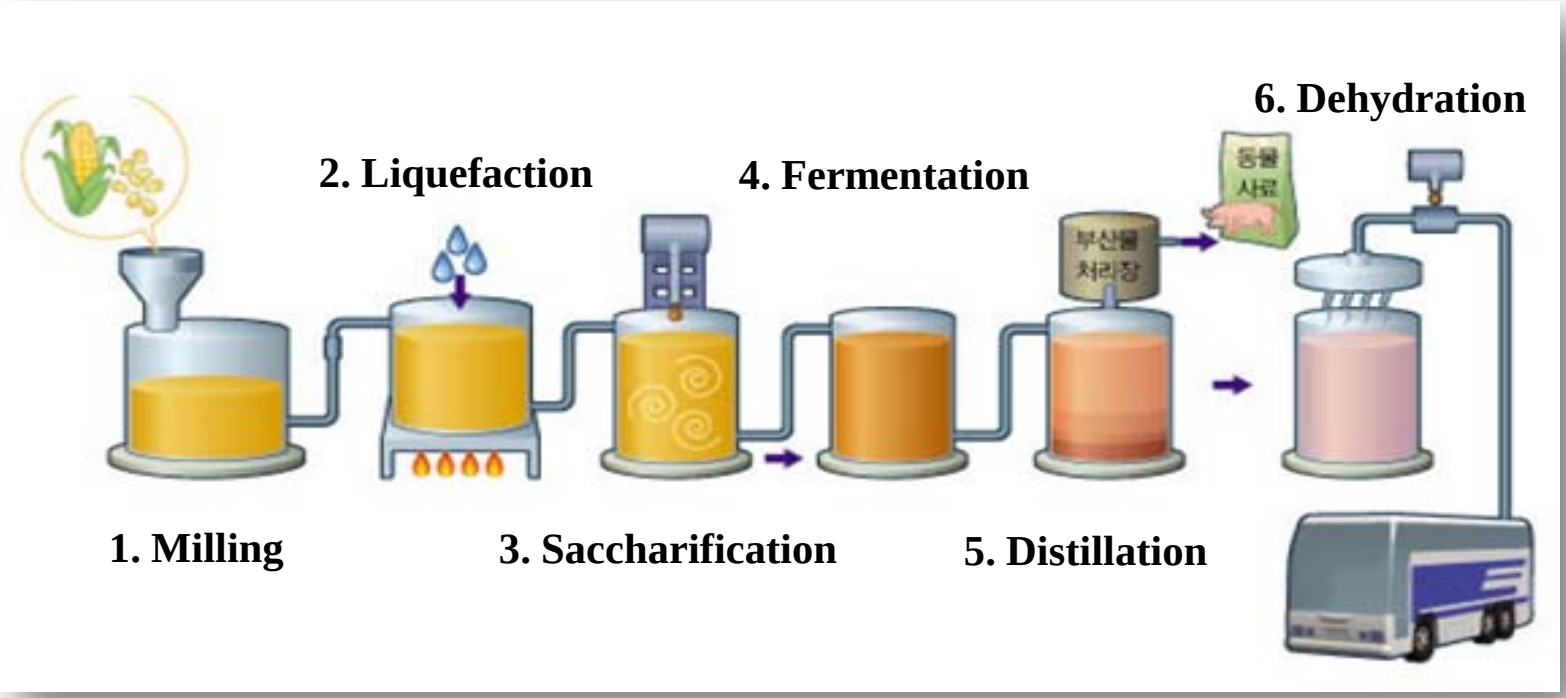
The potential for first-generation ethanol production from sugarcane

LOGO

Introduction

Introduction

Bioethanol Process



Introduction

Ethanol

- A good fuel for a substitute for gasoline
- Fuel from agricultural products
- No impurities present

- Greenhouse gas emissions
- Particulate matter
- Ozone precursors

Introduction

- **Ethanol production from sugarcane**

  = 1 % of the gasoline used in the world

	Amount of ethanol	Material raw
USA	**34 billion liter**	**Corn**
Brazil	**22.5 billion liter**	**Sugarcane**
EU	**2.7 billion liter**	**sugarbeet**

Introduction

Competitive of sugarcane

1. Reduces GHG emissions by 84 %
2. Low cost
3. High yield (liters of ethanol per hectare)

Table 1. Characteristics of different crops for ethanol production

	Sugarcane (in Brazil)	Corn (in the USA)	Sugarbeet (in Europe)
Energy balance[3,9*]	8.1 – 10	1.4	2.0
Production cost (€/100 liters)[8**]	14.48	24.83	52.37
CO_2 reduction compared to gasoline[10]	84%	30%	40%
Total production (billion liters) (D)	22.5	34	2.7
Area cultivated (million hectare) (E)	3.4	8.13	0.49
Yield (liter/hectare) (D/E)	6,471	4,182	5,500***

*Defined as energy output in a liter of ethanol over fossil fuel energy needed to produce.
**Updated numbers for production costs in (July, 2009) are: sugarcane 29.34€/100 liters; corn: 36.33 €/100 liters (Nastari P, personal communication)
***Theoretical yield.[9]

