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ORIGINAL ARTICLE

NETWORK TECHNOLOGY COOPERATION OF ETHANOL IN BRAZIL: *IN SEARCH OF A CLEAN FUEL*

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Abstract:

Theworldwide interest in development of biofuelshas increased, in the last decade, due to agreater concern withthe cleaner and renewable energy sources, allowingprogress in overcomingthe currentparadigm,based on fossil fuels. In this scenario, Brazil has a important role, where bioethanol program presents interesting resultsfrom researchon sugarcane varietieswith higher yield per hectare planted and production of alcohol used in engines that are powered by any mixture of alcohol and gasoline.This paper has the main purpose to present anoverviewof R &D activities and technological cooperation between the majorresearch centersof thesugarcane industryin Brazil. It also presents the technological advances in the sugarcane/ethanol production and discuss the benefits of this renewable fuel in face ofcriticisms fromresearchers andinstitutionsinterestedin alternative sources ofclean energy.The study was developed from research literature, analysis of newspaper archive available (through print and internet) and secondary data from government and business associations, research institutions, universities and research funding agencies. After a comprehensive overview of the context in which the problem appears, personal interviews were conducted with leaders of major research institutions in theBraziliansugar and alcohol sector, which led to the identification the scope of Institution activities, the intensity and direction of R & D activity and especially the Institution involvement with the farmers and mill owners, the main beneficiaries of technology developed.

KEYWORDS:

sugarcane, ethanol, technology network, clean fuel.

INTRODUCTION:

The gradual reduction of export subsidies in Brazil, as well as increasing the fleet of flex-fuel vehicles, is major additional incentives to expand the area planted with energy raw materials, particularly sugarcane. Technological development of automobile industry in terms of using ethanol as fuel is extraordinary and has provoked great interest in allindustry around the world. Yet, it is not groundbreaking. In the early years of the global auto industry during the second half of the nineteenth century, biofuels represented the primary energy source for internal combustion engines, with the adoption of ethanol by Henry Ford and peanut oil by Rudolf Diesel. These two products were replaced respectively by gasoline and diesel as fuels derived from oil became plentiful and cheap, since the beginning of last century. (BNDES / CGEE, 2008).

Liquid biofuelscan beusedvery efficientlyininternal combustion engines that equip motor vehicles for different purposes. These engines are basically classifiedinto two types: theOtto

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cycleengineswithspark ignition, for which thebiofuelmost recommended is ethanol andDiesel-cycle engines, in which the ignitionis achievedby compression and the biodiesel is the biofuel recommended for a good performance. In both cases, biofuels can be usedpureor blended withconventional petroleum-derivedfuels. The production process of biodiesel, however is more complex than ethanol and competes with noble raw material used primarily for human consumption, such as soybean, sunflower, cotton, castor bean, jatropha, palm and tallow. The public policies of governments of various countries, including members of the European Community, USA, China and Brazil, which include biodiesel in its energy mix, are not sure about the offer and the projections for this product. (PENTEADO, 2005).

Therefore, it is natural, that programs supported by the government and the private sector, Brazil, which also has tradition and recognized expertise around the world in this sector, develop research and technology in agriculture, manufacturing and transportation of biofuels. The results are more apparent in the case of ethanol, which is the product with the highest level of marketing both domestically and internationally. The country produced in 2009, about 27,5 billion liters of ethanol, enough to supply over 90% of cars manufactured with flex or bi-fuel technology.

The combination of actions between the public and private sector in Brazil over the past 40 years, is reflected in the high level of technological development achieved by ethanol. Currently, there are two major Research and Technology Centers intended exclusively for the sugarcane industry in Brazil. They were created in the mid 70s and have presented amazing results for increasing productivity. The first great Center was created by the private sector and is maintained by a group of farmers and mill owners associated with UNICA SugarcaneIndustry Association, under the name of CTC - SugarcaneTechnology Center. The other, backed by the Federal Government constitutes the RIDESA - Interuniversity Network for Development of Sugar and Alcohol Sector.

Another R&D Center namedIAC-Agronomic Instituteof Campinas, which was the first majorand most important Agricultural ResearchCenter installedin Brazil,hasofferedavery important contribution toincrease productivityin the sector andmainly developing more productive varieties. However, onlyin March2005, was created,and attached to the structure ofIAC, the Advanced Technological ResearchCenterofSugarcaneAgribusiness- CAPTAC,as an specialized Institute,dedicated exclusively toR & Dculture ofsugarcane andalcohol production.

