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Guide Towards a Sustainable Energy Future for the Americas

Workshop at Universum Museum

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Sugarcane Bioenergy in Latin America & Caribbean

Rationale, experience and challenges

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Sugarcane Bioenergy in Latin America & Caribbean

Rationale, experience and challenges

Questions to address

Biomass, bioenergy and biofuels

Why bioenergy? How much?

Why bioenergy in Latin America and the Caribbean?

Why bioenergy from sugarcane?

Implications to take into account

Final remarks

Bioenergy

Current status and perspectives for bioenergy in Latin America & Caribbean: addressing sugarcane ethanol

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Summary

The availability of land for agriculture expansion in the world is highly concentrated in two continents: Latin America and Africa. This work analyzes the perspectives for the production of modern and sustainable bioenergy in Latin America, a region that already boasts successful examples of national programs such as Brazilian sugarcane ethanol and Colombian palm oil. This work also analyzes the current status of Latin American countries concerning energy and food securities.

It shows that, in general, the region has made significant progress in increasing both energy and food securities and that many countries are even prepared to play a more important role globally in the areas of energy and food supplies. The text also highlights the potential to increase sugarcane bioenergy, specifically bioethanol and bioelectricity, which can play an important role in the socio-economic development path.

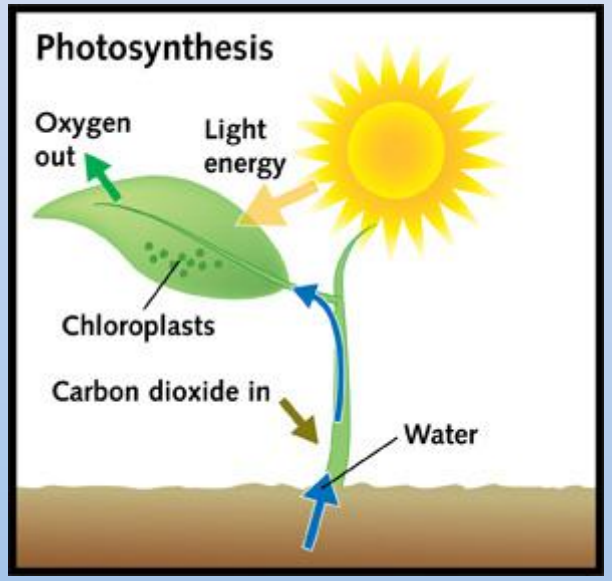
A brief summary is given of each country's energy situation and the way sugarcane bioenergy can positively impact these economies. Lastly, a brief introduction is given to the Global Sustainable Bioenergy Initiative, more specifically the LACAf Project, a joint collaborative project involving FAPESP and IANAS, among other research institutions.

Biomass, bioenergy and biofuels

***Biomass** is made essentially from carbon captured from the atmosphere, plus water, bonded by solar energy, through the photosynthesis process.*

***Bioenergy** is generated when these bonds are broken through combustion, releasing the stored solar energy.*

***Biofuels** are biomass used as source of bioenergy.*



Bioenergy: our first energy resource

Biomass was the first energy source used by mankind and the main source of energy until the last century.

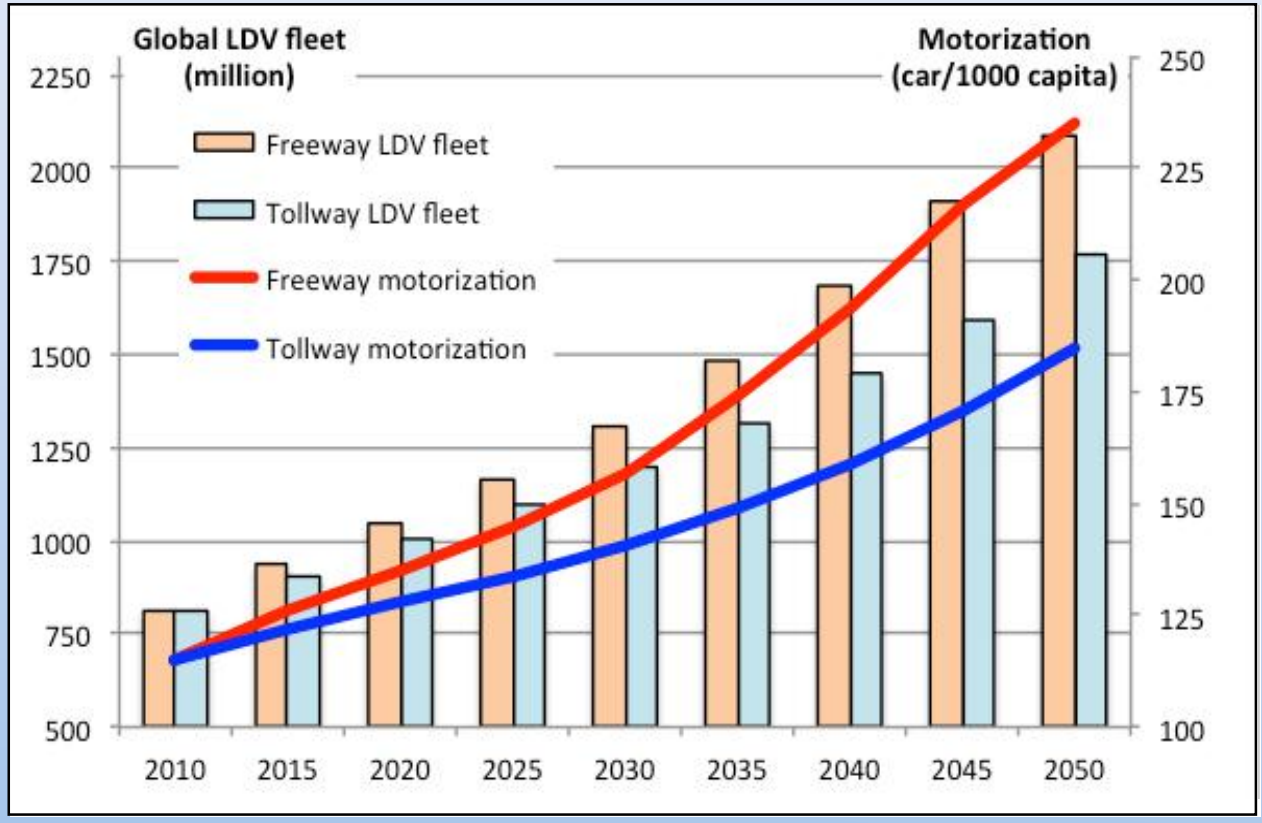
More recently, due to economic, environmental and energy security reasons, there is a growing interest in bioenergy, mainly as liquid biofuels and bioelectricity.

The quest for fire, J.J Arnaud, 1981

Why we need bioenergy?

The global market for liquid biofuels is related to the energy demand in transport.

The global fleet is expanding fast, so the fuels demand is expanding. But we should care of our planet…

