
IICA
Frequently asked
BIOFUEL
questions and answers

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Preface

The high price of oil and its tendency to continue rising or to remain high while reserves drop have affected global energy security, forcing non-oil-producing countries to spend a significant share of their budgets on imported fossil fuel. This, coupled with growing concern regarding global warming – which is largely a result of the release of gases from burning fossil fuels – has led to increased interest in the use of renewable energy sources. One such source is biofuel derived from biomass, which may significantly improve the income of the agricultural sector.

Accordingly, IICA has prepared this basic document, which is intended to answer the most frequently asked questions regarding biofuels, their current and potential uses, their advantages and disadvantages, the controversy they have caused in certain sectors, and the terminology that surrounds them. Provided clear, socially inclusive policies are established, biofuels should be an effective tool for improving the standard of living of rural communities.

1. What are biofuels?

Etymologically speaking, biofuels are fuels with biological origins. However, since this would include petroleum, which is derived from fossil remains produced millions of years ago, biofuels are better described as fuels with biological origins, obtained in a renewable manner from organic remains. They are the first source of energy known to man. Sources of biofuel include biomass obtained from crops such as sugarcane, corn, sorghum, cassava, etc., which is used to produce ethanol, and oils obtained from African Palm, soybean, castor bean, Jatropha Curcas, rapeseed, etc., which are used to produce biodiesel.

Jatropha curcas

2. Will increased biofuel production jeopardize food security and raise the prices of certain foods?

This might be the case if land intended for food crops is used to produce biofuel, or if food crops are used for biofuel production rather than for their original purpose. It should be borne in mind that over 50% of the poor population of Latin America and the Caribbean lives in and depends on the rural sector. Of the 525 million inhabitants of Latin America, 128 million live in poverty (less than US$ 2 a day), while 50 million live in extreme poverty (less than US$ 1 a day). Consequently, if higher-paying crops emerge, farmers will focus their efforts on those crops. While rural producers should be paid more for their products, clear policies on the issue are essential, in order to prevent natural reserves from being destroyed to make way for farmland. Additionally, it is necessary to adopt regulations that will ensure that the amount of a given crop earmarked for biofuel production, and that set aside for use as food, do not put food security at risk.

The price of certain foods has increased, however. Such is the case with corn, due to increased demand for ethanol production. As mentioned in Foreign Affairs magazine (2007), the impact of ethanol-driven price increases is often high, and plant diseases, weather conditions and government policies have exacerbated the situation. Ultimately, the market will continue to set prices; if supply exceeds demand, the price of this raw material will fall. For the time being, the fact is that crops with biofuel potential represent an opportunity to revitalize and improve the standard of living of rural communities, and opportunities should be taken as they arise. An effort is required to ensure that the right policies are in place to properly distribute the resulting income throughout the production chain. It should also be noted that rising oil prices have made agricultural production inputs significantly more expensive, and growing Chinese and Indian demand for grain has also contributed to price increases.

According to the United Nations, hunger is caused by inequality, not lack of food. Over a nine-year period, the income ratio between the richest 20% of the world's population and the poorest 20% rose from 60:1 to 74:1. The assets of the planet's richest 200 people exceed the combined income of 41% of the world's population, and are greater than the combined GDP of all of the world's least-developed countries, with their 600 million people. The conditions and local policies of each country should also be taken into account. The latter should promote greater social inclusion and discourage the formation of oligopolies. Moreover, a distinction should be made between countries with large quantities of usable farmland and countries with limited land and water resources.