The work of theseresearch centersthroughprograms ofresearchin the areas ofplant pathology, soils and plant nutrition, environment and especiallyin the area of? ? genetic improvementto the production ofnew varieties,allowed Brazil toincrease itsproductivity ofthree thousand litersofalcohol perha.plantedsugar canein the late70's,to nearlyseven thousand litersof alcohol perha.nowadays. This is avery comfortable situationin termsof capacity andcompetitiveness, comparing withotherworld producers ofsugar and alcohol.

2.THE INDUSTRIAL PRODUCTION

Brazilian ethanol production is mainly for the domestic market. In 2007, only 16% of the total production was destined for export. The demand for fuel has been increasing in Brazil, boosted by sales of flex fuel cars, which can run on alcohol, gasoline or a mixture of both, in any proportion. According to the National Association of Automobile Manufacturers - ANFAVEA, 81% of all cars sold in 2007 were flex vehicles. The Association estimates that the Brazilian fleets of light flex fuel vehicles will make up 46% of all vehicles in circulation by 2012.

Therefore, theBrazilian alcohol exportshave grownstrongly in recent years, mainly due to the worldwide concernwith the"clean energy", reaching 4,7 million liters in2009.This value places Brazil as the world's largest exporter, ahead of all the other countries put together. One strategy that hasbeenadopted in thissector is theformation ofpoolsofmarketing, whose goal is to increasethe scaleof operation. Chart 2showstheextraordinary increasein exportsof alcoholandthe attractiveline of businessthat presents itself. The main destinations for Brazilian exports are European Community, USA, Japan and Jamaica

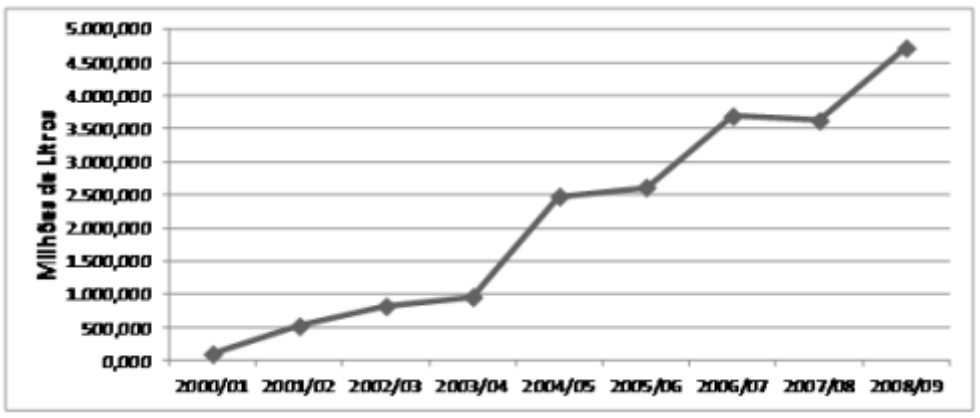

Chart 2- Evolutionof the exportof alcohol
Source:UNICA(2010)

Thus, the prospects for this market have attracted national and foreign groups in search of opportunities for investments in the sector. This interest has led to a significant appreciation of assets in 2005 were around US$ 30 to US$ 40/ton and are now being valued at US$ 100/ton, excluding land values.
The expansion of sugarcane areas is already outlined for the next years, building on new projects underway and will occur predominantly in the region Centre-South/Southeast, The environmental agencies are worried about the invasion of the sugarcane crop in the agricultural frontier that extends to the Amazon rainforest.

TheSouth-Central regionaccounts for89%the ethanol producedin the country.This corresponds, in2006/07 crop, to 17.6 millionm3 of alcohol.Thisproduction volumeisdilutedamong the325plants installed, although the fourlargest plantsaccount for less than15% of Brazilian production.The reasons for thisspraying productioninclude:

low barriersto entry,since thetechnology isaffordable, and
limitthe optimal scaleof not more than2milliontons of sugarcaneper harvestprocessed, becausethe sourceof raw materialsare up to50 kmindustrial plant.