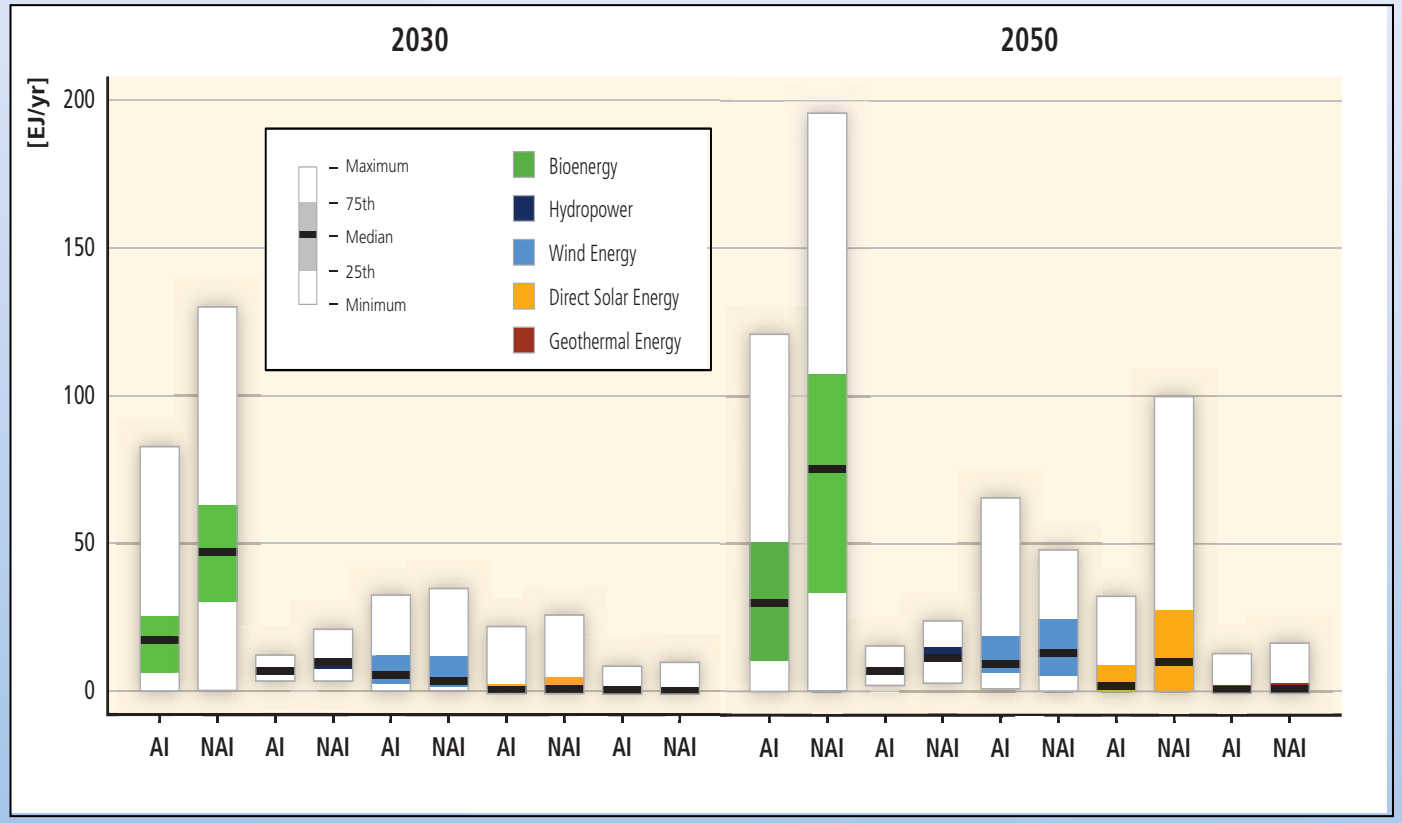


Projections of global fleet and motorization for regulated (Tollway) and non regulated (Freeway) scenarios (based on WEC, 2011)

Why we need bioenergy?

For transport, biofuels are a low carbon technology already available, using the existing logistic infrastructure and fleet.

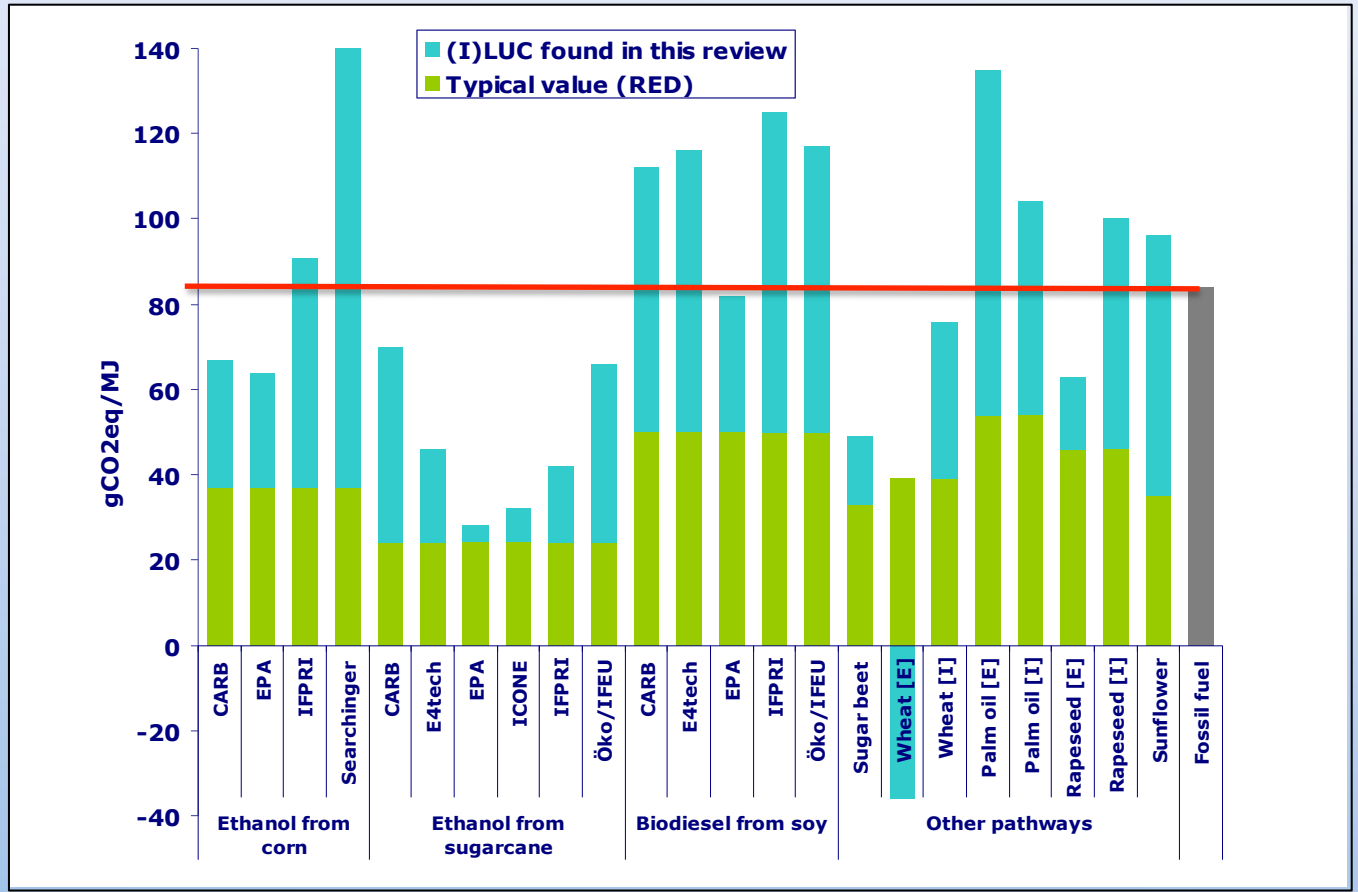
To achieve climate mitigation scenarios, bioenergy and specially liquid biofuels, have a crucial role to play.



Estimated global renewable primary energy supply by source by 2030 and 2050 (IPCC, 2012)

Are biofuels really low carbon fuels?

When produced efficiently, with low environmental impact in their life cycle and socially acceptable, biofuels represent the most relevant alternatives to reduce GHG emissions in modern society. Sugarcane is particularly good in this regard.



GHG emissions from ethanol and biodiesel, including ILUC
(GBEP, 2011)

The estimated global demand of biofuels

Biofuels supply currently 3% of global demand of energy for road transport, but their contribution should increase.

The future demand for biofuels was estimated at a conservative scenario, following the current trend and in a scenario defined by the need of stabilize the climate change.

Scenarios for biofuels and ethanol demand in 2030

Scenario	References	Biofuels demand in 2030	Ethanol demand in 2030
Business as usual: Biofuels supply 5% of energy transport consumption.	BP, 2015 WEC, 2011	2.85 million barrels of oil equivalent per day	161 million m3
Needed: Biofuels cover 11% of energy transport consumption, to stabilize GHG and limit global climate change.	IPCC, 2011	7.16 million barrels of oil equivalent per day	404 million m3

Sugarcane: an excellent feedstock for ethanol

Sugarcane, a traditional culture in tropical countries, is:

- ***one of the most efficient solar energy converter to biomass and so a feedstock of choice for bioenergy production.***
- ***a semi-perennial crop, planted once and harvested annually for 5 to 6 years.***

As a whole, 1 ton of sugarcane is equivalent to 1.2 barrel of petroleum, thus one sugarcane hectare produces yearly about 100 barrels of oil.

