Brazilian Biofuel – Has Ethanol Research advanced in Brazil ?

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Abstract

This article intends to shows how Brazilian ethanol research has evolved since the early of 2008, considering patents documents at the Industrial Property Institute of Brazil – INPI, in contrast to world research in this area. Indeed, many technologies have been developed in various countries to produce ethanol at lower cost in order to create a competitive market to real compete with fuel fossil. Ethanol competitiveness must be accomplished with social-environmental responsibility: without generating so much dangers residues, which damages the environment, as well as, without damaging the safe food production.

1. Introduction

Nowadays, there is a current global demand for replacement fossil fuels to renewable energy alternative to mitigate the effects of climate changes. The scientific community has been advertising about the constant rise in temperature during the last century, which became drastic after the second industrial revolution (1870-1914). After that, the crescent demands for energy has blew and the consumption of fuel fossil has trigged. Indeed, the level of carbon dioxide has been rising fast since 1960s and according to scientist and researchers this gas plays an important role in climate change and has contributes significantly to greenhouse effect. The situation attained a crucial point: the adoption of renewable energy matrix, per se, involves a large sum of investments in new technologies and a great effort of industrial sectors, government leaders and scientific communities, researchers and others group in providing tools to face this challenge. So it would imply on a decrease in factor productivity that would lead to a reduction on economical growth in medium to large period of time. Indeed, the whole industries scattered worldwide would be affected, but it would compromise specially the long-run equilibrium growth in developed countries. As developing countries would have a considerable delay in their industrialized process, it would mean to neglect people in developing countries to ascend the minimum-basic human life to medium-high level one. At certain aspect, it means to share of a climate change bill; in spite of the major participation of developed countries, on the changes climate effect, has been caused by their industrialization process.

The most international climate change agreement in the world is Kyoto protocol, in which 37 developed countries compromise to diminish the average of greenhouse gas emission (CHC) in order of five per cent against 1990 levels over five years period 2008-2012. The increased concentration of greenhouse gas, in the atmosphere, is due to anthropogenic activities, and the most relevant greenhouse gas is carbon dioxide that contributes to more than a half of global warming. Kyoto Protocol establishes reduction emission targets for developed countries (as a really active actor), while developing countries may participate in the process, without pre-stipulating a reduction target. The scientific communities have been frequently advising of the risks of the high-level temperature at the earth atmosphere and one of the most harmful greenhouse gases is the carbon dioxide (CO2), resulting as major time from the burn of fuels fossil. Biofuels are one of alternatives for renewable source of energy and Brazil has adopted t

the technology based on ethanol use, as a strategic replacement. Although developing countries governments have rejected biofuel technologies in name of the world food crisis, there is no space for criticism in the future since the biotechnologies have appeared in the agriculture industries. Biotechnological researches have been increasing rate productivity in cropped areas. By the early of 1980th, there was a global criticism towards the future of one of the basics human rights: the access a food-secure world for present and future generations. It was due to the profile of food crisis that had been sketched: the food productivity rate was lesser than the rate of human growth. In African countries, the situation was the worst one: people suffer from chronic hunger, undernourishment and even died. The future points out towards biotechnology agriculture industries, as a response for the urgency of the food world claims to eradicate hunger, despite the critics driven to Food and Agriculture Organization of the United Nations (FAO) by developing countries, in questioning the FAO closer alliance to agribusiness producers.

Small sustainable agriculture projects models can increase the productivity in small-scale farmers and enhance the local communities life, but do not solve the food world crisis problem. Indeed, the growing industrialization of agriculture is each more intense and irreversible. Developing countries must follow this trend and developed countries should aid them to enhance and even support, in some way, their technical growth and enable them to absorb this new technological tool. Biotechnological research lies on the frontier of knowledge and its manufactures protect their innovations by using the patent system that allows the recover of investments done in developing and researches (P&D), besides, at the same time, stimulates new researches as far as re-investments are done. So it looks like as feedback mechanism. Indeed, patent system rewards researcher's creative attempt by conceding a temporary monopoly: 20 years.