According to industry estimates, the government programs to stimulate the ethanol production and consumption (internal and external) could expand the area planted with sugarcane till 2013/14 season, to nearly 10 million hectares, as shown in Chart 1. (IBGE, 2007)

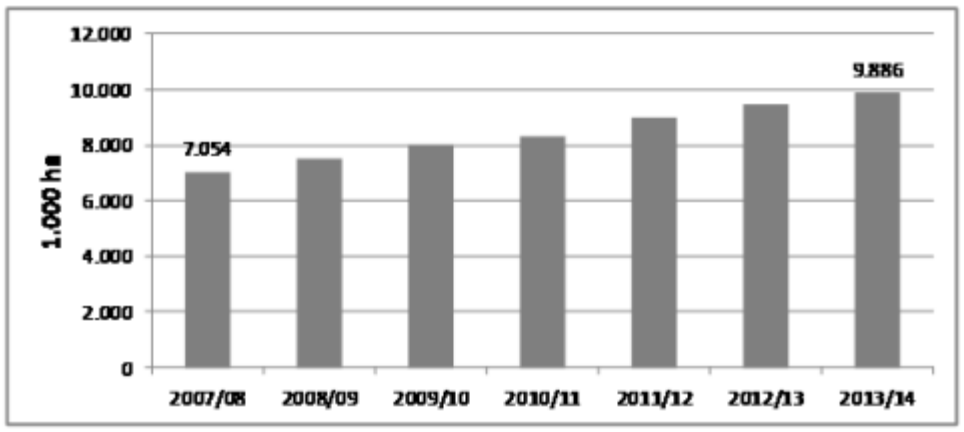

Chart 1 -Projection of areaplanted withsugarcane
Source: IBGE (2007)

TECHNOLOGY DEVELOPMENT

From the culture of canesugar areproduced sugar, ethanol fuel and electricity, referred to asmain

product, and as by-products, raw materialsthat are usedas animal feedand in the production ofbiodegradable plastic, paper, thechemicals andpharmaceuticals,spirits andothers whocontribute to theutilization of the plantand reductionof wastein industrial processes(CTC, 2009)

In the technological environment the agricultural research and production of sugarcane/ethanol, operatesthe three major research institutions- CTC, RIDESA and IAC/CAPTAC –thathave shown significant results in terms of technological development and innovation in their areas of expertise and current research projects.

These institutions represents, from the perspective of a technological network, the cooperation, participation and interface with other links in the sugarcane industry value chain,anchoredin asystemthat also involvesgovernment agenciesfor research funding, environmental law, industrialequipment companiesand otherinstitutionsof activitiesancillary or complementaryto the researchsector.

CTC - Sugarcane Technology Center

Created in 1969 by Coopersucar - Cooperative of Sugar and Alcohol Producers of the State of São Paulo, Coopersucar Technology Center (CTC) developed new varieties of sugarcane and new production processes for plants associated with the cooperative. In 2004,Coopersucar alienated the CTC, which became the National Center for Sugarcane Technology, acquired by members of the cooperative, which restructured its board of directors, corporate and management model. In this model, the associates finance the projects and receive the immediate benefits from the research that focuses mainly on projects of sugarcane genetic improvement. (Fronzaglia and Martins, 2005) The Center's work involves the development of research for the entire production chain of sugar cane, the agribusiness field and ranges from the development of genetic variations in the experimental units to the delivery of the final product.

Organizations associated tothe CTC

The CTC currently has 182 units associates: industrial units producing sugarcane, sugar and alcohol; sugarcane planters and sugar/alcohol producers associations,They cultivate an areaequivalent to 4.5 million hectares and as we have seen, corresponds to 60% of the grinding sugarcane produced in the Midwest/Southeastregions.

The CTC sources of funding originate from contributions of members, proportional to itssize andscalethe company's financial, revenue derived from contracts, and donations. The main benefit of the members is access to advanced technologies, where the CTC participates in various stages of sugarcane production: technology transfer, provision of technical and administrative services, industry information and the global economy, update price and markets indicators, training programs and promoting technical and institutional events.

Performance of CTC in agricultural field

The CTC works along with their associates in each stage of the sugarcane production cycle, from planning to planting till the renewal of the area planted.

planting planning: recommendations of varieties for planting, soil and climate environmental identification , areas of potential saving irrigation;

soil conservation: efficient erosion control and reducing the burning of the straw, according to the law and protocolagro environmental

soil preparation, weed control, soil compaction assessment, renewal the planted area,fertilization and furrowing

planting: rationalization of manpower, quality of work and technology, focusing on mechanical planting;

control of pests and diseases, promoting the natural and biological control, replacing the chemical tests and early diagnosis of diseases;

planning the harvest: use of geographic information system, rationalization of manpower to mechanical harvesting, directtransshipmentand transportationof caneto the mill;

renewal of culture: studies of harvested areas and spared areas.