The sugarcane agroindustry

Ethanol and sugar are produced jointly from the sugarcane juice, while the bagasse is used as fuel in cogeneration schemes to produce electricity. Considering all direct and indirect energy costs, each unit of fossil energy produces 8 to 10 units of renewable energy.

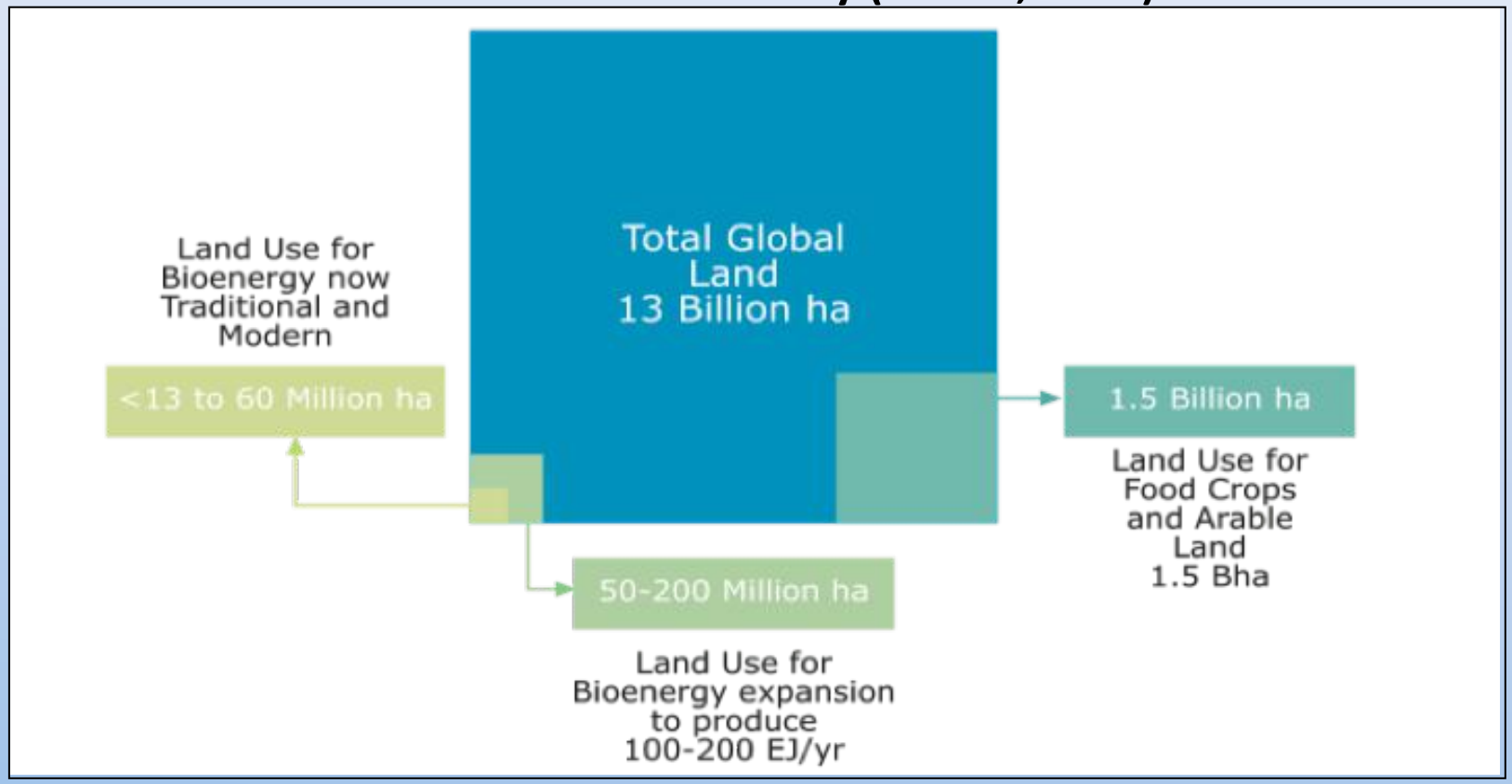
This industry today adopts modern automatic systems, but still requires much more manpower than any other energy technology.

A typical sugar and ethanol mill in Brazil
(BNDES, 2009)

Modern bioenergy: land use impact

Today there is a sound base of data assessing the current and future requirements of arable land to sustainably produce food, feed and biomass for energy, to assure that, from a global perspective, land is not a real concern.

Global land availability (SCOPE, 2015)



Biofuels and food security

The analysis is often biased by ideological assumptions.

<u>After all, what is food security?</u>

Food security depends on food availability and conditions to access, process and use properly. Detailed studies of price changes and its causes indicate that it is really small the impact of biofuels sustainable production on the availability and cost of food.

From **World Agriculture: Towards 2015-2030,** FAO, 2004

> … growth in food production will be higher than population growth. By the year 2015/2030 per capita food supplies will have increased and the incidence of undernourishment will have been further reduced in most developing regions … The world population will be increasingly well-fed by 2030, with 3050 kilocalories (kcal) available per person, compared to 2360 kcal per person per day in the mid-1960s and 2800 kcal today. This change reflects … the rising consumption in many developing countries whose average will be close to 3000 kcal in 2030.[652]

There is no lack of food, there are people not able to access food

***Obesity** is currently a more serious problem than hunger in most countries.*

Effectively, there is no shortage of food, there is lack of access to food resources, most due to poverty of some social groups. The growing food waste indicates the untapped surplus production.

The Lancet, Volume 378, Issue 9793, Pages 804 - 814, 27 August 2011

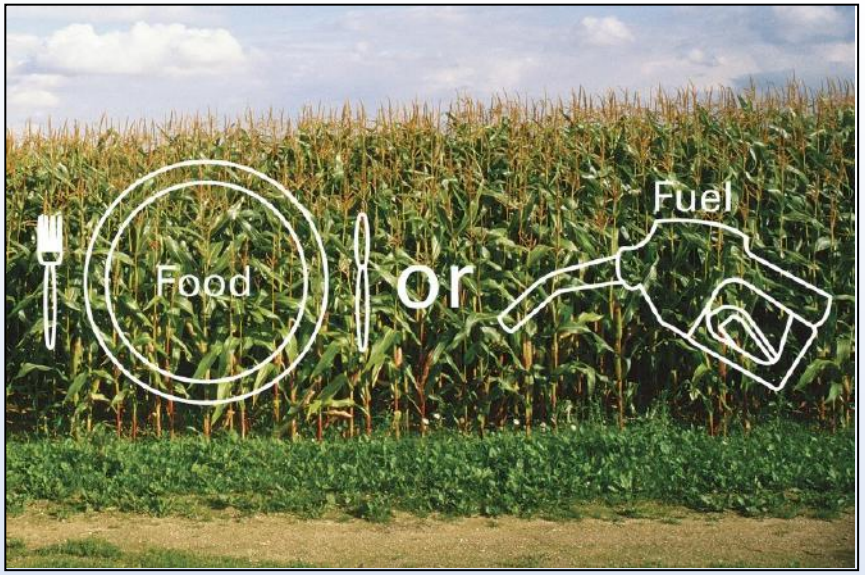
The global obesity pandemic: shaped by global drivers and local environments

Prof. Boyd A Swinburn MD a , Gary Sacks PhD a, Kevin D Hall PhD c, Prof Klim McPherson PhD d, Prof Diane T Finegood PhD e, Marjory L Moodie DrPH b, Prof Steven L Gortmaker PhD.

Summary

The simultaneous increases in obesity in almost all countries seem to be driven mainly by changes in the global food system, which is producing more processed, affordable, and effectively marketed food than ever before. This passive overconsumption of energy leading to obesity is a predictable outcome of market economies predicated on consumption-based growth. The global food system drivers interact with local environmental factors to create a wide variation in obesity prevalence between populations…

La opinión de la FAO, Organización de las Naciones Unidas para la Agricultura y Alimentación, sobre biocombustibles



"El cambio climático y la competencia entre los productos agrícolas alimentarios y no alimentarios -como la bioenergía- han hecho más complejos los problemas de la alimentación del futuro. Pero es importante no olvidar que los biocombustibles surgieron con fuerza como fuente de energía alternativa debido a la necesidad de mitigar los gases producidos por los combustibles fósiles y los de efecto invernadero, y esa necesidad no ha cambiado.