3. What are some of the advantages and disadvantages of using ethanol instead of gasoline?

The main **advantages** are as follows

- Since it is renewable and locally produced, ethanol reduces dependence on oil, improving the energy security of countries. This is even more important for non-oil-producing countries, since most of the world's oil is concentrated in politically unstable areas such as the Middle East, and the trend is for prices to continue to rise or to remain high.
- Ethanol, being an oxygenate, significantly improves the octane performance of gasoline, and does so in a sustainable manner. This helps to reduce pollution in our cities, as well as greenhouse gases.
- As an oxygenate, ethanol also replaces additives such as lead and MTBE, whose negative health effects include higher percentages of cancer (MTBE) and mental retardation in children (lead).
- The Research Octane Number of pure ethanol is 113, and it burns better than gasoline at high compression levels, making motors more powerful.
- It acts as an antifreeze, improving cold-start performance and preventing freeze-ups.
- It increases the value of the agricultural products from which it is derived, improving the income of the rural sector and thereby raising its standard of living.

The main **disadvantages** are as follows:

- It burns 25% to 30% faster than gasoline, which means that it must be sold at a lower price per gallon in order to remain competitive.
- In many areas where it is produced from sugarcane, the practice of pre-harvest burning persists. This leads to the release of large quantities of methane and nitrous oxide, two gases that aggravate global warming. While mechanizing the harvest process is one solution, such a measure would result in lower rural employment, regardless of the criticisms leveled at rural labor conditions.

- When it is produced from corn, the ethanol production process employs natural gas or carbon to produce vapor, and the farming process employs fossil-based nitrate fertilizer and herbicides, as well as heavy agricultural machinery. This would be solved through the use of organic – or at least eco-friendly – farming techniques. The CO_2 produced by distilleries can also be used to produce algae (which can itself be used to produce biofuel). Provided a cattle ranch is located nearby, methane from manure can be used to produce vapor (this is essentially equivalent to using biogas to create biofuel).

4. What are the advantages and disadvantages of using biodiesel rather than diesel?

The main **advantages** are as follows:

- Biodiesel is more lubricious than fossil-based diesel, and therefore increases engine shelf life.
- Its flash point is 100° C higher than fossil-based diesel, which makes it safer to ship and store. Biodiesel is only in danger of exploding at 150°C.
- Biodiesel breaks down four to five times faster than fossil-based diesel, and it can be used as a solvent to clean fossil diesel spills.
- Biodiesel enables farmers to create their own fuel supplies, and its production encourages social inclusion, which benefits the poorest members of the rural population, since no significant investment is required for its production.
- Since it contains virtually no sulphur, it does not generate SO_2 (sulphur dioxide) – a gas which contributes significantly to environmental pollution. The ICCT (International Council for Clean Transportation) calls sulphur "the lead of the next century". Laws requiring

lower sulphur content in diesel are ubiquitous; they are part of a drive to promote low-sulphur diesel, or LSD. LSD is even less lubricious than diesel, and therefore requires biodiesel as an additive.

- It does not pollute surface water or underground aquifers.

The main **disadvantages** are as follows:

- Lack of fluidity and freezing are an issue at low temperatures (<0°C), particularly for biodiesel produced from African Palm.
- The prices of raw materials are high, and are related to international oil prices. They account for 70% of the overall cost of biodiesel, making it a relatively expensive product at present.
- Given its high solvency, biodiesel should be stored in clean tanks; failure to do so could cause engines to be contaminated with impurities from storage tanks.
- The energy content of biodiesel is somewhat lower than that of diesel (12 % in terms of weight, 8 % in terms of volume). Consumption is somewhat higher as a result.
- Poor-quality biodiesel (low cetane number) can increase NOx (nitrogen oxide) emissions; a cetane number higher than 68, however, produces NOx emissions equal to or lower than those produced by fossil diesel.

5. Will the use of biofuel reduce environmental pollution?

This is true; the figures below show the degree to which biofuels benefit the environment, in addition to the advantages mentioned above. It should be noted that the closing address at the Biofuels Congress of the Americas was given by Al Gore, who received the Nobel Peace Prize in 2007 for his efforts to combat global warming. This spotlights the important role biofuels play in the world environment.

Vehicles that run on biodiesel emit up to 78% less carbon dioxide, and reduce carcinogenic hydrocarbon emissions by up to 75%.