In terms of technology transfer,direct assistance to producers includes the recommendations of varieties, modern management methods, efficient agricultural systems and industrial production, consulting and monitoring performance in production and several other technologies.

CTC conducts an annual event called Cane Show, with the aim to present the news from sugarcane to its members.In recent events, was showed technological innovations that are likely to be adopted in the coming years: the biofactory, CTCSat, soil and climatic production environments, implementation of varieties selection sector by associate and the fourth generation of CTC varieties. Besides the annual events, the CTC provides to its members, seminars and distance learning courses about the technologies developed on CTC, through electronic portal training.

Bioenergy

Besides theextraordinary technological growththe first generation ethanol, derived from primary sources, CTC is developing research in other raw materials sources. In a few years, biofuels will also be made from the bagasse of cane, corn cobs, grass, bark, tires and even garbage. This technology has been called the second generation of biofuels. The process is to use enzymes, micro-organisms or acid to separate the sugars existing in biomass and then producing fuel.

Considering the potential of this technology, the CTC has partnered with the Danish company Novozymes Latin America, specializing in industrial enzymes, and opened in January 2010, a pilot plant to produce the second generation ethanol with wastefrom the production processof thesugar andalcohol. The technology route used is called enzymatic hydrolysis, in which the cellulose molecules are converted into sugars by means of enzymes (ETHANOL SUMMIT, 2009).

To the leaders of the CTC, the pathwayto research in this sector is to show the efficiency of sugarcane, both to produce ethanol, which currently constitutes the most viable substitute for gasoline and for bioelectricity generation from the use of straw and bagasse, which is what remains after the process of cane sugar and alcohol production (UNICA, 2009).

RIDESA - Inter-University Network Development the Sugarcane/Alcohol Sector

In 1991 was created RIDESA - Inter-University Network Development the Sugarcane/AlcoholSector succeeding toPLANALSUCAR - National Program forImprovement of Sugarcane, a Federal Research Institution, extinct in 1990, with a large contribution toimprovement the productivity ofsugarcane, since 1970. The research activities are developed on four Coordinating Regional Centers, whose officerssupervisingthe research activitiesat each stationunderits area of ? ? influence In addition to the amount allocated annually by the Federal Government, through the Departament of Science and Technology, the Institution, has 130 partner companies that provide resources and make use the research outputs. (INOVAÇÃO UNICAMP, 2007).

The areas of research in RIDESA

The main line of research in the Institution lies in classical genetic improvement. The other focus research areas involved:

Biotechnology and Plant Health
Environmental Management
Soil, Nutrition and Fertilization
Soil, Water and Energy
Handling and cultivation
Management, Socio-Economics and Product Diversification
Industrial Technology and Quality Control
Dissemination and Technology Transfer

The RIDESA also works in the enzymatic hydrolysis research and transgenic plants, a partnership with IAPAR - Agronomic Institute of Paraná, the most important agricultural research Institute in the South region

The Genetic Improvement Program RIDESA

The large expertise in genetic improvement, allows RIDESA to create a Sugarcane Genetic Improvement Program. Successfully conducted, the program has launched, since its formation, 65 new cultivars identified by the initials RB, which account for 57% of the area cultivated with sugarcane in Brazil (RIDESA, 2008).

A priority for breeding programs is to satisfy the needs of the cane grown in less optimal environments, such as degraded pasture areas, which are part of the new frontiers of culture. One of the challenges of research has been to develop and evaluate varieties that may have characteristics more suitable to these areas, such as greater hardiness, tolerance to water stress and good resistance to pests and diseases.

The RIDESA relationship network

As a formalized network of Federal Universities, the R&D activities occurs in the main production centers in the country, where are sited the experimental stations, laboratories and other research institutions.

Agricultural and Industrial Producers

The RIDESA maintains agreements with agricultural producers and private industrial area that support financially the Institution and returns through the advice on selection and planting the appropriate varieties. Testing the varieties, the producers begin to multiply the plants in their area of production. Not all do this work because experimentation is a major cost to the company and the Institution provide the manpower and machines. The RIDESA sells seedlings, primary and secondary nursery and varieties selected to yield eight to ten cuts. The healthier is the cane, the longer it remains in the field and brings savings to the producer in the cost of renovating the area.