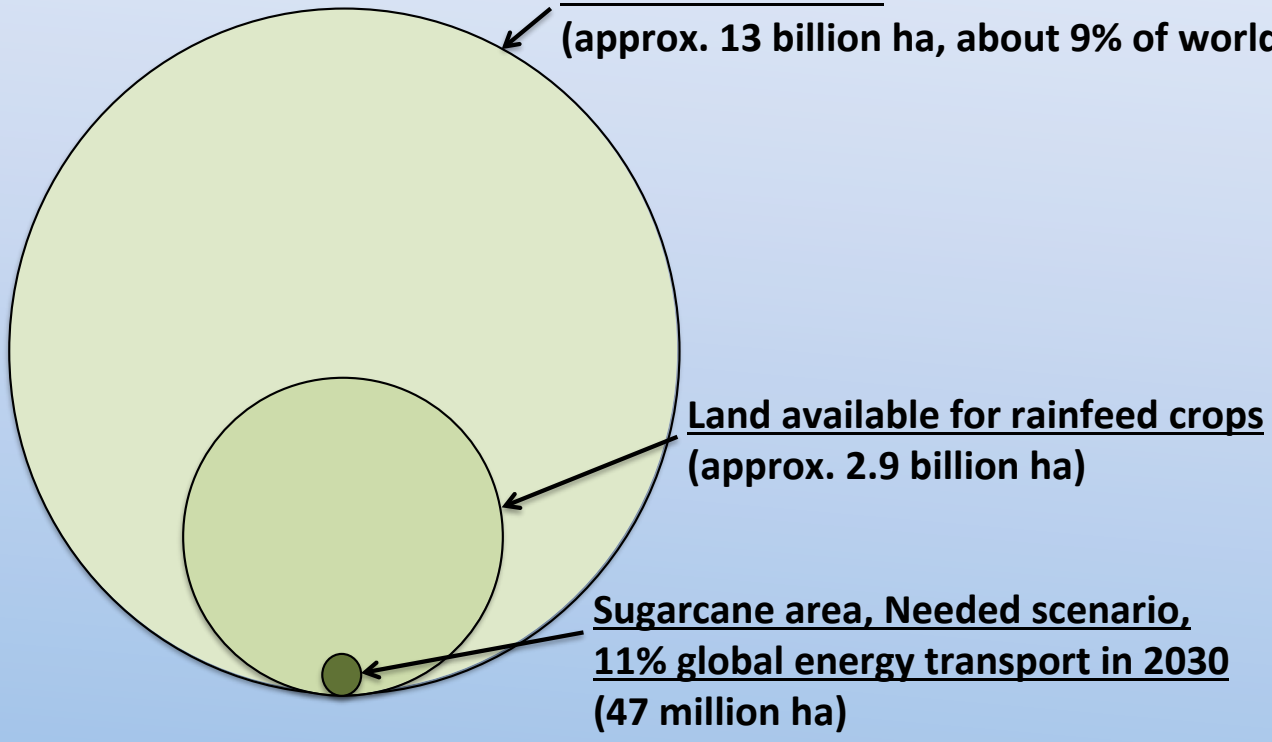
Tenemos que pasar del debate de alimentos contra combustibles a un debate sobre alimentos y combustibles. No hay duda: los alimentos son lo primero, pero los biocombustibles no deben ser vistos simplemente como una amenaza o como una solución mágica. Al igual que sucede con otras cosas, pueden ser buenos o malos".

José Graziano da Silva, Director General de la FAO,

en el **Foro Global de Agricultura y Alimentación** (Berlin, 2015)

Global impacts of innovative bioethanol from sugarcane: GHG mitigation and land use

The land to be planted with sugarcane to produce ethanol enough to replace 11% of expected global demand of gasoline (2050), means 1.6% of land available for rainfed agriculture, mostly in Latin America and Africa (FAO, 2012).



Bioenergy potential in LAC

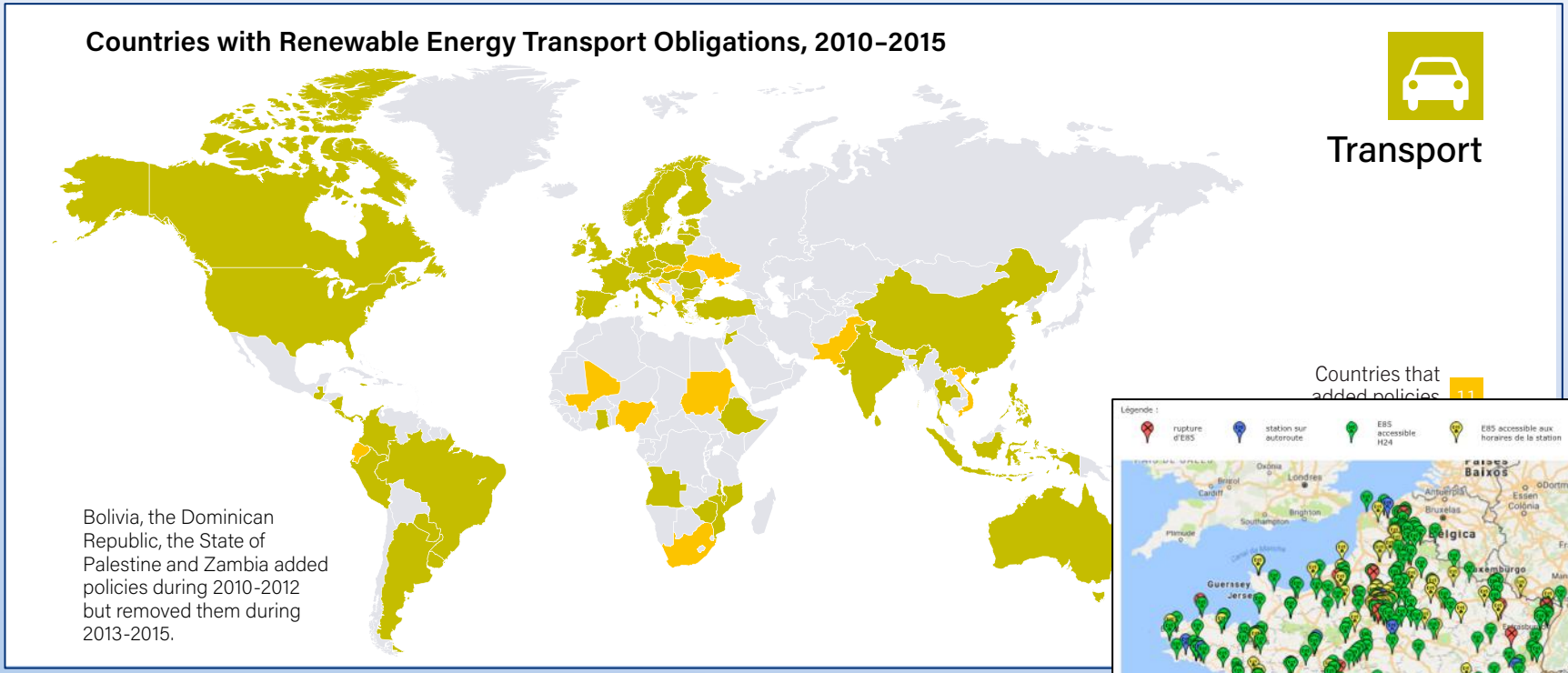
Latin America and the Caribbean present excellent conditions to produce bioenergy.

About 360 Mha of land suitable for rainfed agriculture are available for expanding agriculture in LAC (FAO, 2012); 37% of global total and more than 3X the area required to meet future world food needs.

