Brazilian Biofuels: your wallet or your life?

Autoria: Marcos Amatucci, Eduardo Eugênio Spers

Abstract

Alternatives to fossil fuels rely on technological development and its adoption by consumers is sensitive to their perceptions and to economical parameters. While electrical engines seem to be the international standard trend, Brazilian automotive industry took the road of biofuels, with which it has a long tradition, the "flex" engine (hybrid utilization of petrol or ethanol or any combination of them) being currently the market standard for family car engines. Notwithstanding its ecological advantages, some negative aspects may influence its use, such as price, origin and the accessibility, of both final product and raw materials. This study aims to identify factors from the formal and informal institutional environment that influence decision making in Brazilian producers, government and consumers relating to biofuel technology adoption, as well as to describe the Brazilian ethanol alternative to car engines. The study was conducted using document analysis and in-depth interviews with consumers, private agents, and government agencies related to the biofuel production. Results suggest that Brazilian experience on ethanol and on biodiesel differs significantly; the first having reached a mature level of sustainability along its value chain, and the second being yet vulnerable and dependent on institutional initiatives in order to fully develop. Implications for possible generalization of Brazilian experience are discussed.

1 Introduction

The nineties brought the discussions of the necessity of dropping down carbon emissions and other pollutant elements associated with cars, mainly in large cities and metropolitan areas. It is a very tangible issue to public health, which can be measured in hospital admissions due to respiratory problems, lost work days, morbidity and mortality (MIRAGLIA, 2007). The Brazilian government has invested directly in emissions inhibition, though had ceded to postpone the full adoption of Euro 5 standards, due to lack of investments of the state oil giant PETROBRAS in the S50 (not to mention S10) diesel standard technology. The standard for São Paulo, the major metropolitan area in Brazil, is currently S500; but it still is S2000 in many parts of the country (MUNHOZ, 2008).

Notwithstanding the fact that the use of ethanol and biodiesel has proven results in the emissions reduction, consumer and producer behaviours apparently remain based in the immediate economic optimization. Along with a new "flex" car, the owner gets a table with ethanol and petrol prices combinations, in order to make a quick decision between the two fuels in the gas station. The main newspapers have published such tables as well. The decision is made purely in terms of prices and efficiency considerations. By the same token, producers react to breakeven prices of fossil oil and of alternative feedstocks.

On top of economic behaviour of the agents, some myths surround the ethanol discussions all over the world: its energetic and ecological balance, the competition for the soil with food, and the food prices potential growth due to ethanol use of sugarcane in Brazil and of corn in US. This study aims to discuss the material and the psychological barriers which prevent economic agents to more effectively adopt less pollutant biofuels, as well as the decision making of these agents regarding biofuels adoption.

2 Institutional Arrangements

In order to make better decisions and to better manage the main questions regarding alternatives and sustainable products such as biofuels, it is important to understanding the dynamics and the behaviour of economic and institutional agents at both macro and micro levels. The characterization of Brazilian biofuel institutional environment in formal (laws and rules) and informal (traditions, perceptions, costumes and behaviours) constraints (NORTH,

1990) allows a better comprehension of the incentives for the adoption of biofuel technology. The way these formal and informal institutional constraints interact is influenced by the institutional arrangement. The institutions, formal and informal, provide the incentives to individuals engaged in economical activities (ALSTON; EGGERTSSON; NORTH, 1998).

For North (1990), the main role of institutions in the society is to decrease the uncertainness. Formal and informal constraints could establish a stable, but not necessarily efficient, structure for the human and organizations strategies and interactions. Depending of the structure of institutional environment (institutional arrangement), it could incentives the production of sustainable forms of energy like biofuels (ethanol and biodiesel). This is the case of Brazil and is what this study seeks to explore.

The environmental threatening brought a new era of consensus and research around the search for new patterns in the use of natural resources to reach higher levels of protection and sustainability of human and global surveillance (GOLDEMBERG, 2000). Both environment and technology bring benefits and improvements to human life, but limited natural resources are used to satisfy human desires and needs that are unlimited (MILARÉ, 1994). Therefore, the institutional arrangements must incentive the allocation of sustainable strategies and activities.

"Bio" has been used to denote characteristics related to future biotechnologies improvements (ENRÍQUEZ, 2003). It is a process which aims the use of biological raw materials to industrial development and final consumer use. In the agro energy sector, Brazil is one of the most important international players, with economic advantages, both in actual and future probable scenarios. While ethanol from maize produces only 1.7 energy units per unit spend in it production, in sugarcane ethanol this proportion is 8 to 10 units, as it is shown below.

Notwithstanding its ecological advantages, some negative aspects may influence its use, such as price, origin and the accessibility, both from the final product and raw materials. This study aims to identify factors from the formal and informal constraints of the Brazilian institutional environment that influence the decision making among Brazilian producers, government and consumers, regarding biofuel technology adoption, as well as to describe the Brazilian ethanol and biodiesel alternatives to car engines. The main goal is to characterize the successfully acceptance of biofuel in The Brazilian market, characterizing the reasons for its adoption. Regarding the informal institutional environment constraints, specific goals are the evaluation of attributes such as price, accessibility and origin to some Brazilian consumers.

This paper focus in four benefits that one sustainable strategy could provide: economic, social, technological and environmental benefits. All four dimensions are based on the positive viewpoint of correcting market failures and in the negative viewpoint of creating and capturing rents.

3 Methodology

The study analysed institutional and economical documents and secondary data, aiming to characterize the actual behaviour of the economic agents of the biofuel chain. The actual data is analysed through classical Economy concepts (market theory).

Furthermore, the study used in-depth interviews and a questionnaire, with two different groups of economic agents involved in the biofuel chain, in order to determine formal and informal institutional constraints (NORTH, 1990).

To characterize the formal constraints, the study was carried out through document analysis and in-depth interview with economic agents involved in the biofuel chain in Brazil. Some important private players are described in Table 1.

To characterize the informal constraints, a questionnaire based on laddering method (means and ends), that link attributes, consequences and benefits (GUTMAN, 1982) was applied to 37 individuals. This sample was defined by 37 final professional consumers that

use ethanol or common Diesel in their vehicles to transport students to a specific university in Brazil. The consumers were invited to answer a questionnaire of 28 questions divided in two parts. One about their personal and social characterization and other composed by a sequential group of questions regarding the importance of each biofuel attributes (laddering). The sample was mainly characterized by male with low level of education.