Research Institutions

Although there is some degree of competitiveness in finding the best varieties and farming practices, the result of the research institutions of the sector is shared and used in developing new projects. The RIDESA conducts field research, using varieties developed by CTC and the IAC, in order to get better crop yield in some regions where the varieties characteristics are more suitable. The results of the tests are disseminated to stakeholders and useful as inputs for future research.

However, the joint action with other institutions, in termsof technology development, takes place effectivelyin specific areas. A partnership withIAPAR-Agronomic Instituteof Paraná,involves tworesearch projects: the firstregards the hydrolysisof cellulosicusing sugarcane biomass andthe otheraimed toobtaina variety oftrans genicsugarcaneresistantto drought.This materialis still being evaluated, but the RIDESA technicians believedthatfor a longperiod,sugarcane varietieswill stillbe obtained bynatural hybridization, "because the metabolic pathways ofsugarcane,due to the existence ofmanychromosomes andgenes,are verycomplex". (INOVAÇÃO UNICAMP, 2007)

In the area of physiology,and more specifically concerning tofactors related to thematurity of the plant, where soil moisture, air temperatureand luminosityare themain constraints,RIDESA iscarrying out research withCENE -Nuclear EnergyCenter, a Research Institute from USP – University of São Paulo.These studiesaim to gain,by controllingthe factors that affectthe bioconversionenergy, ahighersucrose contentof the plant andhighest incomecrop. (HOFFMANN, 2008)

In the field oftransgenics,the goalof the partnershipwith EMBRAPAis to join forcesand make it possible to developajoint projectto producetransgenicsugarcaneresistant topests and diseases,and to providevarieties with differentgenetic characteristics. (CENARGENDAonline, 2006)

However, according toinvestigator assessmentofRIDESA, João Carlos Bespalhok, theresearch ontransgenicsugarcanenot yetreported results. In his presentation at the"Workshop onBIOENSugarcaneImprovement", sponsored by FAPESPon 18 and19 March 2009, in SaoPaulo, theresearcherbegan hisinvolvementwith the image ofa2005reportJournalofCana, where there wasthe prediction thatin fouryears, Brazilwould begrindingtransgenic sugarcane. "Four years later, we're not anywherenearthat,"the researcher said, noting that one reasonfor this is thatthe clones producedtoday byconventional genetic engineeringare betterthan thetransgenic clones. (INOVAÇÃO UNICAMP, 2009)

UniversitiesandFostering Agencies

FINEP, a Federal Governmemnt Studies and Projects Funding Agency offers financial support to RIDESA conducting basic and applied research in traditional breeding program and encouraging the development of biotechnology tools for genetic improvement; also promote the formation of qualified human resources in the agricultural field. The government's goal is to provide genetically improved seedlings and encourage transfer of technology for small producers in traditional areas and new agricultural frontiers (MCT, 2007)

A project funded by CNPq -National Council for Scientific and Technological Development involves researchers from Unicamp - Campinas University and UFV-Viçosa Federal University/RIDESA. The partnership between researchers from these two Institutions will assist in the data interpretation from complete sequencing of sugarcane genes and in a program to guide the selection of genetic material more suitable to the production of cellulosic ethanol. (PORTAL UNICAMP, 2009)

In the same way, there is a project, funded by FAPESP, as part of the Bioenergy Research Programme, involving researchers from Unicampand RIDESA and devoted to improving the productivity of Brazilian ethanol and also advancing in basic science and technological development related to power generation from biomass. The groups are working to reach a new step in DNA sequencing of sugarcane and understanding the defense mechanisms of sugarcane to water scarcity. (FAPESP, 2008)

CAPTAC - AdvancedTechnology ResearchCenterof Sugarcane Agribusiness

Research InstitutesandUniversitiesmaintained bythe State ofSao Paulodevelopstudies and researchin agricultural andindustrialsugar cane sector.However, we can not saythat there isaformal network ofR &Dbetween theseInstitutions, althoughthesurveys conducted in many cases arecomplementary andcould beassociated with projectsandexperiments performed oneach one.

So, in 2005, was created theCAPTAC -AdvancedTechnology ResearchCenterof Sugarcane Agribusiness,originated from one of these research centers, the IAC Agronomic Institute ofCampinas. The creation of the CAPTAC was intended tofocus the research andtechnological developmentefforts in aresearch centerdedicated exclusively tosugar caneagribusiness. Addition to thespecialization andconcentration in the sugarcane/alcohol sector, another reason for the emergence ofCAPTACwas the formation ofa technology cooperationnetwork around thecenter,in order todisseminate andtransfer the resultsofjointresearch and studies and to obtainsynergyof effort betweeneveryone involvedin the activity ofR &D sugarcane agribusinesssector.