Brazil dominates completely the first generation ethanol, derived from of sugar cane, which has been accused to compete with agricultural lands. In spite of this accusation, Brazil arises as one of the principal international players, not only because the technological leadership in ethanol sector, but also due to its advances in biotechnological researches and development, especially in the agricultural sector. So these aspects benefit Brazilian position and reinforce its sustainable competitive advantage from the others biofuel competitors, as Brazilian biofuel can be exploited on a commerce scale, without endangering world food provision. Indeed, the international market is compelled to accept ethanol, as a standard biofuel, in favor to a global sustainable economic growth. Besides that, ethanol technology is yet compatible with gasoline, derived from fuel fossil, once it can be blended into gasoline or can be settled alone also. Higher levels of ethanol can be added into gasoline blend, it is just a matter of preparing the combustion engines. So it is interesting, as it can allow a transition period and also contributing to a reduction of greenhouse emission into the atmosphere. However, at the present time, ethanol production has yet met a great resistance in the international market.

Nowadays, many technologies are being developed in various countries to produce ethanol at a lower cost and without jeopardizing the food production, but meanwhile, only Brazil's ethanol is competitive in the market, as stated by FAO. Studies have been pointed out to the second-generation ethanol, also namely as cellulosic ethanol, which can make use of the carbon chain of any biomass. In fact, it can use any organic residue for providing sugar to turn it into ethanol, which turns the technique attractive, as its production is independent from food resources. So it does not compete with agricultural lands, on the contrary it uses marginal lands and even waste byproduct of society. In fact, any kind of plant is structured considering four building groups: lignin, cellulose, starch and sugar. These groups have the same compounds, but arranged in different ways. The lignin and cellulose groups belong to a long organic chain category that human being does not digest; while the starch and sugar belong to

a short chain one that can be digested by human being. So biofuel productions, derived from long chains, must be incentive.
The state of art has yet been in early stages, and it is far from the production on commercial scale, although many companies have been opening pilot test plants together with their traditional frame. However, as long as the researches and development into second-generation ethanol have evolved, the first generation ethanol will be put aside.

2 – Brazil ethanol Fuel

The national ethanol program to produce ethanol fuel from sugar cane started in 1975, which initial goals were to reduce oil importation dependence and also to provide an additional market for Brazilian sugar producers. A government articulation stimulated ethanol production[1], creating suitable legislation and financial incentives. At the same time, it created mechanism to incentive technological developments that were responsible for improvements in sugarcane productivity, better ethanol yields and lower production costs. Furthermore, at the beginning of the process, Brazilian government settled subsided and regulated ethanol price until 1990s. Besides that, at the beginning of ethanol fuel program, a strong base industry had already been formed that was the sugar industry. The federal government had supported this program over the past 28 years.
Brazil has formed a light energy basis for fuel car combustion and a strong internal market.
At the presented time, Brazilian government has been trying to put ethanol in an international market, as a standard biofuel. The global strategy is to seek partners to produce their own biofuels, for that reason five countries in Africa, Central America and the Caribbean are selected. As a part of global strategy, Brazil and US, the world's top two producers of ethanol, will do a partnership to develop research into cellulose-derived biofuels, in order to use inedible plant instead of crops areas, as their feedstock. In this context, the second-generation ethanol production will be easy widespread. The US will also participate for helping others countries in developing the biofuel industries.
Nowadays, Brazil has the global ethanol leadership for the first generation and seems to arise again ahead of the second generation for the sugar genetic improvements, but far from enzymes production. It is a worried situation: for how long time should Brazil has yet been the leader, without developing hard the enzyme studies?
Brazilian second-generation ethanol is based on the use of sugar cane bagasse and straw that provides a great competitive advantage, as it employs theirs owners' sugarcane byproducts. So it implies on the most inexpensive raw material in the world. In contrast, American second-generation ethanol relies on corncob and wood chips, and the yield is lesser than the Brazilian systems. The most famous and traditional Brazilian institute of technological research centers in the sugar is the Centro de Tecnologia Canavieira (CTC), founded in 1969. It has a sugar cane genetic improvement program. Their studies have been concentrated into engineering new varieties of sugarcane[2] to be used in specific types of soil and climate. It is objective is to augment the opportunities of new production areas. It is a corporative belief that the success of the global biofuel market concerns on the development on the enzyme industries. For that reason, the CTC has recently signed an international agreement with Novozyme Company that leads the global enzyme production industrial sector. The key of the