This technique postulates that very specific product attributes are related to increasing levels of abstraction. This approach reveals the associations consumers make between specific attributes, their functional or psychological consequences, and their values (WANSINK, 2000). The study consists of using qualitative interrogation techniques to establish the link between elements that influence, affect, or predict events or outcomes (ENNIS, 1999). This method is appropriate because it makes it possible to link green product like biofuels attributes to the consequences they have on the motivation to purchase this type of product based on the various perceived risks.

Table 1. Some private stakeholders involved in the Brazilian Biofuel Chain.

Companies Names	**Description**
Marborges	Vegetal oils production (peanut, babaçu, cotton seed, sesame seed, sunflower seed, corn, rice, soybean, dendê, tucum, olive) and edible fat (margarine and compound fats)
Agropalma	Extraction and production of palm oils .
Compañia Palma Tica	Production of pal oil and derivative products such as margarines, estearines, oleines and industrial margarines.
Alten Industries	Alternative energy company.
Nova Biosource Fuels	Processing 25 different kinds of animal grease and several seed oils. Producing and commercializing biodiesel and glycerine.
Biauto	Production of biodiesel through used vegetal oils recycling.
Brasil Ecodiesel	Larger Brazilian biodiesel producer. Production of biodiesel both through vegetal and animal oils.
Mitsubishi Corporation do Brasil	Solutions for commercial operations in areas such as: chemical, energy, food, metal, mineral, machinery, IT, textile and paper.
Mitsui	Extraction and production of energy resources such as oils, gas, coal, nuclear fuels and others. Ethanol from biomass in Brazil.
Mission NewEnergy	Global renewable energy company.
Itochu	Commerce of textiles, machinery, IT, communication devices, metals, lubrication oils, energy sources, chemical specialties and food.
Algodoeira Aliança	Services of cotton seed processing, storage and commercialization.
Usina Camen	Land procurement for soybean and sugarcane cultures; sugar and ethanol production and electrical energy production.
Branco Peres Açúcar e Álcool AS	Verticalized sugar and ethanol production (plantation and processing).
Cooperativa Cocamar	Extraction of oil and powders, oil processing and bottling, residues mixtures, coffee processing.
Tropical Bioenergia	Development of sustainable processes in Bioenergy according to environmental laws.
Cargill	International products and services supplier to agricultural, food and risk management sectors.
Companhia Energética Albertina	Larger Brazilian sugarcane, sugar and ethanol producer.
Cooperativa Pindorama	Small producers owned coop producing juices, ethanol, coconut derivatives and sugar.
Agrenco do Brasil	International company providing personalized solutions to agribusinesses, in all steps of the value chain including: financing to producers and consumers, tracking, storage, logistics, operations, port transit, export and distribution.
BSBIOS	Production of Biodiesel. Capacity for 100 Million litres of Biodiesel from soybean, canola, sunflower seed and castor oil seed.

Caramuru Alimentos	Grain industrialization: seed production, storage, de-germination, corn pre-cooking, extraction and processing of special oils from soybean, maize, sunflower seed, canola and powders production.
ETH Bioenergia	Company of Odebrecht Group. Production of sugar, ethanol and electric energy.
Infinity Bio-Energy	Renewable energy, producing and distributing ethanol fuel.
Multigrain do Brasil	Agricultural commodities operator for global markets. Investing in the whole agricultural value chain, from production, processing, logistics, and distribution. Operation of soybean, cotton, maize, sugar, wheat and fertilizers.
Brenco	Greenfield projects of energy production. Integrates production, commercialization and logistics for ethanol.
Clean Energy Brazil	Investment society for sugar and ethanol industry.
LDC Bioenergia	Trade of agricultural commodities in international markets. Among the traded products are: maize, barley, rice, wheat, sorghum, soybean, colza oil, ansunflower seeds.
A&S Bioenergia	Renewable energy. The company developed an alternative catalytic process for biodiesel production from low quality oils.
Fiagril Participações	Products and services supplier for agribusiness..
Celltrion	Biopharmaceutical company dedicated to research and production to global markets.
Equipav Açúcar e Álcool	Diversified group with presence in clay, stone extraction, sugar, ethanol, bioelectricity, residues collecting, green areas maintenance, roads, bus stations, termoenergy generation and public sanitation.

4 Biofuel World Market:

The fossil oil market was estimated in 84.7 million barrels per day in 2006 (OPEC, 2008) or 30.9 trillion barrels a year, meaning approximately US$ 1.2 trillion a year at US$ 40/barrel. For comparison purposes, if all possible petrol were extracted from the oil, it would represent 605 trillion gallons (2.29 quadrillions of litres) of petrol per year.

Ethanol world production in 2007 totalized 52 billion litres (not all is used as fuel), while biodiesel totalized 10.2 billion litres. Maize global production represents 711 million tons, and sugarcane 1.3 trillion tons a year. At current technology, they represent a "potential" production of ethanol (i.e., if hypothetically all maize and sugarcane were converted into it) of 284 billion litres and 91 billion litres, respectively (FAO, 2008).

It can be observed that the oil market is currently much larger than biofuels markets. It is fundamental to look at the magnitude of these figures in order to understand how much international oil price pressures investments in biofuel production up or down; and how the instability of the international oil price causes insecurity in the investors' minds, preventing the biofuel market from growing without institutional assistance.

FAO (2008) estimates the 2006 breakeven oil price for profitable production of maize ethanol as US$ 58/barrel, and around US$ 38/barrel for sugarcane ethanol (these breakeven points will vary according to feedstock prices as well; but as seen, the oil market has more important effects). Table 2 shows a hypothetical potential of ethanol for petrol substitution, from different feedstock.

Table 2 – Hypothetical potential for ethanol from principal crops.

CROP	GLOBAL AREA	GLOBAL PRODUCTION	BIOFUEL YIELD	MAXIMUM ETHANOL	PETROL EQUIVALENT	SUPPLY AS SHARE OF PETROL USE (2003)
	(Million ha)	(Million tonnes)	(Litres/ha)	(Billion litres)	(Billion litres)	%
Wheat	215	602	952	205	137	12
Rice	150	630	1806	271	182	16
Maize	145	711	1960	284	190	17

Sorghum	45	59	494	22	15	1
Sugarcane	20	1300	4550	91	61	6
Cassava	19	219	2070	39	26	2
Sugar beet	5,4	248	5060	27	18	2
Total	599	-	-	940	630	57

Source: FAO (2008:21).