The CAPTAC research programis divided into severalR &Dprojectsin the areas ofbreeding, bioclimatology, soil science,economics, statistics, engineering, agriculture,fertility andplant nutrition,plant scienceand health plant. Thebreedingareais alsothe focusof the institution, but they establishedthe strategy ofregional selectionand thusseek to developand introducevarieties adapted to themainsugarcane areas of thestate ofSao Paulo. Currently, besidesworking withmolecular biology, the Center hasaimportantworkto supportthe qualificationof production environmentsthat generatesessential informationfor the application ofhandling varietal conceptsand therefore, for the adoption oftechnologies developedin this areafor improvement.

4.THE CONTRIBUTION OF THE ETHANOLAGROENERGY SYSTEM

On the way to reach sustainability, the goalof the sectoris to showthe efficiency ofsugarcaneto produce ethanolbiofuel, replacing more than halfof the gasolineneeded tofuel the fleetof light vehiclesin the country.

Howeverthe most significant advancementandbenefitsmoresensitiveto the environment, isthe generation ofbioelectricityfrom the useofstraw andbagasse, whichis what remainsafterproduction process. The leaders of the industry emphasize that the ethanol agro-energy system is not only self-sufficient, but also a provider of energy from bagasse burning in power plants. The co-generation power has proved a great way to take waste, reduce production costs and to increase the revenue of the business through sale of surplus energy to electricity distributors and other businesses.(UNICA, 2009).

For plants that historically favoredthe sugar in the export market, economic alternatives for ethanol bio-energy, and demand for other products such as brandy and derivatives for chemical and pharmaceutical industry, addedto the sector new perspectives forincreasingdemand for sugarand ethanolin Braziland abroad.

Fertirrigationisanother high pointintechnological development achievedby the sector.In addition to solvinganenvironmental problemrather complicated, the solution foundto allocatevinasseand filter

cakealsohelps reducethe fertilizer cost.

The domestic industry of capital goods has been successfully developedabusiness modelin the biofuels industrythatisa “turn key”construction for sugar and alcohol plants which can becarried out in Brazil oranywhere else in theworld.

The agricultural machinery industry developed equipments to mechanized harvesting, which has minimized the harmful effects of burning on environment.

The growth potential of the first generation ethanol already signaled a series of technological advances in the industry, but the novelty seems to be the technology of the second generation of ethanol: cellulosic ethanol. Although Brazilhas reachedavery hightechnological level, it doesn't seem to beembarkingon the cellulosic ethanol paradigm. Everything indicates that thecellulosehydrolysis technologycandramatically affectthe competitiveness ofethanol production, but we are no seeing,on the national scene, substantial investments in this direction. There is research supportprovided bygovernment agencies and CTC receive incentives from the private sector. However, comparatively,these effortsare too farto US$1.5 billionbeinginvested by theU.S.to develop this technology. (USDA &USDOE, 2008)

Advanced technologies in the sugarcane agro-industry

The possibility of producing ethanol from sugarcane does not end with the second-generation technology. Other innovative technologiesinthis field, continue to be developed using theresulting biomassproduction process and utilization of lignocellulosic materials extracted from the gasification process. It is also included in this context, the employment opportunities of bioethanol as a basic input for the petrochemical industry (or Ethanol), field in which major projects have been developed decades ago and are now included in new initiatives (BNDES / CGEE, 2008).

Today, the production of ethanol from sugarcane can already be considered an example of a biorefinery, combining production of sugar, alcohol and some other chemicals, as well as power generation from biomass waste (MACEDO, 2005).

Gasification

Gasification is a thermochemical conversion process of biomass carried out at high temperatures, where organic substances (solid or liquid) are converted into gaseous products and water vapor, noting also the formation of other compounds such as volatile and condensable secondary products (GRABOWSKI, 2004).

The prospect is that the gasification of biomass can enable both the production of liquid biofuels, mainly for automotive use, as bioelectricity generation in large scale. The main factor driving this technological development is the need to reduce emissions of gases "greenhouse effect" and substitute the consumption of petroleum products. Despite the previous experience with several demonstration plants, research efforts and development have not been consistent over the years, so it is expected that these technologies will become commercially mature options only in the medium and long term, in over ten years. (BNDES / CGEE, 2008).