[1] Many measurements were created: low loans for the construction of distilleries, guaranteed purchase of ethanol by the state-owned oil company, sales tax incentives to stimulate the purchase of neat ethanol vehicles and favorable pricing of neat ethanol in comparison to the alternative gasoline-ethanol blend.
[2] The innovations in breeds are protected by an especial system, named by *Suis Generis* systems, which is different from the patent system.

cellulosic ethanol cost reduction concerns on the development of the enzymes to accelerate the reactions and maximizing the yields. (http://www.altenergy.com.br/Ed_01/ped.html).

3. Ethanol

By several decades, the fuel ethanol production was based on the residues of cane and beet sugar processing, but generating harmful residues along the fermentation process to produce ethyl alcohol. Similarly and widely used is the bioconversion of starch (derived from corn or maize) to sugar for producing ethanol. Both techniques were well successful, but they have yet had environmental damages. Furthermore, both techniques use agriculture ground to produce ethanol. Accordingly to environmentalist, these techniques compete with the world food supply, which creates a great resistance to ethanol production in an international market.
Nowadays, modern biotechnology techniques have already showed their potential to couple environmental care and economic growth, since the production of ehanol tends to be friendlier to environment. As sustainability development is the great challenge for the humanity survival, biotechnology arises as a strategic tool to face this problem. Another alternative is the bioconvertion of lignocellulosic biomass to sugar in order to obtain sugar for fermentation into ethanol. But it has yet seemed to be uncompetitive in market, although the exhaustive attempts. Studies (Gavrilescu and Chisti, 2005) have indicated that genetic modified corn diminishes the cost of feedstock and the starch in gene engineered corn is friendlier to enzymatic bioconvertion to sugars than the natural and traditional corn starch. Besides that, microbial enzymes have been constructed to improve stability and ability in starch conversion into fermentable sugar, as well as, microorganisms have been constructed to resist higher stages of toxic ethanol in order to attain fast fermentation. These researches intend to turn ethanol more competitive in price than, nowadays, comparing to fossil fuels. Even though, ethanol has yet been lesser harmful to environment, the global economic growth pressure has yet put fuel fossil ahead of the process.
In fact, measurements have been adopted to reduce the consumption of fuel fossil and, consequently, diminished environmental pollution as such to blend gasoline with ethanol, as well as, the production of liquid hydrocarbon fuels from plant, animal and microbial oils. The biodiesel has yet been more attractive than petrodiesel production, as it is lesser polluting than the others.

4. Ethanol Patent Documents

In order to evaluate the development of technologies of ethanol production, patent documents are used as a source of information. With this purpose, this work presents a survey of patent documents filed among different countries in the first six months of 2008. The search was made using the EPODOC database, accessed through the website http://pt.espacenet.com. The words “ethanol” and “alcohol” were used as keywords and the International Patent Classification used were C07C, C12N or C12P. The search resulted in 182 family patents that were read in order to eliminate the documents that weren’t relevant to the present study. This operational strategy resulting in 94 documents that were again read for extracting the key data. After that, it is possible to observe that the study related to sugar cane is saturated, documents regarding the extraction of sugar cane broth or even about its trials of fermentation are not included among the documents published in 2008. The technologies researched and protected by the patent system are related with the production of second-generation ethanol, obtained by the use of biomass as cellulose, lignocellulose, organic waste and alternative types of sugars like the potato, as suggested by table 1.