According to the FAO (2008) report, ethanol from sugarcane in Brazil is an exception in the world ethanol production, due to its lower production costs. All the other ethanol production could not compete with oil without subsidies, even at high oil prices. However, factors such as technological developments and feedstock prices may alter this situation in the future.

5 Antecedents of Brazilian biofuel production

The automotive industry, one of the first industries to internationalize, arrived in Brazil early in its internationalization process: Ford in 1919, GM in 1925. After WWII, with Brazilian government incentive policies, VW came in 1953, and then Fiat, later in 1974.

In 1973, the oil crisis hits the Brazilian economy which was already indebted, suffering high inflation and having a low value currency. At that time, Brazilian oil production was far lower than its demand, and the country had to rely on oil imports for consumption and growth. The military government, which held a nationalistic ideology of national security, materialize a traditional idea (it can be traced back to the early Republic foundation period) of substituting the petrol consumption by ethanol, putting forward the PROALCOOL ("*Pro-alcohol*") program, officialised in 1975. The PROALCOOL program aimed to incentive the production of dehydrated ethanol (99.5% pure ethanol), adding it to the petrol in such a rate that would not require engine modifications (a proportion between 10% and 15% or E10 and E15); with minor engine adaptations, it could reach up to 25%. Technically, this resulting fuel is called "gasohol". This procedure remains until today, and Brazilian petrol is currently regulated in 25% (E25) since 2007.

Together with this process, there was also a long time research going on, aiming to deploy an engine exclusively powered by ethanol, in this case, the hydrogenated ethanol (94.5% pure ethanol, the rest being mainly water). Urbano E. Stompf, engineer of the Instituto Tecnológico da Aeronáutica (ITA), continuing the studies of Eduardo Sabino de Oliveira and Lauro de Barros Siciliano, developed the first Brazilian modern prototypes of ethanol powered engines to the automotive industry (INOVAUNICAMP, 2009).

The first family car exclusively ethanol powered produced in Brazil was the 147 model from Fiat, in 1978. A protocol signed in the same year by President Figueiredo and automotive industry representatives brought all the other automakers to the program from that year on.

The production of ethanol powered vehicles reached its peak in the middle of the decade of 1980, when more than 90% of family cars production held ethanol powered engines. In 1989 however, ethanol demand surpassed its offer, causing supply shortages. Long lines appeared in the petrol stations, deeply marking the consumer's experience. These facts remain influencing consumer's behaviour until today.

On the other hand, international oil prices dropped to "normal" levels in this period, eliminating the economic advantage of ethanol to the consumer's wallet.

As a result, the ethanol new cars sales dropped down to 4% in 1994 and 0.56% in 1996. Some small shops were offering "reconverting" services to turn ethanol engines "back" to petrol at that time. These macroeconomic factors, allied with technical issues characteristic of innovative processes (worst performance when in comparison to traditional engines, lower efficiency, difficulties in cold starts, corrosion problems etc.), caused ethanol engines to be tagged as inferior in the consumer's minds (KREMER; FACHETTI, 2000).

Even years later, with a regular supply and a completely developed technology (the kilometre per gallon rate was enhanced, being today 30% less efficient than petrol engines; and it provides more horsepower than an equivalent petrol engine), market was hesitating to adopt the exclusive ethanol powered engines, and these cars gradually lost value in the secondary market (used cars), costing less than their petrol peers; and they practically disappeared from the assembly lines.

The technology being available in the USA since the decade of 1980, the hybrids bi-fuel petrol-ethanol powered engines ("flex" as they are called in Brazil) were brought to Brazil in the 1990s, eliminating forever both the shortage fear of the market and the inconveniences of the international oil prices variations. The VW Gol 1.6 litre, powered with injection technology from Magneti Marelli, was the first hybrid produced in scale in Brazil; rapidly imitated by the other players (MAROTTI DE MELO; VASCONCELLOS; MARX, 2005). The figures of March, 2009 indicate that 87% of the new plates were licensed to cars with flex engines (AUTOMOTIVEBUSINESS, 2009a).

The new technology changed the process of choosing between ethanol and petrol. Before the "flex" engine, it was a one time and long term decision: which type of car to buy; now it is a decision of which fuel to fill the tank with – it is a daily and non-durable decision. It carries no consequence to the re-selling price. It is purely a matter of immediate price... and sustainability.

Sugarcane is the major Brazilian ethanol feedstock. It is cultivated in Brazil since 1532, brought by the earlier Portuguese colonizers, who were reproducing cultures they were experienced with in Açores. This species adapted very well in Brazil, and it was spread by the coastline during the colonial period. Currently, it is cultivated in several parts of Brazilian territory, but mainly in the Northeast region and in São Paulo state (still relatively near the Atlantic shore). Contrary to a common mistaken idea, the Amazon rainforest climate (of the North and Northwest regions of the country) is not appropriate for sugarcane culture.

Sugarcane is nowadays the third major Brazilian agriculture outcome, after soybean and corn; and it is responsible for 13.5% of the Brazilian energy matrix. It occupies 9% of Brazilian agricultural lands (BNDES, 2008). After the end of the PROALCOOL program in the 1980s, the business grew by itself without any government subsidy to the producers, though ethanol has tax incentives if compared to petrol, which carries 44% of taxes in its price (BRAZIL INSTITUTE, 2007).

On the side of biodiesel, the military government also planned a biodiesel program in 1975; however, it didn't take off. Again, it revived researches initiated the 1920s, and intensified during the Second World War. It was officially retaken in 1983 as PROÓLEO ("Pro-Oil"), aiming the production of biodiesel from vegetal sources (cotton, canola, sunflower seed, soy, castor oil seed and other typical Brazilian seeds such as babaçu and several types of palms), and from animal oils. The program suffered with the international downfall of oil prices, being discontinued by 1985. The initiatives would be retaken in 2003.

6 Basic Biofuel decision making by economic agents

Evidence shows that economic behaviour of producers and consumers are mainly driven by prices, as basic economic theory explains, and not for sustainability concerns. On the production side, producers decide to produce biofuels or food based on the substitutability of fossil fuels, which will depend on oil international prices. Figure 1 shows the break-even levels for ethanol production in USA based on the oil barrel price. Subsidies policies on ethanol production pull the curve down. Breakeven prices for maize vis-à-vis crude oil are approximately given by the indifference curve $p=7.6m-338$, where p is the price of oil in US$/barrel, and m is the price of the maize in US$/tonne (FAO, 2008:37)[1].