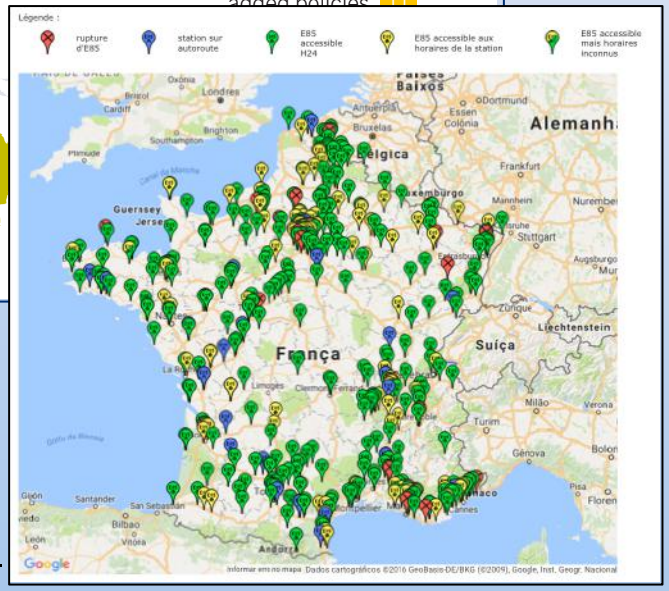
20% of this area, managed properly and using efficient processes (3 Mha/EJ) could produce annually 24 EJ of liquid biofuels, equivalent to 11 million bpd, more than current US or Saudi Arabia oil production.

Biofuels use expands globally.

Today 66 countries have national programs fostering the use of biofuels, typically in blends with conventional fuels and in some countries promoting also the use of pure biofuels.



(REN21, 2016)



(available at: http://ethanol-e85.fr/carte_stations_E85.html)

Current status of biofuel programs in LAC

Since the 80's several LAC countries have promoted biofuels production and use.

Several countries have introduced ethanol and biodiesel mandates: Argentina, Brazil, Colombia, [Costa Rica], Ecuador, Honduras, Jamaica, [Panamá], Peru, and Uruguay.

Programs for bioelectricity and biogas production have been also implemented.

E5 in an Ecuadorian gas station

Current status of biofuel programs in LAC

Table 2. Biofuels Policies in LAC selected countries

Country	Biofuels Law/Program [1]	Ethanol and Biodiesel Blending Mandate [1]	Mandate Blend (%)
Argentina	in progress	in progress	E10, B10 [1,4]
Brazil	in progress	in progress	E27, E100, B7 [1]
Chile			E5 [3], B2
Colombia		in progress, subnational level	E8 [1,4], B8-B10 [1]
Costa Rica	in progress	expired, superseded or inactive	E0-E8, B0-B5 [1]
Ecuador	in progress	subnational level, in progress	E5 [1], B5 [1,4]
Guatemala		in progress	E0-E10 [2]
Honduras	in progress		
Jamaica		in progress	E10 [3,4]
Mexico	in progress	expired, superseded or inactive	E2 [3]
Nicaragua	in progress		
Panama	in progress	expired, superseded or inactive	E5 [1]
Paraguay	in progress		E24, B1 [3]
Peru	in progress	in progress	E7.8, B5 [1]
Uruguay	in progress	in progress	E5, B5 [1,4]

Notes: Colombia: E8 (mandate), E10 (target), B8 and B10 (different regionals levels); Chile: up to E5 (voluntary blending); Costa Rica: up to E8 (voluntary), up to B5 (voluntary); Guatemala: ethanol use as additive, Mexico: Guadalajara (mandate), Mexico City and Monterrey (target).
Sources: 1 – (IRENA, 2015), 2 – (GUATEMALA, 2015), 3 – (GRFA, 2015), 4 – (REN21, 2015)

From: Current status and perspectives for bioenergy in Latin America & Caribbean,
Guide Towards a Sustainable Energy Future for the Americas, IANAS, 2016

Ethanol production in Paraguay

Empresa: **SAN LUIS SAECA**
Capacidad: 20.000.000 lts/año
Producción: 17.000.000 lts/año
Localización: Col. F. Caballero Álvarez

Empresa: **INPASA**
Capacidad: 90.000.000 lts/año
Volumen de Producción: 20.000.000 lts/año
Localización: Col. Nueva Esperanza

Empresa: **ALMISA**
Capacidad: 5. 000.000 lts/año
Producción: 1.000.000 lts/año
Localización: Colonia Repatriación

Empresa: **ALCOTEC SA**
Capacidad: 10.000.000 lts/año
Producción: 4.000.000 lts/año
Localización: Ruta 2 Km. 198

Empresa: NEUALCO SA
Capacidad: 10.000.000 lts/año
Producción.: 4.000.000 lts/año
Localización: Ruta 2 Km. 206

Empresa: **EXPELLER SA**
Capacidad: 10.000.000 lts/año
Producción: 3.300.000 lts/año
Localización: Maciel,

Empresa: **COOPERATIVA CNEL OVIEDO**
Capacidad: 10.000.000 lts/año
Producción: 4.000.000 lts/año
Localización: Ruta Cnel Oviedo- Carayao

Empresa: **PETROPAR**
Capacidad: 36.000.000 lts/año
Producción.: 22.000.000 lts/año
Localización: Mauricio Jose Troche

Empresa: **ITURBE SA**
Capacidad: 20.000.000 lts/año
Producción: 15.000.000 lts/año
Localización: Iturbe

Empresa: **AZPA SA**
Capacidad: 30.000.000 lts/año
Producción; 26.000.000 lts/año
Localización: Tebicuary

Empresa: **PHOENIX**
Capacidad: 10.000.000 lts/año
Producción: 2.000.000 lts/año
Localización: Maciel

Empresa: **ALPASA**
Capacidad: 15. 000.000 lts/año
Producción.: 6.000.000 lts/año
Localización: Colonia Santa Isabel, Dpto. de Paraguarí

Capacidad de produccion: 266 M litros etanol/año

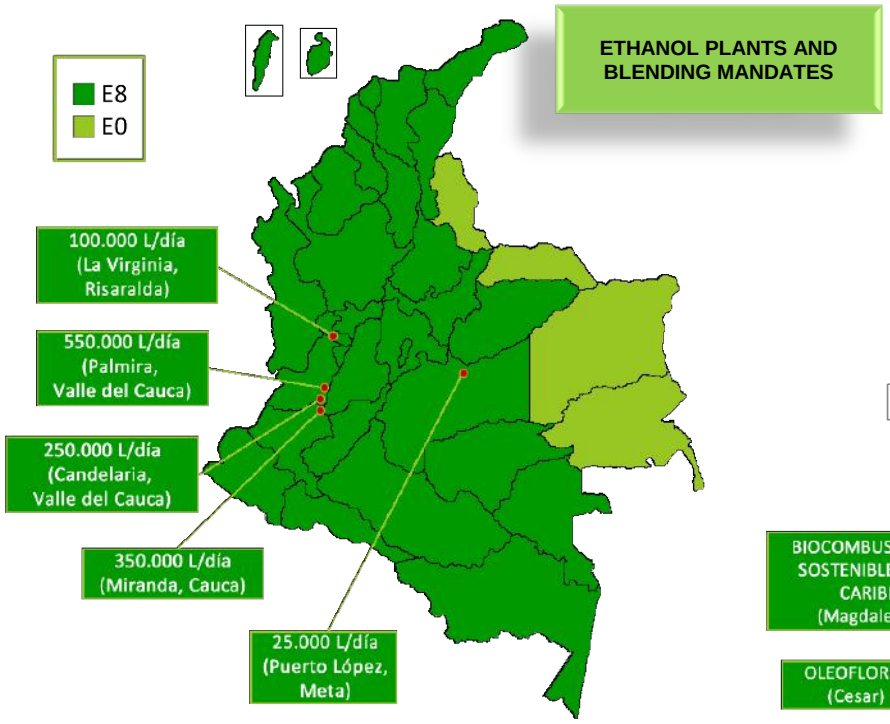
Superficie Cultivada en Caña para Etanol: 30. 000 hectareas (2011)