Emission reduction or increases in vehicles using soy, sunflower and rapeseed biodiesel (in its pure form or mixed with fossil biodiesel)

Type of emission	B100	B20	B2
Unburned hydrocarbons	-67%	-20%	-2,20%
Carbon monoxide	-48%	-12%	-1,30%
Particulate matter	-47%	-12%	-1,30%
Nitrous oxides	+10%	+2%	+2%

California environmental protection agency.
National Biodiesel Conference, San Diego USA, 2006.

According to the Canadian government, if only 35% of gasoline in Canada was 10% ethanol (E10), a 1.8-million-ton reduction in greenhouse gases (GHG) would be achieved. This is equivalent to removing 400 thousand vehicles from the road.

It is estimated that the use of an E10 mixture (10% ethanol, 90% gasoline) is enough to reduce greenhouse gases by 12% to 19%. Such a mixture would also reduce CO_2 emissions by 30%, while the fine particle emissions that cause respiratory problems and the volatile organic substance emissions responsible for smog would drop by 50%.

6. What percentage of greenhouse gas emissions can be attributed to the transport sector?

The transport sector is responsible for approximately 20% of the greenhouse gases that cause global warming.

7. Can biodiesel be produced at the farm level for use in agricultural machinery?

This is entirely possible. What is needed is some type of oil that can be transformed into biodiesel, and very simple technologies are available for that purpose. This approach is particularly useful in isolated areas where the transport of fuel is a complicated and costly process. In addition, the financial and energy resources employed remain in the production area.

8. How can biofuels help family agriculture and small farmers, and improve the social inclusion of the poorest rural sectors?

Crops capable of producing oil, and hence biodiesel, are better suited to family agriculture. Certain crops, such as castor beans and Jatropha Curcas, are more adaptable and require less water and agricultural care; consequently, they can be grown at a much lower cost. Another advantage of such crops is that they can be planted together with other crops. For example, bean crops can be planted among castor bean or Jatropha rows; in addition to providing sustenance, they add nitrogen to the soil, making it more fertile. Furthermore, if several small-scale producers joined forces, they could acquire a small biofuel production plant. This would enable them meet local energy needs or seek new opportunities for marketing their crops, which they could sell as raw material or add value to by extracting the oils they contain and processing same into biodiesel. It should also be noted that farmers have seen the prices of certain crops with biofuel potential increase.

9. How are ethanol and biodiesel produced?

In order to produce **ethanol** from grains such as corn, starches must be converted into sugars. This is accomplished through the use of enzymes. The resulting sugars are then fermented, creating ethanol. It is somewhat easier to produce ethanol from sugarcane; no enzymes are required, since approximately 20% of sugarcane is already made up of sugar. While sugarcane begins to ferment as soon as it is cut, it must be fermented at a sugar mill in order to produce ethanol.

Biodiesel is produced from fatty acids obtained from oils, which are in turn derived either from plants or animals. These oils may be subjected to a variety of procedures; the most common is transesterification, which involves converting triglycerides into esters by reacting an alcohol such as methanol or ethanol with the oils, using a catalyst such as sodium hydroxide or potassium hydroxide. The resulting substance is then decanted; biodiesel floats to the top, while glycerine settles at the bottom. It should be noted that the quality of biodiesel is closely linked to the type of raw material employed.

10. Does the production of ethanol or biodiesel require large investments?

While the answer to this question depends on the size of the operation, ethanol requires a larger investment than biodiesel. Some small biodiesel plants, for example, are worth no more than US$ 12,000, and do not require large quantities of oil. Such plants can, however, help to meet the energy needs of small communities, or serve as a fuel supply for agricultural machinery and farm vehicles. Projects seeking to export biodiesel must comply with international standards, including the rules established by ASTM in the North American market and EN in the European market. National standards should also be taken into account if the fuel produced is to be included in local renewable-energy initiatives.