Table 1 – Summary of the technologies found in patent documents at the early of 2008

%	**Raw Material**
39	Biomass (cellulosic or lignicellulosic)
16	Potato
14	Sweet Sorgus
10	Corn grain
21	others

Technologies also involve the development of enzymes for hydrolysis of cellulosic material and the development of microorganisms for sugar fermentation in general. Brazil presents a total of four patent documents published in the year of 2008. One of the documents mentions the use of sweet potato, microalgaes, lignocellulose or the acidic residue of the distillation (vinhoto) as raw materials for the production of ethanol fuel. Still, in the research carried out, it is possible to observe, accordingly to figure 1, that among the documents published in the first semester of 2008, there is predominance documents with American origin, that accounts for approximately 41% of the total, followed by the Chinese with 22% and Japanese with 11%, the Brazil presents approximately 4% of the total of documents published. Table 2 shows the patent applications by applicants' country and indicates that Novozymes North America Inc. is the principal company in this sector that develops enzymes to benefit biomass, followed by the others players.

Companies	**Applications' Number**
Novozymes North America Inc. (US)	5
Mengile Wang (CN)	3
Capital Normal University (CN)	2
Fcstone Carbon LLC (US)	2
Harbin Haige Science Tech. (CN)	2
Nat. Inst. Of Advanced Ind & Technology (JP)	2
Stake Eng CO LTD (JP)	2
Tasei Corp. (JP)	2
TMO Renewables (GB)	2
University of Michigan (US)	2
University of Florida Res. Foundation (US)	2

Table 2 – Patent application by applicants' country

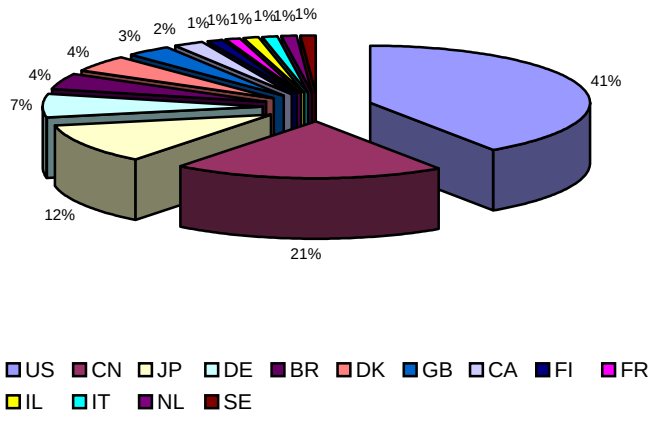

Figure 1 - Principal Applicants Country

After the evaluation of the present preliminary study, it is possible to observe that Brazil is not developing technology in this area, with the exception of isolated cases, that refer to the development of new technologies for production of second-generation ethanol.

5. Conclusion

Although Brazilian ethanol production is the most competitive biofuel in market, document patents shows that Brazilian research has not evolved as it was noticed in others countries, or at least has not been protecting this new knowledge. In the biotechnological sector, it is common established that works developed in partnership optimize studies and facilitate the fusing multiple technologies, as it involves so multiple research disciplines. These aspects allow faster advance in R&D, but it is essential to protect the knowledge to avoid tradeability difficulties. Furthermore, stand-alone, without settling partnership, in knowledge frontier, ought to imply in a strong intellectual property protection, as a tool of assurance. Otherwise, in Brazil, if the new knowledge developed is not protected, other international groups may use it, totally free. And besides that any kind of enhancement derived from it, certainly protected, will imply in royalties payments. Brazil has an enormous potential and has preserved the leadership in ethanol market, until now, but must go along into ethanol research and protected the knowledge created to preserve it strategic position, otherwise it tends to loose this place in the future. Furthermore, as second generation ethanol is settled; it will gain a right international acceptance, once it does not compete with agriculture areas.

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