Mano de Obra Agrícola: 18.000 Personas
Mano de Obra Industrial: 1.500 Personas

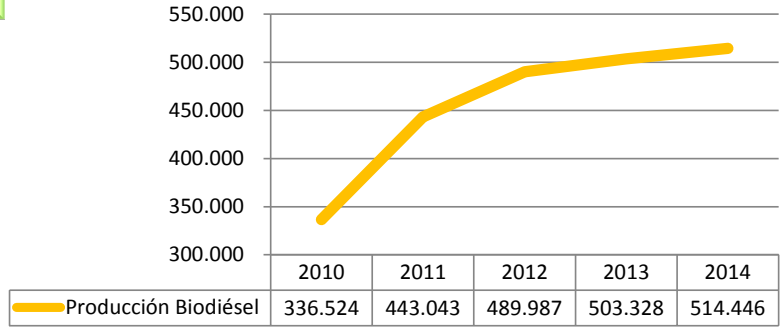
Rendimiento:
Agricola: 55 ton/ha cañaveral
Industrial: 65 litros etanol/ton caña
Agrondustrial 3.080 litros etanol/ ha

(adapt. Comarca Guaireña, 2012)

Biofuels production in Colombia

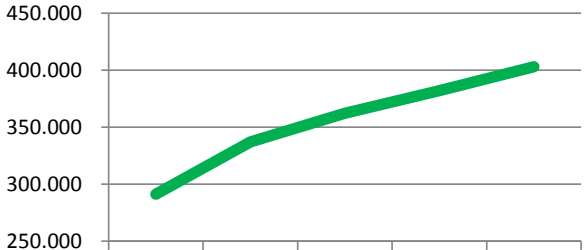


BIODIESEL PRODUCTION

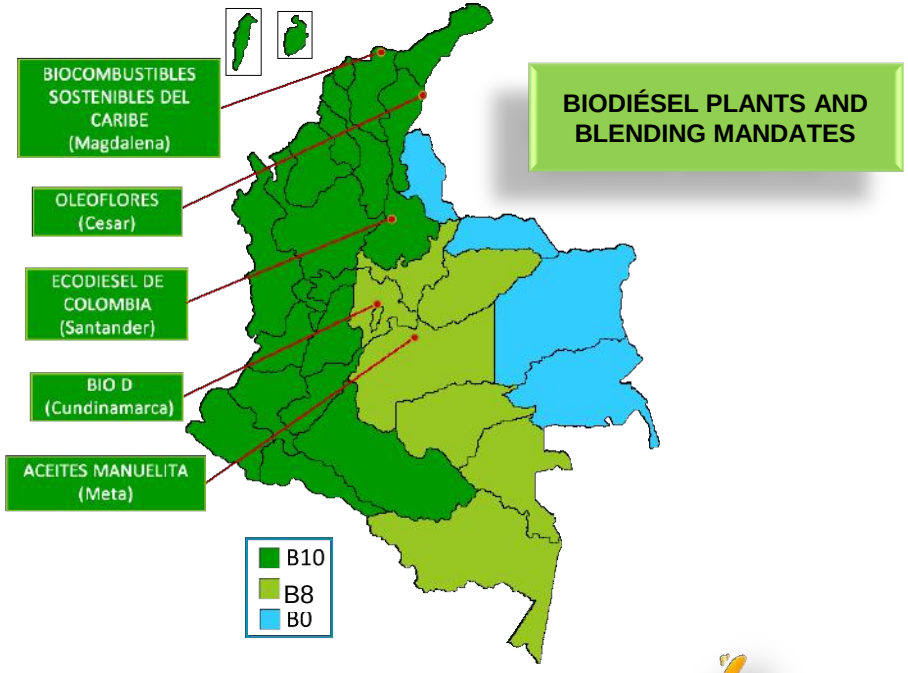


	2010	2011	2012	2013	2014
Producción Biodiésel	336.524	443.043	489.987	503.328	514.446

ETHANOL PRODUCTION



	2010	2011	2012	2013	2014
Producción Etanol	291.286	336.957	362.145	382.032	402.973



Source: Fedebiocombustibles.

NATIONAL BIOFUELS FEDERATION OF COLOMBIA

APOYAMOS EL PACTO GLOBAL

Opportunities and challenges

New frontiers for bioenergy in LAC

There are new areas to develop bioenergy projects in LAC, presenting risks and rewards. For instance, in Piura (North of Peru) two large greenfield sugar/ ethanol projects were deployed (20,000 ha of sugarcane); in Uruguay the ALUR Paysandu plant, commissioned recently, will supply ethanol for E10.

Irrigated sugarcane in Piura, Peru, 2013

Promoting ethanol use in Uruguay, 2014

Opportunities and challenges

Informing consumers

It is relevant identify the risk perception associated to biofuels use and promote marketing campaigns and demonstration programs to reduce misunderstanding.

Guatemala produce and export large amounts of ethanol; adopting E10 blend could reduce gasoline imports, replace MTBE, among other advantages. However, there are persistent concerns about the technical feasibility of ethanol. A well planned demonstration program was launched to clarify these aspects.

Plan Piloto de Etanol

Modelo	Cantidad
2011-2014	2
2000-2010	12
1990-1999	6
1986-1989	2
1985-menor	3
motocicletas	5
TOTAL	30

Fleet composition, Guatemala demo plan, 2015

Frontiers developments in sugarcane bioenergy

Innovation have always played an important role to improve the sugarcane bioenergy agroindustry, increasing its sustainability in all aspects.

New opportunities for improvement:

- ***Sugarcane trash recovery and utilization***
- ***Energy cane***
- ***Second generation ethanol processes***
- ***Precision agriculture***
- ***Biogas production from stillage, and other.***

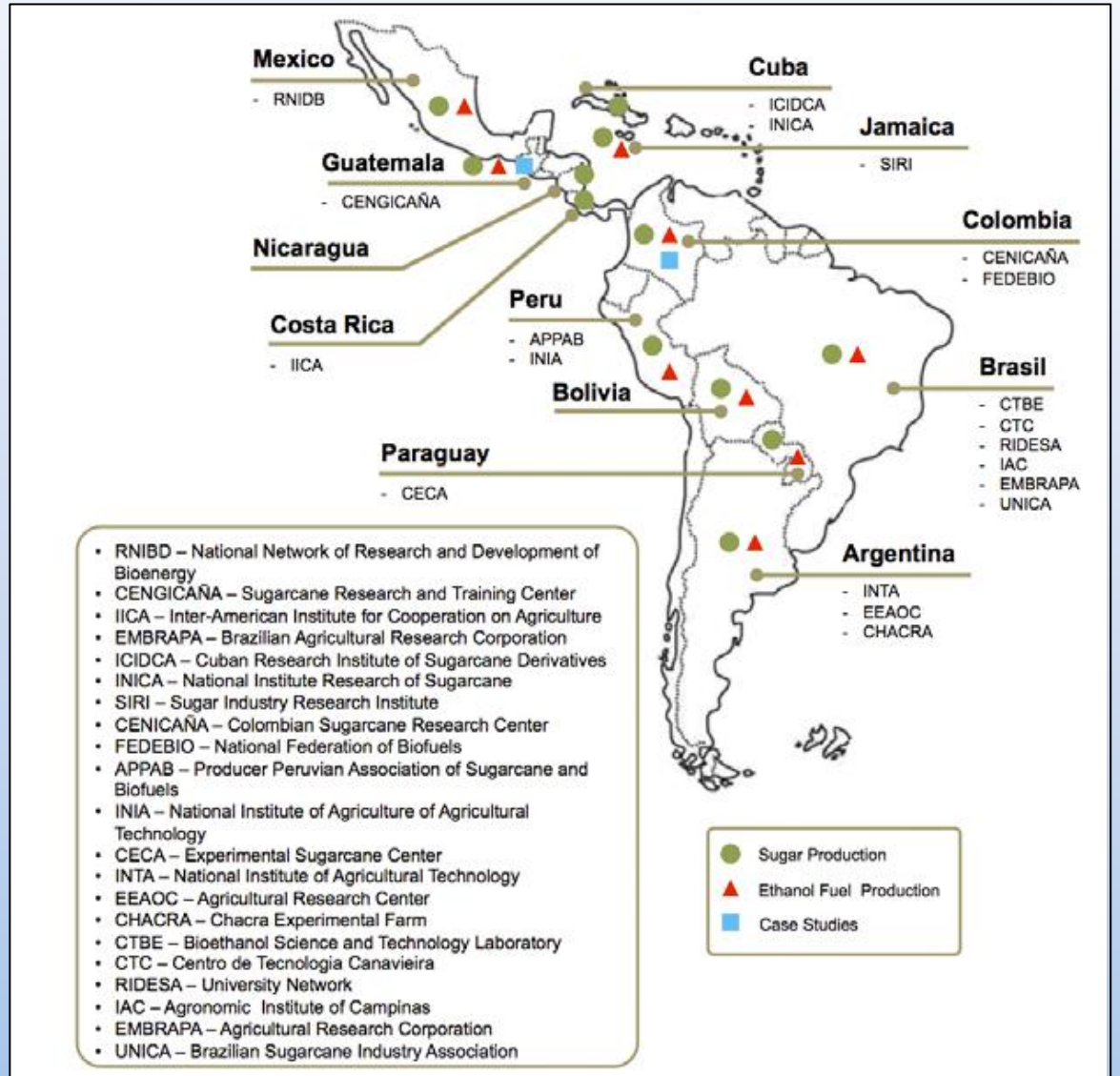
2G ethanol plant Alagoas, Brazil (Granbio, 2016)

Energy cane (at left) and commercial sugarcane (at right) at 90 days after planting (Carvalho-Netto et al., 2014)

R&D institutions dedicated to sugarcane in Latin America and the Caribbean

There are several active institutions, with a good potential for promoting cooperation.

