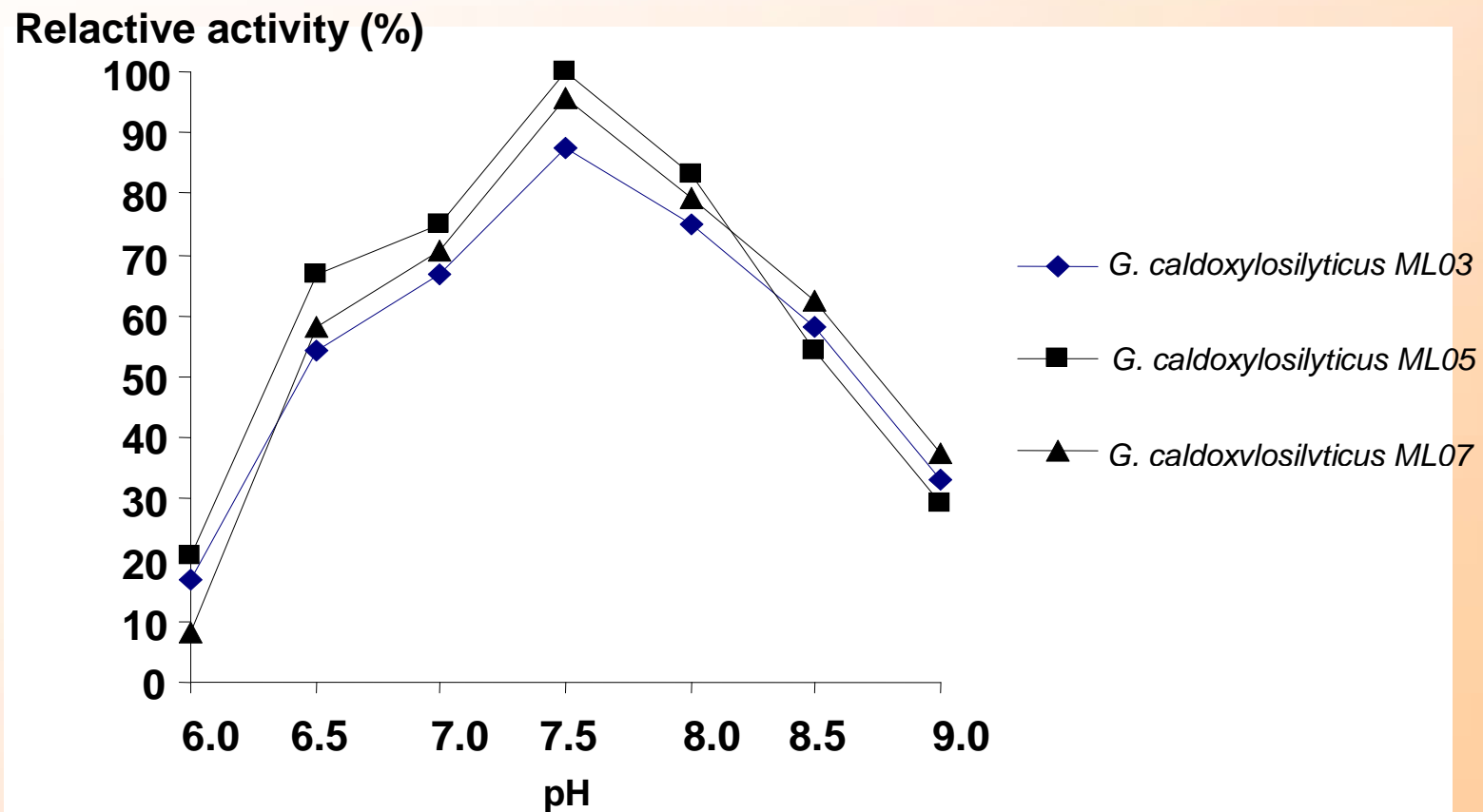


Figure 6. Effect of pH on cellulase production of three bacterial strains isolated

Biodiesel production

Presently, the main potential feedstock for biodiesel production in Vietnam are: “Basa” fish oil, used cooking oil and rubber seed oil.