11. Why should a farmer grow crops that can be converted into biofuels?

Ever-increasing oil prices and falling reserves have created a need for alternative energy sources, and biofuels derived from crop biomass are a highly feasible and current option. Liquid-fuel consumption is expected to increase by 55% over the next 30 years. The demand is there, and farmers who plant crops which can be converted into biofuels are adding value to their products, since they can be sold for their original purpose (human and animal nutrition, production of oils) or for the production of ethanol or biodiesel, depending on the crop. Commercial opportunities are definitely on the rise, and the market is growing. National policies requiring minimum biofuel levels are beneficial, as they guarantee a market for biofuels and enable their producers to focus on quality requirements.

12. How much ethanol and biodiesel per hectare can crops produce?

Productivity varies greatly, and depends on weather and soil conditions, humidity, farming techniques, crop varieties, and many other factors. Generally speaking, however, the following table shows the yields achieved using various crops for ethanol and biodiesel production, given favorable conditions.

Ethanol and biodiesel yields

CROP	BIODIESEL lts./hectare	ETHANOL/hectare
AFRICAN PALM	4000-5000	
RAPESEED	900-1300	
SOYBEAN	300-600	
SUNFLOWER	600-1000	
RICIN	1000-1200	
JATROPHA CURCAS	800-2000	
ALGAE (2nd-generation biofuel)	20000	
SUGARCANE		4500-6000
CORN		2500-3500
SWEET SORGHUM		2500-6000
SWITCHGRASS (2nd-generation biofuel)		3000-7000

13. Do some crops provide a better energy balance than others? What are those crops?

Energy balance is understood to mean the number of energy units consumed to obtain a biofuel, compared to the units the biofuel produces.

	Ethanol		Biodiesel	
Energy balance (energy unit yield obtained for every unit of non-renewable energy consumed)	Wheat	2	Sunflower	3.2
	Sugar beet	2	Rapeseed	2.7
	Corn	1.5	Soybean	3
	Sugarcane	8.3	Palm	9
Environmental balance (GHG emissions per ton of petroleum, in equivalent tons of CO_2)	Sugar beet	2.17	Soybean	2.6
	Wheat	1.85	Rapeseed	1.79
	Sugarcane	0.41	Palm	1.73
	Hay	0.33	Wood	0.27

ADEME, Comisión Europea.

African Palm (used to produce biodiesel) and sugarcane (used to produce ethanol) provide the best energy balance.

African Palm

14. Which countries possess regulatory and legal frameworks and incentives (tax breaks, tariff incentives) to encourage ethanol production?

The following table answers this question.

	Regulatory framework for the use and management of ethanol			
	Laws mandating ethanol in gasoline	Laws establishing incentives for ethanol production	Laws and regulations regarding ethanol quality	Bills currently before legislative bodies
Argentina	✔	✔	✔	no
Belize	no	no	no	no
Bolivia	no	no	no	no
Brazil	✔	✔	✔	✔
Chile	no	no	no	✔
Colombia	✔	✔	✔	no
Costa Rica	✔	no	✔	✔
Ecuador	no	no	no	✔
U.S.	✔	✔	✔	no
El Salvador	no	no	no	✔
Guatemala	✔	✔	✔	✔
Honduras	no	no	no	✔
Jamaica	no	no	✔	no
Mexico	no	no	no	✔
Nicaragua	no	no	no	✔
Panama	no	✔	no	no
Paraguay	✔	✔	✔	✔
Peru	✔	no	no	no
D. Republic	no	no	no	✔
Uruguay	no	no	no	✔
Venezuela	no	no	no	✔

15. Which countries in the Americas produce ethanol, and how much land is needed to meet the 10% ethanol (E10) requirement in gasoline using sugarcane?

The following table answers this question.