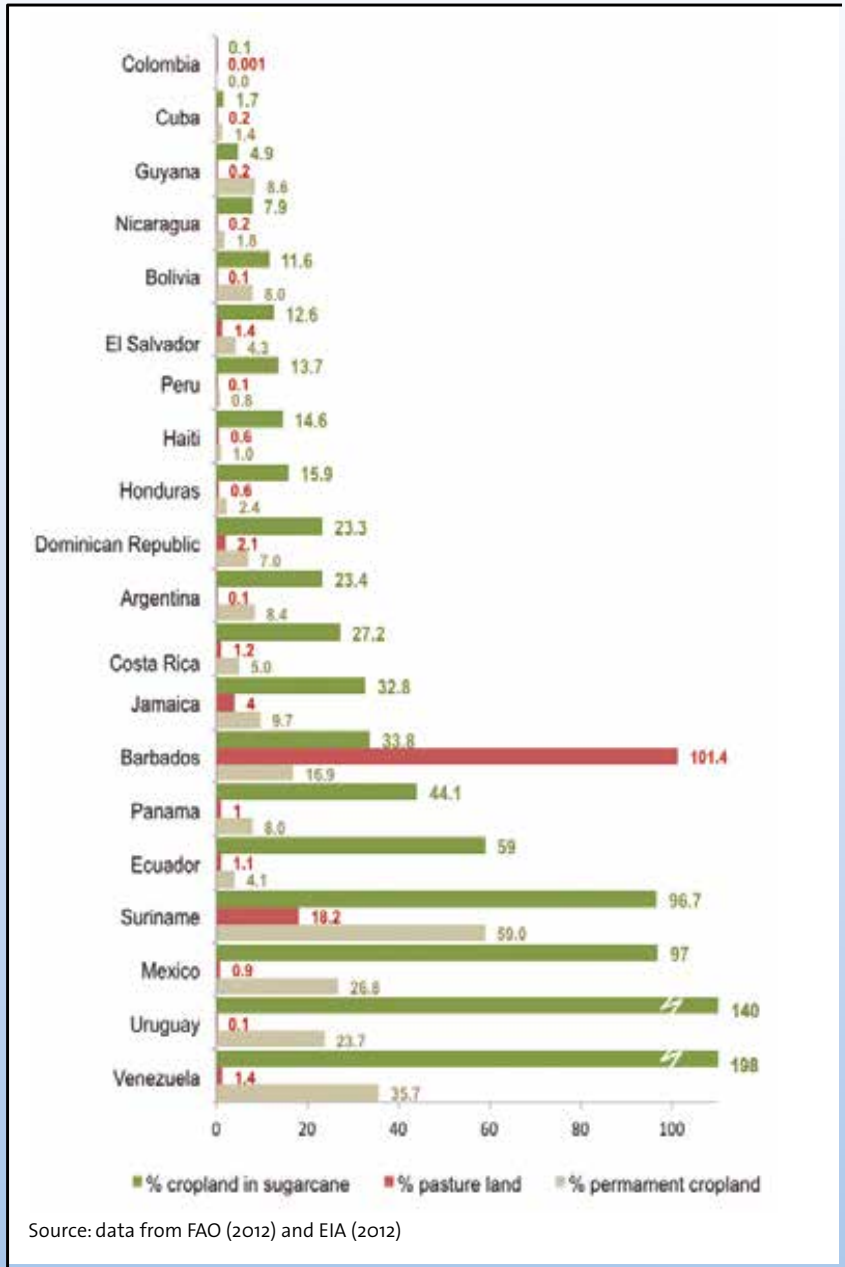
From: Current status and perspectives for bioenergy in Latin America & Caribbean, **Guide Towards a Sustainable Energy Future for the Americas, IANAS, 2016**



Source: adapted from (CORTEZ, 2012).

Perspectives for ethanol from sugarcane in LAC

Sugarcane is a traditional culture in this region and relatively small area will be required to produce ethanol, either by expanding current sugarcane fields or occupying areas currently with low productivity ranching.



Source: data from FAO (2012) and EIA (2012)

Agricultural land requirements to produce bioethanol for a 10% gasoline blend (as % of planted sugarcane land, pasture land, and permanent cropland), 2012 base year (IANAS, 2016)

Final remarks

A detailed assessment of global sustainable bioenergy potential and perspectives, the SCOPE (Scientific Committee on Problems of the Environment) report (2015), Bioenergy and Sustainability: bridging the gaps, prepared by 137 experts from 24 countries.

In this study is indicated that bioenergy properly implemented can help to:

- ✓ ***increase resilience in food supply both locally and globally***
- ✓ ***decrease pollution***
- ✓ ***preserve biodiversity***
- ✓ ***improve human health***
- ✓ ***rehabilitate degraded land***
- ✓ ***mitigate climate change***
- ✓ ***provide economic and business opportunities***

Biofuels ethical principles (Nuffield Council on Bioethics, 2011)

A number of overlapping moral values form the basis of an ethical framework that can inform society's approach towards biofuels. These are: rights and global justice; solidarity and the common good; and stewardship, sustainability and intergenerational equity.

From these values we derive six Ethical Principles which can be used to evaluate biofuels development and guide policy making. These Principles are as follows:

1. **Biofuels development should not be at the expense of people's essential rights (including access to sufficient food and water, health rights, work rights and land entitlements).**
2. **Biofuels should be environmentally sustainable.**
3. **Biofuels should contribute to a net reduction of total greenhouse gas emissions and not exacerbate global climate change.**
4. **Biofuels should develop in accordance with trade principles that are fair and recognise the rights of people to just reward (including labour rights and intellectual property rights).**
5. **Costs and benefits of biofuels should be distributed in an equitable way.**

We then consider whether there may in some cases be a duty to develop biofuels. To address this we propose a sixth Principle:

If the first five Principles are respected and if biofuels can play a crucial role in mitigating dangerous climate change then, depending on additional key considerations, there is a duty to develop such biofuels.

These additional key considerations are: absolute cost; alternative energy sources; opportunity costs; the existing degree of uncertainty; irreversibility; degree of participation; and the overarching notion of proportionate governance. We believe that these Ethical Principles should guide any policy making in the field of biofuels – and indeed, they should be applied to comparable other technologies.

Objectives of LACAf Project

- ***Contribute to the Global Sustainable Bioenergy Project***
- ***Study the potential for sugarcane bioenergy production in Latin America and Africa, in particular South Africa, Colombia, Guatemala and Mozambique.***
- ***Evaluate the social, economic and energy benefits and difficulties to promote the use of sustainable sugarcane bioenergy in these countries.***

Muito obrigado por sua atenção.