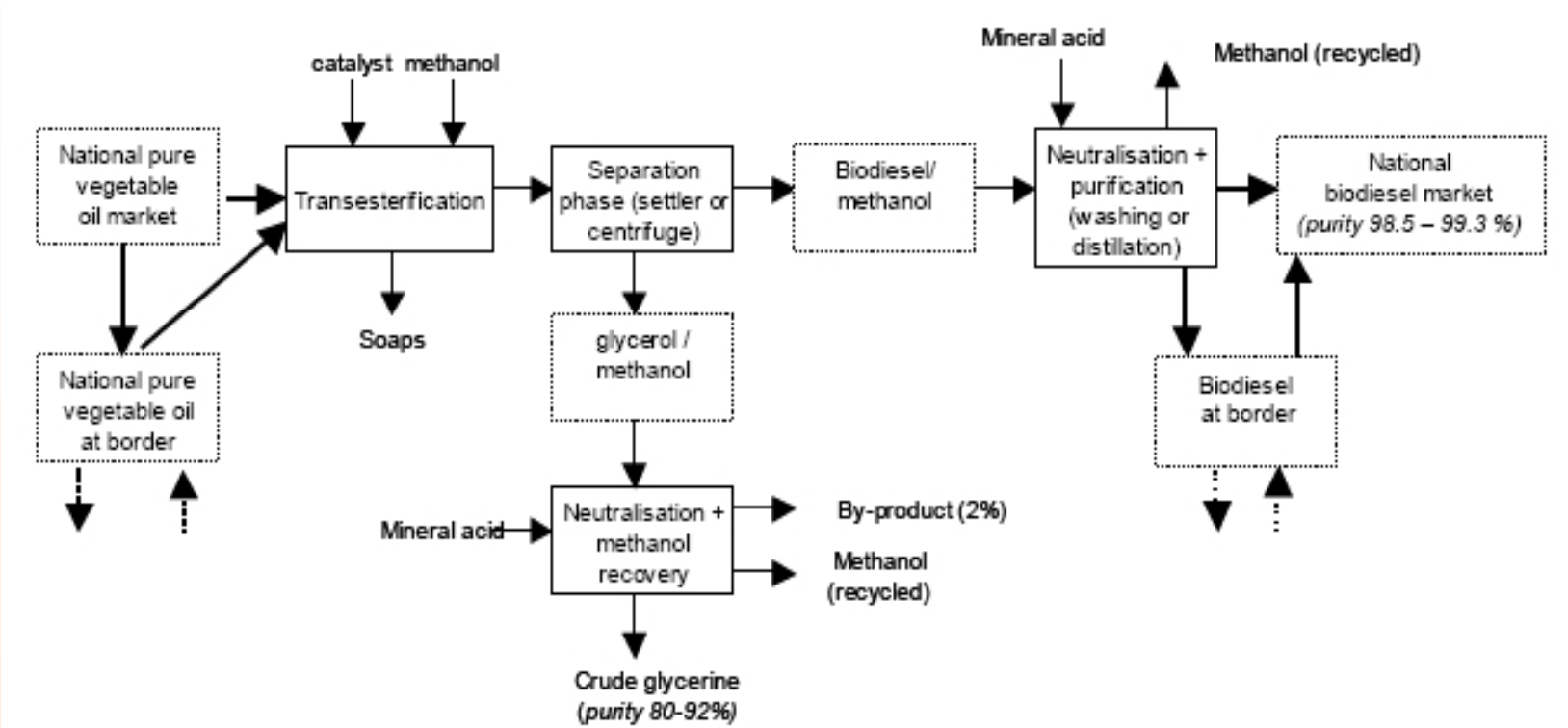
1. Biodiesel from “basa” fish oil:

- Technology has been successfully developed by Agifish, An Giang province. Pilot plant: 1.6 tons of biodiesel per day.
- Potential: 60,000 tons of “Basa” fish oil (2005) → 48,000 tons biodiesel .
- A project producing 10,000-tons/year biodiesel is being developed by Saigon Petro & Agifish (in 2007).

2. Biodiesel from used cooking oil:

- Technology has been developed by HCM City Research Centre for Petrochemical and Refinery Technology.
- Potential: 73,800 tons of used cooking oil (est. 2005) → 33,000 tons biodiesel.
- A project producing 2 tons/day biodiesel is being developed by Saigon Petro (4-5 tons per day of used cooking oil will be consumed).

Biodiesel – production process



Biodiesel production from Rubber seed oil

(Ho Son Lam et.al, Institute of Applied Material Science)

- **Today, Vietnam has more than 500.000 ha of Rubber Tree.**
- **If calculated with considerable amount area Rubber Tree of Vietnamese Company are planted in Laos and Cambodia, total area of Rubber Tree have more millions hectare.**
- **Lifetime of every Rubber Tree is 30-40 years. After planting from 5 to 7 years, the Tree begins giving Latex and Fruit.**
- **•1 ha Rubber Tree planted from 400 to 550 Trees and giving 200-300 kg fruit every year.**
- **•1 kg Fruit has 0,4 - 0, 5 kg seeds.**
- **•1 kg Seeds gives 22% oils, 18, 5 % bait, 58% husk, 1, 5 % corrupt.**
- **With 1.000.000,00 ha Rubber Tree give 200.000-300.000 Ton Rubber Fruits every year, equivalent 17.600 – 330.000 Ton Rubber Oils. Rubber seed Oil is not edible oil and it is still an unshakeable direction to use, so that Rubber seed Oil is one of important Bio-resource to Bio-diesel production**



FRUIT AND SEED

RUBBER TREE



1. Vietnamese rubber seed oil will be alternative oil for bio-diesel in the future. It can be use directly, thermal cracking to hydrocarbon or in form of ethyl ester, blended with petroleum diesel .

2. Optimal condition of reaction thermal cracking (pyrolysis) and transesterification between ethylic alcohol and rubber seed oil were studied.

3. Bio-diesel from ethyl ester of Vietnamese rubber seed oil according to the European standard for determination of bio-diesel (E.DIN 51606), blended from 5% to 20 % with petroleum diesel using, can be used on electric generator and car-diesel motor.



**Pilot for
extraction of
vegetable oils**

**PILOT FOR
BIODIESEL
PRODUCTION
FROM RUBBER
SEED OIL.**



Development Jatropha cultivation and technology for biodiesel production from Jatropha oil

- Jatropha curcas in Vietnam is called Dau lai or coc rao
- Jatropha were planted in many places of Vietnam as traditional medicine and hedge: Hoa Binh, Son La, Phu Tho, Lai Chau, Lao Cai, Thanh Hoa, Lang son, Ninh Binh, Quang Tri, Ninh Thuan, Binh Thuan, Khanh Hoa, Lam Dong, Dong Nai...
- At present, Many projects has carried out to develop cultivation of Jatropha at many provinces of Vietnam.
- Some projects in Pilot scale for biodiesel production were established



THANK YOU FOR ATTENTION