Introduction

❖ **The most successful raw material from two angles**

1. Productivity gains

2. Geographical expansion to larger areas

Productivity gains

❖ Simple process of fermentation

1. The stalks are crushed to extract the juice
2. Remaining bagasse is burned to originate heat or electricity

❖ The amount of ethanol depends on

- the agricultural yield of sugarcane
- the amount of sugar in the juice

Productivity gains

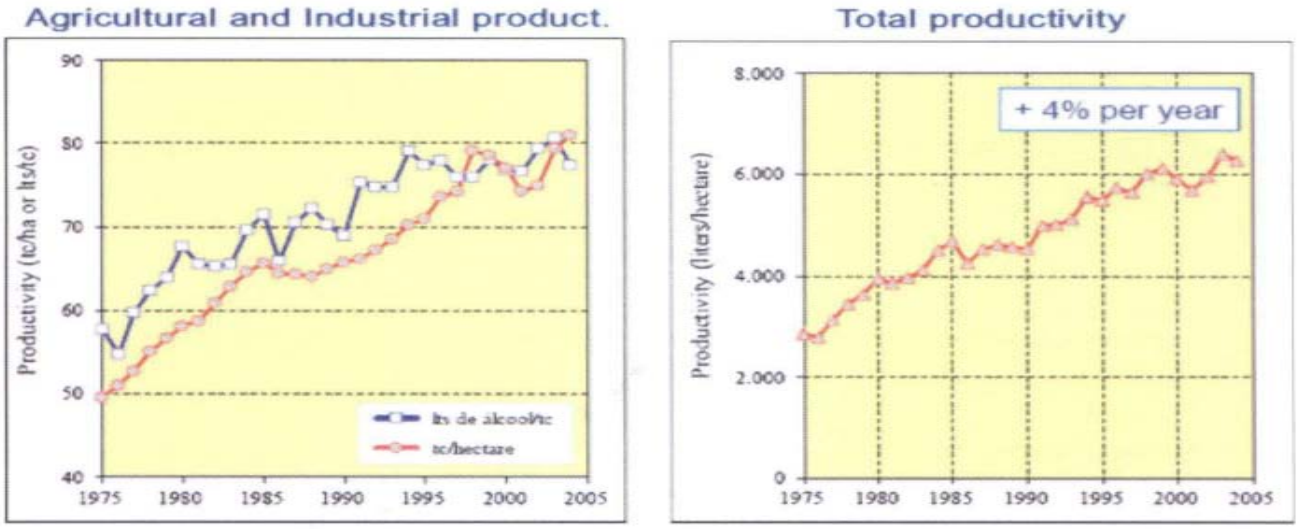


Figure 3. Increase in productivity through R&D (1975–2005).[17]

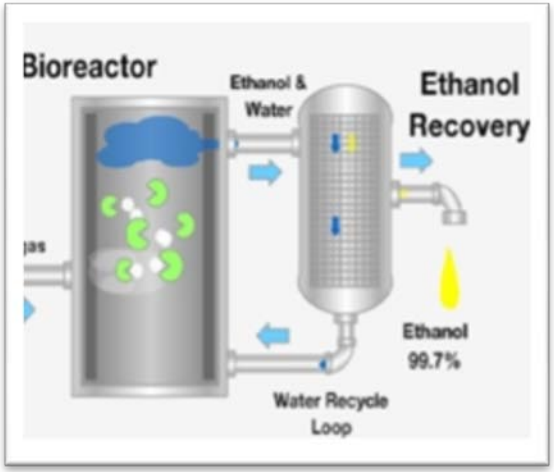
- The ethanol yield per hectare – 6000 l/ha
- This yield has been increasing steadily since 1975

- Large scale production of ethanol was began

Productivity gains

Gain in the industrial process

- Economies of scale
- Distillation process



The agricultural gain

- The selection of higher productivity variety
- Higher sugar content

Geographical expansion

- The planted area required to supply the sugarcane is 30,000 hectares.
- Most of the large plants are located in Brazil.

Table 3. Brazil: 1% of arable land displaces 30%+ of the gasoline

Millions hectares (2007)		Total (%)	Tillable lands (%)
Brazil	851		
Total of tillable lands	354.8		
1. Cultivated area	76.7	9.0	21.6
Soy	20.6	2.4	5.8
Corn	14	1.6	3.9
Sugarcane	7.8	0.9	2.2
Sugarcane for ethanol	3.4	0.4	1.0
Orange	0.9	0.1	0.3
2. Pasture	172.3	20.2	48.6
3. Available area (total tillable – cultivated areas – pasture)	105.8	12.4	29.8

Geographical expansion

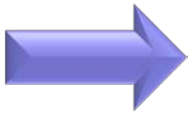
Table 4. 2050: Available land for biofuels

Land (in Gha)	North America	South & Central America	Europe & Russia	Africa	Asia	Oceania	World
Total land surface	2.1	2.0	2.3	3.0	3.1	0.9	13.40
1. Apt for rain fed cultivation	0.4	0.9	0.5	0.9	0.5	0.1	3.30
2. Apt and under forest	0.1	0.3	0.1	0.1	0.0	0.1	0.80
3. Apt, already in use	0.2	0.1	0.2	0.2	0.6	0.1	1.50
4. Necessary for food, housing and infrastructure until 2030/50	0.0	0.1	0.0	0.1	0.1	0.0	0.30
5. Available (Gross) (5=1–2–3–4)	0.00	0.25	0.08	0.44	0.07	0.04	0.74
6 % for grassland	0%	0%	50%	60%	n/a	0%	
7 Additional land potentially available (7) = (5)x(1-% for grassland)	0.00	0.25	0.04	0.18	–0.07	0.04	0.44

13.5 %

Future perspectives

- A number of very promising scientific advances (ex. GMO)



Strict regulations

- If these restrictions are removed, additional gains could be achieved.
- No commercial release of transgenic sugarcane (public perception)
- The expansion of sugarcane .

Conclusion

- There are gains in productivity of a factor of from genetically modified varieties and a geographical expansion.

- The replacement of 10% of the gasoline by ethanol seems possible.