In Brazil, producers decide between sugar and ethanol at the production time, according to ethanol prices at business to business market, which is also influenced by

government policies, mainly the levels of government security stocks. The rationale is the same; the indifference curve is approximately ***e=0.58s+0.31***, where ***e*** is the ethanol price in US$ cent/litre, and ***s*** is the sugar price in US$ cent/kg (BNDS, 2008:55).

That is to say, the decision to produce ethanol is influenced by fossil oil price and by competing feedstock prices.

The consumer of a "flex" engine can decide at the pump which fuel to use. There are variations along the Brazilian territory in both ethanol and petrol prices. A common coloured table distributed by automakers to their customers in order to facilitate their decision shows the buyer's indifference curve given by ***er=pr-0.2***, where ***er*** is the retail ethanol price in R$/litre and ***pr*** is the petrol retail price in R$/litre. This is a purely economical decision (evidences from anecdotal information suggest some inertia acquired by habit, i.e. consumer may take some time to realize changes in prices).

The international oil price that allows economic production of ethanol in Brazil is currently around US$ 40.00 per barrel (BARBOSA; SACHS et al., 2009).

It can be observed that the whole chain decides according to traditional economic parameters, maximizing utility. The parameters themselves suffer influence of market forces (surplus or shortage in total production, consumption volumes and stocks), as well as influences from governmental policies, such as subsidies to producers (in USA) or petrol tax management in Brazil, which keeps the petrol and diesel prices artificially high. Such governmental interferences try to minimize the impacts of international oil prices variations over investors' decisions regarding to the opening of new plants, the development of the existing ones, and of fostering technology research in the area.

Because this market is hugely sensitive to international oil prices, the very survival of the biofuel market relies heavily on formal and informal institutional constraints. These are discussed below.

7 Formal Institutional Environment Constraints: Biofuel main characteristics in Brazil

The world demand for energy could increase at 1.6% per year until 2030 according to International Energy Agency (IEA, 2006). At the same time, the increase in production and the new alternatives for energy are more influenced by how efficient it is in terms of climate impact. The challenge for the economies is to provide an institutional environment that could increase the participation of renewable and less pollutant sources like biofuel. Bio organic products could be used as energy resources. They are derived from a natural biological process that uses the solar energy as the primarily step of accumulation.

Brazil has an extension of 850 millions of hectares with abundant solar irradiation and water resources to produce biofuels. Excluding the Amazon region and other areas, the agricultural part represents more than 300 millions of hectares. Only 70 millions of hectares are used to crop production. The sugar cane production, that is the main source of ethanol biofuel, occupies less than 9% of the agricultural part. The potential for a sustainable increment is significant. The productivity also can grow and the costs can decrease by investments in technology and logistics efficiency.

Regarding to fossil oil production, Brazil has became self sufficient in the dawning of the XXI Century, currently producing an average of 2.25 million barrels a day. Brazil exports its petrol surplus; however, depends on imports in order to supply the internal diesel demand.

Biodiesel in Brazil

In 2003 the Brazilian government put forward a new program, the PNPB (*National Program of Production and Use of Biodiesel*), which includes the mandatory mixture of biodiesel in the mineral diesel from 2007 on. It began with a 2% proportion, with plans of gradual increasing, according to the growth of the national production (MASIERO; LOPES, 2008). Half year after the new mix regulation, in August, 2008, Brazil became the third world

producer, after Germany and the USA, with 41 operating plants and 52 in process of authorization by the governmental agency ANP, National Oil Agency (INOVA BRASIL, 2008).

The implementation and consolidation of the biodiesel chain in Brazil is a result of incentives that was offered by the government. The operation management of the program is made by the Ministry of Mines and Energy. The main goal of the PNPB is to implement economically and sustainably the production of biodiesel. The institutional arrangement stability is guaranteed by several government acquisitions. The diversification in the source of raw materials is the strategy for the supply provision.

The program still fails in the social arena. Initially, the program was formulated to include small farmers with alternatives sources of vegetal oil, but problems in the constancy availability of these raw materials and disagreement in the contracts (mainly price) with agricultural producer and the biodiesel industry, redirect the program to traditional and abundant sources like soybeans. Government has offered preferences in the acquisition of biodiesel to small farms certificated by the Social Fuel Seal.

The federal government guarantees the purchase of 315 millions of biodiesel fuel in the second semester of 2009 in order to achieve the resolution number two of the National Council of Energy Politics, which establishes for March, 2008 the minimum of 3% addition of biodiesel oil diesel to final consumer use.

To sum up, the Brazilian biodiesel program still did not achieve full economic sustainability. Therefore, the government needs to provide several formal constraints to guarantee the goal to increase the mixture in the common Diesel. There is also a gap in achieving the social sustainability, the main initial focus of the program defined by the left side govern of the actual president. The technological sustainability is still in course to improve the efficiency and alternatives in production of raw materials. Finally, the environment sustainability benefits are related to the decrease in CO2 emission. In order to achieve the B20 (20% of biodiesel in common Diesel) in Brazil, it would be necessary 12.8 million hectares of raw material to produce 8 billion litters/year of biodiesel, which is a reasonable goal in medium term, as discussed earlier.

In contrast, FAO's (2008) simulation of the effect of removing of all "trades distorting" policies for biodiesel, discovered that Brazil would have a positive balance for biodiesel, unlike all other tested countries (FAO, 2008:51).

Ethanol in Brazil

According to projections of Brazilian Ministry of Mines and Energy, Brazil will increase its ethanol production in 150% until 2017, becoming the main world exporter of this product. In this projection, Brazilian ethanol production will reach 64 billion litres, of which 8 billion will be exported. In this period, the planned investments in biofuels will totalize US$ 23 billion (compared with US$ 146 billion in oil and natural gas and US$ 83 billion in electric energy).

Differently of what happens in the biodiesel Brazilian initiative, ethanol production is capital intensive, relying upon technological development investments and scale of production. The social side of ethanol production is in the employment generation. Sugar and ethanol together currently generate around 765 thousand direct jobs, 93.8% of which are protected jobs (UNICA, 2005).

The ethanol value chain in Brazil has reached a maturity level which leads to competitiveness. The products and services provided by actual enterprises, as shown in Table 1, denotes a cosy environment for the development of business activities in this area.