Ethanol production potential and land required to meet 10% (E10) gasoline standard									
Country	Gasoline consumption		Area planted with sugarcane		Farmland	Ethanol E10 demand	Current ethanol output	Farmland devoted to sugarcane for E10 demand	
	Millions of m^3	%	Thousands of hectares	%	Thousands of hectares	Millions of m^3	Millions of m^3	Thousands of hectares	Current % sugarcane
Argentina	4.911,1	0,77	296,8	3,7	128.747,0	491,1	230,0	81,9	27,0
Barbados	124,4	0.01	8	0.01	19	12,4	-	2,1	26
Bolivia	763,4	0,12	105,0	1,3	37.087,0	76,3	33,8	12,7	12,0
Brazil	16.000,0	2,52	5.800,0	72,0	150.000,0	1.600,0	15.999,2	266,7	4,6
Colombia	4937,0	0,70	212,4	2,6	45.911,0	493,7	270,0	63,0	29,6
Costa Rica	855,1	0,13	52,0	0,6	2.865,0	85,5	30,5	14,3	29,0
Ecuador	1.944,6	0,31	78,0	1,0	8.705,0	194,4	47,1	24,5	33,0
U.S.	548.000,0	86,20	np	0,0	np	54.800,0	16.139,2	9.000,0	np
El Salvador	560,0	0,09	63,0	0,8	1.704,0	56,0	42,3	10,0	18,0

Country	Gasoline consumption		Area planted with sugarcane		Farmland	Ethanol E10 demand	Current ethanol output	Farmland devoted to sugarcane for E10 demand	
	Millions of m^3	%	Thousands of hectares	%	Thousands of hectares	Millions of m^3	Millions of m^3	Thousands of hectares	Current % sugarcane
Guatemala	1.160,1	0,18	197,0	2,4	4.652,0	116,0	144,0	17,9	10,0
Guyana	130,0	0,02	49,0	0,6	1.740,0	13,0	23,6	2,2	4,0
Haiti	288,0	0,05	18,0	0,2	1.590,0	28,8	2,0	4,8	27,0
Honduras	457,2	0,07	88,1	1,1	2.936,0	45,7	26,3	7,6	10,0
Jamaica	699,8	0,11	40,0	0,5	513,0	70,0	12,0	11,7	29,0
Mexico	39.455,3	6,21	680,0	8,4	107.300,0	3.945,5	50,0	657,6	96,7
Nicaragua	248,9	0,04	45,0	0,6	6.976,0	24,9	36,0	4,1	9,0
Panama	576,7	0,09	37,0	0,5	2.230,0	57,7	12,4	9,6	26,0
Paraguay	233,5	0,04	80,0	1,0	24.836,0	23,3	45,3	3,5	4,37
Peru	1.203.0	0,22	66,1	0,8	21.210,0	120,4	78,4	20,1	30,0
D. Republic	1423,3	0,0	350	0,0	3696	142,3	0,0	23,71	6,7
Suriname	106,5	0,02	3,0	0,0	89,0	10,6	0,4	1,8	59,0
Trinidad & Tobago	493,1	0,08	13,0	0,2	133,0	49,3	5,3	8,2	63,0
Uruguay	281,1	0,04	3,0	0,0	14.955,0	28,1	0,7	4,8	147,0
Venezuela	12.700,6	2,00	130,0	1,6	21.640,0	1.270,1	0	234,5	180,3
Total	637.552,7	100,01	8.414,40	100	589.515,00	63.755,10	33.623,70	10.487,3	

Source: IICA (2007) and ECLAC (2006) Renewable Energy in Latin America and the Caribbean.
Source: Gasoline Consumption, United States and Brazil. Grain Feed Division, Foreign Agricultural Service, USDA.

16. Is biofuel production good business?

This depends on the type of crop, productivity levels and costs, but most of all on the existence of a clear policy, with clear playing rules established by the government and the private sector in the locale where production is to take place. Business 2.0 magazine has described soy biodiesel production in Argentina as one of the 12 best investment opportunities in the world: "…opportunities to invest US$ 100,000 to 500,000 in emerging markets. The biodiesel market is currently valued at US$ 15 billion, and will triple in value by 2015." Of course, in addition to its many environmental benefits, from a business and price perspective the biofuel business is closely linked to oil prices.