Ethanol as petrochemical feedstock or alcohol

To meet the market of plastic materials, the conventional petrochemical industry uses mainly natural gas and oil nafta as inputs in the manufacturing process of consumer goods such as films, containers, objects, paints, packaging, clothing, coating materials and structural materials etc. The ethanol is a substance that can be used as inputs for traditional petrochemical processes, which in this case could be termed alcohol-chemical. As output of the chemical and petrochemical industry in Brazil it represents about 3% of world production. It is clear that there is great potential for expanding use of ethanol from sugarcane as feedstock in a global scale, but the barrier for the development of this market is the relative price of ethanol when compared to other inputs. (APLA, 2006)

Biorefinery

A biorefinery is similar to its analog for oil and can be defined as an integrated complex capable of producing different products (fuels, chemicals and electricity) based on different biomasses, a concept that would allow the achievement of higher efficiency, both thethermodynamic point of viewandfrom the standpoint ofeconomic and environmental (Ondrey 2006).

Ragauskas et al. (2006) provide a broad discussion of the concept and the possibilities involving

the biorefineries, which according to the authors represent an option for the optimal use of biomass in the sustainable production of bioenergy, biofuels and biomaterials, both in the short and long term.

Similar process of production diversification and recovering by-products is underway in the forest-based industry, which involves the production of pulp and paper, energy and diversity of chemicals, helping to increase process efficiency, improve the economy and reduce environmental impacts. This agribusiness industry presents growth prospects similar to the sugarcane industry and certainly, synergies will occur between the two in developing technologies and markets (Karlsson, 2007 apud BNDES/CGEE, 2008).

CONTROVERSIES AND CRITICISMS

Although there is a huge euphoria, mainly by environmental agencies, to replace fossil fuel with biofuel, there is no unanimity among scientists and communities about the actual benefits and advantages of ethanol as an alternative energy source. In our country, organizations involved in rural social movements, beyond the usual questions about land ownership, landowners, crop, farm work, etc. also argue that ethanol produced from sugarcane presents restrictions at all stages of the process. A document prepared by thePastoral Land Commission-NE and the Network for Social Justice and Human Rights-SP shows a series of critical remarks about the culture of sugarcane and ethanol production:

cultivation and processing of sugarcane pollutes the soil and drinking water sources, because they use large quantities of chemicals and each gallon of ethanol produced within the plant consumes about 12 liters of water.

the process of ethanol distillation produces vinasse. A portion of the stillage can be used as fertilizer, if diluted in water. But researchers warn that this substance pollutes rivers and underground water supplies.

the burning of sugarcane facilitates the work of the harvest, but it destroys a large proportion of microorganisms in the soil, pollutes the air and causes respiratory ailments.

the processing of sugarcane in the mills also pollute the air through the burning of bagasse, which produces soot and smoke.

addition of environmental degradation and indiscriminate use of natural resources, the monoculture of sugarcane dominate some of the best arable land in Brazil, the expansion of monoculture will use food-producing land to produce bioenergy

A study by the Belgian Office of Scientific Affairs shows similar results for biodiesel, "Biodiesel provokes more health and environmental problems because it creates a more pulverized pollution, releases more pollutants that promote the destruction of the ozone layer"(PINTO, 2007).

The criticism of this organization has also reached the second-generation ethanol, produced from organic waste. What is usually called waste organic natural fertilizers are used to nourish and protect the soil. If this material is used for another purpose, would be "necessary to apply chemical fertilizers, petroleum based, thus negating the positive effects in relation to global warming. Biomass from cellulosic material is being developed primarily by genetically modified species of trees, which pose a great danger of contamination of other crops, it is virtually impossible to control their pollination, and the risk of extension of these crops in forest areas." (AGROENERGIA, 2007)

These issues are permanently on the agenda for discussion between the research institutions, associations of producers and government agricultural and environmental area. Recent proposals for change that resulted from meetings between stakeholders, addressed these problems and solutions contained time-bound to implement. In the case of criticism of the second generation ethanol, the discussion goes beyond the benefits of production and product use to include in its agenda the politics surrounding the validity and necessity of the use of transgenic varieties in any type of crop.