Four Myths about Brazilian Ethanol

Four problems are generally raised about Brazilian sugarcane plantations and ethanol experience: the risk of deforestation while sugarcane plantations grow; the food security

problem; the GHG (Greenhouse Gases) balance of the ethanol chain; and the particular character of the Brazilian experience, and its reproduction feasibility.

The total area dedicated to sugarcane is currently less than 1% of Brazilian territory, or less than 9% of its grain cultivated area. Sugarcane production has a territory distribution as follows: 81.7% of cultures located in Centre-South region (Sao Paulo, Mato Grosso do Sul, Mato Grosso, Goiania, Minas Gerais and Espirito Santo), of which 60% are located in Sao Paulo. Northeast part of the country has 18% of the cultures. Therefore, 99.7% of sugarcane plantations are thousands of kilometres away from the rainforest.

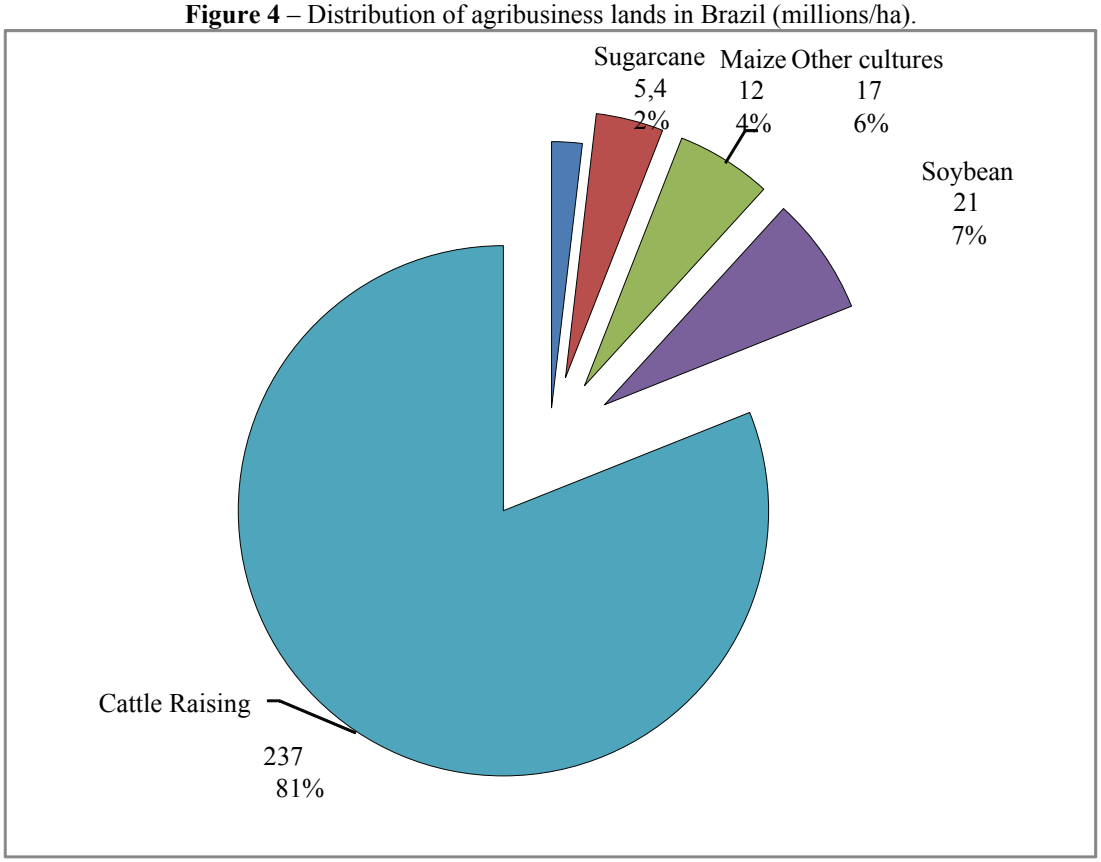
Figure 4 shows the distribution of land use in Brazil, including cattle raising and excluding forests and urban areas. The main use of manageable lands is still cattle raising. However, evidence show that this activity is currently going through an intensification process: in Sao Paulo, the livestock grew from 13,154,649 heads raised in 10,288,887 ha in 2001 to 14,072,447 heads raised in 10,010,491 ha in 2005, increasing the land occupation in 11%.

Sugarcane is the third Brazilian feedstock in importance, and, conversely, occupies 5.4 million hectares, a relatively small area compared with other Brazilian agribusiness activities, mainly cattle breeding.

In the last eight years, the main crops cultivated areas have grown, with exception of corn (see Table 3), which have decreased as American production has increased.

Regarding to the energetic and GHG balances, the net results are positives and increasing as the technology and the institutional environment improve. Table 4 shows the current energetic balance, compared with 2002 and a projection for 2002. Table 5 shows the GHG balance, again compared with the past and with a projection. The MACEDO; SEABRA; SILVA's (2008) study follows the FAO's (2008:56) methodology to analyse biofuels production balance, and they are used by Brazilian economical reports as reference (e.g. BNDES, 2008).

Figure 4 – Distribution of agribusiness lands in Brazil (millions/ha).



Source: LOPES (2008a:20).

Table 3 – Compared evolution of cultivated areas.

Country	Crop	2000	2004	2008	Average Year Growth
Brazil	Sugarcane	4.6%	5.3%	7.0%	5%
	Soybean	13.5%	21.4%	21.0%	6.6%
	Maize	9.8%	9.5%	9.6%	(-0.7%)
USA	Weath	25.3%	24.2%	25.6%	(-0.1%)
	Soybean	30.1%	30.5%	30.3%	(-0.7%)
	Maize	32.2%	32.8%	34.8%	1.6%

Source: LOPES (2008b:23).

Table 4 – Energy Balance, external flows (MJ/ton).

	2002	2005/2006	Scenario 2020
Sugarcane transport	201.8	210.2	238.0
Ethanol processing	49.5	23.6	24.0
Total fossil input	251.3	233.8	262.0
Ethanol production	1921.3	1926.4	2060.3
Bagasse surplus	168.7	176.0	0.0
Electricity surplus	0.0	82.8	972.0
Total Renewable output	2090.0	2185.2	3032.3
Renewable output/fossil input:			
a) Ethanol + bagasse	8.3	9.0	7.9
b) Ethanol + bagasse + electricity	8.3	9.3	11.6

Source: MACEDO; SEABRA; SILVA (2008:590).