17. Is it true that oil is running out? How many more years of reserves do we have?

Oil reserves have fallen significantly. At the end of the nineteenth century, reserves stood at 2.2 trillion barrels; today there are only 1.13 trillion reserve barrels, while consumption continues to rise, particularly in developing countries such as India and China. It is very difficult to determine how many years of reserves we have left; what is certain is that we must reduce our oil dependency, especially in countries that do not produce petroleum but possess the natural resources necessary to grow crops with biofuel potential.

18. What do initials such as (E10), (B5) or (B100) mean when used in connection with biofuels?

These initials refer to the percentage and type of biofuel present in petroleum-based gasoline or diesel. The first letter identifies the biofuel in question: (E) for ethanol or (B) for biodiesel. The number refers to the percentage of biofuel in the mix. (E10) means that a fuel contains 10% ethanol and 90% gasoline, whereas (B5) means that a fuel contains 5% biodiesel and 95% diesel.

19. What are flex fuel vehicles?

These are vehicles capable of running on two types of fuel –either ethanol or gasoline, or a mixture of both in any proportion. They contain software in their electrical control system which sets the fuel mix and makes adjustments automatically. The first flex fuel vehicle was a Volkswagen Gol, manufactured in Brazil in 2003, with the help of the firm Magnetti Marelli. At present, 85% of the internal combustion vehicles sold in Brazil are flex vehicles. The adoption of the flex fuel system in hybrid cars (which have a dual electric / internal combustion engine) will further enhance their ability to reduce CO_2 emissions and other pollutants.

20. What are second-generation biofuels?

These are fuels produced using raw materials that are not food sources, using new technologies that are still being researched and developed, at high production costs. We are fully confident that second-generation biofuels will be a highly effective alternative to fossil fuels. No food crops will be required for their production, and they will help to combat a problem which concerns us all: global warming.

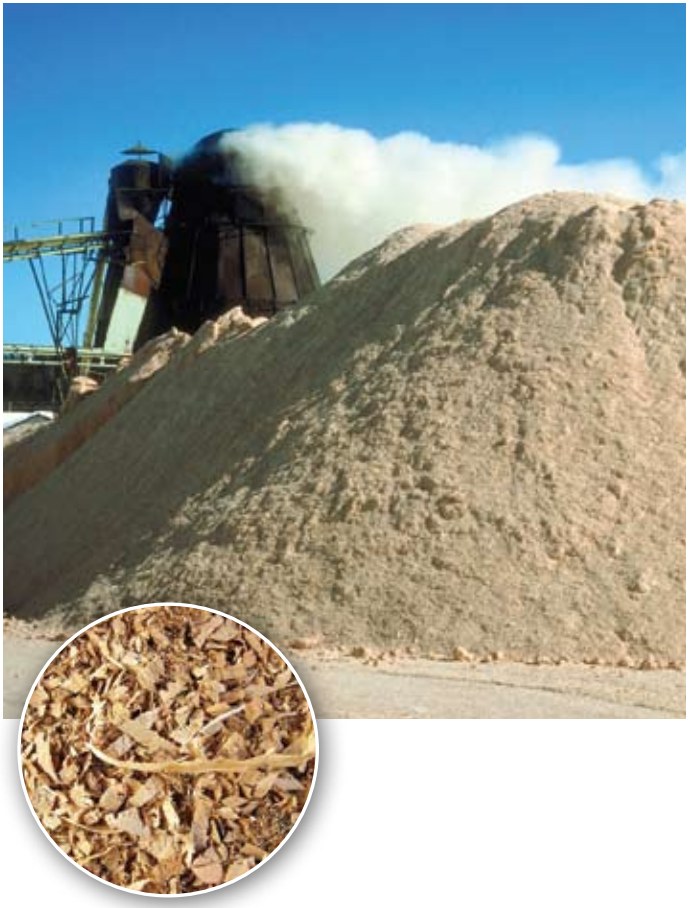
Cellulosic ethanol is produced by converting cellulose (which may be obtained from perennial grasses such as switchgrass, crop waste, cornstalks, sugarcane bagasse, rapid-growth trees, municipal organic waste, or almost any organic material) into sugar, using hi-tech enzymes, and fermenting the sugar thus obtained to produce ethanol.