Luiz A. Horta Nogueira

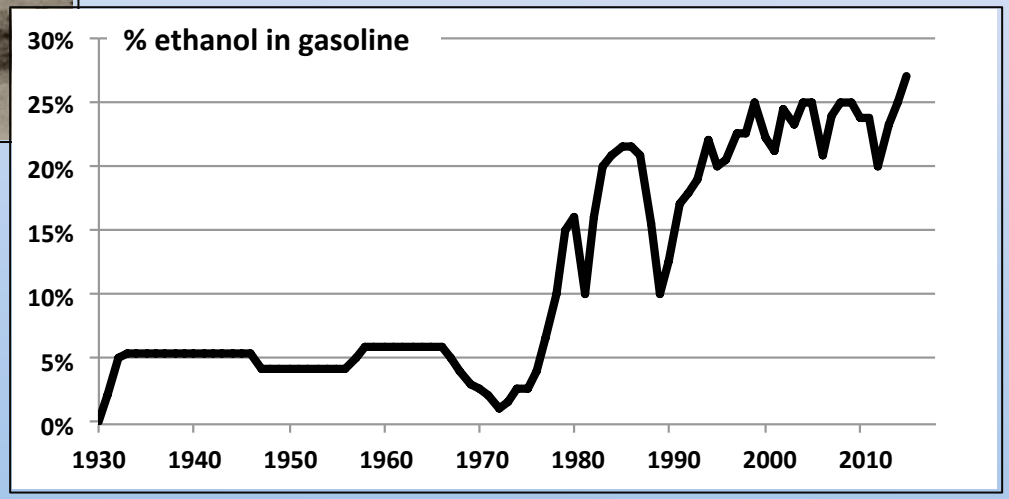
LACAf Project - NIPE/UNICAMP

EXCEN UNIFEI

Ethanol use in Brazil: the initial steps

Gasoline blended with ethanol has been a mandatory practice in Brazil since 1931 (minimum E5, average E7.5), reinforced after the oil crisis during the seventies, when the use of high blends (currently E27) in all gasoline and pure hydrous ethanol (for dedicated motors) was adopted.

Ford Model T adapted for pure ethanol, used for public demonstrations in the 20's
(INT, 2006)



Ethanol content in the Brazilian gasoline
(BNDES, 2009, updated)

Un breve histórico

Los biocombustibles fueran utilizados en los primeros días de la industria del automóvil: Rudolf Diesel sugirió el uso de aceite de maní en su motor y Henry Ford fue un gran defensor de etanol, produciendo modelos específicos para este biocombustible.

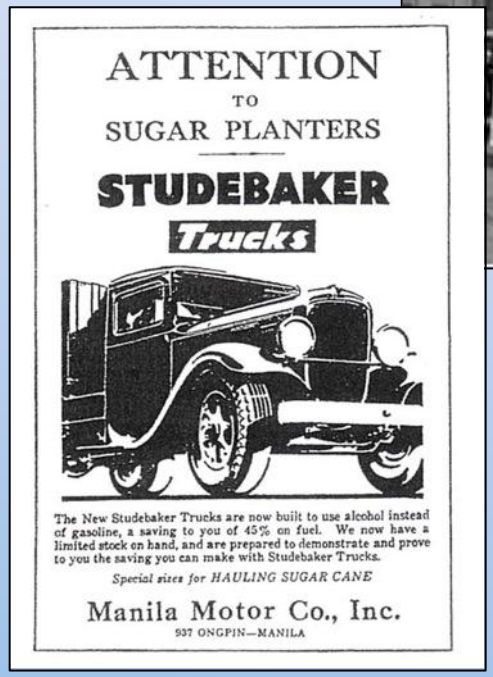
Congrès des Applications de l'Alcool Dénaturé (catalogue), Automobile Club de France, 1902

Henry Ford manejando un vehículo a etanol puro en 1896

Un breve histórico

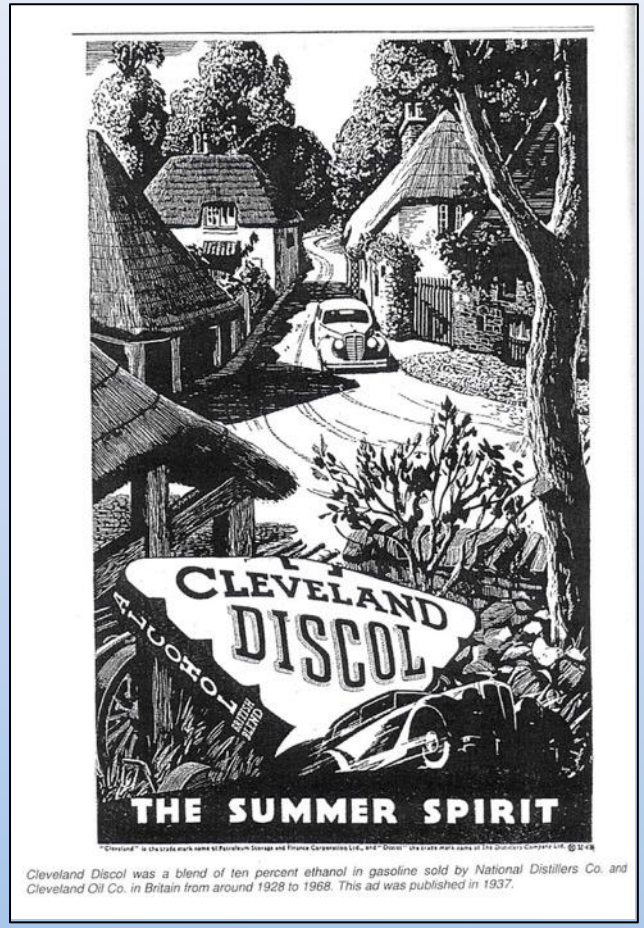
A partir de los buenos resultados alcanzados desde 1890 en los EUA, Francia y Alemania, en principios del siglo pasado etanol fue adoptado regularmente en muchos países, puros o en mezclas.

Estación de servicio, EUA,1933



Propaganda de camión a etanol puro, Filipinas, 1928.

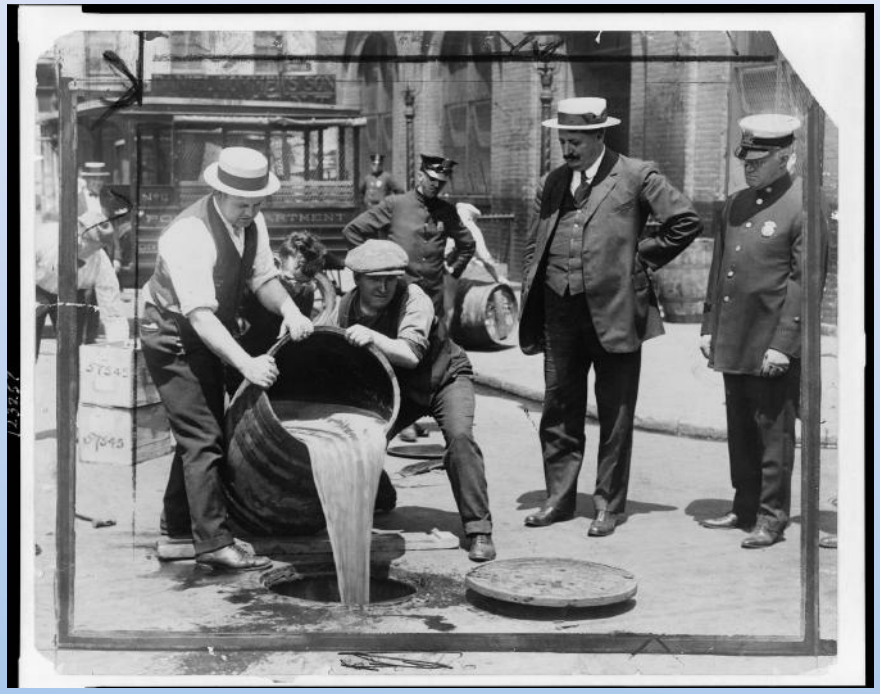
Propaganda de combustible E10, comercializado en Inglaterra entre 1928 y 1968.



Un breve histórico

Porque no se fue adelante? Los bajos precios de la gasolina y la presión de las empresas petroleras fue decisivo para el progresivo abandono del uso de etanol. En los EUA tuve un papel importante la Ley Seca, que prohibió la comercialización de alcoholes entre 1920 y 1933. Solo en Brasil, India y Reino Unido* se mantuvo el uso de etanol combustible desde entonces hasta la actualidad.

*(hasta 1968)



Removal of liquor during Prohibition.