The main source of energy input in the production process is the diesel used in agriculture, which is supposed by the methodology to be conventional fossil diesel; therefore, the figures can be improved.

The total GHG emissions on ethanol production were calculated by (MACEDO; SEABRA; SILVA, 2008) as being 401 kg CO_2 eq/m^3 for anhydrous ethanol in 2002, 436 in 2005/2006 and projected 345 kg CO_2 eq/m^3 for 2020. Hydrous ethanol measures are approximately 97% of these in the three cases. Such totals consider emissions of the ethanol production process from fossil fuels (around 50%), trash burning (to be ceased by 2020) and soil emissions. The main emission sources are trash burning and the use of fertilizers based in Nitrogen. However, there is more room in technology development than in the reduction of trash burning or diesel use, in order to improve net avoided emissions and net energy balance as well.

Table 5 – Avoided emissions (kg CO_2 eq/m^3).

	2002		2005/2006		Scenario 2020		
	Ethanol	Gasohol	Ethanol	Gasohol	Ethanol	"Flex"	Gasohol
Total avoided emissions	2190	2401	2181	2323	2763	2589	2930
Use of biomass surplus	141	145	143	150	0,0	0,0	0,0
Electricity surplus	0,0	0,0	59	62	784	784	819
Use of ethanol	2049	2256	1979	2111	1979	1805	2111

Source: MACEDO; SEABRA; SILVA (2008:591).

Nonetheless, the burning of the old plants after the reaping ("trash burning" in the above study or "queimada" in Portuguese) is a major problem regarding GHG emissions in the sugarcane plantation management. Despite the fact that it is not specific to ethanol production problem (since it has been a practice for more than three hundred years in the Brazilian traditional sugarcane culture), it was precisely with the ethanol culture and its environmental drive that the institutional environment in this respect began to change. Brazilian Law 11.241/2002 establishes that all sugarcane plantations burning will cease until 2021 in areas susceptible to mechanization (so considered all terrains with slopes lower than

12% and no major irregularities), and all burnings must be eliminated by 2031 whatsoever. In addition, a major Sao Paulo producers association, UNICA, has signed a protocol with state government shortening these deadlines to respectively 2014 and 2017 in the state of Sao Paulo (BOUÇAS, 2007). Anyhow, in Sao Paulo, 46.6% of sugarcane production is already mechanized, avoiding trash burning; the immediate perspectives are to reach 50% in Sao Paulo, and 35% in the Centre-South region already by next harvesting.

The particular characteristic of the Brazilian biofuel experience and the feasibility of its generalization will be considered in the final remarks, since such discussion intends to be one of the contributions of this paper.

8 Informal Institutional Environment Constraints: Final biofuel consumer perceptions

In order to selecting, organizing and interpreting the product information, the human being has a process of perception, which is influenced by stimulus from the source of this information (SHETH, et. al., 2001). Consumers percept products in different ways, and develop positive or negative attitudes related to advertising and product information (KARSAKLIAN, 2000). The adoption of an innovation like biofuels is related to its use by the consumer. Some innovations are rapidly adopted, others take more time to be accepted (SHETH, 2001, p.309), depending, for instance, from its economic or ecological advantage.

Regarding to the interviewees perception and acceptance of biofuels, four of its attributes related to production and commercialization were evaluated. The first attribute associated with the use of biofuel analysed was pollution reduction in comparison to fossil diesel. For each attribute, an analytic diagram like Figure 5 (which represents the first attribute) was generated. The diagram shows environmental concerns regarding to future generations and their quality of life. It also shows the importance of the knowledge about alternative fuels as organic products akin to nature preservation as well as to job creation in Brazil. On the other hand, the lack of information about environmental preservation leads to fewer concerns. Scarceness of less pollutant products and lack of consumer approval to biodiesel are inhibitor factors of its commercialization.

The second attribute analysed was the Brazilian economic development due to production and commercialization of biodiesel. Most interviewees take biofuels into consideration due to its relation with the country economic development, job creation and improvement in quality of life of Brazilian people. The wealth of the nation, a decrease in prices and purchase power enhancement are also related to the need of the fuel to self maintenance, something felt as being difficult nowadays, even to job holders.

Job creation in several economic sectors results in benefits to future generations in terms of less vicissitudes due to country development, more self-actualization opportunities, and wealth creation and distribution. Interviewees denoted interest in life improvements in Brazilian society generally speaking, and sensibility regarding the needing ones, since there should be more jobs available for them.

The fourth attribute was the technological advances in biofuels. This attribute was also related to Brazil's economic and social development, and taxes reductions. Having biodiesel as an alternative to oil scarceness was also associated with job creation and social development. Technological advance would also imply, according to consumers perceptions, to new technologies development, such as new vehicles; and the improvement of Brazil's position before other countries, increasing exports and again creating new jobs; more affordable fuels; general economic improvement and higher purchase power and family support capability to Brazilian people and to the future generations. On the other hand, there was also concerning about the fossil diesel as a country wealth, though the main beneficiary in the interviewees' perception is the government, due to high taxes charged on oil derivatives.

Regarding to the experts interviews, the negative aspects of production and commercialization of biofuels listed were: impact on food prices; investments and technological developments needed in order to have production matching demand (mainly in the biodiesel case); the high transaction costs imposed by the national regulatory agencies (in this case, the ANP); potential environmental damage caused by inefficiency in the production processes; voids in government surveillance and law enforcement; lack of planning and R&D investments. As positive aspects, the reduction in diesel imports (which may reach 20%); energy autonomy and security; improvements in the economy performance; pollutants and GHG reduction; the stimulus to R&D and innovation; and to potentially get credits in the Carbon Market generated by the Kyoto's Protocol.

9 Final Remarks

The findings suggest that the analysis of the institutional constraints, formal and informal, is important to describe a sustainable strategy.

In the formal perspective, Biofuel in Brazil has in biodiesel and in ethanol two different phenomena, with different dynamics and different levels of maturity, which therefore demand separate analyses.

The ethanol strategy is based on stable institutional constraints that have an economic, social, technological and environmental sustainability. Its value chain is fully developed, and Sao Paulo can be considered an ethanol cluster.