In order to produce biodiesel from algae, the latter must have a high lipid (oil) content. Suitable species and technologies are available for that purpose. The resulting oil is converted into biodiesel through the transesterification process mentioned above. Using current technologies, it is estimated that one hectare of algae can yield over 20 thousand liters of biofuel per year. These yields will

continue to increase as technology improves. Algae require water, light, and CO_2, which may be obtained from industrial smokestacks, thus significantly reducing one of the main sources of greenhouse gas. Algae can also produce starch, which can be converted into ethanol. Some algae possess high nutritional value as crop fertilizer, and meet established organic agriculture standards.

Scientists are now describing algae as a biological "petroleum" – a biological, renewable resource capable of endless CO_2 absorption.

Ethanol and biodiesel produced from traditional crops such as sugarcane, corn, sorghum, African Palm, soybeans, Jatropha and castor beans, using known technologies, can be described as first-generation biofuels.



21. Will biofuels replace fossil fuels?

We live in a culture that is still overly dependent on fossil fuels. The latter are buttressed by a large existing infrastructure, and surrounded by vested interests. Global warming should force governments to invest more in research, particularly in the field of second-generation fuels, which offer the greatest potential. Our dependency on fossil fuels will continue at least into the next 2 decades, when, it is expected, more affordable new biofuel production technologies will be available on the market. Brazil is an exception in this regard; the country already possesses a highly organized sugarcane-based ethanol industry, with an ethanol output of 13.4 million cubic meters. Ethanol accounts for approximately 40% of the fuel consumed by internal combustion vehicles in Brazil.

22. What by-products do ethanol and biodiesel generate?

The by-products generated by grain-based ethanol are known as distillery grains, which are used as animal feed. Ethanol wastewater is rich in nitrogen, and is used as fertilizer. Sugarcane-based ethanol generates the following by-products: bagasse, which is used as an energy source for the generation of electricity and steam in sugar mills, and stillage, which is used as fertilizer.

The main by-product of biodiesel is glycerine, which is sold for use in various industrial processes, including the manufacture of soap and cosmetics.

23. Are there two types of ethanol? What is the difference between them?

Ethanol can be classified as **hydrous** or **anhydrous**. The difference lies in its water content. The water content of anhydrous ethanol is approximately 0.5%, compared to 5% for hydrous ethanol. Anhydrous ethanol is used as an additive in gasoline, whereas hydrous ethanol is used in its pure form, in vehicles that have been duly adapted for this fuel.

Hydrous ethanol can be obtained directly through distillation, whereas anhydrous ethanol requires an additional procedure to remove most of the water from the fuel.

24. Is it true that ethanol and biodiesel can only be used as additives in fossil fuels, and that in their pure form they could cause engine damage?

One must bear in mind the words and deeds of two of the fathers of the auto industry, Sir Rudolph Diesel and Henry Ford. The former created the diesel motor in 1912, and said: "The use of plant oils as fuel may seem insignificant today. But these oils may, over time, become as important as petroleum or coal are now." The first diesel motor ran on peanut oil. Speaking to the New York Times, in 1925, Henry Ford predicted that ethanol would be the fuel of the future. "There is fermentable fuel in every particle of plant matter. There is enough alcohol in a year's harvest of one acre of potatoes to fuel the machinery to farm that field for the next 100 years."

Motors can run on 10% ethanol and up to 5% biodiesel without undergoing any change. The Brazilian experience with flex fuel motors clearly shows that biofuel, in its pure form or used as part of a mixture, is a feasible option. Both gasoline and diesel engines require certain modifications in order to run on pure biofuels or mixtures with high biofuel concentrations. These modifications can be carried out using relatively inexpensive kits. The vast majority of new vehicles are capable of running on E20 or B20 mixtures.

Biofuels with social inclusion