This is also the conclusion of a study published in 2007 by two Norwegian scientists Karl Hoyer and Erling Holden, who compared the environmental costs of various fuels for automobiles, gasoline, diesel, natural gas and alternative fuel sources, like ethanol, methanol, biofuels and hydrogen. The comparison between the alternative fuels for vehicles has been made, ? ? taking into account the energy costs and pollutant emissions in the stages of production, processing and consumption of various fuels. The data were computed in terms of energy consumption, the emission of gases causing the "greenhouse effect" and pollutant emissions locally and regionally. As might be expected, gasoline and diesel occupy the first places, but in sequence appeared natural gas and biofuels. The winner in terms of environmental gains is hydrogen extracted from methanol and generating electricity through fuel cells. This is, however, an option still far from economic feasibility, and even from a strictly technical point of view, it still has problems to be solved. (HOYER & HOLDEN, 2007)

Machado & Habib (2009) take up the burning effect of sugarcane and add other things that damage

the environment and the population residing in urban areas near the sugarcane plantations:
destruction of soil organic matter leaving exposed to erosion, which has led to silting of water sources;
elimination of birds, animals and insects, many of these organisms are important as natural enemies of pests;
removal of some soil microorganisms;
by the end, can cause volatilization of essential nutrients to the plant.

These investigators also enhanced the production ofsoot, whichcauses the release ofcarbon monoxide,highly toxic, polluting urban centersnear andin many casescausing irritationof the respiratory tractofhumans.

FINAL CONSIDERATIONS

The worldwide interest in development of biofuels has increased significantlysince the lastdecade of the20thcentury,due mainly to the great concernwith renewable energy sources and cleaner, enabling progress and overcoming the current paradigm, based on fossil fuels. In this scenario, R&D bioethanol programsin Brazil,provides significant results, from research onnew sugarcane varieties with higher yield, to manufacturing engines that run on any mixture of gasoline and ethanol.

So,the greatest contributionofAgriculturalResearch Centersin the sugarcane sector is in environmental protection.Aware of the needto protect the environmentto perpetuatetheir businessor pressuredby environmental legislation,farmers andmill ownershaveexploitedthe innovationscoming from theResearch Centersandsignificantly improvedbusiness performance. As we have seen, the issues related to the use ofagricultural and industrialwastesfor irrigation, fertilizationandother uses, the energy productionfor own consumption andfor local distribution, the useof ethanol as afeedstockin the petrochemical industryand the development ofvarietieswiththe higheryield in theworld, arelandmarksin the work ofBrazilian R &Dinstitutions. The protection ofspringsand reducing thewater usedin industrial production, as well as the gradual elimination of burningthe straw, whose deadlineis already defined, are the nextitems on theagendaof R&D Institutions.

The recent Brazilian government efforts to help ethanol become ainternational "commodlty" sparked the debate about the benefits of biofuels versus fossil fuels. The various arguments for and against, make it clear that resolving the issue is nowhere to be found easily.

Rising prices of agricultural raw materials and food in recent years, has led to doubt whether one of the important causes for this, was the demand of agricultural products to biofuels plants. Therace betweenfood productionversusfuel productionmust take into accountthe raw material usedand theagricultural and industrial productivityof each. In this sense it is necessary to distinguish between the different systems biofuel production, considering theenvironment, energy yeldand possible tradeoffs with food production. Biofuels are quite different regarding the impacts and benefits. Bioethanol from sugarcane has little to do with bioethanol from wheat or corn, in terms of effects on energy and food security.In these terms, sugarcane ethanol is superior to other alternatives.

Very clearly and in favor of Brazilian politics, it manifests the United Nations Development Programme - UNDP in its Human Development Report 2007/2008:

”International trade could play a much larger role in expanding markets for alternative fuels. Brazil is more efficient than the EU or the United States in ethanol production. In addition, ethanol from sugarcane is more efficient in reducing carbon emissions. The problem is that imports of Brazilian ethanol are restricted by high import tariffs. Removing these tariffs would generate gains not just for Brazil but also for climate change”. (UNDP 2007)

The formation of a global market for bioethanol and expansion its benefits, depends largely on if this understanding of reality is correct and widely accepted by global village to becomemore effective actions.

It is still notable to reachaconsensus on whatwould bethe most sustainable optionandmore environmentally friendlywhen it comes tofuel, evenbiofuels. Many evaluationsand assessmentson the subjectare loaded withconveniences, interests orpolitical ideologies that overlapthe technical aspects, which, in turn, do not gobeyond thepartial resultsand justifythe purposes ofresearch.

Eventhere, however, there are problems, as the evaluation ofHoyer&Holden(2007), already mentioned in this document, "each route has its defenders, but in reality, there are hugegray areasbetween them”

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