On the other hand, Biodiesel still needs a more intensive participation of the government to incentive the economic agents to allocate their resources into production. However clear are the signals emitted by the government to the market, Brazilian history on biodiesel is only beginning. It is important to emphasise that "participation of the government" does not mean to be permanent subsidies; as the ethanol case has shown, the right institutional environment can build a sustainable market and a sustainable value chain in the long term.

The informal perspective is based on the hypothesis that the final consumers need the economic incentives to buy a sustainable product. Therefore, the means and ends approach indicates some import values that are related to the attributes benefits of an ecological fuel. These values could be explored by a public or private marketing strategy.

What part of Brazilian experience can be "exported" to other countries? Although there are several other countries with significant sugarcane production, many of them with available lands for crop expansion, able to develop technology, such as India, China, Pakistan, Mexico, Colombia and others, maybe the main lesson of Brazilian ethanol experience is that is possible to build an artificial market with institutional support that is sustainable, competitive and profitable. This experience, the institutional environment to foster a profitable activity, could be transported to other areas of alternative sources of energy, not necessarily ethanol.

Specifically to automobile industry, this type of approach could be used to analyze the formal and informal constraints in other types of fuels like electric and hydrogen.

This study has limitations in its conclusions mainly because is based in information from several heterogeneous sources. Other studies could validate these results testing the contribution, influence and interactions of these different types of sustainability. Furthermore, a comparative study is possible between different institutional environments.

References

ALSTON, L. J.; EGGERTSSON, T., NORTH, D. C. **Empirical Studies in Institutional Change.** United Kingdom: Cambridge University Press, 1998.

ALVES, M. F.**, Biodiesel reduz emissão e poluentes.** *Jornal da Unicamp*, n. 11. Available at: <http://www.unicamp.br/>. Accessed in Aug. 17, 2006.

AUTOMOTIVEBUSINESS. **Veículos flex representam 86,7% dos emplacamentos.** 10/03/2009. Internet document. Available at: http://www.automotivebusiness.com.br/noticia_det.asp?id_noticia=3026. Acessed in 20/03/2009.
BALTHAZAR, R. **Febre do etanol se espalha pelo interior dos EUA**. Valor Econômico, p. A16, 24 ago. 2006.
BARBOSA, M. Z.; SACHS, R. C. C. ET AL. **Mercado para biocombustíveis.** Instituto de Economia Agrícola: Textos para discussão. TD-IEA no. 3/2009.
BARCELLA, C. B., **Coplacana constrói usina de biodiesel**. Jornal de Piracicaba, p. B-1, 15 abr. 2007.
BATISTA, A. C. F. **Biodiesel no tanque**. Internet Document. Available at: <http://www.ambientebrasil.com.br/>. Accessed in: Aug. 28, 2006.
BNDES. **Bioetanol de cana-de-açúcar – energia para o desenvolvimento sustentável**. *Banco Nacional de Desenvolvimento Econômico e Social Report.* Rio de Janeiro: BNDES, 2008.
BOUÇAS, C. **Multigrain quer dobrar receita e estuda investir em etanol e biodiesel**. Valor Econômico, p. B11, 31 ago. 2006.
BOUÇAS, C. **Mecanização ganha terreno na colheita de São Paulo.** *Valor Econômico Especial* – Energia para o Mundo, Mai 2008 (a), p. 34.
BRAZIL INSTITUTE. **The global dynamics of biofuels**. Brazil Institute Special Report, April 2007 (3).
CEZAR, G. **Busca de eficiência une governo e empresários.** *Valor Econômico Especial:* Energia para o Mundo, May-2008.
CHANDLER, A.D. **Strategy and Structure**: **Chapters in the History of the Industrial Enterprise**, MIT Press, 1969, 463 p.
COELHO, S. **Brazilian experience on biofuels – perspectives for cdm projects**. *Presentation to the Conference on Biofuels: an option for a less carbon-intensive economy*. UNCTAD, Dec 4-5, 2007.
GLOBO. Cresce número de pontos de venda de biodiesel no interior de SP, G1. Available at: <http://g1.globo.com/>. Accessed in: Mar 15, 2007.
DW-World. **Debate sobre proteção climática domina o Salão de Genebra**. DW-World. Available at: <http://www.de-world.de>. Accessed in: Mar 06, 2007
ENNIS, C. A **Theoretical Framework: The Central Piece of Research Plan**. *Journal of Teaching in Physical Education*, 1999, p. 129–140.
ENRÍQUEZ, J. **A hora da bioestratégia**. *HSM Management*, n.36, p.64-69, jan. 2003.
FAO. **Biofuels: prospects, risks and opportunities**. *Food and Agriculture Organization*: The State of Food and Agriculture, 2008.
FAPESP, Agência Fapesp, Available at: <http://www.agencia.fapesp.br/>. Accessed in: Sept. 15, 2006.
FREITAS, A. B. **Traços brasileiros para uma análise organizacional**.In: MOTTA, F. C. P.; CALDAS, M. P. (org.), **Cultura Organizacional e Cultura Brasileira**. São Paulo: ATLAS, 1997, p. 49.
GÓES, F.; VIEIRA, C. **Biodiesel chega à bolsa de valores**. Valor Econômico, p. B1, 25 ago. 2006.
GOLDEMBERG, J. **Energia, meio ambiente & desenvolvimento.** São Paulo: Edusp/CESP, 1998.
GOLDEMBERG, J. **Energia**. In: TRIGUEIRO, A. (org). **Meio Ambiente no século 21: 21 especialistas falam da questão ambiental nas suas áreas de conhecimento**. Rio de Janeiro: Sextante, 2000, p.173-180.

GREENPEACE. Available at: <http://www.greenpeace.org/brasil/>. Accessed in: Feb 06, 2007.
GUTMAN J. **A Means-End Chain Model Based on Consumer Categorization Processes.** Journal of Marketing, 46(2), 1982, p. 60–72.
BIODIESELBR. **HBIO: o novo diesel da Petrobrás**. Internet Document. Available at: <http://www.biodieselbr.com/>. Accessed in: 12 set. 2006.
IEA. *International Energy Agency.* Available in: http://www.iea.org/Textbase/stats/index.asp. April, 2009.
INOVA BRASIL. **Cadeia produtiva do biodiesel já é a 3ª maior do mundo.** 15/08/2008. Internet document. Available at: http://inovabrasil.blogspot.com/2008/08/cadeia-produtiva-do-biodiesel-j-3-maior.html. Acessed in 20/03/2009.
INOVAUNICAMP. **Motor a àlcool.** 2009. Internet document. Available at: http://www.inova.unicamp.br/inventabrasil/caralc.htm. Acessed in 02/03/2009.
IPCC. **Intergovernmental Panel on Climate Change**. Available at: <http://www.ipcc.ch/>. Accessed in: Mar 01, 2007.
KARSAKLIAN, E. **Comportamento do Consumidor**. São Paulo: Atlas, 2000, p.11 e 42-44.
LOPES, F. **Áreas voltadas á pecuária agora possuem canaviais**. *Valor Econômico Especial* – Energia para o Mundo, Mai 2008 (a), p. 20.
LOPES, F. **Protecionismo e segurança alimentar na ordem do dia**. *Valor Econômico Especial* – Energia para o Mundo, Mai 2008 (b), p. 23.
MACEDO, I. C.; SEABRA, J. E. A.; SILVA, J. E. A. R. **Green house gases emissions in the production and use of ethanol from sugarcane in Brazil: The 2005/2006 averages and a prediction for 2020.** *Biomass and Bioenergy,* 32 (7) 582 – 595, 2008.
MAROTTI DE MELLO, A.; VASCONCELLOS, L. H. R.; MARX, R. **Estariam as Montadoras Abrindo Mão de Suas Competências Essenciais no Desenvolvimento de Motores? - Um Estudo de Caso do Primeiro Veículo Nacional Bicombustível.** ENANPAD. *Anais do XXIX ENANPAD,* 2005.
MASIERO, G.; LOPES, H. **Etanol e biodiesel como recursos energéticos alternativos: perspectivas da América Latina e da Ásia.** *Revista Brasileira de Política Internacional no.* 51 (2): 60-79, 2008.
MILARÉ, E. **A Participação Comunitária na Tutela do Ambiente**. São Paulo: Terragraph, 1994.
MIRAGLIA, S. G. E. K. **Health, environmental, and economic costs from the use of a stabilized diesel/ethanol mixture in the city of São Paulo, Brazil.** Cad. Saúde Pública, Rio de Janeiro, 23 Sup 4:S559-S569, 2007.
MORAN, E. **Um mundo em mudança.** *Pesquisa Fapesp*, n. 125, p. 14-19, jul. 2006.
MOREIRA, A. **Cresce na França a área de canola para biodiesel**. Valor Econômico, p. b13, 30 ago. 2006.
MOTTA, S. L.S.; ROSSI, G. B. **A influência do fator ecológico na decisão de compra de bens de conveniência**. ENANPAD. Anais do XXVII ENANPAD, 2003 (GSA -1661.pdf).
MUNHOZ, F. **Acordo adia redução de enxofre no diesel por quatro anos.** São Paulo, Eco-Finanças, 04/11/2008. Internet Document. Available at: http://ef.amazonia.org.br/index.cfm?fuseaction=noticia&id=290768. Accessed in: Jan, 5 2009.
NATALE NETTO, J. **A saga do álcool**. Osasco, Novo Século Editora, 2007.
NORTH, D. C. **Institutions, Institutional Change and Economic Performance**. Cambridge University Press. 1990, 152p.
OLIVEIRA, M. **Alternativas ao petróleo**. *Pesquisa Fapesp*, São Paulo, Fapesp, n.126, ago. 2006.
ONAGA, M.; SALOMÃO A. **Etanol**. *Exame*, Ano 40, 21 jun. 2006, p. 18-24.

OPEC. **World oil outlook**. *Organization of the Petroleum Exporting Countries*, 2008.
PADUAN, R. **Biodiesel virou negócio**. *Exame*, Ano 41, 28 fev. 2007, p. 68-70.
PARANÁ, Ministra das Minas e Energia, Jornal Paraná, ano VII, ed. 97, jul. 2004.
PLANO Nacional de Agroenergia 2006-2011 / Ministério da Agricultura, Pecuária e Abastecimento, Secretaria de Produção e Agroenergia. 2. ed. rev. – Brasília, DF: Embrapa Informação Tecnológica, 2006.
QUINTÃO, C. **Biodiesel de sebo atrai investimentos.** *Gazeta Mercantil,* p. B12, 10 jul. 2006.
REINACH, F. **Aquecimento pode reduzir produção de alimentos**. *O Estado de São Paulo*, 09 ago. 2006.
RIPPEL, R.; RIPPEL, V. C. L.; LIMA, J. F. **Percepções genéricas sobre o crescimento populacional a demanda por energia e os padrões de consumo dos recursos ambientais atuais.** In: XV Encontro Nacional de Estudos Populacionais, ABEP, 22 set. 2006, Caxambu (MG).
SALOMÃO, A.; POLONI, G. **Combustível da riqueza**. *Exame*, Ano 41, 28 mar. 2007, p.84-88.
SHETH, J. N.; MITTAL, B.; NEWMAM, B. I. **Comportamento do cliente**. São Paulo: Atlas, 2001.
SIMON, F.; Kotler, P. **A construção de biomarcas globais: levando a biotecnologia ao mercado**. Porto Alegre: Bookman, 2004.
SIQUEIRA, C. **Empresários lançam usina de biodiesel 100% nacional**. *O Estado de São Paulo*, 08 mar. 2007.
SUPERA. **Dados do Biodiesel Brasil, Incubadora de empresa de base tecnológica**. Ribeirão Preto - SP, declaração de Miguel Dabdoub, presidente da Câmara Setorial de Biocombustível do Estado de São Paulo, 2004.
UNICA. **Como e por que o álcool combustível melhora a vida do planeta**. *União da Indústria de Cana-de-Açúcar*/Globo Editora, 2005(?).
VELUDO-DE-OLIVEIRA, T. M.; IKEDA A. A. **Usos e Limitações do Método Laddering**. *Revista de Administração Mackenzie*, São Paulo, Ano 5, n.1, p. 197-222, 2004.
WANSINK, B. **New techniques to generate key marketing insights**. Chicago: *Journal of Marketing Research*, v. 12, n. 2, p. 28-36, Summer 2000.
FAO. **The state of food and agriculture – Biofuels: prospects, risks and opportunities.** Rome, Food and Agriculture Organization of The United Nations, 2008.
KREMER, F. G.; FACHETTI, A. **Alcohol as automotive fuel – Brazilian experience.** SAE Technical Papers, 2000-01-1965, Jun 2000.

[1] The curves are presented in analytical form in order to save space.